Papers Presented at the

NEW ZEALAND AGRICULTURAL ECONOMICS SOCIETY (INC.)

THIRD ANNUAL CONFERENCE *"NEW ZEALAND AGRICULTURE IN THE 21ST CENTURY"*

Incorporating the 21st Annual Conference of the NZ Branch of the Australian Agricultural and Resource Economics Society (Inc.)

Blenheim Country Lodge

July 1996

Discussion Paper No. 144

Published on behalf of the
New Zealand Agricultural Economics Society (Inc.)
PO Box 19-560
CHRISTCHURCH
Telephone & Fax: (64) (3) 384 2432

by

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Lincoln University
CANTERBURY
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ISSN 1170-7607
ISBN 0-909042-09-8

Copies of this publication can be obtained from:

The Secretary
Agribusiness and Economics Research Unit
PO Box 84
Lincoln University
Canterbury 8150
New Zealand

A remittance of $30 (plus postage and handling for overseas orders) should be forwarded with the order.

Postage and Handling:

Australia	$NZ 6.00 per copy
Other International airmail	$NZ 14.00 per copy

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WELCOME AND CONFERENCE OPENING

Ladies and Gentlemen, friends and colleagues, members of the society and invited speakers, I am very priveledged indeed in welcoming all of you to the 21st Annual Conference of the NZ branch of AAES and the 3rd Conference of the New Zealand Agricultural Economics Society Inc.

We hope that you find the forward looking theme chosen for this year's conference to your liking. We have attempted to provide a vision for the New Zealand agricultural sector in the 21st century. This theme could have been chosen in any one of the four remaining years in the 20th century leading us to the next millennium, but we have embarked on it this year!

This broad theme has been addressed by focusing on four sub-themes and we are pleased that we have four excellent invited speakers best able to deal with them. Foremost is the advent of the first MMP based government to be elected in October this year and the consequences which will be taken up this morning by the first invited speaker. Major and minor land use changes already taking place and likely to continue within and out of the sector will be addressed by the next invited speaker this morning.

In tomorrow's Plenary Session, the implementation phase of the last GATT/WTO agreement with its current and future trade implications will be taken up by the first invited speaker followed by the potential ramifications for property rights and land use of those Waitangi Treaty land claims highlighted in the media and others discussed by second invited speaker.

We are very pleased, as the organisers of this year's conference, with the level of attendance and also participation in the Contributed Papers Programme, which has a full complement of papers that could be accommodated in a day and half conference, for the second year in a row. This leads me to wonder whether we have outgrown this facility in Blenheim that we have used to hold this conference for the last several years to our general satisfaction.

With those comments, I invite you to make the best out of this year's conference which I am pleased to declare open now.

Dr Ram SriRamaratnam
1996 President
New Zealand Agricultural Economics Society

New Zealand Agricultural Economics Society (Inc.)

PO Box 19-560, Christchurch 8030, Canterbury
New Zealand

1996 President's Report to the AGM

The NZAES committee was kept busy throughout the year with various activities culminating in the organisation of the 1996 Annual conference. I am quite pleased with the level of attendance once again and also the level of participation in the Contributed Papers programme. The postponement of this conference by a week has evidently enabled our academic membership to attend without potential clash with their Varsity calendar.

1996 Conference Theme:

With the choice of a forward looking theme for this year's conference, we have embarked on providing a vision for the New Zealand agricultural sector in the 21st Century. We decided to address this theme by focusing on four sub-themes: the advent of the first MMP based government to be elected in October this year and the consequences; major and minor land use changes already taking place and likely to continue within and out of the sector; the implementation phase of the last GATT/WTO agreement underway with its current and future trade implications; and the potential ramifications for property rights and land use of those Waitangi Treaty land claims highlighted in the media and others.

Student Awards:

The undergraduate award for the 1995/96 year sponsored by AARES was presented to **Sven Koops** of the Dept. of Economics & Marketing at the 1996 February conference in Melbourne. Following the decision at the 1995 AGM to also consider candidates from the Farm Management departments for the NZAES Postgraduate awards, the selection criteria was drafted in consultation with the respective departments in late 1995. The three winners for 1996 are **Airton Spies** of the Dept. of Farm & Horticultural Management at Lincoln university, **Joa da Silva** of the Dept. of Agriculture & Horticulture Systems Management at Massey university and **Scott Brian Lee** of the Economics Dept. At Waikato university. I take this opportunity to extend the society's congratulations to all these worthy recipients.

AARES Matters:

I represented the NZAES at the Council meetings held before and after the above conference in Melbourne in February 1996. As many of you are already aware from NZAES newsletters and other sources, the AAES was renamed AARES based on a ballot of members to include Resource Economics in the name. This AGM will have to consider the appropriateness of a consequent name change for NZAES to NZARES. Other major change underway within the AARES is the amalgamation of the two journals AJAE and RMAE from 1997 onwards under the name of Australian Journal of Agricultural and Resource Economics (AJARE) and also produced by Blackwell, a major publishing house based in the UK. A proposal to move the AARES conference from the current summer (February) timing to winter (June/July) was objected to by NZAES for obvious reasons and was defeated in the ballot. The 1997 AARES conference is to be held two weeks earlier

during 22-24 January, in Gold Coast, Queensland, to coincide with school holidays. The next AARES conference to be held in New Zealand could be in the year 1999 or 2001.

Secretariat Matters:

At the beginning of this financial year, the NZAES secretariat moved from the AERU to the Strategic Research Services (SRS) at the direction of the 1995 AGM and a 3 year contract was signed for basic services, at the previous rate, with annual extensions to be decided at the AGM. The running of the NZAES secretariat by SRS has generally been smooth, even though a mechanism for more frequent communication would be beneficial. Last year's conference proceedings cost the society much more than in previous years and the committee was compelled to limit the number of pages per paper to 25 this year, to keep the cost from escalating further.

Consultation:

NZAES was asked to comment on the draft FORST papers that looked at funding priorities for Public Good Science Funded (PGSF) research outputs. The assistance of Jim Sinner in carrying out this function is acknowledged. NZAES continued its representation on the NZQA Advisory Group, and a report from Dr Chris Gan is provided for information.

In April 1996, the Committee became aware of plans by the New Zealand Institute of Agricultural Science (NZIAS) to introduce an accreditation programme (CPAg) for all agricultural professionals in New Zealand, including those members of our profession. We objected to the process adopted by the NZIAS without due consultation with NZAES as it is likely to impact, especially on those members of our profession in the consulting business. See further details in another attachment to the AGM package.

Committee Business:

The NZAES committee conducted the affairs of the society through two teleconference meetings and one regular meeting in Wellington. Three newsletters were sent to the members during the year in December 1995, April and June 1996.

We are very pleased with the continued participation of the Farm Management professionals in this conference in full strength, and the addition of two papers in the general subject area of Agricultural Sociology.

This AGM will also consider amendments to the constitution enabling Life Membership to be awarded to worthy contributors to our profession and the society. Pending its acceptance by the membership, we feel that we have a very worthy recipient in Dr Robin Johnson.

Finally, I would like to extend my sincere thanks to all the outgoing Committee members for their contributions and particularly to the other members of the executive based in Wellington, Rod Forbes (Treasurer) and Prakash Narayan (Secretary). I wish the incoming Committee the very best for the next period of management.

Dr Ram SriRamaratnam

SECTION A

INVITED PAPERS

The Implications of MMP for New Zealand

Dr Paul Harris

Chief Executive
Electoral Commission

Speech prepared for delivery to the conference of the New Zealand Agricultural Economics Society, Blenheim, 5 July 1996

Dr SriRamaratnam, ladies and gentlemen:

Thank you for the invitation to speak to you today.

I do so as a member of an independent Electoral Commission which has statutory responsibility for a number of important functions in relation to the electoral system. This year marks a significant milestone in the history of our country, because this year we will hold the first general election under the Mixed Member Proportional voting system.

In my view, the adoption of MMP will prove to be the most significant change in our system of government for over a century. That decision was made by a margin of 54% to 46% of those who voted. That doesn't seem like a very significant margin for such an important decision. But it is significant in the context of the popular support for governments elected in recent years.

New Zealand has held 20 general elections since the beginning of our modern party system in 1935. A party been elected to government with the support of more than 50% of those who voted on only 4 occasions in that time - in 1938, 1946, 1949 and 1951. The governments elected in 1981 and 1993 had the support of 39% and 35% of those who voted respectively. Even the reforming government elected in 1984 had the support on election day of only 43% of those who voted.

One question asked about the decision to adopt MMP in 1993 is, why did 54% of those who voted support MMP?

The answers to this question are undoubtedly complex. There is, however, considerable evidence that many New Zealanders hold politicians, political parties and Parliament in low esteem. In spite of our democratic traditions, many New Zealanders feel alienated from politics; they feel their views are not listened to and that they are powerless in the face of government action.

There is also some evidence that New Zealanders had become more uncomfortable with the adversarial style of politics that had become increasingly noticeable from the 1970s onwards. Such a style is often said to be a consequence of an FPP voting system. In New Zealand, however, it seems to have become reinforced by approaches to politics that emphasised conflict and confrontation at the expense of consultation and compromise. It is clear that many of those who voted for MMP did so in order to try to introduce a more cooperative and less confrontational style into New Zealand politics. It remains to be seen whether their hopes will be realised.

In fact, of course, democratic politics are always about conflict, debate and argument. But we ought not overlook the fact that a good deal many political decisions are not a matter of partisan conflict, and much legislation is passed by the House without division.

It may be in the nature of the case that conflicts get the media headlines, but that ought not blind us to the fact that many political issues have always been resolved through discussion and compromise.

One of the Electoral Commission's statutory functions is 'to promote public awareness of electoral matters by means of the conduct of education and information programmes or by other means.' Before I discuss some of the implications of the change to MMP, I want to remind you of the basic features of the MMP system.

I stress that MMP is **not** complicated for the voter. It is like a lot of things these days – driving a car, using a computer, even simple everyday things like turning a light on or boiling a jug. People do **not** have to know everything about how these things work in order to make them work for them.

The same is true for MMP. We have identified 4 key facts we want to convey to each voter:

1. they have **two votes**, a party vote for the party they most want to be represented in Parliament, and an electorate vote for their local electorate MP [see the sample ballot paper];

2. each party's share of **all 120 seats** in Parliament will depend on its share of **all the party votes**;

3. in order to have seats in Parliament, a party must cross the threshold by winning **either** at least 5% of all the party votes cast at the election, **or** at least one electorate seat;

4. a party on the party vote that crosses the threshold will receive enough list seats to add to the electorate seats it has won to bring it up to its rightful total number of seats based on its share of all the party votes.

Before I discuss some of the implications of the change to MMP, I want to make one obvious but important preliminary point: New Zealand is yet to have an election under MMP. It is necessary to make that point because there is a tendency to assume that some of the kinds of events that have occurred since 1993 – e.g. MPs changing parties and the formation of new parliamentary and non-parliamentary parties – will continue at the same rate after this year's election.

While it is possible for some party hopping to occur, and for some new parties to emerge after the election, I do not expect these to occur at anything like the rate we have seen in the last 2 years or so. Depending on how New Zealanders vote on 12 October, I believe the MMP election will clear the air and remove some of the uncertainties we currently face. In other words, we cannot assume that 'politics as normal' under MMP will have the same characteristics as 'politics as normal' under FPP or as politics during this transitional phase. If current opinion poll results are repeated at the next general election, there would be fewer parties in Parliament after this year's election than are represented in Parliament now.

I turn now to some of the implications of MMP, under 3 broad headings. Although I am not qualified to consider directly the implications of MMP for the agricultural sector, I hope that what I say will suggest some of those implications to you, and that we will have an opportunity to discuss them later during questions.

1. Implications for political parties

Political parties are pivotal to the operation of MMP. It may seem paradoxical that New Zealanders have a low opinion of political parties yet voted in 1993 for an electoral system that is based on political parties. Yet the apparent paradox is readily explained by the low opinion of parties being a response to the existing parties' behaviour rather than to parties as such. One of the challenges to political parties is to improve their public standing through their behaviour under the MMP system.

Parties' campaign methods are likely to change. General elections under FPP were won and lost in marginal electorates, about a third of all electorates. Under MMP, however, to paraphrase a comment made by the Prime Minister: in terms of the party vote, New Zealand is one big marginal electorate. Because each party's share of all the seats in Parliament is decided by its share of all the party votes, every party vote is important to the parties, no matter where it is cast. Each party will therefore want to win as many party votes as possible – including those cast in areas of the country which have usually been 'safe' for it or for another party.

That may place some burdens on parties' resources, since it is in their interests to have effective organisational structures throughout the country. Parties for which that proves difficult, however, are likely to put more emphasis on campaigning from the centre, using the mass media and centrally-controlled activities such as direct mail.

In that context, it is worth noting that political parties in New Zealand no longer have large memberships. Research done by the Electoral Commission in October 1994 showed that 6.5% of respondents were currently members of a political party (although 19% said that they had been a member of a party at some point). It is notable, however, that current party members tend to be older. Of all the current members, 39% were over 70 years of age, 20% were aged 60-69, 16% were aged 50-59, 8% were aged 40-49, 14% were aged 30-39, and 2% were aged 20-29.

Further, registered parties must now comply with three new requirements that have been added to New Zealand's electoral law:

1. they must ensure that their candidate selection methods are democratic;

2. beginning in 1997, they must each year disclose the names and addresses of those who, in the previous calendar year, made one or more donations totalling $1,000 at electorate level or one or more donations totalling $10,000 at national level. This information will be public.

3.Parties will also have to devise ways of developing policies that take account of the possibilities that they may have to negotiate with other parties after the election. They may find they need better access to information and expertise to enable them to do so.

I am often asked what list MPs will do. That question is often linked with another: how will the larger electorates under MMP affect the representation of rural and provincial areas?

At this stage, the answer to both questions is 'we'll have to wait and see.' Although list MPs will have the same parliamentary duties as electorate MPs, their role in the community will be up to their parties. On the evidence to date, however, it is likely that most list MPs will also have been candidates in electorates and that their parties will expect them to continue to represent their parties in the electorate or region in which they stood, not least in order to help win party votes at the next election. If so, their role in the community is unlikely to be much different from that of an electorate MP. In some areas, therefore, voters may be able to approach MPs from several parties concerning matters on which they want an MP's assistance. The resources available to electorate MPs in their electorates will be increased.

In short, the established and new political parties all face considerable challenges as they adapt to MMP. Party leaders are likely to have a difficult path to tread in this transitional period before the first MMP election, and in the immediate aftermath as a government is formed. Like everyone else, they will be learning as they go. Given time and experience, we can expect conventions and expectations to develop that will remove some of the uncertainties they currently face.

2. Implications for legislative and governmental processes

It is, of course, unclear what the outcome of the first election under MMP will be.

The crucial consideration in forming a government is that it must have the 'confidence' of the House. That means a government can only stay in office if it has the support of a majority of MPs who vote on certain important votes in Parliament. Some votes are always matters of confidence in the government (such as the annual Budget). The government can also declare other votes to be matters of confidence if it regards the issue as important enough to put its survival at risk. Finally, there are some debates in Parliament when the opposition can move a motion of no confidence in the government. A government that loses a vote of confidence must resign.

It would indeed be ironic if, after all the difficulties of the transition period, the result of the first election was that one party had a majority of seats in Parliament and New Zealand had a single-party majority government.

Although that result might be unlikely, it is not impossible. It will depend in part on the proportion of all the party votes that are cast for parties that do not cross the threshold, because in fact shares of seats are based on shares of the party votes cast for parties that do cross the threshold.

It is, however, more likely that no one party will have a majority of seats in Parliament. There are then two options for producing a government that has the confidence of the House.

The first is a majority coalition government, where a government is formed by two or more parties that together have a majority of seats in Parliament. The formation of such a government is likely to come after post-election negotiations between the parties, and it is likely they would then publish the policies and other matters on which they had agreed.

The second option is to have a minority government. That occurs when a government is formed from one or more parties that do not have a majority of seats, and the government relies on the support of other parties on votes of confidence and to pass its legislation.

In both cases, there would clearly be some changes to the ways government and Parliament would work compared to the simplicities of those processes under FPP.

The extent of those changes will depend on the type of government in place. In the case of a majority coalition government, the policy-making, decision-making and legislative processes would have to adapt to the fact that more than one party was in government. Coalition partners might compete against each other at the next election. There will be more pressure points for lobbyists and interest groups to aim at. The media will have to meet new challenges in reporting on political events and processes.

Some of those issues would be particularly acute in the case of minority government. If the government is to win votes of confidence and be able to pass its legislation through Parliament, a majority would have to be created on each issue. That may mean different allies on different issues. The processes of consultation, negotiation and decision-making could become quite complex and time-consuming.

But we should not conclude that majority coalition or minority governments must lead to policy stagnation. That does not happen in other countries, and it need not happen in New Zealand. A recently-published book on the change to MMP concludes:

> It is likely that incremental rather than radical change will characterise the future policy agenda....Nevertheless, the modern world, and New Zealand itself, is sufficiently turbulent for new socio-economic crises to eventuate and new policy ideas to develop. A multi-party Parliament, plus active and involved interest groups and new social movements, might well be able to place new policies on the official policy agenda.[1]

In addition, we should not overstate the difficulties of managing either a majority coalition government or a minority government. Since the 1993 election, New Zealand has had all the types of government it is constitutionally possible for us to have, some more than once. I do not believe that changes of the form of government will be as frequent after the first general election under MMP.

Contrary to the expectations of some New Zealanders, it is likely that parliamentary parties will be as disciplined under MMP as they were under FPP. There are two related reasons for this view. First, majorities are likely to be smaller, and that has always meant less leeway for independent spirits in Parliament. Second, a party leader who negotiates with another party leader will want to know that he or she can deliver the voting support of all that party's MPs in the House.

That is not to say that there will never be occasions when MPs cross the floor. For example, there may be some issues which are not part of a coalition agreement on which the coalition partners agree to differ and to vote accordingly. But party discipline can be expected to be extremely tight on matters that were agreed during post-election negotiations on government formation, or during a minority government's negotiations for support on a particular piece of legislation. For it to be otherwise would risk the survival of the government itself, and that is often a big electoral risk, particularly for a smaller party.

An issue that was frequently debated before the 1993 referendum concerns the stability and hence the effectiveness of governments under MMP. A common argument against the change to MMP was that governments elected by proportional representation would be prone to change more frequently than governments elected by FPP, and that therefore there was likely to be less effective government under MMP than under FPP.

It is always difficult to examine an activity as complex as government and isolate one factor (such as the voting system) as the cause of something else, such as policy changes in general or in a particular area. Many factors in addition to the voting system affect the stability of governments, for example thresholds and provisions for early dissolution. There are examples of stable majority coalition governments elected by PR, and of stable minority governments elected by PR, as well as of unstable governments of each type. It is also clear that stability and effectiveness of governments do not necessarily go together: one could have very stable but not very effective government, or rather unstable but quite effective government.

In the Royal Commission's view, the introduction of a significant threshold of representation to reduce the number of parties in a Parliament elected by proportional representation would reduce the prospects of short-term governments. Moreover, it considered that the need for more negotiation between parties under proportional representation would be more likely to result in policies that are 'acceptable both to the majority of electors and to subsequent governments' (Report, para. 2.158).

A related issue concerns whether the type of electoral system a country has is related to its economic performance. I know of two recent studies which examine this matter, published in 1992 and 1994. Both used OECD figures to compare economic indicators in countries with FPP and countries with PR. The first concluded that 'Differences in economic performance ... cannot be explained by differences in electoral systems' and that differences in economic policies and in the use of economic resources by the private and public sectors are much more important.[2]

The second[3] reached similar conclusions, that there is 'a somewhat superior performance by proportional systems in respect of economic growth and unemployment, but a marginally superior performance by the non-proportional systems in respect of inflation. The findings in respect of government expenditure support the notion that the consensualism of proportional systems leads to somewhat higher government expenditure.... [But] none of the reported relationships even begin to approach the level of statistical significance.'[4]

A related issue concerns the extent to which current economic policy settings are likely to survive the election. There seem to be two broad opinions among those willing to pronounce on the issue. First, some say that any government after the election will need the support on confidence issues of parties that are committed to the direction of current economic policy, perhaps with a bit of tinkering here and there.

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[1] Jonathan Boston, Stephen Levine, Elizabeth McLeay and Nigel S. Roberts, *New Zealand Under MMP. A New Politics?* (Auckland University Press, 1996), pp.169-70.

[2] Richard Rose, *What are the Economic Consequences of PR?* (London: UKERS, 1992), p. 17.

[3] Francis G. Castles, 'The Policy Consequences of Proportional Representation: A Sceptical Commentary', *Political Science*, vol. 46, no. 2, December 1994, p. 167. The variables Castles considered were economic growth, unemployment, inflation, and government expenditure.

[4] Castles, p. 168.

Secondly, on the other hand, there are those who expect a government to be formed that relies on the support of parties opposed to current economic policy.

Current uncertainties about which of these possibilities is the more likely are said to have affected foreign investment and led to a weaker sharemarket and inflationary pressures. Such concerns also occurred from time to time under FPP, depending on the degree of uncertainty about the election outcome. I am not qualified to offer a view on monetary and fiscal policy in the MMP environment, and you will appreciate that it is not appropriate for me to discuss parties' policies. But my hunch is that the levels of concern about these issues we are seeing at present is more a symptom of the *transition* process before the first MMP election than of MMP itself, and that later elections under MMP will not be subject to the same degree of uncertainty.

Last year, the State Services Commission published an excellent book[5] outlining the issues for the public service arising out of the change. The study concludes that, on the whole, the public service is reasonably well-placed to adapt to the new political environment. However, the book identifies some issues likely to arise for the public service under MMP:

- the need to ensure coordination between different parties in a coalition government;
- the possibility that more use will be made of non-public service advisers to government;
- the likely 'challenge for the public service to maintain a focus on long-term strategies if particular governments need to focus on short-term political management';
- the likelihood that select committees will become more important in the legislative process and in holding governments and government agencies to account;
- the budgetary process, including the ability to maintain supply during periods of political uncertainty;
- the role of the public service during the period of negotiations to form a government.

Other preparations for MMP are well advanced. For example, Parliament has adopted new Standing Orders more suited to a House elected by proportional representation. The government's circumstances since 1993 have meant that much valuable experience relevant to MMP is being gained on all sides, even though from time to time the participants may not welcome the need to do so. In my view, we have every reason to expect that these challenges can and will be met.

[5] State Services Commission, *Working under Proportional Representation. A Reference for the Public Service* (Wellington, 1995).

4. Implications for the New Zealand public

The final implication really represents a challenge to the public of New Zealand. MMP offers new opportunities to voters as well as to political parties. In my view, it is now the responsibility of each and every one of us to help make MMP work effectively. That means taking our responsibilities seriously as democratic citizens by getting on the electoral roll and encouraging others to do so, and by exercising our democratic rights on election day to promote what we think is the desirable future for our country. MMP provides voters with new opportunities to have an influence on the composition of Parliament and hence on the kinds of policies that will be pursued. But it is up to New Zealanders to take those opportunities.

In concluding, Dr SriRamaratnam, ladies and gentlemen, I again thank you for the opportunity to speak to you today. I would be pleased to try to answer any questions about what I have said, or about any other aspect of MMP, or about the role of the Electoral Commission.

AGRICULTURAL LAND USE CHANGE

WITH REFERENCE TO SHEEP AND BEEF FARM LAND

SALIENT POINTS

PAPER NO. G2107

5 JULY 1996

Presentation to
NZ Agricultural Economics Society (Inc.)
Conference
Blenheim

R. M. Davison
NZ Meat and Wool Boards'
Economic Service
Box 5179
WELLINGTON

NZ Subscription: $25 (GST incl.)

1. INTRODUCTION

Land use change has been a feature of New Zealand since human settlement. The land area of New Zealand is 27.1 million hectares of which 52 per cent (14.1 million hectares) was occupied as farm land at the turn of the century. At that time there were 62,800 farm holdings and New Zealand's population totalled 815,000.

Today, New Zealand's population is 3.6 million and the rural land area in occupation has increased to 17.3 million hectares which is 65 per cent of the total area, includes exotic forest plantations and supports 81,200 farm holdings. In addition there is 0.9 million hectares (3%) of urban land and road networks with the residual 8.8 million hectares (32%) land area in conservation parks, reserves, lakes and river beds[1].

Related to land use is the population and how population growth has and will influence change. In the last 50 years the population doubled to 3.6 million and urbanisation[2] has increased from 74 per cent to 85 per cent of the population. With a medium growth rate, the population is expected to increase a further 800,000 (+22%) over the next 25 years to 4.4 million, and urbanisation to increase to 90 per cent or more.

Looking ahead it is easy to see that the political interests of the population will be strongly urban. In turn, this urban influence will at times be expected assert different values on the rural countryside to those who depend on land based industries for their livelihood. Those who depend on the countryside for their livelihood include those on-farm, the input supply industry, and the downstream handling and processing businesses in the sector.

The MAF input-output analysis of the 1991 census showed that employment on sheep, beef and dairy farms totalled 5 per cent of the total work force. A further 19 per cent of the work force were involved in the input supply, wholesale distribution, transport, processing and associated service sectors. This latter component of the land base dependent work force largely reside in "urban" areas.

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1 Source: Statistics New Zealand and MAF Situation and Outlook for New Zealand, June 1996.

2 Population centres with 1,000 or more people. In 1991 68 per cent of the population lived in centres of 30,000 or more people.

Land use changes in the deregulated economy of today reflect individual assessments of competing land use enterprises. These enterprises range from the shifting balance between sheep, beef cattle and deer within a farm, to the conversion of sheep and beef land to dairy, horticulture, forestry, lifestyle subdivisions or urban development.

The conversion of whole farms to plantation forestry on more extensive country or the subdivision of farms to lifestyle blocks near urban centres differs in that this demand for land is essentially urban investment back into the countryside.

This urban demand for farmland is one of the factors that provides an influence underpinning farmland price expectations above what the existing land use productive value often indicates.

2. LAND USE, LIVESTOCK TRENDS, AND PRODUCTIVITY

2.1 Land Use Change

Land use change since 1960 is shown in Table 1. However, there is a problem with viewing longer term land use data series as definitions change through time. In particular censuses prior to 1987 included large areas of land under the administration of the NZ Forest Service which was largely used for recreational and conservation purposes.

Table 1 **Land Use 1960 to 1994**
million hectares

	1960	1984	1994	% Change 1960 to 1984	% Change 1984 to 1994
Sheep and Beef		11.83	9.90		-16%
Dairy		1.27	1.72		+35%
Deer		0.05	0.20		+300%
Other grassland use		1.24	1.72		39%
Total Grassland#	15.34	14.39	13.54	-6%	-6%
Farm Forestry		0.14	0.14		-0%
Plantation		0.90	1.35		+50%
Total Forestry	0.38	1.04	1.49	+174%	+43%
Other	1.85	5.79	1.58	n.a.	n.a.
Total Occupied	17.57	21.22	16.61	n.a.	n.a.

Grassland area defined to include Lucerne, tussock and danthonia, fodder crop areas and other crop areas that would be part of pasture rotations.

Source: Statistics New Zealand

With the corporatisation of the Forest Service approximately 3.5 million hectares were removed from the Agricultural Census of occupied land. This qualification largely explains the 1984 inconsistencies for the "other" and "total occupied" items for 1984 at foot of Table 1.

The grassland and forest areas data in Table 1 are the most relevant to this paper and are comparable though 1960 detail is limited.

The most striking feature of Table 1 is the decline in grassland area attributed to sheep and beef cattle farming over the decade from 1984 to 1994. This decline amounted to 1.93 million hectares (-16%) and can be reconciled on the seemingly reasonable assumption that most of the land use change has been away from sheep and beef production. This analysis provides a broad picture of the land use change shown in Table 2.

Table 2 **Sheep and Beef Land Use Change Reconciliation 1984 to 1994**
million hectares

	Net Land Use Change	% Allocation
Other grassland use	+0.48	25%
Dairy	+0.45	23%
Plantation Forestry	+0.45	23%
Residual other	+0.40	21%
Deer	+0.15	8%
Farm Forestry	0.00	0%
Sheep and Beef	-1.93	100%

Source: Statistics New Zealand
N.Z. Meat and Wool Boards' Economic Service

One point to be aware of is that Tables 2 and 3 show net changes in land use. For example, some small dairy farms on the edge of urban areas leave the grassland classification through subdivision and are an offset against the area of new dairy farms that are established on land previously farmed for sheep and beef production.

The "other grassland" increase shown in Table 2 for the decade to June 1994 is mainly sheep and beef land converted to diverse land uses that are still have associated pasture areas. These land uses range from horticulture, vineyards, orchards, bee keeping and the subdivision of farms to lifestyle semi-urban development.

The increase of dairy shown in Table 2 is onto some of the highest producing sheep and beef country and had the largest impact on reducing sheep and beef livestock numbers. Even so, dairy production systems of management are generally more intensive than sheep and beef farming and a greater number of dairy stock units replaced the previous level of sheep and beef stock units. The higher effective stocking rates per hectare under dairy management are achieved with higher inputs of fertiliser and usually more intensive pasture management.

Plantation forestry expansion onto to sheep and beef farmland averaged 45,000 hectares per year over the decade to 1994. At the start of the decade this would have been sales of relatively low producing farmland to forest owners. However, in more recent years sales of whole farms to forestry has included clean better producing extensive farmland. The average rate of forestry expansion for the decade of 45,000 hectares coincides with the area increase in a study carried out by Valuation NZ and N.Z. Meat and Wool Boards' Economic Service on sheep and beef farmland sold to forestry in 1993-94.

Interestingly the "farm forestry" area for the decade in Table 1 shows no change for the decade and is contrary to what most would expect. This reported static situation may reflect some harvesting followed by replanting and possibly some farms with larger wood lots being sold or converted totally to plantation forestry changing their classification. The Economic Service's Sheep and Beef Farm Survey reports farm wood lots across the country averaged 2 hectares per farm in 1983-84, increasing to 5 hectares in 1993-94 and continuing to increase in 1994-95 and beyond. Indications are that farm wood lot expansion does not usually impact on stock numbers carried.

The "residual other" in Table 2 includes sheep and beef farmland changes to alternative uses such as forestry but not planted [yet]. This is believed to include land closed for conservation purposes and reversion of marginal land from any effective grazing.

The deer farming land use shown in Table 1 for 1994 is relatively small to the total grassland area in absolute terms (1.5%) but it's expansion from a small base is large (+300%) for the decade to 1994.

In summary there was an overall reduction in sheep and beef grassland area of 1.93 million hectares for the decade to June 1994. Of this, 1.08 million hectares (56%) were changed to other grassland uses including dairy farming, deer farming and diverse uses that include farmed grassland associated with vineyards, orchards and horticulture and semi-urban lifestyle blocks. The residual 850,000 hectares of grassland (44%) is land that has been converted to non pastoral uses such as forestry or land retirement.

2.2 Land Use and Livestock Trends

From the 1960s through to 1984, land use change was partly influenced by governmen assistance to encourage the expansion of farm production and forestry. In this 24 yea period total stock units[3] including sheep, beef cattle, dairy cattle, deer and goats increased 4(per cent on the 1960-61 level to 107.3 million, see Table 3. Most of this growth (89%) came from the expansion of the sheep flocks and beef herds. This was probably because sheep and beef cattle were more suited to take advantage of the Livestock Incentive Scheme (LIS) and the Land Development Encouragement Loans (LDEL) that was available during this period.

Table 3 **Livestock Units, June 1960 to June 1995**

	1960 (m)	1984 (m)	1995e (m)	% Change 1960 to 1984	% Change 1984 to 1995
Sheep	42.8	64.2	44.3	+50%	-31%
Beef Cattle	16.0	24.2	25.6	+51%	6%
Sheep & Beef Cattle	58.8	86.4	69.9	+47%	-19%
Dairy	17.6	20.3	25.9	+15%	+28%
Deer	-	0.5	2.2	-	+340%
Goats	-	0.1	0.2	-	+100%
Total	76.4	107.3	98.3	+40%	-8%

Source: N.Z. Meat and Wool Boards' Economic Service
Statistics NZ

Table 3 is important for it describes land use change that has occurred since 1960 in terms of livestock numbers. In particular note that sheep stock units at June 1995, though down 31 per cent in the preceding 11 years, similar (+4%) to the June 1960 level. In contrast beef cattle on a stock unit basis increased 60 per cent over the 35 year period.

The overall 19 per cent decrease of sheep and beef stock units for the 11 year period to June 1995 is a sharp contrast to the 47 per cent increase from 1960-61 to 1984-85.

[3] A stock unit is a broad measure of feed demand based on a breeding ewe producing a fleece and one lamb. Stock can be placed on the same feed demand basis where for example a beef breeding cow is said to be equivalent to 5.5 stock units, dairy cow 7 stock units and a mature stag 2.1 stock units.

The decline in sheep and beef stock units from their near peak[4] of 86.4 million at June 1984 to 69.9 million (-19%) at June 1995 was partly due to deregulation, partly due to changes in market prices and the subsequent adjustment to both these factors. This resulted in lower per hectare stocking rates, land use changes to dairying and forestry, the expansion of the deer herd, and subdivision of farms to life style blocks near urban centres. In addition, the balance between sheep and beef cattle within sheep and beef farms altered from sheep to favour more cattle. (i.e., nationally 2.7 sheep stock units to 1 cattle stock unit in 1960-61 compared with 1.7 in 1995-96).

It is also interesting to contrast the sheep and beef land area change form 1984 to 1994 of minus 16 per cent with the stock unit decline of 19 per cent noted above implying the marginal decline in per hectare stocking rates. In part, this reflects higher producing land being converted to dairying.

These livestock and land use changes were driven by expected "enterprise" price relativities which are continuously re-evaluated in the dynamic farm-agribusiness market.

2.3 Productivity Change

Table 4 below illustrates an important point that farm productivity has improved between 1960-61 with 1995-96. This demonstrates that productivity improvements have made up for some of the land use decline in the meat and wool sector. Productivity gains have also enhanced dairy farm output.

Table 4 shows that comparing wool production from 1960-61 with 1995-96 that there has been a 4 per cent increase. This increase is matched by the increase in sheep stock units indicating that wool productivity has been maintained per sheep stock unit. However, wool is a joint product with lamb and sheep meat production and cannot be viewed in isolation.

Export lamb and mutton production in Table 4 are shown to be up 30 and 25 per cent respectively reflecting the productivity increase from the 4 per cent increase in sheep stock units. For lamb this productivity lift represents predominantly reflects the improvement in lambing percentages, plus 10 percentage points, which allowed a higher export lamb slaughter (+25%) and higher slaughter weights (+5%). Even if the sheep flock has been in a

[4] Peak sheep and beef stock units were reached in 1981-82 at 88.7 million and declined from that point.

slow decline, continued focus on productivity increases has made up for some of the land use change.

Table 4 Livestock Changes and Productivity Change - 1960-61 to 1995-96

	1960-61 (000 T)	1995-96e (000 T)	Production % Change	Stock Unit % Change
Wool, clean	190.0	197.0	+4%	+4% sheep
Export lamb[1]	276.0	357.9	+30%	+4% sheep
Export Sheep[1]	85.7	105.4	+25%	+4% sheep
Export beef[2]	87.8	463.5	+428%	+60% beef
Dairy Milk solid	432.4	786.0	+82%	+47% dairy

1. hot weights
2. after deducting estimated dairy cull beef of 46,200 tonnes for 1960-61 and 80,600 tonnes for 1995-96.

Source: Wools of New Zealand
NZ Meat Producers Board
NZ Dairy Board

The 428 per cent lift in beef production and 60 per cent lift in beef stock units reflects firstly the productivity gain from higher slaughter weights. Secondly there is also a productivity gain relative to 1960 from the large input of dairy beef in the 1995-96 export slaughter. These slaughter cattle were the result that followed from high retentions of dairy beef calves 18 to 24 months earlier. Dairy beef calves raised for beef production increase productivity by bypassing the overhead of traditional beef cows to produce calves.

Similarly the dairy herd gain of 82 per cent lift in milk solid production measured against a 47 per cent increase in dairy stock units (including replacements) is a measure of productivity gain in this sector.

3.0 LAND USE OUTLOOK

3.1 General

Pastoral sector land use is driven by the relative prices received between enterprises and their associated profitability. These factors are continually evaluated resulting in continual shifts in land use.

In the above context it is also worth remembering that any general exchange rate appreciation or depreciation is approximately neutral on land use considerations. For example, with 80 per cent or more of deer, dairy, meat and wool production exported a fall in the exchange rate would boost export prices in New Zealand dollar terms for all products and boost profitability expectations similarly in all competing land use activities. In other words, real international price relativities and expectations drive competitive land uses, not the exchange rate.

3.2 Forestry Land Use Change

The sale of whole sheep and beef farms to forestry has been a feature of land use change since the early 1990s which initially coincided with the log price boom-let and the change in the forestry taxation regime. To establish the exact level of farmland sold to forestry the Economic Service worked with Valuation New Zealand to establish actual sales for 1993-94. The results of this analysis are shown in Table 5.

Table 5 **Farmland Sold to Forestry - 1993-94**

	Hectares	Displaced Stock Units	Stock Units per Hectare
North Island	26,000	179,800	6.9
South Island	20,200	56,500	2.8
New Zealand	46,200	236,300	5.1

Source: Valuation New Zealand
N.Z. Meat and Wool Boards' Economic Service

The expectation is for this rate of sheep and beef farmland conversion to continue and average around 50,000 hectares per year to the year 2000-01. In total this implies a stock unit loss of 1.5 to 1.75 million from 1994-95 to 2000-01. This translates to 1 million fewer export lambs or 120,000 export cattle or some mix of these in the year 2000-01 if there is no further productivity gains in the sector. In reality, some productivity gains are expected.

The reason for the growth in forestry is the long term expectation, 25 years or more, that prices will continue to be maintained in forestry despite supply expected to double in that time period.

One of the major issues with the forestry expansion is the upgrading of roads required for logging trucks at harvest time. Who pays for road upgrades is likely to be the issue particularly where there is a relatively low rating base in the surrounding area. In many situations, major roads will be upgraded from a general road fund but minor feeder roads may need to be maintained or upgraded by the forest owners.

3.3 Dairy Land Use Change

Tables 1 and 2 showed that the new dairy farm expansion has been significant. The Economic Service estimates of new dairy farms established in recent years on sheep and beef land is given in Table 6.

Table 6 **New Dairy Farms Established**

	No. of Farms	Estimated Stock Units
1994-95	299	500,000
1995-96	266	400,000
1996-97p	375	700,000

Source: N.Z. Meat and Wool Boards' Economic Service

The number of dairy conversions may slow in future due to the capital contribution requirements with dairy companies and the phase in of the Dairy Board capital contribution. This would amount to $2 or more per kilogram of milk solid production depending on the company involved.

It is interesting to note that dairy prices in inflation adjusted terms today are broadly similar to the late 1970s and early 1980s. The real gain in the dairy sector has been the increase in cow productivity and the number of dairy cows milked by each farm family business. In 1975-76, the average dairy herd size was 113 cows. In 1995-96, 20 years later, the average herd size is 193 cows, a 71 per cent increase in per farm productivity. The new dairy farms starting today have the farm family business milking 300 plus cows exploiting the advantage of larger farms and new efficient large dairy sheds.

3.4 Sheep and Beef Farms

The Statistics New Zealand 1994 Agricultural Production Survey showed 28,700 farm holdings running sheep and beef cattle. The current Economic Service estimate is that of these 17,700 are "commercial" sheep and beef farm businesses with the remaining 11,000 being small holdings. Further, the 17,700 farms were down 15 per cent from their level of 22,000 farms in the early 1980s. These farms are estimated to run 95 per cent of the sheep flock and 75 per cent of the beef cattle herd.

In terms of size structure, 50 per cent of the commercial farms carry 25 per cent of the sheep and beef stock units. This structure is almost identical to that of 25 years ago, despite the reduction in the number of sheep and beef farms over that period. The average size of sheep and beef farms has increased 18 per cent in stock unit terms over this period.

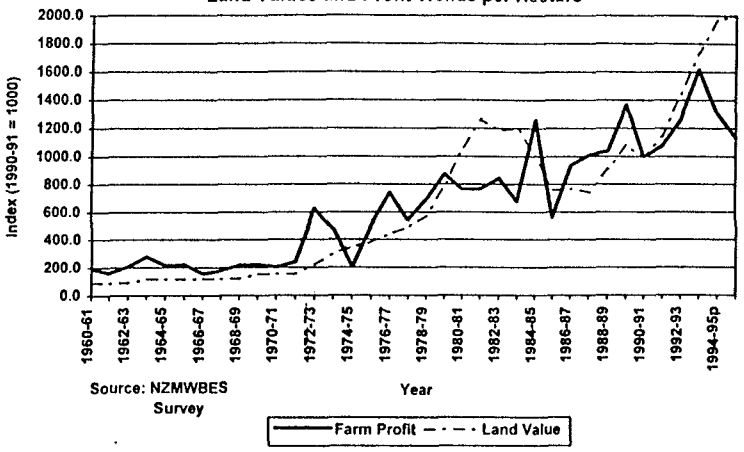
Figure 1 on the following page shows the indexed nominal[5] trend for the per hectare average farm profit from 1960-61 compared with the nominal price trend for sheep and beef farmland excluding the homestead. This shows that assistance measures in the late 1970s and early 1980s were capitalised into the land price whose trend deviated from the farm profit before tax trend line at that time. With deregulation in 1984-85 there was a correction in land price as farm profitability fell.

Post deregulation, the relationship with land prices and farm profit before tax was restored up until 1993-94. The recent overshoot in land prices began in 1993-94 and continued on into 1994-95 and 1995-96. The overshoot reflects the influence of alternative land uses such as dairy farming, forestry, peri-urban subdivision, and urban development.

[5] Not adjusted for inflation.

Lower profits from sheep and beef farming suggests that land prices may ease slightly. However, existing owners with sale intentions are likely to defer selling keeping to keep their sale price near the 1995-96 level. A recovery in profitability for sheep and beef farms is not expected until the beef price recovers in late 1997, despite lamb prices starting a recovery now.

FIGURE 1 Sheep and Beef Farm Land Values and Profit Trends per Hectare



4. SUMMARY

- The New Zealand population is expected to increase 800,000 (+22%) over the next 25 years. Following from this urban investment can be expected to have a significant impact on rural land prices.
- The grassland area attributed to sheep farming declined 1.93 million hectares (-16%) in the decade to June 1994.
- Of this, 1.08 million hectares (56%) went to alternative grassland uses such as dairy or diverse farming use. The residual 850,000 hectares (44%) of grassland was converted to non pastoral use such as forestry or land retirement.
- Productivity increases have been greater than the sheep and beef stock unit change when taken over a 35 year period from 1960-61 to 1995-96.

- Land use changes are driven primarily by the expected relative price profit relationships between competing enterprises.

- The exchange rate is generally neutral on land use activities.

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CURRENT AND FUTURE LIKELY TRADE DEVELOPMENTS IN AGRICULTURE

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Introduction

Thank you for inviting me to talk to you about current and future agricultural trade developments.

It is sometimes difficult on a topic like this to think of an initial punch line that will instantly capture the audience's attention. I do not, I am afraid, have the ability that MAF vets have to turn a discussion on SPS into a lurid description of the particular gender preferences of the fruit fly.

I am reassured, however, by having been told that I have a hardy audience before me, with proven abilities in coping with the likes of stochastic models, phytosanitary measures and re-instrumentation.

So let me get straight into it.

What I want to do today is to look at the achievements in agricultural trade policy over the last few years, what we are doing now, and where we want to go.

And when I say "we" I hope that we reflect the views and ideals not just of the people in MAF and my own Ministry but of the New Zealand agricultural community in broad terms. In short, anyone who agrees with us.

Overview

Let me start with a quick overview of the achievements of the Uruguay Round. A lot of this may be known to you but it puts what follows in context.

Then I'll pick up on some of the issues to have emerged through the implementation of the Round outcome, beginning in January 1995.

And talk about some of the newer issues with the potential to affect reform of agricultural trade - sanitary and phytosanitary measures (or SPS), trade and the environment, food security. SPS is in a special class of its own because it contains positives and negatives.

Finally, I'll discuss the next round of negotiations in agriculture, which are to start by 1999. I'll talk about the preparations for this next round, and what we want to see from these.

GATT: Uruguay Round

First, the Uruguay Round.

I realized with a bit of a shock the other day that this Round - the eighth and most important so far - was launched nearly a decade ago: September 1986. I was in Geneva at the time and the optimists reckoned it would take four years. I even attended the so-called "Mid Term Review" in Montreal in 1988.

In fact as we all know it took seven long years to reach a conclusion.

The World Trade Organisation, or WTO, agreement was finally signed in Marrakesh in April 1994. The Organisation itself came into being on 1 January 1995.

It was a long time coming but it was a landmark in the history of multilateral trade negotiations. Not only did it finally set up the full World Trade Organization that had first been mooted, then stymied, just after the Second World War but, most importantly, it brought agriculture into the GATT framework for the first time.

For New Zealand and other Cairns Group countries, this was the key achievement from the Round.

It was no easy task. And the reason the Uruguay Round took so long was because of the difficulties involved in securing a place for agriculture. But the Cairns Group had a simple but effective position - no result without agriculture.

We did not get all we wanted. Far from it. Nevertheless, the new rules in agriculture negotiated in the Uruguay Round do mark a quantum leap forward. And provide a platform for ongoing reform.

WTO Agreement on Agriculture

Agriculture was largely excluded from the disciplines applied to industrial goods under the GATT over the last 40 years. This is no longer the case. Key changes under the WTO Agriculture Agreement include:

a) a fundamental move away from quantitative import restrictions and other non tariff measures to tariffs as the only WTO-legal form of protection for agriculture;

b)breaking new ground in beginning the process of negotiated reductions and the reinstrumentation of domestic support - which is to fall by 20% over the six year implementation period from 1995-2000;

c) the maintenance of current access, which is the level of trade over the 1986-88 base period - particularly important for New Zealand given our historical trade with the EC;

d) the opening up of minimum access of at least 3% of domestic consumption (rising to 5%) for products covered by non-tariff barriers, and implemented through the establishment of tariff quotas; and

e) for the first time, negotiated reductions in export subsidies on a quantity and value basis - volumes are to fall by 21% and budgetary outlays by 36%. No new products may be subsidised.

The deliberate intention is that these elements will be built on in the years to come.

The Agriculture Agreement provides for further negotiations to commence at least a year before the end of the implementation period (ie by 1999) - under Article 20, known as the "Continuation Clause".

WTO Agreement on Sanitary and Phytosanitary measures

Another key outcome of direct relevance to New Zealand's agriculture interests was the development of food safety rules under the Sanitary and Phytosanitary (SPS) Agreement.

(I understand there was a paper given in the third session yesterday on quantifying phytosanitary measures.)

This Agreement complements the Agriculture Agreement. It aims to ensure that SPS measures that restrict trade do so only to the extent necessary to protect human, animal and plant life and health.

As a result, any future food safety requirements must be scientifically justified, based on an assessment of the true risks, and applied to domestic producers as well as exporters. Any departures from these requirements can be challenged in the WTO.

As I will mention later, New Zealand has already participated as a third party in one of the dispute settlement proceedings on an SPS issue, and we have interests in a number of other cases.

The SPS Agreement also encourages the use of international standards, such as those developed by the Codex Alimentarius Commission.

The GATT outcome for New Zealand: economic assessments

What does all this mean in practice for New Zealand?

In *Trading Ahead*, the Ministry's assessment of the Uruguay Round's impact on New Zealand (released in 1994), we estimated that agriculture sector incomes should rise by NZ$1-1.5 billion

over the next decade. The overall gain to the country from these negotiations is expected to be in the range of NZ$1.5-2.3 billion.

We expect there to be little discernible impact on New Zealand's inflation rate. But our terms of trade are expected to rise by three percent.

And there should be modest but helpful impacts on employment growth, especially in sectors supplying primary exporters.

Something of a thriving business has sprung up in offering assessments of the global impact of the Uruguay Round. A number of these studies, some arising from a World Bank conference last year, have suggested much lower returns than initial estimates.

It was always going to be difficult to assess in a quantitative way the returns to New Zealand. As much because some of the real benefit from the Uruguay Round is the result of strengthening the multilateral system of trade rules.

I should say here we took a conservative approach in *Trading Ahead*. But we consider it still holds as a reasonable estimate of the returns to New Zealand.

Empirically, New Zealand always stood to gain the most of any GATT member from agricultural trade liberalisation.

New Zealand's comparative advantage lies in sectors, such as dairy and meat, that have suffered the most from market distortions internationally.

Implementation

Of course without full and effective implementation of the Uruguay Round outcome, these forecasts have little meaning.

But on the whole, I can report that implementation of UR commitments over the last 18 months is going well.

WTO Members are for the most part meeting their commitments, with trade in agricultural products flowing accordingly.

For New Zealand, we are enjoying country-specific access now secured in the Round to the European Union (EU) for our butter and sheepmeat, and to the US and Canada for our beef. There are many other access opportunities open to global exporters, including New Zealand - such as to Korea for beef, the EU for cheese and apples.

There have been some problems. WTO Members have brought many of the issues arising before the Committee on Agriculture, or COA, which is charged with reviewing progress in implementing UR commitments.

These have largely been in the area of market access, and particularly tariff quota administration, which has been the focus of the Committee's work to date.

Issues raised include:

a) the nature of tariff quota allocation, such as the use of lotteries or historical share, and whether countries using such methods can impede access;

b) whether auctioning is a WTO-legal form of allocation;

c) for some tariff quotas, placing limitations on end-use, such as confining import access to processors, or in some cases to domestic producer organisations - does this impair the access opportunity?;

d) the ability of suppliers from countries with preferential access arrangements to access the "global" tariff quotas opened under the Uruguay Round;

e) the use of "mixing ratios", or making imports under tariff quotas conditional on the "absorption" of domestic production of the product concerned.

What this list shows is the ongoing refinement necessary as we bring agriculture into the rules-based system of the WTO.

These issues will need to be resolved, perhaps through the development of guidelines in the Committee on Agriculture, or through more formal mechanisms such as the WTO dispute settlement process. Or they may have to be picked up in the next round of agriculture negotiations.

On the two other areas of commitments besides market access, namely export subsidies and domestic support, we have yet to get a clear picture of what countries are doing.

This is through no fault of the system. But notifications on these areas have still to be submitted to the Committee on Agriculture. These will be considered over the next year as they fall due.

We do know, however, that at least one country (Hungary) has breached its export subsidy commitments.

With Argentina, Australia, Canada, Thailand, Uruguay and the United States we have sought consultations with that country to find a way to bring its policies back into WTO-conformity. We took a conscious decision to be involved in order to maintain the integrity of the WTO Agreements.

As the end of the implementation period draws near, and the export subsidy disciplines start to bite, we will be watching the performance of other countries, like the EC, very closely.

On domestic support, a combination of weaker disciplines (particularly the lack of product specificity) and the use of a base period which was an historic peak for levels of support, means the UR disciplines will constrain effectively the existing practices of very few countries.

In fact, important countries like the US already meet their reduction commitments. No policy changes necessary. (It is reassuring, however, that the recently passed FAIR Act does continue the process of reducing support to agriculture, allowing market forces to operate.)

But at least the internal support disciplines provide a base from which to ensure genuine reform through the next round of negotiations.

New issues: (i) Trade and the Environment

Of the so-called "new" trade issues to have emerged since the Uruguay Round, trade and the environment is perhaps the most significant.

The issue arose because of concern at the potential for conflict between trade liberalisation and environmental policy-making.

This issue takes us into complex areas. One main concern is that trade measures adopted to protect the environment are not used as disguised forms of protection.

Work is underway in the WTO to identify the linkages between trade and environmental measures, and to recommend changes to trade rules as appropriate.

The aim is to reach an outcome that allows for legitimate measures to protect the environment without undermining an open and non-discriminatory trading system. The focus of this work is on reaching some recommendations to be put to the Singapore WTO Ministerial meeting, in December.

We are closely involved in this process, with a domestic consultative mechanism in place to guide us.

It's a highly technical, and occasionally contentious, issue. Progress can be slow - but necessarily so.

And there is some valuable analysis emerging - for example on the real contribution that trade liberalisation can make to sustainable development, with a specific focus on the agricultural sector.

(ii) Food security

This issue will gain increasing prominence in the lead up to the World Food Summit, to be held in Rome by the Food and Agriculture Organisation (FAO) in November this year.

You will be aware that global cereal production has fallen for a third consecutive year, and world prices have surged.

This situation has created concern, particularly among some developing countries and net food importing countries, who are facing higher food import bills. Meantime, traditional donors are also facing budget constraints, and in some cases have lowered food aid levels.

These issues will be addressed at the World Food Summit, and are also being taken up in the WTO.

Our concern is that the food security issue, and the quite legitimate problems facing developing countries, may be used by countries like Japan and Korea to oppose further agricultural trade liberalisation.

We feel, as do others in the Cairns Group, that a more balanced approach to food security would focus on the importance of poverty alleviation, economic growth, and improved access to food. And trade liberalisation will contribute to each of these.

There is in fact no evidence that the Uruguay Round has caused the surge in cereals prices.

To the contrary, distortions to world markets through internal and export subsidy policies have exacerbated commodity cycles, undoubtedly contributing to the present difficult situation.

Moreover, the disposal of surplus commodities on world markets serves to depress prices and incomes, sending out inappropriate signals to domestic producers. Rising commodity prices will inevitably prompt a supply response reflecting comparative advantage. Domestic producers in developing countries will benefit over time from an end to these distorting practices.

But clearly we still have some distance to go to gaining widespread acceptance that agricultural trade liberalisation will benefit producers and consumers around the world. That is a task the Cairns Group is particularly well equipped to take on, given its regional and developing/developed country mix.

I can also see scope for some useful work by agricultural economists on the food security issue!

(iii) SPS measures

As I mentioned earlier, the SPS Agreement is intended to complement the WTO Agriculture Agreement.

Trade negotiators in the Round were acutely aware that as protection at the border comes down, these barriers can easily be replaced by other equally effective methods.

In particular, food safety measures have a very potential to act as non-tariff, technical barriers to trade.

It was most important to have the SPS Agreement as one of the Uruguay Round outcomes. It provides disciplines on the extent to which quarantine measures, food standards and other technical measures can be used to restrict trade.

This Agreement, supported by improved dispute settlement procedures in the WTO, allows countries to challenge the measures of others that appear to have no scientific justification.

And, just as importantly, it provides a standard against which governments can assess their own actions.

This is a complex and sensitive area. But it is an integral part of the process of agricultural reform.

In my view, it is highly likely that many of the agriculture-related disputes brought before the WTO in the future will be over SPS issues.

The first real test for the SPS Agreement is now before the WTO. This is the complaint brought by the United States against the EC for its ban on imports of meat from animals treated with hormonal growth promotants (HGPs).

The US argues that there is no scientific basis for the ban in relation to five HGPs, given that each is covered by international standards.

We participated as a third party in the consultations phase of this dispute, with Australia and Canada, because of the importance we attach to upholding the principles of the Agreement.

The Government is now considering whether to put in a written submission to the panel hearing of this dispute.

We have an interest in a number of other SPS cases "in the pipeline". As one example, both the US and Canada have taken action over Australia's ban on salmon imports.

Regarding salmon, I would mention that last year MAF conducted a lengthy risk assessment on imports of Canadian salmon. The conclusion was that New Zealand's ban on such products could not be sustained. Access is now open to Canadian product (and MAF is presently working on an assessment of Alaskan salmon).

This was a delicate issue - the fishing industry wanted to retain the status quo. But if we expect others to respect international agreements, we have to be prepared to take the tough decisions ourselves.

Accessions

I should point out that the negotiation of Uruguay Round disciplines has not quite finished.

You will no doubt be aware that the WTO has a large membership, with over 120 members at last count.

In fact, WTO members are responsible for around 94 percent of world trade.

But some of New Zealand's important trading partners remain outside the WTO - including China, Taiwan and Russia. Not surprisingly, these three, and some 30 countries in total, have sought to join or "accede" to the WTO. What these countries have to do is negotiate acceptance on the part of the WTO membership for their application.

The Uruguay Round outcomes provide the standard for new entrants into the WTO. Their commitments should be consistent with those undertaken by existing members under the Uruguay Round.

The accessions- or the cost of joining- give New Zealand leverage we would not otherwise have to pursue particular access issues. And it allows New Zealand and other WTO members to push such countries to introduce genuine trade liberalising measures as part of the concessions for membership.

Regionalism

I should briefly refer to the issue of regional trading blocs, which have been the subject of considerable trade policy activity in recent years.

Regional trade arrangements can and must reinforce multilateral trade liberalisation. Indeed, the Director-General of the WTO, Renato Ruggiero, has said that the multilateral system should have aims no less ambitious than the regional blocs (otherwise regionalism will prevail).

Asia Pacific Economic Cooperation (APEC) members, involving a number of our major trading partners, have committed themselves to free trade and investment by 2020 at the latest.

The CER Agreement with Australia was a critical step in opening up the New Zealand economy, and securing open access to our most important trading partner.

And with Australia we are exploring potential linkages with the ASEAN Free Trade Agreement (AFTA) countries.

We have entered into a dialogue with the countries of Mercosur (Argentina, Brazil, Paraguay and Uruguay), three of whom are already Cairns Group allies. Links with countries in NAFTA may be another possibility. And with Chile. We are keeping all our lines open.

Future negotiations

The next round of negotiations is to start by 1999. This is part of the "built-in agenda" from the Uruguay Round outcome. There are a number of steps on the way.

I have already talked about-**implementation**. Making sure that countries live up to their commitments is an essential first step towards re-engaging in the next round.

We are not ready to enter into negotiations at this point. The second step, therefore, is to ensure that we are adequately prepared to begin these negotiations.

For this reason, we are seeking endorsement from the Singapore WTO Ministerial meeting in December for the Committee on Agriculture to begin **preparatory work** from 1997.

The detail of this work programme will be determined next year, assuming we get the outcome we and others in the Cairns Group want from the Singapore meeting.

But preparatory work will need to focus on the three areas of market access, internal support and export subsidies.

And these areas would be further broken down into implementation issues (some of which I have already referred to), further improvements to the rules and commitments already agreed to, and changes to the framework of the Agriculture Agreement.

The work programme should take us through to the next Ministerial meeting, due to take place at the end of 1998. This meeting may well provide the basis for moving to negotiations from the following year.

Obviously New Zealand's priorities would include tightening up disciplines on domestic support, further reductions in export subsidies with a view to their elimination, and negotiating down the high tariffs still in place for key sectors such as dairy and meat.

These priorities are shared by others in the Cairns Group.

State trading enterprises

I would note that a US priority for the next round is to apply disciplines to the practices of state trading enterprises. And New Zealand's producer boards fall under the GATT Article XVII definition of state trading enterprises.

The New Zealand Dairy Board is the principal focus of US attentions, along with the Australian and Canadian Wheat Boards.

In our view, the US interest is primarily a response to lobbying by the domestic industry, which for a first time is facing competition in its own market, while looking to turn its attention to export markets - where it finds an efficient, low cost competitor in the New Zealand industry. In other words, it is all about protectionism.

What this does show, however, is that while New Zealand may be the WTO member with lowest level of support to agriculture, we are not immune to pressures from others. I have already mentioned work done by MAF on Canadian salmon. No doubt other issues will emerge.

We need to be conscious of these issues, and be able to respond appropriately.

Conclusion

We are now firmly on the path to more open and fair trading arrangements for agriculture.

Difficulties remain - access restrictions, subsidised competition, costly requirements at the border and the emergence of new non-tariff barriers relating to food safety, and environmental issues.

But there are built-in positive elements - security of access into New Zealand's traditional markets, new access openings, improved ways of dealing with non-tariff barriers, all with the backing of WTO rules for the conduct of agricultural trade.

And as I said earlier, the WTO Agreement on Agriculture was designed to be built upon. We are already working to that end.

1996 NZ Agricultural Economics Society Conference

NZ Agriculture in the 21st Century

The Treaty of Waitangi Settlements: Implications for Māori Development

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Introduction

Thank you for the invitation to speak at this Conference and to comment on some of the implications of Treaty of Waitangi settlements, as they apply to Māori development, and perhaps as they impact on wider issues pertaining to agriculture and the economy. Essentially there are only three points I wish to make. The first is that considerable progress has been made in resolving issues which even a decade ago often seemed beyond rational discussion let alone just settlement. The second point is that the sizeable claims which have been settled - or are about to be settled - are being resolved within the framework of full and final, durable settlements and in that sense are even more significant. And the third point is that settlements are being concluded within a wider context of positive Māori development and its triple goals of economic self sufficiency, social equity and cultural affirmation.

Underlying all three points are two further considerations which provide, as it were, a backdrop against which Treaty settlements might be usefully discussed: a changing Māori demography, and a threatened Māori economy.

A Changing Māori Demography

The most significant characteristic of the Māori demography is still the high proportion of the population under the age of 15 years. The 1991 census data confirmed that, although there has been a downward trend in the rate of population growth, 37% of all Māori were under the age of 15. This means that the population will continue to grow more rapidly than the non-Māori population but that the rate of increase will be less dramatic than it was when fertility rates were higher. At present Māori fertility rates are almost the same as for non-Māori, around 2.2, a reduction from 6.4 in the 1960s. Over time therefore the elderly will account for a greater percentage of the total Māori population so that by 2031 the elderly should make up 13% of the total Māori population compared to 4% in 1991.

Given the likely reduced role for the State in providing for the elderly, Māori planners will need to consider what provisions should be made for a cohort of men and women who may have no personal savings or retirement plans and who may not be able to depend on children and grandchildren for economic support, as their parents could. In effect Māori will not be exempt from a national ageing trend, though there will be a lag before the implications for Māori are apparent. Hardest hit will be those who have entered old age directly from unemployment and who have no asset base which could be realised to meet costs associated with growing old.

Urbanisation is the other feature which characterises the Māori demographic position. Following World War II, and at an alarming rate, by the mid 1960s more than half of the Māori population had shifted from rural to urban locations. New economic necessities probably accounted for the migration but it was poorly planned in social and cultural terms and led to the marginalisation of large numbers of families who were no longer able to take advantage of whanau or tribal support measures. Moreover, in the process they often became effectively alienated from tribe and, important to this discussion, from tribal resources. In the 1991 census some 27% of respondents did not know their tribal affiliations let alone have any meaningful contact with them. I suspect that there were even more who might have known which tribe they had links to, but did not exercise those links in any practical way. As if to highlight the point the Court of Appeal ruled last month that urban Māori had a right to share in any benefits from the Sealords Agreement and that urban Māori authorities could act on their behalf. Predicably tribal groups were incensed by the decision, arguing that the property concerned - fish - was a tribal resource, not an individual Māori one. They have successfully obtained leave to have the case heard in the Privy Council.

A Threatened Māori Economy

At the 1984 Māori Economic Summit meeting, the Hui Taumata, it was clear that the Māori economy was in a perilous state. Incomes tended to be concentrated in the lower two quintiles, the numbers of beneficiaries was alarmingly high and Māori employment patterns favoured industries which were either heavily subsidised by the State or which required little formal training. These concerns were shown to be justified during the period of economic and State restructuring when Māori unemployment rose to over 20%, and in some rural communities, was over 60%. There has been some improvement in the situation but long term unemployment remains a significant problem and Māori continue to be over-represented in the low skilled, secondary occupational groupings.

Education has been identified as a key factor in overcoming income related disadvantage and both Māori and State have contributed to initiatives designed to reduce educational under achievement and promote entry into more secure employment. Already there are signs of improvement. The number of Māori school leavers who leave school with no qualification has been reduced from over a half (in 1986) to around one-third in 1995. And over the same time frame the number of Māori in tertiary education has increased from around 4% (of the total tertiary population) to 9%.

But the other approach to improving the Māori economy is linked to realising better returns from Māori assets and re-establishing a stronger resource base. Tribes, often on the basis of Treaty of Waitangi guarantees have sought to reclaim significant roles in fisheries, forests, energy resources, land and riverbeds. It is in this context that Treaty of Waitangi land claims are so significant.

Mechanisms for the Resolution of Treaty Grievances

Three processes have combined to improve avenues for the resolution of Treaty of Waitangi grievances: the Waitangi Tribunal, the Courts, and direct negotiation with the

Crown. These settlement mechanisms are not mutually exclusive and often operate together or serially, depending on opportunity, urgency or political interest.

The Waitangi Tribunal

The Waitangi Tribunal, was established through the passage of the Treaty of Waitangi Act 1975. Then it was a small three person tribunal able to inquire into grievances against the Crown in respect of legislation, policy or practice dating back to 1975. Claims were relatively few and, because of the limited jurisdiction (to 1975) as often as not were about environmental issues rather than resource alienation. Some substantial cases were, nonetheless heard, including the controversial Motunui dispute which would have led to widespread pollution of the Taranaki coast line. Though politically unpopular, and despite the fact that the Tribunal could only make recommendations, the Motunui case demonstrated that the Tribunal was poised to make a significant impact on understandings of the Treaty of Waitangi as well as its contemporary applications.

In 1985 the Treaty of Waitangi Act was amended to extend the jurisdiction of the Tribunal to 1840, thereby opening the way for claims against the Crown dating back over a hundred years. A surge of claims was lodged so that there are now over 500 claims to be addressed. Their diversity almost equals their number - claims for land, flora and fauna, lakes and rivers, harbours, children, cultural properties. Not all will lead to a resolution that satisfies everyone. Often claimants will be disappointed, not only by the lengthy wait for a hearing but also because the Tribunal may not have been able to conclude that the Government was at fault.

It needs to be emphasised that claims to the Tribunal are against the Crown - not against individuals or third parties. During the lengthy Ngai Tahu hearings there was unnecessary concern voiced by businessmen in Dunedin that the Tribunal would recommend the return of the private land from which their businesses operated. It should also be added that the number of cases reported on each year is not large and many claimants are worried about the lengthy delays before their particular cases will be heard.

The Tribunal has three mechanisms at its disposal for settling claims. Mediation may be recommended if the facts are reasonably clear and are not necessarily in dispute. The role of the Tribunal is to bring the aggrieved parties together and seek consensus as to the most appropriate remedy. Though not used extensively, it remains a viable process which avoids many of the delays and costs of the second mechanism - a full hearing. A formal Waitangi Tribunal hearing enables the claimants to present their case in Māori and on a marae if that is what they wish. By then extensive research will have been undertaken by the claimants, the Crown and the Tribunal itself. A hearing may last for days, weeks, months or even years. Both the Ngai Tahu and the Taranaki cases had several hearings over a period of two years. Subsequently the Tribunal members prepare a Report for the Cabinet with recommendations. It is then over to the Government to action or not action the recommendations. A third mechanism for settling a claim is for the Tribunal to refer the case to another more appropriate agency such as the court or the Crown itself.

The Courts

The second major avenue for settling claims is through the Courts. This avenue had little Māori confidence until quite recently largely because of a decision taken in 1877 which in effect declared the Treaty of Waitangi to be devoid of legal or even moral implications. In Wi Parata v the Bishop of Wellington, Judge Prendergast described the Treaty as a "simple nullity" and dismissed a claim by Ngati Toa for land near Wellington which had been gifted to the Church of England for a school. When the school failed to materialise, and for other reasons as well, the terms of the gift were challenged in Court using a Treaty argument. Subsequently other cases faired equally badly but in 1938 (Tukino Te Heuheu v Aotea Māori Land Board) the Court ruled that the Treaty of Waitangi would have legal significance if it were incorporated into domestic law.

In recent times, the Court has ruled in favour of Māori claimants on at least three occasions. The best known was the New Zealand Māori - Council State Owned Enterprises case in which the New Zealand Māori Council challenged the legality of the SOE Act 1986 on the basis of the Treaty of Waitangi. Because section 9 of the Act required that nothing in the Act should contradict the principles of the Treaty of Waitangi, the Court was able to find that, in allowing for the transfer of Crown assets to SOEs, the Act had not acted to protect Māori Treaty interests. Moreover, section 27 was inconsistent with section 9. The result was that the Government was directed to negotiate an outcome with the New Zealand Māori Council.

A further court case arose in connection with the transfer of the Huntly coal mines to Coal Corp. Tainui challenged the transfer in the Appeal Court in 1989 and again the Court found in their favour, not by ruling that Tainui owned the coal, but by recognising that Tainui had an interest in the business of coal mining (at least at Huntly).

But the most liberal interpretation of the legal significance of the Treaty arose in 1987 when Justice Chilwell ruled that because the Treaty of Waitangi was "part of the fabric of society", then it should be taken into account in the interpretation of legislation even when the Treaty was not specifically referenced.

Direct Negotiation

It was evident when the five principles (including the principle of redress) for the Treaty of Waitangi were released in 1989, that the Government was intending to play a more proactive role in Treaty matters, rather than simply waiting for the Tribunal or the Courts to make decisions on its behalf. Early in 1990 the Prime Minister, Geoffrey Palmer said as much when he outlined an intention to return the Treaty to the political arena, arguing that from the start the Treaty had been a political matter and that it was time for politicians to take back the high ground.

As a result, the Labour Government and then subsequently its National successor, actively encouraged the resolution of Treaty issues through negotiated settlements. The Ngati Maniapoto claim on the Waitomo Caves was an early negotiated settlement. The Sealords Agreement occurred near the end of 1992 though had been under negotiation since 1987. Then in 1995 the Tainui settlement was negotiated with Tainui. Along the way Ngai Tahu have been in (and out) of negotiations with the Crown and it is likely

that Taranaki and Ngati Awa will follow suit later this year. Important to a framework for direct negotiation is the so-called fiscal envelope. The proposal, launched in December 1994 and promoted during 1995, outlined a series of constraints which would apply to all historic claims settlements. Natural resources, the conservation estate and evidence of a mandate to negotiate with the Crown were integral to the proposal and a billion dollar cap was introduced as a non-negotiable ceiling. Despite wide Māori criticism of the proposal, more so because it failed to justify the billion dollars either in fair or affordable terms, nonetheless it appears to be guiding negotiations. Certainly the Tainui settlement was consistent with its provisions.

To assist with negotiations the Crown has established an Office of Treaty Settlements, and a Minister of the Crown, currently Hon Doug Graham, has a Treaty Settlements portfolio. Negotiated settlements may occur as a consequence of Waitangi Tribunal hearings (Ngai Tahu is an example) or as an outcome of a court finding. Negotiations which ended in the Sealords Agreement for example had their origins in High Court action by several tribes because of the Quota Management System, introduced before Māori fishing rights had been determined. To overcome what appeared to be an impasse, and under pressure from the fishing industry, the Government opted for direct negotiation.

It is now unusual for the Waitangi Tribunal to make specific recommendations on remedies and levels of compensation; instead Tribunal reports expect that final solutions will be negotiated, using Tribunal findings as a backdrop and framework for discussion.

Major Land Claims

There have been a large number of land based claims and the following examples are used to illustrate particular issues. They should not however be regarded as exhaustive either in significance or precedent.

Bastion Point

A 1987 Waitangi Tribunal report dealing with a Ngati Whatua claim for land at Bastion Point, the Orakei Report, pointed to a series of Crown policies and laws which had all but caused the tribe to become landless. A 700 acre block at Orakei was to be their nest egg for the future, but through a variety of unjust laws and mounting pressures from local and central government, tribal interests had dwindled and the sale of the remaining prime land was likely. The Tribunal recommended otherwise and went to some lengths to spell out details of a fair settlement. The proposed remedies included the return of some land (only a fraction of the original 700 acres), shared management (with the Auckland City Council) of public reserves, and compensation amounting to $3 million. Eventually the Government agreed and legislation was passed giving validity to the settlement. The approach was different from current practice in that it specified the remedies and recommended them to the Government for implementation. Later, the Tribunal preference was to discuss findings, reach conclusions and leave it to claimants and the Crown to negotiate practical solutions.

Te Roroa

Another Tribunal report, the Te Roroa Report released in 1992, attracted attention for different reasons. Having found that the Crown had unfairly gained title to substantial land from Te Roroa, a northern tribe, it was recommended that when the opportunity arose, the Crown should purchase back the land in question and return it to Te Roroa. For cultural reasons the tribe was interested in that particular property rather than alternate land owned by the Crown. The problem was that the land had meanwhile been acquired, quite legally, by a farmer who did not want to part with it. Under pressure to make good the original injustice, Government began a negotiating process with the farmer and eventually a price was agreed to - substantially higher than the purchase price. Despite the inflated sale price, however, neighbouring farmers claimed that the incident has severely reduced real estate values for their properties. And it worried the Government to the point that an amendment to the Treaty of Waitangi Act in 1993 now prevents the Tribunal from offering any comment about privately owned land, regardless of its history.

The Tainui Settlement

Probably the most significant land claim settlement, however, was the Tainui settlement, finally concluded in 1995. Triggered by the confiscation of 1.2 million acres of land in 1863, allegedly because Tainui were in rebellion against British Imperial forces, the claim represented more than eighty years of petitions, delegations, pleadings, negotiation, litigation, and Tribunal hearings. A settlement of sorts had been achieved in 1946 when Te Puea and Peter Fraser agreed to an annual £5,000 compensatory payment but then there was no return of land. And then in 1991 the Labour Government offered a $9 million "take it and leave deal." Tainui, however, never lost sight of the goal of land for land; "as land was taken so land should be returned" and with the advent of the Waitangi Tribunal a more comprehensive claim had been registered. Meanwhile Court proceedings were filed against the Crown because of the proposed transfer of the Huntly coal mines to Coal Corp and in the wake of a favourable decision, the Crown agreed to negotiate directly. The Tribunal hearings never reached reporting stage.

The Tainui settlement included three main components: the return of 40,000 acres (although the Crown had another 40,000, the land component was limited to what could be readily returned); an apology from the Queen (delivered in person at Wellington in 1995) and monetary compensation to bring the total value of the package to $170 million. In fact the Crown did not have a great deal of land other than what was already occupied by Crown agencies and guarantees were required to protect existing tenants such as the University of Waikato, the Police, the Court. Tainui have agreed on the broad principles which will guide the distribution of benefits to the tribe. Individual dividends are unlikely but education will be actively promoted; land holdings will be increased (as an investment for the future) and the twenty or so Waikato marae will be encouraged towards greater economic independence. As for the land returned, it will be vested in Potatau Te Wherowhero (the first Māori king) and never alienated. On the other hand, land purchased with proceeds from the settlement will be used more flexibly. Thus the tribe will be able to realise two often conflicting objectives - to retain land for cultural and customary purposes and to use land for maximum economic

advancement. To assist in the post-settlement phase a new tribal corporate structure has been developed.

The Ngai Tahu Settlement

One of the larger Waitangi Tribunal reports is the 1992 Ngai Tahu Report. The three volumes are about dispossession, deceit, broken promises and inflicted poverty. As in the case of Tainui a token settlement was made some years ago and the Ngai Tahu Māori Trust Board set up to administer compensatory payments. But it was an inadequate step which failed to satisfy a sense of grievance. The Waitangi Tribunal allowed a more realistic appraisal of the situation especially in light of Treaty of Waitangi promises. Though recognising the severity of the injustice and the amount of land alienated, largely by a failure to establish reserves as agreed to before large scale land sales, the Tribunal did not make specific recommendations for remedies. Instead they adopted the now familiar practise of recommending settlement through negotiation with the Crown.

Ngai Tahu has yet to reach agreement with the Crown. Negotiations have been less than straight forward and they have been punctuated by Court action, walkouts and recriminations. But, perhaps because of the approach of an MMP system of government there appears to be fresh impetus from both sides to accelerate the negotiation process and to conclude an agreement within the next few months. Whether Ngai Tahu will follow the Tainui precedent and give way on the conservation estate and natural resources is uncertain, but like Tainui they have already developed a new tribal corporation which will be able to handle substantial land and cash benefits. Nor is it any secret that the tribe will be a major economic force in the South Island with substantial land holdings as well as interests in a diverse investment portfolio.

The Taranaki Settlement

Another major land based claim was reported on by the Waitangi Tribunal in June 1996. The report covers 21 claims: five for Taranaki generally (the Taranaki Māori Trust Board, the Taranaki Iwi katoa Trust, Nga Iwi o Taranaki, the Paraninihi ki Waitotara Incorporation and Taranaki Tribes); and the remainder for various kin groupings (Ngati Tama, Ngati Maru, Ngati Mutunga, Te Atiawa, Taranaki, Nga Ruahine, Ngati Ruanui, Tangahoe, Pakakohi, and Nga Rauru). Although described as an interim report (the Crown has yet to be heard on all matters), the Tribunal appears confident that the report is sufficiently indicative to be used to expedite negotiations for a settlement.

At the heart of the matter is the confiscation of land following the 1860's wars. For over nine years armed initiatives continued and as a result confiscation was extensive and severe. The Tribunal considers that 1,199,622 acres were confiscated with a further 296,578 acres illegally purchased, 426,000 acres expropriated by land reform and the Governments Native Land Court process, making 1,922,200 acres in all. But the absolute amount of land taken is not seen as important as the impact of loss by reference to the proportion of land taken and the amount retained. Some hapū lost everything; others virtually everything and no hapū had sufficient lands returned to provide even minimum relief. Using these measures, the Tribunal predicts that the Taranaki land losses will be the most severe in the country. Even after the wars, when

hapū (sub tribes) were promised lands for survival, none were returned and when pushed, some reserves were eventually defined but given over to administrators rather than to the owners. Leases in perpetuity were then sold to settlers. Legislation to correct this inequity may be introduced to the House this year but the termination of those leases will not occur for a further 63 years, some 180 years since the original alienation.

The Taranaki Report was released before final conclusions could be made and as a consequence recommendations are not made either, though the report itself will be a welcome starting point for both sides as negotiations get under way. However, a warning is sounded by the Tribunal. Aware of the determination to negotiate settlements which are full and final, the report doubts that the present political frameworks for Treaty settlements could do justice to the extent of tribal suffering and cautions against requiring the tribes to sign for a full and final settlement when legal principles do not apply or must (perhaps of necessity) take second place to political expediencies. They urge the Crown to make a generous reparation and to seek a solution which restores the people, removes prejudice and prevents similar prejudice from arising again.

Māori Development

I mentioned at the beginning of this address that Treaty settlements are not occurring in a vacuum but are part of a wider context of positive Māori development. After the General Election in 1984, a Māori Economic Summit meeting was called by the Ministers of Finance and Māori Affairs. Arising out of the meeting, known as the Hui Taumata, the Decade of Māori Development was launched.

The Decade of Māori Development prescribed pathways for Māori cultural, social and economic development. It contained some of the earlier direction and enthusiasm which had emerged from previous policies but it also brought fresh approaches, emphasising greater commercial awareness and positive development, with reduced dependency on the State and stronger emphasis on tribes as vehicles for development.

Six themes emerged as central to the philosophy of the decade: the Treaty of Waitangi, tino rangatiratanga, Iwi development, economic self reliance, social equity and cultural advancement.

While these themes were not the only ones to emerge, they did so consistently enough to force major policy and legislative changes and to redirect Māori energies towards new visions based as much on old structures as on new economic imperatives. Having adapted awkwardly to life in urban surroundings, and all too aware that the provision of social services was often inadequate to meet Māori needs, the new call was for "Māori solutions to Māori problems." Both the lack of confidence in the capacity of the State to offer positive solutions and a desire to capitalise on existing Māori structures and values, combined to inject a sense of independence and renewed commitment to alternate approaches. Significantly, a sound economic base was seen as a crucial step towards achieving any real political autonomy or even cultural survival. Economic self sufficiency was not to be merely another name for political gamesmanship; it was to be an opportunity for Māori to reach full potential on their own terms and for their own

reasons. Whether or not it accorded with economic policies of the State currently in vogue, was a secondary issue.

As the decade moved towards its close, the settlement of Treaty claims came to occupy centre stage. The ownership of fishing quota typified the differences between Māori and the Crown illustrating the immense difficulties arising when attempting to make a full and final settlement on behalf of all Māori. Then at the end of the Decade, the Governments Proposals for the Settlement of Treaty of Waitangi Claims, known as the Fiscal Envelope, brought forward another approach based as much on acceptability and affordability as on just and equitable solutions. Māori reaction was uniformly dismissive, not only because of an imposed fiscal cap on settlements but also because ownership of the conservation estate and natural resources had, it appeared been decided prior to consultation.

There were also lessons to be learned from the Decade of Māori Development. First, before the decade was half-way through questions were being asked about the underlying intentions. Doubts arose as to whether Māori development was primarily a Māori agenda or whether it was essentially part of a Government plan for privatisation, reduced state responsibility and user pays. Māori suspected that they were implicitly being cast as agents of the Crown and that the disastrous effects of economic and state restructuring in terms of Māori unemployment, were being masked by a semblance of economic recovery that simply did not extend to households. Was Māori development intended to create a facade of positive recovery in the face of increasing disparities in employment, incomes and whanau stress? Often it seemed so.

Second, the focus on Iwi (tribal) development did not always appeal to Māori who were alienated from tribal structures and activities. Three or four generations of urban dwelling in Auckland and other metropolitan centres had long since extinguished any real sense of tribal affinity. At the 1993 Beehive Hui to discuss the appointment of Treaty of Waitangi Fisheries Commissioners, June Jackson estimated that fewer than one half of Māori living in the greater Auckland area had any meaningful contact with an Iwi, nor did they wish to. In June 1996 the Court of Appeal agreed that the rights of urban Māori must receive direct attention, at least for any distribution of assets derived from fisheries.

The settlement of Treaty of Waitangi claims is part of positive Māori development. For some tribes who have virtually no economic base, Treaty settlements represent an opportunity to begin the long journey towards economic self sufficiency. And if at times the settlements seem generous, they really need to be considered within an overall context of dispossession, social inequity and cultural diffusion. From that perspective few tribal members would describe them as anything other than minimal.

My final point is that Treaty of Waitangi settlements are not simply about paying back the injustices of the past. More important they are about positioning tribes and tribal groups to develop in a positive way so that their people can stand tall in New Zealand, as Māori, and ready to play active roles in all aspects of the life of the nation.

SECTION B

CONTRIBUTED PAPERS

AGRICULTURAL MARKETING: RECENT AND PROPOSED CHANGES TO PRODUCER BOARD LEGISLATION[1]

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ABSTRACT

Most of New Zealand's agricultural and horticultural exports are controlled or influenced in some way by producer boards or licensing authorities. These organisations are creatures of statute, and several of these statutes have been under review in recent years. The ongoing reform of producer board legislation seeks to take into account the evolving nature of producer boards and the changing environment within which they operate. This paper outlines the current and proposed roles and functions of the producer boards and the recent and proposed changes to the legislation that regulates their activities.

INTRODUCTION

The primary purpose of this paper is to document changes to producer board legislation in the 1990s and briefly comment on the rationale for those changes.

BACKGROUND

The marketing of New Zealand's pastoral exports has been subject to the influence of statutory producer boards[2] for most of this century. In more recent years, most horticultural exports have also become subject to the influence of statutory marketing boards or licensing authorities. Approximately 80% of the value of New Zealand's agricultural and horticultural exports in the year to June 1995 were subject to such influence.

Three of the ten producer boards are export trading boards. The New Zealand Dairy Board, the New Zealand Apple and Pear Marketing Board, and the New Zealand Kiwifruit Marketing Board (except for exports to Australia) have export monopoly powers. While these boards can allow others to export, they generally handle most of the exports of products for which they have acquisition powers. These three producer boards do not have statutory powers over the New Zealand market. Two more, the New Zealand Hop Marketing Board and the New Zealand Raspberry Marketing Council, have both export market and domestic market monopoly powers. The powers and functions of these two boards are currently under review.

The other five boards, the New Zealand Wool Board, the New Zealand Meat Producers Board, the New Zealand Pork Industry Board, the New Zealand Game Industry Board, and the New Zealand Horticulture Export Authority, are not directly involved in the purchase or sale of their commodities. Their roles are mainly in the areas of licensing exporters, promotion and market development, research, industry support, and quality control, although in the past some of these five non-trading boards have been involved in export trading. These Boards have varying degrees of regulatory and control powers, and have other powers that enable them to carry out industry support and leadership functions.

The boards have developed on the apparent premise that in order for producers to better manage the risks inherent in producing primary commodities for export, legislated disciplines and controls are necessary (Cottrell and Walker, 1991). In addition, advocates of producer boards argue that they can lead to the implementation of more sophisticated and coordinated marketing strategies, and increased returns for New Zealand. Like New Zealand, a number of other countries have also relied on marketing boards to influence the returns which producers receive (Zwart and Moore, 1990).

COMPONENTS OF PRODUCER BOARD LEGISLATION

In looking at producer board legislation, it is helpful to think of the various things that the boards are required or enabled to do under four broad headings.

Object

Some boards have an "object" spelt out in their legislation. A board's object is like its mission statement; it is a short statement of the fundamental thing that Parliament wants the board to achieve. Other boards have no object specified, and must look to their functions and powers to determine their reason for being.

Functions

A board's functions are the things that Parliament is asking it to do in working towards the achievement of its object (whether explicit or implied). Functions might range from exporting a product to funding research and development. All producer boards have functions spelt out in their legislation, but some are spelt out in more detail than others.

Powers

Powers give a board the ability to carry out its functions for the achievement of its object. The powers that Parliament has given each board are spelt out in its legislation.

- Powers of a natural person enable a board to do what any person or company can do, such as borrow money. Because boards operate only under their own legislation (and not, say, the Companies Act), they have natural person powers only if granted them by that legislation.

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1 The views expressed in this paper are those of the authors and do not necessarily reflect the official view of the Ministry of Agriculture. Errors and omissions remain the responsibility of the authors.

2 In this paper we use the term "producer board" to cover all of the statutory agricultural producer, marketing, and licencing boards and authorities.

- Other powers enable boards to do things that ordinary people or companies cannot, such as require levies to be paid to them, license exporters, or compulsorily acquire product for export. These are sometimes called coercive or regulatory powers.

Duties

As discussed under "Directors Duties", below, duties similar to those in the Companies Act are being imposed on individual directors of some boards. In addition, all boards have various duties to carry out as an adjunct to their functions and powers. These are commonly accountability requirements (eg financial reporting) or safeguards in the exercise of statutory powers (eg requirements to consult before exercising some powers).

THE NEED FOR REFORM

The ongoing reform of producer board legislation seeks to take into account the evolving nature of producer boards and the changing environment within which they operate.

The boards' statutory status and the wide range of powers they had provided a useful mechanism for the Government to implement its interventionist policies of pre-1984. However, policies and schemes such as Supplementary Minimum Prices, and income stabilisation, have now been removed in line with wider government moves to a more market oriented economy. In addition, producer board access to Reserve Bank funds was removed in 1986, government involvement in the financial affairs of the boards has been reduced, and price fixing committees have been abolished (Cottrell and Walker, 1991). Therefore, some of the powers and functions of most of the boards have become redundant and the need for government representatives on the boards has been substantially reduced.

These organisations are funded by the producers, either through levies or through deductions from payments to producer-suppliers. With the reduction of government involvement, the need for improving the accountability regimes for these organisations to the producers who fund them has grown. In addition to accountability to producers, the need for boards to be accountable to Parliament for use of their statutory powers remains.

During the 1980s and early 1990s, a number of non-trading producer boards got increasingly involved in commercial activities. This gave rise to concern about the connection between the commercial activities of those boards and their regulatory powers, particularly the licensing of exporters. The benefits of these boards' regulatory powers have also been increasingly questioned, both from within the industries and from outside, and the possible costs of the existence of these powers in terms of deterring investment and stifling innovation have been highlighted.

Finally, in some industries there has been pressure to clarify the ownership of board assets.

REFORMS UNDERTAKEN IN THE LATE 1980s

Between 1984 and 1990, significant changes occurred in the domestic marketing boards. The marketing of wheat and eggs was completely deregulated. The town milk industry was partially deregulated during this period and has been completely deregulated since then.

The Producer Board Amendment Act passed in 1988 allowed boards access to a wider range of funding sources without needing government approval or supervision (Zwart and Moore, 1990). The boards were granted the 'powers of a natural person' which gave them more financial flexibility. This followed the 1986 removal of access to Reserve Bank funds which some boards previously used to finance exporting and stabilisation activities at minimal cost to the industry. Since 1988, producer board earnings have been fully taxable. According to Zwart and Moore (1990), while these changes had little direct impact on the marketing activities of the producer boards, they were significant in that they reduced the degree of government involvement.

Interestingly enough, while the Government was removing the financial concessions to producer boards it created two new boards, the New Zealand Horticulture Export Authority in 1987 and the New Zealand Kiwifruit Marketing Board in 1988.

Readers are advised to read an earlier paper on this subject, presented by Sharon Cottrell and Victor Walker at this conference in 1991, for information on changes in the late 1980s.

AMENDMENTS TO PRODUCER BOARD LEGISLATION IN THE 1990s

The main amending Acts for producer board legislation in the 1990s to date have been the Dairy Board Amendment Act 1992, the Horticulture Export Authority Amendment Act 1992, the Apple and Pear Marketing Amendment Act 1993 and the Primary Products Marketing Amendment Act 1993. The last two of these were made via a Producer Board Act Amendment Bill.

A further Dairy Board Amendment Bill is currently before Parliament, and is expected to be passed soon. A bill to replace the Meat, Wool and Pork Board's legislation, to be called the Producer Board Acts Reform Bill, is expected to be introduced into Parliament this year. For a detailed list of amendments to producer board legislation see Appendix One.

REFORMS IN THE 1990s WHICH WILL AFFECT ALL OR MOST PRODUCER BOARDS

The main focus of the changes in producer board legislation during the late 1980s was the withdrawal of direct Government involvement in the industries. In comparison the changes in the 1990s are mainly in the areas of improving the accountability of the boards to the producers who fund them, and focussing their objects, functions and powers to meet future needs. The nature of these changes has meant that initiatives are coming from boards and industries as well as the Government. The current changes being proposed have been developed following wide consultations with the boards and the industries. The changes below are progressively being applied to the producer boards as their legislation is amended.

Performance and Efficiency Audits

Producers need to be provided with sufficient information to assess the performance of the boards that they fund. There is a move to require boards to undertake performance and efficiency audits

every five years. Some boards already have this provision in their legislation, for others these provisions will be included when their legislation is next amended.

Financial Reporting

As the boards' legislation is being amended they are being required to comply with the accounting standards that apply to public companies under the Financial Reporting Act 1993. The requirement for audited annual reports and statements to be laid before Parliament will continue.

Annual General Meetings

As the boards' legislation is being amended they are being required to hold annual general meetings of producers or suppliers along the same lines as companies are required to hold annual general meetings of shareholders.

Reporting on Use of Statutory Powers

To improve the accountability of the boards to Parliament for the use of the statutory powers granted to them by Parliament, the boards are being required to report on their use of statutory powers in their annual reports.

Directors' Duties

The Dairy Board Amendment Bill currently before Parliament provides for individual directors of the Dairy Board to be subject to legislative duties of care in a similar way as directors of companies under the Companies Act 1993. This is expected to be applied to other boards in the future, and will contribute to the process of making the producer boards more accountable for their actions.

Unlike companies, producer boards have statutory powers and do not have shareholders, so the Companies Act provisions need to be altered to reflect the producer board situation. The Companies Act allows shareholders to bring actions against directors, but because the boards do not have shareholders, complex and contentious questions would arise in establishing who should be entitled to take action. The enforcement provisions of the Companies Act are not being applied at this stage.

However, other enforcement options exist. These include the ability of a board to take action against individual directors, judicial review of board decisions, boards being subject to the Official Information Act 1982, the ability of the Governor General to remove a director from office for failure to observe a duty to the Board, and the overall accountability requirements to be placed on the boards.

Interface of Producer Board Legislation with Commerce Act

The Commerce Act 1986 is all about promoting competition in the domestic market, whereas producer board legislation is co-operative by nature in relation to export markets. Because of this conflict it is necessary to define the interface between the Commerce Act and producer board legislation. This can be done by exempting certain export related powers of the producer board Acts from Part II of the Commerce Act.

BOARD BY BOARD ANALYSIS OF REFORMS IN THE 1990s

This section of this paper will focus on policy changes implemented since 1990 and what is being proposed for some Boards now. These will be discussed board by board.

New Zealand Dairy Board

The New Zealand Dairy Board (NZDB) is governed by the Dairy Board Act 1961. The primary function of the NZDB is to undertake the export and marketing of all dairy products manufactured for export in New Zealand. The NZDB purchases dairy produce from dairy manufacturing companies and sells it either directly or through its world-wide marketing network of subsidiary and associate companies, distributors and agents. Available net proceeds from sales are distributed to the manufacturing dairy companies and ultimately to dairy farmers. The Board also plays a leading role in the formulation of industry policy and the general development of the New Zealand dairy industry.

Dairy Board Amendment Act 1992

The Dairy Board Amendment Act 1992 sought to make the NZDB more independent of government and more accountable to producers and to the industry. Specific changes included:

- formal recognition that cooperative dairy companies (or the dairy farmer suppliers of any other companies) were the "owners" of the NZDB's capital;
- replacing the NZDB's two government appointees with two directors appointed for their commercial expertise, and giving the industry the responsibility to decide how it wishes to appoint or elect the remaining 11 directors; and
- requiring the NZDB to publish the guidelines by which it would assess applications from prospective additional exporters of dairy products in order to increase transparency in the licensing of exporters other than the NZDB.

Changes in line with general producer board legislation included:

- more commercially oriented financial reporting;
- independent performance and efficiency audits every five years; and
- exempting some of the Board's export related powers from Part II of the Commerce Act.

Dairy Board Amendment Bill currently before Parliament

Currently before Parliament is another amendment to the NZDB's Act, the Dairy Board Amendment Bill. The Bill is expected to be passed in 1996.

The dairy industry has identified that significant investment will be required to enable the NZDB to capture future market opportunities. This investment will be needed to fund working capital requirements, brand building activities, and technology and distribution systems. The Bill will provide a means to source the necessary capital from within the dairy industry.

The Dairy Board Amendment Bill:

- repeals the NZDB's current ownership provision, added in 1992, and replaces it with a share structure;
- provides for the NZDB to have a constitution on matters relating to shares; and
- recasts the NZDB's current dissolution provision to provide for the continuation of marketing activities should the NZDB ever be dissolved.

The Bill provides for shares in the NZDB to be owned by cooperative dairy companies in proportion to the quantity of milksolids supplied by companies to the NZDB. Existing suppliers of dairy produce who increase their production, and new suppliers, will be required to purchase additional shares in line with the additional supply. The shares will not have voting rights but can attract a dividend.

If the NZDB was ever dissolved, the proposed new dissolution clause will provide for the continuance of the body corporate in a company form, unless the shareholders of the NZDB have decided that its assets and liabilities should be transferred to some other entity or entities. The industry believes that a dissolution clause is needed to protect the brand value and usage of those brands owned by the NZDB beyond the life of the NZDB for the advantage of the whole industry.

In line with proposals for other boards, the Bill will add directors duties provisions to the Dairy Board Act similar to those found in the Companies Act 1993.

Proposed Producer Boards Acts Reform Bill

The Government intends to introduce a Producer Board Acts Reform Bill (PBARB) this year. The Bill will replace the three Acts governing the Meat, Wool, and Pork Boards with three completely new Acts. The changes are in line with the general move to make boards more independent of the government and more accountable to producers, and there are significant changes to the Meat and Wool Boards' powers. In addition, the fact that the Acts are being replaced rather than amended provides an unusual opportunity to make changes right through the legislation and bring it into line with the way boards operate in practice in the current environment.

The boards and industries are generally supportive of the changes in the proposed Bill. In fact, the Wool Board actually wrote to the Government requesting that most of its regulatory powers be removed. Federated Farmers of New Zealand has been supportive of the changes, but some farmers have expressed concern about the reduction of the Meat Board's powers.

PBARB: Generic Reforms Applying to All Three Boards

Objects

It is proposed that the objects of the three boards be to help attain, in the interests of producers, the best possible net ongoing returns for their industry. For instance, in the case of the Meat Board, the object will be to help attain, in the interests of producers, the best possible net ongoing returns for New Zealand livestock, and for the meat and byproducts derived from that livestock. In addition, in pursuing their objects, the three boards will have to have regard to the desirability of their wider industry making the best possible net ongoing contribution to the New Zealand economy.

The proposed objects are intended to strike a balance between the boards' accountability to their levy payers, their responsibilities to the wider industry, and the national interest.

Functions

The boards' main functions are in the areas of:

- increasing the demand for their industries' products;
- conducting or funding research and development;
- encouraging the adoption of more efficient processes and practices in their industries; and
- collecting, processing, maintaining and making available information, in order to assist production, investment, processing, product development and marketing decisions.

In the case of the Meat Board, functions will also include facilitating exports to those markets where restrictions and/or requirements are imposed that directly affect access of New Zealand meat and meat byproducts.

These functions will only be performed to the extent that they are consistent with the boards' objects.

Powers

The three boards will retain the powers of a natural person and powers to collect information from their industries.

Each board will also retain power to collect levies from producers. Some commentators have proposed that the boards collect levies under the Commodity Levies Act 1990. They consider that this would make the boards more accountable to producers, and more focused in their operations, as there is a five yearly review under that Act. However, this would not guarantee

that the boards, which are required to carry out statutory functions, would be adequately funded for the effective discharge of their statutory responsibilities. The Government did not wish to run the risk that organisations established by statute cannot function because of lack of funds. The accountability provisions that will be included for the three boards in the proposed Bill are stronger than those required by the Commodity Levies Act.

Duties

Each board will be required to:

- account to producers, such as through annual general meetings and regional meetings, on its activities and its use of levy monies and other resources;
- discuss matters relating to board activities or proposed board activities with industry organisations and interests;
- report to the Minister on its performance of its functions and its use of statutory powers;
- undertake five yearly performance and efficiency audits; and
- implement financial reporting similar to companies.

In addition, board directors will be subject to duties similar to those in the Companies Act.

PBARB: New Zealand Meat Board

The New Zealand Meat Producers Board is governed by the Meat Export Control Act 1921-22. Apart from the amendments outlined earlier in this paper, a number of other changes will be included in the new legislation.

The Board (to be renamed the New Zealand Meat Board (NZMB)) will comprise 12 directors, up from 11. The NZMB will have six directors directly elected by farmers (see Meat and Wool Boards Electoral Regulations section, below), four directly elected by processors and exporters, one nominated by the New Zealand Dairy Board, and one appointed by the Minister of Agriculture on the NZMB's recommendation. The most significant change here will be the addition of directors elected by processors and exporters. Previously there were four directors with commercial expertise appointed by the Minister of Agriculture on the Board's recommendation. This change is designed to bring expertise from the meat processing and exporting industries to the Board, while also boosting their buy-in to the NZMB's activities, and therefore encouraging industry segments to work together. While some meat companies sought a fifty-fifty split of the Board between directors elected by processors/exporters and those elected by farmers, this is was not agreed for inclusion in the proposed Bill, because, at the end of the day, it is the farmers who fund the Board.

While the NZMB's powers will be substantially reduced, it will still have a wider range of powers than the Wool and Pork Boards. As well as its natural person, levy, and information collection powers, the NZMB will have:

- powers to license exporters (effectively on demand);
- powers to impose requirements on exports in certain circumstances, including allocation of access to tariff quota markets; and
- powers relating to the quality of export meat.

The current licensing regime will not be retained. However, all persons who export meat will be required to hold an export licence, issued by the NZMB on the provision of basic information. The current restrictive system was changed on the basis that it may reduce the incentive for exporters to innovate, block out some (potentially innovative) exporters entirely increase costs, and deter investment in the industry. It is also less transparent than the proposed system.

In most markets the ability to increase prices by restrictively licensing New Zealand exporters is constrained by competition from other suppliers, and demand for red meat is sensitive to price because of the availability of substitutes. Changes to export licensing were made on the basis that in most markets, any benefits from imposing disciplines are likely to be outweighed by the costs of stifling and deterring investment.

In order to maximise the capture of quota rents, it is necessary to retain powers over exports to markets where importing countries have imposed restrictions. The NZMB will have the power to impose requirements on meat and meat product exports where there are market access restrictions, arrangements or requirements (not being of a hygiene or sanitary nature) imposed by the government of the importing country (such as country specific tariff quotas). Requirements could include restrictions over quantities, timing, or types of meat exported. The NZMB will be required to consult the industry before imposing any such requirements, and will have to be satisfied that the imposition of a requirement is likely to be the most effective and efficient way of dealing with the importing country's restrictions.

As a subset of its powers to impose export requirements, the NZMB will be responsible for establishing and administering mechanisms for the allocation of access to tariff quota markets. In developing an allocation mechanism the NZMB will be required to consult with the meat industry. If any mechanism developed involves the NZMB making an allocation of access (rather than, for example, tendering the access) the NZMB must, in making such an allocation, take into account previous investment, and provide for new entrants.

The NZMB will have powers relating to export meat quality (not relating to hygiene or importing countries' sanitary requirements which are the province of MAF). The NZMB's powers here may be exercised only where:

- there is a reasonable likelihood that one or more sectors of the New Zealand meat industry would suffer significant detriment if such powers were not used;
- the meat industry has been unable to voluntarily implement measures to counter that detriment; and
- the NZ Meat Industry Association (which represents meat companies) has, after wide consultation within the industry by it and the NZMB, given its agreement to the NZMB using these powers.

The proposed Bill provides for the NZMB's current grading powers to be replaced by the power to establish carcass description systems, with the point of compulsion shifting from point of export to in the works. The NZMB will be required to consult with the meat industry before implementing or amending any carcass description system.

Under its current Act the Board can assume control of any export meat, and make directions relating to slaughter of stock from which meat is intended for export. These powers have not been exercised in recent years, and their existence is likely to deter investment and innovation in the meat industry. These powers will be repealed in the proposed Bill.

The Bill will also repeal the NZMB's transport powers. The rationale for the Board having transport powers in the past was for the industry to have bargaining power with shipping companies. However, in the absence of this provision, exporters could still act together voluntarily to increase their bargaining power. The repeal of this power will enable exporters, acting either individually or collectively, to seek out shipping arrangements that suit their own requirements.

PBARB: New Zealand Wool Board

The New Zealand Wool Board (NZWB) is governed by the Wool Industry Act 1977. Apart from the proposed amendments listed earlier in this paper, the proposed Bill will contain a number of amendments specific to the NZWB.

The NZWB will comprise six directors elected by farmers by direct election on a ward basis (see section on Meat and Wool Board Electoral Regulations below) and four directors with relevant expertise appointed by the Minister of Agriculture on the recommendation of the NZWB itself. These replace three directors appointed by the Government, and the position held by the Director-General of Agriculture.

The NZWB will retain powers of a natural person, levy powers and information collection powers. The NZWB will also retain some powers over the quality of wool exports, similar to those proposed for the NZMB.

The NZWB's power to control and influence the transport of wool; power to license operators to receive, store and appraise wool; power to license wool exporters; and power to compulsorily acquire and market wool will be repealed.

The NZWB has been licensing wool exporters permissively, which has led to compliance costs for exporters but few benefits. The NZWB's powers to compulsorily acquire and market all wool have never been used, and cannot be invoked without a referendum of growers. Repealing these powers is designed to remove any indirect effects on commercial behaviour, such as deterring prospective entrants to, and investors in, the wool industry.

PBARB: New Zealand Pork Industry Board

The New Zealand Pork Industry Board (NZPIB) operates under the Pork Industry Board Act 1982. The NZPIB's statutory powers are limited, and almost all of New Zealand's pigmeat production is supplied to the domestic market. Apart from the proposed amendments listed earlier in this paper, the proposed Bill will contain amendments specific to the NZPIB relating to the directorship of the NZPIB and administrative matters.

The NZPIB will have five directors elected by pork producers, and at least two and no more than four directors recommended by the NZPIB.

The NZPIB's powers of a natural person, levy powers and powers to collect information will be retained.

Meat and Wool Board Electoral Regulations

The method by which farmers elect directors to the NZMB and the NZWB are governed by regulations made under the boards' Acts. These election regulations were replaced in 1995 (Meat Board Regulations 1995 and Wool Board Regulations 1995).

Previously, sheep and beef farmers elected 25 members to an electoral committee and that committee in turn elected directors to the NZMB and the NZWB. In a referendum held in 1993, farmers voted in favour of a direct form of election based on a ward system of voting. Direct elections provide more direct accountability of directors to farmers.

The new regulations, in force since 1995, allow eligible farmers to vote directly for directors on the two boards. The country is divided up into six wards with each ward electing one director to each Board every three years.

Primary Products Marketing Act 1953

The Primary Products Marketing Act 1953 is the umbrella legislation for the regulations providing for the New Zealand Game Industry Board, the New Zealand Kiwifruit Marketing Board and the New Zealand Raspberry Marketing Council.

In 1993 the Primary Products Marketing Act was amended to increase the financial independence of boards established under it. This removed the requirement for these boards to obtain the Minister of Finance's consent to their borrowings and investments.

New Zealand Apple and Pear Marketing Board

The New Zealand Apple and Pear Marketing Board (NZAPMB) operates under the Apple and Pear Marketing Act 1971. The NZAPMB is responsible for all the export marketing of apples and pears produced in New Zealand. The NZAPMB also plays a leading role in the formulation of policy and the general development of the New Zealand pipfruit industry.

The main aims of the 1993 amendment to the Apple and Pear Marketing Act 1971 were:

- to deregulate the domestic market for apples and pears; and

- to increase the independence of the NZAPMB from the Government, and improve the NZAPMB's accountability to the growers who fund it.

In addition the NZAPMB was given the ability to "claw back" money already paid to growers where market returns are lower than the price set by the NZAPMB. Market returns are now the main factor the NZAPMB must consider in setting prices. These changes were designed to limit cross-subsidisation between different types of fruit.

Deregulation of the domestic market for apples and pears

The 1993 amendment provided for the deregulation of the domestic market from 1 January 1994 with the NZAPMB's principal functions being limited to the acquisition and export marketing of apples and pears. The NZAPMB is free to trade in any horticultural product in New Zealand and can obtain Ministerial approval to export horticultural products other than apples and pears.

The NZAPMB has the legal responsibility for all exports of fresh apples and pears, and it generally exports the fruit itself. However, the 1993 amendment required the NZAPMB to publish the guidelines by which it would assess applications from prospective additional exporters of apples and pears. The NZAPMB already had the power to permit others to export, but this amendment made the process more transparent. It is up to the NZAPMB to decide what is in the guidelines and to make the decision on any applications that it receives. This is considered necessary given that the NZAPMB has the legal obligation to accept all apples and pears that meet its standards.

Increasing the independence of the NZAPMB from the Government, and improving the NZAPMB's accountability to the growers who fund it

The 1993 amendment to the Apple and Pear Marketing Act replaced the two Government members, who represented New Zealand consumers, with three directors appointed for their commercial expertise. These three directors are appointed by the Minister of Agriculture on the nomination of the NZAPMB itself. The other four directors are appointed by the Minister of Agriculture on the nomination of the New Zealand Fruitgrowers Federation. The changes reflected the increased independence of the NZAPMB from the Government and the deregulation of the New Zealand apple and pear market.

The 1993 amendment also:

- required the NZAPMB to commission a performance and efficiency audit at least once every 5 years - the first audit was carried out as at 1 October 1994;
- provided for more commercially oriented financial reporting;
- formalised the NZAPMB's annual general meetings; and
- exempted certain export related powers of the NZAPMB from Part II of the Commerce Act.

New Zealand Horticulture Export Authority

The New Zealand Horticulture Export Authority (NZHEA) is governed by the Horticulture Export Authority Act 1987.[3] The primary function of the NZHEA is to promote the effective export marketing of horticultural products. The Horticulture Export Authority Act provides for horticultural products to become "prescribed products", the establishment of export marketing strategies for prescribed products, and the licensing of exporters. Currently there are 19 prescribed products.[4]

The only significant amendment to the Horticulture Export Authority Act was made in 1992. The 1992 amendment was designed to improve the effectiveness of export marketing strategies and improve the NZHEA's efficiency so that Government funding could be ended.

The NZHEA Amendment Act 1992 gave greater powers to the NZHEA in relation to what could be included in an export marketing strategy. Strategies can now:

- impose limits on the volume of a prescribed product to be exported to a specific market; and
- limit the number of exporters to be licensed to export a prescribed product.

To restrict these powers the 1992 amendment put export marketing strategies under constant review. Restrictions on the volume and number of exporters automatically expire three years after their approval by the NZHEA.

The 1992 amendment also changed the rules for export licensing:

- export licences must be renewed every five years;
- licence applicants must comply with stricter conditions in order to be granted a licence; and
- the NZHEA can refuse to grant an export licence.

These provisions gave the NZHEA the teeth to enforce the conditions on exports commonly found in export marketing strategies.

The 1992 amendment also:

- reduced the number of board members from nine to five; and
- introduced five yearly performance and efficiency audits - the first one was carried out as at 1 October 1994.

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[3] For information on the establishment of the NZHEA refer to Cottrell and Walker, 1991.

[4] The 19 prescribed products are: apricots; avocados; blackcurrants; blueberries; boysenberries; citrus; feijoas; garlic; myoga; nashi; nectarines; peaches; persimmons; plums; squash; sweet cherries; table grapes; tamarillos; and wasabi.

The Government has now phased out its funding of the NZHEA. Today the NZHEA recovers the full cost of its activities by means of fees imposed on recognised product groups.

New Zealand Kiwifruit Marketing Board : Industry Review

The New Zealand Kiwifruit Marketing Board (NZKMB) is governed by the Kiwifruit Marketing Regulations 1977, under the Primary Products Marketing Act 1953. The NZKMB was established in 1988, with substantial grower support, in response to a dramatic fall in orchard profitability in the 1986 to 1988 seasons. The primary function of the NZKMB is to organise and control the export marketing, other than to Australia, of kiwifruit produced in New Zealand.

There have been several amendments to the Kiwifruit Marketing Regulations mainly to amend the price fixing mechanisms that the NZKMB uses to pay growers for kiwifruit.

In 1992 the NZKMB significantly overestimated the value of the 1992 crop and overpaid growers early in the season, leading to the NZKMB incurring a debt of NZ$93m. In response to this situation the kiwifruit industry initiated a review, which was undertaken in three stages. Stage one of the review resulted in the formation of a national organisation of kiwifruit growers, New Zealand Kiwifruit Growers Inc, to represent the interests of kiwifruit growers, and for the NZKMB to be accountable to. Stage two, a marketing study, recommended options for export marketing strategies and provided the basis for considerable industry consultation. This consultation constituted the third stage of the review, which resulted in a final report being completed in November 1995. The report recommendations were in three main areas.

- **"Corporatisation"**The NZKMB would be established under its own Act of Parliament, with grower ownership and a share structure. There would be eight directors of the new NZKMB, six appointed by New Zealand Kiwifruit Growers Inc and two appointed by the NZKMB for their commercial expertise. The NZKMB's marketing functions would be performed by a wholly owned marketing company which would be free to focus on commercial marketing without interference from the industry, but would be directly accountable to the new NZKMB.

- **"Collaborative Marketing"** The NZKMB would be enabled to work with other organisations in exporting kiwifruit. A committee of the new NZKMB would be responsible for receiving and processing applications, and making recommendations to the new NZKMB.

- **"Operational Restructuring"** The point of supply between grower and marketer would be more flexible than permitted under the current Kiwifruit Marketing Regulations, with growers taking more responsibility for onshore activities such as coolstorage and transport.

The objective of these proposals is to retain a cooperative, single-desk structure while:

- improving marketing performance, mainly through the marketing company concentrating on operating commercially in overseas markets, and the NZKMB working with growers and postharvest operators to improve the efficiency of onshore handling; and

- improving the accountability of the NZKMB to growers.

The final report of stage three of the industry review was presented to the Government and to growers in November 1995. Kiwifruit growers showed their support for the review recommendations in a referendum held in December 1995.

The NZKMB and New Zealand Kiwifruit Growers Inc have formed an Industry Change Group to implement the review recommendations. Many changes can be made under the existing Kiwifruit Marketing Regulations 1977. The changes proposed for 1996 include:

- setting up the separate marketing company as a subsidiary of the NZKMB;

- appointment and election of new directors for the NZKMB (by the methods currently specified in the Kiwifruit Marketing Regulations) and for the marketing company;

- assessment of collaborative marketing proposals from private organisations; and

- trial contracts with growers, to investigate different allocation of responsibilities between growers and the NZKMB.

Some changes, such as clarification of the NZKMB's ownership, issue of shares, and compulsory changes to onshore operational structures, would need legislative changes. However, various issues need to be worked through before any new legislation can be considered. These include:

- the roles of New Zealand Kiwifruit Growers Inc, the proposed new NZKMB and the marketing company (measures would be needed to ensure transparency and accountability of the NZKMB and marketing company to growers);

- the extent to which more flexible and commercial relationships with growers can be introduced, while retaining the fairness and transparency required for a single-desk marketing operation; and

- details of share value and redeemability.

CONCLUSIONS

The 1990s have seen a continuation of the changes to producer board legislation that began in the mid 1980s. In 1991 Cottrell and Walker predicted that decision makers were likely to continue making changes to producer board legislation in an incremental manner, and this has proved to be the case over the last five years. For example, while the Producer Board Acts Reform Bill will substantially reduce the Meat and Wool Boards' statutory powers, many of these powers were not being actively used. The changes to the Dairy Board's ownership provision are substantial, but they stop short of full corporatisation (on the basis that this would be inappropriate while the Board retains its export monopoly status).

Sources of Pressure

Continuing pressure for changes to producer board legislation can be expected from a variety of quarters, including:

- producers in importing countries who wrongly consider that New Zealand's trading boards are subsidised and have an unfair advantage;
- New Zealand producers who wish to have their ownership stake in boards' assets more clearly defined; and
- business lobbyists and economists who consider that the continued existence of statutory producer boards does not lead to net benefits for New Zealand and is inconsistent with the wider changes in other parts of the economy.

In addition, the need to amend legislation for practical or administrative-type reasons should not be underestimated. When producer board Acts are amended or replaced, there are usually a number of changes that have no philosophical origin, but are merely intended to make the legislation work better in practice.

The boards themselves and a majority of producers have generally gone along with the incremental changes of the 1990s, and in some cases have actively sought them. However, both boards and producers have vigorously resisted suggestions of wholesale changes or repeal of producer board legislation. In particular, most producers who export through the trading boards are firmly of the view that their returns are enhanced by those boards' activities.

Implications for Legislation Under MMP

The change to MMP will affect how these influences translate into decisions by government and legislative change by Parliament. However, it is not clear what these effects will be. The introduction of MMP may have implications for the quantity of legislation considered by Parliament. Looking to the experience of proportional systems overseas the evidence is mixed. The relative strength of the governing coalition may be a determining factor. In countries where the coalition is relatively weak, the passage of government legislation depends on securing consensus. This is likely to delay the pace of legislation, which has implications for both the ability to implement major policy changes and the ability to keep producer board legislation up to date and workable. It is also likely that the rural sector will have less influence in the political sphere under MMP (this is aided by demographic changes), and that Parliament may very well have fewer MPs with any understanding of the organisation of New Zealand's agricultural marketing.

Implications of Changes for Industries

Many of the recent and proposed changes to producer board legislation put more responsibility in the hands of farmers. AGMs, for example, will be ineffective if farmers do not participate. While turnouts at AGMs to date have been encouraging, it remains to be seen how effectively farmers will hold the boards accountable. Other industry participants will also have to take more responsibility. In the meat industry, for example, the Meat Industry Association will have greater input into decisions on the Board's use of its statutory powers. Further, the reduction in the Board's role will mean that processors and exporters will be able to make more decisions for themselves. If results are poor, they will be less able to blame the Board. As the reforms take effect it will be necessary to monitor the extent to which industries are taking up the responsibilities they are being given.

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NON TRADING BOARDS

Name of Board and Act under which Board Operates	Statutory Object/Functions	Powers Relating to Export Market	Powers Relating to Domestic Market	Other Powers Conferred by Statute
Meat Producers Board* (Meat Export Control Act 1921-22 - as amended)	statutory object is to ensure that the producers in New Zealand of stock from which meat is derived obtain the best possible long-term returns for that stock	the Board is actively involved with product promotion: it has unused powers to take control of export meat: it licenses exporters	Nil	- establish grading standards - arrange shipping* - impose a levy on stock slaughtered
Wool Board* (Wool Industry Act 1977 - as amended)	statutory object is to obtain in the interests of growers the best possible long-term returns for NZ wool	the Board is involved with product promotion and research: it has latent powers to acquire all wool for export: it licenses exporters and requires all export wool to be certified	Nil	- establish standards - control freight, storage* - impose a levy on wool sold
Pork Industry Board* (Pork Industry Board Act 1982 - as amended)	statutory functions include promoting and assisting with the orderly development of the industry and marketing of its products: the PBAR Bill will insert an object for the PIB*	N/A	the Board is actively involved with product promotion	- impose a levy on pigmeat producers
Game Industry Board (Game Industry Board Regulations 1985 under the Primary Products Marketing Act 1953 - as amended)	statutory functions include promoting and assisting with the orderly development of the game industry and marketing of its products	the Board does not trade: it has latent powers to license exporters of deer products	Nil	- impose a levy on deer and deer products - undertake and control research
Horticulture Export Authority (Horticulture Export Authority Act 1987 - as amended)	statutory primary function is to promote the effective export marketing of horticultural products	the Authority does not trade: it approves export marketing strategies and licenses exporters for horticultural products prescribed under the Act - there are currently 19 prescribed products	Nil	- undertake market research - latent power to levy

* The Producer Board Acts Reform Bill scheduled for introduction into Parliament in 1996 will refocus non trading Boards away from regulating their industries towards using farmers' levies to increase demand, fund research and development etc. The Meat and Wool Boards' control/acquisition powers and some other powers will be repealed.

APPENDIX ONE

LIST OF AMENDMENTS TO PRODUCER BOARD LEGISLATION IN THE 1990s

Apple and Pear Marketing Act 1971
- Apple and Pear Amendment Act 1993
- Apple and Pear Marketing (Annual General Meetings) Regulations 1994

Dairy Board Act 1961
- Dairy Board Amendment Act 1992
- Dairy Board Amendment Bill (1996 No 1)
- Dairy Board Amendment Bill (1996 No 2)

Horticulture Export Authority Act 1987
- Horticulture Export Authority Amendment Act 1992
- New Zealand Horticulture Export Authority (Fees) Regulations 1994

Marketing Act 1936
- Hop Marketing Regulations 1939
  - Amendment No. 17 1991
  - Amendment No. 18 1994

Meat Export Control Act 1921-22
- Producer Boards Acts Reform Bill (1996)
- Meat Board Regulations 1995

Pork Industry Board Act 1982
- Producer Boards Acts Reform Bill (1995)

Primary Products Marketing Act 1953
- Primary Products Marketing Amendment Act 1993
- Game Industry Board Regulations 1985
  - Amendment No. 3 1991
- Kiwifruit Marketing Regulations 1977
  - Amendment No. 6 1991
  - Amendment No. 7 1991
  - Amendment No. 8 1992
  - Amendment No. 9 1992
  - Amendment No. 10 1993
- Raspberry Marketing Regulations 1979

Wool Industry Act 1977
- Producer Boards Acts Reform Bill (1996)
- Wool Board Regulations 1995

TRADING BOARDS

Name of Board and Act under which Board Operates	Statutory Object/Functions	Powers Relating to Export Market	Powers Relating to Domestic Market	Other Powers Conferred by Statute
Dairy Board* (Dairy Board Act 1961 - as amended)	statutory functions include acquiring, controlling and marketing export dairy produce	the Act empowers the Board to acquire and market all of NZ's export dairy produce: it may grant permission for others to export	the Board operates a price equalisation scheme between domestic and export market for certain products	- authorise appointment or election of 11 of its 13 directors - retain money to maintain reserves - control dairy livestock breeding
Apple and Pear Marketing Board (Apple and Pear Marketing Act 1971 - as amended)	statutory function includes acquiring, exporting and marketing apples and pears	the Act requires the Board to acquire and market all of NZ's export apples and pears that meet export standards: it can give consent to others to export	Nil	- establish standards - impose levy on fruit acquired - retain money to maintain reserves
Kiwifruit Marketing Board (Kiwifruit Marketing regulations 1977 under the Primary Products Marketing Act 1953 - as amended)	statutory object is to obtain in the interests of NZ producers, the best possible long term returns for kiwifruit intended for export	the regulations require the Board to acquire and market all of NZ's export kiwifruit (except exports to Australia): private traders can export only if acting as an agent of the Board	Nil	- establish standards - retain money to maintain reserves
Raspberry Marketing Council (Raspberry Marketing Regulations 1985 under the primary products marketing Act 1953 - as amended) (Currently under review)	statutory functions include regulating , controlling and promoting the orderly marketing of raspberries both locally and overseas	the Council has the power to purchase, sell, or dispose of raspberries on the world market as it thinks fit: private traders can export only if acting as an agent of Council	the Council has the power to fix quotas for supply to domestic manufacturers and resellers	- undertake production and market research - impose levies on growers
Hop Marketing Board (Hop Marketing Regulations 1939 under the Marketing Act 1936 and the Agriculture (Emergency Powers) Act 1934 - as amended (currently under review)	statutory functions include regulating and controlling the marketing, both locally and overseas, of all hops produced in NZ	subject to Ministerial approval the Board controls and regulates exports as it sees fit; it acts as the sole agent for hop producers	subject to Ministerial approval the Board controls the domestic hop industry including imports	- establish standards - arrange shipping and storage - register producers

* The Dairy Board Amendment Bill before Parliament will repeal the Board's current ownership provision and replace it with a share structure.

The Evolution of Institutions in New Zealand Agriculture

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Institutions dramatically impact economic performance yet are an often neglected area of study by economists. New Zealand agricultural institutions have continually evolved since the nation's settlement and yet there has been substantial stability. These institutions include farm organizations, cooperative agribusiness, corporate agribusiness and agricultural marketing boards. This paper assumes institutional choice is in large measure endogenous and presents a model for institutional choice based on property rights theory and the theory of contracts. It highlights critical issues for research by agricultural economists during the 21st Century.

Introduction

Analysis of institutions by economists has rarely been a major part of economics research. However, the New Institutional Economics (NIE) with studies focussed on property rights (Demsetz), public choice processes (Olsen), organization and agency theory (Coase and Williamson), the dispersion of knowledge (Hayek) and economic history (North) provide economists with a rich array of intellectual apparatus to examine institutions.

The thesis of this paper is that: a) agricultural institutions have changed throughout the twentieth century and will continue to change through the twentyfirst century, and b) economists need to understand the determinants of these changes if they are to anticipate future changes. Further, it contends that institutional choice in large part derives from agent's decisions in response to their given opportunity set (of prices and quantities) and opportunities to change that set. It contends that we can consider institutional choice in large measure endogenous.

Agriculture has changed in terms of prices, output, incomes and in terms of its contribution to the New Zealand economy. At the same time institutions have changed. For instance, some marketing boards have been created, abolished and recreated during this century. Other changes include the dramatic consolidation of cooperative dairy companies during the later half of the century from over 500 in 1945 to 16 in 1996.

Despite the evolution of institutions in New Zealand agriculture there has been remarkable stability. Family farms remain the dominant form of farm business. Cooperatives and Statutory Marketing Boards remain as major forms of business organization in the agricultural sector.

The patterns of stability and change raises the question as to why institutional change has occurred? (and in some cases why has it not occurred?) Certain hypotheses immediately spring to mind: eg technological change makes certain forms of organization less efficient, or certain organizational forms allow the capture of economies of scale. The purpose of this paper is to describe some of the observed institutional change as a basis for formulating hypotheses for testing in future research. The results of such hypotheses testing can facilitate the prediction of future changes in organizational form.

The Farm[1]

The family farm has been and continues to be the dominant form of farm organization. Fairweather (1992) reports that in 1988 public companies owned only 0.3% of all farms in New Zealand and in 1990 private registered companies owned 6.9%, individuals 47.1% and partnerships 42.3%. This institutional form is not limited to New Zealand. In the United States non-family farms comprise less than 1% of total farms and in Canada non-family farms comprise less than 2% of total farms (Allen and Lueck). This stability in farm institutions is in some senses surprising given the changes in other family owned businesses (eg grocers and

[1] Generalizations about farms need to be treated with caution due to differences between farm types (eg sheep and beef versus dairy) and even within these broader categories (eg South Island High Country versus North Island Hill Country Sheep and Beef Farms).

automobile service stations).

Despite the stability in family ownership, farms have not remained the same during the last one hundred years. The number of farms and farmers has declined, farm sizes have increased and farmers have purchased more inputs and manufactured less. They have become more capital intensive and they have engaged more contractors. However what is notable is how stable they have been during the last two decades. Gouin et al. show that farm numbers by size have been almost constant between 1972 and 1992 except for farms of less than 40 ha. However, farms with 500 to 2000 sheep have declined substantially as have farms with less than 200 cows while farms with more than 5000 sheep or farms with more than 300 cows have increased substantially (see table 1). Fairweather (1994) reports on a survey of 29 dairy farmers with an average of 895 cows.

Table 1
Changes in Farm Size 1972 to 1992

Year	Dairy farms <200 cows	Dairy farms > 300 cows	Sheep Farms 500-2000 sheep	Sheep Farms >5000 sheep
1972			15586	1564
1975	1071	393		
1992	532	1257	8924	1947

Source: Gouin at al.

Three issues are of particular importance when considering farm organization: the gains from increasing size and specialization, the contribution and scope of family business forms, and the biological nature of farming systems. In many industries increasing business size and specialization has produced economies of size and specialization which has been made possible

by the investment of additional capital, labor and management. Family businesses are important management and investment vehicles because they are associated with minimal moral hazard. However, families are by definition small and as a business grows the particular significance of family management and labor declines due to the delegation of tasks to non-family or distant family members. This loss of family protection from moral hazard is not critical where there are satisfactory monitoring mechanisms and/or the gains from increased specialization and size more than offset the moral hazard losses. However with farming systems being biological systems with substantial stochasticity the extent of moral hazard problems increases substantially. Seasonality, timing, weather and pests have the potential to mask the impacts of shirking.

The challenge of taking advantage of increased specialization and size in farming requires the development of contracting mechanisms that capture gains and minimize risks of shirking. Developments in shearing technology facilitated the employment of contract shearers which in turn facilitates the farming of more sheep per permanent labour unit. The development of share milking and volume milking contracts provided a mechanism for reducing farm owners direct monitoring of labour inputs. Various share farming agreements have been important as corporate investors have sought to invest directly in agricultural production.[2]

Three issues of particular importance are: advances in technology, advances in information technology, and alternative contracting regimes. Specific technological advances may provide the opportunity to change input mixtures (capital/labour ratios) or reduce the variation in output

[2] eg Apple Fields and Tasman Agriculture.

from a given production system. Information technology is particularly important in facilitating monitoring and adapting production systems in real time. Alternative contracting regimes can vary in terms of the degree to which both input costs and output returns are shared. As biological stochasticity has been reduced (as in the production of broiler chickens) contracts have been more precisely specified and more vertical integration has occurred. One tentative hypothesis is that contractual evolution is associated with expanding industries (eg dairy and forestry) as new capital and human capital enter the industry as opposed to declining industries.

Family farm businesses in New Zealand have been surprisingly resilient during the last century. However they have adapted in many ways and it would seem likely this adaptation will continue in the face of technological, economic and political pressures. The significant increase in off farm earnings over recent years (Journeaux, 1995) indicates that both financial capital and human capital is being reallocated, though this has not happened to the extent of similar change in the United States.

Corporate Agriculture

Corporate agricultural investment shave long been part of New Zealand agriculture. British (eg Vestys, Dalgety's) and other foreign companies (Unilever) invested in New Zealand to provide inputs and export products along with numerous domestic investors. Five forms of corporate investment have been particular important: the farm supply business, meat and wool processing and marketing, horticultural and grain marketing, intensive livestock production and marketing,

and the corporate farmers. The farm supplies business was historically dominated by the major firms such as Dalgetys and Wright Stephensons). These firms have been under substantial pressure through recent years from within industry competition, competition from banks providing alternative sources of finance, competition from non specialist agricultural firms providing inputs and multiple opportunities for the sale of farm produce. The result has been significant amalgamations and restructuring of operations. A critical issue for farmers and input suppliers alike is the evolution of mutually satisfying trading relationships.

Meat and wool processing and marketing firms in New Zealand have been characterized by competition between each other, the cooperatives and the boards. Initially the field was dominated by foreign companies but slowly that has changed. The development of product, technology and contracting has been slow. Horticultural and grain processing and marketing historically focused on the domestic markets though the development of the Watties Group showed the potential for a greater export focus. Intensive livestock business, including the production of broiler chickens has been dominated by corporate investment with highly specific contracts between growers and integrators. Corporate farmers[3] have never been more than a minor part of New Zealand farming (Fairweather lists six Corporates owning 156 properties in 1992). Where it has developed it has usually depended on substantial partnerships (such as share milkers). Corporate agriculture has historically involved investment in highly competitive markets subject to substantive regulation and substantial production and price fluctuations. Given the disequilibria visible in these markets[4] substantial change seems inevitable.

[3] This excludes family farms held as companies.

Agricultural Cooperatives

Cooperatives have become the sole investment vehicle for dairy processing and major investment vehicles for meat and wool processing and the supply of some farm inputs in New Zealand. The reasons for this particular investment vehicle are multiple. Cook (1996) refers to the "wave theory", the "wind it up theory", the "pace maker theory", and the "mop up" theory. The "wave theory" relates to waves of cooperative formation when prices are depressed; the "wind it up theory and the "pace maker theory" refer to the stimulation of competitors to greater efficiency, and the "mop up theory" refers to actions to prevent competitors acting opportunistically in declining markets.

The potential for cooperative success has long been debated (Helmberger (1966) and Abrahamsen (1966), Ernst and Young (1994)). Whatever the degree of one's optimism concerning this institutional form there are five major challenges facing cooperatives: the free rider problem, the horizon problem, the portfolio problem, the control problem and the influence costs problem (Cook, 1995). Free rider problems occur when property rights are untradable, insecure or unassigned. Horizon problems arise from the time horizon of the member's claims not matching the life of an asset. Portfolio problems relate to the inability of members to adjust their portfolio in terms of their own risk preference. Control problems primarily relate to the lack of information (particularly that associated with traded equity information) available to members and their directors. Influence cost problems derive from diverse cooperative objectives with the potential to have different impacts on the wealth of members. The resolution of these

[4] As evidenced by debates about over capacity, profits and the possibilities of empty cores.

issues will involve the demise of some cooperatives and varying degrees of reform for those that remain. Any reform must take account of the heterogeneous nature of members.

Statutory Marketing Boards

Statutory marketing boards (SMBs) have been substantive institutions in New Zealand since the 1920s. There history has been characterized by ongoing modification of their roles and functions and debate about their effectiveness. It is useful to distinguish between export SMBs and domestic SMBs.

Domestic SMBs in New Zealand have included the Wheat Board, the Milk Board, the Potato Board, the Tobacco Board and the Poultry Board among others. These boards from the outset faced conflicts between the interests of producers and the interests of consumers. These conflicts were further complicated by Government interests such as implicit nutrition policies and the subsidy of favored activities. Cooperative action to facilitate the development of domestic markets to enhance and stabilize producer returns are understandable. However the coercion associated with statutory cooperation, the diversity of producer interests, and the impact on tax payers (in the case of subsidies) and on consumers (in the case of regulations) meant these institutions were unnecessarily politicized. Hence it is not surprising that when the winds of deregulation blew there were few people committed to their defense.

Export SMBs have evolved in two different directions. One path has been that of the sole exporting authority eg Dairy, Kiwfruit, Apple and Pears, while the other has been that of the

regulatory, promotion, and investment agency. While all the boards have experienced substantial producer support, their roles, activities and performance have been a matter of continuing tension. This has manifest itself in attempts to continually reform the boards and accountability mechanisms. These continuing changes partly relate to changes in technology, products and markets and partly to the economic and political tensions inherent in these institutions. Table 2 illustrates some of these changes in both the dairy and wool industries.

Table 2
Evolution of Dairy and Wool Statutory Marketing Boards

New Zealand Dairy Board	New Zealand Wool Board
1923 Dairy Control Board established (renamed NZ Dairy Board in 1935)	1944 Wool Board established
1935 Primary Products Marketing Dept	1952 Wool Commission established
1947 Dairy Products Marketing Commission established	1972 Wool Marketing Corporation established
1961 Merger of DB and DPMC	1977 WMC and Wool Board merger
1992 Dairy Amendment Act	1996 Wool Amendment Bill
1996 Dairy Amendment Bill	

The structure and purpose of SMBs reflect the tension between government goals and producer goals. Government interests over the years, in addition to a general interest in producer welfare, have focussed on responses to war, macroeconomic fluctuations, and attempts to stimulate and manage the growth of the New Zealand economy. Producer interests have involved both attempts to achieve more satisfactory marketing arrangements and attempts to obtain more tax funded support for the agricultural sector.

Debate about SMB effectiveness focuses on whether the performance of a particular SMB is superior to any alternative form of business organization. The evaluation of the effectiveness of

SMBs depends on the yardstick used to assess performance and the availability of data. Informational constraints have to date forced the debate to focus on issues of first principles with supporting observations. The decreasing homogeneity amongst producers, the adverse effects of pooling and the potential for new producers to dissipate rents suggests that even with superior SMB management (in terms of both executives and directors) their potential for superior performance is seriously constrained. Further, given the adverse effects of SMB regulation on other commercial agents and some producers, SMB institutional structures will continue to be highly politicized.

A Model of Institutional Choice.

Institutional forms are the result of agent choice through time in the context of prevailing law. Alternative institutional forms and contracting arrangements are possible. Each regime is associated with a particular set of outcomes (transaction costs, rent dissipation, incentives). Through time outcomes change and the relative importance of different determinants of outcomes change. Individuals have incentives to press for institutional change when changes in prices, information, information technology, technology or other parameters suggest there are benefits from change.

This model for institutional change is based on Lueck's model for maximizing the value of future rents:

$$V = \int_0^{\infty} R(x^*(t)e^{-(r-g)t}dt \qquad (1)$$

where $X^*(t)$ is a matrix of optimal input levels in period t and $R^*(t)$ = optimal periodic rent in period t. However achieving maximum V requires investment in institutional reform, so equation (1) be rewritten as:

$$V = \int_{t'}^{\infty} R(x^*(t)e^{-(r-g)t}dt - Ce^{-rt'} \qquad (2)$$

The challenge for the individual agent is to determine expected rents with different institutional arrangements, and the costs of adjustment from one institutional arrangement to another. Both the expected returns and the expected costs are uncertain and shared with other agents. Clearly the degree of agent homogeneity is critical in determining the possibility of institutional reform.

Generally efficiency is associated with increasing specification of rights so that individual agents bear the consequences of their actions. However in most institutions there are some unassigned rights and some group rights. Groups must attempt to determine the optimal group size, optimal contracts, and optimal enforcement of contracts. The agents then choose their level of effort. Optimal groups size is determined by economies and diseconomies of size. Optimal contracts determine the appropriate allocation of opportunity sets, input costs, and output returns. It is important to note that contracting has costs associated with input and output division, pricing, management and enforcement.

Institutional reform and contract design takes place within a framework of law. Agents are generally not free just to decide what maximizes benefits to themselves. Laws govern agents

behaviour in a host of ways, such as protection of third parties in the cases of both environmental protection and anti-collusion legislation. The fact that there are other stakeholders within the agricultural sector and outside the sector provides a constraint on institutional design. Further, within a free society there are limits to which individual agents can be constrained[5].

Issues in Institutional Analysis

The burgeoning literature in the field of *Law and Economics* and Douglas North, Ronald Coase and James Buchanan all winning Nobel prizes in economics illustrates the importance of institutional analysis. Institutional analysis is however still immature. Contextual issues are of critical importance and formal models and analysis are only slowly emerging. Despite the slow development of institutional analysis opportunities for useful research are abundant. An important task within New Zealand is the writing of an economic history of agriculture which pays adequate attention to institutional issues. What are the different institutional forms that have emerged? What outcomes have been associated with those forms. How can these alternatives be modeled? What hypotheses concerning institutions can be tested?

Historical analysis of institutions must grapple with the reality of different institutional forms and outcomes. At the level of the farm, research can examine the boundaries of the farm organization and the determinants of those boundaries. What is it that determines farm size, input purchases, and input and output contracting arrangements? Agribusiness firms and agricultural

[5] One example of such a limit is the constitutional protection of commercial free speech in the United States.

cooperative contracts and trading arrangements are ripe for further analysis as are their forms of governance. The heterogenous nature of their suppliers and memberships raises complicated pricing and decision issues that have generally not be well addressed in published research. Statutory Marketing Boards need to be continually scrutinized in terms of their impact on willing and unwilling members as well as other stakeholders.

The first step in institutional analysis is primarily descriptive. Currently we lack such descriptive studies which document the nature, structure and performance of agricultural institutions.[6] What do we know about the activities of stock and station firms, meat and wool processing and marketing firms (both cooperative and investor owned), the dismantled domestic producer boards[7], and the remaining statutory marketing boards? Most of this institutional knowledge is locked away in locationally specific human capital or in private files. The development of an institutional knowledge base documenting goals, activities and results, statistics of performance and persistence takes time and debate concerning the definition and value of different indicators. Yet it appears the academic marketing profession has lagged behind the farm management profession in developing that knowledge base and this limits the use of more sophisticated analytical techniques.

Four particular issues in all institutional arrangements are the role of the State, natural resource ownership issues, pooling payment systems, and rent dissipation associated without production

[6] Except in the case of Dairy Farms and Sheep and Beef Farms.

[7] AERU Reports 193 and 216 provide some interpretation of the Poultry Board and the Milk Board.

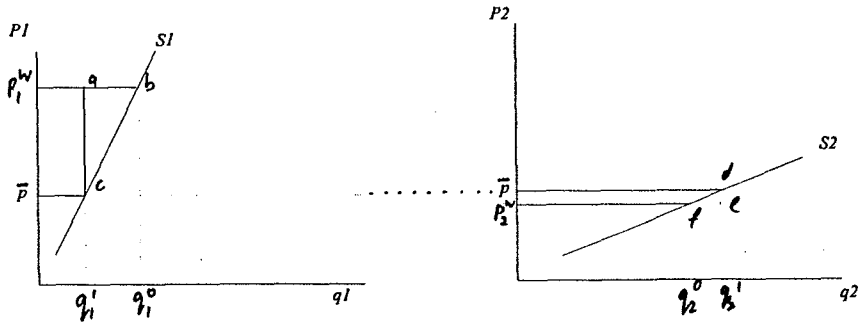
controls. In New Zealand business decisions are in large part left to individual agents and firms. It is assumed they know better than politicians and/or bureaucrats. However where individual agents, firms, or coalitions can harm domestic consumers (eg through monopoly practices), or restrict the commercial actions and freedom of individual firms government has responsibilities with respect to those firms and consumers who are harmed as well as to the dominant producers and their institutions. Given the documented link between economic freedom and economic growth (Gwartney, Lawson and Block, 1996) government has strong grounds to carefully scrutinize restrictive actions. Authors like Hayek and Demsetz emphasize the spontaneous evolution of institutions while Bromley (1991) emphasizes the primary role of the state

Natural resource ownership in agriculture is clearly limited. Although rights in property have been seen as absolute they have usually been restricted, and rights can perhaps be most usefully seen as a bundles of rights. Although surface rights, below ground rights, and above ground rights are clearly separable, the particular configuration of rights and their allocation has the potential to significantly impact management decisions. Perhaps more important than the nature of the rights is the potential for these rights to be qualified by political action. Efficient management decisions requires that agents have at the very least, knowledge about their existing rights, and clear expectations as to the basis on which property rights may be altered. The current United States debates about "takings" is illustrative of the larger problem (Miceli and Sergerson). As population changes property rights are likely to change in line with demographic trends. This will be accompanied by greater political activity by those effected and by pressure for compensation. Further, changes are likely to occur in discrete jumps given the uncertainty about

the resulting costs and benefits (Howitt, 1995).

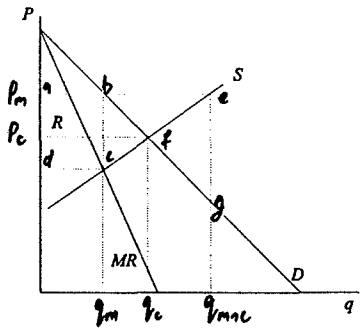
Pooling payment systems are common in agriculture. They occur in payment systems associated with cooperatives, other agricultural traders and statutory marketing boards. Pooling may exist for three different reasons. Returns may be pooled as a basis of risk sharing, to achieve some equity goal or simply because the cost of monitoring multiple product lines is perceived to be too great. Many institutions use some mechanism to sort income streams (eg by source or by quality) and then pool within the separate streams. However the impact of pooling can be substantial. It discourages the production of higher value product and encourages the production of the lower value product. Unless supply is perfectly inelastic welfare losses result. Figure 1 shows given world prices of P_1^w and P_2^w which generate a pooled price $\bar{p}$ the result is a welfare loss of *abc* + *def*. This suggest that through time there will be increased specification of pools to decrease the heterogeneity. The alternative is the pool risks failure.

Figure 1
Initial Economic Effects of Pooling



Rents are potentially available from restricted markets and from export agencies successfully engaging in price discrimination. Martin and Zwart (1987), and Rae (1978) both illustrate the possibility of this occurring. However to the extent that such activity returns higher prices they encourage higher farm production which in turn dissipates the rent. Hence the only way the rent can be protected is by some restriction on production.[8] Without such restrictions there is no reason to believe a monopoly export agency will achieve a superior outcome to a competitive export agencies. Figure 2 shows a supply restricting agency may theoretically generate a rent *abcd* but if the agency pays out the higher price, P_m rather than P_c, you could potentially end up with higher production, at q_{mnc} which is greater than q_m or q_c and which would generate a deadweight loss of *efg*. Similarly, efforts to enhance producer incomes by entrepreneurial activity, may be counterproductive if profits are returned on the basis of production.

Figure 2
Rent Generation and Dissipation



[8] However restrictions on production are likely to be inequitable and potentially trap an industry in a time warp. Hence there are good reasons not to proceed along this path.

Conclusions

Agricultural institutions in New Zealand have changed and will continue to change. These changes will result from the decisions of many individual agents in response to their economic and political environment. Economic analysis is critical in evaluating the changes that have occurred and developing a positive theory of institutional choice. To this end there is an urgent need for a new expanded economic history of agriculture in New Zealand. The writing of such history is essential for hypothesis testing. Further, economic analysis is essential for facilitating institutional design and institutional choice. All institutions are imperfect, but analysts can identify what rents are generated, what rents are dissipated and what the effects are in terms of economic efficiency, equity and freedom.

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Participatory Inquiry - A Methodology for Correcting Market Failure and Addressing Sustainability

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Abstract

Neoclassical economic theory is built upon assumptions such as perfect competition, perfect information, the absence of externalities, the absence of government failure, and clearly established property rights. When these assumptions are not met, the theory suggests economic instruments, such as taxes and tradable permits, as a method of correcting for market failure. This paper considers an alternative methodology that has advantages of correcting market failure, in the process of addressing broader issues of sustainability.

The methodology is participatory inquiry (PI). The methods of PI are increasingly being applied in sustainable development projects to address complex problems which benefit from the group learning and consensus building processes of participatory methods. This paper shows that the conditions necessary for the market to operate as the theory suggests, can be improved upon in the process of using PI to address the complex issues associated with sustainable development. Agricultural and natural resource management examples from Australia, Scotland and New Zealand are used to explore the effectiveness of PI. The relevance of PI for addressing sustainable land management issues in New Zealand is also considered.

Sustainable Development, the Market, and Participation

The existence of Agenda 21 is possibly the most convincing evidence that there is international consensus in the desire for sustainable development, amongst the policy makers of the societies represented in the agreement. Their concept of sustainability, in its broadest sense, represents development which meets social, environmental and economic needs of current society without compromising future generations from being able to meet their needs (World Commission on Environment and Development, 1987).

There is less consensus on the policies and practices which should be applied in order to achieve sustainable development. The issues will vary across different ecosystems, according to the human interactions with the natural environment and the interactions within the human society itself. As the market has a major role in managing these interactions between people and environment it seem obvious to address aspects of sustainability via the market mechanism.

Management of society's needs via market mechanisms is potentially compatible with some aspects of sustainable development but:

- An objective of continuous economic growth is not synonymous with sustainable development. When growth is heavily reliant on throughput of natural resources or when it occurs at the expense of intergenerational or intragenerational equity, the objective of growth potentially conflicts with development.

- Better measures for assessing the health of society and the environment which society is reliant upon are needed. In particular, GDP/GNP is restricted to accounting for monetary costs and benefits which is only part of the assessment of welfare or well being.

- Neoclassical economic theory has perhaps lost some of its original intent and meaning by current emphasis on monetary values. Early development of neoclassical economic theory emphasised human well being as an outcome of the theory's application. The current use of monetary wealth or utility as an indicator of well being has been only partial successful (Perkins, 1995).

It must be recognised that the outcomes of neoclassical economic approaches which require individuals to act independently in their own self interest will always be limited when:

- collective action is required to address issues (i.e. soil and water conservation issues which require co-ordinated effort of individual landuser efforts.)
- non monetary aspects of the environment or society are part of the problem and solution (i.e. life support functions and existence values of the environment.)
- stakeholders in the situation are not represented. (i.e. wildlife, future generations.)

Carley (1994) appreciates theses points and elaborates by identifying as a fundamental challenge to the practice of sustainable development as *"the need to take co-ordinated action across a broad range of issues and among often disinterested stakeholders (national, regional and local)"*.

Pretty and Howes (1993) considering sustainable development in agriculture and identify the need for group action because the land degrading externalities from unsustainable practice often impact on the farmers who are trying to act sustainably, and individual efforts are often compromised when practiced in isolation.

The participation of local people in development projects occurs to varying degrees. It is often limited to information gathering by those external to the group or to the implementation of externally imposed requirements for change. This was characteristic of early development projects (Chambers, 1992) and again today when it is used to extract relevant information to external analysis, and as a means of informing people of externally imposed policy. Pretty (1995; p173) further illustrates the variation in degrees of participation by developing a Typology of Participation, located in Appendix 1.

If individuals operate in their own self interest, then the adoption or implementation of externally imposed policy is only likely to happen if the individuals recognise that the policy is in their best interest. This self interest is likely to involve values which are unique to the individuals in the group and which are easily overlooked by outsiders.

One means of improving the success of policy for addressing complex situations and diverse interests is to include the people responsible for implementing policy by involving them in policy establishment and the decision making process. The methodology of participatory inquiry will be explored further.

Participatory Inquiry (PI) - the Methodology

Participatory Inquiry is a methodology for improving situations in situ, by drawing on the resources, knowledge and perceptions of the people who are most closely related to the situation. The process of inquiry includes the people who are directly involved in or who are affected by the situation (subsequently refered to as stakeholders in the context of this paper) in the identification of relevant issues and the development and implementation of change. The resulting changes should be perceived by the stakeholders to be improvements in the situation.

Pretty (1993) defined participatory inquiry as:

> *"A structured methodology based on principles of multiple perspectives, group inquiry, context specificity and flexibility that uses systematic methods to bring about changes in problem situations that the people in the situations see as improvements"*

Pretty (1995) outlines four main classes of methods. Within these categories are numerous techniques which are currently being further developed by the people applying the methods within diverse settings and conditions. Pretty (1995, p 176) states, " *It is the collection of these methods into unique approaches or assemblages of methods, that constitute systems of inquiry or interaction."* The classes of methods are listed below:

- group and team dynamics methods
- sampling methods
- interviewing and dialogue methods
- visualisation and diagramming methods

The purpose of this paper is not to elaborate on the details of the methods, but rather to consider whether use of such a methodology is potentially effective at correcting market failure and addressing sustainability issues. In order to do this, it is worthwhile considering the characteristics which are common to the diverse applications of participatory methods. Pretty (1995) recognises the vast diversity in alternative systems of learning and action, or participatory inquiry, but identifies common principles which unite most of them:

"A defined methodology and systemic learning process." The methods are used as systems of inquiry and interaction, and focus on achieving learning in all the people involved. In order to achieve this the process must be participatory, including all the participants without favouring any particular party's view.

"Multiple perspectives." All views of a situation and the most appropriate action to be taken are subject to interpretation. The objective is to draw out the diverse interpretations of a given situation as different evaluations of it will result in different actions.

"Group learning process." The group could comprise people from different disciplines or sectors within or external to the situation. Experts from various relevant fields, policy makers, people with a personal interest and local knowledge, people affected directly by the situation - or any combination of these- could be included in the group.

"Context specific." The general techniques are adaptable to the unique conditions and people involved in the specific inquiry.

"Facilitating experts and stake holders." The inquiry process is facilitated by experts or stakeholders who are trained to assist the group in learning and carrying out activities which they deem relevant to the system that they operate within. Facilitation may be the only involvement of experts who are external to the group.

"Leading to sustained action. *The learning process leads to debate about change, and debate changes the perceptions of the actors and their readiness to contemplate action. Action is agreed, and implementable changes will therefore represent an accommodation between the different conflicting views. The debate and/or analysis both defines changes which would bring about improvement and seeks to motivate people to take action to implement the defined changes. This action includes local institution building or strengthening, so increasing the capacity of people to initiate action on their own* (Pretty, 1995)."

As achieving sustainability requires processes which are flexible enough to operate in changing and diverse social and environmental conditions, this paper makes an inquiry into whether PI is potentially a means for addressing sustainability. During the application of PI the multiple perspectives of the individuals in a group are considered, so the outcomes are more likely to be compatible with the values, ability, knowledge and limitations of the part of society represented by the individuals in the group. Knowledge is expanded and consensus for action is developed so that people are more capable and confident in the decisions made through the process. As PI is context specific, the unique conditions of the natural environment and the society in which the processes is used will have been considered, therefore the outcomes potentially address the sustainability issues specific to any given system. An illustration of the results of using a PI approach to sustainable development is found in Appendix II, which describes the Australian National Landcare Program.

PI - Correcting Market Failure

The remaining sections of this paper are organised around relevant market assumptions to examine how PI can be used as a tool to correct for market failure in the process of addressing the broader issues of sustainability.

Human Nature

Earlier it was established that individuals have different perceptions of situations and diverse values and approaches to satisfying their values and managing for their well being. These values encompass goals broader than those satisfied by trade of goods and services, yet economic theory attempts to narrow the definition of well being to that of economic utility. Aguilera-Klink (1994) sees this as a failing of economic theory. *"It is precisely the narrowing of the broad Smithian view of human beings, in modern economies, that can be seen as one of the major deficiencies of contemporary economic theory."*

Economic theory also suggests that people act in their own self interest, without altruism, which is probably one of the greatest reasons that 'green' thinkers often view economics as selfish and distasteful. Perhaps the real issue is not whether altruism exists or not but whether individuals value other people and the environment and whether they receive any benefit from acting to satisfy broader values. If altruism is not a reality then the reason people do good things for others could be

because it increases their own level of personal benefit. In either case, what is really important are the values held by individuals. Human self interest may be a fixed trait as some economists suggests. However, the components of this self interest are variable and are influenced by the environment of the individual and by influences from society, family, peers, market advertising, and regulation. These influences affect a persons perceptions of how their values can be satisfied and have an immeasurable effect on peoples' actions.

Individuals act not only as consumers in a market but in a myriad of other roles and as an element of different groups in society such as family, community, special interest group, etc. It is through rewarding involvement in these groups that the values of co-operation are developed, values which are essential to the achievement of many aspects of sustainable development. If the environment and social well being are priorities to society and aspects of sustainable development, then individuals need means of accounting for these values and relating them to their actions, both as individual consumers and as members of groups within society. In addition, there is a need to better account for benefits from the non-monetary aspects of environmental and social management at a macro level.

For the aspects of sustainability which can be achieved effectively through interactive group participation, PI has the potential to be an extremely useful tool.

Clearly Defined Property Rights and Externalities

It is important to implement sustainability policies at the appropriate scale for addressing the relevant issues. Considering that sustainability is some combination of economic, environmental and social priorities, it is essential that policy designed to address sustainability considers all three elements and empowers the people at the most appropriate level of the system to address the issues.

If responsibility for ensuring environmental protection is appropriated to the level of the system which exhibits the costs and benefits of action, the environmental costs are internalising costs to the group. If this group is also a social institution, then it is in people's best interests to address both the environmental and social agendas simultaneously. In effect, on the individual level there may be externalities, but because the individual is a member of a group and is directly affecting others in that group, peer pressure and support from others helps to regulate individual externalities. Therefore, establishing a social institution for managing the needs of the group is a means of establishing a property right for a common.

A common need not be a situation of tragedy and exploitation, which Hardin (1968) believes it to be. Soderbaum (1994) examined the misuse of the term common property and established that, if clearly defined, common property is an effective property right, established at a group rather than an individual level. There are instances where the allocation of a property right to the relevant group could be effective policy for internalising externality (Meister and Sharp, 1993). Land degradation as a result of agricultural practice is an example of an environmental issue which could be addressed more effectively by establishing the common property right to a group whose members share a common social and environmental boundary. The following two paragraphs further explain this concept.

Some aspects of land degradation, such as soil compaction, fertility decline, and some types of erosion, directly influence the productive capacity of the farm, and are therefore internal costs to that individual system. Thus the most effective policy intervention may be to ensure that there is increased awareness of the cost associated with land degradation and how to act effectively to reduce that degradation.

In comparison, issues such as salinity cross individual farm boundaries and the system which exhibits the majority of the costs and benefits is the catchment or watershed. If the individuals of the catchment are also part of the same social system, then it is in the group's best interest to address the environmental degradation.

The Landcare program in Australia is a good example of this philosophy in action. Instead of pouring money into subsidies, or imposing heavy regulation, the government established a nation-wide education campaign to increase awareness of environmental damage and its costs to individuals and to society. It then supported action by providing trained facilitators to assist self-established catchment groups to address land degradation through means compatible with their social and economic constraints. The effect was to give the people of the catchment area ownership of their own local issues. The result has been the establishment of over 2000 Landcare groups, involving one third of Australia's farming families in the process of finding more sustainable farming practices (Campbell, 1994).

This approach of supporting local people to improve their own situation, is increasingly being recognised for its effectiveness in sustainable development, working as it does from within the system rather than having external agencies attempt to impose change (Pretty, 1995; Chambers, 1992; Scoones and Thompson, 1994). PI applied within these groups has the potential to establish ownership of the issues with the group while empowering individuals to manage their resources more effectively through collective learning and action.

Perfect Competition

As technology and trade agreements increase the size of the market upon which firms are trading, there is a tendency towards increased company specialisation, in order to take more advantage of the economies of scale principle and hence to maximise profits. While society may value the social and environmental benefits often associated with small scale production and local trade, these practices will ultimately decline in a free market if they cease to become economically viable. One approach for addressing these values via a market is the provision of subsidies to encourage compliance to policy intended to account for non monetary values.

In Scotland, payments are currently made to farmers producing in unfavourable environmental conditions in order that these farmers be able to survive financially and continue to provide the social and environmental benefits linked to their way of production. Payments are also made to farmers who comply to lower stocking rate restrictions in environmentally sensitive areas. This policy is perceived to be a means of discouraging the land degradation associated intensification of farming practices, which would otherwise be necessary for economic survival.

An alternative approach for assisting these disadvantaged smaller firms, which creates less interference with the market, is establishment of effective common property rights as suggested in

the previous section, followed by a process of improving the conditions of competition for smaller firms.

Collective action has advantages in both production and marketing. Machinery rings, common in Scotland, are an example of collective action reducing production costs. Small scale farmers form groups for the purpose of sharing machinery. This practice reduces the capital costs for individuals and potentially conserves environmental resources associated with the production of machinery. Cooperatives are another way for groups of small firms to take advantage of the economies of scale principle, both in buying resources and marketing their products.

International agreements which reduce barriers to trade are making it increasingly difficult for governments to provide direct subsidies to disadvantaged firms which provide cultural and environmental benefits beyond the value of the product being marketed. Instead of providing a monetary handout it might be more effective help small businesses to trade more effectively by providing marketing information and assisting them to manage the marketing of their produce more effectively. PI can be a useful tool both for developing and sharing information and coordinating appropriate collective action.

Perfect Knowledge

Perfect information as to the effects of resource consumption on society and the environment is rarely provided to consumers in the price of goods and services, which frequently results in the occurrence of externalities.

One step towards addressing this lack of information in the market is to include social and environmental impact information on produce and product labels. Such a program would give consumers the information necessary to express their social and environmental values and increase consumer awareness as to the direct link between their personal consumption and its impacts (Holloway and Wallich, 1994).

For example, potatoes are often sprayed with a defoliant, primarily for reasons of harvesting convenience. This could be considered unacceptable to some people but the chances are that most are unaware of the practice. If more detailed information regarding the production methods, is available for all products and produce then consumers could make more informed choices in their purchasing. Consumers would have the opportunity to act on social or environmental values via the market.

Currently the labelling advantage belongs to conventional producers who have no obligation to state the conditions of production while organic producers are subject to strict production and labelling requirements. There is potential here to shift the balance through the provision of better information in the market. This seems a much simpler and more efficient way to address the market failures to account for the environment than trying to develop accurate estimates of consumer willingness to pay for environmental goods.

PI can contribute to the process of producer groups adapting and developing their production

systems to meet the changing product demands expressed in the market, or other priorities unique to their social and environmental system.[1]

Government Failure

For participatory inquiry to be a successful tool in bringing about changes for sustainable development it has to be supported by the governing institutions which are making the programs and policies for society. Therefore participatory inquiry:

i Must be applied at the level of the environmental and social system where resulting changes to practice are most effective implemented to address issues.

ii Requires empowerment of the people implementing the change. If individual in governing institutions act in their own self interest rather than in the interest of the society that they represent, and find a decentralisation of their power threatening, then the success of participatory inquiry is diminished.

iii Requires training of facilitators to guide the process and support of the participatory learning process at all levels of implementation. Pretty (1995) identifies this trait of PI as being a crucial link in the process.

iv Requires transfer of information from the people involved in the PI back to the policy makers so policies can continually be refined and adjusted as the environmental and social system changes. At present this is a process often lacking.

The usefulness of PI will be limited unless the people managing the resources recognise the need for change, feel that they are in control of the resources needed to make that change, and that their efforts are worthwhile. In situations where the problem is not "owned" by an identifiable group, the role of PI is probably restricted to information sharing. Even then, the participants need to recognise the issues and be motivated to learn and empowered to act upon improved knowledge.

There are numerous organisations and institutions, both government and voluntary, with an interest in sustainability which is often reflected in written aims, objectives, and policies. At present, there appears to be little consensus between these organisations and institutions or a recognition of the benefits of cooperative efforts. In contrast, the success of the establishment of the Australian Landcare Program was, in no small part, due to the joint working of national conservation and farming organisations with national government.

Cost Effectiveness

PI can be a relatively low cost approach to policy. The cost of Landcare to the Australian taxpayer was only a few cents per hectare. The majority of the government funding was used for the

[1] See Parminter, Wedderburn, Carter and Paine (1994) for more information about farmer study groups, which are operating in the manner described above.

facilitation process and spent on training and educational materials. Policy implementation costs were largely met by local people and were within their own resource constraints.

PI is sometimes criticised for being a more lengthy process than traditional policy development processes. If the end point of analysis is the policy then this can be the case. If the end point of analysis is a positive change to a problem situation, then an effective PI process is likely to take less time, and to cost less to implement. This is because the education and training, consensus building, regulations, and often the resources, necessary for implementing the policy, are built into the PI process. In New Zealand, the situation of regional councils facing lengthy and costly consultation and appeal processes, followed by the costly enforcement of regulations and policies, brings to question the effectiveness and efficiency of their use of less participatory methods.

Conclusions

Participatory inquiry can be a useful technique for addressing market failure while simultaneously bringing about progress toward sustainability. Its successful implementation depends heavily upon the governing institutions which control policy, their ability to recognise appropriate applications for the methods of PI, and to act in the best interests of the society they represent. The success of PI methods is also dependent upon competent facilitation of groups, and the inclusions of all relevant stakeholders of the situation which requires change. In situations where these conditions can be met, PI has particular merit as a methodology for addressing diverse needs and complex issues, which are common to the issues of sustainable development challenging today's society.

Acknowledgements

I very much appreciate the support and assistance provided to me in preparation of this paper. Sincere thanks goes to the following: My colleagues in the extension science unit of AgResearch, Terry Parminter and Mark Paine, provided comments, support, and assisted with editing. AgResearch, funded my attendance to the conference. Ian Tarbotton proof read. Murray McGregor, supervised the development of the foundation to this paper, which was my dissertation for the MSc degree in Ecological Economics at the University of Edinburgh. Alasdair Craig provided support through the process and development of both the thesis and this paper, and assistance with editing.

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Appendix I

A typology of participation: how people participate in development programmes and projects

Typology	Characteristics of each type
1. Passive participation	People participate by being told what is going to happen or has already happened. It is a unilateral announcement by an administration or project management without any listening to people's responses. The information being shared belongs only to external professionals.
2. Participation in information giving	People participate by answering questions posed by extractive researchers using questionnaire surveys or similar approaches. People do not have the opportunity to influence proceedings, as the findings are neither shared nor checked for accuracy.
3. Participation by consultation	People participate by being consulted and external agents listen to views. These external agents define both problems and solutions, and may modify these in the light of people's responses. Such a consultative process does not concede any share in decision making and professionals are under no obligation to take on board people's views.
4. Participation for material incentives	People participate by providing resources, for example labour, in return for food, cash or other material incentives. Much on-farm research falls in this category, as farmers provide the fields but are not involved in experimentation or the process of learning. It is very common to see this called participation, yet people have no stake in prolonging activities when the incentives end.
5. Functional participation	People participate by forming groups to meet predetermined objectives related to the project, which can involve the development or promotion of externally initiated social organization. Such involvement does not tend to be at early stages of project cycles or planning, but rather after major decisions have been made. These institutions tend to be dependent on external initiators and facilitators, but may become self-dependent.
6. Interactive participation	People participate in joint analysis, which leads to action plans and the formation of new local institutions or the strengthening of existing ones. It tends to involve interdisciplinary methodologies that seek multiple perspectives, and make use of systematic and structured learning processes. These groups take control over local decisions and so people have a stake in maintaining structures or practices.
7. Self-mobilization	People participate by taking initiatives independent of external institutions to change systems. They develop contacts with external institutions for resources and technical advice they need, but retain control over how resources are used. Such self-initiated mobilization and collective action may or may not challenge existing inequitable distributions of wealth and power.

Source: Pretty, 199

Appendix II

Landcare in Australia: an Integrated Participatory Approach to Sustainability

Helen Alexander (1993) of the Sustainable Agriculture, Food and Environment (SAFE) Alliance stated, *"Nowhere in the western world are farmers having to face quite the battery of economic and environmental blows felt by Australian farmers."*

The Australian sub-continent, with its flat landscape, has some of the oldest soils in the world, being heavily weathered, poor in fertility and low in organic matter. The climate is extremely harsh, with intense sun, strong winds, seasonal rain and unpredictable long dry spells. The established ecosystem includes unique, diverse and well-adapted species. However, two hundred years of inappropriate land management practice, developed for the young fertile soils and mild climates of Europe, have caused serious problems. Since European settlement, two-thirds of Australia's original forests and one-third of scrub and woodland have been removed. Over 500 plant and animal species have been introduced and many have out-competed native species. These combined effects have degraded soil and water quality, and vegetation and habitats have deteriorated.

In 1989 it would have taken an estimated NZ$37bn of immediate input to halt and repair Australian agricultural land degradation, with an additional annual cost of NZ $270m. The prospect of finding that kind of money was daunting to say the least as Australia was facing the most severe rural crisis since the Great Depression. Farmers in 1992 were facing over five consecutive years of negative profit and were, on average, carrying more than NZ $150,000 of farm debt. Added to these difficulties has been the fact that, even if the money did exist, technical solutions were not available. Andrew Campbell, former National Landcare Facilitator, stated,

"Ultimately, rural decline is not just a social and economic issue, it has profound environmental implications. More sustainable systems of land use and management are unlikely to be developed or implemented by people preoccupied with short-term survival. In short, existing systems of food and fibre production are unsustainable. The rural sector is ageing, declining, stressed and going broke – depleting natural resources in the process" (Alexander, 1993).

In these conditions of ecological and economic crisis it would have been difficult to apply traditional reductionist methods of research and extension to the complex issues of Australia. The speed at which radical ecological change was occurring meant that by the time scientists had determined the issue, found an answer, and passed it to extension specialists to transfer the solution to farmers, the original situation would often have changed radically and the solution would no longer be relevant.

In 1989 the National Farmers' Federation and the Australian Conservation Foundation joined forces and approached the government with a proposal for addressing land degradation. The prime minister launched a 10-year national campaign known as Landcare and committed NZ $510m of support (Campbell 1991). A bipartisan agreement meant that regardless of which political party was in office, funding and support was secure for the decade of Landcare. The movement was launched with the goal of developing a Landcare ethic in the people of Australia and is mobilising private and community resources through sponsorship and awareness campaigns.

Landcare is built on the idea that land degradation has an impact on people's lives, and in conditions of limited funding and knowledge, positive change can most effectively be achieved by facilitating participatory inquiry, on-farm research, and empowerment of the people on the land. National and state funding pays for the employment of trained facilitators, education and monitoring. Communities, farmers, and some big corporations are funding most of the implementation process.

People all across Australia are planting trees and co-ordinating with neighbours so that combined efforts establish wildlife corridors and address issues such as salinity that cross their own property boundaries. Numerous group efforts exist. For example, Saltwatch, which began as a participatory community education initiative in Victoria, involves over 900 school children and 50 Landcare groups in a large scale water monitoring program. Farm Management 500 was another private organisation which developed in south-eastern Australia with the aim of increasing the viability of farms. This was through a process of group learning where farmers worked with peers. The work was facilitated by 15 private consultants and a resource network of industry experts.

Throughout Australia people are now attending field days and workshops where they learn to read the land and recognise the issues. As a result, ideas are being exchanged on everything from fencing and pest control to crop rotations and agroforestry. Over 2,000 groups of farmers and one third of the farming families across the country are involved (Campbell, 1994).

Landcare encourages 'land literacy' – people learning to read and understand the conditions of the land and of the environmental trends occurring around them (Campbell 1994). Groups and their actions vary tremendously across the country but the most common thread linking them is the speed and effectiveness of developing and sharing local knowledge, and the development of a consensus for action over issues that cannot be successfully addressed by individuals operating independently. Above all, Landcare recognises that the roots of sustainability are in the people.

DECOLLECTIVISATION OF THE CHINESE PASTORAL SECTOR: A PROPERTY RIGHTS ANALYSIS OF AN INSTITUTIONAL CHANGE

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Paper presented at the New Zealand Agricultural Economics Society's Annual Conference, Blenheim Country Lodge, Blenheim, New Zealand, 5-6 July 1996.

ABSTRACT

Drawing upon neoinstitutional economics, this paper analyses the post-1978 transition from communes to family farms in the Chinese extensive pastoral sector. There has been considerable variations in the pace and path of institutional reform in pastoral agriculture, both within and between different pastoral provinces. However, it has been typical for forms of common property management to persist, even after pastoral lands have been assigned to individual households. Three possible explanations of this particular phenomenon are discussed: 1) the marginal costs of exclusion outweigh the marginal benefits 2) economies of scale, and 3) the temporal resolution of risk.

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1. INTRODUCTION

This paper represents an application of neoinstitutional economics to the post-1978 institutional reforms in the Chinese pastoral sector. More specifically, it discusses the economic logic of a particular type of institution arrangement that has emerged at the village level: common property management of lands, even after lands have been assigned to individual households. To this extent, institutions are treated as endogenous to the economic system. However, no attempt is being made to explain (or endogenise) the decision of the Central Committee of the Chinese Communist Party in late 1978 to decollectivise the Chinese agricultural sector. Such a project would require a theory of the state and of ideology. Neoinstitutional economics is being used in this paper at the much more limited level of explaining the economic logic of a particular institutional arrangement that has emerged, with the context of the given changes in the national property rights system and the wider choice of institutions this has allowed.

With respect to the organisation of this paper, firstly, property rights are defined and 'core' elements of the neoinstitutional paradigm are introduced (Section 2). Then the Chinese pastoral sector and past property rights structures in this sector are briefly overviewed (Section 3). Changes in property rights structures arising out of the post-1978 reform are described (Section 4), and then a neoinstitutional approach is used to explain the persistence of common property management even after pastoral lands have been contracted out to individual households (Section 5). Finally, conclusions are drawn (Section 6).

2. PROPERTY RIGHTS IN THE NEOINSTITUTIONAL PARADIGM

> Property rights do not refer to relations between [people] and things but, rather, *to the sanctioned behavioural relations among [people] that arise from the existence of things and pertain to their use* (Furubotn and Pejovich, 1972:1139, emphasis original).

In the arena of land tenure, property rights relates to individual's 'authority', with respect to others, to use land, earn income from land, contract over its terms of use with others, and to alienate land.

Property rights are not the same as legal property rights, unless one takes the legal centralist view of official law as unified, rational, consistent and all-encompassing of social and economic behaviour. If it was, official law would encompass all norms of justice and the mechanisms of promoting order and security and preventing anarchy. And this paper could be based upon a scrutiny of land tenure laws and regulations generated by the Chinese government. Unfortunately, in reality there are:

> inconsistencies and uncertainties embodied by the law itself; a plurality of 'legitimate' claims to, and interests in, property; and a plurality of ordering mechanisms which are capable of generating rules and inducing compliance, thus establishing 'property' (Razzaz, 1993: 341-342).

This distinction between property rights and legal rights is clearly needed when examining changing property rights structures in Chinese agriculture. County governments retain considerable autonomy in interpreting and implementing (or otherwise) higher-level regulations and decrees. Rights to property can be revoked or modified by county governments or village collectives through administrative fiat rather than resort to legal processes. Furthermore, property rights that are ordained and enforced by the force of etiquette, social custom and ostracism rather than official regulation constitute an important component of the property rights structure.

The conceptual foundations of the property rights literature are associated with, amongst others, Ronald Coase (1960), Harold Demsetz (1967) and Posner (1977). Some central propositions of this literature are that:

- Property rights develop to internalise externalities when the gains from internalization become greater than the cost of internalization. These externalities can be generated by changes in economic values, stemming from the development

of new technology or markets, that create new benefit-cost possibilities that existing property rights are poorly attuned to deal with. The cost of internalization is largely a function of transaction costs (Demsetz, 1967:350).

- Common property regimes, under which members have a communal right to the same resource before it is taken but a private right to a resource after it is taken, are inherently inefficient because they encourage the over-utilization of natural resources and the dissipation of rents (Demsetz, 1967; Hardin, 1968; Alchian and Demsetz, 1973:22-24). This proposition has been rightly criticised for equating common property regimes, where members have clearly defined rules regarding rights to use of a resource, with open access regimes, where use rights are not defined at all (Dahlman, 1980:200-204). Much of the resource degradation originally attributed to common property regimes by these authors and others, can more accurately be attributed to the demise of common property regimes.

- Institutions change in order to economise on transaction costs. Lower cost institutions thus supersede higher cost institutions. Furthermore, this is generally construed to mean that only institutional change towards individual private property rights is consistent with the furtherance of economic efficiency. Such a system has three efficiency-enhancing properties: *exclusivity,* which ensures that individuals have the incentive to maximise the value of land; *transferability*, within a system of voluntary exchange, to ensure that resources can obtain their highest-value use; and *universality*, in that all resources, except those of a public good nature, are owned by someone (Posner, 1977:10-13).

- When high-cost institutions (ie.non-private property rights) seem to persist, the possibility of hidden benefits at unexpected margins needs to be investigated (Eggertsson, 1990b:453). Dalhman, for example, persuasively states the case for the efficiency of the English open field system (a form of common property

management), as it helped minimise the transaction costs associated with, among other things, realising the returns to scale in livestock farming (Dahlman, 180:129).

- If no hidden economic benefits are to be found, then one should next search for political constraints to producers' adoption of lower-cost institutions (Eggertsson, 1990b:454).

3. THE CHINESE PASTORAL SECTOR

The northern and western regions of China contain the bulk of its pastoral lands and all twelve of its officially designated 'pastoral provinces' (see Figure 1). Some two thirds of China's total pastoral lands are located with high plateau, mountainous or semi-desert regions. These areas are characterised by low and highly variable rainfall, extreme temperatures and poor soil fertility. Droughts, winter blizzards and sand storms are some of the natural hazards faced by pastoral farmers. Pasture growth is restricted to 3-4 months of the year, and the salient feed constraint is the lack of natural pasture during winter and early spring. In corresponding order sheep, goats and cattle/buffalo are the major types of livestock found in the pastoral provinces.

The seasonal migration of livestock has been a salient feature of extensive livestock production systems in China. Migratory patterns vary widely within and between provinces, but it is possible to identify a few common characteristics. Stock are kept at or near the household's permanent dwelling over winter (and sometimes spring), then taken to more distance (and, in Xinjiang and Tibet province especially, higher-attitude) pastures in spring, summer and autumn, with herders or whole households tending them from temporary encampments. The annual distance travelled on migration routes varies widely, from about 20 to over 200 kilometres.

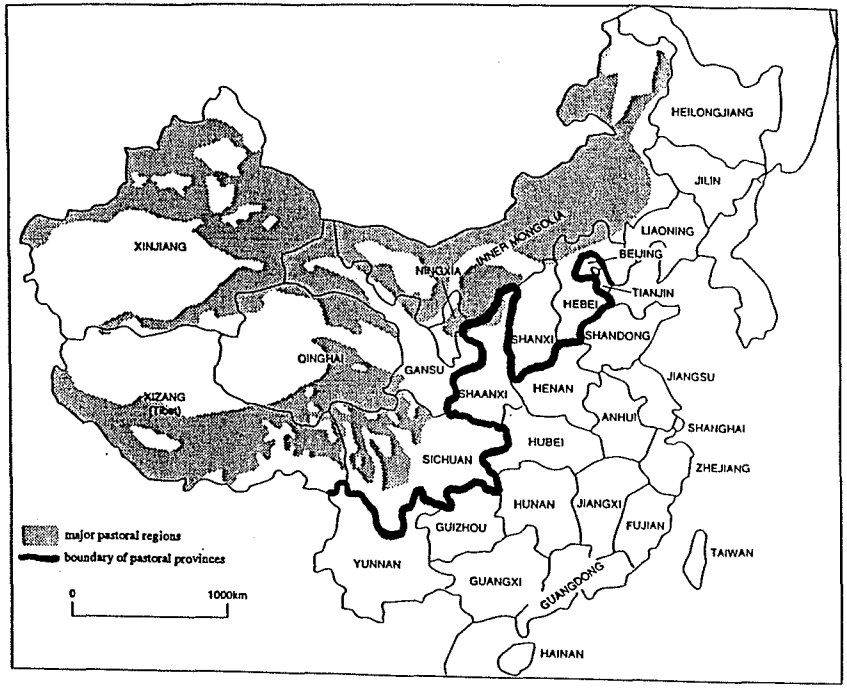

Figure 1: Map of Pastoral Provinces and Regions

Adapted from R. Niu, 1990. 'Project Objectives and Rationale'. In *Economic Aspects of Raw Wool Production and Marketing in China* edited by J.W. Longworth. ACIAR Technical Reports No.25. p.6 (fig.1).

Over the last fifty year, the winter bases of households have become more permanent, in part because of consecutive governments' policy of encouraging sedentarization. Typically, such winter bases now include a permanent dwelling, barn, and hay storage facilities. Hay cutting pastures will be in the vicinity and sometimes the growing of fodder or food crops has been integrated in the production system. Finally, there is an increasing tendency for just herders, rather than whole households, to move between seasonal encampments. Thus transhumance has more or less superseded nomadism as the dominant livestock production system.

4. PROPERTY RIGHTS IN THE CHINESE PASTORAL SECTOR

Prior to the Communist Revolution

The pastoral regions of China are inhabited by ethnic minorities, including Mongols, Kazaks, and Tibetans. Prior to the Communist Revolution of 1947-49, pastoral communities were constituent parts of larger political and social institutions, typically tribal clans, feudal estates or monastic estates. Property rights structures were embedded in the prevailing form of political and social organisation. Two cases will suffice to illustrate the range of property rights structures.

The first case is of a remote community of nomads in Pala, north west Tibet. As in the case of much of Tibet, they were the subject of the lord Panchen Lama. The Panchen Lama had a huge fiefdom, composed of numerous farming and nomad estates and administered by monastic and aristocratic officials. Nomads were serf-like subjects of their lords, with obligations to pay taxes, in kind and in covee labour. But they owned the livestock and had full rights over their disposal, subject to the payment of taxes (Goldstein and Beall, 1990:92). Pastoral land was divided into thousands of parcels of various sizes, often small, with delimited borders being kept in a register book. Boundaries, though not fenced, were known and monitored by all and enforced by officials of the lord. Pastures were allocated to individual nomad households (or small groups of related or friendly households) according to the numbers of animals owned, with each household receiving a share of the pastures required at different times of the year. Each household enjoyed exclusive rights over their alloted pastures. Adjustments in the allocation of land within pastoral communities or between pastoral communities within the same estate were made by officials in accordance with changes in livestock numbers, the latter being determined through a triennial household livestock census conducted by the local lord and officials (Goldstein and Beall: 1990:69-70).

Mongol-Turkic nomadic communities, though related to tribal clans, were usually more politically autonomous than their counterparts in Tibet. Leadership of the communities, which were comprised of ten to fifty extended families, was provided by a headman supported by elders or heads of related families. These communities authorities rather than external officials, were ultimately responsible for determining the distribution of encampments and pasturages among extended families, as well as the arbitration of disputes (Krader, 1963:335-337).

Most pastoral communities in Tibet, Xinjiang and Inner Monglia were characterised by considerable inequity between households, in terms of wealth, livestock ownership and access to pasture. Patron-client relations existed between the richer households and the poorer ones, with the former using the labour of the latter for herding animals and other tasks. (Sneath, 1991:162; Goldstein and Beall, 1990:54).

The Collective and Commune Eras (1947-78)

The pastoral areas of China were among the first to be liberated by the Chinese Communist Party's forces. Under the Communist Party's Ethnic Reform Law (1947), private ownership of rangeland was confiscated in favour of the village or state, with the intention of freeing up access to rangeland by all herders. An Agrarian Land Reform Law (also 1947) provided for the redistribution of livestock ownership from the wealthy nomads in favour of landless or tenant herders. But in the major pastoral provinces, redistribution efforts centred around ensuring improved wages for herders rather than the implementation of the Agrarian Land Reform Law. The consequence of early livestock redistribution had been a mass slaughter of livestock by the old and new owners, the latter afraid that a counter-revolution may deprive them of their new possessions (Longworth, 1993:42-44).

The collectivisation of agriculture in the pastoral sector (with the exception of Tibet) paralleled developments in the cropland sector. Between 1952-1958, mutual aid teams,

primary cooperatives and then advanced cooperatives were consecutively formed, with each stage representing a further attenuation of private property rights with respect to livestock and land tenure. Then over 1958-59, the commune system was established. All livestock, save a fixed family quota, were sold to the commune and commune income was allocated on the basis of work points gained through contributed labour. The use of rangeland was centrally administered by the commune, and herds and labour became specialised. The communes had to fulfil compulsory quota sales, pay taxes to the state, and provide labour for public works projects. The advent of the Cultural Revolution in 1966 brought about the end to all private ownership of livestock for several years.

In Tibet, the reform of property rights structures started at a later stage. Up until 1959, there was virtually no change in institutional arrangements in the pastoral sector and it wasn't until after the failed uprising of 1959 that the aristocratic and monastic lords lost their estates. Mutual aid teams were formed, former wealthy nomads progressively taxed, and then full communisation occurred in 1966, at the start of the Cultural Revolution.

The Post-1978 Reforms[2]

Decollectivisation of the Chinese agricultural sector was authorised by the Third Plenary Session of the Central Committee of the Chinese Communist Party in 1978. This signalled the end of the Commune system and its replacement by the Household Production Responsibility System (HPRS). In the pastoral areas, decollectivisation started in 1980 and generally followed three consecutive phases (Liu, 1990:93-94):

1. The contracting (or leasing) out of livestock to individual households by the commune management.

[2] This description of property rights change is based on secondary sources as well as information I gathered during two months of field-level research in Beijing and Inner Mongolia over December 1994 - January 1995.

2. The 'sale' of animals to individual households, which were required to pay a fixed annual fee for each animal ('animal tax'). Animals were allocated on a household population basis, with each household getting a proportionate share of different types of livestock.

3. The contracting out of pasture land to households, which were required to pay a grassland improvement fee. Lands were allocated on the basis of livestock units and total household population, and with households receiving a proportionate share of different types of pasture, in terms of seasonal useability and quality.

The regulatory framework regarding the ownership and use of pastoral lands was established by regulations passed by governments at the autonomous region/provincial level. Inner Mongolia's Rangeland Management Regulation (1985), subsequently amended in 1991, was the first and served as a model for the other pastoral provinces. All rangeland continued to be state-owned, but came under the administrative jurisdiction of either county governments or village collectives. The latter in turn were empowered to contract use rights over 'their' land to management units or individuals.

The regulatory framework with respect to land use contracts has been evolving. Initially the term of land use contracts was established at 15 years; now terms of 30 and 50 years are permitted, with rights of inheritance attached. Originally, land was contracted free of charge. Since the late 1980's a 'users pay' system has been promoted, under which households are charged for grassland use on a per mu[3] basis (with different rates applying to different qualities of pasture) or on a sheep-equivalent basis. The intention is that these grassland 'construction' or 'management' fees will be used to fund grassland improvement. Since the early 1990's, the subcontracting of use rights has been allowed, although each case requires the approval of the collective or county government. An associated auction system for land use rights is at an experimental stage.

[3] Mu is a unit of land area (15 mu = 1 hectare)

To summarise the implications of the new regulations, farmers now have:

- the right to exclusive use of specific lands for pastoral activities for long periods
- the right to derive income from the land
- limited rights to sub-contract the land to others
- absolutely no right to alienate the land to others, or to change its use without the permission of county government
- the duty to invest in land improvements and abide by sustainable stocking rates, as determined by county government
- the duty to pay livestock taxes and grassland use fees, as determined by county government

As noted previously, official regulations are only one aspect of property rights: in and of themselves, they do not establish property. In practice, there has been considerable variation between and within provinces in the pace and extent to which the new rangeland regulations have been adopted (Longworth, 1993:99). This is in part due to the large degree of autonomy that county governments have had in the implementation (or otherwise) of the new regulations. Existing property rights structures at the village level now range from a virtual continuation of the commune era institutions to the development of informal 'markets' for the subcontracting of land use rights. Even in areas where pastoral lands have been contracted to individual households, the term of the contracts, if actually specified, has often been considerably shorter than that provided in the provincial regulations. Furthermore, many county governments have neither determined nor enforced grassland construction fees and stocking rates, as required under provincial rangeland regulations.

As a consequent of the incomplete implementation of the HRPS, a significant proportion of pastoral lands have yet to be contracted to individual households. For example, by 1990 one third of pastoral land in Inner Mongolia had not been contracted out to individual households (Yu and Wu, 1994:140) and by 1995 some 60,000 out of the 320,000 pastoral households in the same province had still not been contracted land. But even these statistics do not capture the full extent to which common property (or open access) persists, for even in cases where lands have been contracted to individual households, it is not an uncommon practice for small groups of households to combine their livestock into specialised herds and contribute labour for herding. Such practices can be observed when livestock is browsed from home-base encampments as well as other temporary encampments (Goldstein and Beall, 1990:60-61).

5. EXPLAINING THE PERSISTENCE OF COMMON PROPERTY

Marginal Costs of Exclusion Exceed Marginal Benefits

The naive theory of property rights, associated with Demsetz (1967) and Alchian and Demsetz (1973), among others, proposes that forms of open access or common property persist when the marginal benefits of establishing exclusive private property are outweighed by the marginal costs. Anderson and Hill (1975) expressed this in graphic form (see Figure 2). The position of the marginal cost function is defined by the price of exclusion inputs (such as fencing) and the state of exclusion technologies. A fall in the price of exclusion inputs or change in exclusion technology will shift the marginal cost function downwards and, ceteris paribus, increase exclusion activities. The marginal benefit curve represents the derived demand for exclusion activity, and shifts outward when the value of an asset increases, and when the probability of encroachment by outsiders increases.

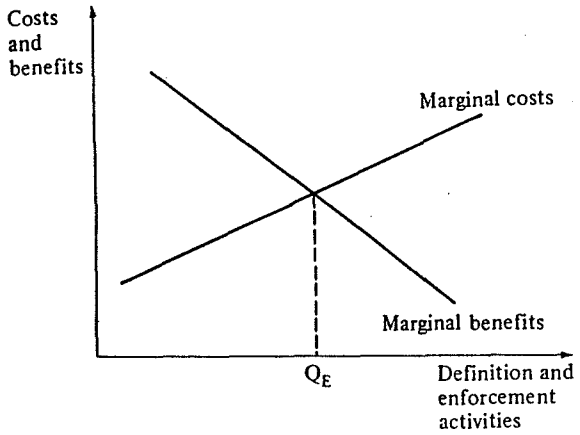

Figure 2: Equilibrium Quantity of Exclusion Activities
From Eggertsson (1990). Derived from Anderson and Hill (1975)

In the context of the Chinese pastoral sector, the naive theory of property rights is most applicable to pastoral lands of poor quality in remote, sparsely populated areas. Here the pasture has low yield and potential for improvement, and thus the value of the asset and the probability of encroachment are low. However, the cost of defining and establishing individual property rights (through, for example, the construction of fences) is relatively high.

In the converse situation, where the potential benefits of the establishment of private rights are high relative to the costs of defining and enforcing them, the fuller implementation of the HPRS would be expected. This seems to be borne out by the observation that the HPRS has indeed been more fully implemented in regions with richer pastures (and greater population density). This theory could also account for why commune lands allocated for cutting grass, which has the high-value use as winter fodder and is located near the household's winter base (and thus relatively easier to enforce exclusive rights to) was among the first land to be assigned to individual households.

It should be recalled, however, that a potential problem with the Demsetz-Alchian hypothesis is that it is predicated on an erroneous conception of 'common property'. The benefit of establishing exclusive (individual) private property is phrased in terms of the avoidance of the dissipation of rents, but rent dissipation is inherent to open access rather than common property regimes. In this light, it may be more useful to think of the avoidance of rent dissipation as a benefit rather than cost of common property.

Economies of Scale

The persistence of seemingly high-cost institutions (in this analysis, common property) should lead us to search for the possibility of 'hidden benefits at unexpected margins' (Eggertsson, 1990:453). Dahlman's (1980) analysis of the English open field system, a form of common property regime, postulates the existence of economies of scale in herding as the underlying rationale for that particular system. He argues that collective management entailed less transaction costs with respect to the realisation of economies of scale than the alternative of a system of private property rights. To have realised economies of scale in herding under a system of private property rights, individual owners would have had to voluntary agree to a joint decision making formula. The withdrawal of any individual member would have imposed costs on other members, in terms of some loss of scale economies. Although members were unlikely to withdraw, because of the profitability of staying in the organisation, by threatening to withdraw they may have been able to appropriate some gain from the institutional arrangement ie. others may have to pay them off (Dalhman, 1980:115-121).

Because China's new land tenure regulations provide for the parcellation of village pastoral lands into private plots, with each household receiving a proportionate share of each type of pasture (in terms of quality and seasonal useability), they could conceivably led to a loss of economies of scale. Economies of scale could in particular explain the observed practice of small groups of households pooling their livestock into specialised

herds, sharing herding responsibilities, and grazing pastoral lands collectively, even when the latter have been allotted to individual households. This form of common property regime enables households to realise economies of scale not just respect to the cost of herding labour, but also through being able to better match grazing locations and resources with specific livestock capabilities and needs.

The Temporal Resolution of Risk

Another type of 'hidden benefit at unexpected margins' could be the minimisation of transaction costs needed to realise economies of scale. A potential benefit of common property regimes in semi-arid and arid areas (such as the Chinese extensive pastoral sector) is that they allow flexibility in response to highly variable weather and pasture conditions. Instead of making all their production plans for the year or season *ex ante*, pastoralists adopt a strategy that allows for *ex post* reaction to new information about rainfall and pasture conditions. (van den Brink, et al, 1995:384). In other words, flexibility in land tenure arrangements facilitates the temporal resolution of risk. This explains the observed tendency of nomadic pastoralists to place more value on preserving rights of access to pastures, water and salt for their animals than land ownership per se.

The establishment of individual private rights in land prevents such flexibility. Holders of exclusive use rights could conceivably trade land use rights with one another in response to new information about rainfall and pasture conditions, with those in better endowed areas in one particular year 'selling' their rights to others that have below average pastoral conditions. But the transaction costs associated with many rights holders trading land use rights would be very high, and would require the voluntary participation of a large number of spatially diverse farms to be successful. Dalhman's analysis of the English open field system, discussed above, concludes that common property was 'efficient' because it required the participation of all farmers and thus allowed the maximisation of collective benefits. Although it was economies of scale rather than the temporal resolution of risk that gave rise to collective benefits in Dalhman's analysis, his analysis is also applicable to

the latter. In both cases, under a voluntary trading system for trading rights, an individual's withdraw would negatively effect the welfare of the entire group. Although withdrawal would not be profitable for an individual, the threat of withdrawal could conceivably be used by an individual to realign institutional arrangements in his favour: he would have to be 'bought off' by the rest of the group.

It can be predicted that common property management is a more effective tool for the temporal resolution of risk the 1) lower the average rainfall (and thus the higher the variability in rainfall and pasture conditions) 2) larger the area of pasturage available to the village (and thus the less covariance of weather risk between households); and 3) poorer the quality of pasture lands (derived from the assumption of an inverse correlation between size of village pasturage and quality of pasture land). This is consistent with anecdotal evidence and thus we have an alternative explanation for the observed persistence of common property management, especially in regions with low average annual rainfall and poor quality pastures. However, it should also be noted that trading in grazing land ownership and use rights is still politically precluded from the choice set of producers. Thus the absence of tradeable exclusive property rights could be due more to political factors rather than it necessarily being a more costly institution than common property with respect to the temporal resolution of risk.

At a higher level of analysis, the temporal resolution of risk could also explain why some boundaries between different villages, counties, prefectures and even provinces have not been clearly delimited. Given that ownership of, and the right to assign use rights to, lands in such border areas has not been clearly determined, a defacto common property or open access situation between villages is the result. Such flexibility would presumably facilitate the temporal resolution of risk in the same fashion as it does at the household level of analysis. Although provincial rangeland regulations allow for the negotiated use of other's pastoral lands in times of natural calamity, this may entail higher transaction costs and be considered a more risky form of social insurance compared with the flexibility associated with the existing lack of clearly defined boundaries.

The temporal resolution of risk doesn't explain why small groups of households pool livestock and graze their lands in common, given the high covariance of weather risk faced by the households. However, this practice could help resolve spatial risk if, for example, stock losses due to adverse weather were highly uncorrelated between neighbouring households. This condition appears to hold, at least in the case of Tibet (Goldstein and Beall, 1990:70).

6. SUMMARY AND CONCLUSIONS

Neoinstitutional economics has been used to analyse property rights structures that have emerged in Chinese pastoral agriculture since the central government's decision, in late 1978, to decollectivise the agricultural sector. Although there has been considerable variation in the pace and extent of reform within and between different pastoral provinces, an interesting phenomenon has been the persistence of forms of common property management even when pastoral lands have been allocated to individual households.

Three potential explanations for the persistence of common property have been discussed. The 'naive theory of property rights' suggests that the marginal benefits of exclusion outweigh the marginal costs. This is plausible for Chinese rangeland, particularly in the case of poor quality pastures in sparsely populated areas. Next we discussed two possible 'hidden benefits' of common property. The first was that common property minimises transaction costs associated with the realisation of economies of scale. Economies of scale are evident in Chinese pastoral agriculture and potentially provide a reason for the observed practice of small groups of households pooling their livestock and pastoral lands. The second potential 'hidden benefit' of common property was the temporal resolution of risk. This explanation applies only to those common property units that are significantly large to reduce the covariance of weather risk faced by their members.

It can not be assumed that common property is the lowest-cost institutional arrangement simply because it exists. Both the 'hidden benefits' of common property mentioned above relate to 'missing markets': economies of scale to a missing market for land use rights, and the temporal resolution of risk to a missing market for stock or social insurance. Assuming that individual use rights to land are not precluded from producers' choice set of institutions, common property may be the preferred (and lowest-cost) institution only given that other institutional arrangements, such as transferable land use rights, are precluded from their choice sets.

In order to attain a better understanding of the persistence of common property in Chinese pastoral agriculture, three tasks have to be undertaken: a more precise specification of existing property rights structures; a continuing search for 'hidden benefits' of common property; and a clearer understanding of the extent to which political constraints block producers' adoption of lower-cost institutional arrangements. All three tasks require further field-level research.

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Paper Presented to the *Annual Conference of the New Zealand Agricultural Economics Society*
Blenheim, 5-6 July 1996

Exchange Rate Impacts on Farm Income: An Historical Analysis (1981-1995)[1]

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Abstract

The recent appreciation of the New Zealand dollar has been singled out as one of the main causes of the decline in farm incomes in the mid-1990s. The main objective of this article is to evaluate the relative impact of the exchange rate vis a vis the variability in overseas commodity prices on farm returns.

A quarterly trade weighted exchange rate index has been developed in this paper. It is weighted according to the relative importance of the three main markets for each commodity, and the currencies of trade in those markets. The exchange rate impacts on farm inputs is evaluated in order to provide a balanced perspective. This paper will also discuss measures available to exporters to minimise adverse exchange rate impacts, eg forward cover.

Introduction

During the past year, returns to farmers, especially sheep and beef farmers, have declined in conjunction with a rapidly appreciating New Zealand dollar and there have been increased calls for the government to relax tight monetary conditions. Many farmers (and exporters) perceive the high New Zealand dollar as the primary reason for their inadequate returns. In the long run, an appreciating exchange rate should have a depressing impact on farm incomes, even though a fall in farm gate output prices should be offset to some degree by decreasing input prices. This hypothesis should be particularly valid for the pastoral farming sector, where many capital inputs (such as farm machinery) are imported from overseas. According to a recent study by the New Zealand Meat and Wool Boards' Economic Service, 82 per cent of the beef price decline in New Zealand dollars was attributable to the US market price decline and only 18 per cent was from the exchange rate effects. To arrive at these figures, the mid February 1996 US bull beef price was compared with the price twelve months earlier. When the mid February 1996 UK wholesale lamb price was compared with prices from one year earlier, it was discovered that most of the decrease in lamb price in New Zealand dollar terms was caused by the exchange rate. Thus, no firm conclusion about the exchange rate effect on prices as a whole was evident, ie. across all key commodities and markets.

This paper analyses the exchange rate effects for eight commodities (lamb, beef, wool, cheese, butter, whole milk powder (WMP), kiwifruit and apples), chosen because of their importance to New Zealand's overseas export returns, over a fifteen year period (January 1981-December 1995).

[1] *The views expressed in this paper are those of the authors and do not necessarily reflect the official view of the Ministry of Agriculture. The helpful information and comments of Rob Davison of NZMWBES, Patrick Conway of WNZ and colleagues at MAF Policy are acknowledged. Errors and omissions remain the responsibility of the authors.*

It is important that the time period chosen for analysis commenced before the float of the New Zealand dollar in 1985. This was necessary to provide a more comprehensive analysis, as it is considered that farm returns were greatly influenced by the floating of the NZ$ and the removal of output subsidies.

The currencies used in this paper were selected on the basis of importance in the various export commodity markets. For most commodities, the US$ may seem to have a disproportionately high weighting. This is because the US$ is the major currency of trade. For example, New Zealand's WMP trade with Malaysia is conducted using US$ rather than the Malaysian currency Ringgit. Similarly, most international dairy trade in the developing countries is conducted in US dollars. Recent studies in New Zealand (Anne-Marie Brook, 1994) have attempted to define an exchange rate index that best represented the competitiveness of New Zealand's export sectors. Results indicated that an exchange rate index should weight currencies according to the degree to which they set prices, not according to trade destination or denomination of receipts. In this paper, the quarterly trade weighted exchange rates have been weighted according to the degree to which the respective currencies are used to set prices, with only minor emphasis on trade destination.

Some other studies on exchange rate impacts were concerned with the effect of exchange rate volatility on New Zealand's exports and international commodity prices (Coleman, 1988 and 1989). This study has attempted to develop the methodology further to study the exchange rate impacts specific to individual commodities. It has also attempted to determine which of the two; the "volatility" of the New Zealand exchange rate or the "variability" of international commodity prices, have had the greatest impact on farm returns for the different key export commodities.

Objectives

The objectives of this paper are:

i. to evaluate the relative impact on farm returns of exchange rate volatility vis a vis the variability in overseas commodity prices;
ii. to evaluate the impact of the exchange rate changes on input costs and the terms of exchange; and
iii. to discuss measures available to exporters to minimise adverse exchange rate impacts.

Data

The following four categories of data were used in this paper:

- quarterly exchange rates and Reserve Bank Trade Weighted Index (TWI);
- quarterly trade values (FOB);
- international and domestic commodity prices; and
- farm input price indices.

1. Quarterly exchange rates and reserve bank trade weighted index (TWI)

The exchange rates used in this analysis are the US$, UK Pound, Japanese Yen, Canadian $, German Deutschmark, Australian $ and French Franc. The quarterly values were calculated from mid-rate monthly values. All these currencies were obtained from the Quarterly Reserve Bank Bulletin, except for the NZ$/FFr exchange rate which was provided by the Financial Markets Department of

the Reserve Bank. This exchange rate was only available from the third quarter of 1981. The TWI[2] was also obtained from the Quarterly Reserve Bank Bulletin. The currency weightings used in this paper were determined according to the importance of certain currencies as a facilitator of trade and the importance of various export markets. The currency weightings used in this paper to determine the quarterly trade weighted exchange rate indices can be found in Table 1.

Table 1: Weightings for Exchange Rates used in determining the Quarterly Trade Weighted Exchange Rate Indices (QTWI) for the different commodities

Wool	US$	48%	Beef	US$	80%
	DM	32%		C$	12%
	UKP	10%		JYEN	8%
	JYEN	10%			
Lamb/Sheep Meat	UKP	64%	Butter	UKP	69%
	DM	22%		US$	31%
	FFr	14%			
Cheese	JYEN	52%	WMP	US$	100%*
	US$	26%			
	AU$	22%			
Kiwifruit	DM	55%	Apples	UKP	55%
	JYEN	25%		US$	45%**
	US$	12%			
	AU$	8%			

* The US$ was given a 100% weighting for this market as the three major markets for WMP would use the US$ as their currency of trade. The three main markets in question are:

1. Malaysia 57%
2. Mexico 23%
3. Taiwan 20%

** The Swedish Kroner had a weighting of 7%, but as there was not a NZ$/Swedish Kroner exchange rate available, extra weighting was given to the US$.

In order to obtain the above currency weightings, the annual totals of the FOB value of the commodities were analysed to determine the top three or four markets for each year in question. Each top market is ranked by year in order to arrive at the top three markets for an eight year period (1988 - 1995). Statistics New Zealand's INFOS trade data was unavailable before 1988. The three top markets are then combined in order to arrive at an annual total, with each market contributing to a certain percentage of this annual total. This percentage is then used as the currency's weighting. For wool and kiwifruit estimates of currency weightings were obtained from MAF Policy. For kiwifruit this was especially important because the FOB values obtained for each of the eight years showed widely variable results depending on the prices received in each particular market.

[2] *The Reserve Bank TWI weights at present are approximately: Australian dollar, 35 per cent; US dollar, 25 per cent; Yen, 25 per cent; Pound Sterling, 10 per cent; and the Deutschmark, 5 per cent.*

2. Quarterly trade values (FOB)

Statistics New Zealand provided the quarterly trade values (available on INFOS) for all of the commodities except for wool for which the data was supplied by Wools of New Zealand. Trade data for kiwifruit, apples and WMP was available only on INFOS from mid 1984, so the data series included are for an eleven year period only. Value of exports were used in preference to volume, as the value data was considered a more accurate indicator of exports for each quarter. The exception to this was kiwifruit and apples, around 90% of New Zealand kiwifruit and 70% of New Zealand pipfruit are shipped on a consignment basis to major markets. As there is no legal requirement to adjust documented fob consignment prices to the actual price received, any changes to market returns may not be fully reflected in these fob returns.

3. International and domestic commodity prices

International commodity prices for lamb and beef were provided by the New Zealand Meat and Wool Boards' Economic Service. The international beef price used was the United States bull beef price in the New York market, converted from US c/lb to US c/kg to aid comparison. The international lamb price is the United Kingdom Prime Medium (PM) Lamb price in the London market, converted from UK p/lb to UK p/kg. The prices used were an average of the individual monthly values. The domestic prices for lamb and beef were provided by MAF Policy. Wools of New Zealand figures were used for international and domestic wool prices. In the absence of an international market indicator price for wool, the Australian auction price in US dollars was used as a proxy. The Australian auction price is a good indicator of the world price for wool due to its importance in the world wool market. The domestic wool price used is the clean wool market indicator in NZ c/kg. International and domestic dairy and horticultural prices were both obtained from MAF Policy. International dairy prices are set in US$/tonne. This is because the US$ is the major facilitator of trade in dairy products.

4. Producer price indices

The producer price indices for inputs, for sheep and beef farming, dairy farming and horticulture were sourced from Statistics New Zealand. For each form of farming, there were three aggregate indices over the fifteen year period, each with their own base period. The three producer price indices were rebased to a common base year of 1986, the same base period as all other quarterly trade weighted indices used in this paper.

Methodology

Quarterly trade weighted exchange rate index (QTWI)

The first step in the process of calculating the quarterly trade weighted exchange rate index was to ascertain the quarterly FOB value of exports for the commodities for the years 1981-1995. Value was preferable to volume as it is a more reliable indicator. Each quarter was weighted according to its importance as a percentage of the annual total. Quarterly data was used owing to the variability of commodity exports; some quarters would have a very low export total, others, an extremely high total.

The quarterly exchange rates used for each commodity were then multiplied by the value weightings for each quarter in order to arrive at a quarterly trade weighted exchange rate for that particular exchange rate. The four quarters were added together to arrive at a yearly figure for the exchange rate. Each quarterly trade weighted exchange rate is then indexed, with a base year of 1986=1000. Finally, each exchange rate index was multiplied by its currency weighting to arrive at a basic QTWI for that particular commodity.

Terms of exchange

The terms of exchange indicates the real purchasing power of each dollar at the farm gate relative to previous years. In order to arrive at the terms of exchange it was first necessary to develop a farm expenses price index for three different types of farm: sheep and beef farms, dairy farms and horticultural units. Three different price indices were obtained for each farm type, with three differing base years, that of 1971, 1982 and 1992. These indices were compiled into one index with a base year of 1986=1000.

Farm gate prices of the eight commodities for the fifteen year period were collected and indexed. The final terms of exchange index was arrived at by dividing the individual commodity farm gate price index by the farm expenses price index for that farm type.

International commodity prices

The most important market/currency for New Zealand's commodities was chosen as the relevant international commodity price. For lamb, this was the London Smithfield price for PM lamb in p/lb, for dairy products such as butter, cheese and WMP the US$ and for beef the United States bull beef price in US c/lb was used. Apple and kiwifruit prices used were German market prices in DM per tray carton and tray, respectively. Monthly prices were obtained and converted into a yearly average, or, as in the case of wool, quarterly prices were converted in to annual yearly prices. Prices used were for the calendar years.

Results

The results reported in this paper fall under four categories and are for eight important New Zealand agricultural exports (lamb, beef, wool, butter, cheese, whole milk powder (WMP), apple and kiwifruit). The categories are as follows:

- Quarterly Trade Weighted Index (QTWI) of exchange rates for eight commodities and their rate of appreciation or depreciation in relation to the individual currency exchange rates and the Reserve Bank TWI;
- The qualitative tracking of farm gate price changes in relation to the respective overseas commodity prices in the key markets and the QTWI calculated for each commodity;
- Regression analysis and elasticity estimates of the relative importance of overseas commodity prices (OCP) and the QTWIs of commodities in determining farm gate/fob prices in New Zealand; and
- The evaluation of the exchange rate impacts on input price indices for the different sectors and hence on the terms of exchange (TOE) indices which summarise the total impact of exchange rate changes on both input and output prices of a commodity.

1. Commodity based exchange rates and the reserve bank trade weighted index (TWI)

Table 2 contains the level of appreciation of the different commodities and the exchange rates over a three year period, 1992-1995. Those commodities that had a high level of appreciation, such as apples, were influenced by exchange rates that increased at a faster rate than some of the other exchange rates (eg UK Pound and US Dollar). These rates of appreciation were useful in determining which commodity had shown the greatest level of movement over the last three years, regardless of the level the commodity started from.

Table 2: Appreciation of the estimated QTWI's of different commodities and individual exchange rates (1992-1995)

Commodity		Exchange Rate	
Lamb TWI	28%	US$ - NZ$	23%
Beef TWI	22%	UK Pound - NZ$	35%
Wool TWI	17%	DMark - NZ$	12%
Butter TWI	26%	Yen - NZ$	-9%
WMP TWI	23%	Au$ - NZ$	21%
Cheese TWI	8%	C$ - NZ$	38%
Apples TWI	31%	FFr - NZ$	15%
Kiwifruit TWI	11%	Reserve Bank TWI*	14%

* Refer to footnote number 2

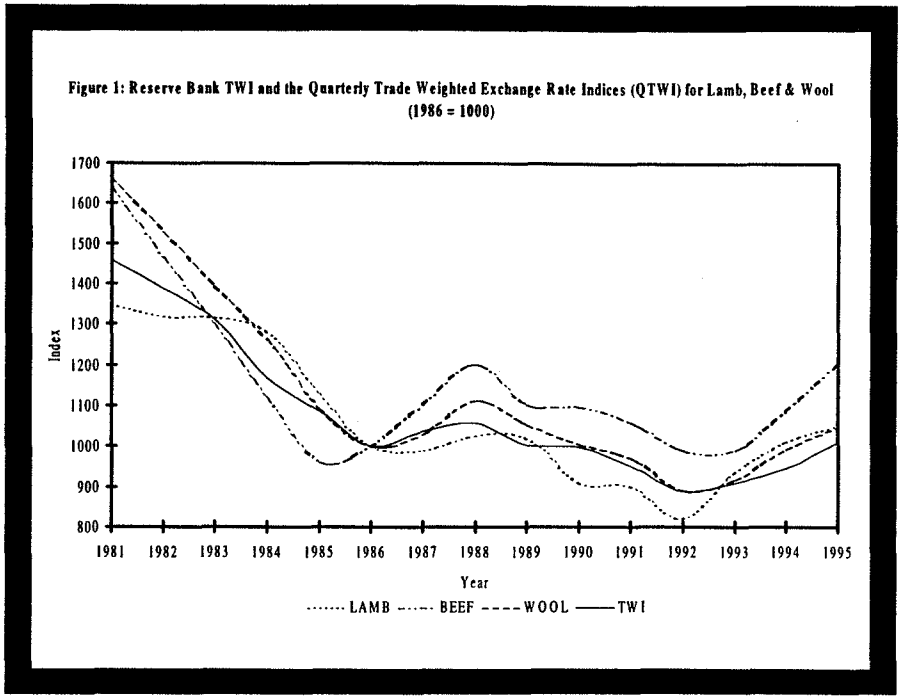
Note: The years compared in this table are an annual average of four quarters converted into a year, eg. 1992 figures were an average of the March, June, September and December quarters for that year.

The Reserve Bank TWI has been used in all of the following graphs as a basis for comparison with the individual commodity based quarterly trade weighted exchange rate indices (QTWI). Each commodity's QTWI is derived using the 2-4 most important NZ$ exchange rates with different weightings (table 1) for the baskets of currencies for each commodity. Thus, those commodities with their derived QTWI appreciating faster than the Reserve Bank TWI are becoming less competitive than those commodities whose QTWI are not appreciating as quickly. In 1981, before the float of the New Zealand dollar[3], the TWI was nearly 50% higher than in 1995. Unlike today, the effect of this on farmers' incomes was offset by supplementary increases in prices if they fell below a certain minimum level. The following graphs use 1986 as the base year; the indices are thus compared on a relative basis and not on an absolute basis.

(a) *Sheep and beef sector*

In 1981, both the beef and wool QTWI were above the TWI; these commodities were thus less competitive than lamb with respect to the exchange rates (figure 1). After 1983, beef fell below the TWI, before rising above it again after 1986, where it has remained ever since. Wool, which had the highest QTWI of all the three commodities in 1981 remained above the TWI until 1986. Since 1986, the QTWI for wool has consistently followed the trend of the TWI, except for a brief period between 1987 and 1990 when it was above the TWI. In 1981, lamb was the only commodity with its QTWI lower than the TWI. Between 1983 and 1986 the QTWI for lamb rose above the TWI, otherwise remained mostly below it until late 1992, when it rose again and has stayed above the Reserve Bank TWI since (figure 1).

[3] *The NZ$ was floated on 4 March 1985.*

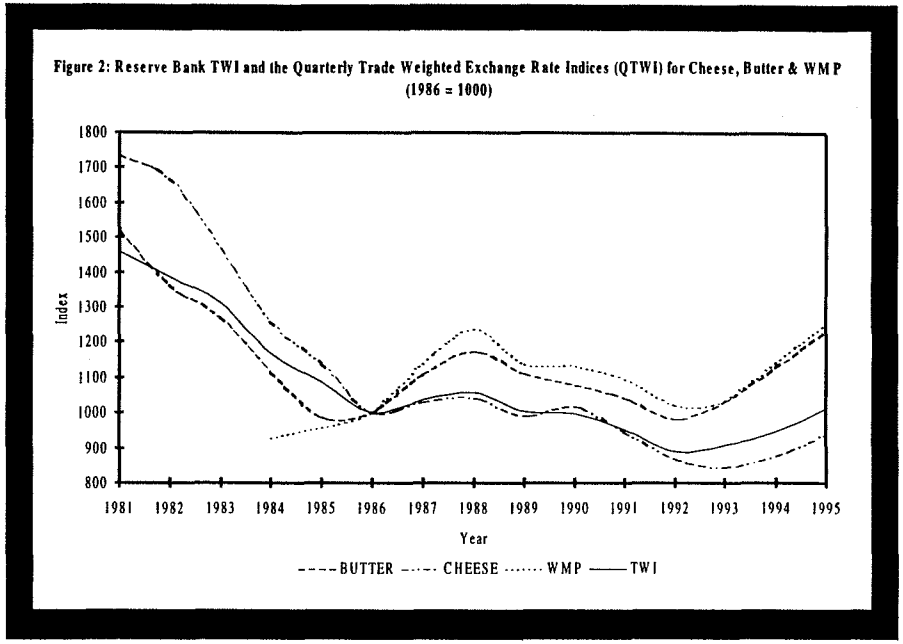


Sources: Reserve Bank (TWI), MAF Policy (QTWI)

During the 1993-95 period, QTWI for beef, lamb and wool have increased at a faster rate than the Reserve Bank TWI owing to the dominance of the US$ and UK pound in their trade respectively (table 1); QTWI for wool has stayed nearer to the TWI owing to the importance of the Deutschmark also in its trade. Between 1992 and 1995, the QTWI for lamb increased by 28% and the beef QTWI rose by 22%. The NZ$ appreciated by 23% and 35% respectively, against the US$ and UK pound, between 1992 and 1995. The QTWI for wool rose by 17 per cent between 1992 and 1995; a larger rate of increase than the TWI, but a smaller increase than for lamb and beef, because the NZ$ appreciated only 12% against the Deutschmark in this period (table 2).

(b) Dairy sector

During the early 1980s the cheese QTWI declined at a faster rate than the TWI (figure 2). Since 1986, it has remained consistently below the TWI. Butter QTWI fell below the TWI in 1982 before rising above in 1987 and has remained above the TWI since then. The QTWI for WMP available from 1984 was at a low level then in comparison to other commodities. QTWI for WMP rose sharply from 1986 until 1988 and has remained above the TWI since then though decreasing slightly for some of the period. In 1993, the QTWI WMP began to rise sharply again along with the QTWI for butter (figure 2).



Sources: Reserve Bank (TWI), MAF Policy (QTWI)

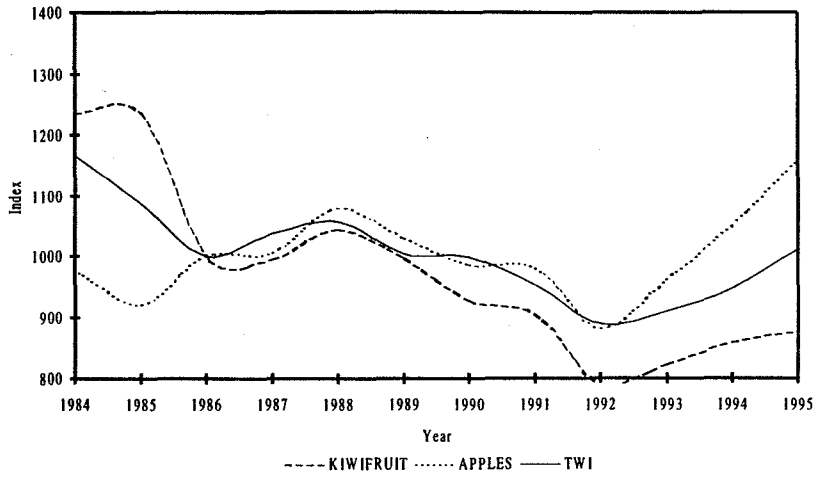
Again the dominance of the US$ in WMP trade and the UK pound in butter trade (table 1) explain the higher rate of appreciation of the QTWI's for WMP and butter relative to the TWI. The QTWI for butter increased by 26% and the QTWI for WMP increased by 23% between 1992 and 1995. In contrast, the QTWI for cheese increased by only 8%, because the cheese trade is mainly in Japanese yen. It has remained below the TWI as the Japanese yen depreciated by about 9%, between 1992 and 1995 (table 2).

(c) Horticultural sector

QTWI for kiwifruit was at a level moderately above the Reserve Bank TWI between 1984 and 1986. Since 1986, it has managed to remain below the TWI . QTWI for apples, on the other hand, has not fared as well. It was below the TWI from 1984 until 1988 and then fluctuated around the TWI until 1992; since 1992 QTWI for apples has remained above the Reserve Bank TWI.

The dominance of the US$ and UK pound in apple trade has ensured that the QTWI for apples appreciated at a higher rate (31%), than the Reserve Bank TWI (14%), between 1992 and 1995. In contrast, the QTWI for kiwifruit has not appreciated as much as the Reserve Bank TWI owing to the importance of the Deutschmark and the Japanese Yen in kiwifruit trade. The QTWI for kiwifruit appreciated by only 11% during this period (table 2).

Figure 3: Reserve Bank TWI and the Quarterly Trade Weighted Exchange Rate Indices (QTWI) for Kiwifruit & Apples (1986 =1000)



Sources: Reserve Bank (TWI), MAF Policy (QTWI)

2 Correlations of QTWI's and International Commodity Prices with New Zealand Prices

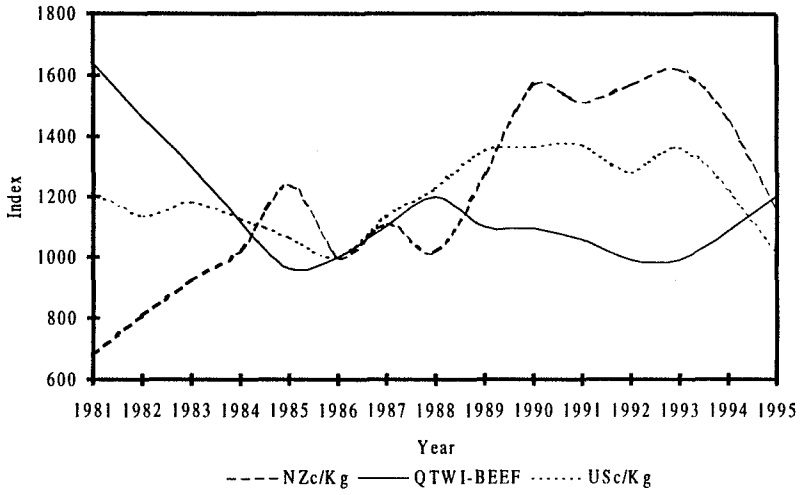
(a) Sheep and beef sector

The New Zealand price of Bull beef (NZc/Kg) moves in the opposite direction to the beef QTWI (figure 4). The international beef price (USc/Kg) also has an effect on the national price; when the US price rises so does the national price. Thus, when the beef QTWI decreased and the US price rose between 1989 and 1993, the New Zealand price was driven even higher than the international price of beef (figure 4).

The lamb QTWI does not show as much volatility as other commodities (figure 5) since the period of comparison for PM lamb is from 1986, after the devaluation and the float of the New Zealand dollar. The reason New Zealand lamb prices exhibit such great variability and are at a high level is due to the base year used (1986) being a particularly low year for domestic lamb prices (figure 5). Thus, it is difficult to arrive at any definitive conclusions except that domestic price changes appear to match international price movements.

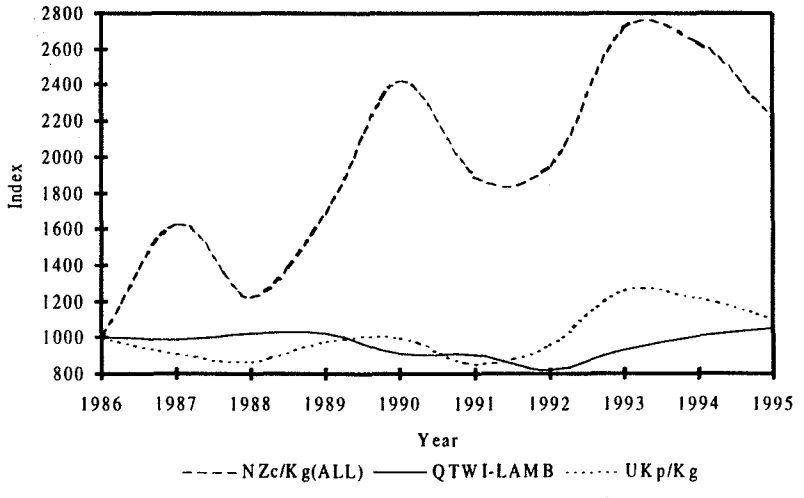
During 1981-1986, as the wool QTWI decreased the domestic price of wool increased (figure 6). This rise continued even when the wool QTWI rose slightly in 1988, as the international wool price which was very high at this time pushed up New Zealand wool prices. Towards the end of this period of analysis, the QTWI began to rise again but did not cause the New Zealand wool price to fall further as the international wool price increased as well following the 1991-93 wool price slump.

Figure 4: Beef QTWI and the Indexed International and New Zealand Bull Beef Prices (1986 = 1000)



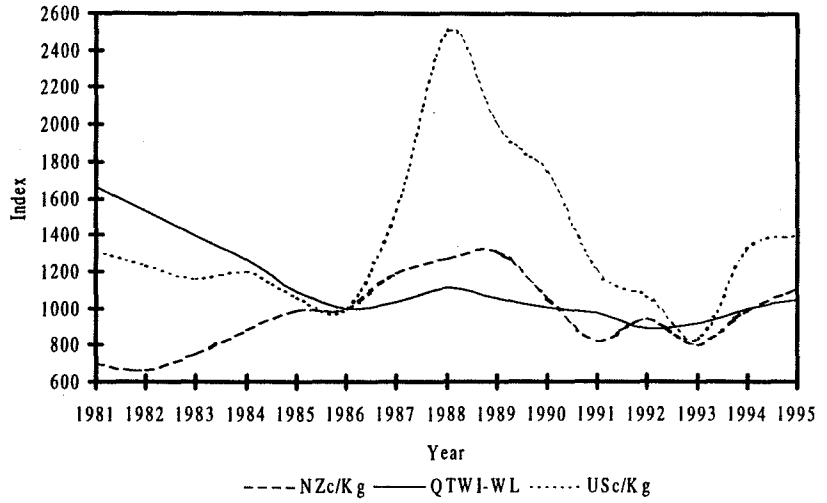
Sources: MAF Policy (QTWI-BF, NZc/Kg), NZMWBES (USc/Kg)

Figure 5: Lamb QTWI and the Indexed International and New Zealand PM Lamb Prices (1986 = 1000)



Sources: MAF Policy (QTWI-LB, NZc/Kg), NZMWBES (UKp/Kg)

Figure 6: Wool QTWI and the Indexed International and New Zealand Clean Wool Prices (1986 = 1000)



Sources: MAF Policy (QTWI-WL), WNZ (NZc/Kg, Australian Price in USc/Kg)

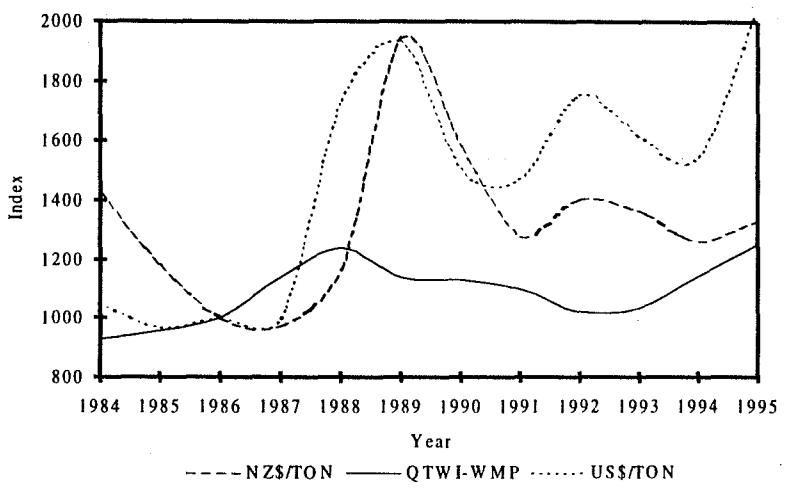
(b) Dairy sector

The FOB price of WMP originally contrasted the movement of the WMP QTWI (figure 7). As the international price of WMP became volatile after 1987, it began to have a greater effect on the New Zealand FOB price of WMP. After 1993, as the QTWI increased New Zealand WMP prices declined; but this decline was arrested in 1994 when rising international prices led to the rise of domestic prices.

In the early 1980s, the cheese QTWI had a greater effect on New Zealand prices than did international prices (figure 8). As the QTWI and international prices decreased between 1981-86, New Zealand prices increased. From 1987 onwards and up to 1993, the QTWI decreased and international prices increased causing an overall rise in New Zealand prices. Since 1993, a rising QTWI appears to have more than offset the increase in international cheese prices leading to a decline in the New Zealand FOB price of cheese.

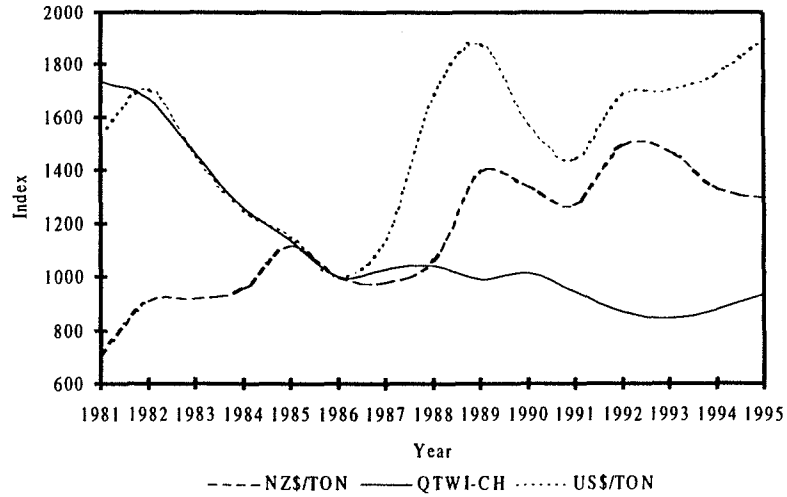
The New Zealand FOB butter prices rose as the butter QTWI fell in the early 1980s, in spite of the decrease in international prices (figure 9). Eventually this large international price fall resulted in a New Zealand price drop and this decrease was exacerbated by an appreciating QTWI. From 1988, as international prices fluctuated, so too did New Zealand prices; a decrease in the butter QTWI until 1992 caused the New Zealand price to rise despite falling international prices. Since 1992, the QTWI has risen and international prices also declined before recovering in 1995 leading to a smaller rise in the New Zealand FOB price of butter.

Figure 7: WMP QTWI and the Indexed International and New Zealand FOB WMP Prices (1986 = 1000)



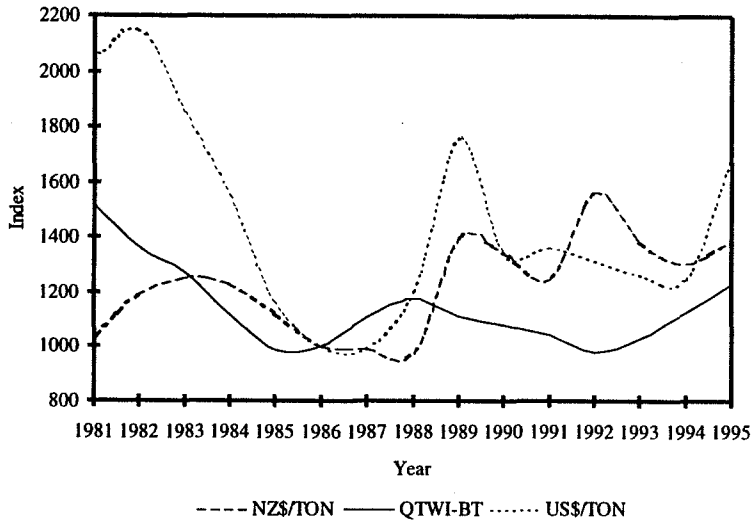
Sources: MAF Policy (QTWI-WMP, NZ$/TON, US$/TON)

Figure 8: Cheese QTWI and the Indexed International and New Zealand FOB Cheese Prices



Sources: MAF Policy (QTWI-CH, NZ$/TON, US$/TON)

Figure 9: Butter QTWI and the Indexed International and New Zealand FOB Butter Prices (1986 = 1000)



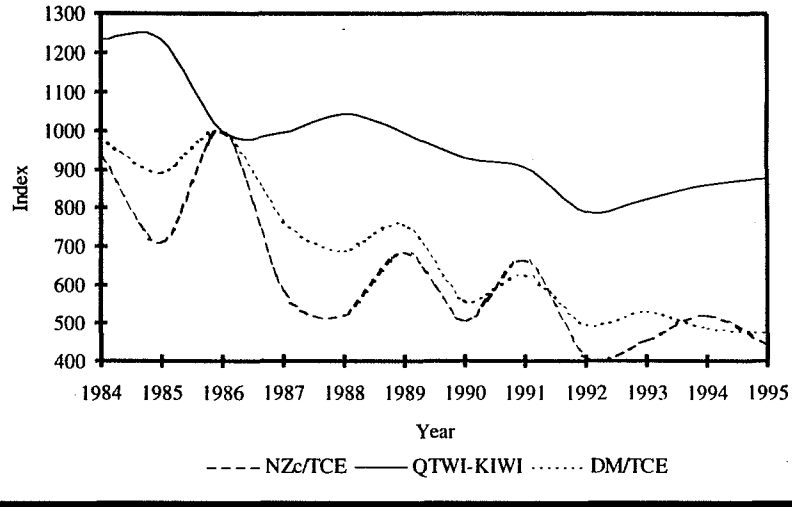
Sources: MAF Policy (QTWI-BT, NZ$/TON, US$/TON)

(c) Horticultural sector

Kiwifruit prices received by growers seem to more closely match the movements in international kiwifruit prices than the kiwifruit QTWI (figure 10). The volatility in international prices is also matched by domestic price volatility. New Zealand prices did seem to move in the opposite direction to the QTWI in the earlier years; however, from 1992, this does not appear to be the case. Domestic kiwifruit prices have continued to fluctuate in line with trends in international kiwifruit prices, while the appreciating kiwifruit QTWI has had minimal impact.

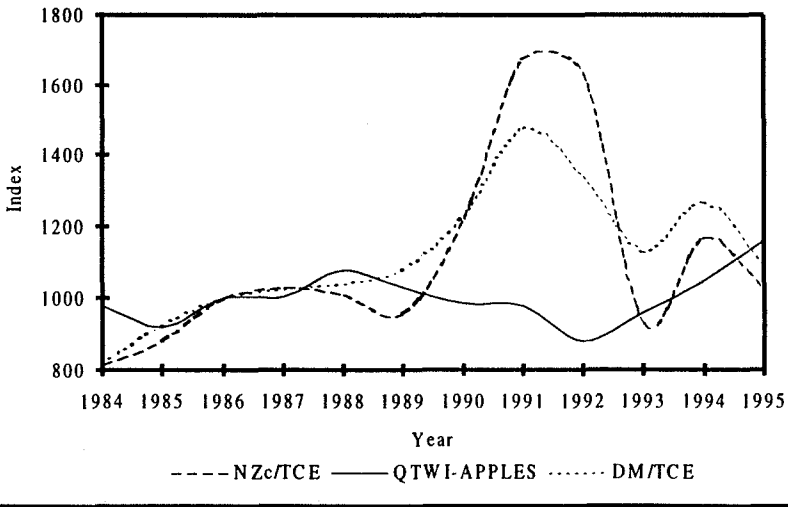
The New Zealand grower and international apple prices appear to follow each other fairly closely. The magnitude of the rise and fall in domestic prices are affected to a certain degree by the apple QTWI (figure 11). The large rise in domestic prices in the early 1990s was influenced both by rising international prices and a decreasing apple QTWI. However, as the apple QTWI increased from 1993 onwards, the New Zealand apple price initially rose in line with international prices before declining in 1995.

Figure 10: Kiwifruit QTWI and the Indexed International and New Zealand Kiwifruit Prices (1986 = 1000)



Sources: MAF Policy (QTWI-KF, NZc/Tray, DM/Tray)

Figure 11: Apple QTWI and the Indexed International and New Zealand Apple Prices (1986 = 1000)



Sources: MAF Policy (QTWI-AP, NZc/TCE, DM/TCE)

3. Regression relationships and elasticities

(1) Regression Results

The regression results for the eight commodities studied in this paper are summarised in appendix table 1. The period of analysis was in general for 15 years (1981-1995). The exception to this was WMP, apple and kiwifruit where the analysis was for 12 years (1984-1995) due to the unavailability of fob export data by quarters for the earlier years. For PM lamb, the analysis was only for 10 years (1986-1995) when this grade of lamb has been of importance in the international market place. Lamb, beef and wool prices in the sheep & beef sector were in NZc per kg at the farm gate level, while WMP, cheese and butter prices in the dairy sector were in NZ$ per ton at the fob level, due to the absence of prices at the farm gate level for these processed commodities. Apple and kiwifruit prices were at the orchard level in NZc per tray or tray cartons.

Regressions of New Zealand farm gate or fob prices as the dependent variables (regressand) were carried out with only the QTWIs and overseas commodity prices (OCP) as the independent variables (regressors). The estimated co-efficients were of the correct signs always, with a negative effect on New Zealand prices from rising QTWIs and a positive impact from rising OCPs. The co-efficients on the regressors were also statistically significant in most cases, at least at the 10% level of confidence. The overall explanatory power of equations was also high with R^2 values above 75% in most cases, the exception being PM lamb, butter and WMP prices.

(a) Sheep and beef sector

Bull beef schedule prices were explained by Beef-QTWI and Beef OCP (US Bull beef prices) with about 84% explanatory power and the co-efficients were significant at the 1% level and were of the correct signs. The PM lamb equation with Lamb-QTWI and the Lamb OCP (UK PM lamb prices) had an explanatory power of only 56%. The co-efficient on Lamb-QTWI was significant only at the 20% level (t-value of -1.6527) while that on Lamb OCP was significant at the 5% level (t-value of 3.488) as the degrees of freedom for the lamb equation was only 7. Wool auction prices were explained by Wool-QTWI and Australian wool indicator prices in USc per kg with about 77% explanatory power and with co-efficients significant at the 1% level and of correct signs

(b) Dairy sector

Among the dairy products for which New Zealand prices were analysed at the fob level, cheese exhibited high explanatory power with an R^2 value of 0.83 followed by butter at 0.49 and WMP at only 0.38. All the dairy product co-efficients also had the correct sign and were significant at the 1% level of confidence, with the exception of WMP-QTWI which was significant at the 10% level (t-value of -1.701).

(c) Horticulture sector

Both apple and kiwifruit New Zealand grower price equations had R^2 values above 0.80 and overseas commodity prices co-efficients, which in both cases were the German prices in DM per TCE and tray of the respective commodity, significant at the 1% level, . Both the AP-QTWI and KF-QTWI co-efficients had the correct negative sign, but were significant only at the 20% level.

(2) Elasticity Estimates

Table 3: New Zealand Price Elasticities of Quarterly Trade Weighted Exchange Rate Indices (QTWI) and Overseas Commodity Prices (OCP) and Their Ratios Estimated at the Mean

Products	QTWI	OCP	QTWI/OCP	OCP/QTWI
Beef (M Bull) (1981-95)	-1.0776	1.218	0.88	1.13
Lamb (PM Lamb) (1986-95)	-1.5358	1.7963	0.85	1.17
Wool (Clean) (1981-95)	-0.5576	0.4684	1.19	0.84
Butter (1981-95)	-1.3744	0.6943	1.98	0.51
Cheese (1981-95)	-0.6401	0.4556	1.40	0.71
WMP (1984-95)	-1.1281	0.7079	1.59	0.63
Kiwifruit (1984-95)	-0.6303	1.2906	0.49	2.05
Apples (1984-95)	-0.6692	1.3381	0.50	2.00

The elasticities reported in table 3 are measured at the mean level of respective New Zealand prices and the corresponding quarterly trade weighted exchange rate indices (QTWIs) and the overseas commodity prices (OCPs) using the respective co-efficients from the regression analysis as the rate of change parameters. The objective was to determine whether the QTWIs or OCPs had the greatest effect on New Zealand farmer returns for the respective products.

While both the QTWI and OCP for beef were elastic, overseas commodity prices had a slightly greater effect on returns than the exchange rate index. The same is true for lamb but both the QTWI and OCP were more elastic suggesting that PM lamb schedule prices were more responsive to the above factors than were the Bull beef schedule prices. The QTWI for wool had a slightly higher elasticity than OCP, but they were both inelastic.

The QTWI for butter is highly elastic and has a greater effect on farm gate returns than does overseas commodity prices which are inelastic. The data for cheese showed that both the QTWI and OCP are inelastic and don't have a great impact on New Zealand farm returns, but the QTWI has a slightly greater elasticity than OCP. WMP has similar results to butter in that the QTWI is elastic and OCP are inelastic.

Overseas commodity prices have a greater effect on New Zealand farm gate returns for kiwifruit than the QTWI as shown by its elasticity. Apples follow a similar pattern with OCP having an elastic impact and the QTWI an inelastic impact. These results show that to a certain extent those commodities which belong to the same product group have similar levels of elasticity and inelasticity.

When the ratios of QTWI/OCP and vice versa were calculated the following results were obtained:

- the QTWI was more significant for wool, butter, cheese and WMP; and
- OCP were more significant for beef, lamb, kiwifruit and apples.

These ratios supported the above conclusions.

4. Terms of exchange

In table 4, the nominal farm gate output prices for the commodities are reported along with the corresponding input price indices for the sectors for the 15 year period (1981-1995).

Table 4: Nominal Farm Gate Output Prices (NZc/Kg) and Input Price Indices (Base Year=1986)

Year	PM Lamb Prices	Bull Beef Prices	Clean Wool Prices	Sheep & Beef Input Index
1981	124	120	347	600
1982	164	143	331	710
1983	168	164	372	769
1984	176	181	437	809
1985	191	220	490	932
1986	102	177	496	1000
1987	166	197	591	966
1988	125	180	632	1031
1989	172	226	652	1055
1990	247	278	525	1165
1991	193	268	408	1239
1992	199	278	468	1244
1993	277	287	399	1315
1994	269	257	492	1329
1995	226	203	548	1337

Table 4: (Continued)

Year	Milk Fat Prices	Dairy Input Index	Apple Prices	Kiwifruit Prices	Hort Sector Input Index
1981	265	612			
1982	340	738			
1983	360	805	555	732	780
1984	350	838	630	880	801
1985	396	920	682	669	898
1986	398	1000	773	942	1000
1987	355	994	796	551	1039
1988	407	1050	783	490	1106
1989	575	1137	740	646	1141
1990	630	1278	944	477	1215
1991	423	1280	1294	627	1256
1992	584	1285	1260	385	1269
1993	638	1370	717	430	1298
1994	577	1363	904	490	1279
1995	691	1395	788	418	1293

Table 5 reports the terms of exchange indices derived as the ratio of output price index to the respective input price index. The base period chosen for this analysis is 1986 so as to be consistent with the derivation of QTWIs earlier in the paper. However, it is important to note that 1986 was an exceptionally poor year for lamb and beef prices and this is reflected in the terms of exchange indices derived for the recent period for these commodities in table 5.

Table 5: Terms of Exchange Indices (Base Year = 1986)

Year	PM Lamb	Bull Beef	Clean Wool	Milk Fat	Apples	Kiwifruit
1981	2019	1131	1167	1089		
1982	2269	1137	941	1158		
1983	2137	1203	976	1124	920	996
1984	2131	1264	1089	1050	1018	1167
1985	2010	1333	1060	1082	983	791
1986	1000	1000	1000	1000	1000	1000
1987	1684	1148	1233	897	991	563
1988	1191	988	1236	974	916	470
1989	1599	1211	1246	1270	839	601
1990	2076	1346	908	1239	1005	417
1991	1522	1221	664	830	1333	530
1992	1568	1262	759	1142	1285	322
1993	2063	1230	612	1170	714	352
1994	1985	1089	746	1063	915	407
1995	1658	856	826	1244	788	343

Since 1986, the base period used in this study, the PM lamb terms of exchange had been quite high during 1990, 1993 and 1994 (near 2000), but low during 1988 (1191); while the Bull beef terms of exchange had been the highest in 1990 (1346) and the lowest in 1995 (856). Wool terms of exchange had been high during the 1987-89 period (over 1200) and very low in 1991 (664) and also in 1993 (612). Dairy terms of exchange was the lowest in 1991 (830) and quite high in 1989 (1270) and then in 1995 (1244). Apple terms of exchange was the highest in 1991 (1333) and the lowest in 1993 (714) while the kiwifruit terms of exchange was the highest in 1989 (601) and the lowest in 1992 (322).

Between 1993 and 1995, lamb and beef terms of exchange declined by about 20% and 44% respectively, while wool terms of exchange increased by about 35%. Meanwhile, the dairy and apple terms of exchange increased by less than 10% during the same period and kiwifruit terms of exchange actually declined. In 1994, the dairy terms of exchange was lower while the apple and kiwifruit terms of exchange were higher than in 1995.

Foreign Currency Forward Exchange Rate Contracts

Since the mid 1980s the use of foreign currency futures and options as a hedging tool has become a major foreign exchange activity. They are used to hedge the foreign exchange risk that results from international commercial transactions. A foreign currency futures contract is an agreement calling for future delivery of a standard amount of currency at a fixed time, place and price. Whereas, a foreign currency option gives a purchaser the right but not the obligation to buy or sell a given amount of foreign exchange at a fixed price per unit for a specified time period. Based on information obtained in their annual reports all of the following Boards use hedging against foreign exchange risk to a certain degree:

1. New Zealand Wool Board (NZWB)

With the removal of the minimum price for wool and continued foreign exchange risk, the NZWB adopted a policy of hedging against these risks in 1994, within predetermined policy limits. Foreign exchange contracts were entered into with various trading banks in order to manage the exchange rate exposure. The notional contract amount of foreign exchange for the Board and its subsidiaries outstanding in the year to June 1995 was $44.5 million, while it was $33.2 million in the year to June 1994. While these contracts are not relevant to the wool market as such, they are important in the case of the NZWB's International Wool Secretariat expenditure commitments and for sales from wool stocks. These foreign exchange contracts do not affect the returns to producers because, since February 1991, the Board has not played an active role in the market.

2. New Zealand Dairy Board (NZDB)

During the year to May 1987, the NZDB put in place a policy of managing foreign exchange risk, for the first time. This was in response to high and volatile interest and exchange rates. The Board undertakes a mixture of forward rate cover and options. Another form of hedging that the Board undertakes is denominating loans in US$; these are employed to manage interest rate exposure in relation to borrowings.

About eighty per cent of the NZDB's revenue is denominated in US$ which meant that the taking out of forward cover is extremely important. The US$ is therefore, the major currency in which the Dairy Board takes out forward contracts. This resulted in a $297million benefit to the NZDB in the year to June 1995. In the year to June 1994, the resultant currency benefit was $248 million. Exchange rate cover currently extends over 1995/96 and the subsequent two seasons.

3. New Zealand Kiwifruit Marketing Board (NZKMB)

Foreign forward exchange rate contracts were first used by the NZKMB in 1988. In 1995 without forward cover growers would have lost NZ$42 million owing to exchange rate fluctuations. The Board's forward cover saved growers over NZ$20 million of this expected loss, however, exchange rate changes still cost growers NZ$22 million.

During the 1995/96 season, the NZKMB entered into forward foreign exchange and option contracts able to be sold at the equivalent price of NZ$203,763,047 with a fair value of NZ$196,719,775. This fair value is based on the market values at balance day. The major currencies in which the Board takes out forward cover are the Deutschmark, the Yen and the US$, with the Pound utilised to a lesser extent.

4. New Zealand Apple and Pear Marketing Board (NZAPMB)

In 1987, the NZAPMB first used financial instruments to hedge future seasons' foreign currency revenues and costs. In 1995, a comparison of sale and purchase commitments showed a net

unrealised fair value of $5,500,000. This is in comparison to 1994 where there was a net unrealised benefit of only $483,000. In 1995, currency movements reduced grower returns by $2.86 per carton despite an estimated benefit from forward cover of $0.70 per carton. In 1994, growers benefitted by $3.00 per carton from forward cover. Not all sales are covered, hence there is still some exposure to currency movement.

5. New Zealand Meat Producers Board (NZMPB)

Because the NZMPB does not sell meat in overseas markets, it has not needed to obtain forward foreign exchange contracts and options on the scale of the trading boards. The NZMPB plays a role of promoting New Zealand beef and lamb overseas; thus when the NZ$ appreciates, it reduces the Board's overseas promotion costs. In 1993, the Board used forward foreign exchange contracts for the first time. In the year to 30 September 1995, no foreign exchange forward contracts were outstanding. In relation to meat companies; it is unknown as to the extent to which individual meat companies use forward exchange cover.

Summary

Recent commentaries by industry analysts on the effects of exchange rates on farm returns have focused on selective time frames of partial analysis to highlight the adverse impacts on the different sectors. In this paper, a balanced emphasis and a more comprehensive evaluation is attempted by considering a longer time frame covering periods of pre- and post- New Zealand dollar float, as well as the overseas price cycles for the different commodities. In summary, this paper looked at the medium-term effects of the New Zealand exchange rate and international commodity prices on farm returns. This paper suffered from some limitations in terms of the length of the data series mentioned earlier in this paper. However, these limitations did not appear to have affected the results to any significant degree.

Those commodities that showed the highest level of appreciation in the last three years (eg apples and lamb) were traded mainly in currencies that have appreciated rapidly. In the case of these commodities, trade was dominated in recent periods by the US Dollar and UK Pound, which appreciated 23% and 35%, respectively.

When the correlation of the QTWI's and international prices with the New Zealand farm gate prices were considered, it was found that both the QTWI and international commodity prices had the anticipated effect on New Zealand prices. If international prices were high then this tended to increase the New Zealand price, or when the QTWI was going through a period of rapid appreciation then this would cause New Zealand prices to fall. New Zealand prices for commodities such as lamb, apples and kiwifruit seemed to mirror international prices more closely than the QTWI. However, New Zealand prices for wool and cheese appeared to move in the opposite direction to their QTWI, while being positively influenced to a certain degree by international commodity prices. The price elasticities of the QTWI and OCP supported the above conclusions. When the ratios of QTWI/OCP were considered it was discovered that the QTWI was more significant for wool, butter, cheese and WMP. OCP were more significant for beef, lamb, kiwifruit and apples.

The terms of exchange indices clearly show the high and low periods of relative purchasing power for each of the commodities. For the beef terms of exchange, 1995 was a particularly low point, while the majority of the other commodities seemed to reach their lowest point in the mid 1990s and their highest point in the late 1980s or early 1990s.

All of the producer boards mentioned in this paper used foreign currency forward exchange rate contracts to varying degrees to hedge against foreign exchange risk. The level of cover obtained depended on the role of the producer board, eg whether its role was mainly to promote the commodity concerned overseas, or whether it acted as a single seller of the export commodity concerned.

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Appendix

Appendix Table 1: Regression Results of Quarterly Trade Weighted Exchange Rate Indices (QTWI) and Overseas Commodity Prices (OCP) on New Zealand Farm Gate/FOB Prices (1981-1995 and sub-periods)

New Zealand Prices		R^2	F
1.	Bull Beef Schedule Prices (BBFP)-NZc/Kg		
	BBFP = - 0.1978 Beef QTWI + 1.0296 Beef OCP	0.839	31.3
	(- 6.0742)**** (4.431)****		
2.	PM Lamb Schedule Prices (PMLP)-NZc/Kg (1986-95)		
	PMLP = - 0.2984 Lamb QTWI + 2.3252 Lamb OCP	0.558	6.7
	(-1.6527)* (3.488)***		
3.	Clean Wool Auction Prices (CAWP)-NZc/Kg		
	CAWP = - 0.2362 Wool QTWI + 0.3518 Wool OCP	0.773	24.
	(-4.2837)**** (5.5711)****		
4.	FOB WMP Prices (FWMPP)-NZ$/Tonne (1984-95)		
	FWMPP = - 4.9675 WMP QTWI + 2.3113 WMP OCP	0.380	4.4
	(-1.701)* (2.9385)***		
5.	FOB Cheese Prices (FCHP)-NZ$/Tonne		
	FCHP = - 1.7965 CH- QTWI + 0.8653 CH-OCP	0.830	35.2
	(-7.081)**** (3.6276)****		
6.	FOB Butter Prices (FBUP)- NZ$/Tonne		
	FBUP = - 3.5465 BU-QTWI + 1.3217 BU-OCP	0.493	7.8
	(-3.840)**** (3.6557)****		
7.	Grower Apple Prices (GAP)- NZc/TCE (1984-95)		
	GAP = - 0.5734 AP-QTWI + 26.3732 AP-OCP	0.826	27.2
	(-1.539)* (6.9688)****		
8.	Grower Kiwifruit Prices (GKFP)-NZc/Tray (1984-95)		
	GKFP = - 0.3778 KF-QTWI + 48.8059 KF-OCP	0.843	30.6
	(-1.3999)* (5.3849)****		

Values in parentheses are t-statistics, with the asterixes (*) representing the level of significance at the 20%(*), 10%(**), 5%(***) and 1%(****) level.

Paper presented to the *Annual Conference of the New Zealand Agricultural Economics Society*
Blenheim, 5-6 July 1996

Value Added in Agriculture: The Rise in Off-Farm Contribution to the New Zealand Economy

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Abstract

The agricultural sector makes a significant contribution to the New Zealand economy. Despite the removal of government assistance from this sector over the last decade and the competition from producers who are heavily subsidised in other countries, the industries within this sector continue to play important and significant roles in the New Zealand economy.

This study uses the input-output framework to analyse the contributions made by the dairy industry, the sheep and beef industry, and the total agricultural sector to New Zealand's gross domestic product (GDP) and employment. Changes in labour productivity is analysed. Trends in the two industries and the agricultural sector are also presented.

In the ten years to 1996, the value of net output of the agricultural sector, of the dairy industry and of the sheep and beef industry, in real terms, have increased. The increase in percentage contribution to GDP by the farm output processing sub-sector more than compensated for the decrease in percentage contribution to GDP from the farming (up to farm gate) sub-sector.

Introduction

This study analyses the contributions made by the dairy industry, the sheep and beef industry and the total agricultural sector to the New Zealand economy. The analysis is based on contributions to gross domestic product (GDP) and employment. In this paper, value added or contribution to GDP is calculated by subtracting intermediate consumption (purchases from other firms) and the value of imports for an industry from that industry's gross output (sales or turnover) over a twelve month period. The main components of value added are operating surplus (profits before interest, cost and taxation), employee compensation, and an allowance for economic depreciation.

The objectives of this paper are:

(a) to derive up to date reliable estimates of the total contribution which the dairy industry, the sheep and beef industry and the total agricultural sector make to net output or gross domestic product (GDP) of the New Zealand economy;

(b) to derive up to date reliable estimates of the number of people employed in the dairy industry, the sheep and beef industry and the total agricultural sector;

(c) to analyse recent trends in the contribution of the dairy industry, the sheep and beef industry and the total agricultural sector to New Zealand's GDP and employment; and

(d) to analyse recent trends in labour productivity in these two industries and in the agricultural sector.

[1] *Views expressed in this paper are those of the author and not necessarily those of the Ministry of Agriculture.*

Method

To achieve these, input-output tables for the New Zealand Economy from the Inter-Industry study were used. The Inter-Industry study provides an economic statement of the industrial structure of the economy for a given year, measuring the direct and indirect inter-relationships between industries. This data is compiled by Statistics New Zealand. The input and output figures for the dairy industry, the sheep and beef industry and the total agricultural sector were estimated for some years to 1996 and forecast for 1997, using the inter-relationships between industries as published in the 1986-87 and 1990-91 (the most recent study) Inter-Industry tables. MAF and New Zealand Institute of Economic Research, industry and sectoral projections were also used for this exercise.

The input-output transactions (or flows) tables are a means of describing, for a particular period, the supply and disposition of the goods and services of an entire economic system. A framework of the input-output transactions table is presented in **figure 1**.

Employment figures were compiled using data from the New Zealand Census of Population and Dwellings for 1986 and 1991, and Statistics New Zealand's Household Labour Force Surveys for the remaining years to 1996. Employment figures are as at March in any one year, and therefore do not take account of the seasonal nature of employment in the agricultural sector. All analysis is based on full-time equivalent employed. Direct and indirect inter-relationships between industries as contained in the inter-industry tables were used to work out the proportion of the labour force that could be attributed to the activities within the dairy industry, and the sheep and beef industry.

Industry and Sector Definitions

The 'Dairy Industry' consists of a number of sub-sectors, from the producer to the consumer, ie dairy farming (up to farm gate), milk processing, input suppliers to both farming and processing, transport, wholesalers and retailers. Each of these sub-sectors consists of a number of industries or groups of industries, as classified under New Zealand Standard Industrial Classification (NZSIC). For example, the input supply sub-sector includes agricultural services, food and beverages, machinery, chemical products and other services. The composition of the dairy industry as defined in this study is depicted in **figure 2**.

The sheep and beef industry is similarly defined, and includes the wool processing sector as well. The agricultural sector is also similarly defined, and it includes all farming and horticultural industries.

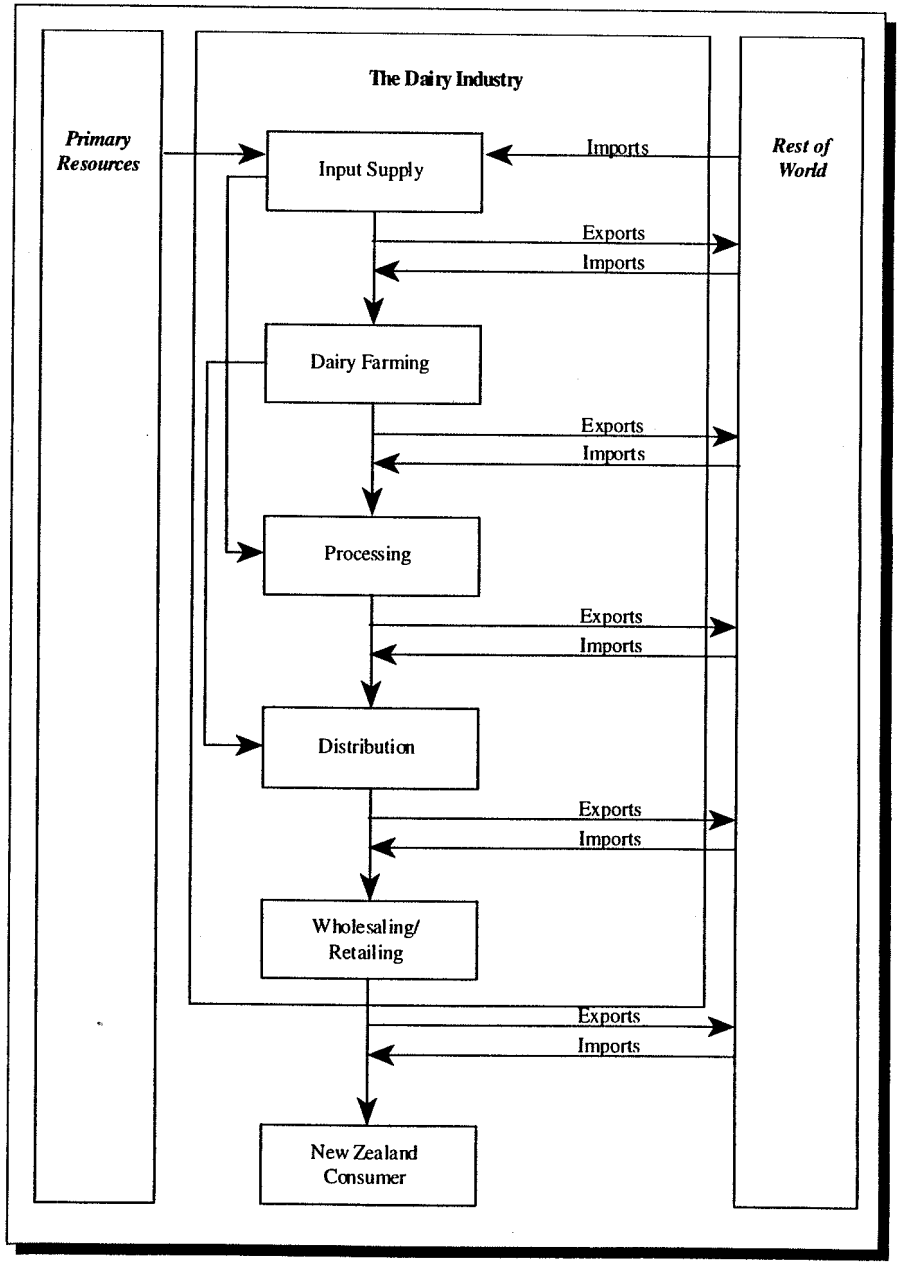
This broader definition is adopted in this study since the primary objective of farming is to make final products available to consumers, and thus all the links in the production and distribution chain need to be considered. The inter-industry tables for the New Zealand economy show

Figure 1: Framework of the Input-Output Transaction Tables

	Total Demand = Total Output				
Final Demand	Final Demand (Sub-total)				
	Gross Fixed Capital Information	Quadrant No. 2		Quadrant No. 4	
	Exports		Final Output of Production		Primary Inputs to Final Demand
	Government & Private Non-profit Organisations' Services Produced for Own Use				
	Household Consumption				
	Intermediate Demand (Sub-total)				
Intermediate Demand	Forestry 3	Quadrant No. 1		Quadrant No. 3	
	Hunting & Fishing 2		Intermediate Production and Demand		Primary Inputs to Production
	Agriculture 1				
For the disposition of output of an industry, read the row for that industry	For the origin of input into an industry, read the column for that industry				
		Agriculture 1	Intermediate Inputs (Sub-total)	Compensation of Employees	Total Input
		Hunting & Fishing 2		Operating Surplus	
		Forestry 3		Indirect Taxes	
		Etc		Subsidies	
		Primary Inputs		Consumption of Fixed Capital	
				Secondhand Assets	
				Imports	
				Primary Inputs (Sub-total)	
				Intermediate Inputs	

Source: Inter-Industry Study of the New Zealand Economy 1986-87, Department of Statistics, Wellington

Figure 2: The New Zealand Dairy Industry



strong interdependence of the farming, input supply, processing, distribution and retailing sub-sectors.

The following is a more detailed description of the above sub-sectors of the dairy industry. A similar description is also applicable to the sheep and beef industry, and the total agricultural sector.

- **Dairy Farming:** This sub-sector is made up of all dairy farming (up to farm gate) activities.
- **Dairy Product Processing:** This sub-sector is made up of milk processing plants, ice-cream manufacturing and the manufacture of dairy products, which can be separately identified.
- **Other Processing Sub-sector:** Industries included in the "other processing sub-sector" are selected on the origin of their major inputs. Hence, industries whose significant component of inputs come from New Zealand dairy farming are included in the "other processing sub-sector".

  Processing industries that derive only a small component of their inputs from dairy farming are excluded from the processing sub-sector of the dairy industry. These exclusions were on the basis that the industry could exist without inputs from New Zealand dairy farming. A related processing industry with a significant proportion of its intermediate inputs coming from the dairy farming industry was assumed to exist primarily because of the inputs available from New Zealand dairy farming.

  On this basis, a proportion of meat works processing industry was included in the "other processing sub-sector".

- **Input Supply Sub-sector:** Input supply to dairy farming and dairy processing are considered here. Input supply industries to dairy farming are defined as any industry with a direct input to the dairy farming sub-sector. On this basis, a number of input supply industries are identified. Industries included range from agricultural services, food, beverages, textiles, wood products, chemical products, metal products, finance and business services, government services, etc. Also included in this sub-sector are the transport of inputs to the dairy farming sub-sector. Similar methodology was used to derive input supply to dairy processing sub-sector.
- **Transport:** Only part of the total net output from the transport sub-sector could be assigned to the dairy industry. Transport industries included here were rail, road, water and air transport and storage. Road passenger transport was omitted from the general transport grouping as it did not apply directly to the movement of dairy inputs or outputs.
- **Wholesale/Retail:** Only part of the total net output from these industries could be assigned to the dairy industry.

Dairy Industry's Contribution to GDP

It is estimated that the value of net output (or value added) from the dairy industry rose by 164%, from $1,659 million in the year end 31 March 1987 to $4,377 million in the year ended 31 March 1996 (see **table 1**). This is forecast to rise to $4,718 million in the year end March 1997. In 1996, this accounted for 4.8% of New Zealand's gross domestic product (GDP).

Table 1: Dairy Industry's Contribution to GDP

Table 1(a): Dairy Industry's Net Output (Contribution to GDP, $ million, nominal)

Year Ended March	1986/87 $ million	1990/91 $ million	1993/94e $ million	1995/96e $ million	1996/97f $ million
Dairy Farming	696	881	1,188	1,474	1,598
Input Supply — Farming	260	469	624	686	721
Input Supply — Dairy Processing	174	393	465	520	551
Processing — Dairy	395	659	1,294	1,419	1,551
Processing — Other	47	22	53	58	63
Transport	66	126	124	133	142
Wholesale/retail trade	20	58	75	87	91
Total Dairy Industry	1,659	2,608	3,823	4,377	4,718
Total NZ GDP	55,024	72,962	79,999	90,420	95,330

Table 1(b): Sub-sector's Contributions to Total Dairy Output (Percent of Total Dairy Net Output)

	%	%	%	%	%
Dairy Farming	42.0	33.8	31.1	33.7	33.9
Input Supply — Farming	15.7	18.0	16.3	15.7	15.3
Input Supply — Dairy Processing	10.5	15.1	12.2	11.9	11.7
Processing — Dairy	23.8	25.3	33.9	32.4	32.9
Processing — Other	2.8	0.9	1.4	1.3	1.3
Transport	4.0	4.8	3.3	3.0	3.0
Wholesale/retail trade	1.2	2.2	2.0	2.0	1.9
Total Dairy Industry	100.0	100.0	100.0	100.0	100.0

Table 1(c): Dairy Industry's % Contribution to GDP (Percent of Total NZ GDP)

	%	%	%	%	%
Dairy Farming	1.3	1.2	1.5	1.6	1.7
Input Supply — Farming	0.5	0.6	0.8	0.8	0.8
Input Supply — Dairy Processing	0.3	0.5	0.6	0.6	0.6
Processing — Dairy	0.7	0.9	1.6	1.6	1.6
Processing — Other	0.1	0.0	0.1	0.1	0.1
Transport	0.1	0.2	0.2	0.1	0.1
Wholesale/retail trade	0.0	0.1	0.1	0.1	0.1
Total Dairy Industry	3.0	3.6	4.8	4.8	4.9
Total NZ GDP	100.0	100.0	100.0	100.0	100.0

e = estimate, f = forecast

Sources: Statistics New Zealand, NZIER, MAF.

The dairy farming sub-sector (on-farm activities) accounts for around 34% of the dairy industry's contribution to GDP. Processing of dairy products (excluding processing of meat from dairy farms) accounts for around 32% of the dairy industry's contribution. Inputs purchased by dairy farmers and the related processing sub-sector, processing of meat from dairy farms, wholesaling/ retailing activities and the transport of dairy farm and dairy processing inputs and outputs account for the remaining 34%.

During the ten year period to 1996, the nominal value of output from dairy farming and the other dairy sub-sectors has increased steadily, apart from a slight decrease in the other processing sub-sector (mainly meat) in 1991 and in the transport sub-sector in 1994. The percent contribution by the total dairy industry to the country's GDP has increased from 3.0% in 1987 to 4.8% in 1996. This is expected to rise further in 1997.

The dairy processing sub-sector has increased in relative importance since 1987. In 1987, the dairy processing sub-sector accounted for 24% of the dairy industry's contribution to GDP and in 1996 it was over 32%. An expanding dairy industry has led to the expansion in expenditure on farm inputs, such as fertilisers, repairs and maintenance, and agricultural machinery. The sub-sector supplying inputs to dairy processing has also expanded.

The nominal value of net output of the transport sub-sector, as well as its relative importance has not increased much. The key factor behind this slower growth is the improved efficiency from increased competition in the transport sector.

The total dairy industry's contribution to GDP has risen and is forecast to rise further. This reflects improvement in milksolid prices, weaker performance of some key competing farming enterprises, increased investments in the dairy industry, and expansion of dairy land use. Over the long term, international dairy prices are forecast to remain favourable, as the EU cuts back its subsidised exports in line with GATT and economic growth boosts demand.

Dairy Industry's Contribution to Employment

It is estimated that the dairy industry provided employment for around 4.6% of the New Zealand work force in the year ended March 1996 (see **table 2**). In 1987, over 58,800 people were employed in the total dairy industry. This increased by more than 8,000 (14%) to around 67,200 in 1996.

The increase is mainly in the input supply to dairy farming and to dairy processing industries. The estimate of numbers employed in the dairy processing industry is lower in 1996 compared to 1987.

This is due to larger and more efficient processing factories and better use of technology. Employment on dairy farms has increased in recent years but is slightlylower than the numbers recorded in 1987. The recent increases in numbers employed on dairy farms reflect the increase in the number of dairy farms, as more sheep and beef farms are converted to dairying.

Table 2: Dairy Industry's Contribution to Employment

Table 2a: Dairy Industry's Contribution to Total NZ Employment (Numbers)*

Year Ended March	1986-87 Number	1990-91 Number	1993-94 Number	1995-96 Number
Dairy Farming	33,962	29,241	30,797	32,139
Input Supply — Dairy Farming	6,533	12,404	13,649	14,195
Input Supply — Dairy Processing	4,393	6,929	7,732	8,097
Processing — Dairy	8,003	7,091	7,686	7,157
Processing — Other	1,248	1,158	1,212	1,150
Transport	1,711	1,975	2,150	2,165
Wholesale/retail trade	2,994	2,553	2,248	2,381
Total Dairy Industry	58,845	61,351	65,473	67,285
Total NZ Employment	1,399,883	1,271,297	1,348,601	1,467,241

Table 2b: Dairy Industry's Contribution to Employment (Percent of Total)

	%	%	%	%
Dairy Farming	2.4	2.3	2.3	2.2
Input Supply — Dairy Farming	0.5	1.0	1.0	1.0
Input Supply — Dairy Processing	0.3	0.5	0.6	0.6
Processing — Dairy	0.6	0.6	0.6	0.5
Processing — Other	0.1	0.1	0.1	0.1
Transport	0.1	0.2	0.2	0.1
Wholesale/retail trade	0.2	0.2	0.2	0.2
Total Dairy Industry	4.2	4.8	4.9	4.6
Total Employment	100.0	100.0	100.0	100.0

Note: * Full-time Equivalent

Sources: Statistics NZ, MAF

Sheep and Beef Industry's Contribution to GDP

The value of net output from the sheep and beef industry was $4,689 million for the year ended 31 March 1996, rising from $3,294 million in 1987 (see **table 3**). This accounted for 5.2% of New Zealand's gross domestic product (GDP) in 1996, declining from 6.0% in 1987. The sheep and beef farming sub-sector accounted for around 30% of the industry's contribution, down from 43% in 1987. Processing of products from sheep and beef farms accounted for 15% of the sheep and beef industry's contribution, rising from 13% in 1987. Inputs purchased by sheep and beef farmers and the related processing sub-sector, processing of meat and textiles accounted for 49% of the industry's contribution. The remaining were contributions from wholesaling/retailing activities and the transport of farm and processing industry inputs and outputs.

Table 3: Sheep and Beef Industry's Contribution to GDP

Table 3a: Sheep & Beef Industry's Net Output (Contribution to GDP, $ million, nominal)					
Year Ended March	1986/87 $ million	1990/91 $ million	1993/94e $ million	1995/96e $ million	1996/97f $ million
Sheep & Beef Farming	1,426	1,422	1,600	1,389	1,377
Input Supply — Farming	486	683	849	951	999
Input Supply — Text/Meat	782	999	1,206	1,350	1,421
Processing — Textiles	139	205	251	277	293
Processing — Meat	285	269	372	408	446
Transport	100	181	179	192	204
Wholesale/retail trade	75	92	107	124	131
Total Sheep & Beef Industry	3,294	3,851	4,564	4,689	4,870
Total NZ GDP	55,024	72,962	79,999	90,420	95,330

Table 3b: Sub-sector's Contributions to Total Sheep & Beef Output (% of Total Sheep & Beef Output)					
	%	%	%	%	%
Sheep & Beef Farming	43.3	36.9	35.0	29.6	28.3
Input Supply — Farming	14.8	17.7	18.6	20.3	20.5
Input Supply — Text/Meat	23.7	25.9	26.4	28.8	29.2
Processing — Textiles	4.2	5.3	5.5	5.9	6.0
Processing — Meat	8.6	7.0	8.2	8.7	9.2
Transport	3.0	4.7	3.9	4.1	4.2
Wholesale/retail trade	2.3	2.4	2.3	2.6	2.7
Total Sheep & Beef Industry	100.0	100.0	100.0	100.0	100.0

Table 3c: Sheep & Beef Industry's % Contribution to Total GDP (Percent of Total NZ GDP)					
	%	%	%	%	%
Sheep & Beef Farming	2.6	1.9	2.0	1.5	1.4
Input Supply — Farming	0.9	0.9	1.1	1.1	1.0
Input Supply — Text/Meat	1.4	1.4	1.5	1.5	1.5
Processing — Textiles	0.3	0.3	0.3	0.3	0.3
Processing — Meat	0.5	0.4	0.5	0.5	0.5
Transport	0.2	0.2	0.2	0.2	0.2
Wholesale/retail trade	0.1	0.1	0.1	0.1	0.1
Total Sheep & Beef Industry	6.0	5.3	5.7	5.2	5.1
Total NZ GDP	100.0	100.0	100.0	100.0	100.0

e = estimate, f = forecast

Sources: Statistics New Zealand, NZIER, MAF.

During the period from 1987 to 1996, except in 1993/94, the nominal value of net output from sheep and beef farming has decreased steadily, while at the same time the sub-sector providing inputs to sheep and beef farms has expanded steadily. The textile processing sub-sector has also expanded steadily. In fact all the sub-sectors in the sheep and beef industry expanded except sheep and beef farming (up to farm gate), whose proportion declined from 43% in 1987 to 30% in 1996. The percent contribution by the total sheep and beef industry to the country's GDP has decreased over the period from 6.0% in 1987 to 5.2% in 1996, though there was a small increase in 1994. This is expected to decline further in 1997.

The decline is mainly due to poor returns to sheep and beef farmers owing to lower prices for their products, and also relatively higher growth in other farming industries, particularly the dairy industry, compared to the sheep and beef industry.

The input supply to both sheep and beef farming and in the processing sub-sector has increased in relative importance since 1987. While the sheep and beef farming sub-sector has contracted, the input supply to sheep and beef farming and the processing sub-sectors has not contracted.

The nominal value of net output of the transport sub-sector, as well as its relative importance has increased. Has rationalisation in the meat processing industry increased transportation requirements for the sheep and beef industry?

Sheep and Beef Industry's Contribution to Employment

It is estimated that the sheep and beef industry provided employment for around 7.9% of the New Zealand work force in 1996 (see **table 4**). This has declined from 8.3% in 1987. In 1987, around 115,600 people were employed in the sheep and beef industry, this figure is estimated to have risen slightly, to 116,300 in 1996. While numbers employed on the farm and in meat processing declined slightly, the numbers employed in the input supply to the sheep and beef farming sub-sector and in the transport sub-sector increased between 1987 and 1996.

Table 4: Sheep and Beef Industry's Contribution to Employment

Table 4a: Sheep and Beef Industry's Contribution to Total NZ Employment (Numbers)*				
Year Ended March	1986-87 Number	1990-91 Number	1993-94 Number	1995-96 Number
Sheep & Beef Farming	35,757	32,720	32,697	34,183
Input Supply- Farming	15,977	16,168	17,687	19,068
Input Supply- Processing	24,313	21,244	20,592	22,074
Processing-Textile	3,811	4,631	3,980	4,690
Processing- Meat	26,025	25,295	26,955	25,331
Transport	7,590	8,891	8,457	8,594
Wholesale/retail trade	2,158	2,373	2,226	2,359
Total Sheep & Beef Industry	115,631	111,321	112,593	116,300
Total NZ Employment	1,399,883	1,271,297	1,348,601	1,467,241

Table 4b: Sheep and Beef Industry's Contribution to Employment (Percent of Total)	%	%	%	%
Sheep & Beef Farming	2.6	2.6	2.4	2.3
Input Supply — Farming	1.1	1.3	1.3	1.3
Input Supply — Processing	1.7	1.7	1.5	1.5
Processing — Textile	0.3	0.4	0.3	0.3
Processing — Meat	1.9	2.0	2.0	1.7
Transport	0.5	0.7	0.6	0.6
Wholesale/retail trade	0.2	0.2	0.2	0.2
Total Sheep & Beef Industry	8.3	8.8	8.3	7.9
Total NZ Employment	100.0	100.0	100.0	100.0

Note: * Full-time Equivalent

Sources: Statistics NZ, and MAF

Agricultural Sector's Contribution to GDP

The agricultural sector as a whole, for the year ended 31 March 1996, accounted for 15.4% of New Zealand's GDP (see **table 5**). The two main sub-sectors of the agricultural sector are farming (up to farm gate) and processing. They together account for around two thirds of the sector's contribution to GDP. The input supply to farming and to processing together account for around 27% of the sector's contribution to GDP. Wholesale and retail trade and transport sub-sectors account for the remainder.

Since 1987, the percentage contribution by the total agricultural sector to the New Zealand economy has increased. One key reason for this overall increase, despite the lower world market prices for many of New Zealand's major agricultural products, was a rise in the contribution of the processing sub-sector.

In nominal terms, the value of output from dairy and meat processing and textile sub-sector has increased from $1,864 million in 1987 to $4,243 million in 1996, or an increase from 3.4% to 4.7% of total GDP. During this period, the percent contribution from the farming sub-sector declined from 5.9% of total GDP to 5.0%. Contributions from the other sub-sectors have either increased slightly or have remained relatively stable.

The agricultural sector's contribution to GDP is expected to improve further in 1997 to 15.5% of the total New Zealand GDP, and the processing sub-sector is expected to become relatively more important.

Table 5: Agricultural Sector's Contribution to GDP

Table 5a: Agricultural Sector's Net Output (Contribution to GDP, $ million, nominal) Year Ended March	1986/87 $ million	1990/91 $ million	1993/94e $ million	1995/96e $ million	1996/97f $ million
Farming	3,233	3,819	4,517	4,501	4,702
Input Supply — Farming	1,133	1,350	1,663	1,882	1,977
Input Supply — Processing	869	1,369	1,630	1,838	1,941
Processing — Meat/Dairy/Text	1,864	2,259	3,868	4,243	4,619
Processing — Other	117	112	178	195	213
Transport	225	408	404	432	461
Wholesale/retail trade	373	528	679	789	831
Total Agricultural Sector	7,813	9,845	12,939	13,881	14,742
Total NZ GDP	55,024	72,962	79,999	90,420	95,330

Table 5b: Sub-sector's Contributions to Total Agricultural Sector Output (% of Total Agric Net Output)	%	%	%	%	%
Farming	41.4	38.8	34.9	32.4	31.9
Input Supply — Farming	14.5	13.7	12.9	13.6	13.4
Input Supply — Processing	11.1	13.9	12.6	13.2	13.2
Processing — Meat/Dairy/Text	23.9	22.9	29.9	30.6	31.3
Processing — Other	1.5	1.1	1.4	1.4	1.4
Transport	2.9	4.1	3.1	3.1	3.1
Wholesale/retail trade	4.8	5.4	5.3	5.7	5.6
Total Agricultural Sector	100.0	100.0	100.0	100.0	100.0

Table 5c: Agricultural Sector's % Contribution to GDP (Percent of total NZ GDP)	%	%	%	%	%
Farming	5.9	5.2	5.6	5.0	4.9
Input Supply — Farming	2.1	1.9	2.1	2.1	2.1
Input Supply — Processing	1.6	1.9	2.0	2.0	2.0
Processing — Meat/Dairy/Text	3.4	3.1	4.8	4.7	4.8
Processing — Other	0.2	0.2	0.2	0.2	0.2
Transport	0.4	0.6	0.5	0.5	0.5
Wholesale/retail trade	0.7	0.7	0.8	0.9	0.9
Total Agricultural Sector	14.2	13.5	16.2	15.4	15.5
Total NZ GDP	100.0	100.0	100.0	100.0	100.0

e = estimate, f = forecast

Sources: Statistics New Zealand, NZIER, MAF

Agricultural Sector's Contribution to Employment

It is estimated that the agricultural sector provided employment for around 17.4% of the New Zealand work force in 1996, declining from 18.4% in 1987 (see **table 6**). The total work force in the agricultural sector has declined slightly, from 257,510 in 1987 to 254,677 in 1996.

The contribution from the farming sub-sector to the total New Zealand work force decreased from 9.8% in 1987 to 9.1% in 1996. Percent contribution to total employment has also declined in the processing sub-sector, after an increase in the early 1990's.

This analysis is based on a full-time equivalent work force, and no account is taken of the seasonal nature of employment in the agricultural sector.

Table 6: Agricultural Sector's Contribution to Employment

Table 6a: Agricultural Sector's Contribution to Total NZ Employment (Numbers)*	1986-87 Number	1990-91 Number	1993-94 Number	1995-96 Number
Farming	137,721	120,173	127,575	132,963
Input Supply — Farming	34,760	29,893	33,002	35,458
Input Supply — Meat/Dairy/Text	24,319	23,476	25,702	27,629
Processing — Meat/Dairy/Text	37,839	37,016	38,620	37,178
Processing — Other	6,832	5,792	5,845	5,866
Transport	13,044	12,285	12,991	13,202
Wholesale/retail trade	2,994	2,553	2,248	2,381
Total Agriculture	257,510	231,187	245,983	254,677
Total NZ Employment	1,399,883	1,271,297	1,348,601	1,467,241

Table 6b: Agricultural Sector's Contribution to Employment (Percent of Total)	%	%	%	%
Farming	9.8	9.5	9.5	9.1
Input Supply — Farming	2.5	2.4	2.4	2.4
Input Supply — Meat/Dairy/Text	1.7	1.8	1.9	1.9
Processing — Meat/Dairy/Text	2.7	2.9	2.9	2.5
Processing — Other	0.5	0.5	0.4	0.4
Transport	0.9	1.0	1.0	0.9
Wholesale/retail trade	0.2	0.2	0.2	0.2
Total Agriculture	18.4	18.2	18.2	17.4
Total NZ Employment	100.0	100.0	100.0	100.0

Note: * Full-time Equivalent

Sources: Statistics NZ, and MAF

Labour Productivity

Labour productivity in this paper is measured by dividing the numbers employed in the industry into the value of net output (measured in real terms) of that industry. This analysis therefore takes no account of changes in capital investment over this period. Therefore, when the value of output increases, in real terms, at a faster rate than the numbers employed in that same industry over a given time period, it indicates an improving level of labour productivity.

Details of labour productivity calculation, presented in **table 7**, show that except for sheep and beef farming, labour productivity for all other industries and sectors presented in table 7 have improved over the ten year period to 1996.

Table 7: Changes in Labour Productivity

Year Ended March	1986/87	1990/91	1993/94e	1995/96e
Net Output ($million, Real), using PPI Output (1996=1) for specific sectors				
All Farming	4,254	3,962	4,381	4,501
Dairy Farming	916	914	1,152	1,474
Sheep and Beef Farming	1,876	1,475	1,551	1,389
Processing — Dairy	509	645	1,191	1,419
Processing — Textiles	169	222	272	277
Processing — Meat	367	263	342	408
Total Dairy Industry	2,182	2,705	3,708	4,377
Total Sheep and Beef Industry	4,334	3,995	4,427	4,689
Total Agricultural Sector	10,281	10,213	12,550	13,881
Total NZ GDP	74,965	79,307	82,134	90,420
Numbers Employed				
All Farming	137,721	120,173	127,575	132,963
Dairy Farming	33,962	29,241	30,79	32,139
Sheep and Beef Farming	35,757	32,720	32,697	34,183
Processing — Dairy	8,003	7,091	7,686	7,157
Processing — Textiles	3,811	4,631	3,980	4,690
Processing — Meat	26,025	25,295	26,955	25,331
Total Dairy Industry	58,845	61,351	65,473	67,285
Total Sheep and Beef Industry	115,631	111,321	112,593	116,300
Total Agricultural Sector	257,510	231,187	245,983	254,677
Total NZ Employment	1,399,883	1,271,297	1,348,601	1,467,241
Labour Productivity ($thousand/labour unit)				
All Farming	31	33	34	34
Dairy Farming	27	31	37	46
Sheep & Beef Farming	52	45	47	41
Processing — Dairy	64	91	155	198
Processing — Textiles	44	48	68	59
Processing — Meat	14	10	13	16
Total Dairy Industry	37	44	57	65
Total Sheep and Beef Industry	37	36	39	40
Total Agricultural Sector	40	44	51	55
Total NZ GDP	54	62	61	62

Annual percentage changes in labour productivity, calculated from figures in table 7, are summarised in **table 8**.

Table 8: Annual Percentage Changes in Labour Productivity from 1987 to 1996

All farming	+ 1.0 %
Dairy farming	+ 7.0 %
Sheep and beef farming	- 2.1 %
Processing — dairy	**+ 20.9 %**
Processing — meat	+ 1.4 %
Total dairy industry	+ 7.6 %
Total sheep and beef industry	+ 0.8 %
Total agricultural sector	+ 3.8 %
Total New Zealand GDP	**+ 1.5 %**

Results in table 8 show that labour productivity in the total dairy industry, dairy farming and in dairy processing grew at much faster rates than that in the total sheep and beef industry, total agricultural sector and the total New Zealand economy.

The fastest growth was in dairy processing, increasing 20.9% per annum between 1987 and 1996. In the total dairy industry labour productivity improved at a rate of 7.6% per annum on average and over the same period labour productivity improved at a rate of 1.5% per annum on average in the New Zealand economy. Labour productivity in the agricultural sector, between 1987 and 1996, improved at an annual average rate of 3.8%.

Sheep and beef farming recorded a negative growth in labour productivity over this period. This reflects the lower prices in recent years for wool and meat. The wool industry in 1987 had the price stabilisation scheme supported by the Wool Board, and this was removed in 1991. It is also relatively difficult for majority of sheep and beef farmers to switch away from sheep and beef farming in quick response to lower prices for their products, and therefore employment numbers do not fluctuate in the industry to the same extent as returns to the industry.

Dairy Versus Sheep and Beef

In nominal terms, the value of net output from dairy farming increased by 118% between the year ending March 1987 and the year ended March 1996, compared with a 2.6% decrease for sheep and beef farming. The dairy processing sub-sector, which accounts for 32% of the total dairy industry, grew by 259% over this period. The meat and textile processing sub-sector account for 15% of the total sheep and beef industry, and its value of net output grew by 62% between 1987 and 1996.

The dairy industry's contribution to GDP increased by 164% between 1987 and 1996, and the sheep and beef industry's contribution increased by 42%. The percentage contribution to GDP for dairy industry increased from 3.0% to 4.8% and is forecast to rise further, while for the sheep and beef industry it declined from 6.0% to 5.2% and is forecast to decline further.

The input supply sub-sector is significantly more important in the sheep and beef industry (accounting for 49% of the industry's contribution) than in the dairy industry (28%).

Labour productivity has improved faster in the total dairy industry, than in the total sheep and beef industry. For sheep and beef farming (ie up to farm gate), labour productivity has declined.

Conclusion

The agricultural sector remains a significant sector of the New Zealand economy, in terms of its contribution to GDP and employment. Its contribution to GDP, in real terms, has grown faster than the New Zealand economy.

While the sheep and beef industry's net output has increased between 1987 and 1996, its percentage contribution to GDP has declined slightly in recent years.

The dairy industry's contribution to GDP has risen significantly over the ten years to 1996, the most significant being the dairy processing sub-sector.

For the total agricultural sector, percentage contribution to GDP declined for farming (ie up to farm gate), rose significantly for processing, rose slightly for trade and remained relatively stable for other sub-sectors. The value of output, in nominal terms, grew for all these sub-sectors over the ten years to 1996.

Labour productivity increased for all sub-sectors except sheep and beef farming. The most significant increase was for the dairy industry, particularly the dairy processing sub-sector.

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The Significance and Implications of Off-farm Income[1]

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A paper presented to
the New Zealand Agricultural Economics Society Conference
at Blenheim, on 5-6 July, 1996.

ABSTRACT

A recent survey has established that most farmers and growers in New Zealand receive off-farm income. This paper develops a demand and supply framework for the farm owner's labour and capital, in order to explore the dynamic aspects of off-farm income. The framework suggests that current trends in agricultural prices and technology worldwide will generate an increasing incidence of both off-farm work and investment by farmers. This is supported in part by the findings of the off-farm income survey. The implications of increasing off-farm income for national output, for the structure of farming, and for support and service delivery to farmers are explored in the paper.

1.0 INTRODUCTION

In New Zealand, as in many other parts of the world, a significant proportion of farmers[2] invest time and capital in jobs and investments off their own farms. A recent publication (Rhodes and Journeaux, 1995) highlighted the current importance of off-farm income for farm enterprises. The publication describes the findings of a survey of off-farm income which was commissioned by MAF Policy. It covered income earned in the 1992/93 financial year, and included income from both off-farm employment and off-farm investment[3].

This paper develops a theoretical model for understanding the ubiquity of off-farm income, and derives some of the policy implications of the findings of the Rhodes and Journeaux report.

[1] The views expressed in this paper are those of the author and not necessarily the views of MAF Policy.

[2] Throughout this paper, the terms farm and farmer are used in the widest sense to include both agricultural and horticultural holdings and producers.

[3] The survey did not cover income earned on-farm from non-agricultural activities such as farm stays.

2.0 THEORETICAL BACKGROUND

There are two main streams of theory dealing with off-farm income. Firstly, the political economy stream of literature hypothesises that when a significant proportion of farmers engage in off-farm work, it may be an indication of the proletarianisation of farming (Benediktsson et al 1990, Nolan 1994) ie, the existence of off-farm income is an indication that the Marxist prophecies of capitalist development are being fulfilled. Marx held that capitalism had a systemic tendency to enlarge the wage earning group. Any observed increase in dependence on off-farm income may be interpreted in this light, as a decline in the capacity of the majority of farmers to earn a living wage from farming. LeHeron et al (1991) consider that those farm households that resort to off-farm work as a strategy to service debt or supplement meagre drawings from the farm are consistent with this theory. However, LeHeron et al (1991) recognise that some farmers buy their properties as "a place to live", while participating in the wider labour force. They also recognise that off-farm income is part of a general trend in society towards dual incomes, work force marginalisation or casualisation, and individualisation even of the nuclear family household.

Throughout New Zealand there has been an increase in the pluriactivity[4] of society (LeHeron, 1991). The increasing importance of off-farm income to farmers is, in part, a manifestation of the trend in society as a whole. As farmers have become less isolated from urban society, their aspirations have become more similar to those of other New Zealanders. These include both social and economic aspirations.

Benediktsson et al (1990) note that off-farm work has been a permanent feature of rural occupational patterns in New Zealand since pioneer times. They argue that if off-farm work is a feature leading to proletarianisation, then the work pattern will be entered into reluctantly, when the farming operation is in trouble. Thus the farm ownership plus off-farm income stage would be a transitionary one, ending in the loss of the farm or the abandonment of off-farm work once the farming operation itself becomes more profitable. The historical omnipresence of off-farm work suggests that this theory is not supportable.

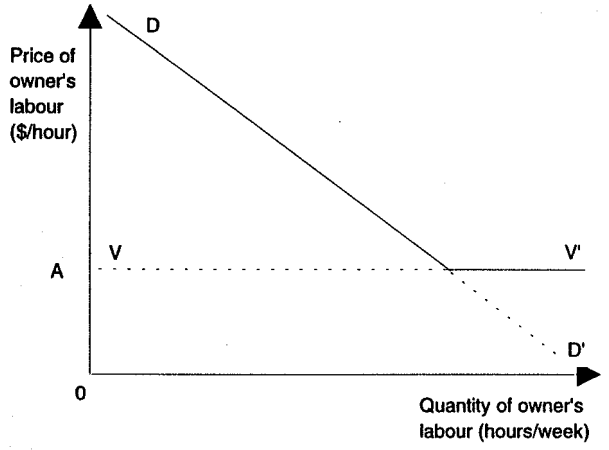
An alternative stream of literature considers off-farm income in the context of economic theory, which provides a framework for understanding the demand and supply of the farm owner's labour. This framework can be used to illustrate that the allocation by farmers of their labour to off-farm work is both rational and efficient.

Economic theory suggests that the demand curve for the operator's labour[5] is kinked (Bollman, 1979). The kink in the demand curve occurs where the wage rate for off-farm work (V-V') exceeds the return to labour expended on the farm (D-D') (Figure 1).

[4] Pluriactivity is the phenomenum of families engaging in more than one form of paid employment.

[5] The same analysis can be applied to the spouse's labour.

Figure 1: A kinked demand curve for the owner's labour



The assumptions underpinning the concept of the kinked demand curve are as follows:

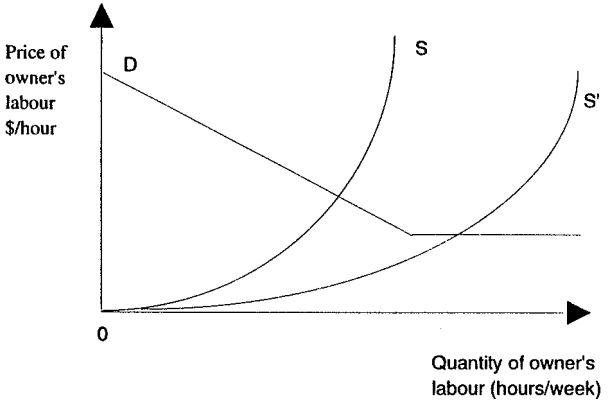
- the production function for the farm has diminishing marginal returns to the operator's labour, so the operator faces a downward sloping demand function for labour for on- farm work;
- the owner is a price taker with respect to the off-farm wage rate and the wage rate is exogenously determined;
- the owner can work as many hours in an off-farm job as desired;
- the owner is indifferent between working on his or her own farm, and working off the farm, at any given rate of return on the farmer's labour.

The net off-farm wage is determined by the cost (in time and money) of commuting, the occupational group of the owner, and the wage level in that occupational group.

The price of the owner's labour in this framework is best understood as the opportunity cost of *not* performing an hour of work. Given the concavity assumptions in the production function; the first hour's farm work has a very high opportunity cost, and therefore a very high price; the second hour has a lower opportunity cost, and so on. Once the opportunity cost of the marginal hour worked on-farm is equivalent to the wage rate for the same hour worked off-farm, the farmer will allocate the subsequent hours to off-farm work. The opportunity cost of the farmer's labour may include the improvement of capital value of the farm i.e, long-term costs may be included.

In order to establish whether the farmer will allocate time to off-farm work or not, the supply curve for the owner's labour must also be derived. If we assume that the more the owner earns per hour, the more hours he or she will work, then the supply curve is upward sloping (Figure 2).

Figure 2: Demand and supply curves for the owner's labour



If the supply curve cuts the demand curve to the right of the kink in the demand curve (S' in Figure 2), then some off-farm work will be undertaken. If the supply curve cuts the demand curve to the left of the kink in the demand curve (S in Figure 2), then no off-farm work will be undertaken.

The type of enterprise may dictate the hours that are available for off-farm work and therefore to some extent the off-farm work type able to be taken up, and may influence the wage rates applicable. For example, other than at critical times of the year, sheep and beef farmers are available for off-farm employment during normal working hours. However dairy farmers are involved in milking cows morning and evening, and may notbe available for normal work schedules.

There are intuitive problems with the demand and supply framework described above. It seems unlikely that farmers formally evaluate the return on their time and allocate it to on- or off-farm work accordingly. This does not invalidate the model. A demand and supply model describes the observed results of decisions, and does not imply that the decision maker has formally evaluated the decision. Intuitively it seems likely that most farmers engage in off-farm work when the budget for the farm falls to unacceptably low levels. In other words, farmers will continue to work on their own farms whether the return from their labour is greater than the available off farm wage rate or not[6], unless the return from the farm falls below a trigger level. Once this trigger level is reached however, the farmer will take on off-farm work if the return from it is greater than the

[6] This does not imply that farmers are irrational. Farmers who continue to work on their own farms despite higher returns from off-farm work are likely to be incorporating non-monetary costs and benefits in the decision. For some farmers, there are high non-monetary returns associated with working full-time on their own farms eg, independence, a sense of pride in his or her work and in the appearance of the farm, working in a rural setting and the like. These non-monetary considerations are discussed in section 4.

return on his or her labour on the farm. In short, the kink in the demand curve is not observed until the returns from farming fall.

An identical framework can be used to explain investment in off-farm enterprises. The demand is not for the owner's labour but for the owner's capital, which is available for investment either on-farm or off-farm. It is clear 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.

This analysis is complicated by market imperfections. For example, less than perfect information will generate uncertainty as to the return on the owner's labour or investment. The farmer may continue to expend time or invest capital on the farm, that would be better expended or invested off the farm. Multiple or different farm enterprise types on one farm will also make the analysis of the best use of the owner's time more difficult. Capital market imperfections may also distort the allocation of the owner's labour between on and off-farm work. A farmer may be able to generate better returns working on the farm than off it, but if the returns from working on the farm are not realised for some time and the farming family has a capital shortage, the farmer may well be forced to allocate labour to off-farm work which provides an immediate capital return[7]. However the analysis suggests that multiple job holding or multiple investment can exist in perfect markets at equilibrium. It is not necessary to postulate market imperfection or to theorise that farmers are becoming proletarianised.

3.0 THE IMPLICATIONS OF A DEMAND & SUPPLY FRAMEWORK FOR OFF-FARM INCOME

The framework developed in section 2 established that the amount of off-farm work and investment taken on by farmers (if any), is dependent on the nature of the demand and supply curves for the farmer's labour and capital. A number of hypotheses may be drawn out of the same framework, by considering the effects of shifts in the demand and supply curves.

3.1 Changes in the Demand Curve for the Owner's Labour Expended On-farm

Changes in the demand curve for the owner's labour on farm, would be expected as a result of the following:

- a change in agricultural product prices;
- a change in the quantity of output produced for the same labour input (ie, a labour saving technical or management change);
- a change in the price of substitutes for the owner's labour on the farm;

[7] If capital markets were perfect, the farmer would be able to convert the future farm income into an exactly equivalent annual or monthly flow of income, by borrowing.

- a change in agriculturally sourced risk;
- a change in the size of the farm.

If the price of the farm's output falls, the demand curve for the owner's labour will move to the left and the opportunity cost of labour employed on the farm falls.

The effect of labour saving technical or management change is ambiguous. An increase in the quantity of outputs produced for the same labour input could be expected to increase the opportunity cost associated with the owner's labour, and decrease the amount of off-farm work undertaken, given that output prices remain constant. However, if the labour-saving change merely allows the farmer to accomplish tasks more quickly, then the shape of the demand curve is changed (becoming steeper near the y-axis and less steep at some point as hours of labour expended increase).

An increase in the price of substitutes for the owner's labour could be expected to shift the demand for the owner's labour on the farm to the right. However, a change in the price of capital is likely to have an ambiguous result. For example, if interest rates fall, farmers may invest in substitutes for labour (e.g, mechanical aids), or in complements for labour (e.g, more land).

An increase in agriculturally sourced risk increases the uncertainty associated with the opportunity costs of the owner's labour. It is likely to move the demand curve for the owner's labour on farm to the left. An increase in on-farm risk increases the value to the farmer of diversifying sources of income.

If it is assumed that management intensity does not change, then an increase in farm size will shift the demand curve for labour worked on-farm to the right, resulting in an increase in the hours devoted to on-farm work. However, it should be noted that the size of a farm is not directly related to the amount of labour that will be expended on it. For example a farmer who owns a large farm that is extensively managed and who has high off-farm wages available, is likely to spend more time employed off the farm, than a farmer who has a small farm that is intensively managed with low off-farm wages available. That is, in this situation there is an inverse relationship between the size of the farm and the number of hours spent in off-farm employment.

In New Zealand agriculture, there has been a continuing trend towards the substitution of capital for labour, which has generated an increase in output per unit of labour input. In addition, there has been a continuing decline in primary product prices. These conditions would be expected to shift the demand curve for the farmer's labour on the farm to the left, and make off-farm work increasingly likely.

3.2 Changes in the Demand Curve for the Owner's Labour Expended Off the Farm

The demand for the owner's labour *off* the farm is likely to change with:

- a change in the wages for off-farm work;
- a change in the employment levels or jobs available in the area;
- a change in the cost of commuting.

An increase in the off-farm wages available to the owner (as a result of an increase in skills or an increase in the general wage rate applicable) is likely to shift the demand curve for the owner's labour off the farm upwards, and therefore increase the amount of time worked off the farm.

A decline in unemployment or an increase in the number of jobs available in the area will similarly shift the demand curve vertically upwards, and is therefore likely to increase the amount of time worked off the farm.

A decrease in the cost of commuting, whether as a result of an increase in the local job opportunities or a decline in petrol prices, is likely to increase the amount of time worked off the farm.

3.3 Changes in the Owner's Supply Curve for Labour

Changes in the supply curve for the owner's labour also generates change in the amount of time spent on off-farm work. Shifts in the supply curve will occur with:

- a change in non-earned income;
- a change in the age of the farmer;
- a change in the value placed on non-work activities;
- a change in the hours of labour required to generate the minimum income required by the farmer.

The supply curve for the owner's labour is likely to move to the left when there is an increase in non-earned income (such as that from pensions for superannuation funds or benefits), when the owner's age increases, or when there is an increase in the value placed on non-work activities (e.g, as a result of increased family responsibility).

A shift in the supply curve to the right may occur when the income generating ability of the farm falls, for example as a result of a poor season or a fall in product prices. If the income falls below the minimum required to sustain the farm family, the farmer may work longer hours at any given return, in order to achieve the minimum income required.

3.4 Changes in the Demand and Supply for Capital

In the same way, various hypotheses may be derived from the demand and supply framework for off-farm investment. For example, in order to shift the demand curve for investment on farms to the right, there must be:

- an expectation of higher product prices or output from the farm; or
- an increase in output for every dollar of capital invested on the farm (provided there is no change in product prices); or
- an increase in the price of substitutes for capital invested on the farm; or
- a decrease in the perceived risks associated with on-farm investment relative to investing both on and off-farm.

In New Zealand, the long term price trend for most primary products has been falling. In these circumstances, the demand curve for investment on the farm is likely to move to the left, making off-farm investment increasingly preferable to on-farm investment of surplus funds. Similarly, if on-farm investment is perceived as a high risk operation, then the demand curve for on-farm investment is likely to shift to the left. It is likely that much recent off-farm investment has been engaged in as a strategy for reducing risk.

To shift the demand curve for investment off the farm upwards, the rate of return on off-farm investment must increase.

To shift the supply curve for investment to the right, it is necessary for the owner to have placed an increasing value on investment vis à vis consumption.

4.0 NON-MONETARY FACTORS

The analysis to this point has concentrated on the economic determinants of off-farm work and investment. However, non-economic factors also influence these decisions. For example, Nolan (1994) and Taylor and Little (1995) found in their respective surveys that the social contact afforded by off-farm work was very important. Non-monetary (or psychic) costs and benefits are associated with decisions to work on or off the farm. For the purposes of the current analysis, these factors are assumed to be constant. In the Rhodes and Journeaux survey, 14.7% of those with off-farm work or investment thought that the money earned was unimportant for both the household and the business. Some of these farmers will be working for personal satisfaction reasons. However others will be working or investing off the farm because the return from such work and investment is higher than can be achieved on the farm (i.e, economic determinants may be an important part of the decision to invest on or off farm for these farmers).

Non-monetary factors can be incorporated in the demand and supply framework. This requires the relaxation of some of the assumptions underpinning the framework. For example, many farmers are *not* indifferent between on and off farm work, but would

prefer to be working on their own farms[8]. This raises the non-monetary costs associated with off farm employment, shifting the off-farm section of the demand curve vertically downwards from the position that would be expected if only monetary costs and returns were considered. The converse may also hold[9].

5.0 THE CONGRUENCE OF THEORY WITH SURVEY RESULTS

As with all models, the demand and supply framework developed in sections 2 and 3 needs to be tested. The survey conducted by Rhodes and Journeaux (1995) provides some data for verifying the model.

Of the farms surveyed by Rhodes and Journeaux (1995), 44.8% of farms had one or more of the farm family involved in off-farm work, and 73.2% of farms had either off-farm work or off-farm investment. It appears that many farmers perceive that the return from working or investing off the farm is greater than the return for working or investing on the farm (at the margin). On over one-quarter of all the farms surveyed, family members were working *over* 32 hours/week (collectively) off-farm, and on a further 19% of the farms surveyed, family members were working *up to* 32 hours/week off-farm.

Significant negative correlations were found between the incidence of off-farm *work* and:

- farm size;
- the number of farm workers employed; and
- mean gross farm income.

By and large these correlations are those to be expected within the demand and supply framework introduced in section 3. The employment of fewer workers on the farms with off-farm income indicates that there is a lower return on labour on those farms[10]. Similarly smaller farms (given the same intensity of land use and off-farm wage rate opportunities) will reach the kink in the demand curve at a lower allocation of the owner's labour than a larger farm. The correlation between lower farm income and more off-farm work also follows from the model. Lower farm incomes imply a lower return on the owner's labour, whether due to the small size of the farm or to the nature of the enterprise.

[8] Taylor and Little (1995) in their survey of South Island farmers found that most males employed off the farm would rather be working on their own property.

[9] Taylor and Little (1995) in their survey of South Island farmers found that most females would rather be employed *off* the farm.

[10] However, the survey also found that one of the "coping strategies" necessitated by off farm employment was to employ outside labour to work on the farm. This is a rational response where the net wage rate able to be obtained off the farm exceeds the opportunity costs associated with employing a worker on the farm.

No significant correlations were found between the incidence of off-farm *investment* and the number of owners, the size of the farm, or the number of workers. In general the gross revenue on farms without off-farm investment were lower than those with off-farm investment. This may be understood in terms of the supply curve in the model. The supply curve of farmers with a high gross revenue is likely to be located significantly further to the right than that of a farmer with a low gross income.

In order to test the hypotheses discussed in section 3 fully, it is necessary to have time series data for key off-farm income parameters. Such data is not currently available.

6.0 THE CASE FOR OFF-FARM INCOME

6.1 Efficiency Considerations

From an efficiency point of view, the existence and growth of off-farm income in the rural sector is not an issue. The allocation by farmers of labour and/or investment funds to higher returning jobs or investments off the farm, improves the efficiency of the economy as a whole.

However, farmers need to be well informed about the prospects for agriculture, in order to make the decision as to where their labour and investment funds will yield the best return.

6.2 Off Farm Income and Sustainable Agriculture

6.2.1 *Economic Sustainability*

Off-farm income improves the total income available to farm households and businesses, and therefore improves the economic sustainability of the unit. However, the income may allow poor performing farmers or sub-economic units to survive. There may be a decline in the economic performance of *farms* when off-farm work is undertaken by the principle farmer, due to a decline in timeliness of operations and intensity of land use. This is not an issue to the economy as a whole as noted above. Off-farm income also reduces the economic risk to the farmer, by diversifying the available sources of income. In remote areas where there are few opportunities for off-farm work, a continuing trend towards lower agricultural output prices and substitution of capital for labour would generate farm amalgamation and extensification of land use.

6.2.2 *Biophysical Sustainability*

The effect of off-farm income on the biophysical sustainability of the farm is ambiguous. It is likely that taking up off-farm *work* will reduce the intensity of land use, necessitating less fertiliser and chemical use, and reducing biophysical risks (Reynolds et al, 1993).

On the other hand, off-farm income may be invested in farm development or to maintain farm expenditure - Rhodes & Journeaux (1995), indicate that 3% of the off-farm income earned in their survey was used for farm development and 12% for farm working expenses. Saunders & Smith (1995) argue that low farm incomes lead to environmental degradation, and if their thesis is correct, then augmenting farm incomes from off-farm sources is likely to improve the biophysical sustainability of the farm.

Where the principle farmer is employed off the farm (rather than, or in addition to, the spouse), the loss of timeliness in carrying out operations may carry biophysical risks, as will a decline in any informal environmental monitoring that the farmer may have carried out when under less time pressure.

6.2.3 *Social Sustainability*

The availability of off-farm income acts to retain rural populations, and therefore improves the viability and vitality of rural communities, by and large. Commuting by members of farm households to work in larger centres, may result in more purchases being made in the larger centres, to the detriment of rural businesses. In addition, rural families involved in off-farm work are likely to have less time available for participation in community and family activities, and for voluntary service to the community. In response to the question posed by Rhodes and Journeaux (1995) concerning rearrangement of work or household activities necessitated by off-farm work, over 28% of respondents volunteered that they were working *longer*, suggesting that less time was available for leisure, family and community pursuits. In response to the same question, over 4% of farmers volunteered that they were exposed to extra *stress* as a result of off-farm work. As the question was not specifically designed to ascertain whether off-farm work generated more stress, the response probably errs on the low side. Other researchers have also highlighted increased stress levels in rural households as a result of off-farm work (e.g, Taylor & Little, 1995).

On balance, off-farm income is likely to improve the sustainability of agriculture, increasing the viability of existing farms and communities, and decreasing the intensity of farming in some instances.

The *loss* of off-farm income is therefore an important issue from a sustainability point of view.

An area requiring further research is the relationship between total income available to the farm business and household (from all sources) and environmental management standards. Reynolds et al (1993) suggest that there is an inverse relationship between environmental quality and farmer incomes, based on the response of sheep and beef farmers to the decline in incomes experienced in the mid to late 1980s. Farmers reduced the inputs used for farming over this period, especially fertiliser and repairs and maintenance expenditure, in order to maintain a minimum income.

This had the inadvertent effect of improving the levels of some indicators of environmental quality. However, Saunders & Smith (1995) demonstrate that environmental management standards may decline with declining incomes. The observations of both Reynolds et al (1993) and Saunders and Smith (1996), are based on the response of New Zealand farmers to lowered incomes faced in the mid to late 1980s. They reach different conclusions because Reynolds et al are focused on the environmental effects passively generated by farming activities (for example, run off of fertiliser nutrients into waterways), whereas Saunders and Smith are concerned with active environmental management by farmers (for example, the planting of trees for soil conservation purposes). The passively generated negative environmental effects of farming are mainly reduced in periods of reduced income, but so also are farmer efforts to actively reduce negative environmental outcomes. The net effect is ambiguous, and worthy of further research.

6.3 Equity

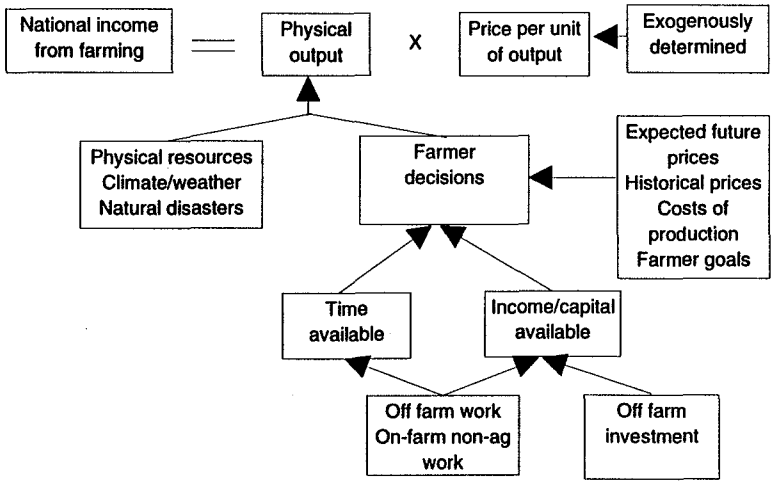
Access to off-farm employment provides rural families with similar opportunities to their urban counterparts. Le Heron (1991) notes that rural families exhibit the same changing aspirations as all New Zealanders with an increasing desire for travel, education and leisure; and for a greater range of quality of services, amenities and employment. "Pluriactivity" may allow farming families to realise some of these aspirations. However, policy intervention to provide opportunities for off-farm income is not justifiable on rural/urban equity grounds. Farming families choose to farm in a particular area, and must weigh up for themselves the opportunities for off-farm work available in the area.

7.0 OFF-FARM INCOME AND POLICY

7.1 Off-farm Work and National Income from Farming

The relationship between off-farm income and national income from farming is depicted in Figure 3.

Figure 3 The relationship between off farm income and national income from farming



The demand and supply models developed in Figures 1 and 2 illustrate that where off-farm work and/or investment is undertaken, agricultural output and national income from farming will decline as resources are directed to enterprises that yield a greater return.

In addition, once off-farm work has been obtained, the farmer may change his or her management strategies and/or livestock type, in order to accommodate the demands of both on and off-farm work. For example, typical responses by Northland's beef farmers to the current downturn in beef prices, have included engaging in off-farm work and reducing on-farm management intensity (for example, shifting cattle less frequently). The productivity of farms will almost certainly be lower with reduced management intensity. Another alternative is for farmers to convert from predominantly sheep based enterprises (which are relatively labour intensive) to predominantly beef cattle enterprises in order to

accommodate the demands of both on and off-farm work[11]. Both strategies have downstream impacts on employment, on the processing and marketing of agricultural products, and on national income from agricultural products.

There are also implications for the innovativeness of agriculture. As farmers become less focused on the farm enterprise, activities that generate innovative change in on-farm management (e.g, field days) are likely to become less important to them, and the time available for such activities becomes very valuable for on-farm work and leisure/family activities. Widespread engagement in off-farm work is therefore likely to reduce the uptake of innovations in agriculture.

However, off-farm income increases the capital available for investment on the farm - Rhodes & Journeaux (1995) indicate that over half of the farmers surveyed considered that off-farm income was useful, important or essential to the farm *business*. For these farmers, some of the off-farm income was used to support the farm business, either for debt servicing, farm working expenses and development (i.e, directly for farm expenses); or for household expenses, drawings, savings and children's education (i.e, removing the necessity for the farm's income to support these expenses). Rhodes & Journeaux' (1995) survey found that 22% of farmers cited farm expenses (i.e, debt servicing, farm working expenses and development) as the most important use of off-farm income, and 62% cited household expenses, drawings, savings and children's education as the most important use[12]. Where the farmer engages in off-farm *work*, and the income derived is expended on the farm, it is likely that the expenditure will be devoted (at least in part) to resources that substitute for the farmer's labour. For example, Rhodes & Journeaux (1995) found that 35.2% of farmers engaging in off-farm work hired more labour to work on their own farms as a direct result.

The use of off-farm income for on-farm investment or expenses mitigates the decline in output and in national income from farming suggested by the demand and supply framework developed in Figures 1 and 2.

7.2 The Effect of a Decline in Product Prices

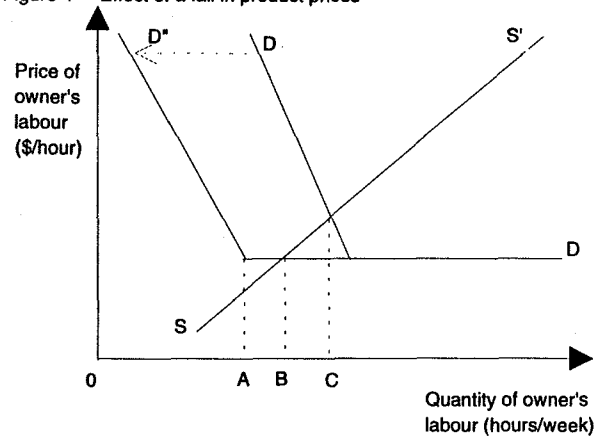
The response of farmers to a change in product prices is important to policy-makers because of the impact on national income from agriculture. If off-farm income has a systematic effect on farmers' responses to product price change, then models that predict future agricultural output may need to take this into account.

[11] Rhodes and Journeaux's survey found that only 3% of sheep and beef farmers had changed their stock type in response to the demands of off-farm work.

[12] A further 16% cited "other" uses or the use was unknown.

The effect of a *decline* in product prices may be understood in terms of the frameworks developed in Figures 1 and 3. A decline in product prices reduces the return to the farmer's labour and capital invested (Figure 4).

Figure 4 Effect of a fall in product prices



The demand curve for on-farm labour and investment moves to the left (D to D"). Off-farm work will be sought where none had been sought before (Figure 4) or increased hours will be sought where some off-farm work had already been undertaken. In addition, more off-farm opportunities for investment will be sought.

The overall effect depicted in Figure 4 is a decrease in output from agriculture (as would be expected from first principles), as farmers reduce the number of hours of labour (and amount of funds invested) in agriculture. If off-farm work continues to be available to the farmer at the same wage rate, the farmer will seek to increase the number of hours of off-farm work, which may amplify the effect of a reduction in product prices (i.e, output may reduce by more than the amount that would be expected, given that no off-farm employment were undertaken). This is illustrated in Figures 5a and 5b.

Figure 5a: The effect of a fall in agricultural output prices (no off farm income available)

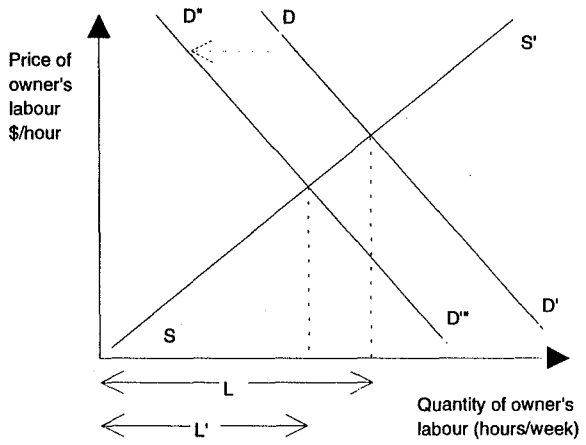
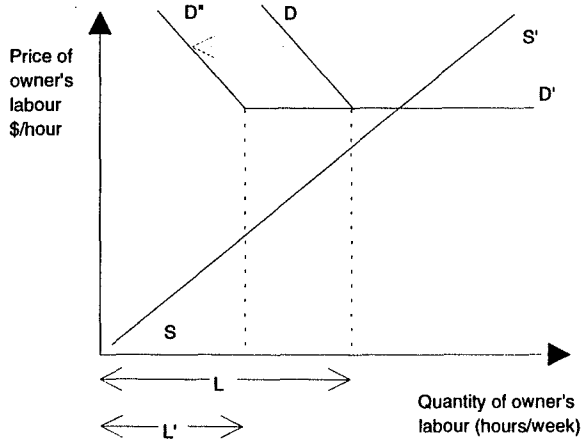


Figure 5b: The effect of a fall in agricultural output prices (off farm income available)



In Figures 5a and 5b, identical demand and supply curves are drawn, except that in (b), off-farm work is available. In figures 5a and 5b, L indicates that hours devoted to on-farm work before the downturn in output prices, and L' the hours devoted to on-farm work after the downturn. When off farm work is available, L' is smaller.

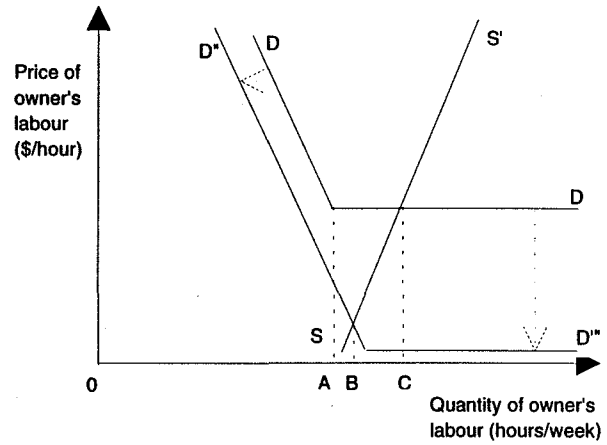
If the existence of off-farm work has the effect of amplifying the decline in labour effort applied to the farm, then farm output will also decline by more than expected.

However some factors may mitigate the difference in the decline in labour input (and therefore in output) between Figures 5a and 5b.

Firstly, a considerable proportion of off-farm work currently undertaken by members of farm households is in the agricultural sector. The Rhodes & Journeaux survey (1995) found that 36.8% of off-farm work undertaken was in the farming sector. Similarly, Taylor & Little (1995) found that off-farm employment in the three communities surveyed, was predominantly in the agricultural sector for *males*, but predominantly in nursing and teaching for *females*. A decline in product prices may result in a decline in the number of jobs available for off-farm employment, especially for males. Although non-agricultural work may still be available, commuting distances are likely to be greater and/or wages lower, making off-farm work unprofitable.

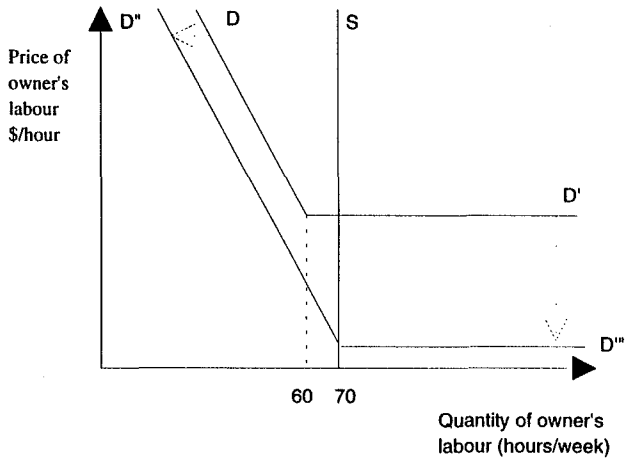
This combination of lowered on-farm and off-farm returns is illustrated in Figure 6.

Fig 6 Lowered on farm and off farm returns



In the figure, the farmer initially devotes OA hours/week to on-farm work, and AC hours to off-farm work (working OC hours altogether). A downturn in agricultural prices reduces the return the farmer receives on his labour on-farm, and also results in the loss of off-farm agricultural work. Alternative jobs return so little that the farmer does not take on any off-farm work. In Figure 5 the shape of the demand and supply curves are such that the farmer works longer hours on the farm, putting in OB hours per week. This effect is particularly pronounced if the supply curve for the farmer's labour is inelastic. For example, the farmer may work 70 hours per week regardless of the return (Figure 7).

Figure 7: The effect of an inelastic supply curve



In Figure 7, the farmer worked 60 hours/week on-farm (and 10 off-farm) before the price downturn, and 70 hours on-farm after the downturn.

A common observation during the rural downturn of the late 1980s was that farmers took on more work on the farm (work that would historically have been carried out by contractors) and that spouses took on (or increased) off-farm work (e.g, Nolan, 1994; Gouin et al, 1995). Farmers appeared to be prepared to work longer hours on the farm for a lower return than they had in the past - probably with a view to retaining the farm, in the expectation of improving returns in the future[13], i.e, the supply curve for farmer labour had moved to the right. Similarly, where a spouse had previously undertaken neither on- nor off-farm work, the rural downturn and a determination to retain the farm, shifted the supply curve for the spouse's labour to the right. Many spouses took on both on- and off-farm work during the downturn.

The Rhodes & Journeaux survey (Rhodes & Journeaux, 1995) indicated that 28.6% of farmers taking on off-farm work had to work longer hours as a result. It is not clear from the survey whether they are working longer on their *own* farms, or longer in total.

It is likely that many farmers who take on off-farm work initially hope to maintain output from their farms by working longer hours in total. The stress

[13] Of course non-monetary factors are important in farmers' determination to retain their farms, as well as an expectation of improving returns in the future. However, farmers would probably have been less determined to retain their farms if there were no hope of improving returns.

associated with this strategy may become too great, and with time, it is likely that less intensive farming systems will be adopted.

In summary, the demand and supply model for the farmer's labour suggests that the downturn in output generated by a decline in product prices, is amplified by the existence of off-farm work opportunities, unless these opportunities simultaneously disappear (especially if the supply curve for the farmer's labour is highly inelastic) or the farmer's supply curve for labour moves to the right.

7.3 Subdivision and Amalgamation

If the trends of the past continue, primary produce prices and the ratio of labour to capital utilised on farms will both continue to fall. Under these circumstances, farmers can elect to either amalgamate (making larger "full time" farms which can generate sufficient return to support the farm family), or take on off-farm work (or if capital is not limiting, off-farm investment - the latter is less likely given the assumption of falling product prices). Gouin et al (1994) note that the number of "significant" farms (i.e, those producing 95% of agricultural output) declined between 1988 and 1990, while the number of "small" farms (i.e, those producing 5% of New Zealand's agricultural output) has increased. The decreasing number of "significant" farms is likely to be the result of farm amalgamation. In remote areas, where off-farm work is difficult to obtain, and even sources of non-agricultural on-farm income are few, amalgamation is the most likely option. However, where population is denser and off-farm work easier to obtain, an increasing proportion of farms will be run as "part-time" units. This implies a continuing demand for "sub-economic" size farm units in rural areas where off-farm work is easy to obtain (e.g, on urban fringes, and in densely populated rural areas), compounding the difficulties faced by territorial local authorities in determining rules for subdivision. The historical concept of an "economic unit" as the minimum acceptable lot size is plainly inappropriate, given the continuously increasing area required to satisfy this criterion.

7.4 Training and Education of Farmers for Off-farm Employment

Taylor & Little (1995) identify training in non-agricultural skills as a critical factor in increasing the ability of farmers to take on off-farm work; and indicate that there are difficulties of access for some farmers. Central Government is the major funder of training and educational facilities in New Zealand. The question as to whether Government should increase the funds allocated to the training of rural people *in situ* is not addressed in this paper, but is worthy of further research.

7.5 Rural Diversification

Rural communities with a diverse range of income-generating activities, offer farmers more opportunities for off-farm employment than those which are narrowly focused on agriculture. Where encouragement of rural diversity is a policy objective (for whatever reason), Government's role is likely to be in coordination and facilitation rather than direct involvement. The "seeding" of ideas (and perhaps finance) and facilitation of the establishment of organisations in the initial stages, if often all that is required to encourage communities to become more diverse.

7.6 Support and Service Delivery

If Government support is provided to farm families (e.g, after adverse events), the existence of off-farm income complicates the delivery of assistance. Where off-farm income is treated as available for family living expenses, assistance may not be deemed necessary. However the Adverse Events Family Income Support available to some farmers during the droughts of the late 1980s did not take this approach, but added off-farm earnings to gross farm income, and only the residual farm income (after deducting farm expenses) was deemed to be available for family living expenses (Taylor & Little, 1995). In doing so, Government was essentially subsidising the farms (Brown Copeland, 1991; cited in Taylor & Little, 1995).

It would not normally be considered acceptable for Governments to support failing businesses in this way; however Brown Copeland (1991) note that the approach taken reflected "the reality of the way in which farm people treat their income" (quoted in Taylor & Little, 1995). That is, that home and business are inextricably entwined[14] and that shedding of the business operation entails loss of the home in most cases. Whilst this justifies (to some extent) the approach taken, it is not likely to go unchallenged in the future.

A wider issue is the definition of a "farm". Where policy interventions are aimed at "full time farmers" or "economic units", a substantial number of farmers will be excluded.

How these issues are resolved will depend on the underlying imperatives for the particular policy. The Adverse Events Family Income Support package was offered at a time when farming fortunes were at their lowest ebb. It is likely that Government's intention was to help farmers disadvantaged both by the weather and by Government policy change - both factors beyond farmers' control - so the package was generous in its treatment of off-farm income. Where Government's budget constraints are more binding, families with off-farm income may be

[14] It should be noted that other home-based businesses may be similarly indivisible however.

excluded from assistance regardless of losses from the farming business. The perverse incentive implicit in this policy is the discouragement of participation in off-farm work, even when it is more efficient to do so.

Service delivery to farmers may be hindered when farmers work off the farm during normal working hours. For example, consultants and stock agents may find it necessary to visit farmers during the evening (when the condition of the farm and stock may not be visible) or on weekends. Attendance at field days or meetings also becomes more difficult if off-farm work hours are inflexible. Compounding these difficulties is the increasing value that farmers are likely to place on the time available to them once off-farm work is completed. Farmers may be unwilling to allocate time to "non-essentials" such as consultancy visits, field days or responding to surveys.

7.7 The Provision of Information

In order for farmers to make economically efficient decisions about the allocation of their labour and capital to on- or off-farm enterprises, they need information about the costs and returns of such decisions. Some of the information required is not readily available to farmers eg, long term product price predictions. The information provided by MAF, in publications such as SONZA and the Farm Monitoring Report, is therefore valuable as an input to efficient decision making, and should arguably be disseminated as widely as possible. Information has some public good attributes, which provides a degree of justification for government supply.

Information on job opportunities and wage rates in an area is also important for farmer decision making.

8.0 SUMMARY AND CONCLUSIONS

The phenomenum of increasing participation by farmers in off-farm work and investment in off-farm enterprises, is part of a wider picture. The long-term trends of declining product prices and of technological change in agricultural production are demanding adjustment by farmers. Gouin et al (1994), in noting the chronically low returns to the resources invested in agriculture, observe that far from driving them to leave the profession, farmers will accept low returns to their own capital and labour assets. That is, there is a degree of asset immobility in the farm sector, attributed to the rural unemployment rate, the skills and qualifications of farmers, and attachment to the profession. However, the drop in farm profitability during the 1980s resulted in an increase in off-farm income, indicating the relative mobility of *human* resources in farming families (Gouin et al, 1994). Most farmers appear to desire to retain ownership of their farms, and will work off the farm in order to achieve this. If the trend towards lower product prices and labour-saving technological change continue, there will be a continuing demand for off-farm sources of income, especially off-farm employment (and/or on-farm non-agricultural income generating activities).

Although off-farm work inevitably diverts labour (and to a lesser extent management) resources away from the farm, the effect on output is not as pronounced as might be expected, because farmers invest at least some of the income derived back in the farm, especially in resources that substitute for their own labour.

The effect of a cyclical downturn in product prices on output may be amplified by the existence of off-farm work. However, off-farm sources of employment may also be reduced during the downturn (especially for males who tend to work in the agricultural sector) and the farmer may increase the number of hours worked on-farm to maintain income levels at a tolerable level. The overall effect of off-farm work on the output response to a downturn in prices, is ambiguous.

Increased demand for off-farm work is likely to increase the demand for training and education in non-agricultural disciplines by farmers.

Central Government funds most of the training and education facilities available to farmers. It is not known whether the facilities currently available are adequate in terms of location and topics covered, nor whether extension of these facilities to meet farmers' needs is justified. This is an area of possible future research.

Rural diversification increases the opportunities open to farmers for off-farm employment. Facilitation of such rural change may be both cheap and effective for appropriately skilled personnel.

Where off-farm work is available, there is likely to be an increased demand for "sub-economic" farm units. This compounds the difficulties faced by territorial local authorities in determining appropriate subdivision rules. The increasing size of farm required for an "economic unit" reinforces the view that a rule based on this criterion is indefensible.

Government intervention to assist farmers is complicated by the existence of off-farm income. Perverse incentives are generated when income support is not provided to families with off-farm income, regardless of any loss situation in the farm business. However if support is provided based on the on- and off-farm income net of farm expenses, the Government could be accused of subsidising the farm business.

Farmers require information about the likely returns from farming and from off-farm work or investment in order to make economically efficient decisions about the allocation of their labour and capital resources. The production and dissemination of information such as that provided by SONZA is therefore important. The public good nature of information provides justification for government involvement in supplying such information.

Off-farm income is received by the majority of farmers in New Zealand, and is likely to be increasingly important in the future. On balance, participation in off-farm work and investment is a positive phenomenum on efficiency, sustainability and equity criteria. Off-farm employment in particular, is likely to increase in more densely populated rural areas, and in districts within commuting distance of urban areas. In this, rural areas reflect the trend towards pluriactivity in New Zealand as a whole.

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Factors Determining Agricultural Sector Debt and Debt Servicing

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Abstract

It is estimated that in the year ending March 1995 the farming sector paid approximately $1billion in debt servicing, and this is forecast to rise further as aggregate debt levels increase. It is estimated that the total amount borrowed by the agricultural sector in that year was approximately $12billion. Debt servicing, intermediate consumption and wages account for most of farm sector expenditure.

In this paper, a methodology is developed for forecasting the aggregate agricultural sector debt and the total annual interest paid by the sector. Factors that influence the levels of borrowing by the sector are also discussed. Information on interest paid is provided as part of an overall report on the current economic situation prepared by the Ministry of Agriculture for the New Zealand Treasury as part of their budget management process.

Introduction

At least twice a year, the Ministry of Agriculture forecasts the aggregate agricultural sector gross revenue and expenditure, sector's operating surplus and income, and its contribution to gross domestic product. This output is submitted to the Budget Management Department of the New Zealand Treasury, for input into their current economic situation reporting and preparation of the government's budget. To derive the agricultural sector income, interest paid by the sector is deducted from the sector's operating surplus and interest received is added to it.

In this paper, knowledge of the sector's total gross revenue, intermediate consumption, interest rates charged by the lending institutions, and the total sector debt is considered necessary to estimate and forecast the total annual interest paid by the sector.

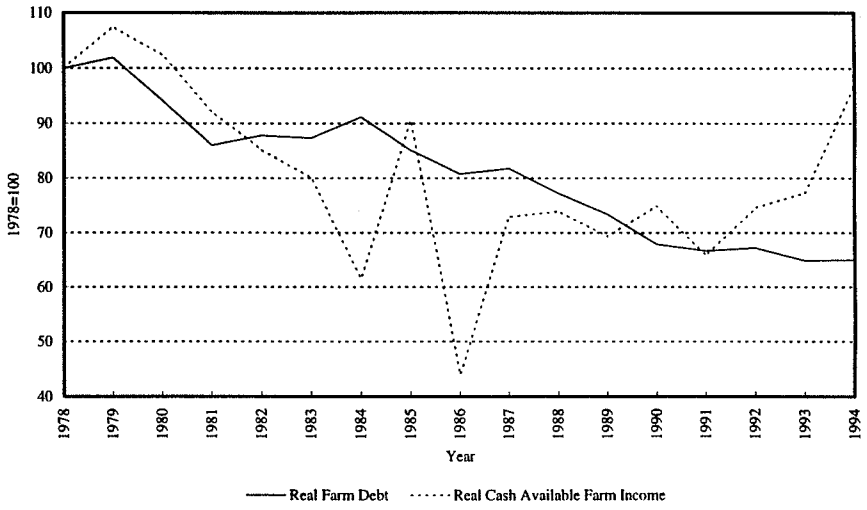
Background

It is estimated that the total agricultural sector debt has risen from $2,165 million in 1978 to $10,580 million in 1994. While some industries within the agricultural sector, such as the sheep industry, have contracted, other industries, such as dairy industry, have expanded. This has had a significant bearing on the debt levels in each of the industries. When the changes in the individual industries are aggregated, the impact on the total agricultural sector is evident.

Between 1979 and 1991, the long term trend for sheep and beef sector real cash available farm income was downwards (see figure 1). The same trend was evident for sheep and beef sector real farm debt over the same period. For the dairy industry, the long term trend for real cash available farm income was upwards between 1986 and 1994 and the trend for real farm debt was the same (see figure 2).

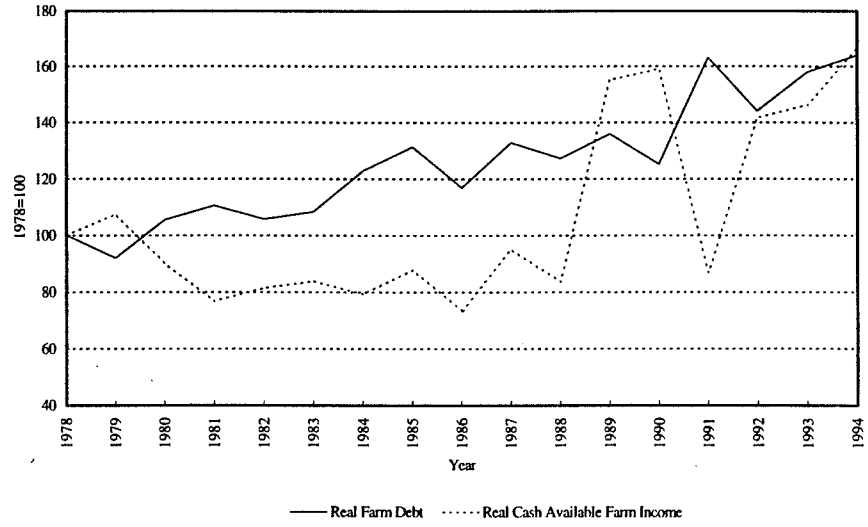
[1] *Views expressed in this paper are those of the authors and do not necessarily reflect the official view of the Ministry of Agriculture. Errors and omissions remain the responsibility of the authors. Typesetting of this document was undertaken by Karen Thompson and her assistance is much appreciated.*

Figure 1: Index of Real Farm Debt and Index of Real Cash Available Farm Income: Sheep and Beef



Source: NZMWBES All Class Average Farm

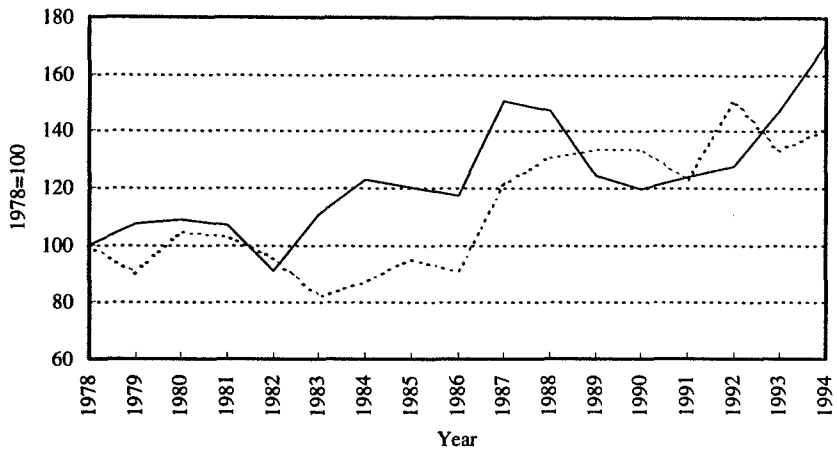
Figure 2: Index of Real Farm Debt and Index of Real Cash Available Farm Income: Dairy



Source: NZDB — Livestock Improvement Corporation

The combined long term trend for total real agricultural debt per hectare and real GDP in agriculture per hectare are shown in figure 3. Since 1983, the long term trend for debt and GDP in agriculture per hectare was upwards. The cash available farm income per hectare was down in 1986 as both the sheep and beef industry and the dairy industry returns were low, and in 1991 the dairy industry returns declined due to lower milkfat prices.

Figure 3: Index of Real Agriculture Debt Per Hectare and Index of Real GDP in Agriculture Per Hectare, New Zealand



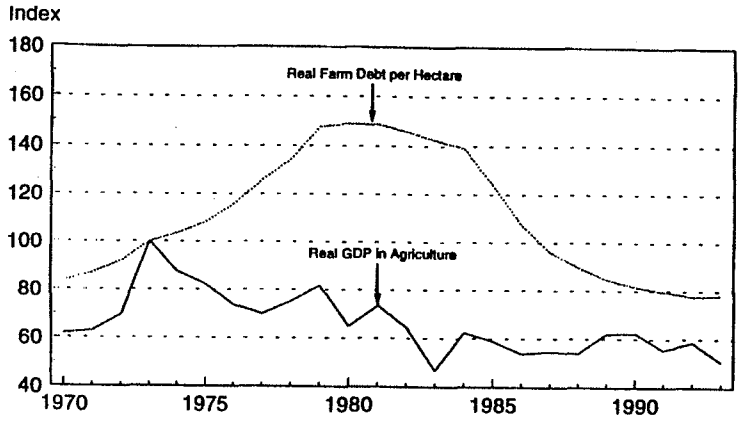
In general, the index of real agriculture debt per hectare in New Zealand has followed the index of real GDP in agriculture per hectare fairly closely. The exception was between 1982 and 1988, when the index of debt was a lot higher than the index of agriculture GDP. This could be attributed mainly to the cumulative effect of the Land Development Encouragement Loan (LDEL) scheme, which provided concessionary interest rates and suspensory loans reducing the principal of the loans, and Livestock Incentive Schemes (LIS) in effect during this period. Their gradual removal was announced in 1986 and at a later date, a $20,000 exit package was offered to farmers still deep indebt.

Since 1992, real agriculture debt per hectare has risen sharply, mainly due to increased investments in the dairy industry and to some extent in the apple industry. The area under agriculture has also been declining since 1985.

An international comparison

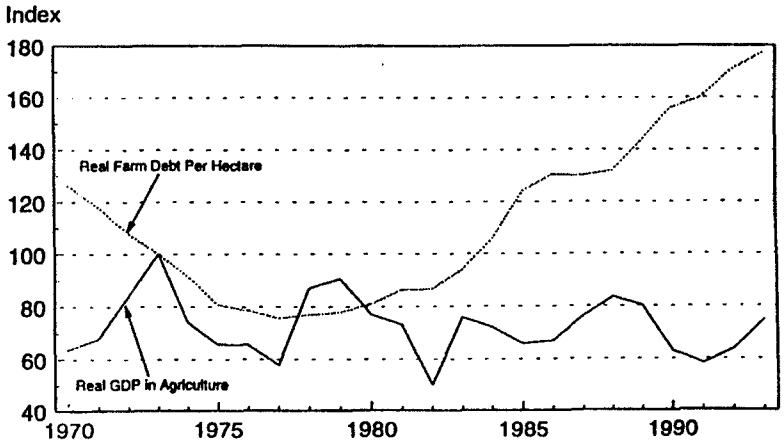
Figures 4 and 5 show the trend in total real farm debt per hectare and index of real GDP in agriculture per hectare for the United States and Australia. These graphs for the United States and Australia are from Hallberg and Herendeen (1996).

Figure 4: Index of Real Farm Debt per Hectare and Index of Real GDP in Agriculture (1973=100), United States



Source: Hallberg and Herendeen (1996)

Figure 5: Index of Real Farm Debt per Hectare and Index of Real GDP in Agriculture (1973=100), Australia



Source: Hallberg and Herendeen (1996)

According to Hallberg and Herendeen (1996), the agricultural boom of 1970s encouraged US farmers to incur ever increasing levels of debt for output expansion until a plateau was reached in the early 1980s (figure 4). By 1982 real interest rates in the US had reached their highest level, since the early 1930s, and real farm prices were at their lowest level in several years. According to Hallberg and Herendeen, agriculture plunged from high prosperity to severe recession. Farmers with high debt had less income with which to pay higher interest charges on their debt, and the collateral to support this debt was rapidly falling in value due to the low commodity prices. During this period the mid west region experienced the worst agricultural debt crises since the great depression (Hallberg and Herendeen, 1996).

Real debt per hectare in the US began to fall quite quickly from 1984 until 1990, stabilising at a level of about 50% of its peak level in the early 1980s. During this period, per farm real gross receipts from farming was declining and did not turn around until 1987, suggesting that farm growth in the US had slowed substantially (Hallberg and Herendeen, 1996).

For Australia, figure 5 shows that the real agricultural debt per hectare was falling during and subsequent to the boom of the early 1970s and continued to decline throughout most of the late 1970s. Real agricultural debt per hectare began to rise during the agricultural recession of the early 1980s and has been rising steadily ever since. According to Hallberg and Herendeen (1996), much of the latter must be attributed to a strong desire on the part of Australian farmers to expand farm size and/or to improve the stock of existing physical capital.

Specific Objectives

The key objective of this study is to develop a regression model that will assist in the forecasting of total intermediate consumption in agriculture, total agricultural sector debt and total annual interest paid by the agricultural sector. The sub-objectives are to:

- understand the determinants of annual intermediate consumption by the agricultural sector which will assist in the development of a regression model;
- incorporate factors that have and will determine total agricultural sector debt in the development of a regression model; and
- develop a regression model for forecasting total annual interest paid by the agricultural sector.

The above information form a key part of the estimates and forecasts made by MAF for the New Zealand Treasury in their Current Economic Situation (CES) reporting and the preparation of the government's annual budget.

Data

Gross revenue for the agricultural sector is the total value of all goods and services produced during a year, including stocks of work-in-progress and non-farm income, valued at producers' price. This is calculated by multiplying the prices received at the farm gate with the volume of output for each of the industries within the sector. These industries include sheepmeat, wool, beef, dairy, deer, goats, pigs, poultry, horse breeding, fruits, vegetables, grains and farm forestry. Also included in this are the revenue earned from contracting services in the sector, sales of live animals, estimated value of change in livestock numbers (ie stocks of work in progress), and income earned off the farm.

In this paper, gross revenue is deflated using Statistics New Zealand's Producers Price Index for Outputs (PPIO) for agriculture.

Intermediate consumption is the purchasers' value of all non-durable goods and services used in production during a year. This mainly includes expenditure on purchase of livestock, feed and grazing, animal health and breeding, weed and pest control, fertiliser, lime and seeds, fuel and power, repairs and maintenance and freight. These together account for 69 percent of expenditure on intermediate consumption. The three key items here are expenditure on purchase of livestock, expenditure on fertiliser, lime and seeds, and expenditure on repairs and maintenance. These three together account for 42 percent of expenditure on intermediate consumption. Excluded from this list are transactions not directly associated with the current production of goods and services such as interest paid.

Operating surplus is defined as total gross revenue plus subsidies, less the sum of intermediate consumption, compensation of employees (wages), consumption of fixed capital (depreciation), and indirect taxes (eg expenditure on rates). The annual operating surplus for the sector for the historic period is calculated by Statistics New Zealand, and is forecast by the Ministry of Agriculture for the forecast period. Operating surplus has increased almost threefold, from $884 million in 1978 to $2,478 million in 1996. Any subsidy received by the sector is added to the operating surplus. In recent years, these subsidies have mainly been in the climatic disaster relief, animal and plant health, and government funded research.

Lending rates used in this paper are based on the interest rates that farmers are charged by the main lending institutions. They are based on a survey of these lending institutions and these are published every second month in "the New Zealand Farmer". The base lending rates are published by the Reserve Bank of New Zealand in its Bulletin.

Agricultural sector debt is estimated using data from the Reserve Bank of New Zealand survey of all the M3 institutions and a formula based on work undertaken by Pomeroy and Reynolds (1991). This is estimated using a three step process, as follows:

1. The Reserve Bank monthly survey of M3 institutions estimates the outstanding loans by each sector from these lending institutions. The M3 institutions include all the registered banks, investment and building societies and large corporate holdings. According to this survey, the agricultural sector's total borrowing from these lending institutions in March 1995 was $7.585 billion.

   Until April 1994 these Reserve Bank surveys of M3 institutions did not have agriculture as a separate category, agriculture was part of the primary sector which also included forestry, fishing and hunting. Based on the 1995 Reserve Bank survey data, loans from M3 institutions to agriculture made up 84 percent of the total loan to the primary sector. This ratio is used to determine agricultural sector's loan from M3 institutions in the years prior to 1995.

2. Based on Pomeroy and Reynolds (1991), it is estimated that the ratio of private loans to loans from M3 institutions is 0.567. This ratio is used to determine loans by the agricultural sector from private sources.

3. Using the above procedure, total agricultural sector debt is estimated for the years from 1978 to 1995. It is estimated that in March 1995, the agricultural sector borrowed a total of $11,890 million. Out of this, $7,585 million was from M3 institutions, and $4,305 from private sources. Later in this paper, regression analysis is used to estimate the factors determining the total debt of the agricultural sector and to forecast future debt levels.

The total agricultural sector debt is deflated using Statistics New Zealand's Producers Price Index for Inputs (PPII).

The sheep and beef farming debt is based on the New Zealand Meat and Wool Boards' Economic Service for all class average farm, and the dairy farm debt is based on figures from Livestock Improvement Corporation for 50:50 sharemilking operations.

Interest paid figures are available for some years from Statistics New Zealand, and has been estimated for other years by MAF. It is estimated that in the year ending March 1993 the total interest paid by the agricultural sector was $913million.

The total agricultural sector interest paid is deflated by PPIO.

Farm sales figures for the dairy sector, grazing and fattening sales for the sheep & beef sector and the total agricultural sector sales are collected and published by Valuation New Zealand.

Annual total fertiliser sales volume compiled by MAF were also used in this analysis.

Sheep and beef and dairy farm fertiliser and repairs and maintenance expenditure totals are used as proxy for agricultural sector expenditure and these are deflated by PPII.

Deflators used in the paper are Statistics New Zealand's PPIO, PPII, CPI, farm input price indices for fertiliser and repairs and maintenance, and an index is derived for intermediate consumption using Statistics New Zealand's farm input price index and actual expenditure by categories of key inputs in intermediate consumption. Expenditure on fertiliser and repairs and maintenance on farms are key components of intermediate consumption, and these figures are available from Statistics New Zealand.

Total land area used for agriculture is calculated by subtracting area under forestry from total agricultural land base, and these figures are published by Statistics New Zealand.

Methodology

I. Identification and examination of factors influencing intermediate consumption, levels of debt and debt servicing in New Zealand agriculture

Intermediate Consumption

Regression analysis is used to identify factors that influence intermediate consumption. It was initially considered that farmers' decide on how much they will spend on intermediate consumption, such as on fertiliser and repairs and maintenance, after taking into account the gross revenue from their enterprises, and price of the various inputs.

In this paper, intermediate consumption is deflated using an index derived for the purpose using Statistics New Zealand's farm input price index for the key categories of the farm inputs, and each category of input in the intermediate consumption group is weighted according to the proportion of that input in the make up of the intermediate consumption between 1982 and 1992.

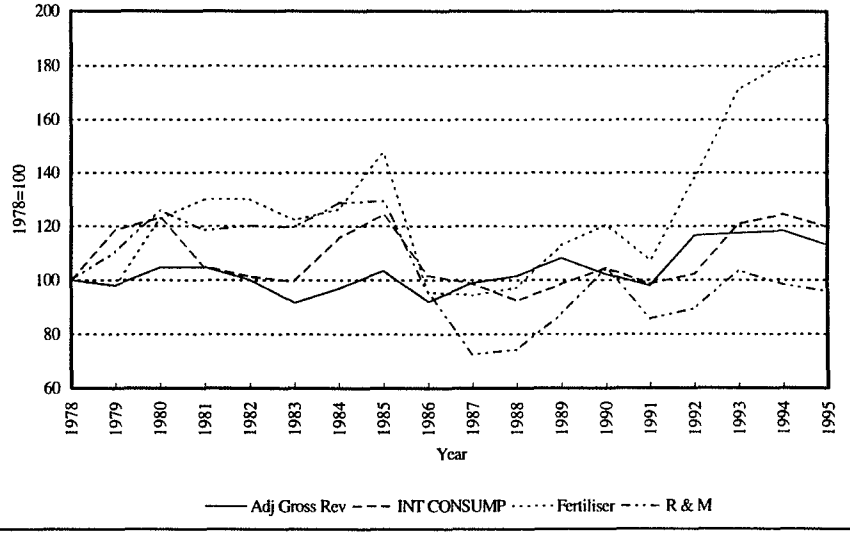
Total gross revenue figures usually reported in the CES analysis have been adjusted, so that only those gross revenue items that provide cash in hand to the farmer are used in this analysis of the determinants of intermediate consumption. Items such as revenue earned by agricultural contractors, sale of live animals (inter farm sales) and value of change in livestock numbers are excluded. The adjusted gross revenue was deflated by the PPIO for agriculture.

The main components of intermediate consumption are fertiliser, fuel, and repairs and maintenance. These have been deflated by their respective farm expenses and input price indices. For levels of expenditure on fertiliser and repairs and maintenance, sheep and beef (all class average) farm and dairy (50:50 sharemilkers) farm data were used as proxies. Volume of fertiliser sales (information collected by MAF from fertiliser manufacturing companies), and use of phosphate fertiliser on pastoral farms were also explored in the analysis.

Factors influencing intermediate consumption

Figure 6 shows that real intermediate consumption had positive correlation with real adjusted gross revenue, real expenditure on fertiliser and real expenditure on repairs and maintenance. There was high correlation between volume of fertiliser used and expenditure on fertiliser and on repairs and maintenance, and therefore volume of fertiliser sales was excluded in the final equation.

Figure 6: Indices of Real Adjusted Gross Revenue, Real Intermediate Consumption, and Real Pastoral Sector Expenditure on Fertiliser, and Repairs and Maintenance



Total Agricultural Sector Debt

It was hypothesised in this paper that total agricultural sector debt was influenced by intermediate consumption and / or operating surplus, either current or lagged. It was also hypothesised that total agricultural debt was influenced by lending rates faced by farmers, and the number of farm sales.

Three categories of number of land sales were tested. These were total agricultural land sales, pastoral sector land sales and sales of agricultural, but non-pastoral, land sales. The latter includes horticultural, arable, partial pastoral farm sales to forestry and numerous sales arising from rural sub-divisions. Price indices for the different types of agricultural land sold were also tested.

Factors influencing levels of debt in the agricultural sector

Intermediate consumption had a significant and positive impact on total agricultural debt, while lending rates had significant but negative impact on total agricultural debt (see figure 7).

Of all the land categories tested, number of sales of other agricultural land had a significant and negative correlation with the total agricultural debt (see figure 8). This category included numerous, but smaller, land sales to purchasers outside the agricultural sector, such as rural subdivisions and forestry blocks.

Figure 7: Index of Real Total Agriculture Debt, Index of Lending Rate, and Index of Real Agriculture Intermediate Consumption

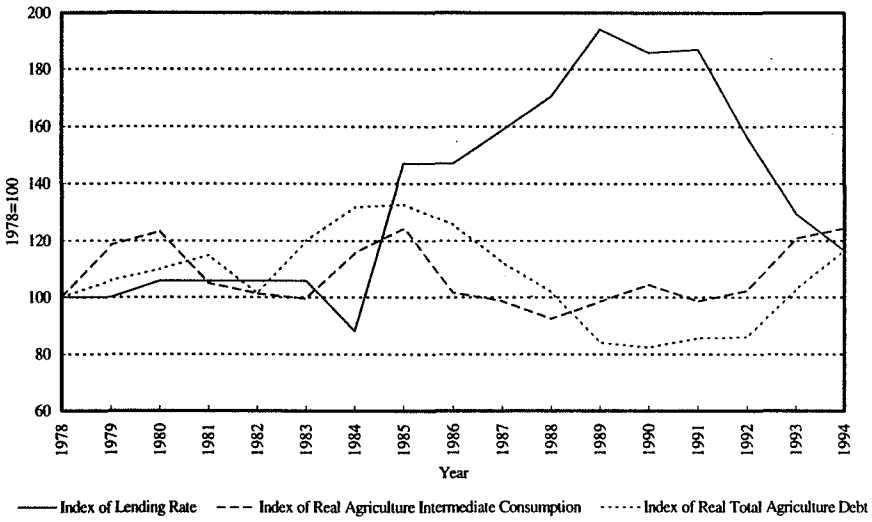
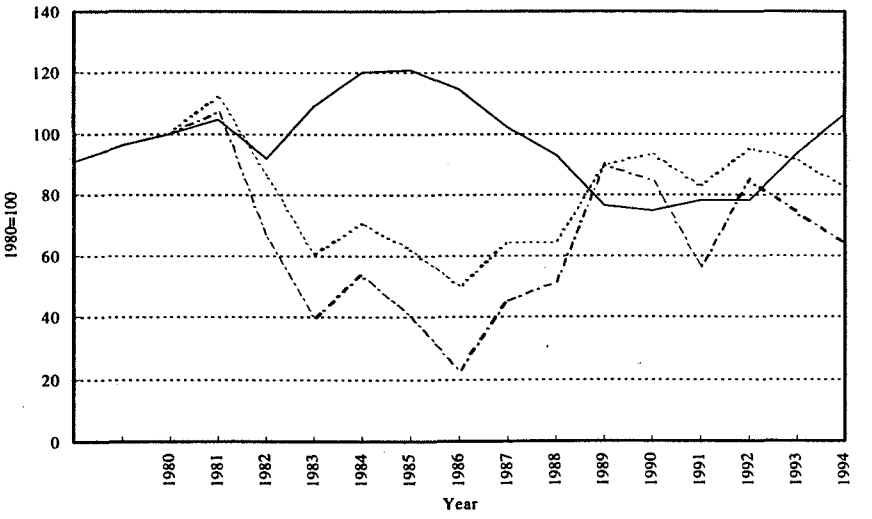


Figure 8: Indices of Real Total Debt in Agriculture and Number of Land Sales



Interest Paid by the Agricultural Sector

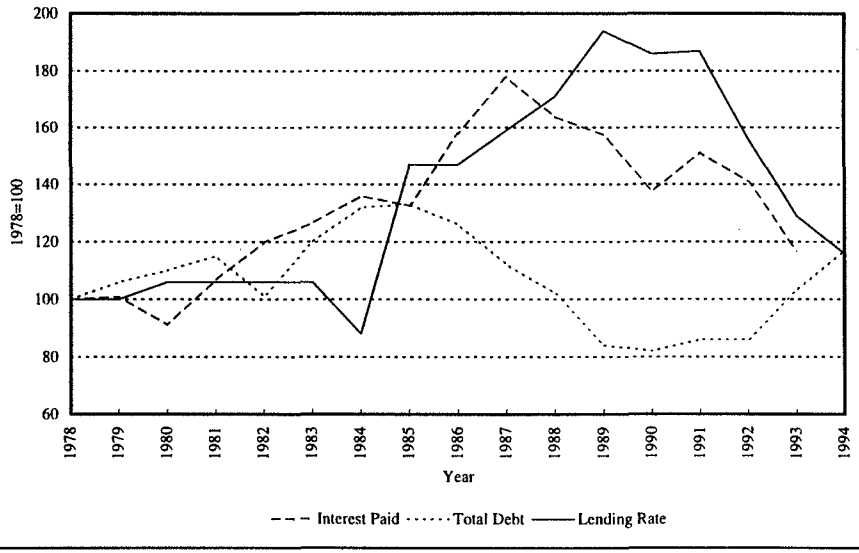
It was hypothesised that real total agricultural sector debt, sector's operating surplus (lagged by one period), and lending rate influenced the amount of interest paid by the agricultural sector in a year.

Factors determining annual interest paid by the agricultural sector

The graphical illustration show that interest paid by the agricultural sector is positively influenced by the levels of real debt in the sector, and the lending rate (see figure 9).

During the period 1987 to 1993, for which the data was available from Statistics New Zealand, interest paid by the agricultural sector declined because the total debt also declined and was low. During this time, lending rates rose and were high.

Figure 9: Index of Real Interest Paid, Index of Total Real Debt in Agriculture, and Index of Lending Rate



II. The Conceptual Model for Regression Analysis

A recursive structure was adopted in the specification of the regression relationships for the three important agricultural sector variables studied in this paper.

1. Real Intermediate Consumption in Agriculture (RINTCON)

RINTCON = f (RAGREV, RPSTFERT, RPSTRM)

where,

RAGREV - Real Adjusted Gross Revenue (sum of individual sector revenues obtained in deriving CES forecasts),

RPSTFERT - Real pastoral sector fertiliser expenditure used as proxy and forecast based on estimates made elsewhere, and

RPSTRM - Real pastoral sector repairs & maintenance expenditure used as proxy, also able to be forecast based on prior estimates.

2. Real Total Agricultural Sector Debt (RTDEBT)

RTDEBT = f (RINTCON $_{(t-1)}$, LRATE, OAGFSLES)

where,

RINTCON$_{(t-1)}$ - Real Intermediate Consumption, lagged one period,

LRATE - Lending rate to the agricultural sector, and

OAGFSLES - Other agricultural farm sales, which include numerous sales to purchasers outside the sector.

3. Real Interest Paid by the Agricultural sector (RINTPD)

RINTPD = f (RTDEBT, LRATE, ROPSUR$_{(t-1)}$)

where,

RTDEBT, LRATE are as described before.

The estimated equations using the above specifications are reported in the next section preceeded by a graphical illustration of these relationships first.

Results

Regression Analysis

Regression results for the three relationships studied in this paper are reported in table 1.

The overall results suggest that the explanatory power of the equations estimated varied from an R^2 value of 0.63 for the Real Intermediate Consumption equation and the Real Interest Paid equation to 0.84 for the Real Total Agricultural Sector Debt equation.

Table 1: Regression Results of Real Intermediate Consumption, Real Agricultural Sector Debt and Real Interest Paid by the Agricultural Sector: (1980-1995)

		R^2	F	DW
I.	Real Intermediate Consumption (RINTCON)			
	RINTCON = 0.1293*RAGREV + 0.0475* RPSTFERT (0.5838) (1.6798) + 0.0554* RPSTRM (2.071)	0.63	9.7	1.30
II.	Real Total Agricultural Sector Debt (RTDEBT)			
	RTDEBT = 1.0757*RINTCON $_{(t-1)}$ - 0.3045*LRATE (3.007) (-4.655) - 0.00159*OAGFSLES (-5.1936)	0.84	26.4	2.25
III.	Real Interest Paid by the Agriculture Sector (RINTPD), (1979-1993)	R^2	F	DW
	RINTPD = 0.0630*RTDEBT + 0.0674* LRATE (2.2530) (4.6680)	0.59	11.3	1.89

The real intermediate consumption levels in the agricultural sector are positively affected by the real agricultural sector revenue, the real pastoral sector fertiliser expenditure and repairs & maintenance expenditure. The co-efficients for pastoral sector expenditure levels were significant at the 10% level of significance, while the co-efficient for real gross revenue was not. This is because, as illustrated in figure 6, real intermediate consumption declined somewhat during the 1986-1992 period when expenditure on fertiliser and other maintenance activities were curtailed, while real agricultural sector revenue was increasing, except in 1991, when revenue was depressed due to lower dairy sector incomes.

The total real agricultural sector debt was positively influenced by the lagged intermediate consumption levels and negatively affected by the lending rate and other agricultural farm sales and all the co-efficients were significant at the 1% level of significance. This is consistent with prior expectations, as higher levels of intermediate consumption are usually associated with more confidence in the prospects for the agricultural sector and hence greater levels of borrowing and the debt levels. Higher agricultural lending rates, however, lead to lower borrowing and debt levels in the agricultural sector. Other agricultural land sales, which include many to sources outside the agricultural sector, will reduce the levels of agricultural sector debt.

The total real interest paid in the agricultural sector is positively impacted by both the total real agricultural sector debt and the agricultural lending rates, as anticipated. The co-efficients for the agricultural sector debt and lending rates were significant at the 10% and 1% level of significance, respectively.

The model validation results presented in table 2 suggest that all three equations exhibit reasonably high level of goodness-of-fit of fitted values to actual values. The correlation between actual and fitted values were high and varied between 0.84 and 0.93, while the Theil's Inequality Co-efficient which measures the level of bias in the estimated values was quite low and below 0.10 and the Root-Mean-Squared Error (RMSE) values were also low ranging from 0.1055 to 0.5650.

Table 2: Model Validation of Intermediate Consumption, Debt and Interest Paid

Variable Estimated	Correlation Co-efficient of Actual vs Fitted	Theil's Inequality Co-efficient	RMSE
I. Intermediate Consumption	0.8409	0.0535	0.2777
II. Total Agriculture Sector Debt	0.9318	0.0554	0.5650
III. Total Interest Paid	0.8077	0.1030	0.1148

Summary

Intermediate consumption expenditure and interest paid by the agricultural sector are two very significant figures that have to be determined when estimating and forecasting agricultural sector income. This forecasting is undertaken by the Ministry of Agriculture, two to three times a year, when estimates and forecasts of a range of agricultural sector figures, such as prices and volume of output, sector revenue and expenditure and export volumes, are provided to the New Zealand Treasury.

The aim of this study was to develop regression models to enable forecast of intermediate consumption expenditure and interest paid by the agricultural sector and determine whether these models would be an improvement over existing models used by the Ministry of Agriculture. The latter is the second phase of this project and has not been completed yet.

The historic data used to develop these models are based on figures from the New Zealand Reserve Bank and Statistics New Zealand. Because some of these data series are for short periods, various statistical means were used to estimate and derive the figures that were not complete.

Three equations were estimated. First, an equation for intermediate consumption was necessary, as this forms part of the total agricultural sector debt, which in turn is part of the total interest paid. Of these three equations derived in this paper, the total agricultural sector debt equation was most satisfactory. While the remaining two equations are acceptable, further work is required. Therefore, the objective of presenting this paper at this conference is to obtain feedback on the models developed.

Debt levels per hectare in New Zealand's agricultural sector has closely followed GDP per hectare in agriculture. However, in the case of the United States there was a period around 1980 when many regions faced severe debt crisis as farmers accumulated high debt levels and incomes were low to service that debt. In the case of Australia, the debt levels are currently rising very rapidly while the farmers' incomes are not. This suggests that in New Zealand and the United States the current agricultural sector debt situation is not of concern while in Australia the farming sector could be facing serious problems soon if the debt situation is not addressed.

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NEW ZEALAND AGRICULTURAL ECONOMICS SOCIETY CONFERENCE
July 5-6 1996 - Blenheim

Cost Benefit and the Environment Debate

By R.W.M.Johnson*

New legislation seeks to control the import and use of risky products that are liable to damage human health or the environment. There is a considerable debate about who the gatekeeper will be and the rules by which the gatekeeper will operate. The aim of such rules should be to seek what is best in the national interest. One way to define the national interest would be to build up a cost-benefit system of evaluation for imports and use of relevant products. At present, no such procedures exist but they could be developed from the ideas set out in this paper.

BACKGROUND

There are currently two pieces of legislation before the House concerning the regulation of deleterious or hazardous products entering trade or used in production processes - The Hazardous Substances and New Organisms Bill (HASNO) and the Agricultural Compounds Bill (AC).** These replace existing legislation following the passing of the Resource Management Act 1991 (RMA). Among other things, the legislation introduces new agencies to manage the introduction of new products and new criteria to choose among alternative products or to reject them from import and use. The legislation attempts to guide the new agencies in their decisions by setting out criteria for admitting entry and processes which should be followed in making decisions. At the time of writing, HASNO has just passed through Parliament but the AC legislation has not been given its final reading so some arrangements may yet vary from those discussed here.

The aim of the Hazardous Substances and New Organisms law reform is to provide a comprehensive and consistent approach to the management of all hazardous substances and new organisms. The aim of the Agricultural Compounds Bill is to reform the law relating to the

*This paper was written by the author in his private capacity. Assistance from Bruce Burdon, Jim Sinner and Rod Forbes is acknowledged.

**Hazardous substances were formerly regulated under the Explosives Act 1957, the Dangerous Goods Act 1974, the Toxic Substances Act 1979, and the Pesticides Act 1979. Some substances regulated under the Animal Remedies Act 1967 are also hazardous (*Introduction to the Bill*). The importation of new organisms (that is, organisms of a kind not already present in NZ) are covered by provisions in the Plant Act 1970 and the Animals Act 1967. The development of genetically modified organisms is not covered by existing legislation. Part III of the Bill establishes a new statutory body, the Environmental Risk Management Authority (ERMA), to assess and develop controls for the importation, manufacture, development, and release within NZ of hazardous substances and new organisms. Acts repealed by the AC Bill include the Stock Foods Act 1946, the Fertilisers Act 1960, the Animal Remedies Act 1967, and the Fertilisers Act 1982 (*Introduction to the Bill*). The Bill names the Director-General of Agriculture as the person responsible for administering the provisions of the resulting Act.

management of risks from agricultural compounds such as animal remedies, fertilisers, stock foods, and pesticides. The risks controlled by the AC Bill are the risks to trade in primary produce, risks to animal welfare, risks to agricultural security, and the need to ensure that use of agricultural compounds does not result in breaches of domestic food standards.

REGULATION

There is a long history of regulation in the area of these products with the exception of genetically modified organisms. Such regulation was based on the principle that import and use was permissible if the deleterious effects on society could be managed safely. Regulations could specify conditions of use, maximum levels of specific substances, purity standards (fertilisers), containment, sanitization treatment and so on. With the passage of the RMA, emphasis changed to more specific attention to the *effects* of import and use of such products, hence the need to update and consolidate the legislation. Part XIII of the RMA provided for the establishment of a Hazards Control Commission; this has never been established - ERMA will take its place.

With new legislation, there is an opportunity to clarify the criteria that need to be taken into account by the relevant agencies and the general objectives of such regulations. Both Bills started out with defining that the purpose of the legislation was to maximise the net national benefit from the use of agricultural compounds, or to manage or prevent harmful effects of hazardous substances so as to enable the net national benefit to be achieved. Net national benefit implies a wide range of social and economic factors should be taken into account in making a decision for importation and use. HASNO provides that ERMA is to assess all new hazardous substances and new organisms for their suitability for importation, manufacture, development, or release from containment, and approve them if the beneficial effects outweigh the adverse effects, or decline the application in any other case. The AC Bill states the benefit is to be achieved by managing the risks associated with the use of agricultural compounds (risks to trade, animal welfare, and agricultural security) by ensuring that the use of agricultural compounds does not breach domestic food standards and enables the provision of sufficient consumer information.

In addition to these requirements, the Bills need to recognise the provisions of the WTO Agreement on Sanitary and Phytosanitary Measures (SPS) that domestic policies do not constitute an unnecessary impediment to free trade. In the case of measures which can be justified under the provisions of the WTO Agreement, then such measures should be chosen on the basis of least disruption to international trade (GATT 1994).

The two Bills address the issue of risk in different ways. HASNO creates a Risk Management Authority and then specifies what the authority must do in non-risk terms. The authority in making a decision on the beneficial and adverse effects of a substance, shall consider the effects of the substance on human health and safety, ecosystems, and the environment and chattels (S 1). The AC Bill speaks of risk management and specifies what kind of risk it means i.e. risks to trade in primary produce, risks to animal welfare, and risks to agricultural security. S19 of the AC Bill specifies that any application shall identify the risks and benefits likely to result from the

manufacture and use of a compound and evaluate the likely risks and benefits of each alternative method of managing risk. S17 refers to relevant risks and benefits and identifies beside the three already mentioned the risk to domestic food residue standards and the benefits of using the compound or the consequences of not having access or restricted access to the compound.

MANAGEMENT OF RISK

The management control function in relation to risk is shown in Figure 1. We can postulate a damage control function that is a diminishing function of the degree of control OY. OX is the initial damage without control. The effect of the management control is a reduction in potential damage. This reduction in damage is the benefit that any agency must assess. There is likely to be some threshold AB that is set down in legislation or is otherwise defined by a maximum residue level (MRL) or somesuch. At this point, the damage is still EB, but the reduction in damage is AE. Further to the right there will be some level of control that maximises net returns, CD, defined by the marginality conditions. CF is the reduction benefit and FD the residual damage.

These propositions can be expressed in marginal terms as in Figure 2. MB is the marginal net return (reduction in damage) at each point of control and MC is the marginal cost of additional control. OD is the point where welfare is maximised. There could be a threshold to the left of D as defined above. Say the threshold is to the right of D, T, representing the minimum amount of control technicians believe to be desirable, then this can be achieved but only at a loss of welfare. In practice, it may be quite difficult for managers to judge whether their threshold is being imposed at a total net loss to society especially in the absence of any evaluation of the possible alternative means of managing the risks involved.

This case only looks after the specifics of the control function administered by an agency. If such an agency was to be instructed to consider the net national benefit in its decision making, then it would need to take a wider view of the economics of the introduction of a new product. Each introduction would have a hypothetical set of private costs and benefits in addition to the public or social costs and benefits described above. In addition, the private importer would be expected to meet some or all of the costs of risk management.

In terms of cost-benefit analysis, an agency would need to estimate a set of functions at different levels of management control. Total benefits are private benefits (B_p) plus damage prevented (B_s); total costs are private costs (C_p) plus social (administrative) costs (C_s) :

Estimate $B_p + B_s - C_p - C_s$

Figure 1: Damage Control Function

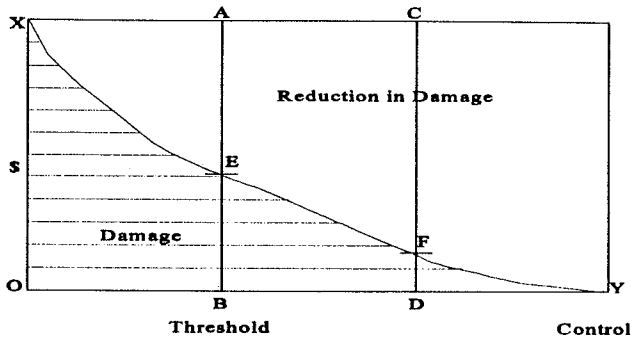
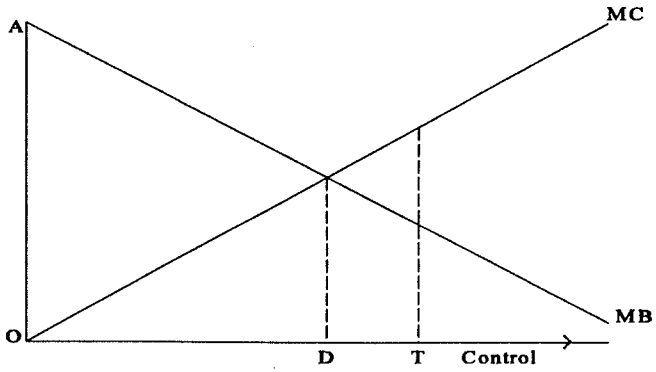


Figure 2: Marginal Positions for Management of Risk



Agencies would need to study and understand the time profiles of benefits and costs into the future and be able to apply appropriate discount rates to the results. It is not clear whether such data is available nor whether social discount rates are appropriate. There could be considerable scope here for inter-agency discussion of these matters before recommendations are made to final decision makers. If it was only desired to be satisfied that management of risk was worthwhile in a national benefit sense, the above evaluation reduces to :

Estimate $B_s - C_s$

Agencies would also need a lot of data to implement this methodology. Applicants could be asked to provide data on private costs and benefits though whether these should be trusted is another matter. The social cost of a management programme should be ascertainable especially if only one agency is concerned. Data on the damage function would need to be sought from the science community though standardised models may soon be developed if they are needed. The sheer variety of hazardous substances, new organisms and agricultural compounds may require a huge data base to carry out the job properly.

In this formulation, there is an unstated management goal that the control levels reached are acceptable to the community. It thus has to be recognised that if the management controls do not achieve their objective (in terms of environmental effects for example) then the substance cannot be imported and used. It may also be the case that even more controls at greater cost could achieve the objective but the benefits are no longer worthwhile. There is thus a need to examine environmental and risk thresholds to more closely understand the conditions under which environmental regulation can take place.

THE RISK TRADEOFF

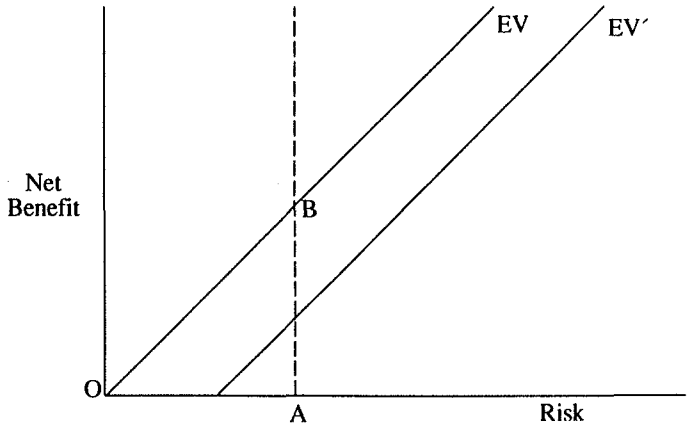
Underlying these propositions so far discussed is the question of *degree* of risk. Thus far it is assumed there is some societal risk (to human health principally) in allowing free import of certain substances where they have not been used before or where continued import involves a continued risk (fruit fly). Regulatory management regimes are imposed to reduce this risk to society, hopefully to safe levels; or the substances are forbidden (sheep semen). Cost-benefit analysis has been suggested as an aid to the importing decision taking account of the cost of risk management.

Three stages in this process are recognised: evaluating the likelihood of a disease or pest entering a country or determining the potential adverse effects on health of additives and contaminants; determining the acceptable level of risk; and selection and application of measures that would limit risk to acceptable levels and which were compatible with trade requirements (GATT 1992). The first is a question of scientific assessment or *evaluation*; the second is a question of *choice*; and the third is a matter of *design*. Evaluation is a matter for science and statistics; choice is a matter of political preferences; while design is what policy advisors and legal experts do. Let us see what economics has to contribute to these stages.

Figure 3 shows the normal trade-off between risk and net benefits; the EV line suggesting a positive relationship between greater imports or use of the substance, and the risks to society created by that import or use in the absence of controls. It is clear that `zero risk' means no imports or production (O) and that `no unreasonable risk' means some threshold level as represented by AB. The latter could be tolerances or maximum residue levels (MRLs) determined by the science agencies or international agreements. These are likely to have high safety margins. Other things being equal, domestic policy makers should seek control measures that push the benefits from imports/production out to point B and no further. Domestic agencies concerned with licencing or evaluation would need to undertake a risk assessment of the possible deleterious effects of the proposed import/process, be able to identify environmental or other effects on human, animal and plant health, and carry out one form or another of the cost-benefit analysis described above.

`Zero risk' is probably a bit of a mirage. Clearly, banning a substance may nearly keep the risk to society to zero. But as Jim Sinner points out to me, there will always be some residual risk of an adverse outcome due to natural importation by birds or the wind, illegal imports, or legal imports

Figure 3: Benefit - Risk Tradeoff



of some other contaminated products (car tyres). Think of the problem with fruit fly larvae these last few months. Thus the EV line could be shifted somewhat to the right EV´.

It is now clear that `managing risk' in the previous discussion means lifting the EV curve for a given amount of risk or reducing risk while still producing net benefits to society (a shift to the left). Recent experience with BSE and fruit fly suggests that public pressure is seeking some minimum or very low risk and that banning is preferable to managed importation. That is why it is important to talk of acceptable risk as a political concept; many of these standards will be established by public pressure on decision makers.

ENVIRONMENTAL COST BENEFIT

S 21 of HASNO sets out the criteria for approval of applications under the proposed Act. ERMA may approve an application if after taking into account scientific uncertainty, management controls proposed, environmental effects of an introduction and the likely effects of the substance being unavailable, the beneficial effects of the substance outweigh the adverse effects. An application would be declined if the reverse holds or insufficient information is available.

I think economists are hardly likely to be satisfied with a qualitative evaluation of societal harms and goods! What alternatives are there? I believe that the economic rigour of the cost benefit model set out above would be the first step in keeping evaluations (how many a year?) to a consistent and transparent system of analysis.

In the AC Bill (S19(c)) the DG shall decline an application if the net national benefit is reduced ...because the risks likely to result from the use of the compound cannot be sufficiently reduced by imposing conditions during registration; or insufficient evidence is available to assess the impact on the net national benefit. In every other case the DG may register the compound without conditions or with conditions...which the DG considers necessary to achieve the *maximum* net national benefit. This wording suggests a threshold of acceptance and that compounds only have to reach that threshold. *Maximising* the net national benefit, however, suggests analysing several alternative means of control, and choosing the least cost way of reaching the threshold.

POSTSCRIPT

In the Select Committee, the wording of the purposes of the HASNO Bill (AC has not passed the Select Committee yet) has been changed from

> `to manage the harmful effects of hazardous substances and new organisms in order to protect the environment, and the health and safety, and the economic and cultural well-being of people and communities so as to enable the maximum net national benefit to be achieved'

to read

> `to protect the environment , and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms'.

It is said that the removal of net national benefit test is to narrow the criteria and thus place more emphasis on environmental effects. The previous wording was thought to give ERMA too much

discretion in placing weight on economic benefits as opposed to environmental factors or vice versa. As it stands, the revised purpose is to give clear focus on the protection of the environment and public health and safety.

Any analysis would still have to account of the Bill's definition of the environment which includes:

> `ecosystems and their constituent parts, including people and communities;
> all natural and physical resources;
> amenity values; and
> the social, economic, aesthetic, and cultural conditions which effect the matters stated'.

These matters to be taken into account still constitute a very wide frame. It might still be asked whether they are to be given equal weight in a determination or used selectively? The Select Committee have certainly moved back from full cost benefit analysis of each import and its conceptual and data problems to one of qualitative analysis which will be most hard to challenge and contradict. On the other hand it might provide lots of work for the courts!

In the third reading of the Bill the Minister drew attention to new S6A. ERMA is `required to develop and apply a consistent methodology (including an assessment of monetary and non-monetary costs and benefits) in making decisions under Part IV of the Act. `A rigorous and consistent approach will be essential if the authority's determinations are to be authoritative' he said. When the Bill was passed, the Minister stated that the methodology to decide the monetary and non-monetary costs and benefits would be decided by elected representatives and members of the public through the same public process as regulation setting (Evening Post, 25/5/96).

SUMMARY OF FINDINGS

i. there need to be clear definitions of benefits to be derived and costs involved;
ii. there has to be a methodology to assess the risks involved on introduction;
iii. there has to be clear specification of, and the weighting of, the matters to be taken into account;
iv. there has to be clear guidelines for identifying management strategies for risk control; and
v. there has to be a clear provision for understanding the international implications of each import and control strategy.

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TRADE, TECHNOLOGY and AGRICULTURAL DEVELOPMENT

Paper Contributed to the Annual Conference of the NZ Agricultural Economics Society (Inc.): Blenheim 5/6 July 1996

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ABSTRACT

This paper outlines developments in the theory of international trade aimed to make this theory more dynamic, especially by incorporating technological change. The argument is that these efforts have not gone far enough and that the dynamics of technological change cannot be accommodated properly in a theory which relies on production functions. In part II, the concept of rhizoids is developed as a conceptual tool for a fully dynamic theory.

PART I: NEW DEVELOPMENTS IN INTERNATIONAL TRADE THEORY

Introduction

In this part a brief and by no means exhaustive overview is attempted of recent developments in the theory of international trade. The emphasis is put on attempts to make this theory more dynamic.

Traditional Theories of International Trade

Traditional theories of international trade explain trade between countries as arising from differences in costs of production. More precisely, the theory emphasises relative comparative advantages. Country A will produce those goods for which it has the largest cost advantage relative to the costs of producing other goods. It will then import the latter from country B which has a relative comparative advantage in its production. Classical economists considered only labour as a factor of production. They explained differences in labour productivity between countries as a result of differences in production functions. Labour, of course, was thought to be immobile between countries.

This led to the question why the productivity of labour would differ between countries. In general, differences in technology as such or in combination with differences in the natural environment (natural resources, soil fertility, geographic position) have been identified. Goods which appear to depend for their production and trade on these location-determined characteristics are often called Ricardo-goods.

The neo-classics of the 20th century, notably Hekscher (1919), Ohlin (1933) and Samuelson (1939) have built their theory of trade upon both capital and labour as factors of production. Thus, the prices of products differ between countries on the basis of differences in costs of labour and capital. In turn, such differences are a function of the relative endowment of countries with labour and capital. Like the classical economists

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1. I express my thanks to my colleague John Lepper for many suggestions and corrections. Any remaining errors in logic or fact are my own responsibility.

the neo-classical theories assume that factors of production are immobile. They differ, however, in assuming that production functions are the same between countries. Again, countries specialise in those products which they are able to produce relatively cheaply. Goods which must be imported from country B are obtained at lower prices than if they had been produced domestically. Country B benefits from the larger production and resulting lower costs of production by importing the goods in which A has specialised.

Since technology is assumed to be freely available to all countries, goods which are produced on the basis of a generally known technology are called Heckscher-Ohlin goods.

The critical assumptions underpinning this theory have been stated as follows by Dosi and Soete (1988, page 403):

> (i) On technology. Differences in technologies can be adequately represented by production functions. The latter are assumed to represent the real world, are well behaved, continuous, differentiable, exhibit non-increasing returns to scale, etc. Moreover, they are assumed identical across countries.
>
> (ii) On behaviours. Perfect competition prevails throughout. Agents are maximisers under budget constraints.
>
> (iii) On demand. Identical tastes across countries and well-behaved utility functions.
>
> (iv) On adjustment mechanism. Adjustments are such as to guarantee ex hypothesis the clearing of all commodity and factor markets.

Despite such very restrictive assumptions, Deardorff (1984), as quoted by Kol and Mennes (1989), concluded on the basis of extensive empirical work that the factor-proportions model provided in general a satisfactory explanation of the goods composition of international trade. Nonetheless, he recommended that alternatives to perfect competition should be considered and that the possibility of introducing increasing returns to scale should be investigated.

Leontieff Paradox and the EEC Cast Doubts on Factor-Proportions Theory

Leontieff (1953) found that the USA, a capital-abundant country, exported labour-intensive products and imported capital-intensive products. Since this result appeared to contradict the Heckscher-Ohlin theory it became known as the Leontieff paradox. It stimulated research into different types of human labour and "human capital".

In the late 1950s the EEC (the original 6 European countries) was formed and, on the basis of the neo-classical factor-proportions model, it was expected to result in a major change in specialisation between the participating countries such that industrial production would gradually be concentrated in West Germany and that France and Italy would become exporters of agricultural products. In contrast, the specialisation which actually occurred was predominantly intra-industrial. Thus, the economic integration had less drastic effects than had been feared and this made the integration process much more socially acceptable in the member states.

Economies of Scale

This unexpected outcome led to the search for alternative theories to explain the pattern of international trade. The most important change suggested was that economies of scale should be incorporated into the theory. Such economies take two forms:

> -External economies. In this case the costs per unit of output fall as the industry as a whole expands its production. Individual producers do not have cost advantages over others.
>
> -Internal economies. Individual firms have cost advantages over others. This leads to monopolies and oligopolies. Monopolistic competition is another case of internal economies inasmuch as firms develop differentiated products in order to exploit cost advantages of larger production runs. The resulting monopoly profits, however, stimulate the entry of other firms.

A good example of external economies is the development of technical know-how which is disseminated to other industries.

Since the 1970s international trade theory has made use of external economies (Krugman, 1994), following A. Marshall. Strictly speaking, external economies are not exactly the same as increasing returns to scale which are defined as a proportionately larger increase in output when the input of all factors of production is increased at a certain rate. This happens at the level of the firm.

By contrast, if the increase in output is proportional to the increase in the application of factors of production, then returns to scale are constant. If output declines when factor inputs are increased, returns to scale are decreasing.

If only one factor of production is allowed to be varied, and the other(s) remain constant, it is assumed that production initially will rise and then decline (law of variable proportions). Such decreasing returns, as a result of the law of variable proportions, are reflected in the convex (with respect to the origin) form of isoquants.

Admittedly, external economies may result from increasing returns to scale, but this is not always necessary as the example of the dissemination of technological know-how illustrates. Firms in such an industry may well have decreasing returns to scale, but by applying technical knowledge, developed perhaps by a leading or by the most innovating firm in the industry, they are all able to offer a better designed product and thus experience higher demand. The industry's demand curve shifts to the right. Costs per unit fall, whilst no firm finds it necessary to hire more staff.

The reference to Alfred Marshall (Krugman, page 64) is rather misleading because Marshall's law of increasing returns in industry is based primarily upon an improved organisation in consequence of increased quantities of labour and capital employed (Heertje, 1973, page 111).

Incorporation of External Economies

If external economies of scale are to be incorporated, then the type of competition is irrelevant, because it is the industry as a whole which is the beneficiary of such economies. Incorporation of internal economies of scale, on the other hand, requires also the identification of the type of competition faced by the firm.

The result of incorporating external economies of scale into the theory of trade is that production is likely to be concentrated in one country, so that the industry there can have the largest size and costs of production will be lowest. Other countries benefit from this specialisation inasmuch as they are able to import the good concerned at the lowest possible price. Thus, external economies of scale can be seen as a source of international trade in addition to relative comparative advantages. However, as Kol and Mennes note (1989, page 9) external economies of scale do not necessarily result in a complete specialisation. The size of world demand, the size of local production capacity and transport costs can be such that production will be concentrated in a number of countries.

> "Historic and accidental factors determine in which country or in which countries production will eventually be concentrated." (Kol/Mennes, page 9).

The incorporation of internal economies of scale, especially via the assumption of monopolistic competition, leads to the expectation that the whole world market becomes available to exploit these economies of scale. Firms will reduce their menu of differentiated products and produce a limited one, so that they can expand production and capture as large a share of the world market as possible. International specialisation will make a larger variety of products available, since those which are not produced locally can be imported. Thus, similar but differentiated products can be both imported and exported by a country.

As in the case of external economies of scale one cannot predict at all accurately the likely pattern of specialisation.

Ohlin (1933) pointed out already that comparative advantages and economies of scale may occur simultaneously and that the latter could strengthen the working of the former. As Kol and Mennes note, products may be differentiated on the basis of differences in the type and quality of inputs used (wood, steel, style etc.).

In many cases the development of a new high-technology industry will require very large capital investment. Thus, fixed costs are very high, so that increases in the scale of production generate falling unit costs. These advantages of scale are such that oligopoly tends to be the dominating market form for such industries.

Rent

An industry which has a monopoly and which operates under increasing returns to scale may be so large that there is room for only one such industry in the world. This enables such an industry to charge high prices and pay high wages. It enjoys a high rent. However, countries may attempt to get such an industry located within their borders by

offering, for instance, substantial export subsidies to a local company. Such action could lead to losses for producers in other countries as they have to tolerate a reduction in demand and hence a rise in unit costs.

The recognition of rent is one result of the new trade theories and has led to the name "strategic theories of trade", meaning that countries may attempt to obtain strategic advantages in international trade by a policy of intervention.

Technological Gap Trade

Vernon (1966) argued that technological innovations are first introduced into production processes in the most highly developed countries where labour is relatively scarce and capital and knowledge are more amply available. Export then takes place because the exporting country has achieved a technological advance on its competitors. In turn, the extra output resulting from export allows for standardisation and mass production. At this stage, rates of factor remuneration become important factors in determining where the standardised production will take place.

Production Function

Krugman (1994) has developed some models of international trade in which he incorporated monopolistic competition and increasing returns to scale. The latter he did in the form of external economies, so that the industry as a whole benefits from lower costs and is thus able to expand. This leads to indeterminateness as it is not clear in which country industries working with increasing returns to scale would locate.

In this collection of papers Krugman nowhere questions the use of the production function. Indeed, by using external economies rather than increasing returns proper, he dodges the issue, as pointed out above.

In neo-classical economic theory increasing returns to scale are an antinomy. To show this, the basic structure of this theory must be considered. The key steps are as follows:

1. Individuals demand goods and services on the basis of their preferences (tastes, utility). Such preferences are psychologically qualified. From an economic point of view we can only assume that choices to buy reveal preferences.

2. In a situation of pure exchange, objects available for purchase are scarce, relative to potential demand and, therefore, command a price. Some individuals have too much of certain objects and are prepared to trade their surpluses.

3. When production is introduced, the scarcity of objects is overcome because they can be produced in the quantities demanded. The scarcity is transferred to the factors of production (land, capital, labour).

4. Producers are supposed to allocate their scarce resources on the basis of their prices. They transform inputs of factors of production into outputs, using a technical production process. The technology used is represented by the form of the production function.

5. From the point of view of consumers, capital is deferred consumption. They are prepared to give up a certain quantity of goods in the present in order to have a larger quantity at a future date. The rate of exchange between the present and future consumption is expressed in their time preference (rate of interest). The higher the time preference, the less eager consumers are to part with present consumption.

6. Producers employ capital in their production process. The lower the price, as expressed in the rate of interest, the higher the capital intensity of the production process is able to be.

7. If productivity were to keep increasing as the roundaboutness of the production process is intensified, more and more capital would be allocated to production.

8. Under increasing returns to scale, the more consumption were deferred into the future, the larger future consumption would be. Eventually, all consumption would be deferred. Producers would keep expanding their production.

9. Clearly, the system would soon develop into a crisis. To avoid this, returns to scale should be constant or more strictly decreasing. It is through falling productivity that equilibrium is attained between production and consumption and between present and future consumption.

This theory reduces economic value to a psychological phenomenon. By shifting the locus of scarcity to factors of production, the actions of producers are reduced to applying a given technology to inputs of factors of production (Kee, 1982).

Serge Latouche (page 15) remarks somewhat scathingly that for the neo-classical theorists the combinations of factors of production are a type of alchemy, outside their field of interest and that the hardly realistic assumption of decreasing returns to scale prevents them from understanding the actual processes of choosing new technologies.

By retaining the concept of a production function, it is possible to consider the effects of increasing returns to scale on issues such as the location of industry, but this is not quite the same as incorporating the economic significance of changing technologies and the effects of changing technology into the theory of international trade.

In his paper "A Model of Innovation, technology Transfer, and the World Distribution of Income", Krugman, for instance, merely assumes that in country North there is a continuing process of technology and technology transfer and that country South is non-innovating. As Krugman notes himself he is only concerned with the (economic) effects of innovation and technology transfer (page 140) and not with their causes. Krugman may also assume technological change as the development of new products. The only information ('reasonable guess') on innovation processes (Krugman, (page 144) is "that the number of new products invented depends positively on the number already developed: The more you know, the more you can learn." (page 144).

The models developed by Krugman all feature the production function with labour and capital as factors of production.

Whilst the results of the models are interesting, they fail to provide much insight into the interaction between technology, technological change and economic production, specialisation, trade flows and international distribution of income.

The reason for this relative property is that technological change cannot be analysed very well by means of a production function. A production function is merely a mathematical relationship between labour and capital as input factors and output. Technology is implied in the form of the function.

Studies based upon the production function will tend to treat technology itself as a black box.

The Neo-Schumpeterians

Joseph Schumpeter paid a great deal of attention to technological innovation both in his theory of economic development as well as in his theory of the business cycle.

Since the 1970s economists who might be called neo-Schumpeterians have done a great deal of work to describe and analyse processes of technological innovation. A typical example is the paper by van Hulst and Soete. They characterize the attempts of the neo-classical theorists to incorporate technical change as follows:

> " Usually one tries to force genuine dynamic problems with regard to innovation, scientific knowledge, uncertainty and change into the corset of more familiar concepts such as 'endowments', relative scarcity and optimisation under budget constraints." (page 65).

They went on to note that the interpretation of technology in this new view on trade is in fact but a faint reflection of the complex process of technological change and innovation. It remains rather a matter of allocative efficiency on the basis of a set of given technologies.

In their view the idea of technical progress as a shift in the production function in consequence of non-incorporated or incorporated technical change does insufficient justice to the more complex reality known from micro-economic studies.

Van Hulst and Soete argue that we should view empirical reality as 'technologically stylised'. They want to pay more attention to differences in technology and product characteristics across countries as well as to the origin of such differences. If technologies and product technologies can be ranked independently from national income distribution and relative price differentials, then the technology gap theory becomes very important. In their paper they review indicators such as Research and Development expenditures, patent-activity and the technological balance of payments (licenses sold overseas less licenses paid to overseas sellers).

Applying these to an ordering of Dutch industry they conclude:

> "..It is interesting to note that there are networks of 'national systems of innovation' in industrial sub-sectors with favourable export performances such as chemical industries and food processing. Their characteristics are good relationships between companies, research-and education institutions as well as a long tradition of cumulative efforts to gather and utilize knowledge. In policies with regard to higher education and research and in technology policy sufficient attention should be paid to the creation and preservation of a qualitatively high value education and research infrastructure which has a beneficial impact on economic activities in the Netherlands." (page 82/83).

Conclusion

The overall results of the newer trade theories with regard to the treatment of modern technology and technology, have been somewhat disappointing. Reducing dynamic change to learning curves, for example, is a rather pedestrian way of dealing with technological change, especially when technology occupies such a dominating position in our culture.

PART II: RHIZOIDS AS A CONCEPT FOR A DYNAMIC TRADE THEORY

Introduction

The question we are attempting to answer is whether it is possible to develop a conceptual way of thinking economically about the use and value of technology. The idea that technology involves a large number of interacting institutions, companies, individuals and that new technologies tend to be diffused across industries suggests that a network concept might be a good starting point.

Static or Dynamic?

The neo-classical theory of trade discussed in outline above is a static theory designed to explain how economic subjects function with respect to international trade. Efforts to make this theory dynamic have been only partially successful. In actual fact, the effort to transform a static theory into a dynamic theory should be regarded as misguided. It can only lead to anomalies in the theoretical framework.

What is required is a special theory of economic dynamics. Such a theory should not have economic functions (how we allocate resources given prices and preferences) as focus, but rather entities themselves such as farmers, farmer co-operatives, NZ Dairy Board, research activities, inventions, innovation processes. The theory should then describe and explain how these entities (or actors) interact with each other during a period of time. If stated in this way, there is no precise limit to the set of actors that can be included. One should define the set with regard to the problem to be analysed.

Since we are dealing with the economic aspect of reality, a dynamic economic theory requires to be guided by an economic idea of value. I suggest that the value concept to be used is that of the economic value generated by all resources involved in the dynamic process.

Technological change should enter a dynamic theory of trade as a special factor which affects what actors are doing and how they are changing their operations and resource use.

Characteristics of Modern Technology

The Dutch philosopher of technology Egbert Schuurman has pointed out that modern technology is inextricably interwoven with science so that as a result the salient aspects of scientific thinking have been imprinted on modern technology. These are:

> -abstraction; concentration on one particular aspect of reality such as the physical or biotic aspect;
>
> -this narrow focus enables a process of dynamic progress,
>
> - a logical compelling and relentless development.

Scientific and technological development have become strongly intertwined. Technology is not just applied science. One can also say that science is applied technology. Without the availability of modern instruments scientific progress would be a great deal slower.

Not only is technology interlinked with science, it is also marked by what Schuurman and Latouche call "laws" or imperatives such as:

> "Whatever can be discovered and made should be made, regardless of any possible harmful consequences (Dennis Gabor)".

Latouche refers in this respect to bio-engineering. Who knows what the long-term consequences of this new technology on animals and plants will be?

> "Whatever has been discovered must sooner or later be applied and used."

When the Americans discovered that it was possible to make an atomic bomb, they decided that it should be constructed. Economically, this means that one makes numerous perfectly useless things. Consumers are subjected to intense media campaigns. As cogs in the big megamachine (Latouche) they must buy micro-waves, calculators, new cars, mobile telephones etc.

Schuurman notes that this motif results in over-development as technology has become subservient to economic and financial powers. The need to make a profit has become an absolute requirement. Natural resources are depleted in an irresponsible fashion. The quality of life of human beings is disregarded. They become clogs in the technical/economic machine.

Another typical feature of modern technology is that it has a pervasive systematic influence. The decision the Americans had to take in 1945, whether or not they would drop the bomb, was a unique decision. At present, the decision to start a nuclear war would involve a set of interlocking weapon systems. The so-called desert war of 1991 might serve as an example.

Latouche makes the point that a great deal of technical innovation originates in the industrial/military complex. It then gets diffused into economic production. In fact, this is one way in which Kondratieff cycles get started. There must be a set of interlocking

new technologies which in combination trigger a stream of innovations over a period of time. At present, such a cluster of new technologies is formed by new materials, microchips and bio-technology.

Economic Value of Technology

Clearly, economic theory cannot be expected to analyse how goods are produced in a technical sense. This is the realm of the engineer. We should be able to analyse, however, how the choice of a particular technology is influenced by economic factors and how that choice affects the allocation, use and waste of resources. Conversely, innovation will often have a basis in economic relationships. If a particular resource is abundant but cannot be harvested by existing technical means, then, producers may be stimulated to invent a new machine able to tackle the job. This happened, for instance, in the 19th century in South Australia. When large areas were sown with grain, the harvest was so large that there was insufficient labour to harvest it by using scythes. Mr. Ridley then was inspired to invent and produce a harvesting machine. The result of such machines was that large areas of grain could be sown and harvested in the USA and Australia for export to other countries.

Examples from New Zealand Dairy Industry[2]

The development of the New Zealand dairy industry provides a series of examples which confirm this pattern. The invention of refrigeration during the latter half of the 19th century made it possible to ship dairy produce to the UK in a better state and in larger quantities than previously. Nevertheless, quality problems remained such as the effect of local flavour on the quality of butter. As prices were differentiated on the basis of quality, New Zealanders invented the vacreator machine over a number of years during the 1920s and 1930s and were so able to improve the returns from exporting.

On the other hand, general technical innovations such as the development of the motor-car, and the introduction of electric power made the collection and transport of milk much more efficient.

The influence of science on the industry's technology became a systematic factor with the establishment of the New Zealand Dairy Institute in 1926. Problems experienced in the industry were systematically analysed and solutions quickly diffused. In turn, this Institute benefitted from close relations with Massey University.

All these factors do not yet explain, however, why New Zealand became a major exporter of dairy products and why the UK became its main export market.

The answer to this question must be found in the fact that New Zealand was set up as a colony within the British Empire. English settlers found that the soil and climate were suitable for dairy farming. Initially, most of the production was destined for local consumption. The industry could develop an export production and trade only on the basis of technological innovation.

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2. This section draws on a study in progress which will provide fully annotated references.

The invention of the milking machine highlights another factor in the dynamics of industrial innovation and social and economic factors. The first machines made milking easier, but it remained a slow process. Since in many cases farmers' wives milked the cows, it took a substantial slice out of their busy days. A new farmer from Canterbury with an engineering background and an inventive turn of mind, invented a different milking machine in Taranaki which was faster. It became so popular that he stopped farming and set up an engineering manufacturing firm to make the machines.

Networks

A theory of international trade should allow systematically for such interaction between economic, technical, social and political factors. Scott's work on economic growth which discards the production function and which focusses on the investment process may serve as a guide. New investment opens up new opportunities, not only for those firms carrying out the capital investment, but also for many others. As demand rises, new products are marketed and consumption and employment patterns change, there will be scope for investment in areas not considered previously.

International trade theory should be a theory of economic and social dynamics. All actors should be represented and their interactions mapped. From an economic point of view the guiding criterion should be whether the network of interactions increases economic value or reduces it. This involves a concept of economic value which differs from the value concept of neo-classical theory. The latter derives value from consumers' utility.

Using a network approach, economic value should be located in the value of all resources available to a community. If, for instance, the production and trade relationships are such that natural resources are depleted and are not replaced by other equivalent resources, economic value produced should be registered as negative. Similarly, if the processes discard human labour without the network being able to offer re-employment in a different part or in a different network, economic value is negative.

Rhizoids

The economic network concept I propose to use (Lepper and Simons, 1994) is called rhizoid, because it involves a network of relationships between natural resources, technology, farms, processing industries and social and political factors both domestically and overseas. Its purpose is to generate economic value as defined. If this value is the output, we can draw a comparison with a tree which draws its sustenance through networks of roots and leaves from its environment and produces fruits and useful materials and gases. The word rhizoid is derived from the Greek word for root system, but it also includes what the roots produce.

Rhizoids may be either closed or open. A closed rhizoid involves a static network in which technical and social innovation is virtually absent. A local farmer may have a few cows for producing milk and some dairy products for local consumption. The town which buys these products draws a living out of making wooden toys and running rest homes for the elderly. Little change occurs.

By contrast, an open network is innovating all the time. Labour requirements change, new knowledge is gained and applied, technological innovations take place and change the relationships between producers as well as natural resource requirements. Economic events overseas change world market prices and impose thereby a premium on innovation. Capital resources must be attracted on overseas markets.

The diagram over the page provides a rough illustration of an open rhizoid. It has been drawn deliberately in the shape of a neural network, because an open rhizoid involves an on-going groping towards a new result. Transnational companies, for instance, set up a kind of groping process in the competition they engender between their subsidiaries.

The number of influences on the network is not only large but keeps changing all the time. Participants keep groping towards what they believe are better solutions all the time. From time to time they may fail, so that the whole network could move close to a collapse and so creates conditions for a transformation into a completely different network. Some innovations could be hugely successful, others might turn out to be dismal failures. With sufficient foresight this uncertainty could be managed, at least to some extent, for instance, by the building up of reserves.

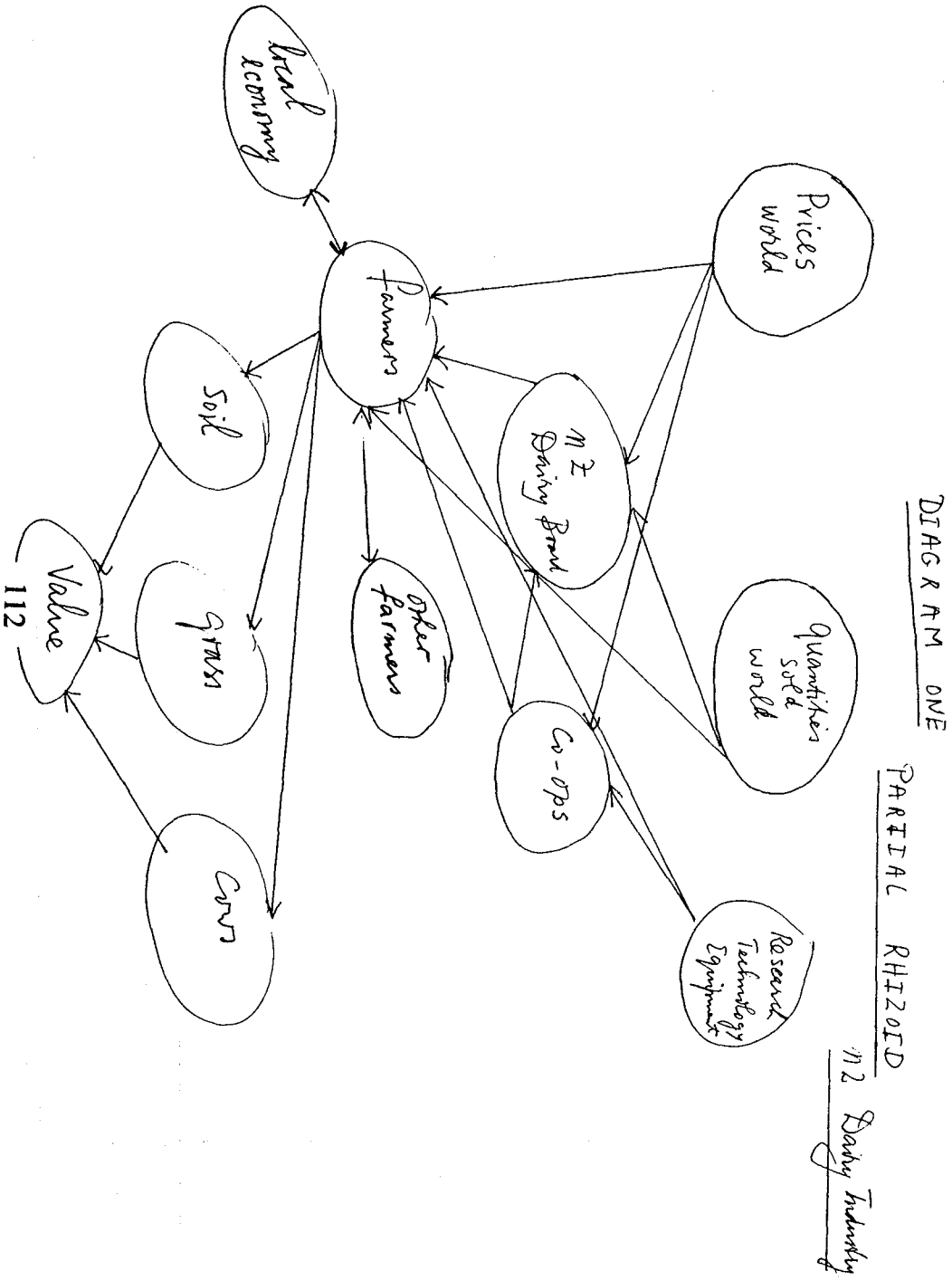

DIAGRAM ONE

PARTIAL RHIZOID

NZ Dairy Industry

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Whilst a dynamic theory should focus on the interacting factors and participants, it should not be forgotten that the dynamics can only take place on the basis of a set of given functions or modalities. In any rhizoid participants will function technically, socially, politically and ethically. They will also operate within a certain value system, so that they act according to notions of what they believe is good or bad. Without such underlying stability, it would be practically impossible to have dynamic rhizoids.

Within an international financial system in which capital is allocated on the basis of the highest financial return by large transnational corporations (Lepper, 1996) the evolution of dynamic rhizoids might well be moved in a direction which generates less economic value, in the sense described above, rather than more. This raises important issues for the attainment of sustainability as defined by the Resource Management Act 1991. To put it another way, an open rhizoid is not necessarily a rhizoid in which participants have full command over their destiny.

For this reason, public policy should strive to develop closed rhizoids not only to complement open rhizoids but also to provide a correcting influence or counterbalance. This could take the form of providing opportunities for stable employment patterns in avenues of caring and environmental preservation.

As in most modern economies, New Zealand has seen a shrinkage of its agricultural labour force under the impetus of large scale technological change. New farming practices may or may not be sustainable from a long-term point of view. If the concept of open rhizoids were accepted, then, it would require the development of a new set of statistical measurements to determine whether current agricultural technologies are the most optimal in the long run. If they were not so sustainable, then change would be very difficult since the open agricultural rhizoids are interconnected with powerful international technical and financial interests. The question then is whether closed or semi-closed rhizoids should be developed to improve overall resource use.

Dynamics of International Trade

As described above international trade does not take place at industry or product level. Rather, it is the result of different rhizoids competing in different ways. The flows of goods and services between countries is the result of quite deep social, technological and economic processes. Some rhizoids may well be companies, others are industries, some are whole regions or countries. Some straddle a number of countries, for instance the copper industry. It all depends. The Leontieff paradox is only a paradox if one looks at international trade as flows of goods and nothing else. It ceases to be a paradox when viewed as competition between rhizoids. Rhizoids with a large labour content might have been more open than those with a large capital content at the time Leontieff wrote. If so, they would have found exporting more advantageous. The opposite may have been true of Japan or Europe.

Unless one investigates the existence and operation of rhizoids during a particular time one may be confronted with paradoxes. The latter arise from using static theories of trade to explain dynamic relationships.

Conclusion

In his survey of international trade theory Haberler noted (p.4) that :"There exist only rudiments of truly dynamic analysis in the field of non-monetary trade theory."

Whilst new trade theories have made some progress by considering dynamics of external and internal economies of scale, they have not yet succeeded in breaking out from the essentially static framework of the basic theory.

Development of a truly dynamic theory requires specific concepts which allow the incorporation of all factors impinging on the generation of economic value, defined as the value of resource use. This paper suggests the concept of rhizoids as one of such possible concepts to highlight the critical factors in the dynamics of international trade.

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Estimating New Zealand's Ecological Footprint[1]

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Paper presented at the 1996 Conference of the
New Zealand Agricultural Economics Society
Blenheim, New Zealand
5,6 July 1996

Abstract

Sustainable development has become a primary objective for many countries throughout the world since the late 1980's. At the core of the legislative framework supporting sustainability in New Zealand is the Resource Management Act (1991), which promotes the sustainable management of natural and physical resources.

A major difficulty associated with sustainable development objectives, however, is the problem of developing reliable indicators in order to measure progress towards the goal of sustainability. The "Ecological Footprint", developed by Wackernagel and Rees at the University of British Columbia's School of Community and Regional Planning, provides an estimate of the land area necessary to sustain current levels of resource consumption and waste assimilation for a given population. It is a static index reflecting current technologies, consumption levels and international trade flows. By comparing the Ecological Footprint of a community with the amount of land available, we can more clearly determine whether our current consumption patterns are likely to be sustainable.

This paper explores the use of ecological footprint analysis within a New Zealand context. Modifications to the procedure for calculating an ecological footprint are proposed, and estimates based on the modified procedures are presented for New Zealand. Preliminary analysis indicates that it takes 3.27 hectares of ecologically productive land per year to sustain the average New Zealander's current level of consumption. This figure represents approximately sixty percent of the productive land available in New Zealand, making this country one of the few developed nations that is not running an 'ecological deficit'.

[1] The authors wish to thank Landcare Research New Zealand Limited for providing the funding for this research.

I Introduction

The amount of productive land required to support a particular population indefinitely at current consumption levels has been defined as that population's "ecological footprint". The concept was developed as a planning tool by William Rees and Mathis Wackernagel at the University of British Colombia's School of Community and Regional Planning. Implicit in the assumptions underlying ecological footprint analysis is the premise that long run economic welfare depends upon meeting the criteria of strong sustainability. In other words, it implies that all economic resources - both sources for inputs and sinks for waste - must eventually be derived from the natural capital contained within the biosphere. The consumption of finite non-renewable resources such as fossil fuels must therefore eventually be replaced by renewable resources if sustainability is to be achieved.

The ecological footprint is closely related to the ecological concept of *carrying capacity*, or the population of a given species that can be supported indefinitely in a defined habitat without permanently damaging the ecosystem on which it is dependent . Carrying capacity is generally expressed in units of head/hectare, making one concept the inverse of the other. The ecological footprint can be readily adapted to incorporate trade, however, making it a more appropriate concept to apply to human populations (Pearce, 1994; Wackernagel and Rees, 1996). The trade adjusted ecological footprint should capture all the bio-physical impacts of a given community regardless of where those impacts occur.

In effect the ecological footprint provides a 'snapshot' of resource consumption, incorporating current technology and processes. As such, it is a static index that can be used as an indicator of sustainability by comparing the total ecological footprint of a population with the land available to support human consumption. Any change in technology or resource use patterns must be incorporated in subsequent estimates. Indeed an interesting use of the ecological footprint concept is to develop a time series of land requirements which reflects trends in technology and consumption patterns.

This paper presents a novel way of calculating an aggregate ecological footprint using input-output methodology. The primary advantage of the input-output framework is that provides a standard method of analysis that can be updated and/or applied to an alternative population in a very uniform manner. Consistency is particularly important if alternative ecological footprint estimates are to be meaningfully compared across time or between populations. The input-output based methodology is described in section two, and applied to the New Zealand economy in section three. Results presented in section four indicate that 3.27 hectares are required to support the average New Zealander's current level of consumption, which compares favourably to estimates from other developed countries. Sensitivity analysis (section 5) indicates that the results particularly depend upon the assumptions governing alternative energy sources and the treatment of the conservation estate.

II Methodology

Previous Work

In two earlier publications, Wackernagel et al. (1993), and Wackernagel and Rees (1996) describe how to calculate an ecological footprint. To facilitate an already complex analysis, the authors construct a consumption — land-use matrix with five major consumption categories[2] and six major land use categories[3]. The authors' goal is to account for all of the land that is appropriated in the production and maintenance of every good and/or service consumed by a particular community. The land embodied in an average house, for example, would include such things as the area required to grow the timber for construction and the 'energy land' required to warm the occupants in winter, as well as the land actually under the building.

The calculation procedure involves using aggregate consumption and population statistics to calculate the 'average person's' annual consumption for each major consumption category. The area appropriated by each person can then be calculated by dividing the resulting annual average consumption figure (kg/capita) by the average productivity or yield for that item (kg/ha). The total per capita ecological footprint is calculated by summing all ecosystem areas appropriated by each item consumed during a particular time period.

Prior work suggests that 'energy land' accounts for over fifty percent of the total ecological footprint for developed countries (Wackernagel and Rees, 1996). This component represents the amount of land required to supply a given amount of energy using sustainable technology, or the amount of land required to sequester the CO_2 emitted from burning fossil fuel. Energy land can be estimated under a variety of assumptions, all of which result in an energy-to-land ratio that describes how much commercial energy per year could be produced or assimilated by one hectare of ecologically productive land. One alternative involves the production of a contemporary biologically produced substitute for liquid fuel such as ethanol or methanol, which range in yield from 80 to 150 gigajoules per hectare per year. A second alternative is to calculate the land area needed to sequester the CO_2 emitted from burning fossil fuel. Prior work suggests that one hectare of average forest can sequester the CO_2 emission generated by the consumption of 100 gigajoules of fossil fuel each year. A final alternative is to determine the land area required to rebuild the natural capital at the same rate the fossil fuel is being depleted. Estimates suggest that one hectare of average forest can accumulate 80 gigajoules of recoverable biomass energy per year in the standing timber. Clearly, once the reserves of fossil fuel have been depleted this method will converge on the first.

Data to support the calculation of Canada's ecological footprint came from a wide variety of sources (Wackernagel et al, 1993; Wackernagel and Rees , 1996). Government publications with national statistics on consumption and trade provided most of the consumption data. Productivity and yield data were obtained from a wide variety of sources, covering a time

[2] Food, Housing, Transportation, Consumer Goods, and Services.

[3] Energy Land, Built (Degraded) Environment, Gardens, Cropland, Pasture, Managed Forest.

span of over 30 years. The authors advocate using world average productivity statistics to reflect the increasing reliance on multi-lateral trade flows. We are of the opinion, however, that this practice obscures the important gains that result from comparative advantage. Although higher yields will not imply smaller footprints if the underlying technology is particularly energy intensive, land requirements for every population could be reduced by allowing production to flow to regions with "land sparing" production technologies.

Wackernagel and Rees (1996) present a number of specific applications of ecological footprint analysis. Not only do they provide estimates of ecological footprints for a variety of countries, but they also use footprint analysis to address some interesting policy questions. The ecological footprint of the average Canadian, for example, as been calculated as 4.27 hectares per person. Similar figures for the Netherlands, the United States and India are 3.32 , 5.1 and 0.38, respectively. Clearly this sort of analysis has the potential to reveal some troubling distributional issues. Comparison of each country's aggregate footprint with the corresponding land available also indicates that most populations are running an unsustainable ecological deficit. Sensitivity analysis demonstrates how specific technologies or lifestyle choices may be encouraged to reduce the impact that a particular region has on the environment.

Modification to the existing methodology

The detailed methodology presented by Wackernagel et al. (1993) to estimate Canada's ecological footprint relied upon an eclectic mixture of data sources, drawing on research from several countries which spanned a 30 year time horizon. Consequently, their results can not be easily reproduced or meaningfully compared across time or between populations. The goal of this research was therefore to initiate a more integrated approach to the calculation of an ecological footprint, using established databases that are adequately maintained and regularly updated in most developed countries. To achieve this objective a modified form of input-output analysis was developed using data collected by Statistics New Zealand and Valuation New Zealand. The methodology is described in the next sub-section using a hypothetical three sector economy.

Input-output analysis, developed in the 1930s and 1940s by Wassily Leontief and expanded considerably since that time, is a well known economic tool that can be used to study how various sectors of a regional or national economy are related. Although input-output models are based on economic transactions tables denominated in dollars, Leontief (1970) pointed out that physical by-products of production processes such as pollution are also tied directly to the economic system which generates them. The links between final demand, the production of goods and services, and the demand for a limiting resource can therefore be explored by input-output methods.

A modified form of input output analysis has been developed by Peet (1991) to examine the energy requirements of economic activity in New Zealand. One invaluable result of Peet's analysis is the production of "energy multipliers" for the New Zealand economy, which indicate how much energy is required, both directly and indirectly, to increase the output of each sector by one dollar. These multipliers, combined with a vector of final demand and an

energy-to-land ratio allow a detailed calculation of the energy land component of New Zealand's ecological footprint. Details on the calculation of the energy multipliers can be found in Peet (1991).

The methodology described below was used to calculate the remaining components of the ecological footprint for New Zealand. This approach facilitates a detailed breakdown of the agricultural, forest and degraded land embodied in the goods and services consumed in any country that maintains standard transaction tables[4]. The following discussion assumes an understanding of the principles of input-output analysis and linear algebra. Texts such as Leontief (1986) or Miernyk (1965) provide excellent background reading.

Closed Economy

Essentially, the method requires the calculation of standard input-output coefficients, which are subsequently multiplied by a ratio of land:value-of-output for each industrial sector. Elements of the resulting matrix are in hectares per dollar of output, and can be multiplied by the vector of final demand to determine the land required to provide for a certain level of consumption. The details of the method, including adjustments for trade, are illustrated using the simplified three industry economy summarised in the following transaction matrix:

Table 1. Transaction Table for a three sector economy[a]

	Sector 1	Sector 2	Sector 3	Final Demand	**Total Output**
Sector 1	50	15	5	75	145
Sector 2	30	20	10	65	125
Sector 3	25	35	30	25	115
Primary inputs	40	55	70	10	
Total inputs	145	125	115		
Land Input[b]	12,760	600	92		13,452

[a] All values with the exception of the land input are expressed in millions of dollars.
[b] Hectares

The technical coefficient matrix (commonly labelled the 'A' matrix) is derived from the transaction table by dividing elements in the Sector j column by the total output for Sector j.

[4] Garden land accounts less than one half of one percent of Canada's ecological footprint, and has been excluded from this analysis.

The result for this simple example is a 3x3 matrix of technical coefficients which represent the amount of inputs from sector i (in dollars) needed to increase output in sector j by one dollar (Table 2). Sector 1, for example, must purchase 21¢ worth of inputs from Sector 2 in order to increase output by $1. The Leontief inverse matrix is then calculated by inverting the matrix that results when the matrix of technical coefficients is subtracted from an identity matrix of the same dimension (Table 3) Each entry in the Leontief inverse matrix represents the amount of economic activity generated in industry i, both directly and indirectly, when output in industry j increases by $1. A $1 increase in final demand for Sector 1, for example, will ultimately require 46¢ of output from Sector 2.

Table 2. Matrix of Technical Coefficients for three sector economy

	Sector 1	Sector 2	Sector 3
Sector 1	0.345	0.120	0.043
Sector 2	0.207	0.160	0.087
Sector 3	0.172	0.280	0.261

Table 3. Leontief Inverse Matrix for three sector economy

	Sector 1	Sector 2	Sector 3
Sector 1	1.648	0.279	0.130
Sector 2	0.464	1.318	0.182
Sector 3	0.560	0.564	1.452

In conventional input-output analysis, the transaction table is denominated in dollars, and the resulting technical coefficients and multipliers are expressed in dollars per dollar. For example, each element in Table 3 represents the total output from sector i required to increase output in sector j by one dollar. To estimate the land area required to increase output in sector j by a particular dollar amount these financial multipliers must be converted to land area equivalents. The conversion factors required are obtained by dividing total land area used directly in each sector by the total output (in dollars) of that industry. Because the transaction table is expressed in millions of dollars, the resulting ratios represent the number of hectares required to increase output by $1,000,000 in each sector. The land requirement in sector 1, for example, is 88 hectares per million dollars worth of output. The remaining sectors are considerably less land intensive (Table 4).

The total (direct plus indirect) land requirements can then be obtained by pre-multiplying the land coefficient vector by an identity matrix of the appropriate size. This procedure results in a diagonal matrix with land coefficients along the main diagonal, which is then multiplied by the conventional input-output coefficients. The results for the hypothetical three sector economy are presented below (Table 5). The column totals represent the number of hectares required to increase output in each respective sector by $1,000,000. A $1,000,000 increase in final demand for sector 1, for example, would ultimately require 145 hectares of sector 1 land, 2.23 hectares of sector 2 land, and 0.45 hectares of land devoted to production in sector 3. As with conventional input-output analysis, a $1 million increase in final demand requires

Table 4. Land:output ratios for the three sector economy

	Land Coefficient (ha/$million output)
Sector 1	88
Sector 2	4.8
Sector 3	0.8

a direct land input of 88 hectares from sector 1. The remaining 57 hectares result from all of the backward linkages required by current production technology.

Table 5. Matrix of direct plus indirect land requirements for three sector economy

	Sector 1	Sector 2	Sector 3
Sector 1	145.07	24.53	11.42
Sector 2	2.23	6.32	0.86
Sector 3	0.45	0.45	1.16
Total[a]	147.75	31.3	13.44

[a] Total land required per $1,000,000 increase in final demand.

The strength of this analysis is that it facilitates a deeper appreciation of land requirements for industries that do not initially appear to be particularly land intensive. For example, although

a $1,000,000 increase in final demand for sector 3 only requires a direct land input of 0.8 hectares, backward linkages with other sectors of the economy mean that 13.44 hectares are ultimately required to meet this increase in final demand. This implies a 'land multiplier' of 13.44/0.8, or 16.8 for Sector 3.

The total land required to meet the current level of final demand in each sector can be derived by multiplying the total land requirement (column totals in Table 5) by the appropriate component of the final demand vector (taken from Table 1). Results for the hypothetical economy are presented in Table 6. In a closed economy the contribution of each sector to the community's total ecological footprint is obtained by dividing the total land requirements for each sector by the population of the community. Results are presented in the second column of Table 6, assuming a population of 5 000.

Table 6. Calculation of the ecological footprint for three sector economy.

	Land Requirement	Ecological Footprint
Sector 1	11,081	2.22
Sector 2	2,035	0.41
Sector 3	336	0.07
Total	13,452	2.7

Open Economy

In a closed economy the above analysis would be sufficient to account for the productive land incorporated in the goods and services consumed by our hypothetical region. Inter-regional trade, however, enables almost every human population to consume goods which embody ecological resources located miles away from the home region. Adjustments must therefore be made to incorporate the overseas land area required to support imports, and subtract the domestic land area used to produce exports. In other words, the ecological footprint should reflect the impact that a given population has on ecological resources, wherever that impact may occur.

As government statistics generally divide final demand into the consumption categories of households, Government, exports, changes in inventory, and gross capital formation, exports are readily accounted for by subtracting them from final demand prior to multiplying elements in the final demand vector by their corresponding land coefficients[5].

[5] Exports should not excluded until after the land coefficients have been calculated.

Imports, on the other hand, can make the analysis more difficult because their impact on the ecological footprint will depend on which domestic sector is receiving them. If they are imported directly to final demand, imports can simply be added to the consumption of goods and services produced domestically. This results in a modified final demand vector that excludes exports and includes imports.

Where imports are used as intermediate goods in the production of other goods or services, the overseas land 'embodied' in the imports needs to be account for, and attributed to the appropriate sector. To achieve this end import data was obtained from Statistics New Zealand in a matrix format with rows corresponding to the exporting (overseas) sector and columns corresponding to the importing (domestic) sector. This information was combined with domestic land:output ratios and domestic input-output coefficients to estimate the amount of "imported land" embodied in the goods imported by industrial sectors.

The ecological footprint for both domestic and overseas land appear in the final columns of Table 7, assuming a population of 5,000.

Table 7. Ecological footprint calculations for hypothetical open economy

	Domestic Land	Imported Land	Domestic Demand	Domestic EF	Imported EF	**Total EF**
Sector 1	147.74	1.34	60	1.77	0.02	1.79
Sector 2	31.31	0.79	80	0.50	0.01	0.51
Sector 3	13.46	0.49	25	0.07	0.00	0.07
Total				2.34	0.03	2.37

The results for this hypothetical economy demonstrate how much land is required to meet current levels of consumption, and provide an indication of how much land is imported from overseas. The modified input-output analysis also allows the analyst to make some interesting comparisons between levels of final demand in various sectors. For example an additional $1,000,000 spent in Sector 1 would increase the total ecological footprint by 0.03 hectares per capita, or 1.2%. By contrast, the same expenditure directed towards Sector 3 would increase the footprint by 0.006 hectares, or 0.26%. Statistics New Zealand provides data at a much lower level of aggregation, allowing for detailed analysis of 80 primary producing sectors. The next section is devoted to a discussion of how a very similar analysis was used to calculate the ecological footprint for New Zealand.

III Estimating New Zealand's Ecological Footprint

Data

Fundamental to the calculation of New Zealand's ecological footprint by the modified input-output approach outlined above is an 80 sector transaction matrix produced by Statistics New Zealand. The 1991 table was used for this analysis as it contains the most up to date information. A matrix of 1991 import data was also obtained from Statistics New Zealand to facilitate the contribution of imported land to New Zealand's ecological footprint[6].

The land area used directly by forestry, conservation, and the agricultural sectors was readily obtained from the Official New Zealand Yearbook (various years). These three types of land uses collectively account for over 94 percent of New Zealand's 27 million hectares. Data on the land area covered by roads was available from Transit New Zealand (1994). Data for other land uses such as commercial buildings and residential dwellings, however, was not so easily obtained from published sources. A comprehensive database from Valuation New Zealand used for this research. Where possible this was cross checked with other sources, such as zoning information, yearbook statistics, and Barker (1978).

The energy intensity coefficients for New Zealand were obtained from Dr John Peet[7], who, in conduction with Mr James Baines[8], had calculated them for a prior study. Following Wackernagel and Rees (1996) a factor of one hectare per 100 gigajoules was used as the land-for-energy ratio for fossil fuel. This figure reflects the amount of ecologically productive land that is required to sequester 1.8 tonnes of carbon each year. Although alternative estimates have been provided for biomass conversion in New Zealand (Sims, pers com 1996) it is important that our initial estimate is comparable to previous work. We explore the impact of changing this important estimate in the following section.

Population statistics to express the ecological footprint on a per capita basis were obtained from the Official New Zealand Yearbook (1995).

Estimation Procedure

After obtaining the data, manipulating the transaction matrix and making the adjustments necessary for trade is relatively straight forward using the methods outlined above. Matching land areas to specific economic sectors was not so straight forward and requires further explanation. Although the best available data was used to link land to economic activity, a number of difficulties were encountered in allocating the land that was not used for either agriculture, forestry or conservation. These difficulties are noteworthy, not because they

[6] Export data is contained in the transaction matrix, where it is shown as a component of final demand.

[7] Department of Chemical & Process Engineering, University of Canterbury

[8] Taylor Baines & Associates, Christchurch

impact greatly upon New Zealand's total ecological footprint, but because they distort the land coefficients for these three major landuse sectors. Fortunately these distortions only occur for degraded land, which represents only six percent of the land area in New Zealand.

The land area covered by residential housing was attributed to the "Home Ownership" sector. Unfortunately the amount of land used by this sector will be overstated, as residential housing includes so called "lifestyle blocks"[9]. The inclusion of lifestyle blocks with residential housing increased the footprint of that sector by a factor of 4. No attempt was made to allocate the lifestyle blocks among agricultural sectors however, because their overall impact on the ecological footprint is negligible, the properties are principally used for residential purposes, and there is no way of telling which of the four agricultural sectors should otherwise absorb the properties.

The allocation of land to the 'ownership of property' sector, which excludes owner occupied dwellings, was problematic because the data indicated land use, not ownership. The inter-industry tariffs in this sector are widely divergent, meaning the financial transactions could not be used as guide to land areas without detailed knowledge of prices. Suitable price data was not available and it was not possible to obtain even general levels of land ownership for each sector. All land was therefore allocated directly to the sector who occupied it, which should provide a more accurate reflection of the land embodied in various goods and services.

All roads were attributed to the commercial road passenger and freight sectors, as there is no private (non-commercial) transport sector. The degraded land component of the commercial land transport sectors will therefore be overstated.

The four education and health sectors[10] included in the original transaction table do not include public sector spending, which is contained within the 'Central Government' category. Land used for health and education was allocated according to the levels of expenditure in these sectors, obtained from the Official New Zealand Yearbook (1992). A related point is that Central Government contains a diverse range of activities. In addition to health and education, the sector provides such services as social security, defence, law and order, administration. In other words, the homogeneity assumption is particularly weak with respect to the Government spending. Further dis-aggregation of the this sector would be beneficial to an accurate assessment of its land use requirements.

[9] A lifestyle block is a residential holding which contains an area of agricultural land, but which because of its size is unable to support its occupants without external financial assistance. Such properties are under 20ha and are generally peripheral to cities or towns

[10] For health and education distinctions are made between commercial services and private but non-profit services.

IV Results

To facilitate the comparison of our results with those published earlier, the final input-output related matrices have been condensed to correspond more closely with the land categories used by Wackernagel and Rees (1996). Agricultural land, for example, represents the land embodied in the output produced by the first four industrial sectors. The results are summarised in Table 8. Cell entries represent the ecologically productive land required per capita to satisfy current levels of (trade adjusted) final demand. Recall that the input-output approach captures all backward linkages, so these figures include not only direct household consumption, but also the land 'embodied' in all of the input processes leading up to the final product

Table 8 Summary of New Zealand's per capita ecological footprint

	Energy Land	Agricultural Land	Forest Land	Degraded Land	**Total**
Domestic	0.53	1.41	0.28	0.36	2.58
Imported	0.36	0.25	0.05	0.03	0.69
Total	0.89	1.66	0.33	0.39	3.27

At 3.27 hectares per person, New Zealand's per capita ecological footprint is very similar to Holland's (Table 9). New Zealand's ecological footprint is also much larger than India's, and larger than the world average.

Table 9 International Comparisons

Country	Ecological Footprint
United States[a]	5.1
Canada[a]	4.27
Netherlands[a]	3.32
New Zealand	3.27
India[a]	0.38
World Average[a]	1.8

[a] Source: Wackernagel and Rees (1996)

Over 27% of New Zealand's total ecological footprint can be attributed to the consumption of fossil fuel. Although differences in methodology mean that our results are not strictly

comparable to estimates from other countries, it is interesting to reflect on how the consumption of energy land may differ among nations. Wackernagel and Rees (1996) indicate that energy land comprises 55% of Canada's total ecological footprint. The figures for the Netherlands and India are 63% and 13%, respectively. Clearly the assumption that is made about the productivity of alternative sources of energy will have a significant effect on the total ecological footprint. This point is explored further in the following section.

An advantage of the input-output approach is that it allows the analyst to determine precisely how much land is being 'imported' from overseas, via the consumption of imported goods and services. Over 20% of the total land embodied in goods and services consumed in New Zealand is imported. Similarly, we can determine how much land is exported by multiplying our total domestic land and energy coefficients by the value of exports. Approximately 14 million hectares were embodied in the goods and services exported from New Zealand in 1991,. On balance, therefore, there is more land embodied in New Zealand's exports then is required for domestic consumption (Table 10).

Table 10. New Zealand's "ecological balance of trade"

	Land Embodied in Imports (ha)		Land Embodied in Exports (ha)	
Agricultural Land	857,055	36%	10,896,300	79%
Forest Land	186,160	8%	964,572	7%
Degraded Land	88,569	4%	237,908	2%
Energy Land	1,208,846	52%	1,678,335	12%
Total	2,340,630	100%	13,777,115	100%

New Zealand's national ecological footprint, obtained by multiplying the per capita figure by the total population, is 11,150,080 hectares. This represents approximately 60% of the total ecologically productive land in the country. New Zealand is therefore one of the few developed countries that is not running an 'ecological deficit'. Other countries that appear to be consuming less than the ecologically productive land within their borders are Canada and Australia (Wackernagel and Rees, 1996).

V Sensitivity Analysis

As demonstrated above, approximately 27% of New Zealand's total ecological footprint can be attributed to energy consumption. It is important, therefore, to explore the possible ramifications of altering the assumption which allows us to convert final demand into land

area equivalents. Another issue we will explore in this section is the inclusion of the conservation estate into the ecological footprint calculations.

Energy-to-land ratios

As mentioned in previous sections, the use of fossil fuels involves the extraction of a finite resource which can not be sustained in the long run. When calculating an ecological footprint, therefore, energy units are converted to theoretical land area equivalents which represent either the area required to supply the same amount of energy using renewable technologies, or the amount of land required to sequester the CO_2 emitted from burning fossil fuel. The ratios required to convert a unit of energy to a land area equivalent will depend upon either 1) the fuel type chosen and where it is produced, or 2) the assimilation capacity of the land. An energy-to-land ratio of 100Gj/hectare (reflecting the CO_2 assimilation method) was used in the base analysis to ensure that our results would be as comparable as possible to previously published results from other countries.

Methanol production from New Zealand's plantation forests

New Zealand's tree plantations are among the world's most productive. Previous estimates suggest that methanol production from wood in New Zealand may yield up to 150 Gj per hectare per year. We therefore re-ran the analysis using an energy-to-land ratio of 150 (Gj/ha) *applied only to the domestic energy component of the footprint*. Results, which of course affect only the domestic energy component of the footprint, are presented in Figure 1. Altering this assumption has reduced New Zealand's total footprint by 0.21 ha/capita/year, or approximately 6.4%.It is also worth noting that although data was readily available for wood-based methanol production, it is unlikely to be the highest yielding alternative for New Zealand. The resulting footprint therefore remains an 'upper bound' estimate.

Accounting for the use of hydroelectricity

Over seventy percent of New Zealand's primary energy comes from fossil fuels, with the remainder derived primarily from hydro and geothermal sources (IEA, 1993). Wackernagel and Rees suggest that the area requirements for hydroelectricity can be estimated by dividing the flooded land behind dams, plus the land areas occupied by high voltage power line corridors, by their annual electricity output (1996). Their examination of the literature indicates that an energy-to-land ratio of 1000 Gj/ha/year would provide a reasonable approximation for the continuous generating capacity of hydroelectricity.

Applying a single energy-to-land ratio, which reflects the lower yielding approaches of carbon assimilation or alternative fuel production, to all energy consumed in New Zealand will therefore bias the per capita footprint upwards. We consequently re-ran the analysis with a 'weighted average' energy-to-land ratio of 0.75(150 Gj/ha) + 0.25(1,000 Gj/ha), assuming that twenty-five percent of the primary energy in New Zealand is derived from hydro sources. Note that this ratio was applied only to the domestic energy component, and the energy not derived from hydro sources was assumed to be derived from methanol under New Zealand

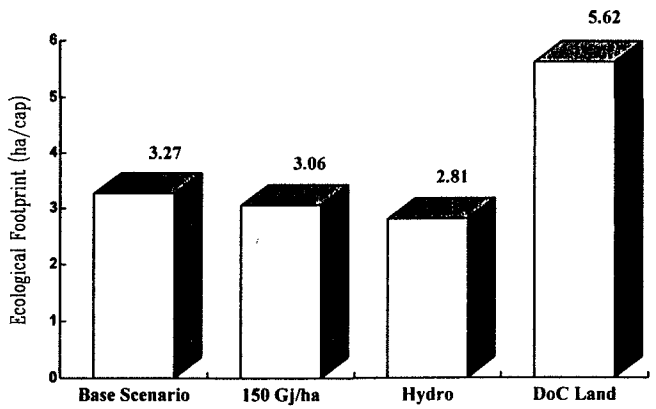
conditions. Accounting for hydro sources reduces the per capita footprint by 0.46 ha, or just over 14% (Figure 1).

Conservation Estate

Eight million hectares, or nearly one third of New Zealand's total land area is administered by the Department of Conservation (DoC). A case for including DoC administered land into the calculation of our ecological footprint could be made on the basis that the conservation estate contributes directly to the well-being of the many New Zealander's who participate in outdoor recreational activities. Outdoor activities are also a major attraction for overseas visitors. However, the conservation estate was excluded from the base analysis because it is managed principally for conservation, and it does not fit readily into any of the sectors in the input-output table.

As a first approximation, the total conservation area was simply divided by total population. This results in an additional 2.35 ha per capita, and increases the total ecological footprint by over 70% (Figure 1). A more satisfactory approach would be to allocate at least part of the conservation estate among sectors such as recreation services, health and education. This would serve to increase the 'base' ecological footprint, but by less than the method suggested above.

Figure 1 Results of the sensitivity analysis



VI Assumptions and Limitations

The method presented in this paper relies on an input-output framework, and the usual assumptions and limitations of that technique apply to our calculation of New Zealand's ecological footprint. The assumption of homogeneity (that each industry produces a single product and all output uses the same processes and technology) may create problems for an individual who wishes to apply ecological footprint analysis to a particular firm, product or service. However, at a macro-level this assumption does not appear to severely limit the technique.

Input-output analysis also assumes linear production functions, which implies that inputs must be used in fixed proportions, and excludes the possibility of economies or diseconomies of scale. If the ecological footprint is being used a general indicator of the effects of current consumption, the linearity assumption may not pose a problem. It becomes a limitation, however, if the transaction tables and their resulting multipliers are used as a forecasting tool.

A third limitation of the input-output technique is that the transaction tables generally exclude unpaid work. The value of most domestic work, for example, is not included in the initial tables. It would therefore not be appropriate to apply the methodology outlined in this paper if a significant amount of economic activity takes place outside the monetary economy. We do not anticipate that the exclusion of non-monetary activities will have a major impact on the size of New Zealand's ecological footprint.

The fixed land-to-output and energy-to-output ratios used for each industrial sector implies that output can not be changed substantially without altering the land and energy inputs. While these assumptions may be tenable (particularly applied to energy) for a shortrun analysis of a single country's economic activity, they are likely to create a problem when applied to imports. As mentioned in previous sections, if production flows to countries who use environmentally sensitive technology, trade may very well provide a means to reduce the global ecological footprint. Unfortunately the impact of 'ecological comparative advantage' can not be explored without obtaining land and energy intensity figures for exporting countries.

The simplifying assumptions discussed in this section are an unavoidable consequence of 1) the modelling process, and 2) data limitations. Their impact on the size of the ecological footprint is difficult to assess without further analysis. It should be noted that many of the data problems represent a practical difficulty, rather than a conceptual problem, and could be eliminated with additional information.

VII Conclusion

By comparing the ecological footprint of a community with the amount of land available, we can more clearly determine whether current consumption patterns are likely to be sustainable. As calculated above, the ecological footprint yields a bio-physical measure of current levels of consumption to complement the monetary measures that already exist. Like any index used to summarise complex processes, the results need to interpreted with caution.

Ecological footprint analysis makes explicit the link between economic and ecological systems. As a bio-physical measure the ecological footprint may help distinguish between sustainable and non-sustainable flows of resources. While it does not represent economic or social welfare, it does reflect ecological well-being. Wackernagel and Rees (1996) suggest that a key strength of ecological footprint analysis is its conceptual simplicity. It incorporates a great deal of information into a single, readily understandable index which facilitates the promotion of the sustainability concept and the inclusion of ecological impacts in decision making.

The benefits of aggregation and conceptual simplicity, however, may be offset to some extent by a lack of specificity. The incorporation of the level and composition of consumption, production technology, and the productivity of natural resources, for example, may be a hindrance to identifying specific unsustainable practices. The current presumption that all sources and sinks ultimately relate to land based ecosystems is also a weakness. In theory the ecological footprint may be extended to account for non-land based natural capital, such as fisheries and the atmosphere, but this does not yet appear to have been done. Finally, ecological footprint analysis is usually based on the assumption that current land use practices are sustainable. In may instances this is clearly not the case. Adjustments for unsustainable practices may be made by multiplying the ecological footprint by what Wackernagel and Rees call a 'sustainability factor'. The magnitude of this factor could vary according to the degree of sustainability in existing practices, but in practice would be difficult to determine[11].

Based on the calculations reported above, New Zealand's ecological footprint represents considerably less ecologically productive land than is currently available within the country. This is in sharp contrast to overseas estimates published by Wackernagel and Rees (1996). Aggregate consumption in the United States, for example, requires almost twice the ecologically productive land area available within the national borders. The ecological footprint of the average person in Holland is more than 20 times the land available on a per capita basis. New Zealand's favourable ecological position is largely attributable to a low population density, although per capita consumption is also lower here than in many developed countries.

Although the procedure outlined in this report would benefit from further refinement, it represents an improvement over earlier work in that it provides a more consistent framework for analysis. If a measure is not consistently applied and regularly updated, variations in the results may be attributable to variations in the method, rather than the phenomena it claimed to measure (Bartelmus, 1994).

[11] Unsustainable practices could not, by definition, continue indefinitely and would at some point have to show up in the ecological footprint. However, the point is that such practices distort the short-term picture implied by the ecological footprint.

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Quantifying Technical Trade Barriers: Phytosanitary Measures*

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Abstract

The Sanitary Phytosanitary Code (SPS) of GATT, is being developed in an effort to reduce the technical barriers to trade created by phytosanitary regulations, or trade barriers related to plant and animal health. A key feature of SPS is risk assessment and risk management in determining appropriate quarantine actions which provide an acceptable level of risk to the importer and which can be justified on technical and trade terms. The major problem so far has been in quantifying the effects of phytosanitary regulations in a way that permits objective comparisons. The paper presents a conceptual model for quantifying quarantine related trade barriers. The model provides a basis for combining the two basic components of pest risk analysis, probability of introduction and economic effects, into a management framework and an objective measure. The model framework provides a systematic basis for defining and measuring acceptable risk and for justifying quarantine actions relative to acceptable risk.

Introduction

One of the outcomes of the Uruguay Round of GATT was that it was able to provide for reductions in a range of trade barriers. The common feature of the barriers which will be reduced is that they were 'quantifiable'. These barriers include actions such as tariffs, export subsidies, embargoes, import bans, quotas, supply management, domestic price supports, licensing and exchange controls. They way in which they were dealt with was by developing a system which converts the barriers into tariff-equivalent level of protection. What remains as problems to be resolved are a range of barriers to trade which were largely non-quantifiable in terms of tariff-equivalent levels of protection. These barriers include many institutional factors such as bilateral agreements, state trading, customs procedures, and administrative practices, but in addition, include a class of barriers which are termed 'Technical Barriers to Trade'. These are barriers which arise due to technical specifications. Among the most prevalent of these barriers are requirements related to sanitary and phytosanitary standards (SPS) which deal with concerns about human, animal and plant health (Hillman 1978, 1991).

There is concern that with the reduction in the availability of quantifiable barriers to trade, countries will turn to technical barriers to trade as a way of blocking imports rather than meeting legitimate sanitary and phytosanitary concerns (Ndayisenga and Kinsey 1994). There are major efforts internationally to address these concerns and to ensure that sanitary and phytosanitary measures do not evolve as major trade barriers. The purpose of this paper is to present a methodology which provides quantifiable measures of the levels of protection associated with SPS.

SPS and Trade

The Uruguay Round was the first round of GATT to make substantial progress on non-tariff barriers to trade. This success was in part caused by the inclusion of agricultural trade barriers as an area for negotiation which meant that a wide variety of trade barriers needed to be considered. The key problem which was face by negotiators was that of finding a common denominator for measuring the level of protection given by actions as diverse as export subsidies and supply management. The way in which this was resolved was to convert non-tariff barriers into a tariff of equivalent effective protection. What this resulted in was a process of 'tariffication' of the easily quantifiable non-tariff restrictions. The key success of this approach was that different trade barriers could then be compared, reduced or negotiated in a common framework.

What remains to be resolved are what are termed technical barriers to trade. These are generally non-quantifiable rules and standards and are typically related to health, safety or the environment. One of the key features of these types of barriers which differentiates them from the trade barriers dealt with earlier is that they are not specifically targeted at trade or production issues. Under GATT rules, countries are allowed to adopt health, safety or environmental policies which take precedence over others. The caveat to this though is that these policies are only allowed as long as the purpose of the policy or standard is to meet a legitimate domestic objective, and as long as domestic and foreign producers are treated the same[1].

This is where problems arise for Sanitary-Phytosanitary Standards (SPS) since they do not easily fit into the generally allowed category. Although the underlying policy objectives, such as keeping out unwanted pests or diseases, are broadly applicable to all parties, the application of the policies a likely to be uneven. The main reason for this is because under SPS domestic and foreign producers are likely to be treated differently by regulatory or quarantine officials. This is because of differences in perceived risk and the potential for introducing unwanted pests or diseases. In addition, individual foreigners are treated differently, again because of differences in perceived risk and their potential for introducing unwanted pests or diseases.

Another characteristic of SPS is that it has historically been an activity of scientists with a focus on an assessment of probability of occurrence as the key criteria for applying trade barriers (Smith 1993, Patterson 1990). This is an objective, but one sided application of standards in a trading environment. One of the key changes under the Uruguay Round of GATT has been a focus on risk assessment and management with an overall objective of minimising negative trade impacts (Papasolomontos 1993). Risk assessment requires consideration of economic consequences as well as probability of occurrence. Risk management requires the consideration of trade-offs in probability of introduction and economic consequences in the context choosing the least trade distorting path. Both of these are considerable departures from past practice in the quarantine area.

The process of developing a system for meeting the objectives of the Uruguay Round of GATT is now in place. The International Plant Protection Convention (IPPC) has produced draft standards for quarantine measures for plants (FAO 1995) and the International Office of Epizootics (OIE) is doing the same for animals. A common theme of the activity of the IPPC and the OIE is a need to develop systems which will measure whether health or phytosanitary standards are being imposed in a way which is consistent with both internal and external standards. They key features of the system will be transparency of decisions, the use of internationally accepted methodologies, and a linking of economics and science.

The major problem is the lack of a system which can convert diverse technical barriers related to plant and animal health into a common framework which allows for comparison in a trade forum. In other words, what kind of a measure will adequately combine the key features of risk analysis, risk of introduction and economic consequences, in a way which facilitates comparison and negotiation? The greatest need is to convert barriers to values which are common in a trade environment, or currency measures. A way for eliciting a value for a barrier is by measuring implicit or explicit economic effects. This could be done in the context of measuring the value of a technical barrier being in place. Examples of this would include measuring the additional costs associated with compliance with a regulation, new labelling or packaging, or reducing residues. This could also be done in the context of measuring the value

* Paper presented at the NZAES Conference, Blenheim, New Zealand. July5-6, 1996. The author wishes to acknowlege funding this research from MAF.

[1] These provisions are contained in Article 2, Technical Regulations and Standards of the Agreement on Technical Barriers to Trade.

of an outcome without a technical barrier in place. In this case the consequences of an economic impact such as a pest infestation could be measured.

One of the key factors in handling trade barriers such as SPS, is that a methodology must be developed which is able to incorporate a probability of occurrence and provide an estimate of economic effects. The implication though, is that they should be considered together (FAO 1995). One way for the two factors to be combined is to calculate, for example, Pest Risk as,

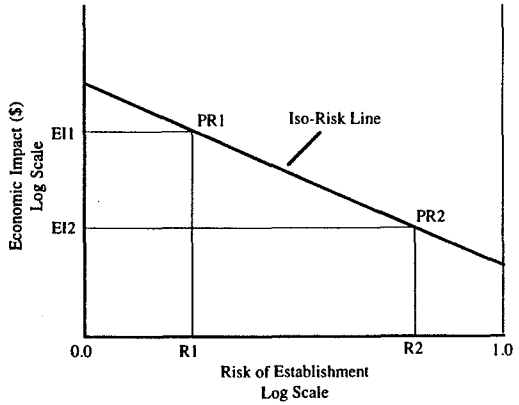
Pest Risk = Economic Effect x Probability of Introduction

In this sense, Pest Risk is otherwise synonymous with expected value. Management options considered could then be approached in the context of changing Pest Risk by altering probability of introduction or the economic effects towards some benchmark or acceptable level of Pest Risk or expected value. The critical component in the process is determining the appropriate framework for combining probability of introduction and economic effects. This must be done in a way that a benchmark level of acceptable pest risk can be established, and so that initial assessment of Pest Risk and subsequent management strategies can be systematically evaluated against the benchmark.

Iso-Risk Framework

The Iso-Risk Framework is a proposed framework for linking probability of introduction and economic effects, and expressing expected outcomes in a way which meets the need for benchmarking, comparison and evaluating management alternatives in a trade environment. The generalised approach comes from discussions during the development of the draft Pest Risk Analysis Standards by the IPPC working group (Orr 1995). The basic framework of the Iso-Risk Analysis is illustrated in Figure 1.

Figure 1
Iso-Risk Framework



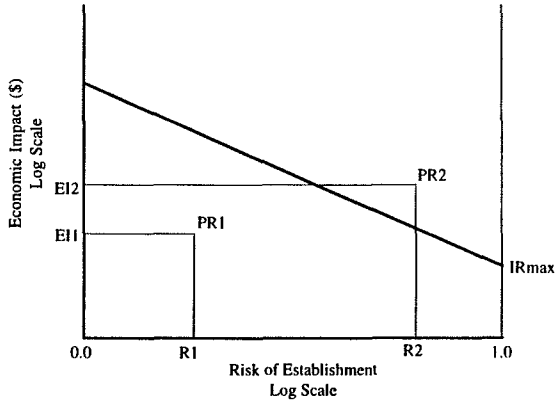
Economic impacts, measured in dollars, are plotted on the vertical axis, and probability of introduction, ranging between 0 and 1 is plotted on the horizontal axis. Both axis are plotted on a log scale. The graph allows any particular probability of introduction and economic effect combination to be plotted. For example, in Figure 1, a pest which has an economic impact of EI_1 and a probability of establishment of R_1 produces a Pest Risk of PR_1, where,

$$PR_1 = EI_1 \times R_1$$

An important requirement for establishing the need for a quarantine action or for analysing management options is to provide a benchmark. This can be done by selecting an 'Iso-Risk Line', or a locus of points in which pests all have the same Pest Risk. This involves plotting combinations of probability of introduction and economic effects which yield the same Pest Risk, or expected value. In Figure 1, PR_1 yields the same Pest Risk as a different pest which has an economic impact of EI_2 and a probability of introduction of R_2, shown as PR_2.

The Iso-Risk framework provides two important outcomes. Firstly, it allows all pests to be evaluated on the same basis using the common measure of Pest Risk. This in turn allows pests to be evaluated relative to one another on a common basis. Irrespective of how the pest manifests its impacts, its choice of hosts, or its rate of spread, as long as the effects can be assigned a dollar value and a probability of occurrence, then there is a common unit of comparison. Pest Risk can then be said to be higher or lower relative to other pests. For example, a pest which produced a Pest Risk of PR_2 in Figure 2 could be said to be worse than one which produced a Pest Risk of PR_1. This in turn could act a signal to quarantine authorities about which pests to be most concerned about.

Figure 2
Benchmark Pest Risk



The second outcome of the Iso-Risk framework is that it provides the basis for evaluating pests against a standard. If the Iso-Risk line in Figure 1 has been determined to be the maximum level of Pest Risk, or maximum amount of expected economic impacts which is acceptable, then it becomes a standard against which any particular pest could be evaluated. Any pest which provides a Pest Risk greater than the maximum acceptable Pest Risk (PR_{max}) lies above the Iso-Risk line (IR_{max}) corresponding to this level of Pest Risk. This is shown in Figure 2. In this example, a pest which resulted in a Pest Risk of PR_2 would exceed the benchmark maximum Iso-Risk of IR_{max} and be subject to actions to reduce the Pest Risk to acceptable levels. The pest corresponding to PR_1 falls below and within acceptable limits, requiring a different management response.

Using Iso-Risk in the context of a maximum Pest Risk provides regulatory authorities with an opportunity to use objective criteria in quarantine decisions and in justifying these decisions in a trade environment. Firstly, it provides a definitive guide as to appropriate types

and levels of quarantine measures. Since an objective is to make sure that Pest Risk is at or below the acceptable level, evaluating the effect of quarantine measures in the Iso-Risk framework means that this can be done relative to a particular criteria. Secondly, the Iso-Risk framework provides a transparent and measurable criteria for justifying decisions to trading partners. In particular, decisions can be shown to be consistent within an overall domestic policy context (IR_{max}).

Implementing Iso-Risk as a Trade Tool

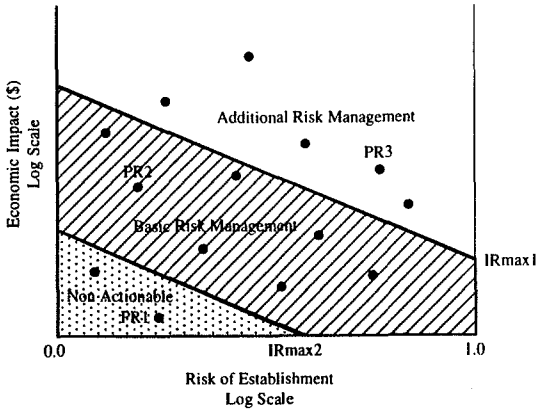
In the context of the Iso-Risk framework, the key questions to be resolved by any regulatory agency could be summarised as follows:

- What is an appropriate benchmark (IR_{max})?
- Should there be more than one benchmark?
- How extensive is the benchmark?

The first point relates to the problem of arriving at an IR_{max} which adequately describes the regulatory agency's perception of acceptable Pest Risk in an Iso-Risk framework. The second point addresses the issue of whether from an operational perspective, there is scope for having more than one category of acceptable Pest Risk or IR_{max} to aid in decision-making. The final point concerns the tails of the IR_{max} line. The issue here is whether the regulatory authority perceives the same acceptable Pest Risk when either economic impacts or probabilities of entry are very high.

One approach to addressing these points is to start from the basis of a country's current regulatory treatment of pests and examine it in the context of an Iso-Risk framework. This would require a number of steps. Firstly, pests would need to be evaluated for probability of entry and potential economic impacts pre-quarantine treatment. Secondly, an identification of how pests are currently categorised and handled from a quarantine perspective is required. Finally, all of this information would be placed in an Iso-Risk framework so that the pattern of current treatment of pests could be examined. The outcome of this type of process is shown in Figure 3.

Figure 3
Iso-Risk and Management Options



For the purposes of this paper quarantine actions are put in a phytosanitary context and are broadly separated into the following categories (MAF 1995):

- Non-actionable (non-quarantine)
- Basic Risk Management
- Additional Risk Management

A non-actionable pest is one for which no quarantine measures are imposed because the pest is not considered to have any potential to establish or to cause crop, environmental, animal, or human problems. Basic risk management involves some action and could include standard practices such as inspection of commodities for the pest upon arrival. Additional risk management generally covers offshore activities. This could include actions such as an additional declaration or a phytosanitary certificate from the exporting country which guarantees that the shipment has been inspected or treated in a particular way. Additional risk management can also include mandatory off-shore treatment of commodities which is audited by the importing country. If quarantine officials have been consistent in the application of decisions, or to some extent implicitly considering of both risk of introduction and economic consequence, then an IR_{max} should emerge when Pest Risk is combined with current quarantine treatment. In an Iso-Risk framework, different benchmark IR_{max}'s will reflect the various quarantine classifications.

Above IR_{max2} in Figure 3, pests will have been generally subjected to some type of quarantine action. IR_{max2} in effect becomes a boundary or benchmark between non-actionable pests and those which are subject to quarantine measures, and represents the maximum, acceptable Pest Risk before a pest will be subject to some type of risk management. IR_{max1} in Figure 3 would emerge because again there is link between the level of Pest Risk and the type of quarantine treatment. A pest and the commodities the pest is associated which resulted in a Pest Risk of PR_2 and falling in the area bounded by IR_{max1} and IR_{max2}, would be subject to basic risk management,. The actual management option undertaken and the position of IR_{max2} will depend on the regulatory authority and its stance on acceptable Pest Risk. A pest which presents a level of Pest Risk above IR_{max1}, such as PR_3, would generally be subjected to offshore treatment. This is a pest which requires more than basic risk management to reduce the Pest Risk to acceptable levels.

IR_{max1} represents in essence, the maximum acceptable Pest Risk. Any pest which carries a Pest Risk higher than IR_{max1} would be unacceptable, and quarantine action would be taken to shift the Pest Risk below IR_{max1}. In a post-quarantine evaluation it would then be expected that there would be no pests with a Pest Risk above IR_{max1}. The post-quarantine situation is shown in Figure 4. This treatment emphasises that quarantine measures are the means to an end, that is reducing pest risk to acceptable levels.

The situation may also arise where economic impact or probability of introduction above particular levels would be considered to be unacceptable. This would modify the Iso-Risk line to that shown in Figure 5.

Summary

The paper has introduced a methodology for quantifying technical trade barriers that contain elements of risk and economic impacts in way in which they can be dealt with in a trade forum. The important change is that barriers can be treated on the basis of expected outcome rather than the technical characteristics of barrier. As such, it is possible to step beyond only considering whether the barrier involves an insect or a bacteria, and instead focus on whether a potential event behind the barrier is above, below or within an expected dollar value.

This then provides the basis for even treatment of technical barriers in a trade environment. Any two events which fall above or below a particular benchmark should then be expected to be subject to technical barriers or SPS which have similar effects. An important point is that two exporters can now be subject to different technical standards but in a way in

Figure 4
Iso-Risk Map after Quarantine Measures

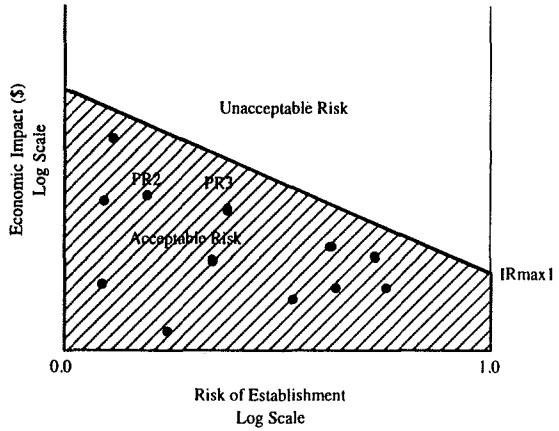
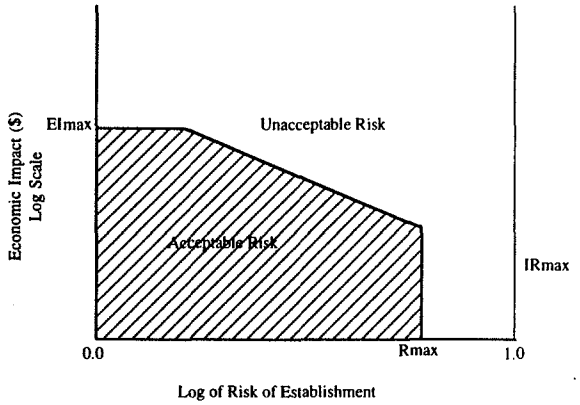


Figure 7
Iso-Risk with Maximum Level of Economic Impacts and
Maximum Level of Probability of Introduction



which the GATT rules on equal treatment should not be violated. This is because the outcome of the trade barrier must be similar. In the early stages of establishing Iso-Risk, a country would only be able to determine whether it is treating its trading partners consistently. This, internal consistency would relative the domestic IR_{max}. At a later stage, when a number of countries basing decisions on Iso-Risk, a country could then establish, or perhaps be challenged, as to whether its treatment of trading partners was consistent with international norms. In this case the international norm would relate to an international IR_{max}.

Values derived from an Iso-Risk analysis can also be expressed as a per unit tariff equivalent to make them comparable to other non-tariff barriers. All that is required is for the expected value, or Pest Risk, to be spread over the volume of the commodity which is subject to the technical trade barrier. It is conceivable that the development of an international IR_{max} could be the basis for reducing technical barriers to trade, since comparisons are being made within a common forum of risk. It is less likely that the calculation of unit tariff equivalents and their comparison to standard tariffs would become the basis for reductions in technical barriers to trade. The main reason for this is that SPS differs substantially from general trade issues. The essence of the difference is that winding back tariffs between nations is a gain-gain game a la Ricardo (assuming equal bargaining power and in the long run after adjustments have been made), while winding back SPS restrictions is a gain-gain game with Russian Roulette thrown in. This is because in SPS the game takes on a different type of risk and the downside always looms more ominously. SPS is made all the more complicated by the inability of science to define how many chambers there are in the gun, how big the bullets are and how many are loaded. This results in more conservative approaches to SPS which focus on the potential bad effects of pests and diseases and largely ignore the welfare gains to trade. The development of international standards and the use of tools such as Iso-Risk should make the SPS interchange less conservative and trade-offs more possible. It is hard to see how this would extend to comparing health standards to automobile tariffs.

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NEW ZEALAND AGRICULTURAL ECONOMICS SOCIETY CONFERENCE
'NEW ZEALAND AGRICULTURE IN THE 21ST CENTURY'

5th - 6th July 1996

Blenheim

FARM BASED ENTREPRENURIAL DIVERSIFICATION:
SHAKING A TAIL FEATHER AT TRADITION - OSTRICHES
AREN'T THE ONLY OPTION

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SHAKING A TAIL FEATHER AT TRADITION: OSTRICHES AREN'T THE ONLY OPTION: FARM BASED ENTREPRENURIAL DIVERSIFICATION

Introduction

Rural social research is a component in understanding how farmers achieve their goal of sustainable resource management. To this end social science research has been funded by the Ministry of Agriculture to explore the range of business activity undertaken by farmers, and the impact of a mix of business and paid employment on the farming system.

The research on which this technical report is based is on-going and yet to be completed. It is a progress report on the findings only and therefore has no conceptual framework. The research has its roots in earlier studies of off-farm sources of income. The current study extends the research to non-traditional entreprenurial activities located on the farm property, but not necessarily based on the farm, or dependent on it.

The enterprises in the research frequently cater for the market demands of the wider, often international, community and the non-farming sector, and are not necessarily dependent on local labour markets. They are distinct from off-farm employment by their on-farm locality and their owner-operator designation. They can be run completely 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.

The definition of 'diversification' is 'to spread [investment] over several enterprises or products, esp. to guard against loss'. (The Concise Oxford Dictionary, 1982). As well as varying amounts of capital, the 'investment' that these farm families spread over their enterprises is their investment in themselves, their skills, their knowledge and their entreprenuerial acumen.

The current study will challenge the common acceptance of the meaning of the word 'diversification'. Traditionally, this term has been applied to other agricultural or horticultural land based activities, for example, deer, goats, blueberries, persimmons and more recently ostriches. Our research shows that diversification now applies to a wider range of enterprises than is accounted for by agricultural or horticultural diversification alone.

We suggest that entreprenurial activity is a diversification based on inherent human skills - skills, in this instance, residual in the farm household. The land base is no longer a restriction to, nor does it control the direction of diversification. Non-traditional on-farm enterprises are therefore, as much a people based as a land based diversification. (See attached figures 1 & 2)

The study is based on interviews with sixty couples located on farms in Mid and North Canterbury and the Manawatu and the Wairarapa. These couples mainly farmed on either sheep and beef, or mixed cropping and livestock farms. The farming couples selected were from a purposively selected sample. They were selected because they ran other economic activities in addition to the farm operation. Emphasis was placed on finding a *range* of business types rather than a representative sample, so although rural tourism businesses

comprised about a third of the farms involved in the study, they may well have been, particularly farmstays, the predominant type of activity. Another factor influencing sample selection was the need and desire to maintain commercial confidentiality: a number of potential respondents were unable to take part in the survey for this reason.

The range of enterprises described in the study are neither inclusive nor finite - they are only an indication of the array of entreperenurial diversifications being undertaken by farm families in addition to their traditional agricultural.

The reasons given by the farm couples for establishing the farm based enterprises fell into two categories, personal and pragmatic. Personal reasons were based on philosophies of self-fulfilment and challenge. Respondent dis-satisfaction or disillusionment with farming were identified, as was the need to 'stop boredom' after developing the farm to its full potential. Pragmatic reasons were firmly grounded in financial concern.

The majority of the entereprises were 'stand alone'. They were financially and structurally independent of the farm business. Integration with the farm business operation, either in full or in part, was described by entrepreneurs as an 'accounting mechanism'. Respondents also reported that separating the activities out, especially if they had more than one, was 'too complex'.

The amount of establishment capital was generally very small or built up slowly and incrementally from farm or enterprise income. This suggests that entreprenurial diversification is not necessarily an expensive option. Nevertheless, the establishment cost of a quarter of the businesses was over $20,000. For the majority (12) of those entrepreneurs (25) who sought establishment capital the farm was the sole source. A small number of entrepreneurs raised their capital from a strictly family source.

In general, entrepreneurs faced few problems raising capital - sometimes as a result of the strong financial positon of the farm but the reverse was also true. When the farm was running at a loss, the Bank was sometimes known to offer loan facilities as a result of the financial strength of the enterprise.

Just under half of the enterprises had no financial liabilities. In particular, the service/advisory entreprises built on intellectual property rather than captial investment. Only a small number of the enterprises shared liabilities with the farm operation but more were shared with the farm than were carried solely by the enterprise. In general the sums were small, under $10,000.

Half of the enterprises had a gross annual income of less than $50,000. At the end of the spectrum there were three enterprises with a gross annual income of half a million plus. Another ten entereprises annually 'grossed' $100,000 plus. Establishment capital appears to bear little relationship to the eventual Gross Annual Income. For example, the start-up capital for one enterprise was a family sourced $200 - today's gross annual income is $350,000.

Cross referencing of gross income with farm liability, or comparisons of levels of income from farming and from the enterprise has not yet been undertaken in this study but this should yield new and interesting information about the structure of these kinds of business.

The enterprises evolved slowly, often from small beginnings. Some started as a hobby or an interest, others were based on a neglected skill or former training. Initially, money made was reinvested in enterprise development. The objective was development following consolidation. The cycle became one of reinvestment, development, consolidation, - reinvestment, development, consolidation.

The evolutionary process so evident in the establishment phase was apparent in the secondary development phase as new businesses evolved out of the core enterprise. A major finding of the study has been the many instances, particularly in rural tourism, where enterprises were not single entities. They flowed with remarkable serendipity into a number of parallel ventures. The opportunity of an 'on the spot' market was not lost on the farm family competing in an increasingly competitive tourist market.

Enterprise Profile

The income from a third of the enterprises studied was described as either 'moderate' or 'very important' to the farm. In these instances the income protected the farm from household drawings. The inter-relationship of a farm operation, a farm stay and a farm tourism enterprise can confuse the value of farm assets used by the enterprise. This duality was also apparent in service and advisory enterprises when a 'space in the kitchen' became a work station. The farm computer is used by the enterprise but then again a farm computer can be upgraded or initially purchased because of its dual role within the enterprise and the farm.

Nevertheless, many of the enterprises benefited from, or may not have existed without, the use of farm buildings. Entrepreneurs acknowledged the competitive advantages, and reduced overheads, that these farm assets gave them.

The majority choice of ownership type in the sixty enterprises studied, was a partnership between the farm couple. The majority of principal operators were women. Twenty- two of the farm households had a member employed off the farm, (12 men and 14 women). These households were engaged in a range of activities which provide income from multiple sources - the two activities of off-farm employment and running non-traditional on-farm enterprises do not appear to be mutually exclusive.

Rural tourism is an important option for many farm households considering a non traditional diversification. These enterprises strikingly demonstrate the fluidity with which new enterprises can evolve out of the core farming activity.

Garden tours naturally evolved towards on-site nurseries selling specialist plants admired in the garden. The establishment of a nursery then lead into starting up an outlet for tea (Devonshire) and a gift shop which stocked home produced designer foods, lavendar or specialist oils. A garden open to public viewing had evolved from craft classes and the need for students to 'stretch their legs' during lunch breaks. From the garden evolved a nursery and from the craft classes evolved a craft retail outlet. Hunting and guiding tours are twinned with farm stays. Garden tours operated via commercial coach touring companies are twinned with catering. A third of the tourism enterprises covered in this study contained a mix of three or more allied ventures. (See attached figure 3)

The evolutionary principle applied to other enterprises. A biodynamic wool producer was in the process of establishing biodynamic meat production. (See attached figure 4). A tree nursery developed into a complete delivery, planting, pruning and maintenance service. A bulk organic cereal producer moved into niche packaging and marketing and is now considering a home-made bread outlet.

Non tourist ventures included enterprises which added value to horticultural, viticulture and agricultural production; light manufacturing; 'up market' fashion; consultancy services; crafts and general services to the agricultural community.

Market research was informal, often reliant on acute observation and deduction reinforced by formidable amounts of reading, frequently from international publications and trade magazines. The entrepreneurs gained a place in the market with a single and deliberate determination and a pragmatic approach to competition. Just under half were either 'constantly' or 'continually' reassessing, refining and adapting their products to market demand.

Distance from markets was no problem for those interviewed. Distance was overcome not least by new communication technology, improved postal and courier services and an upgraded deregulated transport system. Twenty percent of the businesses adapted to distance by mail order marketing.

Some entrepreneurs regularly exhibit internationally and initially launched their product through international exhibitions. Thirty-one of the enterprises had an international focus - that means that half of the farm based entrepreneurs have gained international marketing skills and been competitively successful in attracting an international consumer base.

As some gained experience marketing their enterprise products, they became more critical of the marketing by others of their farm products. These respondents had changed the style of their farm marketing as they gained their own enterprise marketing experience - this was described as a positive move.

For the majority of entrepreneurs there had been little change to the quality of their farm work since establishing their enterprise. Those (16), for whom the quality has improved reported that this was due to the adoption of new farming techniques - seven found that they were enjoying farming more (since the establishment of their enterprise), as their focus had extended beyond the farm gate. Farm tourism entrepreneurs reported that the establishment of the enterprise, the garden tourism, the farm stay, had indirectly enhanced their farm operation. Gardens had visually enhanced the farm, farm operators reported upgrading their farming practices to better match the standards set by the garden landscape.

Conclusion

As this research is ongoing our paper does not attempt to anticipate further research findings. It is sufficient at this stage that we signal the presence of these on-farm non traditional entrepreneurial diversifications within the farm system.

In a study such as this, the inevitable question becomes how typical of farmers generally is this type of entrepreneurship? Two thirds of the entrepreneurs had had previous business experience other than and as well as farming and many reported a history of entrepreneurship in their families. Less than half were "self-taught"- suggesting a high degree of motivation but then many within the agricultural sector would argue that farmers by their very nature are self motivated. Certainly our research into off-farm employment highlighted the synonymity that exists between farming and development. A notable factor in this research was the huge sense of energy, purpose and enthusiasm displayed by these farm families. They demonstrated a vigorous determination to be successful and they possessed a formidable edge of market aggression. They demanded a high standard of themselves and of their product.

Most importantly for these farmer entrepreneurs, they were in a position to set a competitive price for their product, perhaps for the first time in their farming careers. They were no longer **price takers,** they were **price makers.**

Our research suggests that entrepreneurial diversifications are likely to increase in incidence, range, type and importance, as farmers explore alternative ways to generate an income from their resources, and achieve their social goals, while managing their resources sustainably into the 21st century.

RANGE OF CORE ENTERPRISES (NON AGRICULTURAL/HORTICULTURAL)

RURAL TOURISM
Farm stays
Farm tours
Garden tours
Hunting - deer
Guiding - fishing
Game park
Helisport - transport

LIGHT MANUFACTURING
General Engineering
Metal work
Pest management product
Niche feed supplement

FASHION
Leather accessories
Clothes

CRAFTS
Patchwork
Knitting - design, graphing, dyeing
Pottery
Artwork

GENERAL SERVICES
Agricultural Journalism
Computer software development/sales
Importation/sales vehicles
Transport sector operation

RANGE OF CORE ENTERPRISES (AGRICULTURAL/HORTICULTURAL BASED)

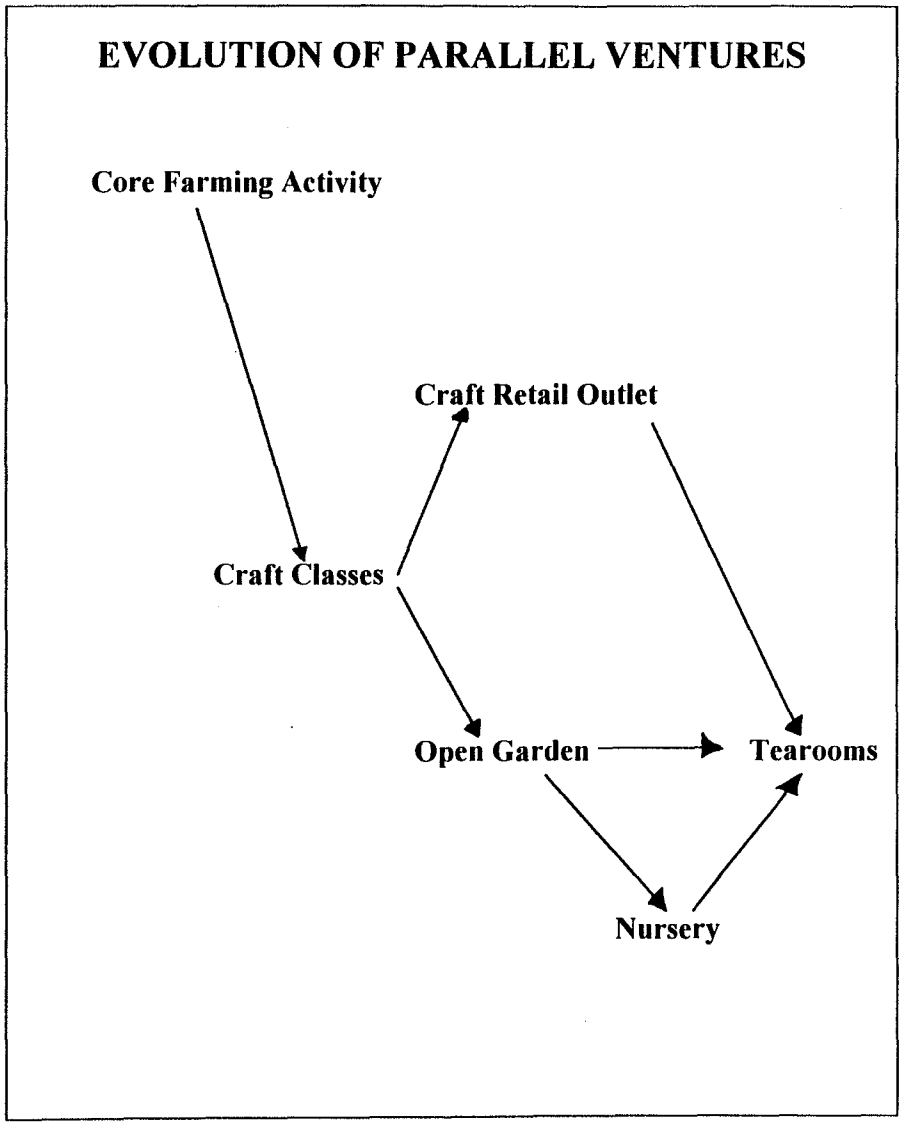
AGRICULTURAL SERVICES
Stud stock recording
Farm consultancy
Farm real estate - vendor's agent
Seed cleaning
Stock breed marketing
Aerial/crop dusting
Agricultural contracting

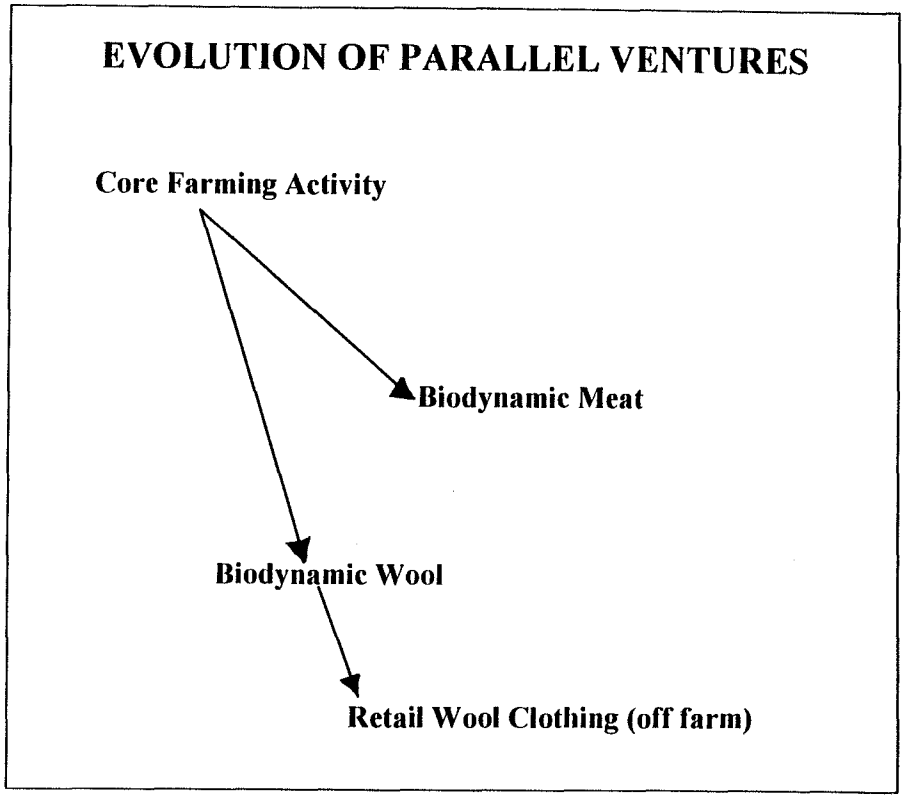
HORTICULTURE
Nurseries
Forestry nurseries
Marketing/Consultancy (domestic/international)
Export bulbs

AGRICULTURAL PROCESSING
(non-traditional/organic)
Medicinal herbs
Non-allergy wool
Dairy products
Specialist cereals

VITICULTURE
Vineyards
Wineries

FOOD PROCESSING
Luxury table birds
Specialist foods
Specialist jams, jellies, pickles, chutneys


EVOLUTION OF PARALLEL VENTURES
Core Farming Activity
Craft Retail Outlet
Craft Classes
Open Garden
Tearooms
Nursery


EVOLUTION OF PARALLEL VENTURES
Core Farming Activity
Biodynamic Meat
Biodynamic Wool
Retail Wool Clothing (off farm)

Cost Benefit Approach to a Rural Subdivision Scenario

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ACKNOWLEDGMENT

This paper reports on a project commissioned by MAF Policy, Franklin District Council, Auckland Regional Council and New Zealand Institute of Surveyors, and carried out by Works Environmental Management (Craig Welsh), Agriculture New Zealand Ltd (Tony Hendrikse, Murray Auld and Tom Hanley), Works Consultancy Services Ltd (Steve Moynihan) and Dr Basil Sharp.

BACKGROUND

The issues associated to rural subdivision are not new to the planning arena in New Zealand. Under the Town & Country Planning Act 1972, the general purpose of regional and district plans was "the wise use and management of the resources, and the direction and control of the development of a region, district or area, in such a way as will most effectively promote the health, safety, convenience, and the general welfare of the people ...". This objective was also complimented by a requirement to protect prime soils, thereby retaining the productive potential of the land. There was no requirement in the Town & Country Planning Act 1972, to justify choices in terms of costs and benefits.

The Resource Management Act 1991 (RMA) introduced a different approach to the management of resources, whereby it assumed that people could make their own choices about resource use, provided that any adverse effects on the environment were avoided, remedied or mitigated. Section 32 of the RMA also requires councils to "consider alternatives, assess benefits and costs, etc" before adopting objectives, policies, rules or other methods in their plans.

It has been argued that the RMA also gives priority to agricultural use and that to use good farm land for residential purposes is counter to the broad purposes of the Act - *that natural and physical resources are to be maintained in a sustainable way.* An opposing view is that the RMA provides no nationwide imperative to restrict the subdivision or use of any land, including prime agricultural land, for non-agricultural purposes. This view holds that councils should identify relevant effects within the district, or within the relevant "area of impact", with the focus being on the net benefit for the district.

MAF's position supports this latter view, and our discussions and submissions to councils emphasise the need to consider the effects of subdivisions, and particularly consider the costs and benefits involved in terms of estimating the net impact on the district. It was felt that while Section 32 was not restricted to the formal process of a cost benefit analysis (CBA), this technique could provide a useful framework in which to compare options.

Many councils were interested in this approach, with the end result being a project commissioned, as per the acknowledgement above, to carry out a cost benefit analysis on a rural subdivision scenario bases in the Karaka, Franklin district.

EFFECTS

In any rural subdivision situation, the following effects could be relevant:

(a) change in the "rural character" of the countryside;
(b) impacts on valued natural landscape features, which may be adverse (e.g, visual impact of buildings), or beneficial (e.g, allowing public access);
(c) incompatibilities or conflicts between activities (e.g, noise, odour, spray drift);
(d) increased demand on roading and/or traffic conflict;
(e) increased demand on services (e.g, water supplies, schools, medical, social);
(f) "hollowing out" of urban areas (e.g, it may be more efficient to require the infill of urban areas, as opposed to allow urban/rural sprawl);
(g) reduced agricultural production or the loss of future production options;
(h) increased investment and increased intensification of agricultural production; the flexibility of production alternatives from small holdings;

(i) increased rating income to council and subsequent flow on effect on services;

(j) impact on the environment.

It should be noted that within the context of this project, the term *rural subdivision* means the actual development of the small blocks (i.e, building of houses and other buildings, provision of services, changes in land use; as opposed to simply creating lots on paper).

All of the above effects may have both positive and negative effects, depending on the situation, and hence MAF Policy's suggestions to councils that they really need to work through the effects depending on the situation, to try and determine the overall net effect.

In the past, a lot of emphasis has been placed on potential changes in agricultural production, and many councils used a minimum lot size criteria based on "economic viability". This economic viability criteria has proved very difficult to justify, and generally has now been discarded. A recent study carried out by MAF and Western Bay of Plenty District Council on changes in agricultural productivity in the Western Bay area as a result of rural subdivisions, showed that overall productivity had actually increased slightly. This was based on a small number of subdivisions which had increased production markedly (e.g, in flower production) which more than offset reductions in production on other lots. Overall very few lots had actually ceased production altogether. This tends to confirm some work that Massey University did in the early 1970s which showed that roughly one-third of the smaller blocks reduced production, one-third maintained production, and one-third increased production; such that overall there was no real change.

Most councils are tending to use a minimum lot criteria, usually of four hectares, as a basis for their subdivision rules. MAF has challenged councils to provide the criteria on which they base these minimum lot sizes, which most of the councils have had difficulty in doing so.

One of the issues with rural subdivisions is that the effects they have tend to be marginal but cumulative. An example of this is that the first subdivision may have almost no impact at all (an extra car on the road, or an extra septic tank discharging to ground water will have very little effect). However, once you got to the (say) 200th subdivision, the extra car on the road or the extra discharge to ground water may be enough whereby a major road upgrade or controls on discharges is necessary. The problem for the councils therefore is to try and gauge what the

cumulative effect may be and hence ensure that any controls or costs are imposed on all subdivisions right from the start.

Many councils are also putting a lot of emphasis on the impact of subdivisions on "the rural character" and/or the landscape. MAF has been urging councils to discuss this through with affected landowners and the community in general, as it tends to be a somewhat subjective issue. MAF is hoping to do some more work in this area to develop methodologies that councils may be able to use to determine landscape impacts.

APPROACH

The intention of the project was to carry out a cost benefit analysis in a traditional discounted cash flow fashion - costs and benefits would be quantified in dollar terms over a set time horizon, and then discounted back to a net present value. The aim was to establish the most allocatively efficient form of land use whereby the NPV calculation must include both:

- market-valued benefits and costs (B_m,C_m); and
- non-market-valued benefits and costs (B_{nm},C_{nm}); or
- $NPV_i = \sum_t[(B_m + B_{nm}) - (C_m + C_{nm})]_t/[1 + r]^t$

  Where "i" refers to the land use option, e.g, i=dairying, lifestyle blocks.

In the event, as will be discussed, this did not prove possible and the end result was only an indication of the relative productive efficiencies of the options.

The time horizon adopted for the NPV calculations was 50 years, which represented the expected life of many of the assets. The discount rates used were zero, two, six and ten per cent.

HOLLOWING OUT OF URBAN AREAS

This issue relates to the impact that rural subdivisions may have on the intensification of residential development in the nearby urban centre. This intensification of residential development is a result of increased subdivision of existing properties, or greater number of high density dwellings, being constructed in the urban area.

It was considered that the scenarios used in the study would have no impact on the rate of intensification within the Auckland urban area. The dynamics of intensification in urban areas is more affected by the regulatory framework imposed by territorial authorities, urban land values and proximity to employment, rather to what is happening in terms of subdivision on the urban/ rural periphery. Within the study, the number of subdivisions created in the scenarios would have done little to absorb the excess demand for housing in the inner urban areas in Auckland. Given this, this aspect was excluded from the study.

One impact of the Karaka subdivision would be to redirect investment funding from the Auckland urban area into Franklin district. From a regional perspective, this is a transfer within the region which will have no impact on the regional economy. Given the scale of existing investment funding in the existing Auckland area, the transfer of investment funding to Karaka will have negligible impact on urban redevelopment opportunities.

However, from a district accounting stance, the multiplier effect of the increased investment in Karaka will have some marginal effects within the district. This was partly recognised in the study, through the inclusion of increased demand for services in the cost benefit analysis. However, further work in the area of multiplier effects will be necessary before the full implications of these could be included in the CBA.

INCREASED RATING INCOME TO COUNCIL

It was considered that rates are a transfer within the district, on the assumption that the marginal additional rate revenue would equal the marginal additional cost of providing services for each scenario. Hence they were left out of the CBA.

It is worth noting that no work has been carried out regarding what the additional services will actually cost the council compared to this additional rate revenue, and it may be worthwhile conducting further work in this area in order to test the above assumption.

SUBDIVISION SCENARIOS

The study involved assessing pre-selected rural subdivision scenarios, related to a 160 hectare property in the Karaka. These scenarios were:

(i) subdivide the property into 40 four-hectare lifestyle blocks, with the land remaining in pastoral (drystock) production;

(ii) subdivide the property into 40 four-hectare lifestyle blocks, with one-third of the blocks in each of the following:
- lifestyle blocks in drystock production
- intensive glasshouse (flowers) production
- citrus production.

(iii) subdivide the property into 80 two-hectare blocks in drystock production

(iv) maintain the farm in its current productive use - two x 80-hectare dairy farms.

Subdivision plans were drawn up for this property, which, after allowing for roads and some reserve sites, resulted in the scenarios being reduced to 32 x four-hectare blocks, and 64 x two-hectare blocks.
The various development and associated costs, plus returns from these various scenarios where then worked through.

MARGINAL BUT CUMULATIVE ISSUES

One of the main issues that arose in the study was the marginal but cumulative impact of subdivisions. An example here is that the first subdivision may have a virtually negligible impact in terms of having an extra car on the road, or having the septic tank discarding to ground water. However, once there is (say) 200 subdivisions in the area, then the 200th car, or the 200th septic tank may well mean that a major road upgrade or controls on septic tanks are required. The question then is in determining an equitable costing amongst all the subdivisions, as this is more than likely to be curvilinear, rather than linear.

Within the study, it was felt that the various scenarios would have a relatively minimal impact on services within the district. The costing on this, relative to different services, is shown in Table 1.

Table 1 : Servicing Cost

Facility	Standard Population Served	% Increase of Standard Facilities Required		Additional Land Requirement (M^2)		Additional Cost ($)	
		4 ha	2 ha	4 ha	2 ha	4 ha	2 ha
Kindergarten	2500	3	6	32	64	7360	14720
Primary School	3000	3	5	533	1066	21067	42134
Intermediate School	8000	1	2	400	800	36300	72600
Secondary School	18000	0.4	0.9	355	710	37200	74400
Health Centre	10000	0.8	1.6	120	240	6360	12720
Ambulance Station	25000	0.3	0.6	32	64	1488	2976
Handicapped Centre	20000	0.4	0.8	80	160	4240	8480
Fire Station	15000	0.5	1.1	70	140	16747	33494
Library	15000	0.5	1.1	43	86	20107	40214
Police Station	25000	0.3	0.6	16	32	3392	6784
Community Hall	25000	0.3	0.6	6	13	7424	14848
Playing Fields	2500	3	6	640	12800	6784	13568
Swimming Pool	10000	0.8	1.6	320	640	6320	12640
Tennis Courts	2000	4	8	80	160	2760	5520
Total per Lot				85	85	5548	5548

Overall, the average impact on amenities for the four-hectare scenarios is an increase in demand of 1.2%, whilst the average impact on amenities for the two-hectare scenario is an increase in demand of 1.5%. The approach taken in the study, with respect to incorporating cumulative impacts, was to assign a proportion of the cumulative impacts into each newly created block.

Similarly, the same issue arose with respect to the environmental impacts. These impacts were quantified to a limited extent, refer Table 2, but within the resources available for the project were not able to be quantified in dollar terms.

Table 2 : Environmental Factors

Environmental factor	2x80 ha dairy farm	4 ha lifestyle drystock	4 ha lifestyle flowers	4 ha lifestyle citrus	2 ha drystock
Water demand[1]	30,080 *l* /day	640 *l* /day/block or 20,480 *l* /day in total	14,885 *l* /day/block or 476,320 *l* /day in total	75,000 *l* /day or 2,400,000 *l* /day in total	360 *l* /day/block or 23,040 *l* /day in total
Effluent discharge	18,400 *l* /day	N/A	N/A	N/A	N/A
Waste water discharges	Minimal	Increase	Increase	Increase	Increase
Discharge of fertiliser	112 tonnes 30% Potash	Decrease	Increase	Significant Increase	Decrease
Discharge of pesticides/ herbicides	Low	Low	Slight Increase	Significant Increase	Low
Soil Erosion	Minimal	Increase	Increase	Increase	Significant Increase
Conflict between activities	Minimal	Increase	Significant Increase	Significant Increase	Significant Increase

Given that these impacts could not be quantified in dollar terms, they were not included within the CBA.

ASSESSMENT OF INTANGIBLE COSTS AND BENEFITS

The issue that arose here was that unless externalities are measured in commensurate units (i.e, in dollar terms), it is not possible to directly incorporate them into the CBA. Within the project, it was felt that there were three intangible factors that needed to be quantified:

(i) on-site amenity values;
(ii) off-site amenity values; and
(iii) environmental impacts.

Within the report, there is a discussion on various methodologies that may be used to assess the above, but given restrictions on resources, these were not quantified in the field.

[1] Domestic water supply comes from roof water. Therefore, it has no impact on ground water demand.

While a number of methodologies were discussed, the authors felt that hedonic pricing would provide the best approach to estimating on-site amenity value, while contingent valuation methodology would be best suited to measuring impacts on off-site amenity values and environmental effects.

One possible measurement of on-site amenity values is that many of the blocks operated at a loss, which the owners were happy to cover from other income sources. Hence this operating "loss" could be used as a possible measure of on-site amenity value.

RESULTS

Given the issues that arose as detailed above, and the subsequent non-inclusion of a range of intangible factors, the final results derived were an indication of the relative productive efficiency of the particular scenarios, and not a measure of the allocative efficiency as originally intended. These results are summarised in Table 3.

Table 3 : Results

		Discount Rate			
		0% $000's	**2% $000's**	**6% $000's**	**10% $000's**
Scenario 1	32x4 ha Drystock	(4,931)	(12,811)	(16,393)	(16,684)
Scenario 2	32x4 ha Mixed Use	33,967	9,186	(8,206)	(13,373)
Scenario 3	64x2 ha Drystock	(11,825)	(24,369)	(29,502)	(29,558)
Scenario 4	2x80 ha Dairy	13,249	5,591	92	(1,633)

At the 0% and 2% discount rates, the four-hectare mixed use scenario gave the greatest NPV, with the dairy scenario second. However, at the higher discount rates of 6% and 10%, the dairy scenario gave the highest NPV, with the four-hectare mixed use scenario second, followed by the four-hectare drystock scenario, and with the two-hectare drystock scenario consistently giving the lowest NPV.

CONCLUSIONS

While the study did not entirely achieve the objectives set out, it did highlight a number of useful factors, namely:

(i) that the cost benefit framework or approach is a useful tool in attempting to analyse the effects of rural subdivisions;

(ii) that more work is required to better quantify a number of the "intangibles" and environmental impacts, and methodology is required to handle the marginal but cumulative impacts of subdivisions.

With the advent of the RMA and the emphasis on sustainable use of our resources, there is a need to consider the costs and benefits of policies relating to resource use, which to date has been almost totally lacking.

Paper presented to the New Zealand Agricultural Economics Society (Inc) Conference, Blenheim, 5-6 July 1996.

Social Impacts Of Land Use Change

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Abstract

Policy makers have devoted considerable attention to the economic and environmental impacts of land use change while the social impacts have received less attention. The social impacts of land use change vary considerably depending on the community and type of conversion. It is often difficult to distinguish between the social impact of land use change and the social impact of wider policy, economic, social, and demographic changes in New Zealand. Nevertheless, land use change does have social costs and benefits for rural communities, some of which are addressed in this paper. There is no one agency assigned with the task of examining and reducing the social impacts of land use change. This paper suggests that such responsibility lies with several agencies and groups at the national and local level.

Introduction

Decision-makers have devoted considerable attention to the economic and environmental impacts of land use change. However, the social impacts have received considerably less attention. The social impacts of land use change vary considerably depending on the community and type of land use conversion. At times it is difficult to differentiate between the social impacts of land use change and the social impacts of wider policy, economic, social, and demographic changes in New Zealand. Nevertheless, land use change does have social costs and benefits for rural communities, some of which are addressed in this paper. There is no one agency assigned with the task of examining and reducing the social impacts of land use change. This paper suggests that such responsibility lies with several agencies and groups at the national and local level.

Land use change in New Zealand

There have been considerable changes in the way land has been used in New Zealand over the last two decades. These changes have occurred primarily in response to changes in the profitability of different land uses, such as the improvement in the returns from dairying and forestry relative to sheep and beef farming. Demographic and social factors have also influenced the rate of land use change. The increasing size of urban populations has placed pressure on resources (e.g. roading, public utilities) and an increase in in-building in urban areas. This coupled with a belief that living in the country is 'healthier' (e.g. perceived to be quiet, stress free, cleaner) has seen an increase in the number of people moving to "lifestyle blocks" on the periphery of urban areas (Fairweather 1993). New Zealand's commitment to maintaining biodiversity, and a perceived need to retain natural landscapes has also contributed to land use change (e.g. the return of parts of the South Island high country to the conservation estate).

While the changes in land use over the last twenty years have been significant, they have to be put in context. The way land in New Zealand is used has been changing, often dramatically, through the entire history of settlement. In particular, the last century saw drastic cutting of native forests, and sowing of pasture (Ward *et.al.* 1996). Not all the change in the way land is used have been as dramatic as replacing native forest with pasture. In some cases, the change in land use has involved converting from sheep to cattle farming or deer or goats.

What are social impacts?

Before the paper considers the social impacts of land use change, it will briefly address the question of what is a social impact. There has been considerable debate as to what constitutes a social impact. Taylor *et.al.* (1995:67) contend that:

> **all** environmental [and economic] alterations have **social** implications. This is not to mean the focus of every analysis will be social, but that all environmental [and economic] outcomes should be looked at, in the final analysis, as being social.

For example, the increased conversion from sheep farming to more intensive dairy farming may raise concerns about the impact of dairying on soils and waterways, and the further build up of greenhouse gases. Concerns may also be raised about the social and economic implications of the change in land use. However, any decision to restrict (or not to restrict) an activity is, as Taylor *et.al.* (1995) argue, ultimately driven by concerns about the human and social implications of the change in land use. In other words, what are the negative or positive impacts on people?

There is growing acceptance that the physical environment and the social environment are inextricably linked (Taylor *et.al.* 1995). However, it can be difficult to isolate social impacts from other impacts. Moreover, views on what a social impact is varies over time and space. When determining what the specific social impacts of an activity or proposed activity are, Taylor *et.al.* (1995) recommend decision-makers ask the affected community. Decision-makers need to consider the positive and adverse changes which occur (or may occur) from the activity on:

- people's way of life (e.g. how they live, work, play and interact with one another);
- people's cultures and traditions such as shared beliefs and values (including landscape values and heritage traditions);
- characteristics of the community, including the population size and diversity, as well as facilities and services; and
- characteristics of the local economy and its place in the regional and national economy.

What are the social impacts of land use change?

The social impacts of land use change vary considerably depending on the community and type of land use conversion. Moreover, it is often difficult to distinguish between the social impact of land use change and the social impact of wider policy, economic, social, and demographic change in New Zealand. Nevertheless, an examination of previous studies and other sources of information indicates there are social impacts associated with land use change.

Change in the size of local populations

Local populations may change in size as a result of rural land use change. The Eastern Bay of Plenty and Central Plateau regions were recently acknowledged as the fastest developing region in the country. A significant element of this increase in population has occurred as a result of land use change, primarily the growth in the number of lifestyle blocks and an increase in dairy farms (Scarrow *et.al.* 1996, MAF Policy Agents 1996c). In several Southland communities, depopulation has been slowed or halted by the influx of people associated with increased conversions to dairying (for example, dairy farm owners, share milkers, dairy farm employees, dairy factory employees). In the past, rural communities in Northland and the Bay of Plenty have seen more people come into their communities following increased conversions to horticulture. The population increased because the more intensive use of the land meant there was an increase in the number of farm owners and greater employment opportunities, particularly for seasonal work (Martin 1983, Stokes 1983, Moran 1986).

In North Otago the introduction of irrigation brought changes in land use which had a positive impact on the size of local communities (Gillies 1978). As a result of persistent droughts farmers were having to increase farm size to remain financially viable. Farm amalgamations increased as farmers retired or sold out and left the district. As many of the farm families were not replaced in the hill country, the local rural population declined. In contrast, where irrigation was available, properties were more intensively farmed and new crops (e.g. sunflowers) were introduced. This helped maintain the population (Gillies 1978).

In some cases the change in land use can lead to a decline in the population. This generally occurs where there is a move from a more intensive land use to a less intensive land use (Cross and

Houghton 1995). In the late 1970s and early 1980s, many left the dairy industry in Northland as returns to dairy farmers declined. More extensive pastoral farming (e.g. sheep and beef) became more prevalent. As a result some rural Northland communities declined in size (Maunier *et.al.* 1985).

Population diversity

Land use change may also affect the diversity of the local population. Increased diversity can improve the strength and vitality of the community. In Northland, Blunden and Cocklin (1995:27) found that 17 percent of those surveyed felt recent land use changes had strengthened their community. However, greater diversity in the community can also lead to increased tension and conflict. According to Blunden and Cocklin (1995), 39 percent of those surveyed felt the recent land use changes had weakened the community. Blunden and Cocklin (1995:27) believe this is symptomatic of "the divided opinions about the implications of expansions in plantation forestry".

Conflict can occur when newcomers have different values and expectations to the existing population. For example, conflict has occurred between the owners of lifestyle blocks and owners of larger farms over the sights and smells associated with some agricultural practices and farm types (e.g. the smells associated with piggeries, effluent ponds, silage, and spraying). Such conflicts have created problems for local authorities who have to balance the needs of farmers to carry out particular agricultural practices (e.g. spraying, making silage) against the distress these practices cause others. Recently, Environment Bay of Plenty warned lifestyle block residents to accept what they find after choosing to move to the countryside. The Council were exasperated by ongoing complaints about smells from places like piggeries and silage pits (MAF Policy Agents 1996b).

Increased tension can also occur where social disparities are increased by a change in land use. For example, the development of horticultural enterprises in Northland in the early 1980s led to greater disparities in income and lifestyle between the owners and their seasonal workers. There was also greater social demarcation between the owners of horticultural enterprises and pastoral farm owners. Horticultural developers tended to be more formally educated, from non-farming backgrounds, and were often supported by substantial capital resources (Moran 1986). Similar tensions developed in the Bay of Plenty as the kiwifruit industry expanded in the early 1980s (Martin 1983).

Employment opportunities

Land use change can lead to greater employment opportunities. The development of horticulture and viticulture often leads to an increased demand for seasonal labour (Martin 1983, Moran 1986). Recent conversions to dairying have increased the demand for dairy farm workers, and in some areas, such as Northland and Southland, the demand has exceeded the supply (MAF Policy Agents 1996d).

The impact of conversions to forestry on employment opportunities is less clear. Forestry development can lead to an increase in local employment, but such employment is often concentrated in the first ten years after planting and at harvest time. A greater level of long term employment may be created if a mill or processing facility is established in the area. However, it is not clear that increased employment from forestry outweighs the loss of jobs associated with the previous land use. It has been suggested that with the growth of farm forestry, as opposed to corporate forestry, there may be fewer changes to the population as farm families are retained in the area (Houghton 1993).

Provision of services and infrastructure in rural areas

Land use change also affects the provision of services in rural areas. Where local populations have increased as a result of land use change, some rural services have benefited. For example, in the Bay of Plenty, the influx of people associated with the expanding kiwifruit industry in the 1980s enabled school rolls to be maintained at a stable level (Martin 1983). More recently, the increase in population associated with the growth of lifestyle blocks in areas such as Oamaru has also helped maintain school rolls (MAF Policy Agents 1995). The increased diversity of population can also lead to the provision of a broader range of services than existed prior to the change in land use (for example, the growth of restaurant facilities associated with the development of wineries).

However, population growth associated with land use change can put greater pressure on existing services. In the Bay of Plenty, the large increase in the labour force associated with the kiwifruit industry put pressure on health services, child care facilities and law enforcement services. Increased social problems amongst seasonal workers such as drug and alcohol abuse and violence also placed pressure on services (Martin 1983). A recent report on rural subdivision in the Bay of Plenty revealed that the change in land use had placed greater pressure on roads and that the demand for services had increased (Scarrow *et.al.* 1996).

In other cases land use change may contribute to the loss of services and/or infrastructure in rural communities. In the late 1970s and early 1980s, the change from dairying to other land uses in parts of Northland contributed to rural depopulation which in turn led to a reduced range of social activities and services (Maunier *et.al.* 1985).

In another example, the increase in heavy vehicle use associated with forestry development can have a detrimental impact on roads. Territorial authorities tax rural land owners (including farmers and forest owners) to finance the local share of road maintenance and upgrade costs. At present, this tax is incorporated in "general rates". These are assessed on the unimproved value of the land, and are not directly linked to the use of the local road network by the ratepayer. In some districts, considerable upgrading of rural roads will be necessary in the near future to meet the forecast use of local roads by logging traffic.

It can be argued that it is inequitable[1], and possibly inefficient, to rate all landowners for roading upgrades that only some landowners need, and that local government should target the critical element of heavy truck use more directly.

[1] The loss of income from having to pay higher rates for damage to roads caused by other land owners could have a detrimental impact on the ratepayers quality of life (e.g. less able to afford the same range of goods and services) and on their business.

However, local government does not yet have the mechanisms to directly target heavy truck use. At the national level, land transport pricing is currently being reviewed by Government. Local government is looking at options for moving towards a "beneficiary pays" regime for land transport, including differential rating and user charges. However, the implementation of some options would require legislative change (Ward *et.al.* 1996).

Impact on those who do not alter their land use

The process of land use change has an impact on those who do not alter their land use. For example, in areas with many conversions to dairying and/or forestry, farm families who do not alter their land use can experience an increasing sense of isolation and a perceived loss of quality of life (Moran 1986, Smith 1988).

Whose responsibility is it to address the social impacts of land use change?

The role of local government

The social impacts of land use change are often localised. Local government can, therefore, play an important role in minimising the social impacts of land use change, for example through using the Resource Management Act (RMA). While the RMA is primarily concerned with the sustainability of the natural and physical environment, there is scope within the Act to address social impacts such as those associated with land use change. According to Taylor *et.al.* (1995:10), the RMA:

> seeks to meet the needs of the present population while keeping environmental options open for future generations, and does this by recognising the connections between the natural and physical environment on the one hand and the social and economic environment on the other. This is done quite specifically in three key definitions within the Act: 'sustainable management', 'environment' and 'effect'.

'Sustainable management', under the RMA, has two essential elements:

> enabling people and communities (present and future) to provide for their social and cultural well-being, and their health and safety,
>
> while
>
> managing resources sustainably in a physical and ecological sense (Refer to s5.2 RMA pp 21).

'Environment' is defined to include ecosystems and their constituent parts, including people and communities; all natural and physical resources; and amenity values. Social, economic, aesthetic, and cultural conditions that affect ecosystems, natural and physical resources and amenity values are also included in the definition of 'environment' (Refer to s2 RMA, pp 11).

The definition of 'effect' is equally broad (refer to s3 RMA, pp 19-20). Taylor *et.al.* (1995) suggest that the when examining the likely effects of an activity on the environment, the environment can be viewed as a network of ecosystems. As part of this network,

> social, economic, aesthetic and cultural effects should be considered in the promotion of sustainable management of natural and physical resources (Taylor *et.al.* 1995: 10).

The RMA does not provide for specific programmes on social and community development. However, it does provide for consideration of the management of any impacts of land use development or protection on the community, and natural, physical or cultural heritage sites including landscape, land forms, historic places and waahi tapu[2]. This means that in setting objectives, policies and methods (including rules) in district and regional plans and policy statements, it is possible to address how social impacts related to land use and developed could be managed. Consultation is one method of resolving or minimising the present or future social impacts of land use change.

What is consultation?

There are numerous definitions of what constitutes consultation. However, consultation may be defined as a process whereby one party (e.g. a council, a developer) seeks the involvement another party (or parties) to assist in policy formulation or the making of decisions regarding an activity or activities. Community values, aspirations, resources and needs can be identified through consultation. Consultation is also an opportunity for councils and developers to provide information on intended developments and feedback on past developments.

There are no universal requirements as to the form consultation must take or as to the duration of the process. Consultation can include any manner of oral or written interchange that allows adequate expression and consideration of views. The process of consultation may take years or it may only last as long as a phone call (Ministry for the Environment 1995).

However, consultation generally involves, but is not limited to the following:

- providing a proposal not yet finally decided upon (that is, the party doing the consulting must keep an open mind and be ready to change and even start afresh);
- listening to what others have to say and considering responses;
- providing the consultees with sufficient *time* and *information* to enable them to make intelligent and useful responses (this may involve the consulting organisation providing relevant information and further information on request); and
- the party obliged to consult, waiting (within reason) until those being consulted have had a say before making a decision.

Consultation is not merely telling or presenting, or intended to be a "rubber-stamping exercise", or the same as negotiation although the result could be an agreement to negotiate.

Why should councils undertake consultation?

Under the RMA, public consultation is required in the preparation of all policy statements and plans. This is set out in the First Schedule of the RMA which *requires* the council concerned to consult with, amongst others, the tangata whenua of the area. A council *may* also consult with anyone else during the preparation of a policy statement or plan (Ministry for the Environment 1991).

Undertaking early and effective consultation with groups in the community likely to be affected by an issue is more likely to result in a successful conclusion for all parties. For example, when developing "enabling" policies and methods for how land is to be managed, regulations can be a blunt instrument. Early and effective consultation with land users is likely to lead to more effective regulations and other methods to address resource management problems associated with land use. This will assist in reducing the social and economic costs of land use change. For example, the liklihood of formal objections to council plans will be reduced, and landowners may eventually have greater certainty in making land use decisions. The well-being of landowners and the community may increase if they are involved in the consultation process because they have a sense of ownership in the decision-making process.

The Fourth Schedule of the Act recommends an applicant for a resource consent to identify those interested in or likely to be affected by, a proposal (unless a rule in a council plan states otherwise), and outline any consultation undertaken. The results of the discussions should be described as part of the assessment of effects.

Other methods under the RMA and other Acts

Social concerns may also be addressed under the RMA through other methods such as the provision of public information (e.g. information on the costs and benefits of different rural production systems), and appropriate systems for feedback (e.g. a log of complaints at the council). Local authorities could also assist in the formation of local community groups which could discuss and address environmental and social issues of concern to them.

District councils can address the social impacts of land use change under other legislation, in particular the Local Government Act. This Act allows district councils considerable discretion to take action on a wide range of issues affecting the local population.

The role of central government

The Ministry of Agriculture has an interest in the social impacts of land use change as a result of its involvement in the promotion of sustainable agriculture. The Ministry of Agriculture defines sustainable agriculture as:

> the use of practices and systems which maintain or enhance:
> • the ability of people and communities to provide for their social and cultural well-being;
> • the economic viability of agriculture;
> • the natural resource base of agriculture;
> • other ecosystems influenced by agricultural activities; and
> • the quality and safety of food and fibre (MAF 1993:4).

Thus agriculture will not be sustainable if the rural communities are not sustainable. The Ministry can assist in minimising the social impacts of land use change though:

- assisting communities to form groups to discuss and formulate solutions to local problems (e.g. managing the impact of the growth of forestry development on their communities);
- knowledge generation through influencing research priorities for Crown funding;
- the provision of information (e.g. technical papers dealing with some of the social impacts of change in rural areas, the Rural Bulletin, the sustainable agriculture education kit); and
- working with local and central government to (e.g. providing an agricultural input into submissions on district and regional plans, joint sustainable agriculture projects such as environmental focus farms).

[2] Refer to the RMA Second Schedule Part I (4) and Part II (2).

The Ministry for the Environment can assist indirectly in minimising the social impacts of land use change through providing councils with advice on the RMA. The Ministry for the Environment was established to administer the RMA.

The role of private enterprise

Private enterprise can play a role in mitigating some of the adverse social impacts of land use change by discussing areas of conflict (real or potential) with the affected local community or party. Such actions may reduce costs for the companies involved as the community may be less likely to oppose land developments. Companies may also work with communities to reduce conflict as part of being a "good neighbour". For example, in early 1996 the Forestry Corporation donated a radio telephone to the Lake Rotoma School (near Kawerau) so the school bus and logging trucks could keep each other informed of their whereabouts. The Forestry Corporation had recently increased operations in the forest and felt the safety of the bus and its passengers was an issue they needed to address (MAF Policy Agents 1996a).

The role of research

Research can assist decision makers in making more informed decisions. With regard to the social impacts of land use change, there is a need for more recent research. Most of the studies on the social impacts of land use change were undertaken in the late 1970s to mid 1980s. However, as Cross and Houghton (1995) point out, these earlier studies provide an opportunity to follow up on the changes that have occurred over the last ten to fifteen years. Most of these earlier studies included information on the impact of land use change on farm incomes, employment trends, social diversity and activity, and local population size.

There is very little research on the social impacts of land use change involving viticulture, arable and deer farming or the development of Maori land, with the exception of the East Coast and Northland forestry studies. There is also a need for studies which include statistical information as well as qualitative information. Unfortunately, as Cross and Houghton (1995) indicate, quantitative information on rural populations, particularly over time, can be difficult and expensive to acquire. This is the case whether undertaking original research or using secondary data (e.g. census data). Research that involves the local community (including local decision-makers) is more likely to provide accurate and useful information on how to resolve issues associated with the social impacts of land use change.

Summary

The social impacts of land use change vary considerably depending on the community and type of conversion. No one agency or group is responsible for mitigating these adverse social impacts of land use change. However, local and central government, private enterprise and research institutions all have a role to play in reducing such impacts. For example, local government can address some of the adverse social impacts of land use change within the bounds of the RMA, particularly those impacts that affect ecosystems, natural and physical resources and amenity values (e.g. landscape issues). Early and effective consultation with potentially affected parties will also reduce the possibility of conflict between different land users and community groups. This process will reduce some of the adverse social impacts of land use change. District councils can also take action on social issues under the Local Government Act.

At the central government level the Ministry of Agriculture can mitigate some of the adverse social impacts of land use change by facilitating the flow of information and development of solutions on such issues between agencies and groups at all levels (e.g. central and local government, research institutions, community groups).

Private enterprise can reduce some of the adverse social impacts of land use change by discussing areas of conflict (real or potential) with the affected local community. This may be seen as part of being a "good neighbour". Finally, research can assist decision makers in making more informed decisions. There is a need for more recent research on the social impacts of land use change as much of the existing research in this area is more than ten years old. The Ministry of Agriculture has recognised this and is funding some new projects as part of its sustainable agriculture programme. Research that involves the local community (including local decision-makers and community groups), and has a balance of quantitative and qualitative information is more likely to provide accurate and useful information on how to resolve issues associated with the social impacts of land use change. This is a methodological approach being adopted by the Ministry of Agriculture.

Note: The views expressed in this paper are the views of the author and not necessarily those of MAF Policy, Ministry of Agriculture.

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Accountability in Funding Flood Control Schemes

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Abstract

Operation and maintenance of flood control, and related drainage schemes forms a significant activity of the regional councils. The proposed Local Government Amendment Bill (No. 5) will require local authorities to explain their selection of funding mechanisms (section 122c(e)). What it means is that the ratepayers should know the benefits that they are paying for. The overall benefits of flood control schemes are multidimensional. The focus of this study is to evaluate the funding structure for two of the largest flood control projects in the Hawke's Bay region. At present, financing for these schemes are obtained by a combination of works rates, general rates and a pool of regional income. The paper analyses the current balance in the council's rating policy, and suggests a cost allocation scheme that is equitable across three identifiable beneficiary groups and efficient administratively.

Acknowledgement:
Financial support for the project was obtained from the Hawke's Bay Regional Council. I am grateful to Mike Adye and Hugh Norton from the regional council for supplying most of the data requirement. Sincere thanks to Dr. Robert Alexander for providing initial leads in to the research. Professor Anton Meister and Dr. John Holland provided useful comments.

Disclaimer:
The views expressed in this paper are those of the author and do not necessarily reflect the views of the Hawke's Bay regional Council. Errors and omissions remain the responsibility of the author.

INTRODUCTION

The Hawke's Bay region is best known for its orchards, vineyards, farms and vegetable crops. The region is popular among commercial and recreation fishermen. But this was not always the case. The region has been notorious for repeated flooding of the Heretaunga Plains. Since the formation of the Hawke's Bay Flood control Board in 1943, continuous efforts by the responsible authorities have reduced the problems of flood and environmental hazards to more acceptable levels and contributed to economic and aesthetic appeal of the entire region. To maintain the present day safety level, maintenance and upgrading of the various flood control schemes will need to continue.

The control of the region's water flows has been a major activity of the Hawke's Bay Regional Council. During 1995-96 period, the Hawke's Bay Regional Council will have spent a total of $5.23 million in these projects[1]. Much of the work programme relates to the maintenance of the flood control and land drainage schemes, which have been developed over the years and currently have a value of $45 million.

At issue is the question of pricing schemes to fund the council's projects. Two fundamental principles underlying any public good pricing (rating) scheme is that of (i) equity and (ii) efficiency. The operational mechanism by which equity is to be enforced is the principle of "userpays". The cost of funding public projects should be borne by the ratepayers in proportion to the benefit that accrues to them.[2] To be equitable, policies need to be transparable. What it means is that the ratepayers should know the benefits that they are paying for. Some will, perhaps, call this as the principle of "accountability". Efficiency is measured in terms of cost effectiveness. In the present context, this would mean the administrative or collection costs should be kept at minimum. Often the twin principles of equity and efficiency pose as conflicting goals, and a compromise is called for[3].

The focus of this study is to evaluate the funding alternatives for two specific projects undertaken by the Hawke's Bay Regional Council:

[1] The split between operating expenditure and capital expenditure is $4.01million and $1.22 million respectively. These figures are taken from the Hawke's Bay Regional Council annual plan 1995/96.

[2] "The rating policy of the council is based on clearly identifiable beneficiaries of council activities paying for the cost of those activities by rates or direct charges whichever is most efficient administratively".

[3] The conflict and the desirable compromise is best observed in our national income tax structure. Strict equity requires a progressive tax structure, where the rates themselves (as opposed to total contribution) would rise with income. This would call for an infinite set of tax rates, one for each level of income, and make it too complex for administrative purposes. To make a compromise, efficiency has been introduced by having only two tax rates. Strict efficiency would require exactly single income tax rate for all residents.

a. The Heretaunga Plains Flood Control Scheme.

b. The Upper Tukituki Flood Control Scheme.

At present, funding for these schemes are obtained by a combination of works rates, general rates and a pool of regional income. The purpose of this research is to carry an independent investigation into the rationale for the current funding policy, and to suggest alternatives if desirable. The fundamental principle of user pay is treated as a binding constraint.[4]

Regional Profile/Scheme Description

The Heretaunga Plains Region

The area has been formed by flooding and eventual deposits from the three main rivers of the region, Tukituki, Ngaruroro and Tutaekuri. Napier and Hastings, both located in these plains forms the hub of the Hawke's Bay region. Together, the twin cities make home for 80% of the regions population.[5] The combination of temperate climate, fertile soil and excellent irrigation facilities enable the Heretaunga Plains to produce 50% of the total New Zealand harvest of fruit, vegetables and grapes.[6] The flood control scheme works as expected during flood events. In particular, floods deemed to be less than a 100 year return period event are carried safely and scheme assets suffer minimum damage.

The Upper Tukituki Region

The area is located in central Hawke's Bay, and consists of 2489 km^2 of plains, hill country and mountainland. The region is an important supplier of horticultural products (pipfruit, stonefruit, asparagus and kiwifruit), sheep and beef, and dairy products. The flood control scheme performs as expected, in reducing the risk of a large scale flooding and maintaining drainage on the Ruataniwha Plains. The scheme is also credited for reduced riverbank and hill country erosion.

A breakdown of expenditure by type of work for both schemes is shown in Table 1.

[4] This is a political issue beyond the scope of this research. The Council has been mandated to recover its costs on this basis as exemplified in Hawke's Bay Regional Council corporate plan.

[5] Socio-economic profile 1996 estimates the regional population of the Hawke's Bay at 141,500. The figures for Napier-Hastings urban areas are stated as 112,200.

[6] Heretaunga Plains Ground Water Report, Environmental and Monitoring Section, Hawke's Bay Regional Council, December 1995.

Table 1: Expenditure by Type of Work

Budgeted Cost 1995/96		
Type of Work	**Heretaunga Plains FCS**	**Upper Tukituki Scheme**
Stopbank Construction	$880,000.00	$78,000.00
Total Capital Expenditure	*$880,000.00*	*$78,000.00*
River Maintenance	$603,000.00	$395,500.00
Stream & Drain Maintenance	$679,000.00	
Pump Station Maintenance & Operation	$274,000.00	
Special Projects	$165,000.00	
Total Maintenance	*$1,721,000.00*	*$395,500.00*
Total Capital + Maintenance Expenditure	*$2,601,000.00*	*$473,500.00*
Interest	$219,000.00	
Capital Loan Repayment	$350,000.00	
Total Expenditure	**$3,170,000.00**	**$473,500.00**

Present funding policy

The general principle underlying the current funding policy of the council is on a "user-pays" basis. All cost relating to these schemes are funded from "Works Rates", i.e. those collected from direct beneficiaries of the work within the classified area. Two exceptions to the above principle reflects the belief the (indirect) benefits of flood control works extend beyond the area classified for works rates. Accordingly, two general rates meets the cost of rate collection, council overheads, and one-third of the capital works. This can be seen from Table 2.

Table 2: How are the schemes financed? 1995/96

	Heretaunga Plains FCS			
Expenditure Type	Works Rates*	General Rates	Other**	Total
Capital Works	586,667 (67%)	293,333 (33%)	0 (0%)	880,000 (100%)
Maintenance	1,721,000 (100%)	0 (0%)	0 (0%)	1,721,000(100%)
Fixed Overhead and Rate Collection	0 (0%)	65,000 (100%)	0 (0%)	65,000 (100%)
Debt Servicing	113,942 (20%)	0 (0%)	451,671 (80%)	565,613 (100%)

Upper Tukituki FCS				
Expenditure Type	Works Rates	General Rates	Other*	Total
Capital Works	52,000 (67%)	26,000 (33%)	0 (0%)	78,000 (100%)
Maintenance	395,500 (100%)	0 (0%)	0 (0%)	395,500 (100%)
Rate Collection	0 (0%)	25,000 (100%)	0 (0%)	25,000 (100%)
Fixed Overhead	0 (0%)	2,000 (100%)	0 (0%)	2,000 (100%)

figures in parentheses represent relative share of funding source.
* the amount includes $10,000 for the Middle Reaches Scheme
** Most notably from port dividends, leasehold rentals and scheme reserves

As the tables will indicate, currently the direct beneficiaries within the area classified pay for all of the operations and maintenance cost. When this "works rates" is combined with other income and the use of reserves, this amounts to a total of $ 3,232,167 during 1995/96[7]. Only the rate collection costs, fixed overheads and 1/3 of the capital works is funded from general rates. For 1995/96, this amounts to $411,333 or (11.3%) of the total capital and maintenance expenditure.

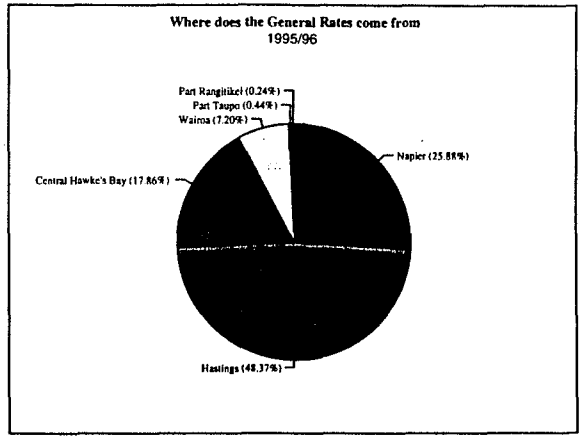
The question arises as to what extent property owners beyond the works rates payers in classified areas benefit from flood control works undertaken in the Heretaunga Plains and the Upper Tukituki areas? This will determine what (if any) is an equitable proportion of the expenditures that can justifiably be funded from the general rate revenue.

Sources of the general rate revenue

When answering the question of fairness in funding, especially contributions coming from rate-payers outside of direct beneficiaries within classified area, one need to look at relative contributions by the districts. To the extent that flood control schemes in the two areas concerned is financed by general rates from the comprising districts, the tax burden of the general rate-payers outside of these districts is lowered. If we call this later group as "Tier III beneficiaries", then their share to the capital and maintenance expenditure is less than the 11.3% stated in the previous section.

[7] In the previous years, the Council operated a Regional Benefit Account (RBA) through its ownership of the Port of Napier Limited and the leasehold land portfolio in Napier. The purpose of the RBA was to identify the benefits arising from its regional assets. Since 1995/96, the Council's financial reporting excludes reference to the RBA in favour of an "Accumulated Reserves" and its components.

The Hawke's Bay region is made up of six districts. The regional council's general rate revenue is made up with contributions from these districts. The share of each district in any year is determined by the system of "equalised land value", which will give rise to the following district-wise relative rating income requirements for 1995/96.



Source: HBRC Annual Plan 1995/96

As the diagram above will indicate, 74% of the regional councils general rate revenue is derived from the districts comprising the Heretaunga Plains region. Another 18% is provided by ratepayers in the Central Hawke's Bay district, which comprises the Upper Tukituki scheme boundaries. This will imply that only about $32,906, or 1 percent of the scheme expenditures in the two areas is derived from the "Tier III" ratepayers that lie outside of the districts where the two schemes are located.

Of course, not all of the general ratepayers in the districts comprising Heretaunga Plains and upper Tukituki schemes are direct users of flood control projects taken within their districts. If we call this group as "Tier II beneficiaries", their share to the total capital and maintenance expenditure currently would be $378,400, or little over 10 percent of the scheme expenditures. The remaining residents will be called as Tier I beneficiaries. The intra-district distinction within the beneficiaries is necessary as the benefits from Flood Control Schemes are more concentrated in the vicinity of the region where the activity is undertaken.

The task is then can be stated as to identify and, as much as possible, quantify the benefits of flood control works as they accrue to the three distinct groups[8]:

- Tier I beneficiaries
- Tier II beneficiaries
- Tier III beneficiaries

The issue of fairness can then be addressed by comparing these benefits with the contribution to costs by each of these groups.

Benefits from Flood Control Schemes

Flood control and drainage schemes generate a broad range of environmental, social, and economic benefits. A majority of the direct economic benefits, like increased agricultural yield from a managed flow of water will accrue to landowners in the immediate vicinity of the scheme. This view is reflected by the current funding policy whereby the major proportion (76 percent) of project financing is obtained from "works rates" levied on those deemed to derive the direct benefit from these schemes. These are the Tier I beneficiaries.

Direct Benefits.

Flood control schemes, like the ones in Heretaunga Plains and the Upper Tukituki are undertaken with two declared objectives,

- to reduce the effects of flooding on life and property.
- To manage the existing drainage system to allow for efficient land use.

Both the schemes performs as expected during flood events in that flood deemed to be less than a 100 year return period event are carried safely, and scheme assets suffer minimum damage. The direct economic benefits from Flood control schemes, are then derived from preserving and improving the values of these assets. The direct benefits can be quantified depending on the availability of data.

Production Approach

One of the direct and visible benefits of flood control schemes is increased output, especially for the agricultural sector. By preventing (or reducing occurrences) of serious flooding, and land loss due to erosion or gravel deposition, flood control schemes contributes to higher output. Agriculture forms an

important base of the Hawke's Bay region. According to the Hawke's Bay Socio-Economic Profile (1996), agricultural production contributed $187 million to the region's GDP during the year 1995.

[8] There is some overlapping between the first two groups. The direct beneficiaries in the classified area also pay their general rates. This means their share to cost is slightly higher, which is completely offset by correspondingly lower share by the second group.

Another $82 million was derived from fishing, hunting, forestry and logging. In terms of employment, a full- time equivalent (FTE) of 6165 workers was employed by all primary industries in the region. Examples of production related benefits to specific sub-sectors that are relatively important in the two regions concerned would be the following:

- Horticultural production
- Crop production
- Dairy production
- Sheep and cattle stocking rates

Valuation Benefit

This is really an alternative (perhaps a better) way of looking at benefit assessment. The idea is that if flood control schemes contribute to increased production (and other benefits), then the value of these stream of benefits over the life of the scheme will be "capitalised" in the current market value of the properties benefiting from the scheme. In other words, "other things remaining same", landowners belonging to the scheme should enjoy higher capital gains than those that do not.

To test this hypothesis, information was solicited from Valuation New Zealand. Specifically, they were asked to supply valuation history on selected properties representing (i) on and off-scheme in (ii) Heretaunga Plains and Upper Tukituki regions and (iii) keep cost of searching at minimum. Four properties were randomly chosen by Valuation New Zealand. Below is a summary description of the properties and an analysis of their differential appreciation rates from their detailed valuation report.

Property 1 (Valuation Reference 9630/22200)

Located on Oak Avenue, Twyford, this is a 13.75 hectares of prime block of soil well suited to intensive horticulture (although it is being used as a stock fattening unit by its existing owner since 1950). Improvements comprise older modest dwelling, a small woolshed and haybarn.

This particular property has always belonged to the special rating area (Beneficiary Tier I) and pays works rates. In particular, new stopbank around the property was constructed in 1981-82. A drainage scheme was also completed in 1982. No major capital project has been undertaken since then. Land value appreciation, on an annualised basis, amounted to 16% during Jul 1980-Oct 1985 period. This compares to a half the appreciation rate (still healthy) during 1980-95 period. The figures for capital value appreciation are very much similar (14.2% 1980-85; 7.4% 1980-95).

Property 2 (Valuation Reference9550/19103)

Located on the corner of Dartmoor and Appley Roads, this is a 16.7 hectares of vineyard property which has been subdivided three times since 1960 and has been in a mixture of permanent crops over that time. This particular property stayed outside of the scheme (Beneficiary Tier II) until 1992 when a new stopbank around the property was completed (currently, Beneficiary I). The independent report from Valuation New Zealand states "we draw your attention to the significant increase in value evident in 1995 as the market fully recognised the benefits of the new stopbank, now protecting the land". During 1992-95 land value appreciation for this property, on an annualised basis, amounted to a steep 33%. This compares to a modest 6.6% annual appreciation during 1980-92 when it remained outside of the scheme.

Both property 1, and property 2 are located in the Heretaunga Plains region, and would currently qualify as Beneficiary I.

Property 3 (Valuation Reference 10790/20100)

185.6 hectares on Onga-Waipukurau Road, this is an intensively farmed property with some cropping. This property is classified for works rates (Beneficiary I) since inception of the scheme. Located at the confluence of the Tukituki River and Tukipo Stream, previous flood prone nature alleviated following topping up of stopbank. During 1988-94, land value appreciation for this property, on an annualised basis, amounted to a remarkable 28%.

Property 4 (Valuation Reference 10950/32600)

Comprising of 122.6 hectares on Arlington Road, handily situated to Waipukurau. This property is located outside of the scheme (Beneficiary II), but otherwise, as the valuation report states "a very attractive fattening property, balance of flats and undulating hill with good standard of well maintained improvements". During 1988-94, on an annualised basis, the land value appreciated at an astounding rate of 42%. This is even higher than the one for property 3 located in the same general area (Upper Tukituki) with added advantage of being in Beneficiary Tier I. One explanation for the paradox is that expected future benefits from the flood control scheme are capitalised around the time of initiating the schemes. Thus, the land value for property 3 were already inflated at the base year of the valuation period, October 1988.

Based on this report from Valuation New Zealand on selected properties, some observations are worth repeating.

- Land owners presumed to be the direct beneficiaries of the flood control schemes (Beneficiary Tier I) experienced a much higher rate of appreciation for their property compared to those that are outside of the scheme (Beneficiary Tier II). This was clearly evidenced in the Heretaunga Plains region. For the Upper Tukituki region, while the data may suggest exactly the opposite, an earlier observation prior to 1988, I believe, will resolve the paradox, as capitalisation occurs at the start (even little earlier) of the scheme.

- For the same property, capital expenditure, like stopbank construction in close proximity results in significant appreciation of the property.

INDIRECT BENEFITS

The more interesting and challenging aspect of benefit assessment involves the positive "externalities" of these schemes. Following are some examples of these "spillover" benefits which extend well beyond the boundaries of the classified rating districts of Tier I beneficiaries:

Protection of Infrastructure

These refer particularly to the roads and highways, bridges, railroad tracks, electricity and telephone transmission poles and underground cables. Flood waters will lead to premature aging of road seals, damage bridge structures, and reduced expected lifespan of wooden power poles. The important highways in the region SH2, SH5, and SH50 runs throughout all of the regions districts, culminating into the twin cities of Napier and Hastings. Most of the regions smaller roads feed in to one of these main trunk roads. Protection offered to the Wellington-Napier main railroad track would benefit all Tier II beneficiaries.

Ecosystem benefits

These benefits are derived from management of sensitive areas such as wetlands, estuaries, watersheds, riparian areas, and critical wildlife habitat areas. Biodiversity is life in all its forms and the habitat and natural processes that support it. Conserving biodiversity and ensuring the viability of ecosystems is essential to all. To the extent that capital and maintenance expenditures are useful in conserving biodiversity (although the primary purpose might have been different), these expenditures confer positive externalities well beyond the district or even national boundaries. Although these benefits cannot be measured in "hard dollar" terms, they are enjoyed by the entire regional community on an equal basis.

Recreation Benefits

The Hawke's Bay region is well-known for its high quality outdoor recreation opportunities provided by its extensive freshwater and marine waterways. Flood control schemes provide the opportunity for specific types of recreational use that depend on a mouth opening, drainage and discharge. Tourism

travel routes along major highways, railroads and the coast are enhanced by protected waterways along these routes by offering opportunities for activities such as, picnicking, boating, or just taking a short break from a monotonous journey. The availability of water based recreational facilities yields a number of personal benefits, and provides a setting for the pursuit of physical fitness.

To the extent that the regions quality and quantity of water resources contribute to a positive life style and provide opportunities for recreation, some of the flood control schemes may influence business relocation and expansion decisions in the regions communities. The same argument can be applied to the manufacturing, sales and exporting of water-based recreational equipment, such as kayaks, canoes, boats, sport fishing gear; industries that benefits from the regions capacity to provide abundant and safe water for recreational use.

Benefits of Cultural Heritage Preservation

Hawke's Bay regions cultural heritage is represented by the distinctive cultures and artifacts of the Maori people. The Maori culture represents a range of eras from pre-European contact, contact and post-contact periods. Historic features from settlement represent eras such as discovery, early exploration, fisheries and agriculture industries. A number of such cultural artifacts were destroyed by the Napier Earthquake of 1931. A new "Art Deco" character of central Napier was established between 1931-33. Buildings to the designs of the architect, J.A. Lewis Hay are also regarded distinctive. Flood control schemes provide a direct benefit in terms of reduced risk of damage from a notorious source, flash flooding.

Statutory Function Benefit

The functions, duties and powers of the Hawke's Bay Regional Council are contained within several Acts that forms its legislative framework. Of relevance for flood control scheme benefits are the following subset of the Acts:

- Resource Management Act (1991)
- Biosecurity Act (1993)
- Civil Defence Act (1983)
- Land Drainage Act (1908)
- Soil Conservation and Rivers Control Act (1941)

The Resource Management Act, for example, was created to promote sustainable management of natural and physical resources. Section 5 of the act requires communities to use its resources in a manner that will:

- sustain resources to meet reasonable needs into the future
- protect the functioning of life-supporting environmental systems
- avoid, reduce and remedy adverse effects on the environment

Statutory responsibility for implementation of the RMA falls quite heavily on the regional councils (RMA, Section 30). Compliance to the act is a responsibility that falls equally on beneficiaries in all tiers. Maintenance of flood control schemes provides vital input data to the council with respect to its land and water usage, quality and quantity of its water resources and other environmental parameters. The council, as part of its obligations under the Resource Management Act (1991), would be required to collect and disseminate these information, with or without the schemes. Same applies to all the other Acts stated above. In these respects, the cost would have to be financed from the general rates.

Option Value

Option value may be thought of as a kind of social or ecological insurance policy. It is a notional value attached to preserving a resource for future use rather than using it now. If a resource has zero option value with no other obvious forms of value attached to it, then the resource should be used, even if this means that it is totally consumed without replacement. This is done, for instance, when permission is granted for conversion of a swamp to an industrial site, and it is built upon. There may have been an endangered bird or other habitat on the swamp previously, but a societal judgement has made its elimination acceptable in favour of an industrial park site.

Indirect Benefits and Cost Sharing

While difficult, and in many cases impossible to quantify in dollar terms, it can be perceived that indirect benefits from flood control schemes are substantial. Table 4 represents a summary assessment of all types of indirect benefit across three beneficiary tiers.

Table 4: Distribution of Indirect Benefits

Indirect Benefit From	Tier I Beneficiary	Tier II Beneficiary	Tier III beneficiary
Infrastructure Protection	High	Medium	Low
Recreation	High	High	Low
Ecosystem/Biodiversity	High	High	High
Heritage Preservation	Medium	Medium	Low
Statutory Responsibility	High	High	High
Options Value	Not Applicable	High	High

For cost sharing purposes, what is important is that unlike their direct counterpart, the indirect benefits are less dependent on distance from particular scheme. Being subjective, actual cost allocation should rely less on the basis of indirect benefits.

Summary of Overall Benefits

The overall benefits of flood control schemes are multidimensional. Some of the direct benefits have very visible "hard dollars" attached to them. Indirect benefits, on the other hand, are based largely on individual value judgements. Existing literature clearly suggest these later group of benefits exist and have worth to both community and the environment. Many of the benefits require a comprehensive visitor and survey data that were not available. It should also be noted that the analysis does not encompass several non-measurable benefits. For these reasons, the estimates of economic impact are conservative in the sense that they deal with a subset of all benefits accruing from flood control schemes.

With respect to cost sharing or accountability, Table 5 summarises the current status.

Table 5: Current Distribution of Benefits and Costs

	TYPE OF BENEFIT RECEIVED		TYPE OF COST SHARED	
BENEFICIARY TIER	DIRECT	INDIRECT	WORKS RATES	GENERAL RATES
Tier I	X	X	X	X
Tier II	X	X		X
Tier III		X		X

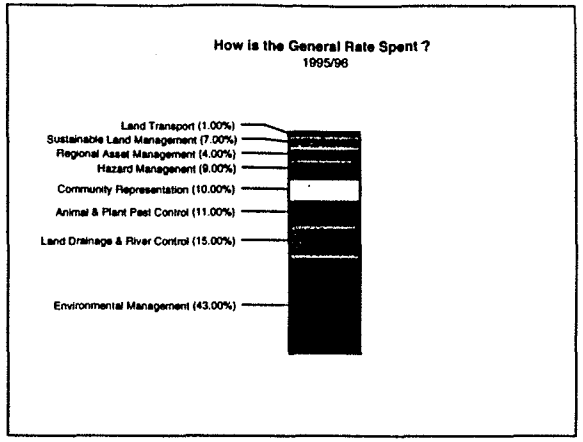
Use of General Rates and Concluding Remarks

General rates comprises the rating income sought from all ratepayers in the region and are used to fund activities which are assessed as being either of a total or partial regional benefit. The Council's entire rating policy is driven by the criteria of what is "fair and equitable, as well as being most efficient administratively". Flood control schemes represent a major expenditure to the Hawke's Bay Regional Council. In terms of annual operating expenditure during 1995/96, land drainage and river control cost $4.1 million. Only environmental management expenditures were higher at $4.3 million. Projected expenditures for 1996/97 are even closer between these top two categories of the Council's "significant activities". The distant third important category is animal and pest control with expenditure of $2.2 million during 1995/96.

Table 6: How much does general rates contribute to various "Significant Activities" ? 1995/96

Significant Activities	Expenditure '000	Funding met by General Rates '000	Relative share of General Rates
Environmental Management	4249	1323	31.14%
Land Drainage & River Control	4090	344	8.41%
Animal & Plant Pest Control	2197	274	12.47%
Community Representation	661	264	39.94%
Hazard Management	644	256	39.75%
Regional Asset Management	348	133	38.22%
Sustainable Land Management	794	271	34.13%
Land Transport	225	20	8.89%
Overall Average	13208	2885	21.84%

When it comes to net funding requirements, only 15% of the Council's general rate revenue is claimed by land drainage and river control activities and about three times of this proportion (43%) by environmental management activities. This policy is illustrated in the graph below. The third significant activity, animal and pest control receives 11% of the general pool, although expenditure on this category is only one-half from that of land drainage and river control. In fact, among all of the council's "significant activities", land drainage and river control relies least heavily (8.41%) on general rates for its funding requirement (see Table 6). In contrast, environmental management and animal and pest control activities derives 31.14% and 12.47% respectively of their funding needs from general sources.



With respect to the two flood control schemes concerned, the share derived from general rate revenue is slightly higher (11.29%) than the overall land and drainage activity (8.41%), but still quite low.

Table 7: General Rates' Share of Scheme Expenditures

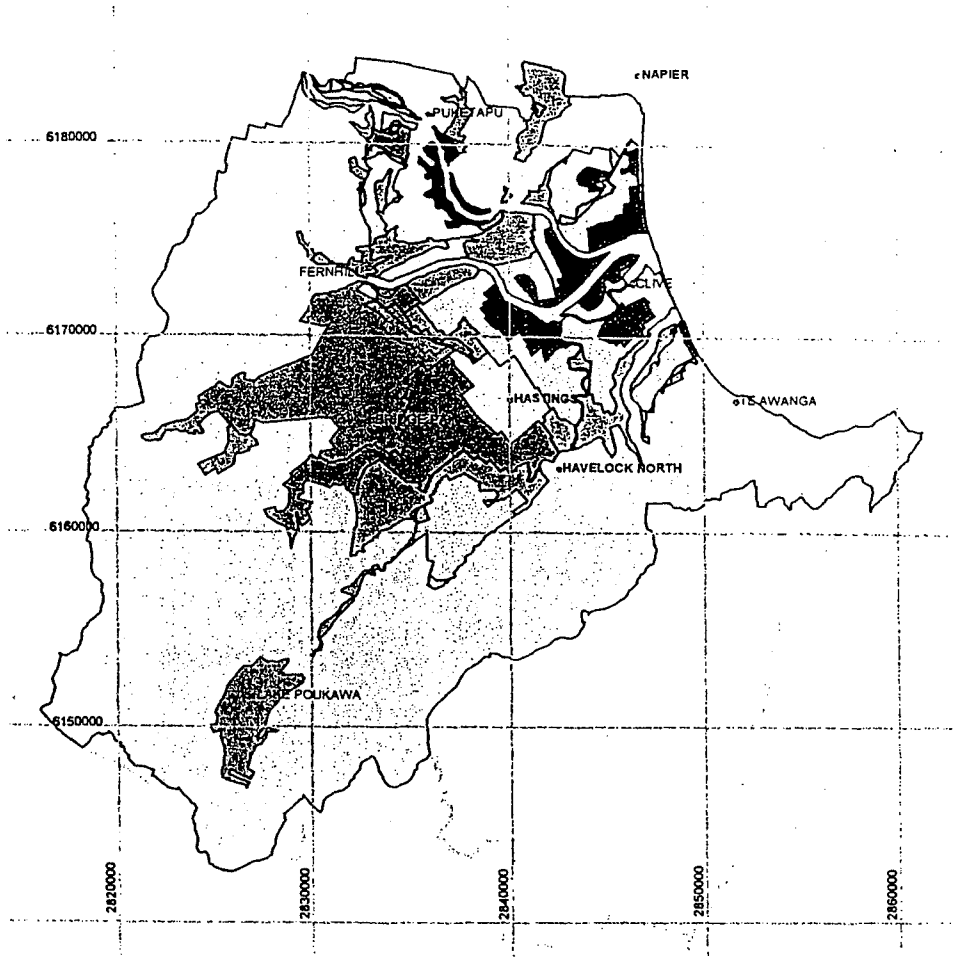
Flood Control Scheme	Total Expenditure	General Rates	Share (%)
Heretaunga Plains	3170000	358333	11.30%
Upper Tuki Tuki	473500	53000	11.19%
Combined Schemes	3643500	411333	11.29%

For rating policy to be transparent, one should rely more heavily on direct benefits. Currently, Beneficiary Tier I accounts for 75.61% of scheme cost by payment of works rates. General rates payers account for 11.29%. Since general rates are levied across the regions population, the combined contribution to scheme costs by Beneficiary II and III is less than this ratio. The remainder of scheme costs (13%) is derived from council reserves, the (opportunity) cost of which is shared evenly by all beneficiary tiers. If we exclude this funding from reserves, the current split between works rates and general rates would be 87-13. Taking this number as the index for current cost sharing and recognition of direct benefit across beneficiary tiers, a 80-20 split would be appropriate. This will imply general rates' share in scheme funding would have to rise from its current level of $411,333 to $632,820.

For an equitable rating policy, the indirect benefits should be recognised. The monetary value of these benefits cannot be determined precisely, but the benefits unquestionably exist. Recognition of these benefits will imply the share of general funding should go up, perhaps to 20% as most of these indirect benefits fall evenly on the wider regional community. The current practice of financing part of the schemes (13%) from council reserves exactly does that. When added to general rate, the combined funding from general revenue (reserves plus general rates) currently account for 23% of scheme costs.

Accountability would require this additional funding from general rates should be derived from Beneficiary Tier II, i.e., the ratepayers in the districts of Napier, Hastings and Central Hawke's Bay, while the other districts be left out to their current cost sharing because of their distance from schemes. For Upper Tukituki flood control scheme, this would imply general rates from the central Hawke's Bay would have to rise from current $515,000 to $543819 (or a 5.6% increase in general rates). For the Heretaunga Plains scheme, this would imply general rates from the districts of Napier and Hastings would have to rise from current $ 2,143,931 to $ 2,336,799 (or a 10% increase in general rates). For the Heretaunga Plains flood control scheme, additional complication arises from the vastness of Hastings district. It can be argued that some outlying areas of Hastings district such as Kuripapango would derive no more benefits from Heretaunga Plains flood control scheme than, say, Raupunga in Wairoa district, and still the former would be classified as Beneficiary Tier II, and the later as Beneficiary Tier III. These tiers were chosen by the operational necessity to remain within the existing district classification. An alternative would be to look at the Heretaunga Plains Flood Classification Scheme (see Map 1) and impose the additional rate on those currently under "G" classification. This group, because of their proximity to the flood control scheme, are at the borderline of Beneficiary Tier I in that they derive a high proportion of the benefits, including direct benefits. By not paying any works rates or direct charges, they currently enjoy a "free rider" status. However, this is just a suggestion, and the council may find a better way to secure this additional rate requirement from those deemed to belong to Beneficiary Tier II. In the meantime, further research need to be undertaken to estimate, as much as possible, these indirect benefits by, for example, a contingent valuation method. This will make the proposed policy both transparable and equitable.

Map 1: Heretaunga Plains Classification Scheme.



Data From: Cadastral information derived from the Department of Survey & Land Information's Digital Cadastral Database (DCDB)

Hawke's Bay Regional Council GIS Database

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FARM MANAGEMENT SECTION

CONTRIBUTED PAPERS

Feed Practices on New Zealand Farms

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ABSTRACT

New Zealand relies more on pasture for its wellbeing than any other single resource, yet we know little about how farmers make decisions on its efficient use. To discover more, a postal survey of a random sample of 3000 farmers was conducted and the results analysed. Currently only about 20% of farmers use formal feed budgeting, the rest maintain it is not worthwhile or economic. Some of the methods used by two example farmers that were studied intensively are also examined. Full details of the practices and responses are reported in this paper with a view to providing background that might stimulate further efforts to improve feed utilisation efficiency.

*Most of the hard work associated with the mail survey reported in this paper was produced by Greg Bishop-Hurley.

INTRODUCTION

The study reported here was designed to uncover the feed planning procedures used by New Zealand farmers, to ascertain the problems they believed hampered their grazing efficiency and to explore the day to day methods used by two example farmers in the Canterbury region.

The importance of the pastoral sector is reflected by the 45% of export income it earns (New Zealand Meat and Wool Board's Economic Service, 1993). It appears, however, that grazing efficiency could be improved. When comparing typical pasture production figures (Hoglund et al, 1979) with ewe requirements (Jagusch, 1973) potential capacity could range from around 12 ewes/ha to 29/ewes/ha depending on the area. Yet actual average carrying capacity is no greater than around 13 ewes/ha (New Zealand Meat and Wool Board's Economic Service, 1992). While a simple division of dry matter by animal requirement is an oversimplification, the figures do suggest gains are possible.

The study reported is a move in this direction through understanding existing procedures and perceived problems.

SURVEY PROCEDURES

(i) Postal Survey

A stratified (region, size (area), farm type) random sample of 3097 farms was selected from the Valuation New Zealand data base with strata numbers being proportional to their size. Each farm was sent a questionnaire containing feed planning questions in November 1992. Full details of the questionnaire and data collected are presented in Nuthall and Bishop-Hurley (1994). The questionnaire was pre-tested on thirty farmers. After reminders and another copy of the questionnaire the response time was ended in late May 1993. After allowing for incorrect addresses, deaths etc an effective response rate of 37.1% was obtained. This is similar to other surveys (Novak and Stagelin, 1988).

A telephone survey of a stratified random selection of 57 non-responders using essentially the same questionnaire was conducted after the postal survey. Of these 42 valid responses were obtained. The remainder had, for example, a changed but unobtainable telephone number, had retired etc. Comparisons of the population statistics (where available) and the non-responders statistics with the postal sample statistics strongly suggested the responding sample was representative. When comparing the sample with the population statistics the largest difference of the percentages falling in each strata was +5.08% and -4.59% (average +1.47% and -1.22%). Respondent and non-respondent responses (averages and distributions) were not significantly different.

(ii) Detailed Observations from Two Example Farmers

To gain further insight into feed planning approaches two farmers who were prepared to undertake several sequential interviews were selected. Over a period of eighteen months several (five in one case, three in the other) non-structured interviews were recorded. At each, all feeding decisions since the last visit were discussed. The objective was to discover the decision rules and procedure used in each case. Both farmers were experienced - one was a Canterbury light land fat lamb and wool producer, the other a Canterbury foothills producer also primarily producing lamb and wool. All interviews were taped and subsequently put onto hard copy for analysis.

FEED PLANNING PRACTICES

Use of Feed Budgeting

Formal feed planning on New Zealand farms is commonly referred to as feed budgeting in which estimates are made of, usually, dry matter requirements relative to production and reserves on a period by period basis. Plans are made to ensure demand matches supply through, for example, *in situ* carry over, conservation, altering demand, changing intake and therefore, usually, production, and so on.

Despite the professed advantage of feed budgeting (Baars, 1987; Baars, 1990), it is not regarded as common practice. The following tables describe farmers' use of feed budgeting.

Table 1

Farmers' Use of Feed Budgeting
(N = 1041)

Budgeting Use	Percent Responders	Percent Non - Responders
Have never used formal feed budgeting	68.6	76.2
Used to use formal feed budgeting	10.3	4.8
Currently use formal feed budgeting	21.1	19.0

In fact a surprising number of farmers believe they use feed budgeting, though exactly how they interpret the meaning of the words "feed budgeting" is, clearly, not known. However even the non-responders gave a relatively high figure.

Table 2

Hours per Month Devoted to Feed Budgeting

(N = 262)

Hours	Percent	Hours	Percent
0.0 - 1	16.5	6.1 - 7	1.2
1.1 - 2	21.7	7.1 - 8	6.1
2.1 - 3	8.0	8.1 - 9	1.1
3.1 - 4	21.4	9.1 - 10	3.8
4.1 - 5	7.3	10.1 - 11	0.8
5.1 - 6	6.9	11.1 - 12	1.5
		12.1 +	5.8

Mean 4.62, Std devn. 4.74, Range 0.15 - 40.0

Some 76% of respondents spent less than one hour per week on feed budgeting (Table 2) suggesting the majority of the 21% carry out informal calculations.

Table 3

Effect of Age on Time Devoted to Feed Budgeting

Age Range (yrs)	Ave. Hours/Month	No. of Respondents
0 - 30	7.12	48
31 - 40	4.01	106
41 - 50	4.44	68
51 - 60	4.64	30
61 - 70	3.42	6
71+	24.00	2

(F = 4.55 pr = .0005)

An analysis of variance of the age and time data (Table 3) showed the differences were highly significant, and a comparison of paired means indicated the first three were different (using the t test @ 5% significance) as was the last group (but small number). The new farmers are clearly enthusiastic about feed budgeting. This is also borne out by the data in Table 4, which relates age to the use of feed budgeting.

Table 4

Use of Feed Budgeting Relative to Age

Use of Feed Budgeting	Mean Age (Yrs)
Never used	46.90
Use to use	40.96
Currently use	39.46

(F = 46.61 pr = .0001)

The paired t tests show significant differences (@ 5%) between 'never used' and the other two groups but not between 'used to' and 'currently'.

Table 5

Relationships Between Farm Type and Feed Budgeting
(N = 1041)
Use of Feed Budgeting
Percentages on a Row Basis

Farm Type	Never Used	Used to use	Currently Use
Mixed cropping	74.0	10.6	15.4
Dairy	58.8	9.8	31.3
Deer	80.0	13.3	6.7
Sheep/Beef	76.2	12.1	11.61
Sheep	71.2	11.3	17.5
Beef	82.2	4.1	13.7
Other	68.0	8.0	24.0

Table 5 shows dairy farmers in particular are the most important users of feed budgeting with nearly a third in the 'currently use' category.

Table 6

Relationship Between Education and Feed Budgeting

Column Percentages

(N = 1020)

Education Level - Highest Attained

Use of Feed Budgeting	No Formal	Primary	Secondary ≤ 4 yrs	Secondary > 4 yrs	Tertiary ≤ 2 yrs	Tertiary > 2 yrs
Never used	100.0	91.7	75.3	57.1	53.7	51.3
Used to use	0.0	0.0	7.0	18.8	17.7	15.3
Currently use	0.0	8.3	17.7	24.1	28.6	33.4

(χ^2 = 65.61, Pr = 0.0)

There is a clear relationship between the use of feed budgeting and education level (Table 6). When comparing the hours on feed budgeting with education, capital value and total stock units there were no significant relationships.

To be able to predict whether a farmer is likely to practice feed budgeting a LOGIT (Pindyck and Rubenfeld 1976) analysis was carried out. The dependent variable is

$$Z = \log\left(\frac{P_i}{1 - P_i}\right)$$

where P_i is the probability, in this case, of the i^{th} individual using formal feed budgeting. The best and most logical equation was

$$Z = 0.361\ E - 0.393\ F - 0.466A$$

Where E = education level (1 = no formal edu,...6 = >2 yrs tertiary)
F = farm code
& A = age code (1= ≤30 yrs, 2 = 31-40 yrs,...., 6 = 71-80 yrs)

The codes/levels start at 1 (less than 30 years, no formal education), and progress through to 6 (greater than 71 years) and more than two years of tertiary education. The farm codes express the degree of intensity starting at 1 for dairying, 2 for mixed cropping, and 3 for all other farms.

The model statistics indicate a good fit and significance. The Akaike Information Criterion and the individual coefficients were all highly significant, and the Tau - c was 0.717 indicating a good ranking between observed and predicted outcomes.

To aid interpretation of the equation it is useful to provide a table of the probability of using feed budgeting for various combinations of the independent variables. Table 7 contains this data for combinations for which observations existed.

Probability of a Farmer Using Feed Budgeting for Various Combinations of Farm Code, Farmer Age and Level of Education.

(See text for code meaning)

Farm Code	Age Code	Education Level	Probability	Farm Code	Age Code	Education Level	Probability
1	1	3	0.55570	2	3	6	0.49542
1	1	4	0.64212	2	4	2	0.12703
1	1	5	0.72019	2	4	3	0.17269
1	1	6	0.78689	2	4	5	0.30049
1	2	3	0.43978	2	4	6	0.38128
1	2	4	0.52966	2	5	1	0.05985
1	2	5	0.61766	2	5	2	0.08369
1	2	6	0.69856	2	5	3	0.11584
1	3	2	0.25565	2	6	1	0.03842
1	3	3	0.33007	2	6	2	0.05421
1	3	4	0.41410	3	1	3	0.36304
1	3	5	0.50345	3	1	4	0.44983
1	3	6	0.59258	3	1	5	0.53979
1	4	2	0.17733	3	1	6	0.62722
1	4	3	0.23619	3	2	2	0.19959
1	4	4	0.30729	3	2	3	0.26347
1	4	5	0.38889	3	2	4	0.33913
1	4	6	0.47723	3	2	5	0.42401
1	5	2	0.11917	3	2	6	0.51363
1	5	3	0.16253	3	3	2	0.13533
1	5	4	0.21778	3	3	3	0.18335
1	5	5	0.28540	3	3	4	0.24361
1	5	6	0.36425	3	3	5	0.31602
1	6	2	0.07827	3	3	6	0.39860
1	6	4	0.14875	3	4	2	0.08944
1	6	6	0.26449	3	4	3	0.12351
2	1	3	0.45779	3	4	4	0.16815
2	1	4	0.54776	3	4	5	0.22479
2	1	5	0.63471	3	4	6	0.29378
2	1	6	0.71367	3	5	2	0.05807
2	2	2	0.26975	3	5	3	0.08125
2	2	3	0.34637	3	5	4	0.11259
2	2	4	0.43188	3	5	5	0.15398
2	2	5	0.52165	3	5	6	0.20703
2	2	6	0.61004	3	6	2	0.03725
2	3	3	0.24958	3	6	2	0.05259
2	3	4	0.32300	3	6	6	0.14079

Clearly, the younger, more highly educated farmers are more likely to use formal feed budgeting.

Problems With Feed Budgeting

To obtain ideas on how feed budgeting might be made more accessible, producers were asked why they did not currently feed budget. The responses are in Table 8.

Table 8

Reasons for Not Using Feed Budgeting

(N = 658)

Reason	Percent
No need, do it in head, never needed to, no benefits, use experience, can't be bothered, not interested.	60.2
Too complicated, don't understand, don't know how.	10.3
Variable climatic conditions make carefully planned feed budgets of little value in some seasons.	10.3
Insufficient time and resources.	9.4
Have learnt all the lessons, rely on past experience.	4.7
No confidence/experience in pasture/animal requirement estimates.	3.2
Accept that it's important and taking steps to start.	1.1
Perceived to be not accurate enough.	0.8

The majority believe feed budgeting would be of little benefit to them, whereas a significant number of others believe training would help. Climatic uncertainty invalidating the results was also a factor. Table 9 contains feed budgeters' comments on the difficulties they experienced and these also indicate similar conclusions. Only difficulties mentioned be more than 5% of the respondents are included.

Table 9

Difficulties and Problems Experienced by Feed Budgeting Practitioners

(N = 202)

Difficulty/Problem	Percent
Extra time and resources required (need for regular updates, teaching staff, getting a computer, etc).	31.2
Can't predict the weather (the effect climate has on budget forecasts).	17.8
Inaccuracy in estimating pasture cover (time of year).	14.4
Lack of confidence in predictions.	9.4
Inaccuracy in predicting pasture growth rates.	9.4
Inaccuracy in predicting energy values of pasture.	5.4

Suggestions on how to improve feed budgeting involve provisions of more information and equipment. Table 10 contains the limited number of responses that were provided for the categories mentioned by more than 5% of the farmers.

Table 10

Comments on Improving Feed Budgeting
(N = 24)

Idea	Percent
Better measuring equipment (DM, probe, etc.).	25.0
Standardised system throughout the country.	25.0
Better/more readily available growth data for each district (incl. nutrient data).	12.5
Low cost technical service to do measuring and/or calculations (budget) for the farmer (bureau).	12.5
Better training/teaching resources/courses (short-courses).	12.5

In contrast to the difficulties and problems, Table 11 lists the benefits feed budgeters believe they obtain.

Table 11

The Benefits obtained from Feed Budgeting
(N = 145)

Benefit	Percent
Easier to determine when to perform critical tasks such as drying off, weaning, when to shut up, lambing/calving date.	31.0
Efficiency improvements (incl. increased stocking rate, better use of feed, stock ready on time, know when to induce, etc.).	24.1
Predicts surpluses and therefore allows time to plan.	17.9
Predicts shortages and therefore allows time to plan.	11.0
Sense of security, greater satisfaction, less panic decisions, sleep better at nights, peace of mind.	11.0

Tables 12, 13 and 14 give the methods used to perform the calculations, the calculation units used, period lengths and so on.

Table 12

Feed Budgeting Techniques and Procedures
(N = 327)

	Percent
Calculate with pencil, paper and/or calculator	82.6
Use personal computer	6.4
Use hand held computer	2.8
Use Kgs of dry matter/lbs of dry matter	72.5
Use Stock units/ewe equivalents	46.8
Use Calories/megajoules	10.1
Use Cow/sheep grazing days	50.8
Cut and weigh feed production	5.8
Estimate feed production by eye	79.8
Use a pasture probe/plate	20.5
Regularly weigh livestock	26.6
Estimate animal weight/condition	51.4
Calculations bases on individual paddocks	54.7
Calculations based on groups of paddocks	28.4
Requirement calculations based on individual mobs	58.4
Requirement calculations based on combined mobs	20.2

Table 13

Period Ahead for which Forecast Feed Demand/Supply

Period Ahead (weeks)	Percent
<= 2.0	15.6
2.1 - 4.0	33.8
4.1 - 4.0	33.8
4.1 - 6.0	11.5
6.1 - 8.0	8.9
8.1 - 10.0	1.5
10.1 - 12.0	11.9
> 12.0	17.0

Mean 8.20, Std devn = 8.96, range 1 - 52.0

Table 14

Average Number of Weeks Between Updates of Feed Budgets

Percent in each season

Week Range	Spring	Summer	Autumn	Winter
<= 1.0	40.2	21.1	24.2	25.4
1.1 - 2.0	25.2	20.4	29.8	29.5
2.1 - 3.0	8.0	17.2	13.6	10.2
3.1 - 4.0	20.9	28.9	26.8	27.0
> 4.0	5.7	12.6	5.5	7.7
n =	187.0	128.0	198.0	244.0
Mean (weeks)	2.54	3.14	2.93	3.06

The traditional methods of pencil, paper and calculator using dry matter units with eye estimation clearly predominate.

The feed budgets are updated every four weeks or so, and are calculated for a slightly reduced period. Presumably there is a gap between the end of one calculation and the next update.

DISCUSSION ON FEED BUDGETING

It is very likely feed management on New Zealand stock farms could be improved thus enabling the same production from fewer resources or, alternatively increased production from the same resources all other things being equal. Either goal is worth exploring. A starting point is a knowledge of farmers' feed planning procedures.

The national survey has revealed some 80% of farmers believe formal feed budgeting is not warranted. Many professionals would argue this is not the case, though a particular farmers' objective (perhaps minimising paper work, for example) may mean what they are doing is correct from a personal view point. From a national perspective, however, it is important to consider ways of encouraging detailed feed planning as the return to the community as a whole is likely to be positive. Appropriate computer packages, better and more readily available information, and simple, but accurate, measuring devices must all be considered.

Of the 20% of farmers using feed budgeting the time input is not great (4.62 hours/month) suggesting the quality and depth of the planning could be improved. Farmers' objectives are likely to play a role in that the younger farmers devote more time to planning. Debt levels may well be a factor here as with lower debt older farmers may not feel the need to extract additional return from their resources.

Dairy farmers are by far the most common users of feed budgeting, perhaps because there is an immediate and obvious response to appropriate feed management. Furthermore, effort has been put into developing procedures and simple rules of thumb for use in this industry. There is no reason why potential responses are not as great in sheep and beef farming though more flexibility exists in that poor management on one or two days can be overcome. This is in contrast to the dairying situation where the effect on output is immediate.

The fact that younger more educated farmers tend to use feed budgeting suggests there would be a response to greater extension work. It could be argued that the 70% of farmers who maintain there is no need to feed budget, or say it is too complicated, could well change their mind if greater effort was put into running introductory courses and developing simple rules of thumb. Clearly any technique or equipment that can be developed which makes the process simpler and less time consuming than the current situation is likely to obtain a response.

Another factor appearing to be significant is the paucity of locally applicable growth information. While it would be expensive to develop a much wider network of sites for field measurements, perhaps farmers need to be enlisted and instructed on how to obtain measurements that can be used by farmers in their locality.

With increasing numbers of farmers holding micro-computers (In 1993 19% used a computer for business (Nuthall and Bishop-Hurley 1994)) a significant factor in the ease of feed-budgeting must be availability of simple but comprehensive feed planning software. The reported techniques farmers currently use (Table 12) should assist software developers in creating suitable systems. As micro-computers, and farmers' understanding of them becomes more extensive, feed planning will make a significant contribution to national efficiency.

FEED PLANNING - PROBLEMS AND SUGGESTIONS FOR ASSISTANCE

Areas of Decision Difficulty

The farmers were asked to specify for each of the four seasons the decisions they found difficulty in providing a satisfactory answer. A very wide range of problem areas were listed, some of which were very specific to farm type (e.g. how to feed stags to maximise velvet production). The following tables list the decisions that more than four percent of the farmers mentioned.

Table 15

Feed Management Decisions That Farmers Find Difficult to Answer SPRING (N = 783)	%
Set stocking (length/speed of rotation) vs rotation grazing of lambs and ewes, cows.	20.1
How much can I afford to take out of rotation for hay or silage (when to shut up for silage/when to cut silage, correctly identifying a surplus).	13.4
Coping with a unforeseen feed shortage (priority animals, if worse - options).	11.1
Stocking rate and mix of capital to trading stock (cattle to sheep ratio).	6.1
Controlling pasture quality (topping etc.).	6.0
Use of growth boosting fertiliser (includes nitrogen), and when to apply.	4.6
Calving/lambing dates/patterns.	4.5
Balancing the needs of different mobs (priorities).	4.3
Parturition feed management (stocking rate for lambing).	4.1

Table 16

Feed Management Decisions That Farmers Find Difficult to Answer SUMMER (N = 583)	%
Controlling pasture quality (topping, deferred grazing and bring in again).	22.6
How much can I afford to take out of rotation for hay or silage (when to shut up for silage/when to cut silage, correctly identifying a surplus).	13.7
Set stocking (length/speed of rotation) vs rotation grazing of lambs and ewes, cows.	11.5
When to sell trading (prime) stock-keep another week or sell.	9.6
Coping with an unforeseen feed shortage (priority animals, if worse - options)	8.4
Weaning, balance feed and age of lambs/calves.	5.3
When to sell, culls, (culling cows).	5.3

Table 17

Feed Management Decisions That Farmers Find Difficult to Answer AUTUMN (N = 639)	%
When to dry off herd/group (spring calvers).	17.7
Quantity of feed to conserve/accumulate for winter (how much/when to shut it up).	15.0
When to sell trading (prime) stock-keep another week or sell.	9.1
Flushing decision when and how much (use grain, go off farm).	8.9
Set stocking (length/speed of rotation) vs rotation grazing of lambs and ewes, cows.	8.5
Coping with an unforeseen feed shortage (priority animals, if worse, options).	6.9
Stocking rate and mix of capital to trading stock (cattle to sheep ratio).	6.3
Autumn feed management with regard to the use of hay, ASP, etc (when to start, when to stop, other supplements and combinations of).	4.5
Use of growth boosting fertiliser (includes nitrogen, when/how much).	4.4

FEED PLANNING - PROBLEMS AND SUGGESTIONS FOR ASSISTANCE

Areas of Decision Difficulty

The farmers were asked to specify for each of the four seasons the decisions they found difficulty in providing a satisfactory answer. A very wide range of problem areas were listed, some of which were very specific to farm type (e.g. how to feed stags to maximise velvet production). The following tables list the decisions that more than four percent of the farmers mentioned.

Table 18

Feed Management Decisions That Farmers Find Difficult to Answer WINTER (N = 502)	%
Winter feed management with regards to grazing pattern (rotation length, fast or slow, mob split).	34.7
Winter feed management with regard to the use of hay, ASP, etc (when to start, when to stop, other supplements and combinations of).	21.9
Controlling the winter pugging problem but need to maintain rotation as best can.	16.7
Stocking rate and mix of capital to trading stock (cattle to sheep ratio).	6.0
Coping with an unforeseen feed shortage (priority animals).	5.4

While there is a wide range of problems, a limited number emerge as the major difficulties. These include:

Rotational and/or set stocking conundrums.
Feed conservation - when, how much.
Coping with unforeseen shortages.
Controlling pasture quality.
When to dry off milking cows.
Winter feed management.
Controlling pugging.

This evidence clearly points to the areas when computer assisted decision aids, such as expert systems, may well be of assistance.

Farmers' Ideas on Improving Feed Planning

The respondents were asked to express their views about information, procedures, and/or assistance that might improve feed management and/or make the system easier to implement or more efficient than those currently available. Tables 19 & 20 contain a summary of their comments and the percentage of respondents making the comment. Ideas expressed by less than 4% of the farmers were not listed.

Table 19 Systems and/or Assistance Necessary to Make Feed Management More Effective (N = 623)	%
Improved weather forecasts and calculation of DM available.	24.7
Better information on pasture plants and fodder production patterns (e.g. more information on new plants which can stand rougher grazing treatment, pasture response to irrigation to assist scheduling, higher producing/more resistant pasture plants, what to grow, wastage, utilisation).	14.8
Localised records on factors affecting production (e.g. regional monitoring of rainfall, temp, soil temp, and soil moisture: ground temperature readings for local areas for better direction on grass growth, daily/weekly growth rate data for pasture by district and soil type).	12.0
Better/easier to use system to measure/calc pasture growth/usage/wastage, inexpensive way of calculating DM available for stock requirement.	7.7
Better market information (i.e. information showing average best times to buy and sell (e.g. what time of year on average are bulls the cheapest per kilo to buy), more feedback from meat companies and marketing organisations (highs and lows)).	6.9
Technical/diagnostic type information/systems (better/faster).	6.4
Better information on feed requirements (e.g. simple charts showing acreage of certain lengths of pasture required for stock for next 1/3 months).	5.3
Monthly local farm discussion groups to shape ideas.	5.0
Better information on alternatives (incl. information on new supplements as they become available, cheap high energy supplements, better information on the different feeds).	4.5

Obviously improved longer term temperature and rainfall forecasting would markedly assist in forecasting feed availability. This comment, however, is not particularly helpful other than to re-enforce the need to continue funding climatic research. All the other suggestions can be acted on, though without a formal government extension service it is not clear who should take the lead in each area.

Table 20 Ideas to Make Feed Management Easier or More Efficient (N = 90)	%
Always budget on having excess feed to accommodate any season (having extra supplements for those really bad years.)	43.3
Better local information on grass and fodder production etc.	8.9
Clear easy to read feeding tables/graphs (general stock req at time of year and all types of feed values for time of year).	8.9
Grasses which produce plenty of quality feed in dry spells, alternative species.	8.9
Better/easier grass measurement.	6.7
Technical/diagnostic information on minerals and protein in plants and effect on animal.	6.7
Localised records on factors affecting production (e.g. regional monitoring of rainfall, temp, soil temp, and soil moisture: ground temperature readings for local areas for better direction on grass growth, daily/weekly growth rate data for pasture by district and soil type).	5.6
Specialists who can be employed to help.	4.4

There is a demand for more extensive, local data on factors affecting production and requirements. Many producers also noted that a conservative approach was a key to success (always budget for a buffering surplus). Perhaps farmers need to take a lead in organising the provision of the information they require as it does seem that they are requesting very localised information. In this sense perhaps there is a place for detailed simulation models that can accept details of the local weather patterns.

When suggesting systems to improve management there is virtually no mention of decision models. As only around 20% use feed budgeting the majority clearly believe the work involved in the simple feed budgeting model is not warranted, or they do not know how to proceed. Yet the 20% believe it is beneficial. The lack of emphasis on decision models is probably due to lack of knowledge of the possibilities. If they are not familiar with simple feed budgeting it is doubtful whether simulation models and the like are a factor in their thinking, yet they should still be kept in mind as possible ways ahead provided suitable farmer orientated interfaces can be developed.

CASE STUDIES OF DECISION PROCEDURES

Introduction

It was suggested existing pasture production would be utilised more efficiently on many farms to give greater output for the same resources. In exploring how this might be achieved it is important to not only be aware of all the information presented earlier, but also to understand the day to day procedures used. To this end, two farmers were questioned intensively. This section reports the conclusions from analysing this data.

It is sometimes suggested that careful feed planning in dairying can be justified, but this is less likely to be the case in sheep farming. However, case studies of sheep farmers achieving extremely high production from careful management do exist. The Wishart-Southland intensive fattening farm (Country Studstock, July 1995, pps 61-62) is one case. For 1994 and 1995 they achieved, respectively, a lambing percentage 157 and 164, lamb weights 19.3 and 17.7 kgs, and wool of 108.1 and 104.7 kgs/ha. The income per stock unit was $87.55 and $98.70 respectively at a rate of 15.5 SU/ha. If all farms could achieve pasture production utilisation efficiency at these levels national income would increase markedly. It is useful, therefore, to consider the methods and procedures utilised in feed management decisions to see whether there are avenues for creating efficiencies similar to the Wisharts.

Construct Theory (Rules of Thumb)

Kelly (1955) believes people develop procedures for handling all decision problems they commonly face. He refers to their method, belief, or idea which prevails in all these situations as 'constructs'. For example, when choosing between an invitation from a best friend and that of a distant aunt to attend a party, the person might accept the friend's invitation based on the construct 'maintaining friendships is more beneficial to me than pleasing relatives'. Kelly hypothesises that such constructs are developed through time following experience, in this case, of attending parties. Such constructs lead to living a comfortable life, and if any one construct does not achieve this objective, it gets changed.

In that eighty percent of farmers do not formally feed budget they clearly use other methods as the basis for feed decisions. It is proposed that each farmer develops feeding constructs and these provide the basis for all feeding decisions. These 'rules of thumb' are initially developed from observing farm managers and peers. Subsequently their own management experience further enhances the 'quality' of the constructs which are probably also dependent on the individual's abilities and objectives. In an attempt to observe whether this hypothesis appeared to be relevant, two farmers, as noted in the introduction, were observed and questioned in some detail through several non-structured interviews. To give greater credence to the idea many more farmers would need to be similarly interviewed.

The transcripts of the taped interviews were considered in some depth to isolate the existence of the constructs and procedures. It was clear the construct idea fitted the data available, though this does not preclude other theories also being compatible. Given non-numeric data it is difficult to prove a concept without presenting all the transcripts. This is impractical.

The Construct Forms

Given below are examples of the constructs. It appeared these were developed through experience (often from mistakes such as running out of feed under certain circumstances), from observing neighbours, and from seeking advice. In addition to specific rules of thumb (e.g. you must have at least two years supply of winter feed on hand), it also appeared a general construct that calculation and comparisons were important under some circumstances. Thus, under these specific conditions, rather than simply apply a rule of thumb, it is appropriate to perform simple calculations to distinguish between the alternatives. Thus, the construct is 'calculate'.

Listed below are some quotes to demonstrate these views:

(i) **General Constructs**

(a) "We're on our normal winter feed programme - that is getting a break of winter feed everyday. I've got the ewes on a 21 day, 21 paddocks rotation. As soon as they started on the winter feed they had two days in each run-off and at the end of this week they'd have been right round. They carry on with a break from winter feed and they have one day in this run-off, and exactly the same for the hoggets".

(b) "The winter feed will probably last until the 5th or 6th of September - I think that will be about it. I've always planned on the 1st of September for finishing our winter feed and we've never missed out yet".

(c) When talking about whether his ewes were receiving sufficient feed one farmer gave his cues "I observe how the animals are responding - sitting down, chewing their cuds contentedly, staying with their lambs, the way the lambs are doing".

(d) "But anyway my effective stock rate is going to go down over the next month which it always does and that's when my silage comes in, that's where silage fits into my system so I've only got to close the paddock up for 5 or 6 weeks and I can do something. But the decision I've got to make is there still a fair possibility that I may not make any silage, I've got nothing on hand so the obvious thing to do is to work up another paddock and stick some more green feed in it. Now that's a decision I've got to make fairly soon".

(e) "Generally we take in a lot of grazing in the spring which goes into the summer. Last year we had 5,000 stock grazing here, the first of them arrived in early November and the last of them went in about the second week of February. It's based on the fact that what has happened in the past. We could run more stock but it's the winters that trip you up and so we use it as a safety bar when at this stage the value of all counted ewes and lambs we consider that they are under valued and that we can make good money out of it, so we're going to buy more of those and possibly take in less grazing so that's basically what we're looking at there.

(f) "I mean in a season like this we don't fatten lambs well in this country over the summer and our feelings are we're better to get rid of them early and get the ewes in really good condition and get a few more lambs to go in the sale next year, so you've got a higher percentage and you make your money up".

(ii) Developing Constructs Through Experience

(a) "Why not buy in additional stock?

I'm reluctant to do that on the count of footrot mainly, don't like buying in sheep. Every time I have bought in sheep I have gotten footrot or lice and/or lice".

(b) "All the effort I put into this year's wx lambs keeping them through that terrible winter and then had to give them away. I'm not going to do that again".

(c) "So I thought the way to make money out of this farm is to bang on plenty of sheep - which is what I did. I got up to 12 per hectare, or 5 to the acre. But when you get a year like this you pay, I've had to buy in feed, I've had to sell stock at give away prices, I've had to dump stock cause I was overstocked, you know all the things that can go wrong, went wrong. But of course in a good year you do quite nicely. But it was a lot more stressful and our overall stock performance suffered, our ewes got smaller cause we never did our hoggets quite as well. It's a little bit easier on a small scale to run bit numbers like that. In the end we reduced to 10 to the hectare".

(d) "Whenever I've sat down and worked it out homegrown feed always comes out on top of purchased feed".

(e) "We felt that weaner deer suited our country and because we're relative new boys we didn't want to get involved with stags, because big mobs of stags wreck tangled. We felt that breeding was where the strength of this country lay, so that's what we are aiming for. But I think the lesson we learnt out of it most of all is that we should have spread our risk a bit more, we should have bought some velveting stags, probably young ones, so we wold have had some cashflow when we were tripped up with the TB. Because the TB wiped all sales, other than the freezing works.

(iii) Learning When to Take Advice

"Why did you drench them then?"

"Well the vet sent out a special newsletter to talk about worm burdens. They've had some of the highest worm burdens in sheep. The vets recommended drenching twice before lambing the ewes".

"So you used the vet's recommendation rather than your assessment?"

"Yes. I've proven to myself over the years that they know more about it than I do".

(iv) The Thinking Ahead Construct

"You've got to think ahead with those 850 cryptorchids. I've got a bit of flexibility built in. They're doing quite well at the moment. I'm feeding them reasonably well. Now I could just put them onto a maintenance situation for say August, with my ewes and the pre-lambing feeding planned. Here's the classic situation, you get to the first of September, or we get to the middle of August, and the weather has turned cold again and we're back into winter, and I'm starting to get nervous about the first fortnight in September, so I could put those cryptorchids back onto silage alone and that gives me a bit of extra greenfeed I can use for the ewes a wee bit. I could even do it with the ewe lambs. The first thing to go would be those cryptorchids, I'm not worried about them, I'm going to get compensatory growth out of those things and I'll whip the wool off in the middle of September and drench them and they'll grow 100 miles an hour, no worries.

(v) The Calculation Construct

"Take these ewes for instance. The price is about $8 all counted, the way things are looking, they haven't got a great deal of wool on them, these ewes aren't in brilliant condition, but you know hopefully the ewes should probably be worth, by the time we shear the wool, more than $8, lambs are $8, this is delivered back on the place for us, and hopefully these lambs will be worth over $20, so that's $12 on the lambs and the ewes have covered themselves, that's $12 for the lambs to cover any interest or whatever, and that's in three months. With selling grazing, say you took in one stock unit and you'd be looking at grazing at present somewhere around 35¢-40¢, that's $1.20 a month, you might have them here four months so that's $4.80 and we are making out of one ewe, all counted, at least three times that".

CONCLUDING COMMENTS

Improving Feed Management

Top dairy farmers undoubtedly convert pasture to saleable product extremely well. Many use feed budgeting, but equally some of the managers of profitable units do not, even though they might have at an earlier time. They have acquired successful constructs.

By far the majority of sheep farmers do not feed budget - most maintain it is not worth the effort in what is only a semi-intensive production system. Yet, there are examples of very intensive sheep farms that achieve high production and high profit. Some would reason that many sheep, and dairy farmers too, could in fact intensify if the economic necessity and suitable management training for appropriate skill development was available.

For those farmers that do wish to improve pasture conversion efficiency it would appear necessary to examine the constructs under which they operate, and to consider how these might be altered. One procedure might be to encourage them to become involved in feed budgeting, and through this process they themselves might well discover and re-develop their constructs. Essentially this is a self education process through the stimulus of feed budgeting. Alternatively, they may seek consultant assistance in developing their skills. In the end various combinations may well be most appropriate. Improving personnel skills must also be individualistic in that the procedures and rules must suit the farmer, the farm family and the specific environment and farm on which the farmer operates. This process offers many challenges.

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SHAREFARMING, PARTNERSHIP, LEASEHOLD
AN EX-POST COMPARISON

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In 1995 at the New Zealand Agricultural Economics Society annual conference the author argued in a paper entitled "The Profits from Sharefarming: An Ex-Post Study" that in the 5 years from 1990, much of the profit in sheep and cattle farming came from increases in land values, and while these increases were of benefit to land owners they did not benefit traditional sharefarmers where the sharefarmer owned the stock and plant. The following paper takes the 1995 analysis and compares the profits from the other common forms of equity farming arrangements, farming partnerships and leasing, with sharefarming. The conclusion is that the partnership and leasing arrangements do improve the return to the non or minor land owning partner, but not to a degree that would suggest major changes to traditional sharefarming agreements.

Six years ago the Lincoln University Property Management Service held a seminar in Auckland on 'equity financing' in New Zealand Agriculture. The purpose of this seminar was to promote the use of equity funding in the purchase and development of farming and horticultural business's at a time when high interest rates and low profits made it difficult for farmers and those involved in horticulture to borrow sufficient funds on mortgage or overdraft.

One of the papers at this seminar (Plank 1990) looked at the returns from 50:50 sharefarming on traditional New Zealand sheep and cattle farms. Sharefarming was selected because it is an excellent example of an equity funding arrangement, it is common in world agriculture, and through sharemilking, is a well established and successful system of equity sharing in the New Zealand dairy industry.

The sharefarming system considered was where the land owner provides land and buildings and the sharefarmer livestock and plant, labour and management. Income is share 50:50 with the responsibility for expenditure based on the assumption that the land owner will pay for land maintenance and capital costs, and the sharefarmer the costs involved in labour, stock, and plant.

The farm used in the example (Schedule 1) was a typical sheep and cattle farm. The farm size, the number of stock and the production levels were adapted from, and were similar to, the Class 6 farms in the NZ Meat and Wool Boards' Economic Service Sheep and Beef Farm Survey. Class 6 is classified as 'S.I. Finishing/Breeding'. Many similar farms were, and are, found in Canterbury, Southland and many parts of the North Island.

In the 1990 analysis (Schedule 2) the return to the land owner at approximately 8%, was considered realistic, and comparable to the returns from similar investments in other sectors of the economy. It was also considered that the land values would increase at, or better, than the rate of inflation ensuring that the 8% return to the land owner remained a real yield.

Sharefarmers are more interested in the actual cash surplus than the yield on capital invested. Most have a debt and use the cash surplus to meet interest and repayments. In the 1990 example the sharefarmer's cash surplus was sufficient to meet interest and repayments on $80,000 of debt over the assumed 5 years of the contract.

The paper concluded with the comment that with land prices beginning to recover from the low prices of the 1980s, and with increasing confidence in the probability of increases in the prices of lamb and beef, 1990 was an excellent time for an investor to consider buying a traditional sheep and cattle farm.

In 1995, at this conference, in a paper entitled "The Profits from Sharefarming: An Ex-Post Study" (Plank 1995), it was assumed that a sharefarming proposal similar to that outlined above had proceeded, with a 5 year contract between an investor/land owner and a sharefarmer from 1 July 1990, and with the completion of the contract and the sale of the farm by the land owner, and the sale of stock and plant by the sharefarmer on 30 June 1995.

The original 1990 capital cost of land, stock and plant, plus the 1990 estimate of income and expenditure for both land owner and sharefarmer form the basis of 1990/91, year one, in the 5 year estimate of income and expenditure (Table 1). The only change to the figures is an increase of $5000 in the wages of management for the sharefarmer. The original figure of $12000 caused considerable debate in 1990 and in retrospect was too low. Otherwise the base 1990/90 figures are identical to those outlined in the 1990 analysis.

In the following years (1991/92 - 1994/95) the estimate of income and expenditure has been adjusted by the same percentage changes to sheep, wool and cattle income, fertiliser, repairs and maintenance, and other expenditure as outlined in Table 4, NZ Meat and Wool Boards' Economic Service, paper G2079 (Davison 1995). This income and expenditure data is considered adequate for the analysis. Other options, eg. full budgeting using actual average prices and detailed itemised expenditure were considered too time consuming and unlikely to alter the final result by a significant amount.

The cash surplus in Table 1 is the money available for tax, capital replacement, interest, debt repayment and profit. It is similar to what is commonly known as Net Farm Profit (NFP). Expenditure does not include depreciation. The salvage value of farm improvements and machinery and plant takes into account depreciation.

Table 1 - Estimate of Income and Expenditure 1990/91-1994/95

1. Land Owner	$	$	$	$	$
Income:	**1990/91**	**1991/92**	**1992/93**	**1993/94**	**1994/95**
Sheep	38220	37260	48000	54960	45710
Wool	40500	38180	34460	33970	44410
Cattle(Profit)	7500	8400	9470	8800	7590
Total Income:	**86220**	**83840**	**91930**	**97730**	**97710**
Expenditure:					
Fertiliser	9000	9950	13630	13710	11780
Rep & Maint	8000	7750	8850	9320	8530
Others	17750	18010	19830	19590	19540
Total Expenditure:	**34750**	**35710**	**42310**	**42620**	**39850**
Cash Surplus:	**$51470**	**$48130**	**$49620**	**$55110**	**$57860**

2. Sharefarmer

Income:	**1990/91**	**1991/92**	**1992/93**	**1993/94**	**1994/95**
Sheep	38220	37260	48000	54960	45710
Wool	40500	38180	34460	33970	44410
Cattle	7500	8400	9470	8800	7590
Total Income:	**86220**	**83840**	**91930**	**97730**	**97710**
Expenditure:					
Fertiliser	2000	2210	3030	3050	2620
Rep & Maint	1500	1450	1650	1740	1590
Others (Including Drawings)	64350	65280	71880	71020	70830
Total Expenditure:	**67850**	**68940**	**76530**	**75810**	**75040**
Cash Surplus:	**$18370**	**$14900**	**$15400**	**$21920**	**$22600**

Table 2., below, is a summary of the annual estimates of income and expenditure outlined in Table 1. It also includes, in 1990/91, the cost of land to the landowner and the cost of stock and plant to the sharefarmer, and in 1994/95 the sale of the farm, by the land owner, and the sale of stock and plant by the sharefarmer. The farm sale price is based on land values for this class of sheep and cattle farm in the autumn of 1995. The stock and plant figures are based on prices being paid in June 1995.

Table 2 - Income and Expenditure Summary and Analysis

1. Land Owner		**$**	**2. Sharefarmer**	**$**
1990	Land Purchase	(600000)	1990 - Stock/Plant Purchase	(140000)
1990/91	Share of NFP	51470	1990/91 - Share of NFP	18370
1991/92	" " "	48130	1991/92 - " " "	14900
1992/93	" " "	49620	1992/93 - " " "	15400
1993/94	" " "	55110	1993/94 - " " "	21920
1994/95	" " "	57860	1994/95 " " "	22600
1995	Land Sale	1200000	1995(sale) " " "	180000
Investment Surplus		**$862190**	**Investment Surplus**	**$133190**

INVESTMENT ANALYSIS:

1. Land Owner		**2. Sharefarmer**	
IRR	= 21.64	IRR	= 17.06
NPV (8%)	= $424,900	NPV (8%)	= $56,000

The investment surplus in Table 2 is the total net profit, before tax, over the 5 years of the investment. No attempt has been made to estimate the amount of taxation. For most investor/land owners, the profit from the sale of the land is a tax free capital gain. Taxation on the remainder of the profit would depend on the individual's marginal tax rate. The sharefarmer may or may not be liable for tax on the profits from the sale of livestock. It would depend on the livestock tax system that is in place and whether the sharefarmer is proceeding with another agreement, or buying a farm.

The second part of Table 2 is an analysis of the investment returns for both parties. The Internal Rate of Return (IRR) and Net Present Value (NPV) are the two measures used.

With an IRR of 21.64 and a NPV (@8%) of $424,900, the investment returns to the land owner are very good indeed. The most significant reason for these high returns is the increase in the value of the land. To some extent this increase was predictable. In 1990 farm land prices were increasing and there was an expectation that these increases would continue. What has been surprising is the amount of the increase. A 30-40% increase might have been expected, a 100% increase in price certainly was not.

The IRR for the sharefarmer is 17% with a NPV of $56,000. The analysis confirms that while the land owner, has made almost 300% more than the original prediction, the sharefarmer's returns are much more modest and very similar to the 1990 estimate.

The increase in the price of farm land since 1990 has had a negative effect on the sharefarmer. Buying a farm is the long term goal of most people involved in sharefarming. If one assumes, from the investment analysis, that the sharefarmer would have approximately $200,000 available cash at the end of the sharefarming contract, then purchasing a 3000 SU sheep and cattle farm at $150/SU was a realistic goal. With a land price of $300/SU it is impossible.

The 1995 analysis concluded that over the past 5 years much of the profit in NZ agriculture and in particular sheep and cattle farming has been due to the increases in the value of land. Despite the optimism of the early 1990s, increases in product prices have not been sufficient to have a significant impact on annual profits. The increase in land value, while benefiting existing land owners, is a problem for farm workers, or sharefarmers, who wish to buy a farm.

It was further stated that more flexible sharefarming or equity sharing arrangements, where all parties involved have an opportunity to share in the profits from both income and capital, could assist with this problem, and that farming partnerships, where all parties have a share in the land would be more equitable.

The remainder of this paper takes the 1995 analysis and compares it with two other popular forms of equity sharing, partnership and leasehold agreements. The assumptions of a 5 year contract from 1 July 1990 to 30 June 1995, with the purchase of land, stock and plant at the beginning of the agreement and the sale at the end remain the same. Two parties are assumed for each agreement, with the major partners (landowner, partner A, lessor) investing $600,000, and the minor partners (sharefarmer, partner B, lessee) investing $140,000.

Partner B in the partnership agreement therefore has a 18.9% share of land, stock and plant, while in both the sharefarming and the leasehold agreements, the sharefarmer and the lessee own the stock and plant. They do not share in the ownership of the land.

The rent for the lease is based on 6% of the 1990 value of land. This is considered a realistic return to the land owner and similar to 'real' returns from other investments. The expenses include equal amounts of wages or drawings for all working partners (sharefarmer, partner B, lessee). All other items of income and expenditure over the 5 years are the same as in the 1995 estimates (Table 1).

The results of the analysis are outlined in Table 3. The cash surplus/deficit is the same as in the 1995 estimates, with the addition of the capital cost of the investment in 1990, and the capital profits from the sale in 1995. The investment surplus is the sum of the net income and net capital profit, before tax, over the five years.

The analysis of the investment returns for all parties is also included in Table 3. As with the 1995 analysis the Internal Rate of Return (IRR) and Net Present Value (NPV) are the two measures used.

Table 3

Sharefarming, Partnership, Leasehold, Summary

	Land Owner $	Sharefarmer $	Partner A $	Partner B $	Lessor $	Lessee $
Surplus:						
1990	(600000)	(140000)	(600000)	(140000)	(600000)	(140000)
1990/91	51470	18370	55870	13970	36000	33840
1991/92	48130	14900	50420	12610	36000	27030
1992/93	49620	15400	51990	13000	36000	28990
1993/94	55110	21920	61620	15410	36000	41030
1994/95	57860	22600	64370	16090	36000	44460
1995	1200000	180000	1104000	276000	1200000	180000
Inv Surplus	**$862190**	**$133190**	**$788270**	**$207080**	**$780000**	**$215350**
IRR	**21.64%**	**17.06%**	**20.50%**	**22.42%**	**20.66%**	**27.32%**
NPV(8%)	**$424900**	**$56000**	**$376695**	**$104184**	**$391300**	**$120442**

The investment surplus of the major partners is highest ($862,190) for land owner in the sharefarming agreement and lowest ($780,000) for the lessor, but the range of IRRs, a more accurate measure of the returns on the investment, is only from 20.5% to 21.64%, a relatively insignificant difference. With the NPV's the highest returns are to the land owner (sharefarming) and the lessor (leasehold), both of whom capture all of the profits from the increases in the value of the land.

The returns to the minor partners is significantly less. Apart from partner B, they do not share in the profits from increased land values, the main reason for the high returns for the major partners. Their investment surplus's range from $133,190 (sharefarmer) to $215,350 (lessee), and their IRR also have a wider range, from 17.06% to 27.32%. Similar differences occur with the NPV analysis.

A comparison of the minor partners confirms that between 1990 and 1995 leasing was the most profitable option. With this option the rent is assessed at the low 1990 land values and the lessee then captures all of the extra income that occurred with product price rises between 1990 and 1995. With both sharefarming and the partnership these additional profits are shared between both the major and minor partners.

The inference from this analysis is that if it is expected that land and product prices will increase over period of the agreement, leasing is the most profitable option for the minor partner, followed by a partnership, with the least profitable sharefarming. For the major partner the differences are much less, but sharefarming is the most profitable, followed by leasing and then a partnership.

Despite the above results, it is considered that the differences in the returns from the different agreements are not sufficient to suggest any major changes. In fact one of the interesting results from the analysis is how similar the returns to the various options are. The sharefarming agreement is the least equitable, given the mix of product prices and increases in land values that occurred between 1990 and 1995. This problem could be solved by using the sharemilkng option of altering the percentage of income as product prices rise or fall.

R.D. Plank
June 1996

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Schedule 1

SHAREFARMING PROPOSAL - 1 JULY 1990

Land owner owns land - sharefarmer owns stock and plant

Physical and Production Data:

Area:	400 ha	
Stock:	2,700 ewes	
	700 ewe hgts	
	140 others	
	3,540	= 3600 SU
	100 weaner strs	= 400 SU
		4000 SU = 10 SU/ha

Policy:	Export lambs	
	Rearing own replacements	
	Ewes culled at 6yrs	
	Sheep deaths 5%	
	Cattle purchased as weaners sold 15-20 mths	
Prices:	Export lambs	$30
	Store lambs	$22
	C.F.A. ewes	$25
	Cull ewes	$15
	Wool	$4.50/kg
	Cattle	$150/hd profit

Capital: (1 July 1990)

Land and Buildings 150/SU - (land owner)			$600,000
Stock and Plant - (Sharefarmer)	Stock	$106,200	
	Plant	34,000	
	Total		$140,000
			$740,000

Schedule 2

Sharefarming
Estimated Income and Expenditure

			Land owner	Sharefarmer
Income:				
Lambs:	Export	(1820)	27,300	27,300
	Store	(450)	4,950	4,950
Ewes:	Breeding	(400)	5,000	5,000
	Cull	(130)	975	975
Wool:		(18,000 kgs)	40,500	40,500
Cattle:	Profit	($150/hd)	7,500	7,500
	Total Income		$86,225	$86,225
Expenditure:				
Stock purchases				1,500
Casual wages				6,000
Animal health				4,400
Farm Electricity				1,200
Hay and silage				6,000
Fertiliser			6,000	2,000
Seeds			3,000	
Freight			2,000	2,000
Shearing expenses			1,000	8,000
Weed & pest			3,000	1,000
Vehicle expenses				6,000
Fuel				7,000
Repairs and maintenance:				
Buildings, fences etc.- materials			8,000	
	- labour			1,000
	- machinery			1,500
Administration			2,750	2,750
Insurances			4,000	500
Rates			5,000	
Sharefarmer (wages/drawings)				12,000
	Total Expenditure		$34,750	$62,850
Summary:				
Income:			86,225	86,225
Expenditure:			34,750	62,850
	Cash Surplus:		$51,475	$23,375
Depreciation -	Buildings		4,500	
	Machinery			4,000
	Surplus		$46,975	$19,375
Capital:			$600,000	$140,000
Return on capital:			7.8%	13.4%

AN ECONOMIC ANALYSIS OF DAIRY FARM OWNERSHIP STRUCTURE: EVIDENCE FROM THE MANAWATU REGION

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ABSTRACT

Sharemilking provides an important framework for young people to gain entry to dairy farming and acquire assets for farm ownership in New Zealand. Recent increases in dairy farm land prices and the cost of shares in the dairy industry cooperative have adversely affected the ability of sharemilkers to purchase their first farm. In addition, steady increases in effective farm and herd size have led to larger capital outlays for herd and farm purchase, and put these goals beyond the reach of many aspiring new entrants to the dairy industry. A 1996 survey of sharemilkers and owner operators in the Manawatu region indicated that although 65% aspire to own a dairy farm, only 20% expect to achieve this goal. The average age of sharemilkers and owner/operators increased from 32 to 37 and 42 to 51 years, respectively, between 1988 and 1996. Fewer children of dairy farm owners are interested in dairy farming as a career and increasing herd and farm size have increased the demand for farm workers which are in short supply. If present trends continue, the number of dairy farms in the Manawatu region is likely to decrease substantially in the next few years as smaller farms become unprofitable. There will be a commensurate decrease in opportunities for sharemilkers and this has long-term implications for the sustainability of the New Zealand dairy industry.

Key words: sharemilking, farm ownership, dairy farming, farmer perception, farm affordability.

Paper presented at the Annual Conference of New Zealand Agricultural Economics Society, Blenheim, 5-6 July 1996.

INTRODUCTION

Ownership of dairy farms in New Zealand can be represented by four categories: owner operators, sharemilkers, contract milkers and others. Owner-operators manage their own farm and dairy herd; sharemilkers manage their own herd on an owner's farm; contract milkers are paid a pre-determined rate per kilogram milksolids produced; and some farms are managed by farm managers or farm workers. The owner-operators and sharemilkers represent the most common ownership arrangement (ca 98%).

Sharemilking in New Zealand is believed to have been introduced by the Scottish immigrants in the 1880s (Maughan et al., 1978). Benefits from sharemilking accrue to both the owners and sharemilkers: it ensures that the property will be well farmed and minimises input of the owner; it provides a career opportunity in dairy farming; it provides, unlike other enterprise, a steady cash flow and generally a higher level of profitability; and it involves only one commodity (Gardner, 1995). In 1994/95, one-third of the dairy farms had a sharemilker (LIC, 1995a). The proportion of sharemilkers to owner-operator dairy farms has remained moderately stable in the past 10 years at about 24% (Parker and Rauniyar, 1995). It is believed that sharemilking has contributed to the maintenance of a relatively young population of dairy farmers in New Zealand.

The recent steep rises in dairy farm land prices has been a limiting factor for aspiring new entrants into the industry. In addition, both herd and dairy farm size have consistently increased over time because of a general decline in the real returns from milksolids, and this has made dairy farm ownership less affordable for many young people interested in dairy farming (Parker and Rauniyar, 1995). In this paper, we examine recent developments in dairy farm ownership structure and their implications for the future of the New Zealand dairy industry. The analysis is based on Livestock Improvement Corporation (LIC) data and a 1996 survey of dairy farm owner operators and sharemilkers in the Manawatu region.

METHODS

Data from the annual LIC reports for dairy statistics and the economic survey of factory supply dairy farmers were used to analyse dairy farm ownership structure, the characteristics of dairy farms under owner operator and sharemilker ownership structures and factors explaining the number of dairy farm sales at the national level. In addition, a mail survey of sharemilkers and owner operators (n=175 per group) was conducted in March 1996. The questionnaire was designed to collect information on the personal opinion of sharemilkers and owner operators about a list of selected statements which had direct relevance to sharemilking and dairy farm ownership. Farm and household data were also collected. The survey instrument was pretested on six suppliers and administered after minor modifications. The suppliers were randomly selected from a Tui Milk Products Ltd mailing list. Independent questionnaires were sent to sharemilkers and owner operators, although several questions were common. A reminder by telephone two weeks after the first posting improved the survey response rate from 39 to 60%. Completed questionnaires were received from 100 and 115 sharemilkers and owner operators, respectively.

TREND IN DAIRY FARM OWNERSHIP

Table 1 indicates the distribution of dairy farm ownership in the past 11 years. Nearly two-thirds of the farms in 1994/95 were owner-operated. Only a small proportion of the farms were under contract milking or other arrangements. Four points are worth noting. First, the proportion of sharemilkers to owner-operators remained in the range of 38 to 44% until 1992/93, when it increased to over 50% in 1993/94 and 1994/95. Second, the proportion of sharemilkers to all dairy farmers was fairly stable (24 to 30%) until 1992/93, after which it increased to 33% in 1994/95. Third, the proportion of 50:50 sharemilkers to owner-operators remained steady in the range of 74 to 77%. Fourth, although the contribution of "other sharemilkers" is small, it has steadily increased in the last few years (from 1.6% in 1989/90 to 6.9% in 1994/95). One significant change is the decrease in the number of fixed 29% and 39% agreements after 1990. The recent changes in the proportion of traditional agreements (that is, 29, 30, and 50%) may reflect the introduction of the Variable Percentage Sharemilking Agreements.

The trend in the number of sharemilkers has followed that for dairy farmers (Table 1), and has remained reasonably stable over the past 10 years. Under the present sharemilking order, the industry is likely to experience a gradual decrease in the number of owner-operators and an increase in "other types of sharemilking agreements" that are mutually negotiated between the farmers and the sharemilkers. An alternate ownership arrangement becomes more appealing to owner operators as they become older or face other social and physical constraints.

PHYSICAL CHARACTERISTICS OF DAIRY FARMS

A comparative review of dairy farm characteristics for owner operated and the 50:50 sharemilking farms for the 1988/89 and 1994/95 seasons appear in Table 2. Both owner operators and sharemilkers increased their herd size and effective farm area, but kept the stocking rate unchanged at 2.4 and 2.6 cows per hectare, respectively. Labour efficiency attained in terms of number of cows milked per labour unit suggests that owner operators have become more efficient in terms of this ratio than sharemilkers, although the latter, on average, continue to manage larger herds on larger farms with fewer labour units. The gains in farm attributes over the period examined are proportionately less for the sharemilkers than the owner-operators in all aspects, including productivity per cow. This may be associated with two factors. First, sharemilkers exploited the potential gains under the present farming environment earlier than the owner-operators possibly because they are seeking to maximise equity generation. Second, sharemilkers may face a different set of constraints than owner-operators (for example, availability of capital) which limits their performance.

DAIRY FARM LAND AND MILKSOLIDS PRICES

The historical data for the past 18 years shows that dairy farm land prices have followed a somewhat cyclical pattern. Dairy farm land prices in the early 1980's increased by more than 40% compared to 1978 but after 1984, due to the introduction of economic restructuring programmes, they declined from NZ$11,467 to NZ$5,948 per hectare by 1988. Thereafter, land prices have continued to rise with the exception of 1991. The per hectare inflation adjusted price of dairy farm land in 1995 was 71% higher than in 1978.

Dairy farm land is typically productive land of easy contour and generally fetches a higher value than land used for sheep and beef cattle farming. Strong overseas demand for New Zealand milk products in the last three years and conversion of sheep and beef cattle farms into dairying because of unfavourable returns from the latter, collectively have increased the market price for dairy farm land. The subdivision of farm land on the outer periphery of urban centres into lifestyle blocks and demand for high quality land for horticultural production has also imposed constraints on the total area available for dairy farming. Together with a positive outlook for dairy exports and generally lower interest rates, these factors contributed to a sharp increase in land prices for dairying over the three year period from 1992.

FACTORS ASSOCIATED WITH NUMBER OF DAIRY FARM SALES

A regression analysis of the LIC data (1978-1995) was performed to examine the factors associated with the number of dairy farm sales in New Zealand (Table 3). The result suggests that the number of dairy farm sales depended on three major factors: price of milksolids per kg, farm area and herd size. These three factors explained 80% of the variation in the number of dairy farm sales. The number of dairy farm sales was found not to be associated with the lagged values of milksolids price and milksolids yield per cow, and thus were not included in the final regression model. The empirical analysis suggests that the number of dairy farm land sales was positively associated with increased per kg milk payout and effective farm size. However, larger herd size had a negative impact on the number of dairy farm sales. The recent announcement by the Dairy Board that the milksolids payout in 1996/97 will be lower than in 1995/96 may dampen the number of dairy farm sales. Average farm and herd size are likely to increase in the future as the number of dairy companies decreases and dairy farms are required to become more competitive in the presence of a lower milk payout through economies of size.

MILKSOLIDS AND DAIRY FARM LAND PRICES

Dairy farmers in New Zealand received 16% less payout per kg milksolids in 1995 compared to 1978 (decrease from NZ$4.05 to NZ$3.40) *in real terms*. However, milk payouts, in general, has guided the dairy farm land price, although at a slower rate. Future milksolids payout and land prices are likely to be governed by external factors such as improved access to international

markets through the World Trade Organisation (WTO), overseas demand for dairy products, the strengthening value of the New Zealand dollar and the extra returns generated value added dairy products.

LABOUR EFFICIENCY ON DAIRY FARMS

Production and cost efficiencies, reflected by increasing herd and farm size, high prices for dairy farm land, and relatively low milksolids returns, have all contributed to dairy farm management decisions being different to what they were 20 or 30 years ago. The relationship between farm owner and employee/ sharemilkers has also changed. The dairy industry has a high turnover of staff (Wylie, 1993) and some farmers are generally perceived as bad employers (Dairy Exporter, 1993). Some farmers employ staff only when returns from farming are good and lay these off when they were deemed not to be necessary (for example, after the peak labour period in early lactation). Blunden's (1995) analysis suggests that between 1984 and 1990 dairy farms had large declines in both hired and family labour use, which reflects gains in labour productivity. Increases in labour efficiency, particularly among owner-operators (Table 2), have led to fewer jobs overall on dairy farms (LIC, 1995b).

OPPORTUNITIES FOR ENTRY INTO DAIRY FARMING

The steady decline in the number of herds has been a driving factor for reduced opportunities for entry into dairy farming. The capital outlay required for a larger herd and farm has become increasingly prohibitive for an average entrant (NZ$1.1 million for farm land purchase alone at 1995 prices). Hall and Martyn's (1993) estimate suggested that in 1992 a sharemilker would have to receive a 20% return on capital simply to build the equity necessary to purchase a farm. Another factor hindering entry into dairy farming is the 'new' farmer classification criteria adopted by the New Zealand Dairy Group, the largest dairy company in New Zealand (ca. 40% of herds). Incoming dairy farmers are classified as "new suppliers" even though they may have been sharemilking for a number of years. The new suppliers are required to pay shares related to their expected level of milksolids production (an estimate average of NZ$44,000) before their milk is picked up (New Zealand Farmer, 1994). Other dairy companies are also requiring shares to be purchased to fund new capital development of processing plant. From 1996 shares at NZ$1.00 per

kg milksolids will also need to be purchased from the New Zealand Dairy Board. These non-farm costs have increased the cost of entering the industry by more than NZ$100,000 for an economic dairy unit, and will dampen both land prices and the rate of growth in milk supply in the short-term.

The statistics on dairy farm sales indicate that about 5% of the dairy farms (an average size of 61 ha in 1994/95) are sold (LIC, 1995a) per year. At the current average farm size of 80 ha, only about 3.8% of the sharemilkers/dairy farm workers will succeed in becoming new entrants into dairy farming. This level of entry may be further reduced as existing farms continue to expand, leaving little room for new entrants to enter the dairy industry. Replacement of existing dairy farmers through their retirement is probably the most likely scenario for the majority of new entrants.

CHARACTERISTICS OF SHAREMILKERS AND DAIRY FARM OWNER OPERATORS IN MANAWATU

The characteristics of sharemilkers and owner operators in the 1996 Manawatu survey are presented in Table 4. The average age of sharemilkers and dairy farm owner operators were 37 and 51 years, respectively. In general, owner operators were in older age group cohorts (43% over 45 years of age) and slightly more than half of the sharemilkers were 35 years or younger. Both groups tended to have a similar level of education up to the high school level. Some sharemilkers may have opted to forego higher education in favour of obtaining a sharemilking position. Proportionately more sharemilkers had obtained a trade-related education compared to owner operators which is reflected in their experience with off-farm employment. Similarly, one in six owner operators and one in 20 sharemilkers were women, although it is known that women significantly contribute to sharemilking or dairy farm work in other categories as well. For example, because the results suggest that 74% of sharemilkers and 53% of owner operators received help from their partners in sharemilking and dairy farming, respectively.

Three-fourths of owner operators and four-fifths of sharemilkers were full-time dairy farm workers prior to their current position and one-third of the owner operators had been a sharemilker prior to owning a farm. Two-thirds of the sharemilking agreements were of the 50:50 type (or larger). The

effective farm size information suggests that there are twice as many smaller farms (60 ha or less) operated by owners than the sharemilkers, and these farms are more likely to disappear first as they become unprofitable. About 43% of the sharemilkers were not raised on a dairy farm.

THE OPINIONS OF MANAWATU FARMERS ON THE FUTURE OF SHAREMILKING AND DAIRY FARMING

The survey participants were asked to reveal their opinion for a list of statements (20 for owner operators and 23 for sharemilkers). They were given 5 choices to choose from: strongly agree, moderately agree, neutral, moderately disagree and strongly disagree. For presentation purposes "strongly agree" and "moderately agree" are grouped into "agree" and "strongly disagree" and "moderately disagree" are grouped into "disagree". The frequency distributions for the responses appear in Tables 5.

The results suggest that an overwhelming majority of sharemilkers and owner operators agreed that sharemilking provided the only realistic path to dairy farm ownership. The farm cadet scheme was seen to be an effective way to train future dairy farmers. They also agreed that information about sharemilking agreements and technology to improve per cow productivity was readily available. The majority of owner operators and sharemilkers also agreed that the lifestyle of dairy farming was just as important as the financial reward achieved.

Sharemilkers were relatively more pessimistic about the future of sharemilking than owner operators. Only one-fifth of the sharemilkers and two-fifths of the owner operators thought that the future of sharemilking was excellent. Another area of concern, was that only 19% of the sharemilkers and 34% of owner operators thought that children raised on dairy farms were interested in dairy farming as a career and almost all sharemilkers and owner operators considered larger herds made dairy farming more stressful. More than half of the respondents felt that dairy farming was more risky now than five years ago.

Table 6 contains additional statements that were of importance to both sharemilkers and owner operators. Almost all of the sharemilkers thought that entry into dairy farming and buying a dairy farm had become more difficult in the past five years. They needed to progress to larger herds, in

order to purchase a farm (which is consistent with the national data on herd size increasing over time). Three-fifths of the sharemilkers agreed that sharemilkers managing two or more herds prevented young people from entering into dairy industry and the same number reported difficulties with finding good farm labour. However, only 47% of the sharemilkers thought that they should not manage herds on two or more farms. Nearly three-fourths of the sharemilkers agreed that uncertainties associated with the milksolids price made financial planning difficult and 84% felt that high feed costs were a major problem in dairy farming. On a positive note, half of the sharemilkers revealed that the 1991 Resource Management Act was good for the environment. They also believed that sharemilking agreements favoured farm owners financially.

Although it was of a less concern to owner operators than sharemilkers, two-thirds of the owner operators thought that high land prices made dairy farming more stressful for farm owners. This finding is consistent with the need to increase effective farm size in order to remain profitable in the market place. Less than one-third of owner operators agreed that a sharemilking agreement was easier to set up and manage than employing a manager, but merely 6% of them agreed that it was easier to obtain a sharemilking position now than five years ago. This clearly reflects a more difficult market outlook for sharemilking positions in the Manawatu region.

More than three-fourths of the owner operators felt that compared to other types of farming, dairy farming provided a good way of life for the family business (presumably assisted by a steady cash flow throughout most of the year). More than two-thirds of the owner operators thought that financial constraints did not permit the full exploitation of available technology for dairy farming, although most of them agreed that technology to improve per cow productivity was readily available. Only 5% of the sharemilkers were women in the sample, but interestingly more than half of the owner operators thought that women sharemilkers were as capable as their male counterparts.

The opinions expressed by sharemilkers and owner operators have important policy implications for dairying in the Manawatu region. It is clear that the number of new farmers will decline and this will contribute to an ageing population of dairy farmers. A comparison between a 1988 survey (Hughes et al., 1989) and the present study suggests that the average age has increased by nine and five years, respectively for owner operators and sharemilkers. Also, increasing herd size

will contribute to greater demand for dairy farm labour, which is already in short supply in New Zealand's leading dairy regions.

FUTURE OF SHAREMILKING AND FARM OWNERSHIP IN MANAWATU

The survey data suggested that 51% of the sharemilkers obtained their sharemilking positions when asked to apply by the farm owner, while 28% had applied for and succeeded in getting a publicly advertised position. Only 5% of the sharemilkers acquired their position with the help of a consultant and 16% had other contacts. Nearly four-fifths of sharemilkers directly report to the farm owner; the remainder (9%) report to a consultant or other designated authority.

Farmers who participated in the survey were asked about their likely farming status five and 10 years from now (1996). Their reaction is summarised in Table 7. One-fifth of the sharemilkers thought that they would be on their own dairy farm in five years, but in 10 years time 42% expect to be on their own dairy farm. Nearly one-third of the sharemilkers will not be sharemilking in five years, while only 28% of them will retain a sharemilking position in 10 years. The rate of exit from sharemilking and dairy farm ownership will depend on prevailing market conditions and the rate of capital accumulation. Owner operators on the other hand, plan to continue their involvement in dairy farming with 71% of them still expecting to be there in 2006. The proportion of sharemilkers contracted out by owner operators is likely to remain at the 42-43% per cent level. Nearly half of the present owner operators will have a manager or contract milker in 10 years time and 19% of them expect to be out of dairy farming altogether.

The confidence in actually owning a dairy farm amongst sharemilkers was quite low as only one in five sharemilkers thought that they would be able to buy a dairy farm, although 65% of them aspired to do so. Another 9% expected to inherit the family farm. However, nearly half of them expected to buy a non-dairy farm in their lifetime. Nearly two-thirds of owner operators, on the other hand, intended to pass the farm onto their children, although only 39% had children currently involved in dairy farming. Only 3.5% of the owner operators intended to sell their farm. About 58% of the sharemilkers would consider off-farm employment if they purchase a dairy farm.

About 35% of the sharemilkers did not aspire to own a dairy farm at this stage, but they expected to continue sharemilking. Two-thirds of them aspired to buy a non-dairy farm. They also would like to save part of their income for retirement and for other purposes, including investing in off-farm assets. Most of the sharemilkers were happy with their agreements as they comprise standard or better than standard terms.

FUTURE OF SHAREMILKING IN NEW ZEALAND

Historical trends suggest that the total number of sharemilkers will decline in the future in proportion to the number of dairy farms (Parker and Rauniyar, 1995). However, sharemilkers will continue to be predominantly involved in operating larger farms with larger herds. The position of a sharemilker, as well as a that of a dairy farm worker, will increasingly become competitive and a large cash outlay will be required to initiate herd purchase. The trend towards large herd and farm size appears to be irreversible unless higher milksolids prices are received or corrective policy interventions are put in place, but in a deregulated market economy the dairy industry itself would need to provide leadership for this change to occur.

Current high dairy farm land prices do not help sharemilkers either. However, the cyclical movement in diary farm prices and the requirement to purchase industry shares means that land prices will eventually decline (Hargraves, 1993) and this should improve dairy farm affordability. Milksolids returns are likely to remain or marginally decrease in real terms from the current levels, but production costs for pasture and milk seem set to continue their increase, further squeezing profit margins in dairy farming.

A survey conducted by Hall and Martyn in 1992 suggested that farm ownership was still the major goal for most sharemilkers in the Waikato district. In recent years, concerns have been raised as to the future of the sharemilking system unique to New Zealand, as land prices have continued to increase (Hall and Martyn, 1993; Parker and Rauniyar, 1995). In 1996, 65% of sharemilkers aspired to own a dairy farm, but less than one-third of them actually expected to attain this goal. Obviously, if high farm land prices relative to milksolids returns persist, farm ownership will become increasingly difficult for most sharemilkers.

Sharemilking has traditionally been recognised as an entry path for young motivated people to gain farm ownership (Maughan et al., 1978). They tend to be innovative and are relatively more receptive to the adoption of new farming technologies and management practices (Gregan and Anderson, 1984; Dairy Exporter, 1976; Jarvis, 1979). Thus, sharemilking has been a factor in keeping the average age of dairy farmers much lower than those in the Northern Hemisphere. If fewer sharemilkers enter the industry and more stay longer in existing sharemilking positions, the competitive 'edge' of New Zealand dairy farmers over their Northern Hemisphere counterparts could be reduced. Also, the goal of sharemilkers is likely to change from dairy farm ownership to maximising income or non-dairy farm ownership.

CONCLUSION

Sharemilking agreements, which are in place on about one-third of dairy farms, have been an important element in encouraging new entrants into dairy farming. However, recent increases in land prices, declining real returns for milksolids, and non-farm barriers to entry have made it more difficult for sharemilkers to acquire their first farm. The squeeze on profit margins has led to a steady increase in both farm and herd size, and dairy companies now require new entrants to purchase shares in proportion to the farms milksolids production. These factors have also increased the amount of equity a sharemilker requires for first ownership.

Dairy farms in the Manawatu region are likely to follow the national trends in terms of larger effective area and herd size. Under the present environment, 40% of owner operator dairy farms are most likely to be purchased by other farmers seeking to expand their operation. This will result in fewer dairy farms unless compensation occurs through new conversions to dairying. In many Manawatu districts there are limited opportunities for further conversions to occur. The region is also likely to see sharemilkers remain longer in their existing positions relative to their predecessors and only a selected few will attain dairy farm ownership. This implies, *ceteris paribus*, that the average age of dairy farmers in Manawatu will increase steadily over time.

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Table 1: Dairy farm ownership structure in New Zealand (1984/85 to 1994/95).

Year	Owner-Operator %	The 50/50 Sharemilker %	The 29% Sharemilker %	The 39% Sharemilker %	Other Sharemilker %	All Sharemilkers %	Other & Contract %
1984/85	67.5	21.9	2.1	3.5	1.4	28.9	3.6
1985/86	66.9	22.4	2.1	3.5	1.4	29.4	3.7
1986/87	69.8	22.4	2.6	3.0	1.7	29.7	0.5
1987/88	71.2	21.3	2.3	2.5	1.5	27.6	1.2
1988/89	68.8	22.4	2.6	2.9	1.2	29.1	2.1
1989/90	70.0	20.0	2.4	2.7	1.6	26.7	3.3
1990/91	68.6	23.4	2.4	1.1	3.5	30.4	1.0
1991/92	74.1	19.4	0.9	0.9	4.0	25.2	0.7
1992/93	75.2	18.6	0.8	0.7	4.0	24.1	0.7
1993/94	65.7	24.9	1.1	0.9	6.8	33.7	0.6
1994/95	65.6	24.9	1.1	0.9	6.9	33.8	0.6

Source: Dairy Statistics, Livestock Improvement Corporation, Hamilton (various issues)

Table 2: Physical Characteristics of Dairy Farms in New Zealand (1988/89 and 1994/95) (Dairy Farm Owner-Operator vas Sharemilker)

Characteristics	Owner Operator 1988/89	Share-milker 1988/89	Owner Operator 1994/95	Share-milker 1994/95	Owner Operator Change %	Share-milker Change %
Cows milked	158	188	181	210	15	12
Effective area (ha)	67	72	77	82	15	14
Labour unit	1.51	1.35	1.41	1.48	-7	10
Cows milked per labour unit	105	139	128	142	22	2
Effective area per labour unit (ha)	44.4	53.3	54.6	55.4	23	4
Stocking rate (cows/ha)	2.4	2.6	2.4	2.6	0	0
Milk yield (kg MS/cow)	252	247	296	277	17	12
Milk yield (kg MS/ha)	597	646	695	710	16	10

Source: Economic Survey of Factory Supply Dairy Farmers, Livestock Improvement Corporation, Hamilton, 1995.

Table 3: Factors Associated with the Number of Dairy Farm Sales (1978-1995).

Factors	Regression Coefficient	t-ratio
Intercept	-969.38	-1.94
Price of milksolids (NZ$ per kg MS)	140.39	2.10
Farm size (ha)	65.54	7.34
Herd size (milking cows per herd)	-22.14	-7.56

Adjusted R-squared = 0.80 and Durbin-Watson statistics = 1.71 (p=0.15)

Table 4: Characteristics of sharemilkers and dairy farm owner operators in the Manawatu region (1996).

Characteristics	Sharemilkers	Owner operators
Age (mean years)	**37**	**51**
Up to 35 years (%)	54	17
36-45 years (%)	33	40
Over 45 years (%)	13	43
Education		
Up to primary level (%)	31	33
Secondary level (%)	27	32
Trade related (%)	17	4
High school (%)	18	17
Above high school	7	14
Gender		
Male (%)	95	84
Female (%)	5	16
Experience on dairy farm		
As a previous sharemilker (%)	40	36
As a contract milker (%)	n.a.	4
As a full-time farm worker (%)	81	97
As a part-time farm worker (%)	49	3
Sharemiking		
Currently are or have sharemilkers (%)	100	33
Less than 50% agreements (%)	33	34
50% or better agreements (%)	67	66
Effective farm size (mean ha.)	**91**	**85**
Up to 60 ha (%)	18	41
61-80 ha (%)	22	27
81-100 ha (%)	18	12
Over 100ha (%)	34	20
Unreported (%)	8	0
Herd size	**210**	**216**
Up to 150 cows (%)	20	17
151-200 cows (%)	25	25
201-250 cows (%)	19	18
251-300 cows (%)	16	15
Over 300 cows (%)	17	25
Unreported	7	0
Milksolids production	.	
Up to 40,000 kg (%)	13	n.a.
40,001-60,000 kg (%)	32	n.a.
60,001-80,000 kg (%)	22	n.a.
80,001-100,000 kg (%)	12	n.a.
Over 100,000 kg (%)	10	n.a.
Unreported (%)	11	n.a.

Source: Survey of sharemilkers and dairy farm owner operators in the Manawatu region, 1996.

Table 5: Opinion of sharemilkers and dairy farm owner operators in Manawatu (1996).

Statement	Sharmilkers (*Strength of agreement*) Agree	Neutral	Disagree	Owner operators (*Strength of agreement*) Agree	Neutral	Disagree
The future of sharemilking is excellent.	21	16	63	43	19	38
Sharemilking provides the only realistic path to dairy farm ownership.	85	5	10	77	8	15
Children raised on dairy farms are interested in dairy farming as a career.	19	37	44	34	30	36
The lifestyle of dairy farming is just as important as the financial rewards.	74	16	10	63	14	23
The farm cadet scheme is an effective way to train future dairy farmers.	80	14	6	75	17	9
Larger herds make dairy farming more stressful.	82	10	6	77	10	13
Keeping up with technological changes in dairy farming is difficult.	39	19	14	50	20	30
Technology to improve per cow productivity is readily available.	87	8	5	90	5	5
Dairy farming is a more risky business now than five years ago.	56	22	22	55	18	27
The 50:50 sharemilking agreements favour sharemilkers than the owners.	41	42	17	57	30	13
Opportunities for women to become sharemilkers are less than those for men.	64	24	12	45	44	10
Information about sharemilking agreement is readily available.	71	13	16	77	11	12

Source: *Survey of sharemilkers and dairy farm owner operators in the Manawatu region, 1996.*

Table 6: Opinions of sharemilkers and owner operators on other relevant issues in Manawatu (1996)

Opinion statement	Agree	Neutral	Disagree
A. Sharmilkers			
Over the last 5 years entry into sharemilking has become more difficult.	90	6	4
Sharemilkers should not manage herds on two or more farms.	47	15	38
It is more difficult for a sharemilker to buy a farm now than 5 years ago.	98	0	2
Sharemilkers now need to progress to larger herds, in order to purchase a farm.	91	4	5
Sharemilking agreements favour farm owners financially.	49	32	19
Sharemilkers managing two or more herds prevent young people from entering the industry.	60	7	33
Corporates such as Tasman Agriculture are good for sharemilkers.	27	39	34
Uncertain milksolid prices makes financial planning difficult.	74	13	13
High feed cost are a major problem in dairy farming.	84	9	8
Good farm labour is difficult to find.	61	22	17
The Resource Management Act is good for the environment.	50	35	15
Owner operators			
A sharemilking agreement is easier to set up and manage than employing a manager.	31	37	31
It is easier to obtain a sharemilking position now than 5 years ago.	6	17	77
Good sharemilkers are readily available.	61	21	18
Women sharemilkers are as capable as their male counterparts.	55	30	15
Sharemilkers have unrealistic expectations for financial returns from dairy farming.	40	32	28
High land prices make dairy farming more stressful for farm owners.	67	13	20
Compared to other types of farming, dairy farming provides a good way of life for a family business.	78	8	14
Financial constraints do not permit the full exploitation of available technology for dairy farming.	68	16	17

Source: Survey of sharemilkers and dairy farm owner operators in the Manawatu region, 1996.

Table 7: Future farming status of sharemilkers and owner operators in the Manawatu region (1996).

Sharemilkers

Planned activities	**5 years from now**	**10 years from now**
Still sharemilking	68	28
Sharemilking and have a partnership farm	22	16
On own dairy farm	20	42
On a non-dairy farm	17	21
Out of farming altogether	4	13

Owner operators

Planned activities		
Be dairy farming on present farm	86	71
Have a manager operating the farm	22	25
Have a sharemilker on the farm	42	43
Have a contract milker on the farm	20	24
Have purchased additional land	49	66
No longer be dairy farming	16	19

Source: Survey of sharemilkers and dairy farm owner operators in the Manawatu region, 1996.

Management and Performance Characteristics of Sheep Farms in the Wairarapa and Tararua Districts

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ABSTRACT

Information on the physical and financial performance characteristics of Wairarapa/Tararua wool production systems was obtained by mail and personal interview surveys of a stratified sample of 75 sheep farmers in the Wairarapa/Tararua region. The information was used to assess the adequacy of existing databases for describing the region's wool production systems, compare wool production system performance between different classes of sheep farm, and indicate ways to improve Wools of New Zealand (WONZ) extension activities in the region.

The New Zealand Meat and Wool Boards' Economic Service (NZMWBES) and Wairarapa Farm Improvement Club (WFIC) databases were satisfactory for describing some, but not all, of the wool production characteristics of farms in the region. Both databases appeared to underestimate wool production. There were few significant differences in wool production and financial returns between different classes and groupings of farms, despite large differences in farm resources, and none of these were consistent across all years. This suggests that considerable potential remains to increase wool production and financial returns on many Wairarapa/Tararua farms through improved farm management practices. Extension programmes to improve wool production and returns are likely to be more effective if they are targeted towards groups (or individuals) facing similar constraints.

Keywords: ***regional databases, wool production, wool income, extension, sheep farm management***

INTRODUCTION

The Wairarapa/Tararua region includes about 2300 sheep farms, and of these, 60% have flocks of 500 or more sheep. In the past, NZMWBES and WFIC farm production databases have been used to identify production trends and yield gap opportunities for Wairarapa/Tararua wool production systems. However, these sources of information may not be representative of the region. The 1993 NZMWBES Annual Sheep and Beef Farm Survey, for example, comprises information collected from only 22 Wairarapa farms and these are aggregated within the East Coast North Island Production Region. The WFIC data (Baker et al., 1993) is based on a convenience sample of club members. A survey of wool growers, the subject of this paper, was therefore conducted to establish whether the existing databases describing Wairarapa/Tararua wool production systems are representative of the region and therefore suitable for identifying problems and opportunities facing the region's wool producers. The latter information is important for WONZ staff and other consultants/extension workers who wish to improve the effectiveness of extension activities to wool growers in the region.

METHOD

Selection of the Survey Area and Sample Farms

The study covered the Wairarapa/Tararua region, except for a small part of the northern Tararua region for which a list of wool producers was not available. Stratified random sampling, with proportional allocation, was used to generate a representative sample of the region's wool growers. A list comprising 749 farmers with a flock size (total sheep wintered) of > 500 sheep was assembled from information provided by 26 local shearing and wool handling operators. According to Department of Statistics (1992) data, this represented 75% of the 996 farms wintering > 500 sheep but only 3% (20) of the reported 612 farmers in the survey area with flocks smaller than 500 sheep. The exclusion of farmers with very small flocks was probably because they often shear their own sheep or employ casual labour, rather than use a shearing contractor.

Sample Selection

Five strata for flock size strata were defined: < 500 sheep, 20 farms; 500-999 sheep, 10 farms; 1000-1999 sheep, 22 farms; 2000-4999 sheep, 44 farms; and > 5000 sheep, 14 farms. The number of farms in strata (2) to (5) was proportional to the numbers reported in these classes by the Department of Statistics New Zealand (1992). The total sample was restricted to 90 farms because this was the maximum number of sampling units that could be surveyed by personal interview in the time available. Systematic sampling was used to select sampling units from within strata, beginning with the first unit in each stratum. All 20 farms in the < 500 sheep stratum were surveyed by mail, but because of the poor response rate, these were excluded from the analysis.

Interview Procedure

Farmers were first contacted by telephone to explain the purpose of the survey, what information and time they would need to contribute, and to arrange a personal interview appointment. Interviewees were then posted a copy of the questionnaire and asked to complete the first three sections prior to the interview. The questionnaire sought information on the farmers and their wool production systems for the 1990/91, 1991/92 and 1992/93 seasons, using both open response and closed response questions. Personal interviews were conducted at the farmer's home and took an average of one hour to complete. At the conclusion of the survey, 75 completed questionnaires had been collected. The remaining farmers in the sample were not able to be interviewed because of their unavailiability and time constraints, but the original distribution of farms within flock size strata was approximately maintained.

Data Analysis

Data were analysed using the SPSSX computer programme. Descriptive statistics were applied to the characteristics of wool production systems and the management systems employed. Differences between means were tested for significance ($P<0.05$) using Duncan's Multiple Range Test for farm class, sheep flock size and summer rainfall/farm class groupings. A two-sample Student *t* test was applied to the summer rainfall groupings. Ordinal data were subjected to oneway analysis of variance and two-sample Student *t* tests.

RESULTS AND DISCUSSION

Comparison of databases

Wool production system performance indices, for 1990/91, from the Wairarapa/Tararua survey, NZMWBES and WFIC databases are presented for individual farm classes in Table 1. Mean values for the NZMWBES survey corresponded relatively closely with Wairarapa/Tararua survey data for farm size, total stock units, stocking rate and lambing percentage indices, but agreement was poorer for data relating to wool production, wool price and sheep wintered as a percentage of stock units. There was close agreement between WFIC results and the survey farm class data on the contribution of sheep to total stock units and average wool price, however the correlation with other indices was relatively poor. Average wool production system performance indices for three seasons from the Wairarapa/Tararua survey, and the NZMWBES and WFIC databases indicated similar trends through time (Table 2).

Differences between this survey's results and those for the NZMWBES and WFIC databases is likely to be related to the small sample size (22 farms in 1990/91 for the Wairarapa region) and the grouping of data into broad regional categories in the former survey, and the non-representative sample of farmer clients who have been long-term users of a private consultancy service in the latter database (Baker et al., 1993). However, it was difficult to obtain a representative sample in the current study as well, and it is likely that none of the data sets truly represent the Wairarapa/Tararua situation. The inclusion of wool sold on "lambs' backs" in the wool production indices in this survey may account for some, but not all, of the difference in wool production performance between the Wairarapa/Tararua survey data and the other databases. In addition, the effect of small flocks on performance attributes was not accounted for in the present study.

Overall, the results suggest that Wairarapa/Tararua wool production systems can be adequately described on an annual basis by combining the information in the NZMWBES and WFIC databases. Modification of the inputs to these databases to derive clean wool price and wool production figures would enable more accurate between-region and between-farm comparisons for these indices.

Table 1 Comparison of Wairarapa/Tararua (W/T) survey, NZMWBES and WFIC sheep and beef cattle farm performance indices for comparable class groupings (1990/91 data).

Parameter	W/T Class 3	NZMWBES Class 3	WFIC Class 1	W/T Class 4	NZMWBES Class 4	WFIC Class 2	W/T Class 5	NZMWBES Class 5	WFIC Class 3
Av. farm size (eff. ha)	552	607	1379	439	376	739	290	215	512
Total stock units	4858	4933	9902	4390	4040	7003	3132	2584	2688
Stock units/eff.ha	8.8	8.1	7.2	10.0	10.7	9.5	10.8	12.0	12.3
Stock units on sheep (%)	83	68	87	80	64	78	77	63	72
Lambing (%)	98	92	77	104	101	94	103	99	117
Greasy wool/ssu (kg)	5.2	4.6	3.9	6.1	5.3	4.9	5.6	5.1	4.8
Greasy wool/sheep ha (kg)	45	38	29	61	56	47	61	62	60
Av. net greasy wool price (c/kg)	292	278	295	291	279	283	293	276	296

Table 2 Comparison of Wairarapa/Tararua (W/T) survey, NZMWBES East Coast North Island Production Region and WFIC average performance indices.

Parameter	1990/91			1991/92			1992/93		
	W/T	NZMWBES	WFIC	W/T	NZMWBES	WFIC	W/T	NZMWBES	WFIC
Av. farm size (eff. ha)	427	444	729	427	442	771	427	434	748
Total stock units	4227	4052	6873	4227	4182	7400	4099	4118	7031
Stock units/eff.ha	9.9	9.1	9.4	9.9	9.5	9.6	9.6	9.5	9.4
Stock units on sheep (%)	80	69	78	77	68	77	74	65	73
Lambing (%)	102	97	94	104	102	101	96	94	88
Greasy wool/ssu (kg)	5.7	4.9	4.7	5.7	4.8	4.9	5.7	4.7	4.9
Greasy wool/sheep ha (kg)	56	46	45	56	45	47	55	45	46
Av. net greasy wool price (c/kg)	292	282	288	266	249	262	271	257	269

Performance between and within farm groupings

Physical and financial performance indices for farms grouped according to summer rainfall and NZMWBES farm class category are presented in Tables 3 and 4.

Table 3 Land and livestock characteristics of farms classified by summer rainfall/NZMWBES Farm Class category.

Parameter	Type 1 (Summer moist/ Class 3)	Type 2 (Summer moist/ Class 4)	Type 3 (Summer moist/ Class 5)	Type 4 (Summer dry/ Class 3)	Type 5 (Summer dry/ Class 4)	Type 6 (Summer dry/ Class 5)	Total n	Mean	± se
Total farm area (ha)	493^{ab}	318^{a}	318^{a}	818^{b}	679^{b}	365^{a}	74	488	45
Effective farm area (ha)	404^{ab}	305^{a}	282^{a}	651^{b}	618^{b}	294^{a}	74	428	38
su wintered per ha									
1992/93	8.8	9.6	9.9	8.9	10.0	9.8	73	9.6	0.2
1991/92	9.2	10.2	10.0	9.0	10.1	10.1	68	9.9	0.2
1990/91	9.0^{ab}	10.2^{ab}	10.4^{ab}	8.7^{b}	9.8^{ab}	11.2^{a}	66	9.9	0.2
Sheep su as % of total su									
1992/93	79^{b}	78^{b}	69^{ab}	77^{b}	71^{ab}	63^{a}	73	74	2
1991/92	81	79	74	79	74	70	68	77	1
1990/91	83	81	78	82	78	75	66	80	1
Lambing %									
1992/93	82^{b}	95^{ab}	98^{ab}	98^{ab}	96^{ab}	105^{a}	73	96	2
1991/92	94	107	105	104	102	108	70	104	2
1990/91	95^{ab}	109^{a}	99^{ab}	99^{b}	96^{ab}	106^{ab}	68	102	2
Clean wool production per ssu (kg/ssu)									
1992/93	3.6	4.5	4.0	4.3	4.2	5.1	62	4.4	0.2
1991/92	3.9	4.6	4.5	4.3	4.3	4.4	62	4.4	0.1
1990/91	4.0	4.7	4.5	4.1	4.5	4.2	62	4.4	0.1
Clean wool production per ha (kg/ha)									
1992/93	24.7^{a}	33.1^{b}	31.0^{ab}	29.9^{ab}	31.0^{ab}	28.4^{ab}	62	30.6	1.0
1991/92	28.3	36.5	38.7	30.6	32.8	30.8	62	33.6	1.0
1990/91	28.1^{a}	38.5^{b}	40.6^{ab}	29.1^{a}	32.9^{ab}	34.5^{ab}	62	34.7	1.0

a, b, c Means within rows with different superscripts are significantly different at $P < 0.05$.

Apart from significant differences in farm size and average paddock size between farm types, there were relatively few significant differences in physical and financial performance indices, and none of these were consistent across all years. This was surprising as differences in, for example, lambing percentage and wool production were expected between different farm "types" due to the variation in land production potential. In particular it was thought that factors normally associated with hard hill country (e.g. lower natural soil fertility, poorer producing pasture species and subsequent lower annual pasture production; steeper contour, less subdivision and subsequent less effective pasture management) would result in significantly lower sheep performance compared with "easier" hill country and intensive lowland finishing farms.

Table 4 Financial returns for wool and costs of harvesting wool on farms classified by summer rainfall/NZMWBES Farm Class category.

Parameter	Type 1 (Summer moist/ Class 3)	Type 2 (Summer moist/ Class 4)	Type 3 (Summer moist/ Class 5)	Type 4 (Summer dry/ Class 3)	Type 5 (Summer dry/ Class 4)	Type 6 (Summer dry/ Class 5)	Total n	Mean	± se
Average clean wool price (c/kg)[1]									
1992/93	322[b]	352[a]	363[a]	362[a]	353[a]	350[ab]	70	352	4
1991/92	346[ab]	330[b]	359[ab]	361[a]	354[a]	339[ab]	67	345	4
1990/91	387	373	379	374	385	382	63	379	4
Wool income per ssu ($/ssu)									
1992/93	11.79[b]	15.76[ab]	14.37[ab]	15.52[ab]	14.73[ab]	18.08[a]	61	15.25	0.58
1991/92	13.61	14.93	16.00	14.97	15.20	15.04	61	14.97	0.38
1990/91	15.99	17.56	16.76	15.37	17.48	16.10	60	16.85	0.62
Wool income per ha ($/ha)									
1992/93	79.64[b]	114.79[a]	112.90[ab]	107.49[ab]	109.84[a]	98.48[ab]	61	107.21	3.56
1991/92	98.75	119.38	137.24	107.72	116.43	104.92	61	114.95	3.93
1990/91	113.08[ab]	143.38[b]	151.88[ab]	109.01[a]	126.50[ab]	118.44[ab]	60	129.63	4.85
Wool harvesting cost 1992/93[2]									
$/ssu	2.52	3.60	3.29	3.43	3.72	3.95	71	3.54	0.15
$/clean kg	0.78	0.85	0.81	0.81	0.91	0.81	70	0.84	0.03
Wool cartage cost 1992/93									
$/ssu	0.26	0.20	0.20	0.31	0.20	0.33	35	0.23	0.02
$/clean kg	0.08	0.04	0.05	0.07	0.05	0.05	35	0.05	0.05
Wool return 1992/93[3]									
$/clean kg	2.41	2.65	2.81	2.77	2.59	2.68	69	2.65	0.06
$/ssu	9.18[b]	11.90[ab]	11.24[ab]	11.93[ab]	10.66[ab]	14.50[a]	69	11.62	0.52
$/ha	61.00	86.35	78.60	83.04	75.82	83.07	69	79.91	3.24

a, b Means within rows with different superscripts are significantly different at $P < 0.05$.

1 Average clean wool price net of selling costs, insurance and wool levy.

2 Wool harvesting cost includes shearing, woolhandling and woolshed supply costs.

3 Wool return = wool income - (wool harvesting cost + wool cartage cost).

Also, farms located in summer moist areas were expected to out-perform those in dry areas due to the positive effects of high summer and autumn pasture growth rates on wool production and ewe liveweights at mating. It can be inferred from these data that farmer and management factors had more influence on wool production system performance than state variables (e.g. farm location and size). The considerable variation in performance noted within individual farm groupings, as illustrated by Tables 5 and 6, supports this hypothesis.

Table 5 and 6 results suggests that considerable potential remains to improve wool production returns on many Wairarapa/Tararua farms. While farmers do not appear to face undue farm physical constraints to improving performance, they are likely to be constrained by their personal goals/objectives (Reid et al., 1994), access to information, and perhaps their management ability.

Table 5 Land and livestock performance characteristics of Type 2 (summer moist/Class 4) farms surveyed in the Wairarapa/Tararua region.

Parameter	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Total n
Total farm area (ha)	318	145	30	80	604	24
Effective farm area (ha)	304	138	28	78	573	24
su wintered per ha						
1992/93	9.6	1.6	0.3	6.6	12.6	24
1991/92	10.2	1.9	0.4	6.4	14.8	23
1990/91	10.2	1.6	0.3	8.3	13.4	22
Sheep su as % of total su						
1992/93	78	11	2	44	100	24
1991/92	79	7	1	67	94	23
1990/91	81	7	1	71	93	22
Lambing %						
1992/93	95	13	6	64	104	24
1991/92	107	17	4	69	133	23
1990/91	109	18	4	74	140	23
Clean wool production per ssu (kg/ssu)						
1992/93	4.5	1.1	0.2	3.1	8.2	21
1991/92	4.6	1.1	0.2	3.2	8.6	21
1990/91	4.7	1.0	0.2	3.3	7.7	21
Clean wool production per ha (kg/ha)						
1992/93	33.1	7.6	1.7	21.7	48.9	21
1991/92	36.5	10.2	2.2	21.4	55.3	21
1990/91	38.5	8.7	1.9	25.6	51.9	21

Table 6 Financial performance characteristics of Type 2 (summer moist/Class 4) farms in the Wairarapa/Tararua region.

Parameter	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Total n
Average clean wool price (c/kg)[1]						
1992/93	352	29	6	304	410	22
1991/92	330	24	5	288	389	23
1990/91	373	41	9	315	421	21
Wool income per ssu ($/ssu)						
1992/93	15.76	3.67	0.80	11.18	29.02	21
1991/92	14.93	3.61	0.79	9.11	27.12	21
1990/91	17.56	3.37	0.75	12.46	29.15	20
Wool income per ha ($/ha)						
1992/93	114.79	23.15	5.05	76.02	161.57	21
1991/92	119.38	32.26	7.04	61.59	174.60	21
1990/91	143.38	31.90	7.13	95.79	197.38	20
Wool harvesting cost 1992/93[2]						
$/ssu	3.60	1.36	0.28	0.48	6.77	23
$/clean kg	0.85	0.30	0.06	0.06	1.15	22
Wool cartage cost 1992/93						
$/ssu	0.20	0.14	0.04	0.04	0.57	14
$/clean kg	0.04	0.02	0.006	0.01	0.07	14
Wool return 1992/93[3]						
$/clean kg	2.65	0.45	0.10	1.94	3.82	22
$/ssu	11.90	4.10	0.88	7.98	27.96	22
$/ha	86.35	23.05	4.91	48.51	155.67	22

1 Average clean wool price net of selling costs, insurance and wool levy.

2 Wool harvesting cost includes shearing, woolhandling and woolshed supply costs.

3 Wool return = wool income - (wool harvesting cost + wool cartage cost).

Wools of New Zealand mass extension activities aimed at improving wool grower performance (e.g. field days, seminars, media publications and free publications) should be designed in relation to the range of farmer and management circumstances affecting sheep performance and activities should be tailored accordingly to address these needs (Gavigan & Parker, 1996). For example, further research could identify wool growers within the Wairarapa/Tararua area, with similar sets of constraints, and extension programmes could be developed to appeal to these particular producer groups, or individuals, rather than the farming community at large.

CONCLUSIONS

A survey of Wairarapa/Tararua sheep farms showed that while both NZMWBES and WFIC databases underestimated average wool production, when combined, they satisfactorily described most wool production characteristics on an annual basis. Importantly, they also provide information on other production enterprises farmed concurrently with sheep.

The disparity in performance between farms with apparently similar physical characteristics reiterated the impact management has on wool production and income, and highlights the potential for wool growers to improve profitability inexpensively through improved decision-making. This suggests that wool extension programmes may be more effective in they are tailored to a small homogenous group or individual basis rather than providing a common message for the entire sheep farming community.

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The Application of Systems Analyses to Group Goal Setting

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Abstract:

The operation of voluntary groups in the community will be enhanced by using procedures that build consensus when setting the groups' goals, and objectives. In carrying out research with farming groups, the authors have developed systems based procedures using Conceptual Pyramids and Resource Exchange Diagrams for incorporating the contributions of independent decision makers in planning the direction and focus of group activities. These procedures are not restricted to achieving production or financial outcomes, but can successfully include a full range of financial, social, intrinsic, and expressive goals contributed by group members.

Resource Exchange Diagrams have been used with groups to help all the members in a group gain an understanding of the exchanges that occur between farm production, agricultural marketing, community life, and natural resources. The use of these diagrams has provided group members with a greater understanding of the context within which their group is operating. From an understanding of group context, Conceptual Pyramids have provided a way for groups to establish and link their central goals with more applied goals and objectives.

Using Resource Exchange Diagrams and Conceptual Pyramids, farmer groups have developed goals and objectives that address the issues they associate with sustainable agriculture. These methods have helped those groups to overcome some of the more abstract and intangible aspects of planning their own learning on these issues. The groups involved have used the results to learn more about how their farming systems can be modified to improve their sustainability.

A paper presented to the New Zealand Agricultural Economics Society 1996 Conference
New Zealand Agriculture in the 21st Century
July 5-6. Blenheim

Introduction

Planning processes in groups are only effective when they function to help groups find a common understanding of their purpose and direction, rather than being an administrative procedure that must be completed before getting on with the real tasks of the group (Little 1988). Any group planning processes should provide:

1. an evaluation of the environment a group operates within, and the resources available to it.
2. a clear purpose for the group's formation and continual function
3. clear roles and expectations for the contributions of group members
4. a means of monitoring, evaluating, and evolving the performance of the group

Planning should also be simple, flexible, and informal (Mortiss and Chamala 1991).

Any voluntary groups dealing with sustainable-agriculture issues need to consider a complex and multiple dimensional hierarchy of systems (Conway 1985) that include a number of different farmer aspirations. Not all farmers wish to maximise financial returns from farming, and some may sacrifice potential financial rewards for more intrinsic, or social goals (Fairweather and Keating 1990). The different goals of individual farmers will affect their perceptions of group priorities.

In group planning, "mental models" of the central farming system to be addressed are often assumed by members (Dent 1995). In some cases these may be refined over time by continual interactions between the members of the group, until they provide a powerful basis to planning. The problem with such informal approaches is that neither their structure nor their imbedded interactions are stated or quantified, therefore they are not easily shared or evaluated (Dent 1995). Objectively developed systems that are currently used for group planning tend to describe only the production aspects of a farming operation, and exclude the equally important but more intractable social and personal but intangible components (Parminter, Howse, Gibson, Blackwell, Mills, & Topp, 1996). In other subject areas, systems models have been used to describe these more difficult aspects of human activity. The way in which groups of people interact have been described in systems of relationships between concepts linked by strands of meaning, such as in G. Vickers' appreciative systems (Checkland and Casar 1986). System models such as those developed using Soft Systems Methodology have also been used to relate purposeful human activities to desired outcomes. The group planning methods used by the authors have developed from both these approaches and been

used in participatory group planning. Resource exchange diagrams have provided a mechanism for groups to model their understanding of the systems that affect them. Concept pyramids have been used as a means of establishing group goals and objectives. As reported in this paper these methods have been applied independently of each other, future studies will link them together to build and maintain a systemic[1] approach to the planning and operation of problem solving community groups.

Setting A Context

In May 1995 Waikato Federated Farmers established some Study Groups in the Waikato. The groups consisted of farmers meeting to address issues related to farming more sustainably (Parminter, Wedderburn, Carter, and Paine, 1994). Currently there exists one group of dairy farmers and another group of sheep and beef farmers. The groups have a systems based approach to addressing the issues that arise within the groups. Both groups are resourced by the Foundation for Research, Science and Technology, Environment Waikato, AgResearch, and the LIC Advisory Service who provide the facilitators. The agencies supporting the groups are interested in encouraging more sustainable farming systems through a process of group learning and inquiry. Extension research staff with AgResearch are assisting by developing methods of facilitation and monitoring the learning progress of the groups. The results of the monitoring will be evaluated and provided to other individuals and agencies interested in establishing similar groups.

In March 1996 the groups revised their plans for their next year's activities. They wanted to understand the context within which their farms were operating as a basis for deciding future priorities. A resource exchange diagramming method was adapted by the authors and used within the groups (Perkins, 1995). Building a resource exchange diagram provided the groups with a way to visually evaluate the environment they were operating within and the resources available to them, as the first step in their planning.

To develop their group's resource exchange diagrams (example in figure 1), each of the farmers identified system components that affected their farming operations or that were affected by their farming operations. Components were placed on the diagrams in the level (or subsystem) within the global system with which they were most associated by group members. Exchanges were marked on the diagram where they crossed boundaries between levels.

[1] systemic because it considers whole systems (Checkland and Scholes 1990)

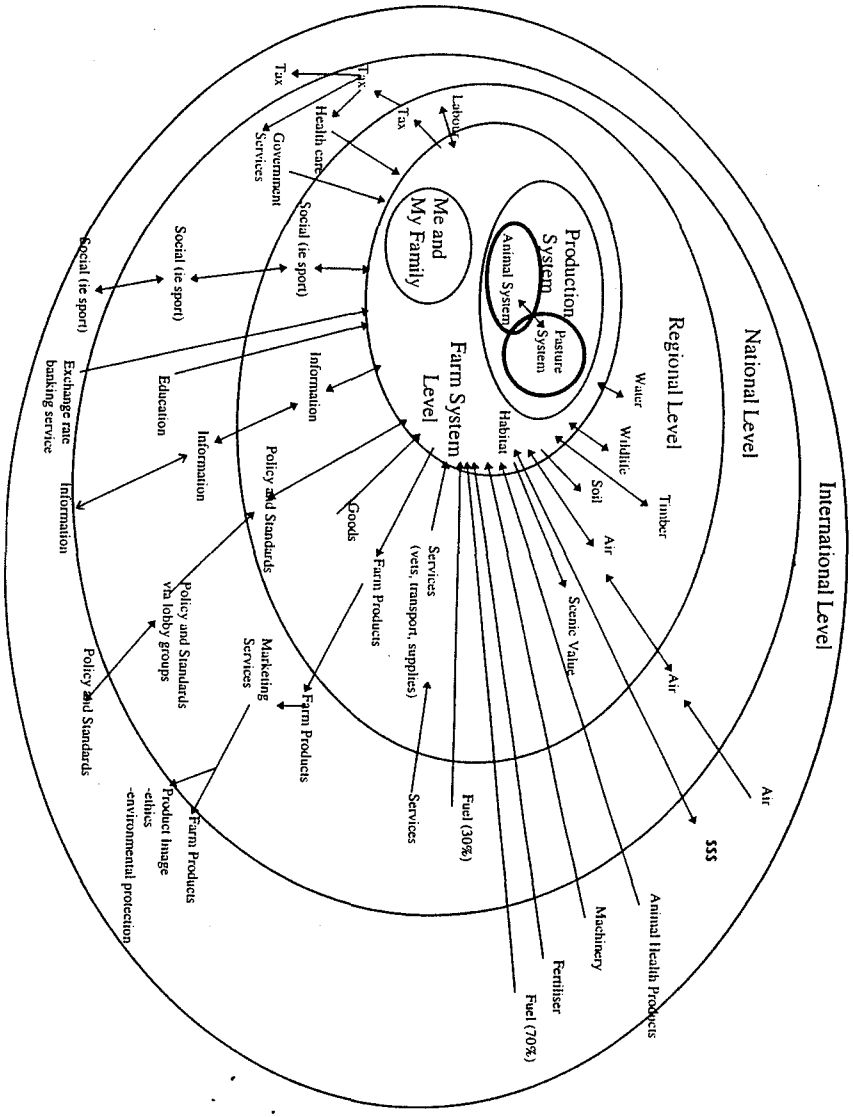


Figure 1. The Resource Exchange Diagram for the Sheep and Beef Farmers' Study Group

Subcomponents of exchange flows were identified when they provided farmers with additional opportunities to possibly influence (directly or indirectly) the outcome of an exchange. Generally a two-way flow of resources or activity is implied by the arrows, with each of the parties involved appropriating a benefit of value in the exchange. Some exchanges were perceived to be out-of-balance. These were identified when group members were aware that there were market or policy forces putting pressure on the system to restore balance.

By developing the resource exchange diagrams the group members developed a shared understanding of the context they were operating in and were able to discuss which areas needed to be part of the groups' goals and objectives. The groups considered they had little control over most international events, even though those events had a big effect upon their lives. Conversely they had much more control over activities inside the farm gate. The groups' farming operations became the focus of their goals, objectives and work plans, but were influenced by the perceived expectations of international markets and external resource dependencies.

Goal Setting

The systems approach to group goal setting was developed following a meeting with Waikato Federated Farmers in August 1993 when the authors were asked to develop a working definition of sustainable farming. The definition was to be recognisable to practical farmers and to provide a vision for setting policy and focus development of new management practices. Farmers themselves wanted to be involved in the process of turning the vision into a sustainable farming goal and planning its implementation.

It was decided to hold three workshops with livestock farmers from throughout the Waikato. Over 100 farmers attended the workshops Their consensus goal for "sustainable farming" was to achieve a balance of efficient farm animals, contented animals, productive pastures, clean water, control of feral pests, access to high value markets, family health, and adequate rural and agricultural services (figure 2). As well as goals for sustainable farming, the farmers also defined goals of having profitable farms and a good standard of living. It was only by balancing between these three that the farmers at the workshops perceived that they would have viable and enjoyable farm businesses and therefore be financially secure and satisfied in their lives (figure 3). Federated Farmers have since used the results of their project to develop farm management guidelines for farmers wishing to progress towards more

Figure 2. Waikato Livestock Farmers' Definition of Sustainable Farming Goal
(from Parminter et al 1993)

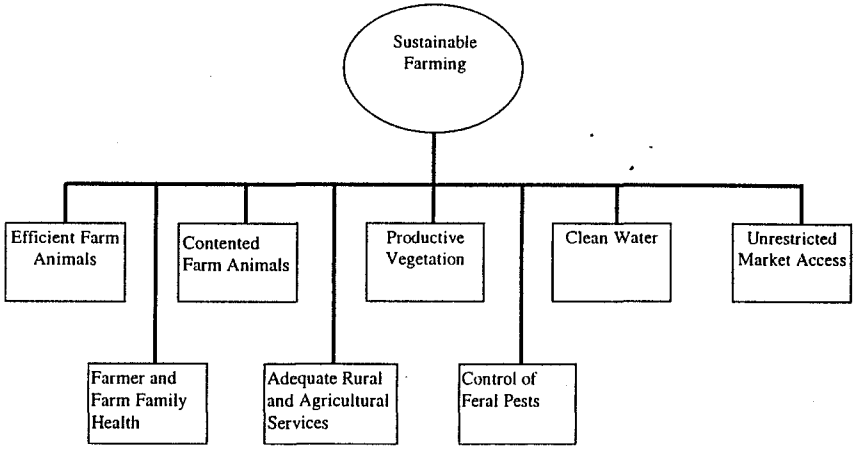
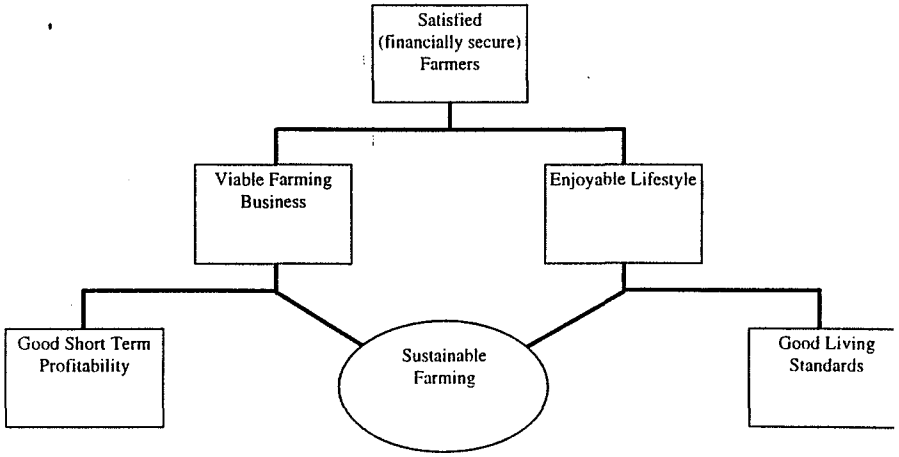


Figure 3. Waikato Livestock Farmers' Goals Super-ordinate to Sustainable Farming
(from Parminter et al 1993)



sustainable systems (Federated Farmers, undated; Jim Cotman 1996). These guidelines are being further developed with contributions from a number of agricultural Study Groups.

A conceptual pyramid method was used in the workshops based upon a clinical psychology theory of personal constructs. Personal construct theory has been applied as a way of considering the construction of meanings and the relationships between meanings which were valued by the people involved (Fransella 1978). The meanings people used to convey their personal constructs were considered to be those most relevant to their purposes and important to their maintaining social transactions. Meanings took the form of simple concepts which could then be interlinked to form a construct. For instance the concept "I enjoy running" may be linked to "when I run I feel free", "when I am not running I fidget", and "when I fidget people get annoyed". The linking of these concepts together provides positive and negative cues for behaviour.

People can be expected to favour those behaviours that they perceive will help them most towards their goals, where goals are considered to be endstates or outcomes about which people hold positive attitudes (Eagly & Chaiken 1993). Some goals can be very abstract and others may be more instrumental and provide ways to achieve more basic goals. The inter-relationships between levels of abstract and instrumental goals are able to be elicited using methods associated with personal construct theory. Laddering of concepts can be used to identify the relationships from one set of concepts to their superordinate concept (Fransella 1972, Crockett and Meisel 1974). Pyramiding of concepts can be used in the other direction to identify the relationships from one concept to its subordinate concepts (Landfield 1971).

In the work with Waikato Federated Farmers, the advantages of using concept pyramid building as a method of goal setting were that it was:

- visionary; capturing the creative ideas of participants and building them into relationships without the constraints of logical analysis or grammar.
- essentially visual; so that although the system was built up from its components the coherency of the whole was always emphasised, and remained visible throughout the process.
- dynamic in space and time; the components to the system could be rearranged or new ones added in subsequent applications of the process.
- linked the more abstract and instrumental concepts to each other; the more generic meanings of superordinate concepts were explained by the instrumental concepts attached to them at a lower levels.

Groups who have used the concept building process have found a great deal of consistency between results when the same context and group purpose is being considered (Parminter, Wedderburn, and Carter, 1993; Brown, Hewson, and Ludemann, 1996). The method has been particularly useful when groups have been dealing with abstract concepts or when the identification of nonfinancial goals was as important as financial goals.

Conclusions

Planning in voluntary farming groups has been a difficult area to develop in an objective way because of the complexity of the systems involved and the diversity of farming goals. Resource exchange diagrams and conceptual pyramids can be included with other methods of Participatory Inquiry including Soft System Analysis to describe the complexity and diversity of farming and agricultural systems. They have helped the groups involved use apparent system complexity to advantage, as a platform for learning and decision making. As a result they have been able to achieve objective and measurable results from group activities.

Acknowledgments

Our appreciation goes to the many farmers, agriculturists, and policy agents we have worked with over the last few years developing these approaches. Thanks also to Mark Paine for his assistance in preparing this paper, and to the Foundation for Research Science and Technology and AgReseach for funding these projects.

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FARM MANAGEMENT IMPACTS OF THE 1990 EAST COAST TECHNOLOGY TRANSFER PROGRAMME*

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ABSTRACT

The serious drought which afflicted the East Coast of the North Island during the summer of 1988/89 severely depressed farm production and profitability. To assist farmers recover from the drought a $30 million "Drought Recovery Assistance Programme" was implemented by the Government. This paper reports an evaluation of the programme's success in encouraging the development of an integrated management approach to "droof proofing" farms. The evaluation included a regional telephone survey, a mail survey of farmers involved in the pasture demonstration programme and an interview survey of participants in the focus farm programme. Most farmers were found to have made at least one 'drought proofing' change to their farming system since 1989 and now felt more confident to cope with drought conditions. The present Government policy of non-intervention is accepted by the majority of farmers. Future adverse event relief programmes are not expected by farmers, although some would like flexibility with items such as taxation when farm profit is radically altered because of drought conditions.

Keywords: **Government assistance, drought relief, technology transfer, farm management, systems.**

INTRODUCTION

The East Coast of the North Island experienced serious drought conditions during the summer of 1988/89, and this had both immediate and short-term effects on farm productivity and profitability in the region. To assist farmers to recover from the drought, and to reduce their exposure to future drought risk, the Government provided $30 million in the form of a special "Drought Recovery Assistance Programme". The components of the programme included Farm Management Consultancies, Drought Rehabilitation Loans, Family Income Support, New Start Grants and a Technology Transfer Programme (King, Government announcement, 13 March 1990). Approximately $413,000 was budgeted for the Technology Transfer Programme with a further $10,000 obtained from commercial sponsorship (Rhodes, 1992). Approximately $775,000 was also budgeted for a separate Pasture Demonstration Programme (Milne *pers. comm.*, 1994).

The Technology Transfer Programme, including the Pasture Demonstration Programme, sought to enhance the "adoption of new and improved on-farm technology and management systems" (Rhodes 1994). It purposely did not seek a "quick-fix" solution by simply encouraging the adoption of 'off-the-shelf' technology and providing direct financial assistance. Instead a more inclusive approach, which encouraged farmers to adopt a range of both short- and long-term practices in their overall farming system to manage climate risk was sought, so that the need for future Government intervention was reduced. This approach to farmer assistance built on experience obtained through the South Island pasture establishment project (MAFPol Technical Paper 91/2).

This paper describes three parts of an *ex poste* evaluation of the impact and effectiveness of the Technology Transfer Programme (incorporating the Alternative Pasture Demonstration Programme), relative to its objectives and the on-farm impact achieved. In Part I the effectiveness of the over-all Technology Transfer Programme was assessed through a telephone survey of 200 farmers (4% in the East Coast region). Quantitative data were collected on the adoption of drought management practices by farmers. In Part II of the research the DSIR Grasslands Alternative Pasture Species Demonstration Programme was evaluated through a mail survey and in Part III aspects of the Focus Farm field days were reviewed through personal interviews of farmers involved and not involved in the programme. Earlier assessments of aspects of the East Coast Technology Transfer programme were reported by Rhodes in 1992 and 1994.

* The views expressed in this paper are those of the authors and not necessarily the views of MAFPolicy.

PART I: TELEPHONE SURVEY OF EAST COAST FARMERS

A telephone survey of 200 farmers (ca. 4% of farmer population) located throughout the East Coast region of the North Island investigated three broad areas: farmer participation (and use of) various aspects of the technology transfer programme, the level of technology uptake and descriptive information about the farmers and their farming systems. The survey area, which included all of the East Coast except the Woodville and Pahiatua counties and western parts of Eketahuna and Dannevirke, was divided into four geographic regions; Wairarapa (Martinborough to Pahiatua), Southern Hawkes Bay (Pongaroa to Otane), Hawkes Bay (Havelock North, Hastings and Napier) and Gisborne (Wairoa to Tikitiki). Interviews were carried out during May 1994 by staff and post-graduate students from the Department of Agricultural and Horticultural Systems Management at Massey University. Individuals on lifestyle and orchard blocks, and people situations whose income from the farming business (or activity, in the case of farm managers) contributed to less than 80% of the total family income, were not interviewed. Data were subjected to descriptive statistical analysis and one-way analysis of variance using the SPSSx package (SPSSx 1986).

RESULTS

Farmer and farm details

The primary characteristics of the farms and farmers surveyed are summarised in Table 1. Almost all (96%) of the farmers had been farming in the East Coast region during the 1988/89 drought. Severe drought, which required the sale of capital stock, were more common ($P<0.05$) in Hawkes Bay districts.

Farmer involvement in drought assistance programme

Slightly over half (55%) of the farmers surveyed had received no assistance from the East Coast Drought Programme (Table 2). Of those farmers who had received assistance, this was most frequently in the form of a drought loan (33%) or a farm management consultancy report (33%). Of those who had received a consultancy report, 61% considered that it was useful and 41% had put report recommendations in the report, into practice on their farms. Only 7% of the farmers indicated participation in the family income support programme; whereas the actual participation was around 20%.

Table 1: Summary of main livestock enterprises, farm size, frequency of sale of capital livestock and grazing off due to summer drought, average farmer age and years of management experience on current property, for East Coast survey farms. Figures in brackets are the percentage of cases within columns.

	Wairarapa (n=51)	Southern HB (n=46)	Hawkes Bay (n=65)	Gisborne (n=38)	Total (n=200)
Livestock type					
Sheep/beef	43 (84)	39 (85)	50 (77)	34 (90)	166 (83)
Other	8 (16)	7 (15)	15 (23)	4 (10)	34 (17)
Farm size (effective)[1]					
Ave. area (ha)	628[a]	391[a]	547[a]	1156[b]	650 ± 53
Farmer details					
Present 1988/89	48 (94)	46 (100)	62 (95)	37 (97)	193 (96)
Farmer age (yrs)	44	49	47	46	48
Management experience (yrs)	16	19	17	16	17
Drought impact (10 yrs)					
Capital stock sold	1.18[ab]	0.74[a]	1.57[b]	1.21[ab]	1.21 ± 0.09
Stock grazed off	0.76[a]	0.39[a]	1.02[a]	1.95[b]	0.99 ± 0.12

[a,b] Means with different superscripts within rows are significant at $P<0.05$.
[1] Effective grazing area data were requested in order to exclude non-pastoral farming enterprises.

Table 2: Farmer involvement with various aspects of the East Coast Drought Assistance Programme by geographic area. Figures in brackets are the percentage of farmers within each column.

	Wairarapa (n=51)	Southern HB (n=46)	Hawkes Bay (n=65)	Gisborne (n=38)	Total (n=200)	Actual uptake (n=5000)[1]
None	26 (51)	24 (52)	35 (54)	24 (63)	109 (55)	
Family Income Support	7 (14)	3 (7)	4 (6)	0	14 (7)	960 (20)
Drought Loan	20 (39)	17 (37)	21 (32)	7 (18)	65 (33)	1205 (24)
Consultancy Report	14 (28)	19 (41)	25 (39)	8 (21)	66 (33)	1280 (26)
- was useful (n=66)	7 (50)	11 (58)	16 (64)	6 (75)	40 (61)	
- ideas practised (n=66)	7 (50)	11 (58)	5 (20)	4 (50)	27 (41)	
Pasture Demonstration Programme	3 (6)	0	2 (3)	0	5 (3)	79 (2)
Unspecified	0	0	1 (2)	0	1 (1)	

[1]East Coast farmer population estimated at 5000.

Farmer views on future Government assistance

Half of the farmers surveyed said that no assistance from the Government should be provided to farmers if a serious drought, similar to that which occurred in 1988/89, was to occur again (Table

3). A range of options were suggested to assist farmers through severe drought situations, but of these tax exemptions on income earned from the sale of capital stock was the most commonly cited.

Table 3: Farmer views on whether Government assistance should be provided to farmers who are seriously affected by drought and the form that this assistance should take. Figures in brackets are the percentage of farmers within each column.

	Wairarapa (n=51)	Southern HB (n=46)	Hawkes Bay (n=65)	Gisborne (n=38)	Total (n=200)
None	25 (49)	32 (70)	26 (40)	17 (45)	100 (50)
Tax relief for capital livestock sold	5 (10)	2 (4)	16 (25)	9 (24)	32 (16)
Same as 1990 programme	3 (6)	8 (17)	7 (11)	2 (5)	20 (10)
Supply feed or cash for extra feed and cartage	6 (12)	2 (4)	4 (6)	5 (13)	17 (9)
Loans with discounted interest rates	8 (16)	1 (2)	6 (9)	1 (3)	16 (8)
Guaranteed livestock prices	2 (4)	-	2 (3)	2 (5)	6 (3)
Subsidy on fertiliser	-	-	3 (5)	-	3 (2)
Family income support	1 (2)	-	1 (2)	-	2 (1)
Cash compensation for livestock loss	1 (2)	-	-	1 (3)	2 (1)
Subsidised demonstration programme	-	1 (2)	-	1 (3)	2 (1)

Effectiveness of focus farm field days

Most of the farmers contacted (81%) were aware of the Focus Farm field days, but only 30% had actually attended one of these events. Of those who had attended, 53% found the field days to be useful in terms of the farm management advice proffered. A breakdown of the farmers who had attended the field days indicated that 54% went to one field day, 37% went to two, and 9% went to three or more. Thus, only a small percentage of the region's farmers were regular attenders of the Focus Farm field days. Of those farmers who had attended the Focus Farm field days, 29% subsequently sought further information from farm consultants and 15% indicated that they had changed their management practices as a result of the material presented or seen at the Focus Farm. However, only a small proportion of the farmers (9%) had visited a Focus Farm at a time other than during a field day in order to seek advice and information from the host farmer.

The frequent reasons given by farmers for not attending a Focus Farm field day was that: they were too busy (30%), the topics covered at the field day were not applicable due to limitations on their own farm situation (19%), or their farm was not seriously affected by summer drought. More than one third (35%) of the farmers either could not recall a particular reason, or did not want to specify a reason, why they were not able to attend a field day.

Relevant information

A range of information sources, including publications, field days, consultancy reports and focus farms were used during the technology transfer programme. The "Drought Proofing Your Farm" booklet was most frequently cited as a source of useful information (78 mentions). However, a relatively large number of farmers who claimed to have read the booklet (and newsletters), were not able to specify how it had been useful in relation to their farm. Overall, the newsletter and Focus Farm field days were not widely rated as being useful. The Focus Farm field days, however, were noted for providing useful information on alternative pasture species (15 mentions). The Farm Management Consultancy Report was mentioned as a useful information source by 44 farmers. Thus, by this criterion it was rated the second most useful source of information on drought management. Twelve of the 44 farmers indicated that the report provided a worthwhile overall review of their current farming situation.

While many farmers were not able to specify why particular sources of information were irrelevant to their situation, two reasons stood out as to why this was the case in relation to a particular farm or farmer. First, the farmer was already practising what was being recommended through the information source (29%). Second, the information was not relevant due to the current situation of either the farm or the farmer (21%). For example, the farmer did not believe that information provided would make his/her farm more drought tolerant.

Table 4: Reasons given by farmers as to why various sources were useful to their situation. Farmers could provide responses to more than one category. Figures in brackets are the percentage of the total farmers (n=200) surveyed.

Topic	Booklet	Newsletters	Focus farm field days	Consultant input	Visit to focus farm	Consultancy Report
Information on:						
Alternative pasture species	23 (12)	3 (2)	15 (8)	12 (6)	1 (1)	8 (4)
Livestock policies	9 (5)	2 (1)	5 (3)	9 (5)	7 (4)	5 (3)
Supplements	5 (3)	-	3 (2)	1 (1)	1 (1)	6 (3)
Decision making	8 (4)	1 (1)	-	-	-	4 (2)
Tree planting	1 (1)	-	-	-	-	5 (3)
Personal contact	1 (1)	-	-	-	-	-
Overall review	3 (2)	3 (2)	1 (1)	7 (4)	-	12 (6)
Fertiliser	1 (1)	1 (1)	-	2 (1)	-	2 (1)
Objective setting	-	-	1 (1)	-	-	-
Water supply	-	-	1 (1)	-	-	-
Financial management	-	-	-	5 (3)	-	2 (1)
Read or took advice into account	27 (14)	20 (10)	8 (4)	-	-	-
Unspecified[1]	-	3 (2)	-	-	-	-
Total	78 (39)[2]	33 (17)	34 (17)	36 (18)	9 (5)	44 (21)

[1] "Unspecified" represents farmers who said information source was useful, but gave no direct answer as to how it was useful.

[2] Total percentages add to over 117% because some farmers indicated more than one topic from the various information sources that were useful.

Alternative information sources

Farmers were also asked to identify sources of information, other than that specifically identified with the Technology Transfer Programme, that assisted them with drought management (Table 5). Neighbours (30%) and previous experience with drought (22%) were the most commonly cited sources of alternative information. Previous experience was an especially important source of information in the Gisborne area (45%), while the "other farmer" source of information was particularly cited in Hawkes Bay (40%). As could be expected, most farmers used one or more sources of information with respect to drought management.

Table 5: Sources of information, other than those specifically identified with the Technology Transfer Programme, used by farmers to assist with drought management. Figures in brackets are the percentage of cases within columns.

	Wairarapa (n=51)	Southern HB (n=46)	Hawkes Bay (n=65)	Gisborne (n=38)	Total (n=200)
Media					
Consultant newsletters	3 (6)	-	-	-	3 (2)
Farming magazines and papers	1 (2)	3 (7)	13 (20)	8 (21)	25 (13)
Local newspapers	1 (2)	-	17 (26)	7 (18)	25 (13)
Personal contact					
Local consultants	10 (20)	1 (2)	4 (6)	10 (26)	25 (12)
Other farmers	12 (24)	10 (22)	26 (40)	12 (32)	60 (30)
AgResearch	3 (6)	1 (2)	-	-	4 (2)
Agribusiness sector	3 (6)	7 (15)	4 (6)	2 (5)	16 (8)
Seminars/Field days					
Discussion group	9 (18)	-	4 (6)	5 (13)	18 (9)
Field days	1 (2)	1 (2)	-	2 (5)	4 (2)
Other Sources					
Previous experience	10 (20)	1 (2)	17 (26)	17 (45)	45 (22)
Records on weather/farm	2 (4)	-	-	-	2 (1)
Family member at Lincoln or Massey	1 (2)	-	1 (2)	1 (3)	3 (2)
Total	56 (110)	24 (52)	86 (132)	64 (168)	230 (115)

[1] Some total percentages sum to more than 100% due to farmers using more than one source of information.

Farm management changes

Since the 1988/89 drought the most common change to farming systems (52%) was the establishment of new pasture species, while 41% had changed their livestock policies, 48% indicated they had improved the timeliness of decision making (e.g. early decisions on stocking rate for summer) and 37% had increased the quantity of feed supplements (including hay, silage and forage crops) to counteract the effects of a drought on their farm (Table 6). Only 9% of the farmers had not changed any part of their farming system. It was not possible, however, to clearly identify which of the changes could be directly attributed to the Technology Transfer Programme compared to those associated with other adjustments in the farming industry (e.g., an increase in the value of cattle relative to the price of sheep over the 1990-92 period).

Table 6: Management changes made since the 1988/89 drought (no. of mentions). Figures in brackets are the percentage of farmers who identified specified management change within each column.

	Wairarapa (n=51)	Southern HB (n=46)	Hawkes Bay (n=65)	Gisborne (n=38)	Total (n=200)
New pasture sown	26 (51)[1]	27 (59)	38 (59)	13	104 (52)[2]
Financial management	2 (4)	3 (7)	3 (5)	1 (3)	9 (5)
Clearer farm objectives	-	1 (2)	-	1 (3)	2 (1)
Livestock policies	15 (30)	16 (35)	26 (40)	25 (66)	82 (41)
Timely decision making	23 (45)	13 (28)	38 (58)	22 (58)	96 (48)
Incorporating feed supplements	17 (33)	11 (24)	32 (49)	14 (37)	74 (37)
Other	22 (43)	19 (41)	15 (23)	11 (29)	67 (34)
No changes	4 (8)	7 (15)	5 (8)	2 (5)	18 (9)

[1] Total percentages add to 226% due to farmers making more than one change.

[2] New pasture sown figures include the establishment of species other than those regarded as drought tolerant (e.g. ryegrass and white clover). The improved varieties of traditional grasses generally have better productivity through most seasons of the year and can be regarded as improving the farm's drought tolerance as well. It is estimated that 92% of the new plantings included the alternative pasture species targeted in the Technology Transfer programme.

Farmer and farm limitations to change

The limitation most frequently cited as preventing change to the existing farming system was the topography of the farm (36%). However, a relatively large number of the farmers also stated that finance (21%) and an inadequate water supply (11%) were limitations to "drought-proofing" their farm. Just over one quarter of the farmers stated that their farm had no limitations, or at least none came to mind at the time of the telephone interview.

DISCUSSION - PART I

Overall, only 8% of the farmers surveyed indicated that they had not received any information through the Technology Transfer Programme. A substantial percentage (84%) of the farmers who had received or taken part in any of the Technology Transfer Programme had made some change to their farming system and 81% considered themselves to be better equipped now to successfully manage a serious drought such as that which occurred in 1988/89. The fact that they had gained more experience was a commonly cited factor for their better preparedness for a drought situation. There was very little difference in the results for the four East Coast geographic area in terms of overall changes to farming systems.

When asked to rate the importance of various aspects of management in reducing the impact of a drought on their farm, 58% identified "early decisions on livestock numbers for summer" and 53% identified the "specification of farm objectives" as being "very important". Both of these factors were strongly promoted through the Technology Transfer Programme. It was not possible to directly attribute all of these changes to the Technology Transfer Programme. However, 84% of the farmers who had received information or attended any event related to the Technology Transfer Programme, changed their farming system so that it was more "drought proof".

As could be expected, parts of the Technology Transfer Programme were more effective than others in providing useful information to farmers. The "Drought proofing Your Farm" booklet was widely remembered by farmers (64%), and cited as being particularly useful for providing information on alternative pasture species, livestock policies and timely decision making. On the other hand, the four newsletters and the Focus Farm field days were apparently less effective, although the latter were noted for providing useful information on alternative pasture species.

PART II: ASSESSMENT OF THE ALTERNATIVE PASTURE SPECIES DEMONSTRATION PROGRAMME

The aim of the North Island Alternative Pasture Demonstration Programme, which built on experience in the South Island (Milne and Fraser, 1990), was to develop farmer confidence in sowing, establishing and grazing drought tolerant pasture species, and thereby encourage the adoption of this "drought proofing" technology into their farming system. To achieve this aim a large area (1500 hectares) of drought tolerant pasture species were to be established on farms representative of the East Coast region. The initial target was to plant approximately 20% of this area on steeper hill country by oversowing.

Ninety-one Alternative Pasture Demonstration farms were selected for the programme, however, 12 subsequently withdrew mainly due to either financial reasons or the relatively high risk associated with oversowing on steeper country (Milne 1994 *pers. comm*). Approximately 20 field days were held during the programme which ran from spring 1990 to autumn 1992. An estimated 1725 people attended these events (Milne *et al.* 1994).

A questionnaire was formulated to evaluate the Alternative Pasture Demonstration Programme from three broad perspectives: physical information about the farm and farmer, the success of the alternative pasture species relative to existing (i.e. traditional) ryegrass / clover pastures, and farmer attitudes towards 'drought proofing' technologies, and their views on the technical support provided and future government assistance. The questionnaire was sent to each of the 78 farmers involved in the demonstration programme; 69 responded (88% response rate).

RESULTS

Farmer and farm details

The predominant livestock system on the Alternative Pasture Demonstration farms was sheep and beef cattle production (72% of the farms) (Table 7). Almost all (91%) of the farmers surveyed ran a finishing livestock enterprise. Total farm size averaged 730 (standard error ± 105 ha), while the average effective and cultivable areas were 631 ± 74 ha and 202 ± 22 ha, respectively. Thus, the area in pasture or crop accounted for 86% of the farm area. The cultivable area represented 22% of the effective area.

Table 7: Summary of main livestock enterprises, farm size, average farmer age and years of management experience for Alternative Pasture Demonstration Programme farmers. Figures in brackets are the percentage of cases within columns.

	Wairarapa (n=18)	Southern HB (n=27)	Hawkes Bay (n=11)	Gisborne (n=13)	Total (n=69) Mean ± SE
Livestock type					
Sheep/beef	13 (73)	21 (78)	7 (64)	13 (100)	54 (76)
Dairy	4 (22)	2 (7)	-	-	6 (9)
Other	1 (6)	4 (15)	4 (36)	-	9 (12)
Livestock system					
Finishing livestock enterprise	14 (78)	25 (93)	11 (100)	13 (100)	63 (91)
Farm size					
Total (ha)	874	593	732	814	730 ± 105
Effective[1] (ha)	678 (78)	526 (89)	655 (89)	765 (94)	631 ± 74 (90)
Cultivable2 (ha)	157 (23)	261[a] (50)	243 (37)	112[b] (15)	203 ± 22 (42)
Farmer details					
Farmer age (yrs)	48	48	47	47	48
Management experience (yrs)	16	15	17	19	16

[a,b] Means with different superscripts within rows are significant at P<0.05.
[1] Figures in square brackets are the effective area expressed as a weighted percentage of the total area.
[2] Figures in square brackets are the percentage of cultivable area expressed as a weighted percentage of the effective area.

Areas of alternative pasture species sown

The average area of alternative pasture species sown in the 1991-92 programme was 16 ha (n=69 farms). This had increased to 37 ha by 1994 (Table 8). As a percentage of effective and cultivable area this equates to an increase from 4.3% to 9.6% and from 15.6% to 25.6%, respectively per farm. Approximately 15% of the farmers had established all of their cultivable land and would therefore need to adopt oversowing technology if further alternative pasture species were to be established on non-cultivable land. The substantial increase in area of alternative pasture species since the initial plantings in 1991/92 also means that these new species now have a greater impact on total seasonal and annual dry matter production on most of the farms and therefore potentially on overall stock and financial performance.

Table 8: Areas of alternative pasture species sown during the 1991-92 programme and in June 1994.

	During programme 1991-92 (n=69)	June 1994 (n=69)
Average area sown per farm (ha)	16 ± 1.5	37 ± 5.6
Percentage of effective area (ha)	4.3%	9.6%
Percentage of cultivable area (ha)	15.6%	25.6%
Proportion of cultivable area sown		
0-25%	57 (85)	42 (62)
26-50%	6 (9)	19 (28)
51-75%	2 (3)	4 (6)
76-100%	2 (3)	3 (4)

Farmers' views on future Government funding

Almost two thirds of the farmers surveyed believed that similar Government input ($30 million) should again be provided (45%), or increased (17%), if a drought similar to that experienced in 1989 occurred again. About one third (30%) of the farmers indicated that no funding should be provided. This contrasts with the 50% of farmers who held this view in the telephone survey (Table 3), possibly because they had received more direct (and tangible) benefits from the overall drought programme.

Importance of alternative pasture species

Increasing summer feed supply (mean "importance" score of 1.55 on a scale 1 = most important, 6 = least important) and improving livestock growth rates (2.23) were rated as the most important reasons for using of alternative pasture species (Table 9). Increasing summer feed supply was

ranked as most important by 58% of the farmers, and 32% as second most important. Protection against ryegrass staggers was rated as most important by 22% of the farmers. Improving winter pasture supply (12%) and testing for on-farm performance (17%) were also rated as "important" factors.

Table 9: Importance rating (1 = most important, 6 = least important) of reasons for using alternative pasture species. Figures in brackets are the percentage of respondents in each category.

Reason	Level of importance[1] Least[2]	5	4	3	2	Most	Mean score
To increase summer feed supply	-	2 (3)	1 (1)	2 (3)	22 (32)	40 (58)	1.55
To improve livestock growth rates	2 (3)	1 (1)	8 (12)	12 (18)	18 (26)	24 (35)	2.23
To protect against staggers in summer/ autumn	5 (7)	8 (12)	9 (13)	19 (28)	7 (10)	15 (22)	3.05
To improve winter feed supply	4 (6)	13 (19)	19 (28)	13 (19)	6 (9)	8 (12)	3.56
To test how they performed on my farm	4 (6)	20 (29)	15 (22)	6 (9)	6 (9)	12 (17)	3.59
Other[3]	13 (19)	3 (4)	1 (1)	2 (3)	2 (3)	4 (6)	4.44

[1]Some farmers ranked more than one aspect at a particular level of importance.
[2]Some farmers did not specify any ranking (hence importance = 0) and therefore omitted from the results.
[3]Other included: Drought protection (3), grass grub tolerance (3), increasing milksolids production (3), and one mention each of increased summer pasture quality, even growth pattern, to replace old pasture and as an alternative greenfeed crop.

Desirable characteristics of alternative pasture species

The farmers' ratings of specific characteristics of alternative pasture species compared to traditional ryegrass/white clover species are shown in Table 10. Ease of establishment was rated as the worst characteristic of alternative pasture species with 61% of farmers rating this aspect as "difficult" (mean score = 2.13). Pasture persistence (mean score = 3.14) was rated similar to ryegrass/white clover, although 32% of the farmers rated this attribute to be "slightly worse". Livestock performance, summer and winter pasture production, value for money and pest resistance all scored higher than for ryegrass/white clover pasture. Thus, the overall view of farmers toward the alternative pasture species was positive compared to existing pastures. These findings imply that improving establishment techniques, which will impact both on the cost-effectiveness and productivity of the new pasture species deserves further research and extension input. Farmers generally rated the improved pastures as being "better" or "much better" than the existing pastures,

although their experience with the new species was largely based on favourable (ie., summer moist, except in 1994) climate conditions for pasture growth.

Table 10: Farmers' ratings of attributes of alternative pasture species compared to traditional ryegrass/white clover pasture (rating = 3). Figures in brackets are the percentage of respondents in each category.

Attribute	Rating of attribute Very difficult/ much worse 1	Difficult/ slightly worse 2	Same 3	Easy/Better 4	Much Better 5	Mean Score
Ease of establishment	11 (16)	42 (61)	11 (16)	3 (4)	1 (1)	2.13
Pasture persistence	3 (4)	22 (32)	9 (13)	21 (31)	8 (12)	3.14
Winter pasture production	1 (1)	9 (13)	17 (25)	31 (45)	9 (13)	3.57
Value for money spent	4 (6)	6 (9)	7 (10)	35 (51)	14 (20)	3.74
Pest resistance	1 (1)	0 (0)	22 (32)	28 (41)	14 (20)	3.83
Livestock performance	1 (1)	1 (1)	11 (16)	30 (44)	24 (35)	4.12
Summer pasture production	0	1 (1)	3 (4)	31 (45)	32 (46)	4.40

Importance of drought management options

Farmer views were obtained on the importance of specified drought management options for their farms (Table 11). Most rated all of the listed farm management aspects as either "important" or "very important" for reducing the effect of drought, with "Early decisions on livestock numbers for summer" (74% indicated that this was "very important") and the "specification of farm objectives" (62% indicated that this was "very important") being rated most highly. Alternative pasture species were rated as the second least important (mean score = 3.38) drought management option, however, just under half (49%) of the alternative pasture demonstration farmers rated alternative pasture species as "important" and 44% rated these as "very important".

Table 11: Farmer ratings (1 = very unimportant, 5 = no effect) of the importance of various management options on their farm that could reduce the effect of a summer drought.

	Importance Rating					
	Very unimportant	Not important	Important	Very Important	No effect	Mean score
Maintenance of financial records	1 (1)	8 (12)	23 (33)	31 (45)	5 (7)	3.33[1]
Alternative pasture species	0 (0)	4 (6)	34 (49)	30 (44)	0 (0)	3.38
Incorporation of hay or silage	1 (1)	3 (4)	18 (26)	41 (59)	2 (3)	3.57
Incorporation of a whole farm plan[2]	0 (0)	2 (3)	23 (33)	41 (59)	2 (3)	3.59
Specification of farm objectives	0 (0)	1 (1)	21 (30)	43 (62)	1 (1)	3.65
Early decisions on livestock numbers for summer	0 (0)	1 (1)	16 (23)	51 (74)	0 (0)	3.74

[1]"No effect" responses were excluded from the mean score calculation.
[2]Including pasture, livestock and finance.

DSIR (Grasslands) alternative pasture demonstration field day analysis

A total of 45 field days were held during the Alternative Pasture Demonstration Programme, however, only 25 of the farmers surveyed actually hosted a field day. Most of these farmers (55%) indicated that few (<10) farmers visited their properties at times other than the field days to inspect and discuss the new pasture species. Total farmer visits were estimated to be 500 (or 10% of the East Coast farming population). Similarly, most farmers (52%) indicated that they knew of few (<10) farmers who had sown alternative pasture species as a result of visiting their farm. The moderate level of farm visits over a three year period and establishment of alternative pasture species by other farmers could mean: farmers could not perceive any advantages from alternative pasture species, or farmers had gained all the information they required at the field days (and/or other sources), or that other limitations (eg., finance) constrained the incorporation of new species on their own properties. However, the telephone survey of East Coast farmers indicated that 48% had used alternative pasture species in some way over the last three years.

DISCUSSION - PART II

Overall, the Alternative Pasture Demonstration Programme survey indicated reasonably strong evidence that farmers believe that alternative pasture species have several important advantages over existing traditional ryegrass/white clover pastures. Alternative species are also viewed as being important in reducing the effect of drought, but not as important as other "drought proofing" technologies such as the early sale of livestock.

PART III: FOCUS FARM FIELD DAY PROGRAMME

Seventy eight Focus Farm field days were held between 25 July 1990 and 7 July 1992, to disseminate information about the alternative pasture species and other "drought proofing" technologies. The field days had the same overall aims as the Technology Transfer Programme, i.e. to enhance the "adoption of new on-farm technology and management systems" (Rhodes 1994). A further intention of the field days was to "provide opportunities to examine technology and provide interaction among farmers, and between farmers and consultants" (Rhodes 1994). These attracted in excess of 3660 farmers and agribusiness participants (Rhodes 1992), although the attendance records did not distinguish between single- and multiple-visitors to field days. The field day programme was evaluated by two case studies and a mail survey of the field day organisers.

METHOD

Selection of case studies

The Southern Hawkes Bay area was selected as the location for the case studies. The Focus Farms selected were located 5 km north of Pongaroa and at Ti Tree point, approximately 10 km east of Weber, respectively. Six farms located around each Focus Farm were randomly selected (12 in total) from a list of neighbouring properties. Ten of these agreed to participate. Some of these farmers had not attended the Focus Farm field days. They were deliberately included to achieve a more 'balanced' view of the drought and associated drought relief programme. At the interview a schedule of topics was discussed. The interviews were taped and these were transcribed for analysis. Interviews took around 1 hour to complete and were conducted in October/November 1994.

Survey of field day organisers

A mail survey of the Focus Farm field day organisers was also undertaken. All 14 of the MAFTech consultants involved completed the questionnaire.

RESULTS

Focus Farmers and Neighbouring Farmers

The selection of both Focus Farms (by MAFTech, Federated Farmers and the Rural Support Trust) was perceived by some farmers to be inappropriate: in the first case because the farm had been used for previous activities and this may have contributed to the disappointing field day attendances, and in the second case because the livestock policy, although a valid option for combating dry/drought conditions elsewhere, had not previously been proven to be successful on the farm, or in the local area, and has since been abandoned. Farmers also perceived one of the Focus Farms to be *"run by MAF from town"* and therefore questioned its applicability.

Overall, farmers regarded the attendance of the field days held on the case farms as poor. However, attendance figures for the two case farms were lower than the overall average field day attendance of 47 (Rhodes, 1992). The perception of the farmers who were interviewed was that farmers who attended were more progressive and financially secure (and therefore able to adopt alternative practices) than those who had not attended. The perceived main reason for the low attendance appeared to be that farmers, especially those who had taken over the family farm, were reluctant to change from traditional farming practices. Peer-pressure from other farmers and families, lack of education, farmer perception of no advantage in change, and financial insecurity were all mentioned as factors that may have reduced field day attendance, and are associated with "traditionalism". The older, established and financially secure farmers, and those involved with managing stations, generally did not attend. Farmers were also able to read the results of the field days in the newspaper.

The field days were considered by farmers to be successful in terms of informing them on how to reduce the impact of drought. The most relevant topics recalled by farmers who attended were timely decision making and increasing stock flexibility by incorporating more trading stock. Most farmers perceived 'alternative pasture species' as being the least relevant drought management

option because of the costs and risks involved in pasture establishment, limited availability of suitable land and perceived poor performance under wetter conditions. Overall, most farmers felt that field day topics were relevant, although some of the suggested changes required expenditure which most could not afford at the time (due to the prior down-turn in farming).

The majority of farmers considered field days to be a useful method of transferring information and for getting the community together to discuss current issues. Also most farmers prefered to attend a relevant field day than to gain the same information through the mail or in some other form. Farmers suggested field days could be improved by targeting their organisation to specific groups of farmers and anticipating natural disasters, such as drought, earlier (a difficult task). The 'Drought Proofing Your Farm' booklet was well regarded. Video tapes may be an effective means of transferring information and could easily be referred to when needed.

Field day organiser survey

Most consultants believed that the field days were successful in terms of farmer interest in the topics covered and their response to the information and advice provided. However they also indicated (64%) that farmer attendance was only "adequate" (30% of farmers in the telephone survey indicated that they had attended a field day).

The consultants surveyed believed that either "some" (57%) or "a high amount" (21%) level of impact had been made on management practices on farms located near the focus farm. Most consultants also believed that either "very little" (43%) or "some" (29%) impact had been made on management practices on farms outside the local district. Of the management options covered at the field days most consultants (71%) believed that alternative pasture species had been most widely adopted. About a third (36%) of the consultants also said that drought proofing stock policies had been widely adopted.

Suggested improvements to the Focus Farm field day concept included more farmer involvement in field day coordination (e.g. like the Meat Research and Development Council (MRDC) monitor farm field days), smaller groups of farmers at more locations and follow-up field days to demonstrate the long-term sustainability of management practices and introduced

technology. It was believed that these modifications would increase farmer attendance and create more farmer interest.

DISCUSSION - PART III

On one hand, it could be concluded that from this qualitative evaluation, that the Focus Farm field days fulfilled a part in reducing the drought susceptibility of East Coast farmers. On the other hand, the vast majority of farmers who did not bother to attend the field days suggests that the programme completely missed the target of achieving effective mass extension. This view could also be mitigated (or supported) by the fact that, non-attenders of field days have instigated similar types and levels of change as those who attended the field days. While they may have been influenced non-directly by the programme, farmers indicated that a number of issues, rather than a single factor, contributed to changes being made to management or policy.

It was impossible to differentiate the amount of change derived from the experience of drought, field day attendance, the overall technology transfer programme or other more widespread changes in the farming economy. To quantify the relative effects of these possible "agents of change" would require a much more detailed and expensive study than that undertaken here. It is suggested that farmer experience had a significant effect on instituting change, although history shows that farmers often forget the lessons learnt through tough experiences that have threatened the survival of their farm businesses.

OVERALL CONCLUSIONS

Effectiveness of the Technology Transfer Extension Programme

Extension is 'an educational process which aims to elicit voluntary change' through two-way communication between clients and sources of information. The East Coast programme followed the 'interventionist approach', with limited initial consultation with the farming community and dominant one-way communication from MAFTech and DSIR-Grasslands to the farmer. As a consequence, some technology was not adequately modified to a district level to meet specific physical and socioeconomic needs, which perhaps could have been expected given the diversity of circumstances on the East Coast. Techniques such as Rapid Multi-

perspective Appraisal (RMA) could have provided an effective method for obtaining farmer participation and providing sufficient quantitative information for decision makers within the short space of time that the design of programmes for adverse event assistance often requires (Curruthers, 1981; Van Beek & Hamilton, 1992).

A relatively high proportion of farmers had incorporated both short- and long-term practices that had been promulgated through the Technology Transfer Programme. Examples of adopted short-term practices included the use of feed supplements and more timely decision making, while longer term changes included the sowing of new pastures and changes in stock policy to increase the flexibility of feed demand.

The programme successfully provided informational and observational learning sources through published material and the Focus Farm and Alternative Pasture Demonstration Programme field days. Although the 'Drought Proofing Your Farm' booklet was cited most widely as a useful source of information, the various types of learning sources (eg, field days) acted to reinforce farmer confidence in adopting new technologies and management practices. Many farmers also suggested experiential learning, gained from farming through the 1988/89 drought influenced their decision to change their farming system to being less drought susceptible.

The majority of farmers, surveyed and interviewed during this study, had made at least one change to their farming system and now felt more confident to cope with drought conditions than in 1988/89. It is difficult, however, to determine how much change occurred due to the direct influence of the Technology Transfer Programme relative to: the farmer's drought experience, and the wider base of agricultural knowledge available to farmers; other farming or non-farming objectives; and generally improved financial returns for livestock products overall the period from 1990 to 1994.

Policy implications

The evaluation of the East Coast programme indicated areas where future technology transfer (extension) programmes could be improved. First, the technology to be transferred must be relevant, proven and readily applicable to the local physical and socioeconomic environment and benefits of change should be readily apparent to farmers. This could be achieved by

working with local farmers in each region, but would increase response times and may not be appropriate for some adverse event situations. Second, specific technologies and management practices should be targeted to different types of farmers, especially in regard to field days, on the basis of their willingness to change and attitude to progress. These characteristics are themselves dependant on a number of inputs (e.g. financial security, physical resources, farmer goals and objectives and to a lesser extent, age and level of education). Relatively simple, risk averse technologies and management practices, for example, could be targeted to less progressive farmers and more complex technologies and management practices targeted to progressive farmers. It is likely that farmers would put themselves into groups with which they felt most comfortable. Farmers should be actively involved in the formation and leadership of these groups.

The present Government policy of non-intervention is now widely accepted by farmers (i.e. the majority of farmers would prefer to take action to protect themselves against future drought events). However, due to decreased meat processing capacity in the East Coast region, the feasibility of the recommendation to make an "early decision on livestock numbers for summer", encouraged throughout the Technology Transfer Programme, has been substantially reduced. This places an even greater reliance of effective forward planning and the medium-term (up to 3 months) assessment of risk associated with climate change.

Overall, this evaluation of the 1990 Technology Transfer Programme suggests that the programme, together with the lessons learnt by farmers from the 1988/89 drought and support from the agricultural infrastructure, has helped to establish sustainable dryland farming systems and greater farmer independence from Government-funded relief in the East Coast region.

ACKNOWLEDGEMENTS

This research was funded by MAFPolicy. We thank all of the farmers for their input and Mr T Rhodes and Mr G Milne for their assistance.

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A SPREADSHEET MODEL OF THE ECONOMICS OF *NERINE* PRODUCTION

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ABSTRACT

Nerine sarniensis hybrids (Diamond Lily), one of the "new flower crops", have a short flowering season of about 8 weeks beginning in mid-February. Over 70 per cent of the crop in New Zealand is produced over a 2 week period with a consequent price reduction during this period in Japan, the main export market. In order to improve the profitability of the flower, HortResearch have developed technologies to delay or advance the flowering of this crop effectively extending the flowering season to 18 weeks.

Despite the seemingly obvious potential of the technology to extend the flowering season, few growers have yet to adopt it. This paper examines the reasons for the slow adoption of this technology and describes a budget model for Nerine production that can be used to assess the profitability of the technology, and for undertaking 'What if?" analysis with grower discussion groups.

Keywords: ***Nerine, Diamond Lily, budget model***

Paper presented to the Annual Conference of the New Zealand Agricultural Economics Society, Blenheim, 5-6 July 1996.

INTRODUCTION

The development of a number of novel flower crops is providing stimulus for strong interest and growth in the floricultural sector. As a result of considerable research and development effort, *Nerine sarniensis* and various of its hybrids are now a viable commercial cut flower crop. Nerine production for export has shown remarkable growth in the last few years. However, the crop is still relatively underdeveloped in comparison to the traditional floricultural crops traded globally.

Many issues related to the phenology, growth and performance of this crop are little understood and are being investigated to improve the commercial potential of the crop. One major issue is that *N. sarniensis* has a very short flowering season; generally between six to eight weeks, from late February/early March to late April/early May, in New Zealand (Warrington, I. J., Brooking, I. R., Schnell, T. A., and Van Dien M., 1994). During the large flush of flowering that occurs, New Zealand growers produce over 200,000 stems per week (Keymer, *pers. comm.* 1995). As a consequence, although demand for *N. sarniensis* in countries such as Japan and U.S.A. is growing, oversupply forces prices to drop significantly during these flushes.

Research, conducted by Warrington *et al.* (1994), has been successful in developing treatments for *N. sarniensis* bulbs which enable earlier and later flowering. Despite the seemingly obvious potential of this technology, only a few growers have shown interest in utilising it (Hollows, *pers. comm.* 1995). This problem highlights one of the difficult questions encountered in agricultural (including horticulture) research extension, namely, why don't farmers (or growers) take up new technologies?.

In the case of the *N. sarniensis* research to extend the flowering season, it would appear the traditional problems associated with the development of new technologies by researchers remote from growers, have been overcome. Firstly, the research was commissioned by the growers, secondly it was conducted on-farm, at Nerine Nurseries and thirdly, there has been good communication between researchers and growers. Therefore, it would appear that the pre-requisites for effective research had been met. However, as the technology has not been widely adopted the problem may be that researchers only targeted "progressive growers". As a consequence, sufficient time has not passed for the "new ideas to diffuse from progressive farmers to others" (Roling, 1988, pp. 29). Also, various members of the Nerine growers group felt that they could not see the financial benefit from using such technology.

The aim of this research is to develop a decision support tool which can be used to assist with the transfer or diffusion of the new technologies. A financial (budget) model is essentially a tool with the potential to be used in aiding the decision making of management. It allows managers to "examine the likely consequences of a particular action" and also enables them to explore alternatives (Bhaskar K., Pope P., Morris R., 1984, pp.1). By developing a budget model, growers would be able to assess the profitability of the new technology, by being able to relate it to their own situations.

THE NERINE INDUSTRY

Nerine is a genus of bulbous plants, native to South Africa, which belongs to the Amaryllidaceae family. There are approximately 30 species of *Nerine* (Harrison, 1971), with the growth habit of each being determined by its geographical origin. Nerines from the northern provinces of South Africa produce foliage in summer, when the predominant rainfall occurs, while the bulbs are dormant during winter. Flowers emerge at the end of the vegetative phase, in autumn. Examples of such species are, the hardy *N. bowdenii, N. undulata* and *N. angustifolia.* Species from the southern provinces, where the predominant rainfall occurs during winter, have a summer dormancy, with winter foliage. These species, such as *N. sarniensis, N. curvifolia* and *N. humilis,* produce flowers in late summer, before foliage appears. A third type, such as *N. flexuosa,* originate from the region between the north and south, and produce foliage all year. Having no distinct rest period, they flower at all times of the year (Salinger, 1985; Warrington and Seagar, 1989).

Nerine sarniensis is considered by many to be "the most beautiful of all Nerine species", with its large, long-lasting flowers (Van Brenk and Benschop, 1993, p. 572). It is known to have existed in French and English gardens since the early seventeenth century, despite originating from South Africa. It is also found in Guernsey, often being referred to as the 'Guernsey Lily'. Whatever its origins, it wasn't until the end of the nineteenth century, in England, that *N.sarniensis* began to be improved through hybridisation. Initially this work was undertaken by the plantsperson Mr H. J. Elwes and later, in the 1930's, it was continued on a larger scale by Lionel de Rothschild and his son Edmund de Rothschild. Great developments were made, until the programme was ceased in 1974. These hybrids have become known as the Exbury hybrids (Smithers, 1990, 1993).

After the Second World War, Mr R. E. Harrison of Harrison's Nurseries in Palmerston North, acquired a "fine collection" of the Exbury hybrids and was successful in breeding some "handsome and robust" cultivars suitable for the cut flower trade (Smithers, 1990, pp. 15). In the early 1980's this collection was obtained from Mr Harrison's estate by Mr Hollows, who later set up Nerine Nurseries in Palmerston North (Smith, 1994). Furthermore, Mr Hollows has also acquired the Exbury hybrid collection and plant material from other private Nerine breeders worldwide. Mr Hollows now claims to have control over most of the hybrid Nerine varieties in the world.

By controlling the ownership of plant material and the technology to grow it New Zealand Nerine growers can "control" the market for their crop to some extent. The Nerine Industry has managed this by forming the Nerine Growers group which comprises 43, *N. sarniensis,* growers from throughout New Zealand, who have formed an incorporated society. The group have developed an industry plan and collectively export and sell their product through one exporter, Eastern & Global and one Japanese importer, Yoko Sakamoto of Y.M.S. *("Nerines* Ready To Rise", 1995a; "Diamond Dust", 1995b). With New Zealand producers being the major suppliers of *N. sarniensis* on the international market (only a few hectares are grown in Holland), the aim of forming a group is to avoid competition between New Zealand growers (Smith, 1994; *"Nerines* Ready To Rise", 1995a).

The advantages for growers belonging to the group are, firstly, only members can obtain more stock, or new cultivars produced by Nerine Nurseries' breeding programme. Secondly, any technologies developed through the groups' research programme belong exclusively to the group. An example of such a successful technology, is the new postharvest treatment, 'Monty's Diamond Dust'. The use of this solution has resulted in four-fold increases in the vase life of the flowers ("Additives Push Up", 1994; "Diamond Dust", 1995b). Thus enabling growers to deliver more consistently, a high quality product to the market.

Nerine Nurseries and associated growers from the Nerine Growers' Group in New Zealand, have exported in the vicinity of 750,000 stems to Japan and USA, 75% of which go to Japan alone. (Keymer, *pers. comm.* 1995, *"Nerines* Ready To Rise", 1995a) In Japan prices for Nerines are generally high during February and early March, when school and university entrance

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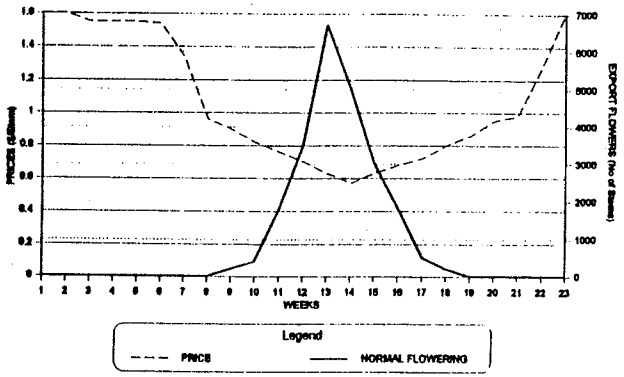

Figure 1 Distribution of flowering and prices obtained for hybrid Nerines.

With this in mind, efforts to extend the length of the flowering season have begun. Firstly, production has been spread throughout New Zealand, to take advantage of the spread in flowering that was assumed to be achieved by the climactic differences between sites. The spread of production sites has been achieved by simply attracting new members into the Nerine growers group from districts which were perceived to have early or late climates in comparison to the bulk of the plantings (established in Palmerston North). Unfortunately, in the few seasons of full production that have been achieved, the geographical differences have not provided the spread of flowering expected.

[1] During both the spring and autumn 'Equinoxes', it is traditional for Japanese to place flowers on their ancestors' graves ("Blooming Imports", 1990; "The Japanese Market", 1992).

The second strategy has been developed from collaborative research with HortResearch that has identified that if the bulbs are subjected to an artificial summer, by heating them, their flowering is advanced. Whereas, if their summer is delayed, by placing the bulbs in 'suspended animation' through cool storage, their flowering will be delayed. Advances and delays of five to six weeks have been achieved through field trials of this technology. As a consequence, growers now have the flexibility of being able to control the flowering of their lifted[2] bulbs. The treatments have no effect on the distribution of flowering, however, the proportion of bulbs that flower does change. In general, more bulbs flower, however, the quality of these flowers is such, that the percentage exported does not change. Experiments are currently underway, to study the effects of temperature treatments on bulb multiplication rates (Warrington, *pers. comm.* 1995).

As a result of the research, it is now possible to extend the flowering season from 8 weeks to 18 weeks, or more (see Figure 2). Consequently, more stems could achieve the higher early and late season prices, while less stems would receive the lower mid-season prices provided the use of the technology was managed in some manner.

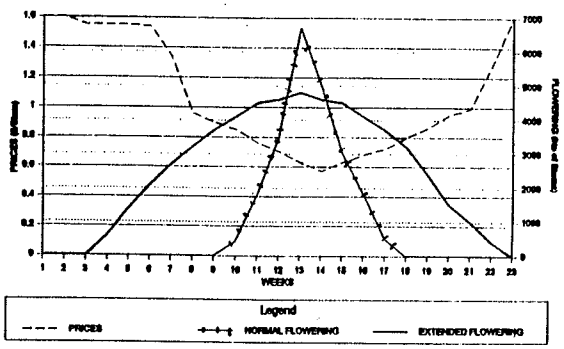

Figure 2. Distribution of flowering in normal circumstances and the range of prices achieved, and the potential extended range of flowering obtained by using new technologies.

[2] Lifting is carried out at least every four years as the crop multiplies quickly and overcrowding needs to be managed to ensure optimum growth of large bulbs which will produce flowers. Large bulbs produce more, long stemmed flowers than small bulbs. The offsets, or daughter bulbs, produced form their large parents are dumped.

NERINE BUDGET MODEL

A Case Study Research method was used to collect information to enable a simulation model to be constructed using Quattro Pro version 5.0, a three-dimensional spreadsheet. An initial scoping study was undertaken by interviewing key informants in the Nerine industry. From this study and from a literature review the conceptual model was developed (Figures 3a and 3b).

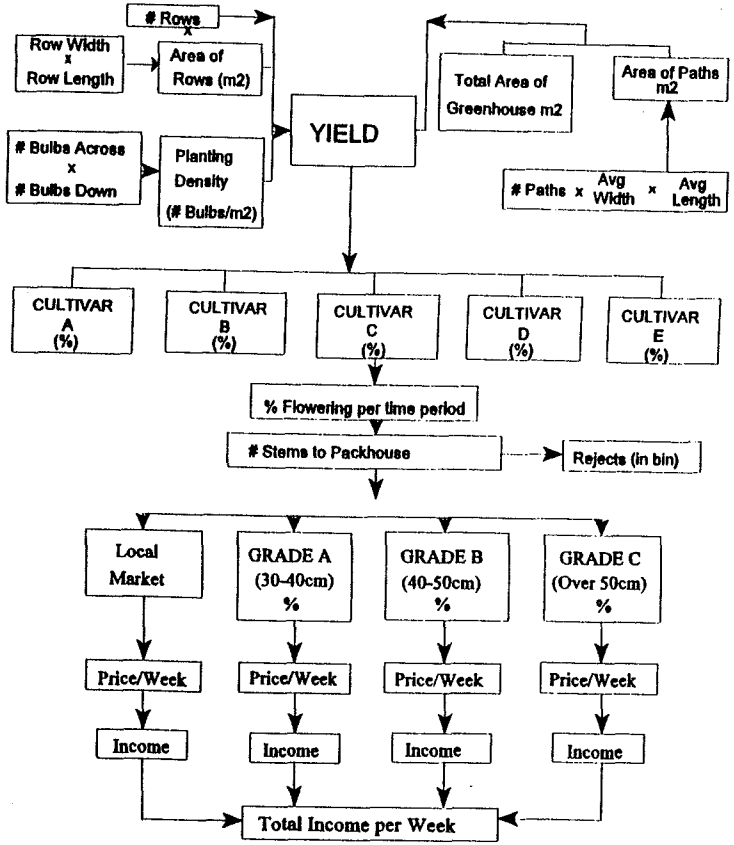

Figure 3a. **Conceptual model of income variables.**
The yield of stems is dependant on the area of greenhouse planted in the crop. The income varies according to yield, cultivar, time of flowering, flower grade and price.

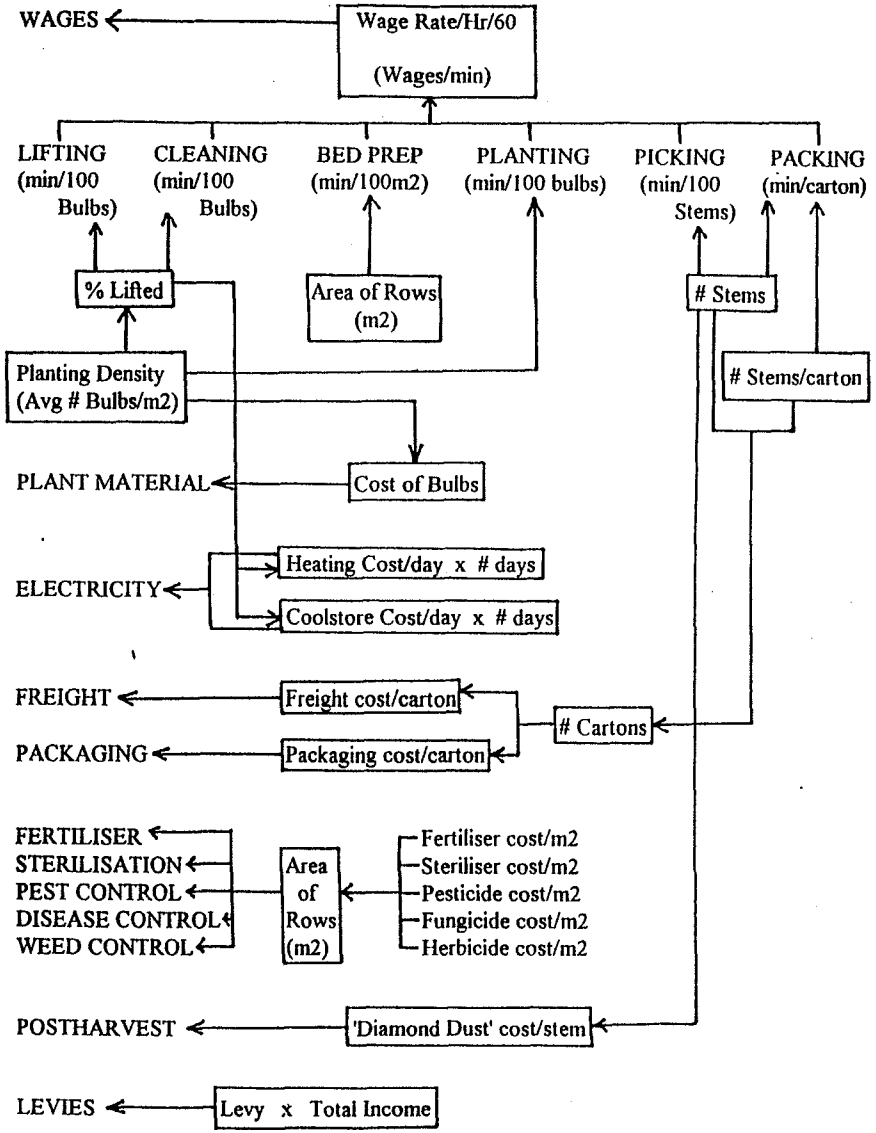

Figure 3b **Conceptual model of Expenditure**

The expenditure incurred on Nerine production is dependent on the costs associated with: preparing and maintaining the beds of bulbs; acquiring and establishing the bulbs; picking, grading, and packing the flowers; and, shipping, storing and selling the boxes of stems.

From this model, and from the interviews with key informants, other sources of information were identified as follows:

(a) Six growers from the Nerine Growers' Group were identified as being likely to keep the required financial and production records.

(b) Sales invoices from Eastern & Global, for the last five years, were obtained setting out the colour, stem length, quantity sold and prices achieved on a weekly basis for the Nerine Nurseries operation.

(d) A survey report of the Nerine Growers' Group (excluding Nerine Nurseries), setting out the estimated production for the group to 1997, was obtained from Egarr (1995).

The spreadsheet model which was developed using the collected data can be divided into three parts, the input section; the control section; and the output section.

Input section

This part of the model is a single page titled "INPUT" and is the first page a user will see. It is here that a user can key in their own data to customise the model to their own production system. Before coming to a discussion group, growers would be sent a form setting out all the information and data they would need to customise the model to their own situation.

Control Section

The control section refers to the data and formulas that drive the model, enabling it to make recalculations when the input variables are changed. There are a number of interlined 'pages' which contain the bulk of this data. Some of the formulas are also included in the input and output pages. The control section primarily consists of the following:

Export price data

The model includes two price scenarios:

(a) Normal export prices:
The first price scenario is based on five years of data gathered from Nerine Nurseries' export invoices[3]. The price information is calculated across three 'pages'. 'PRC' contains five years of weekly price information broken down by colour and size grades. Unfortunately, due to gaps in some of the colour, size grade, and early and late season data, this information has been averaged out. The 'page' entitled 'TPRC' amalgamates this data further to come up with an average price over a normal production period. Seasonal variations in this data have been smoothed by eye, to create the typical price distribution contained on the 'page' titled 'XPORT'. As no price information was available for the early and late season, these prices have been taken at a flat rate based on the closest price information (see the 'normal' price curve in Figure 4 below).

(b) Flatter Price Scenario
A second price scenario has been included to account for the fact that if over 30% of production is shifted into the early and late season (using the new technology), then the laws of supply and demand are such that the prices will drop[4]. As such the price distribution curve would be flatter as shown by the dotted line below.

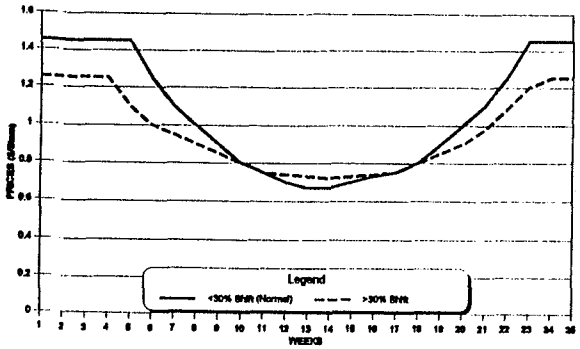

Figure 4. Price structures for a shift in production of more than 30% from normal and for a shift of less than 30% from normal.

[3] Nerine Nurseries account for in excess of 50% of all *N.sarniensis* production in new Zealand. As this information was not available from other sources, Nerine Nurseries price information has been used to calculate export returns.

[4] The Japanese importer, Yoko Sakamoto, has indicated that the Japanese market will sustain current prices if volumes remain below 80,000 stems per week (G Keymer, Personal communication, July, 1995). If, however, over 30% of production is shifted into the early and late seasons, volumes would exceed 80,000 stems per week causing prices to fall.

Local market prices

Little information on local market prices was kept by growers. Therefore, local market prices have been based on the United Flower Auction Flower Reports for 1995, found in the May and June issues of Horticulture News.

Volume data

Nerine Nurseries' export invoices are also the source of this data. Raw weekly data, over five years, by colour and size grade, is held on the 'page' titled "PRD". This data is then summarised on the 'page' titled "TPRD" in the same way as the price data. The total, weekly mean data is then transferred to the "XPRIC" page as a normal distribution of flowering. If any bulbs are temperature treated the normal distribution of flowering is shifted forward or backward by the number of weeks the bulbs are treated. In this way income is calculated on the basis that the early or late season stems will achieve the higher marginal prices.

Bulb multiplication

Facilities have been included in the spreadsheet to calculate the number of new bulbs produced in the following years. A matrix containing the rate at which bulbs multiply is used. However, due to poor records some assumptions have been made. Included on this page is the ability to calculate the additional greenhouse area required to plant the new bulbs. The user can then make a choice as to whether they wish to keep the new bulbs or dump them. Also included on this page are the calculations for bulb temperature treatment costs. The number of bulbs lifted are multiplied by the cost of heating or cool storing the bulbs.

Spray applications

A full spray program, calculated on a monthly basis, is also included as page "SPRAY". This page also contains a table of the chemicals used, their costs and application rates. A third table calculates the labour costs of application on a monthly basis. All this information is combined to calculate the total cost of spray applications on a monthly basis. These costs are divided into Pest and Diseases, and Herbicides and the grand total for the year entered into the gross margins.

<u>Output Section</u>

The output can be displayed in two manners:

Gross Margins

Essentially, gross margins show the "differences between gross income earned and the variable (direct) costs incurred" (Parker, 1991, pp. 49). As recommendations for utilising the new technology are, "growers should lift say 25% of their bulbs every year" (Warrington, *pers. comm* 1995), four years of gross margins, discounted at an interest rate of 9. 5%, have been included. Total gross income is calculated, separating out export and local market flower sales. Income for the sale of bulbs has not been included because growers are currently prohibited from selling any surplus bulbs. Variable expenditure, attributable to growing *Nerines,* has been broken down into six categories, with costs being separated out further under each category. Most of these figures either come direct from the input sheet or one of the control sheets, or they are calculated by combining information from the input sheet and the control sheets. For example, packaging is calculated as follows:

(Total # stems exported / # stems/carton) x Cost of sleeve & carton
(per year) ($/Carton)

Graphs -

Output can also be viewed in graph form as follows:

(i) Gross Margins

The main graph is a bar graph showing the gross margin each year for four years. From this graph, all other graphs, excluding the 'Summary' graph, can be accessed using buttons.

(ii) Income

This bar graph shows the total income earned, across four years.

(iii) Expenditure

A series of four pie graphs showing the way expenditure has been apportioned to six categories can be accessed from the gross margin graph.

(iv) Summary

The main graph in this series of line graphs, shows the total mean price and volume data for the five years of records used. From this graph, a series of similar line graphs can be accessed, showing the same data for individual years.

DISCUSSION & CONCLUSION

As a simulation model, managers of *Nerine* production systems will be able to run 'what if' scenarios, enabling them to evaluate the financial consequences of making changes. This model has essentially been designed to evaluate the new technology to extend the flowering season. However, it has been developed in such a way that managers will also be able to evaluate changes to any of the inputs. For example, a grower could run scenarios such as, 'what would happen if I changed my planting densities?', or 'what would happen if I increased or decreased the average wage rate?'. By making these changes, they would then be able to see graphically how their gross margin is affected; the amount left to pay their fixed costs. Another example might be to evaluate the consequences of a higher percentage packout, or percentage of stems exported. Gross margins are also useful in making comparisons between enterprises. As the model includes calculations on a metre squared basis, growers can also make comparisons between properties of differing performance and potentially identify areas of weakness in the poorer performers. Therefore, the model can be used as a tool to identify both "management problems and opportunities" (Parker, 1991, pp. 55).

Although the model has been designed to evaluate the financial consequences of extending the flowering season, it also has the potential to be used to evaluate new improved cultivars ("*Nerines* ready to rise", 1995a). If a new cultivar which produced a higher percentage of flowers became available, growers could evaluate whether the increase in their gross margin would be enough to cover the cost of purchasing the new bulbs. After a few years of the postharvest treatment, 'Monty's Diamond Dust', being used, comparisons could also be made between gross margins for years prior to and after its use. An additional potential of the model is for evaluating other bulbous crops. With a few adjustments, the model may also be useful for crops with a similar production system.

As with any spreadsheet model, not everything can be measured or incorporated into the model, therefore, assumptions have had to be made. For example, it is very difficult to accommodate differences between cultivars such as the percentage of bulbs that flower, the timing of flowering and the size grade distributions all vary between cultivars

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A FRAMEWORK FOR UNDERSTANDING THE ADOPTION AND USE OF TECHNOLOGIES BY DAIRY FARMERS.[1]

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ABSTRACT

Five dairy farmer case studies were undertaken using semi-structured interviews and matrices. Rogers' (1983) attributes of innovation, as predictors of farmer adoption of innovation, provided a framework for analysis.

The findings of the study supported the usefulness of Rogers' attributes for assessing the likely adoption of an innovation. The detailed knowledge provided by the case-study method highlighted the important relationship between farmer circumstances and their adoption and use of technology. The results indicate that an explanation of the reasons for adoption/ non-adoption and use of technologies is enhanced by understanding not only the nature of the technology but also the circumstances of farmers.

Rogers' attributes of technologies, although useful for initial analysis, failed to provide a satisfactory framework for describing the perceptions of farmers towards five commonly used dairy farming technologies.

Keywords: ***Dairy farmers, adoption, technology***

Paper presented to the annual conference of the New Zealand Agricultural Economics Society, Blenheim, 5-6 July, 1996.

INTRODUCTION

The factors which influence the relevance and appropriateness of technology to New Zealand dairy farmers are not well understood. A framework or process to assist the communication of these factors, between farmers and researchers developing technology for farmers, would contribute to the agricultural research process in New Zealand. Rogers (1983) provides one possible framework which comprises five 'perceived attributes of innovation'.

The current environment for the funding of public good agricultural research in New Zealand gives priority to research which incorporates end user consultation and technology transfer in the research process. This is aimed at maximising the probability of adoption of the resultant technology by end users (FoRST 1995; MoRST 1993).

In the 1960's, research aimed at increasing the rate of technology adoption by farmers was concerned with the development of an understanding of their mode of adoption, and, consequently, the identification of target groups or 'innovators' more likely to adopt a particular technology. Rogers (1962) categorised farmers with respect to the relative rate at which technology was adopted from the time of the technology's first introduction. In the diffusion model of technology dispersal, farmers quick to take up innovations[1] were categorised as innovators, and those slow to take up technology, laggards (Rogers 1962). The nature of the adoption-diffusion process of technology was attributed to the characteristics of individual farmers. This, traditional, model for technology generation and transfer, often referred to as the Transfer of Technology (TOT) model, was less concerned with seeking the involvement of end users (farmers and horticulturists) in the research process (Chambers and Ghildyal 1985). Technology was predominantly treated as a parameter (Norman 1978: Saint and Coward 1972), that is, it was viewed as a given entity generated by researchers and transferred by extension agents to the awaiting farmers (McClure 1991). The 'solution' of technology implementation was one of better identifying the target farmers and more accurately packaging the fixed technology for the market (Guerin and Guerin 1994).

[1] In this paper the word technology is used synonymously with innovation.

Since the 1960's the traditional model of technology transfer and adoption, which was widely promoted in agricultural extension, has increasingly been challenged and refined (Roling 1988). The work of Fleigel and Kivlin (1962) took the stance that different rates of adoption were not necessarily due to the relative 'innovativeness' of farmers, but due primarily to the attributes of the technologies. These authors suggested that technologies were adopted differently as a consequence of their different attributes. Further, it was assumed that scientists were able to define the attributes of a technology that would be relevant and therefore adopted by farmers (Stoop 1989). Wasson (1960), however, reported that the rate of adoption of a technology was influenced to a greater extent by the end users' perceptions of the attributes of that technology than by the attributes of technologies as defined by researchers or change agents. This was supported by later work which showed that farmers and agricultural scientists evaluated farming practices differently (Guerin and Guerin 1994; Gillespie and Buttel 1989; Ridgley and Brush 1992). The premise that technologies generated by researchers are inherently 'good', and thus worthy of adoption by farmers, is no longer acceptable. Farmers assess technology in the context of their farm system and their individual circumstances which are diverse and complex (Okali, Sumberg and Farrington 1994).

It is now recognised, in the literature, that the reason farmers do not adopt a particular innovation is not a function of their inherent lack of 'innovativeness', but a rational decision given their personal and farm circumstances (Guerin and Guerin 1994; Gillespie and Buttel 1989; Ridgely and Brush 1992).

A weakness of the traditional approaches to agricultural research has been described as the failure to incorporate farmers' knowledge and perspectives into the research process (Scoones and Thompson 1993, Roling 1988). Farming System Research (FSR) is an approach to research which aims to place farmers at the centre of the agricultural technology system (Chambers and Ghildyal 1985). This approach recognises that the farmer's production and household decisions are interlinked and socio-cultural factors such as the farmer's goals, attitudes and beliefs are also an important parts of the system (de Walt 1985). Farming System Research advocates that, to improve the likelihood that farmers' needs are met, farmers should be included in the research process (Norman and Collinson 1985). In line with this shift in thinking FSR recognises the need

for technology to be viewed not as a parameter but as a variable that is able to be adapted and changed in response to the specific needs and characteristics of different farming systems (Saint and Coward 1972).

Rogers (1983) identified the need for a 'standard classification scheme' for the perceived attributes of innovation to assist researchers to predict the likelihood that a given technology would be adopted. The proposed classification scheme comprises five attributes that are empirically interrelated but conceptually distinct (Rogers, 1983). The attributes are: trialability; observability, complexity, compatibility and relative advantage. Importantly, these attributes, as opposed to earlier theories about adoption of technologies, were derived from farmers' perceptions of given technologies.

The purpose of the research reported in this paper was to one, gain an understanding of the reasons and factors which influence dairy farmers' perceptions and use of technology, and two, assess the usefulness of Rogers' (1983) attributes of innovations as a framework for analysing and classifying the findings of the research.

METHOD

The qualitative research data that is the basis of this research study was collected from farmers in semi-structured interviews. The interviews were not guided by Rogers' attributes of innovation but were aimed at gaining farmers existing perspectives on the technologies. Rogers' attributes were used as a framework for sorting and analysing the data gained from the farmers. A comparison and consideration of the usefulness and closeness of fit between the data and Rogers' attributes was then possible.

For this study five dairy farm technologies were selected for consideration by dairy farmers. The number of technologies and type of technology chosen was influenced by the need to complete the study within a time frame defined by a postgraduate study programme.

The technologies were chosen on the basis that they were:

- clearly definable;
- potentially adoptable without major change to the existing farm management system;
- in wide use in the industry for at least five years;
- consistent with a definition for technology provided by MoRST (1991): that is " techniques which are systematic methods and procedures, involving people and 'hardware' utilised to achieve desired goals" (MoRST 1991 pp 14).

The five technologies chosen were:

1. Induction of early calving in dairy cows:

   The practice of inducing premature calving through injection of long acting corticosteroids to the cow. The main purpose is to calve later calving cows earlier thereby concentrating the calving spread.

2. Herd testing:

   This involves the collection of milk samples from individual cows in the herd over regular intervals in the milking season. In addition to providing data on per cow milk production, the samples are analysed for levels of milk fat, protein and the presence of subclinical and clinical mastitis. The information contributes to a herd data base which can then be used to assist culling and selection decisions in the herd.

3. Artificial insemination of heifers (Heifer AI):

   The artificial insemination of heifers facilitates the production of calves that have been sired by bulls of high genetic merit selected by the New Zealand Dairy Boards Livestock Improvement Corporation. The alternative policy is natural mating of the heifers. Artificial insemination (AI) necessitates the monitoring of heifers to identify when animals are cycling (in heat) and are ready for inseminating.

4. Soil testing:

   Soil samples taken from the farm are analysed and the resultant soil fertility information is available to farmers to assist their fertiliser application and management decisions.

5. Strategic applications of Nitrogen:

   Applications of nitrogen fertiliser will promote extra grass growth throughout most of the year. It can be applied strategically by farmers to supplement a short fall in feed supply for the dairy herd or other stock.

A multiple case study approach was chosen as an appropriate method to acquire the level of understanding needed to satisfy the objectives of the research. A purposive sample of five farmers was chosen in consultation with a local dairy consulting officer. The farmers[2] were chosen on the basis that they were established owner operators of dairy farms, running a seasonal supply herd in the Manawatu and were conducive to being interviewed by the researcher.

Two semi-structured interviews were undertaken with each of the case study farmers. The objective of the first interview was to gain a description of the farmer's circumstances, that is, their background, dairy farming experience and future objectives, the farm's physical resources, farm management systems and operating constraints. All interviews were tape recorded and transcribed. A summary of the first interview was returned to the farmer for comment and corrections at the second interview.

The second interview focused on gaining the farmers' perspectives on the five chosen technologies and was guided by the researchers understanding of their circumstances gained from the first interview.

The qualitative data generated from the interviews was analysed initially by sorting and categorising on the basis of common factors. Rogers attributes of technology were then compared

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[2] Farmer' refers to the primary decision maker or makers with respect to the management and operation of the dairy farming system.

with the common factors identified from the case studies. The results are thus presented in terms of their concurrence or lack of concurrence with Rogers attributes.

RESEARCH FINDINGS

A description of the personal and business circumstances of each case study farmer was built up from the interview transcripts. Farmers' circumstances varied as did their perceptions and use of the five technologies. All farmers currently use or had used soil testing, herd testing, induction and strategic applications of Nitrogen. Heifer AI was a current practice of one farmer, and another had used the practice in the past but had rejected it on the basis of poor results.

Trialability:

This is the degree to which a technology may be experimented with on a limited basis (Rogers 1983). Findings from this study support Rogers' contention that the higher the risk farmers associate with the technology the more important it is that the technology can be trialled (Rogers 1983).

One farmer artificially inseminated a few heifers one year to gain an indication of the implications of the technology on her farm system. The small scale use of the technology provided the farmer with a greater understanding of the implications of using the technology which lead to her rejection. Artificial insemination of heifers necessitates the identification of animals as they come into heat and the ability to move them into facilities in which they can be inseminated;

> *"...I have run the heifers next to the shed for about a week; I mated a few then to AB, but there is a limit to the amount of time we can leave them next to the shed ... the farm here hasn't really got enough room to keep the heifers at home for too long; the home farm is really supposed to be a milking platform..."*

Observability:

The degree to which the technology and the results of using a technology are visible. The more observable the technology and the results of it being implemented the more likely it is to be adopted (Rogers 1983). This attribute, or any concept akin to it, was not identified by the case study farmers as important in their assessment of the technologies. This may be due to the fact that the technologies under consideration have been widely used, and hence visible, in the dairy sector for at least five years.

Complexity:

This attribute defines the degree to which an innovation is perceived by farmers as difficult to understand and use (Rogers 1983). Rogers' (1983) definition of complexity seems to be confined to a consideration solely of the technology itself and not the implications of using the technology in the context of the farm system. Case study farmers' perception of the complexity of the technology was influenced not only by the nature of the technology, but also by the degree of change and impact that using the technology had on the farming system as a whole. Farmers considered technologies complex when they perceived the successful use of the technology required them to have a high level of knowledge of their farming system, and when the implementation of the technology was dependent on factors they had little control over.

The farmers' own perception of their ability to manage the conditions on their farm was a strong determinant in their adoption decision;

> *"... a high level of farm knowledge will make it easier to use induction and it will also help me to decide not to ... induction requires a high level of knowledge of the farm for its optimal use ... just to race in and decide to induce 30 cows next year so I can get them calving at the right time, with no knowledge of how much grass you are going to have ahead of you, then you will fall flat on your face. I think induction would be one of the most difficult things [in the list of technologies] to use..."*

Likewise, two of the farmers perceived 'strategic application of nitrogen' to be a complex technology as it required of them a high level of knowledge and previous experience of their farm. One of the case study farmers said that;

> "*...the ability to recognise the limiting factor in pasture growth to make the decision whether or not to apply nitrogen is affected by the farm knowledge and requires a high level of this...*"

Herd testing and soil testing are technologies which although potentially have great impact on the farming system, can be implemented with little impact on the operation of the farming system. They are tools for decision making but do not necessitate intervention in the farming system. Induction and Heifer AI, however, require changes to the farming system and have wider management implications for the farmers. The implications of Heifer AI were explained by one farmer;

> *"...if you want to mate heifers, in my opinion and experience, you've got to really start to think about it in autumn and through the winter you've got to have those animals in the best condition ... you've got to give those animals the best possible feed and the best possible chance because if you don't get them in the right condition for AI, you are not going to have the results ..."*

The degree to which the successful application of a technology was influenced by other factors also contributed to farmers' perceptions of the complexity of the technologies. The success of applying nitrogen could be influenced by weather, which would also impact on the farmers' ability to apply the nitrogen. Likewise, heifer mating and early induction of calving placed additional pressure on feed supplies, and the impact of any inclement weather would likely be greater because of this.

In summary, the farmers' perceptions of the complexity of technology were due to the technology's inherent attributes and its interactions with the farm circumstances.

Compatibility:

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of the potential adopter (Rogers 1983).

The case study data strongly supported this perceived attribute of technology as a characteristic that influenced the adoption and use of technologies by the farmers. Importantly however, as with the other attributes put forward by Rogers, the definition of the attribute fails to account for farmers' perception of the impact the implementation of the technology has on their farming system.

The importance of farmers' values and beliefs was highlighted by the case study farmers in their reaction to the nature of the intervention associated with the early induction of calving and the likely death of the calf. Their concerns were apparent in their comments regarding the injection which induces the premature calving: "*it is unnatural*","*it affects the cows*", "*it mucks them [the treated cows] up a bit*". Although all farmers had reservations about the use of the technology it was or had been used by them all;

> "*Induction is not natural so we would rather not use it ... we would rather have a full-term, live calf than have to induce; that is for sure ..*"

Farmers commented that they would apply nitrogen, even if the financial benefit was uncertain. They said that the extra grass that applying the nitrogen produced afforded them *peace of mind* which they rated above financial benefit;

> "*The financial side does not always count; there are some things that you do, not just to make money. If starving the cows was more profitable than putting nitrogen on to feed them, I'd forego a bit of the financial gain and put some nitrogen on to make the cows better. Even if the payout dropped to an extent that they said you are better off to starve your cows to death, I'd probably put the nitrogen on because I wouldn't be able to stand starving the cows to death.*"

Farmers' previous experience had a major influence on their perceptions of the technology's place in their farming system. Poor previous results with artificial insemination of heifers reinforced for one farmer, the misgivings he had in aspects of the technology;

> *"...we have [heifer] mated in the past and had very poor results from it; 50% conception rate and 30% heifer calves which were very expensive ...I have just never had any success to give me confidence in heifer mating. Maybe it's nature, maybe I'm old-fashioned, but my experience with heifers is that the more you leave them alone, the better they do their own thing and do things naturally ... we have a better conception rate with the [naturally mating routine] bull ... my experiences are just not good".*

An unsatisfactory experience with collecting the milk samples for herd testing, over a decade ago, resulted in one farmer's rejection of the technology until recently;

> *"...when I compare what herd testing is now (self-sampling) to what it was back in the 1980's, it is just so much easier. The sampling method is better - position of the numbers is better, writing on the cap is better and mixing the caps doesn't matter now; self-sampling is a breeze now...since doing it, it is just a lot easier than I perceived it to be from previous experiences and I probably would have done it sooner if I had have known it would be so little hassle..."*

An important issue identified by farmers in the study was the degree to which the technology was compatible with their existing circumstances. For example, one of the farmers explained how the labour resources on his farm and the inherent time and labour requirement for nitrogen application influenced his decision to apply nitrogen strategically;

> *"...because we have got more labour units than is really economic on a farm of this size ... if there was only me, I would say 'there is so much labour involved in putting nitrogen on, I might not use it' ... therefore, that number [the rating in the matrix] would have been influenced quite dramatically..."*

One farmer discontinued her plans to use heifer mating in the subsequent season because a combination of her circumstances, particularly influenced by the weather, would not allow her to continue;

> *"... [the changes required in order for the farmer to heifer mate] include having lots of money, .. proper facilities, suitable yards at the run-off ... and be able to make the decision of what I am going to mate them to ... the heifers would have to be a good size at 15 months. I probably could have mated the top 40 this year (that was my intention), but that got knocked on the head because of the weather..."*

The farmer was satisfied with the technology and it was *not* replaced by an improved idea, however, it was still discontinued due to the impact its implementation had on the farmer's farming system.

Relative Advantage:

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers 1983). This relative advantage is most commonly expressed in terms of financial gain and the increased social status adoption of the technology was perceived to infer. Rogers also described a number of sub-dimensions of the attribute: low initial cost, decrease in discomfort, savings in time and effort, and immediacy of reward (Rogers 1983).

Social status as a motivating factor for adoption of a technology was viewed with importance by Rogers (1983). However, it was not identified as an issue for any of the five farmers in respect to the five technologies considered. Rogers (1983) does state that social status is an aspect of adoption that individuals are generally unwilling to state explicitly so the relevance of this component of the attribute in this research context is unclear.

Two of the most common and consistent constructs identified by the case study farmers in their consideration of the five technologies were financial benefit and time and labour component associated with the use of the technology. Farmers viewed the technologies in terms of their short and long term impact on financial return. The benefits were generated both directly through, for

example, the increased value of stock, and indirectly from better informed decision making in relation to resources and inputs and increases in milk production.

All farmers identified the relative advantage of herd testing. The information that the technology provided was used to improve the long term quality and production of the herd as well as increasing the immediate saleable value of excess stock. Prior to herd testing, one farmer was only able to sell his older cows for slaughter. With the information provided by herd testing these animals were purchased by other farmers at a higher price for continued milking;

> *"...if you want to start selling animals ... most people who buy cows now...they want to know what its BI [breeding index] is and they want to see the figures. Without them, selling stock isn't an alternative. It is hard to sell stock without the figures. That is one of the reasons why we picked it up..."*

In addition, herd testing information was used to accurately identify and replace the lowest-producing cows, a task which could not be performed without herd testing data;

> *"... it is pretty hard to find cows ... your low producers, without herd testing; I didn't think I would say that five years ago, but I have. Before herd testing, I culled cows on observation; out of ten cows, I could probably pick five or six of them ... but there are those other four that you just don't pick for one reason or another."*

The short term financial benefit of applying nitrogen was identified as a positive aspect of applying nitrogen. The advantage was gained through immediate increases in feed supply which had the effect of both increasing herd production as well as avoiding a drop in production which had longer term implications;

> *"If you run out of grass, cows go down [in milk production] and it takes a long time for them to come back to their milk again. You drop very quick, but it is a long slow climb out of it again. You get quite a financial return from nitrogen".*

As with all other attributes, relative advantage is influenced by the circumstances that exist on the farm. The current practice of running heifers on a run-off block that may be some distance

from the home farm increases the extra time and labour required to artificially inseminate the heifers. This was the main reason that farmers had rejected this practice;

> *"...Animals are grazed at the run-off and therefore the farmer must go down there frequently to identify stock for mating and in season; this is very labour intensive and if the farmer does not do their own AI, the technician must make an appointment and meet the farmer at the run-off, which is time wasted if either party is late..."*

SUMMARY AND CONCLUSIONS

Four of Rogers' (1983) five 'perceived attributes of innovation': trialability, complexity, compatibility and relative advantage, provided a useful framework for the preliminary sorting and analysis of the qualitative research data. The case study farmers did not identify any factors which matched with the attribute 'observability'. 'Relative advantage' was found to be useful only in terms of the components of it's definition relating to financial benefit and time and labour input. The very general and broad definition given to 'relative advantage' by Rogers (1983) covered aspects of all attributes and was therefore limited in its relevance as an attribute.

Although initially useful, Rogers'(1983) attributes, and definitions of the attributes, failed to encompass all the factors, and the interaction between factors, which were identified by the case study farmers as important in their decision to use, and the way in which they use, the five technologies considered.

A number of factors identified as important by the case study farmers did not fit within Rogers' (1983) standard classification. Rogers' (1983) did recognise, to a limited extent, the importance of reducing uncertainty for farmers. The case study farmers repeatedly identified aspects of 'risk' in their assessment and discussion of the technologies, and their implementation. A technology that was able to be withdrawn or rejected when circumstances changed was described by case study farmers as 'flexible', and was considered a favourable attribute of a technology. The ability of farmers to plan months ahead for induction, and to cancel their plans just prior to the first injection, if seasonal conditions significantly changed the feed supply, was considered a

favourable aspect of the technology. In addition, farmers identified the benefits they perceived from the 'insurance' value of using technologies such as strategic applications of Nitrogen. Nitrogen would be applied even if the financial benefit was uncertain. The '*peace of mind*' they gained from applying Nitrogen was more of a determining factor in the use of the technology than were other considerations, such as financial as well.

The impact individual farmers' circumstances had on their perceptions and use of technologies was a predominant factor that emerged from the research. Farmers decisions in relation to technology are at any time imfluenced by their individual and changing circumstances along with a consideration of the implications of adopting and using a technology in their farming system.

It seems doubtful that any one "classification of technology" will be able to capture the complexity of a technology's attributes, the inter-relationship of those attributes and the full implications of the technology's use on farm. There is a continuing need to investigate new processes and techniques for improving technology adoption through the involvement and knowledge of farmers circumstances into the agricultural research process.

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A STOCHASTIC MODEL FOR ROTATIONAL GRAZING USING EXTEND ™ SIMULATION PACKAGE

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ABSTRACT

Extend ™ is an object oriented generic simulation package which can be used by non-programmers to model decision support systems in the Macintosh or PC Windows environment. This paper describes the first phase of the development of a stochastic, discrete event, dynamic simulation model programmed in Extend ™ for planning and controlling rotational grazing. Pasture intake and net herbage accumulation were described as a function of sward height integrated by time. Variation in production was modelled by generating net herbage accumulation from normal distributions. The decisions on which paddock to graze, or close for conservation, and herbage accumulation rate were based on paddock sward height. Animal intake was estimated from sward height, animal liveweight and herbage quality.

The benefits of modelling dynamic intensive livestock production systems using event driven stochastic simulation model in farm planning are discussed. Some of Extend ™ capabilities for agricultural modelling are also described.

Keywords: Decision support, grazing management, simulation modelling, Extend ™.

INTRODUCTION

Farms are complex systems, comprising biological, social and financial components that are subject to constraints of temporal uncertainty, particularly with respect to prices and weather. Decision analysis in relation to such a complex system requires consideration of the interactions among system components over time. In this context, computer simulation models have advantages because of their capacity to: handle many simultaneous and complex mathematical equations (manipulating many variables and interactions systematically), quickly evaluate alternative plans and incorporate current scientific knowledge into the processes involved.

Managing variable pasture supply with the assistance of a model can help farmers to set appropriate stocking rates and target levels of performance for different periods of the year. Tactical management options such as restricting feed intake, selling animals, using nitrogen fertiliser and feeding out supplements, can be compared quickly and systematically in order to develop plans which are likely to give the best outcome relative to the farmer's objectives (Parker, 1993). However, the high variability of pasture production is an often disregarded feature of decision support models for pastoral livestock systems (Dake *et al.*, 1995), and this restricts planning in relation to unknown future prices and pasture production (Dent and Blackie, 1979). The addition of probabilities also allows the farmer to predict the value of different methods of management control.

This paper describes the first phase of the development of a generic empirical-mechanistic (White *et al.*, 1993) grazing model. The model is designed to provide decision support for tactical and operational planning of rotational grazing on sheep farms, and was constructed using the iconic simulation modelling package Extend ™. Such packages speed up model development for any level of complexity, require little time for training of computer literate users, and can reduce modelling costs by 80 - 95 percent (Murphy, 1995).

MODELLING ROTATIONAL GRAZING AS A STOCHASTIC DISCRETE EVENT SYSTEM

Variability in pasture dry matter (DM) production on a livestock farm maybe perceived as seasonal variations, which reflect environmental and sward changes within a year, and as annual variations, which reflect year to year changes. Dynamic deterministic models can incorporate the average seasonal variation in pasture production, but fail to account for year to year variations.

In dynamic systems risk affects optimal resource allocation over time (Antle, 1983). Cacho and Bywater (1994), using a sheep farm model described by Finlayson (1989) and Finlayson *et al.* (1990), found that deterministic and stochastic runs of the model produced different management solutions. In comparison to the average situation, the stochastic runs (accounting for pasture production variability) indicate that a lower stocking rate would be more profitable (17 vs 21 ssu/ha). Despite the improved reality of stochastic models, some of their characteristics limit on-farm use. For example, stochastic models need a number of runs to

achieve repeatable results and therefore, require much longer solution times. With few exceptions, most of the stochastic dynamic models have been then programmed and run on mainframe computers (Sorensen *et al.*, 1992) and are not easily accessible to farmers. The increasing capability of microcomputers is, however, opening a new horizon to stochastic model development, dissemination and use for farm management decision support.

Modelling rotational grazing obviously requires each paddock to be represented and their data to be recorded and kept for use in subsequent calculations. Two main approaches have been described in the literature as means to include discrete entities such as paddocks into grazing models. The first, adopted by Finlayson (1989), uses a continuous time model and records paddock and events data into dynamic arrays. The same approach was used by Sorensen *et al.* (1992) to represent animals and describe discrete events in animal production such as heat, conception, sex, and involuntary culling. The second approach, applied by Woodward *et al.* (1995), and in several industrial and business applications (Murphy, 1995), is event driven modelling. Both approaches lead to similar overall performance, since representing entities or items in discrete event models is nothing else than the transfer and recording arrays of entities attributes, values and priorities. Discrete event simulation usually involve queues of items to be processed (Pidd, 1988); in this case paddocks are queued to be processed by harvesting, grazing or growing.

The approach adopted in this model is similar to that described by Woodward *et al.* (1995), except intake is calculated numerically. The advantages of this approach lie not only on making time event driven, but also on integrating intake and growth functions by time, so that the post-grazing mass can be predicted after accounting for the influence of sward surface height on intake and pasture growth rates.

MODEL STRUCTURE

Unlike the actual farm system, where the mob or herd are allocated to paddocks, the system was modelled as if paddocks were allocated to the mob. This approach was chosen to facilitate changing the number of paddocks and modifying the variables that describe the state of the paddocks with time. Paddocks are represented by items, or entities according to Pidd (1988), which contain attributes and can be submitted for processing (grazing, growth or cutting). The items (Paddocks) are "created" by the "Create Paddock" block at simulation

time = 0, with initial attributes for Pasture Cover, Annual Production Potential, Slope and ID Number (Figure 1). Subsequently the Paddocks are released by "Create Paddocks", pass through the "Combine Block" and reach the "Decide Paddock Block". The latter block is responsible for selecting the paddock with the greatest sward height and assigning this for grazing or harvesting (paddocks that exceed a specified level of sward surface height (SSH) are sent to be harvested or topped). The remaining paddocks are assigned to the "grow" block (Figure 1).

Paddocks assigned for grazing are released to the "grazing" block, which may be viewed as the core of the model. The attributes of each paddock entering the block are used to calculate grazing time, animal intake, animal performance and supplementation, as described later. The block then delays the release of the paddock for the calculated grazing time and sets the pasture cover and sward height attributes for the paddock to its new calculated value, the post-grazing height and mass. Information about all paddocks passing through the block is recorded. At present, the grazing block processes only one paddock at a time, that is, the model cannot handle more than one mob simultaneously grazing.

In contrast to the "Grazing Block", the "Grow Block" can receive and process as many paddocks as necessary at a time. This block reads the pasture cover and SSH attributes of each of the paddocks as they arrive and calculates the new pasture cover and SSH based on the inputted growth curve parameters. The "harvesting" block also can process more than one item at a time. It sets the new pasture cover of the paddock to a user-defined residue after harvesting (depending on the efficiency of the machinery utilised for harvesting). The quantity of pasture harvested is then recorded and accumulated. The accumulation accounts for wastage during harvesting. Herbage quality (measured as MJ ME) is defined by a multiplicative sub-model using SSH and time of the year. The energy content is assumed to decrease linearly from the top to the bottom of the sward canopy.

Paddocks leaving the "Grazing", "Grow" and "Harvest" blocks are combined through two "Combine" blocks and directed to the "Decide Paddock" block to commence a new rotation (Figure 1). Most of the blocks shown in Figure 1 are actually hierarchical blocks. Such blocks improve the layout and documentation of complex models, and are used either to isolate sub-models (as in the case of the "Grow", "Grazing" and "Harvesting" blocks) or to reduce the

complexity of the model (as in the "Decide Paddock" Block). Double clicking on an hierarchical block opens its hidden structure (Figure 2).

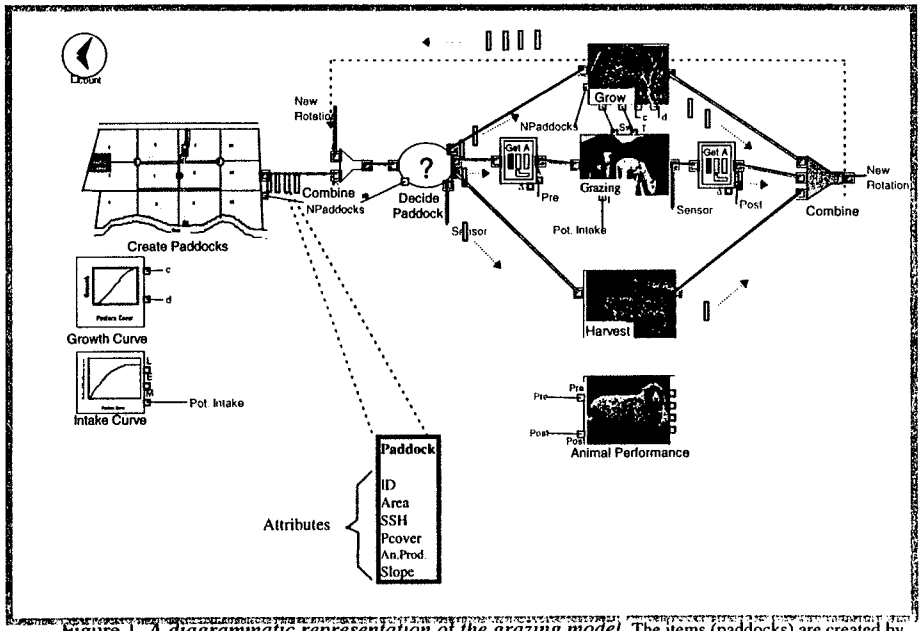

Figure 1. *A diagrammatic representation of the grazing model.* The items (paddocks) are created by the create paddocks block carrying attributes that can be processed by the grow, graze or harvest paddocks. Items and values are defined to be passed from a block to another by linking their connectors by lines or named connectors.. Items and values are passed by distinct connections. The executive block (at the top left corner) is required by Extend ™ to control the arrays containing items attributes, values and priorities and define the next time step of the simulation. The items flow is described by the dotted lined arrows (not present in the actual model).

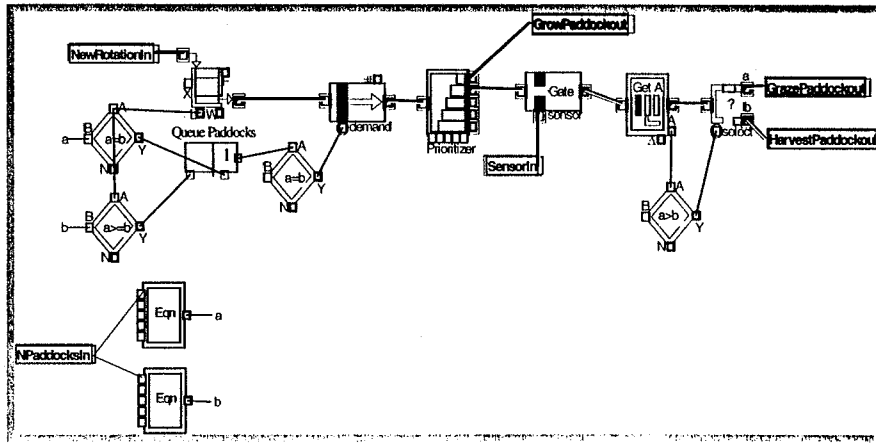

Figure 2. *Internal structure of the "decide" paddock block.* The decide paddock block include several internal blocks. The names within borders represent its inputs and outputs (connections with names ending with "in" are inputs and connections ending with "out" outputs items or values). This block include a queue that stores and sorts paddocks by its sward height attributes. The priorizer block then directs the paddock to grazing or harvesting. Paddocks exceeding a giving sward height are directed to harvest by the select block. After a paddock starts to be grazed a message is sent via the "sensor in" connector and closes the passage of the following paddocks to grazing. The remaining blocks control the query, gates and select behaviour.

MODEL INPUTS, PARAMETERS AND EQUATIONS

Defining farm attributes

In the current version of the model the user can modify values of variables for all equations without having to alter the programming code. Paddock attributes are initially defined in the "Create Paddock" dialog box (dialogs are displayed by double clicking on its respective icon). The paddock attributes are: starting grazing time (usually = 0 if the paddock is available), paddock ID, area, current pasture cover, average annual production and slope (Figure 1).

The models supports 6 categories of sheep: rams, mixed age ewes, two tooth, male hoggets, female hoggets, and lambs. The main equations in the model are located in the grazing and grow blocks. The user is prompted to input data on livestock on hand at the start of the simulation and the lambing percentage, sales, purchases and mortality as appropriate for each category. The model calculates livestock numbers on the farm each month over the time of the whole simulation. Lambing is calculated from a trapezoidal function defined by lambing percentage and the dates for the start, mode and end of lambing.

Sward surface height

SSH is used in most of the model's equations and is also part of the model outputs. Even though herbage mass been the most extensively studied sward parameter, and has been widely used in grazing models, recent studies show that animal intake is better related to SSH than to sward herbage mass (Laca *et al.*, 1992; Hodgson *et al.*, 1994). Also, SSH is more readily understood by farmers (Burnham *et al.*, 1994).

Despite the advantages of using SSH as a predictor and monitoring parameter for pastoral systems, calculations such as grazing time and post-grazing herbage mass, require that sward height and herbage mass values be interchangeable. Linear or quadratic regressions (user defined) are used for converting SSH to herbage mass. Because the SSH / herbage mass relationship changes throughout the year (L'Huillier and Thomson, 1988), different parameter estimates are used over time.

At this stage, pasture growth (and intake) equations of the model are still to be defined and tested. Some trials have shown a consistent sigmoid relationship between net herbage accumulation, herbage mass, sward height and the leaf area index of the sward (e.g. Brougham, 1957; Bircham and Hodgson, 1983). This relationship is usually explained by the greater photosynthetic potential of pasture as leaf area index increases (Parsons *et al.*, 1983). Parsons *et al.* (1994) established a significant linear relationship between SSH and leaf area index, therefore justifying the use of sward height as a predictor of the photosynthetic potential of sward plants.

Pasture growth rate

Grazing models differ in the way they represent the pasture net production / SSH relationship. One of the most widely used, is the logistic function (France and Thornley, 1984; Thornley *et al.*, 1990; Woodward *et al.*, 1995). One advantage of the logistic function is that it is possible to define its shape by inputting just potential growth rates and ceiling herbage mass (Woodward *et al.*, 1995). However, this function has some undesirable characteristics such as maximum growth rate being fixed at herbage mass equal to half the ceiling pasture cover (Cacho, 1993) and pasture growth being equal to zero when herbage mass is zero (This means that growth after cutting may be underestimated). Consequently, more complex skewed

functions have been proposed (Thornley *et al.*,1990; Cacho, 1993) to describe pasture production.

For practical grazing management however, variation in pasture production due to pasture mass is usually small except in extreme conditions (e.g. very low pasture cover), because of the compensating relationship between tiller density and tiller size (Matthews, 1996), and the variability of height within a paddock. For simplicity, the model currently runs using the quadratic equation (Eqn. 1) described below and illustrated in Figure 3.

$$PGR = \frac{-4(G-g)SSH^2}{4b^2} + \frac{4(G-g)SSH}{2b} + g \qquad \textbf{(Eqn. 1)}$$

where:

PGR = Pasture growth rate (kg DM/ha/day),
G = Pasture growth rate at sward surface height optimum (kg DM/ha/day),
SSH = Sward surface height (cm),
g = Pasture growth rate at SSH = 0 (kg DM/ha/day),
b = Sward surface height for optimum growth rate (cm).

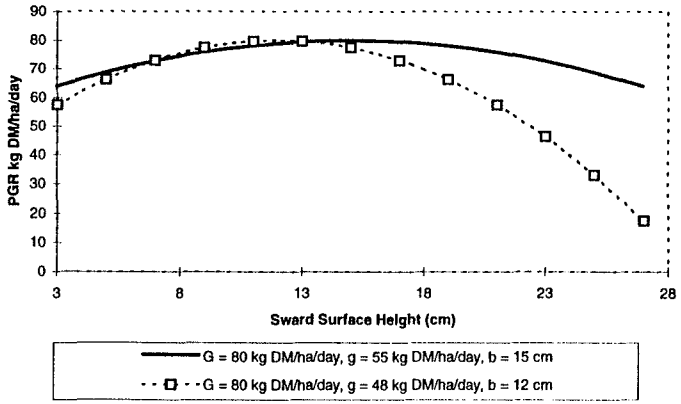

Figure 3. *Pasture growth curve for a range of SSH and different input parameters for G, g and b.*

Pasture intake

Intake is defined by physical (rumen fill), physiological and grazing limitations to pasture consumption. Rumen fill is predicted using body weight and energy demand as described by Finlayson (1989). Initial body weight and potential animal performance are inputted setting

the physiological limit. Maximum intake is defined as the minimum between the physical and physiological limits, as hypothesised by Conrad (1964) and modelled by Finlayson (1989).

Relationships between intake and SSH have been added to grazing models with different degrees of complexity using either linear functions (Woodward *et al.*, 1995) or sigmoid equations (Johnson and Parsons, 1985). In this model, intake is defined by truncated quadratic and linear functions (Eqn.2, Eqn. 3 and Figure 5). This equation produces an intake-SSH relationship roughly similar to that defined by Seman *et al.* (1991) and fits published experimental data (e.g. Allden and Wittaker, 1970). This intake function is defined by three parameters: maximum Intake, critical SSH, and SSH for intake = 0. Different parameters can be defined for each category. The intake-SSH relationship is defined by Eqn. 2 and Eqn. 3.

$$I_i = \frac{2(C_i - I_{max_i})}{CSSH_i^2} SSH^2 + \frac{2(I_{max_i} - C_i)}{CSSH_i} SHH + C \quad \textbf{(Eqn. 2)}$$

where:

$_i$ = 1 to 6 (1 for rams, 2 for ewes, 3 for two tooth, 4 for male hoggets, 5 for female hoggets and 6 for lambs),

I_i = Intake of the i^{th} category (kg DM animal^{-1}.day^{-1}),

$C_i = \frac{I_{max_i} I_{0_i}^2 - 2 I_{max_i} CSSH_i I_{0_i}}{CSSH_i^2 - 2 I_{max_i} I_{0_i} CSSH_i + I_{max_i} I_{0_i}^2}$ (kg DM ha^{-1}.animal^{-1} day^{-1}),

I_{max_i} = Intake at critical sward surface height of the i^{th} category (kg DM/ha.animal.day),

I_{0_i} = Sward surface height for intake 0 of the i^{th} category (cm),

$CSSH_i$ = critical sward surface height of the i^{th} category (cm).

This equation is truncated by SSH values of 0 and CSSH. If sward height exceeds CSSH (critical sward surface height), $I = I_{max}$ and if SSH is less than I_0, then $I = 0$ (Figure 4).

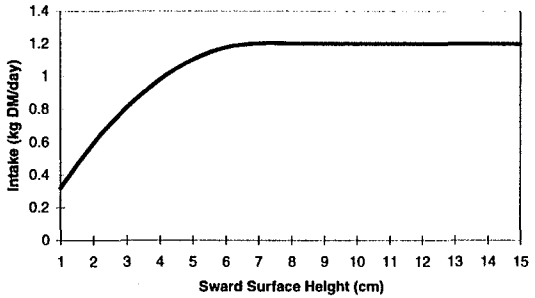

Figure 4. *Typical shape of the intake curve for a breeding ewe.* (I_{max_2} = 1.2 kg DM/day, $I_{0_2} = 0$, $CSSH_2 = 7$ cm)

Intake per hectare is therefore:

$$I = A\,SSH^2 + B\,SSH + C \quad \textbf{(Eqn. 3)}$$

where:

$$A = \sum_{i=1}^{6} n_i \frac{2(C_i - I_{max_i})}{CSSH_i^2},$$

$$B = \sum_{i=1}^{6} n_i \frac{2(I_{max_i} - C_i)}{CSSH_i},$$

$$C = \sum_{i=1}^{6} n_i C_i,$$

n_i = Stocking rate of the i^{th} category.

Pasture growth and herbage intake determine, and are affected by, sward height. To calculate SSH at time t, it is necessary to determine, the variation in sward height with time (dSSH/dt). dSSH/dt = (dw/dt).f , where dw is herbage mass variation and f is the hm → ssh. Variation in herbage mass is equal to dw/dt = G(SSH) - I(SSH), where G(SSH) is the pasture production function and I(SSH) is the intake function. Isolating dt, dt=dw/(G(SSH)-I(SSH)). The grazing time can then determined by integrating the equation and solving for desired pre- and post-grazing masses as described in Equation 4.

$$t_1 - t_0 = \int_{SSH=0}^{SSH=CSSH} \frac{dw}{DSSH^2 + ESSH + F} + \int_{SSH=CSSH}^{SSH=SSH_1} \frac{dw}{GSSH^2 + JSSH + K} - \left[\int_{SSH=0}^{SSH=CSSH} \frac{dw}{DSSH^2 + ESSH + F} + \int_{SSH=CSSH}^{SSH=SSH_0} \frac{dw}{GSSH^2 + JSSH + K} \right]$$

(Eqn. 4)

where:

t_0 = time at start grazing (days),

t_1 = time at the end of grazing (days),

t_0-t_1 = grazing time (days),

SSH_0 = pre - grazing SSH (cm),

SSH_1 = post - grazing SSH (cm),

CSSH = critical sward surface height (cm),

$$D = \frac{-4(G-g)}{4b^2} - \frac{2(C-I_{max})}{CSSH^2},$$

$$E = \frac{4(G-g)}{2b} - \frac{2(I_{max}-C)}{CSSH},$$

F = g - C,

$$G = \frac{-4(G-g)}{4b^2},$$

$$J = \frac{4(G-g)}{2b},$$

K = g - I_{max}

The solution to Equation 4 is shown in the Appendix. If post-grazing mass is lower than CSSH, grazing time is calculated by Equation 5. If both, pre and post-grazing mass are lower than CSSH, grazing time is calculated by Equation 6.

$$t_1 - t_0 = \int_{SSH=0}^{SSH=SSH_1} \frac{dw}{DSSH^2 + ESSH + F} - \left[\int_{SSH=0}^{SSH=CSSH} \frac{dw}{DSSH^2 + ESSH + F} + \int_{SSH=CSSH}^{SSH=SSH_0} \frac{dw}{GSSH^2 + JSSH + K} \right] \quad \textbf{(Eqn. 5)}$$

$$t_1 - t_0 = \int_{SSH=0}^{SSH=SSH_1} \frac{dw}{DSSH^2 + ESSH + F} - \left[\int_{SSH=0}^{SSH=SSH_0} \frac{dw}{DSSH^2 + ESSH + F} \right] \quad \textbf{(Eqn. 6)}$$

Alternatively grazing time could be determined by calculating intake and growth (using Equations 1 and 2) for each step of the simulation and advancing the simulation clock one step. This would however, lead to some error because intake and growth are calculated from the initial sward height on each day. Intake while grazing paddock n, is determined by numeric integration, using Simpson's rule (described by Lerman, 1993). Animal performance is calculated from intake and pasture quality parameters, relative to the maintenance and production requirements for each category of livestock. The new body weight then redefines the subsequent maximum intake for each livestock category.

MODEL OUTPUTS

Extend ™ models do not have fixed start and end simulation times, and therefore the simulation can be set to support strategic planning (select simulation end ≥ 365 days) or to analyse shorter periods (60 to 180 days) to define the level of feeding restriction (grazing time and post-grazing mass for each paddock) to achieve pre-determined production targets. The model is also flexible, allowing either stochastic or deterministic runs: when the user input for a coefficient of variation is greater than 0%, the model becomes stochastic. The user can then define the number of runs necessary to reach a solution. Data from each run is then outputted to a text file (for later analysis in spreadsheets or statistical packages) and to internal graphs and tables.

Extend ™ supports both graphic and tabulated outputs. Stochastic runs of the grazing model outputs ewe body weight at the beginning and end of the simulation, and for the specified critical periods(In this case, mating, 4-6 weeks prior to lamb/calving, and weaning (Parker, 1993)). Lambs, hoggets and two tooth liveweights are recorded in monthly intervals for every simulation run, and can be tabulated or plotted as a frequency histogram. Monthly recordings of SSH and pasture cover are also retained and data for any simulated year can be plotted separately. Model output also includes the annual quantities of pasture harvested and stored for conservation and fed to the animals each year (Figure 5). Graphs of pasture cover in each

paddock (Figure 6) and the daily liveweight change of the animals are available for deterministic runs.

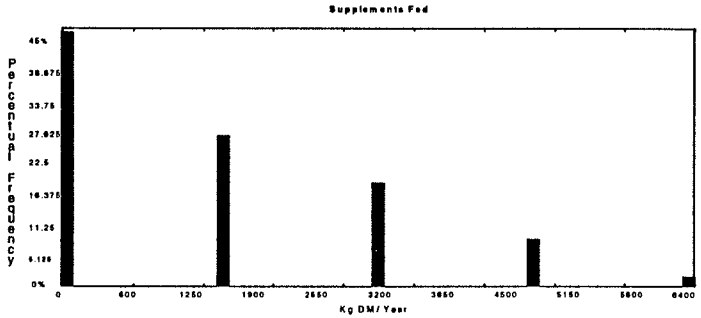

Figure 5: Percentual frequency of supplement fed for 60 stochastic runs of the model.

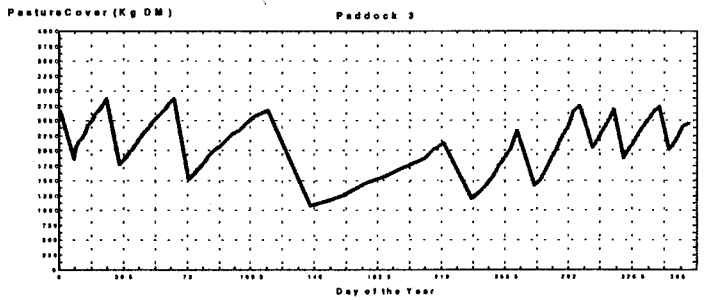

Figure 6: Pasture Cover variation over time in a paddock for a determinist run.

CONCLUSIONS AND FURTHER DEVELOPMENTS

Extend ™ provided an effective means to model the management of rotational grazing for a livestock production system. Addition of stochasticity was facilitated by some of the package's features. Event driven simulation proved to be an effective way to represent multiple paddock systems. Further developments of the model will include: the capacity to handle several mobs in a simultaneous grazing and/or following grazing in the same paddock; estimation of intake parameters for dairy and beef cattle; improved intake and pasture growth

equations and a sub model for economical analysis. An equation to describe pasture-supplement substitution is also being developed.

Control strategies for livestock managers will be studied through the implementation of a feedback controller and an optimisation algorithm. This will allow the determination of optimum production targets and associated control strategies for particular seasons, pasture height and other conditions on the farm at any time of the year.

ACKNOWLEDGEMENT

To Mr Derek Christie (Mathematics tutor at CERTECH-Massey University) for help in developing some of the mathematical equations in the model.

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APPENDIX

Solution to Equation 4:

Given:
$q = 4ac-b^2$

for q>0,

$$\int \frac{dx}{ax^2+bx+c} = \frac{2}{\sqrt{q}} tan^{-1}\left(\frac{2ax+b}{\sqrt{q}}\right) \text{(Eqn. 7)}$$

for q<0,

$$\int \frac{dx}{ax^2+bx+c} = \frac{-2}{\sqrt{-q}} tanh^{-1}\left(\frac{2ax+b}{\sqrt{-q}}\right) \text{(Eqn. 8)}$$

for q=0,

$$\int \frac{dx}{ax^2+bx+c} = \frac{-2}{2ax+b} \text{(Eqn. 9)}$$

According to Equation 7 (for q_1 and $q_2 > 0$), Equation 4 can be solved as:

$$t_0 - t_1 = \frac{2}{\sqrt{q_1}} tan^{-1}\left(\frac{2DSSH_1+E}{\sqrt{q_1}}\right) + \frac{2}{\sqrt{q_2}} tan^{-1}\left(\frac{2GSSH_1+K}{\sqrt{q_2}}\right) - \left[\frac{2}{\sqrt{q_1}} tan^{-1}\left(\frac{2DSSH_0+E}{\sqrt{q_1}}\right) + \frac{2}{\sqrt{q_2}} tan^{-1}\left(\frac{2GSSH_0+K}{\sqrt{q_2}}\right)\right]$$

where:

$q_1 = 4DF-E^2$
$q_2 = 4GK-J^2$
t_0 = time at start grazing (days),
t_1 = time at the end of grazing (days),
t_0-t_1 = grazing time (days),
SSH_0 = *pre - grazing SSH* (cm),
SSH_{1_1} = *post - grazing SSH* (cm),
CSSH = critical sward surface height (cm),

$$D = \frac{-4(G-g)}{4b^2} - \frac{2(C-I_{max})}{CSSH^2},$$

$$E = \frac{4(G-g)}{2b} - \frac{2(I_{max}-C)}{CSSH},$$

F = g - C,

$$G = \frac{-4(G-g)}{4b^2},$$

$$J = \frac{4(G-g)}{2b},$$

$K = g - I_{max}$

If q1 or q2 ≤ 0 Equation 4 can be solved according to Equation 8 or 9.

FORESTRY, A VALUABLE CROP FOR THE PASTORAL FARMER

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ABSTRACT

The integration of forestry into a pastoral system (sheep & beef cattle, hill country) will be discussed with respect to the economic sustainability of the system. The cash flow implications for a case study farm of forest development, and methods used through forestry right agreements, to facilitate these will be developed. Risk management issues, with particular reference to managing market risks, will be discussed.

Keywords: Cashflow, Internal Rate of Return, Sustainability, Forestry Rights, Risk Management

INTRODUCTION

It has been stated that 50,000 hectares a year of pastoral land is being and will continue to be converted to forestry (MWBES,1996). The reason for this land use change is that returns from forestry are currently better than those achieved from sheep and beef cattle farming. These returns are calculated over a 25 to 30 year time horizon and are being compared with predictions that sheep and beef cattle prices will continue at present values. These predictions are being reflected in prices being paid for pastoral land by forestry developers, these prices are currently underpinning values for extensive sheep and beef cattle farms.

There are a number of pastoral farms in the belt of sand country that runs up the west coast of the North Island that have significant areas of the farm in woodlots, planted, in many instances, to control sand dune erosion. These woodlots are harvested at maturity and replanted. They have added useful revenue to these farms over the years to the extent that some farms would generate at least half of their gross revenue from timber (Appendix I). They are in the position now of having a sustainable forestry system within their pastoral farming system. They are in a significantly better financial position than their neighbours with no or limited woodlot areas and are able to maintain an economic unit with fewer hectares of land.

With current returns in the sheep and beef cattle sector the possibility of establishing a similar scenario on a pastoral farm is limited. This paper examines the options that were available in 1993 to a case study farm on which there were existing immature woodlots and discusses the long term implications of methods available to achieve sustainable forest revenue streams within their farming system.

THE CASE STUDY FARM

The property is 1450 hectares of coastal sand country, the predominant soil type is Whananaki Sand which is of medium to low fertility and well drained. The typical vegetation consists of rough pasture and lupin with improved pasture on the flats. Problem weeds in this area include gorse and boxthorn.

Stock numbers have averaged 6500 stock units with the sheep to cattle ratio being 55:45. The property is good wintering country and well suited for cattle but does not perform well in a dry summer. The property in 1993 was yielding an Economic Farm Surplus of 6.9% of Total Farm Capital excluding the woodlot trees. This compares favourably with the MWBES North Island Hard Hill Country model yielding 3% in the same time period and is a reflection of the stock mix at that time. However debt carried by this farm was twice that carried by the MWBES model so the farm cash surplus only just met the landowner's requirements for $30,000, after its various commitments were met.

The total assets, (land, buildings, plant and livestock) of the farming operation were worth $1.2m and the immature forest was valued at $353,572.

The weighted average cost of capital was:

Debt Capital Cost	$38,224 Interest pre-tax,	$25,610 post-tax
Equity Capital Cost		$30,000 post tax
Weighted Average Cost of Capital		$55,610 post-tax

This equates to 4.6% of $1.2m and 3.6% of total capital including the trees of $1.55m. In 1993, with no forestry returns, the WACC consumes 100% of the net operating profit after tax (NOPAT) generated from farming.

When forecast forestry returns were included in future cashflows the Internal Rate of Return (IRR) on total assets of $1.55m, including the trees, was predicted to be 8.5% pre-tax and 6.3% post-tax. This compares favourably with IRRs of 7.0% pre-tax and 4.8% post-tax from farming alone.

Existing forestry on the property included nineteen woodlots varying in age from one to eighteen years old. The management of these woodlots has been variable with some estimated to produce no pruned logs at harvest due to the lack of required silviculture in their early years. There are 227 hectares in total, 16% of the property in forestry. Four of the woodlots were set up under a single rotation forestry right in which a third party establishes and tends the forest with the landowner receiving a share of the forest revenue at harvest. The total equivalent area from which the farm will gain an income after deducting the share that will go to the grantees of the forestry rights is 121 hectares. As each woodlot is harvested the landowner regains the use of the land so the total area available for replanting is 227 hectares. The sequence of harvesting giving the landowners share in hectares as defined by the respective valuations of the woodlots is as stated in Table 1.

Year	Yield m3/Ha	Harvest Area Ha	Replanting Area Ha
2000	415	0.8	4.0
2002	566	13.2	66.0
2003	467	3.16	15.8
2004	505	1.6	8.0
2005	483	6.2	6.2
2007	393	5.0	5.0
2009	471	1.8	1.8
2010	380	8.55	8.55
2012	384	21.3	21.3
2013	384	5.4	21.4
2014	384	7.7	7.7
2017	407	19.7	11.0
2018	424	26.5	50.0
2030...	4240	10.0	10.0

Table 1 Timber Harvest Yields (m3/Ha) , Areas (Ha) and Replanting Areas (Ha) by year

In 1993 the landowner had 7 years to wait before the first timber sales and 9 years before a significant sale. The younger woodlots were all due for pruning and thinning in that time and the farm was generating no surplus from sheep and cattle farming with which to meet the projected costs. The forecast annual cashflows for the property are as illustrated in Figure 1. These are based on three independent valuations of various of the woodlots by Recognised Forestry Consultants, these valuations give estimates of yield and net revenue at harvest as well as estimates of tending and other costs associated with the woodlots up to harvest. The assumptions behind both farm and forestry cashflows are given in Appendix II. The farming business is forecast to continue to generate sufficient funds to meet equity demands, i.e. $30,000 each year. There are annual deficits forecast until the harvest in the year 2002, these deficits accumulate with interest to $103,000.

SCENARIO ANALYSIS

The base model for the scenario analysis is the farm making no change and, as each woodlot is harvested, replanting that area. The aim is to achieve a steady income stream from the replanted area, this would be achieved by harvesting 10 hectares a year from the year 2030 as is illustrated in Figure 1. The cumulative deficit of $103,000 is paid off in 2002 with the revenue from the second harvest. It is assumed that sufficient funds are reserved from sales of timber to meet the future costs of silviculture and management for the new plantings. The harvest of 10 hectares a year from 2030 will add $151,220 net to the annual farm income. The WACC of $55,610 post tax at this point equates to 27% of NOPAT, a more sustainable and less risky situation than that without trees when 100% of NOPAT was needed to meet the cost of capital.

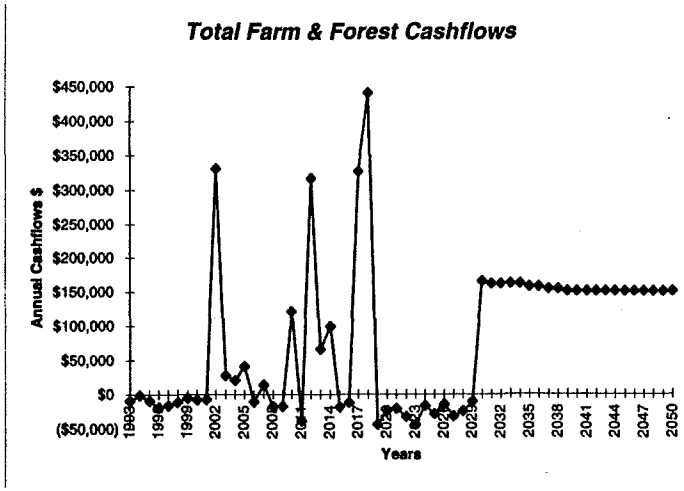

Figure 1 Annual Cashflows from Farming & Forestry Systems

The two time zones that generate concern for this property in its bid to achieve a sustainable yield of timber are:

a) 1993-2002 a nine year period in which $103,000 will be added to the existing farm debt
b) 2003-2030 the twenty seven year period in which the replanted woodlots require tending until they reach maturity.

The two scenarios examined address the problem periods and measure the effect of decisions made in that time on subsequent earnings in the years after 2030 when the farm has a regular yield of 10 hectares a year.

Short Term Scenario - existing levels of debt make the possibility of financing a deficit of $103,000 over the nine year period unlikely. Selling the woodlots as immature forest under a forestry right reduces the funding cost of the farm, the WACC is now $39441, and removes the cumulative deficit forecast to 2002. Retaining a 4% interest in the trees is feasible in the early years in that an average annual cash surplus of $15,620 is forecast after meeting the WACC until the year 2002 (Figure 2). It does not however generate sufficient funds to meet the amount required to replant and tend the forest as each block is harvested. The average annual cashflow from 2002 to 2030 reduces to a negative of $3050. The cumulative cash flow as illustrated in Figure 2 shows an increase in funds until 2002 then cash reserves being depleted until harvest in the year 2030. This suggests the possibility of replanting the woodlots is not a feasible option for the landowner. The internal rate of return (IRR) of this option is 7.2% pre-tax, 5.5% post-tax.

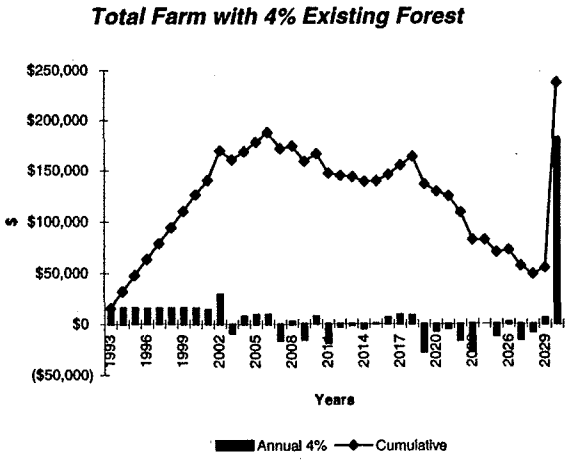

Figure 2 Annual & Cumulative Cashflows from Farming with 4% of Existing Forest and replanting Woodlots from Cashflow

Long Term Scenario - forestry right agreements on the new plantings enable the woodlots to be replanted and tended to harvest at no significant cost to the landowner, as grantor, and still achieve an annual net revenue from forestry from the year 2030, albeit at a lower level due to the share required by the grantees of the forestry right. In theory the IRR for the landowner should be the same post tax under a forestry right as it would have been without one but in practise the return to the landowner is the result of the respective bargaining positions of the two parties and the negotiating skills the landowner can muster. With a 50% forestry right in which the grantor and grantee share equally in the net revenue at harvest the IRR for the grantor is 7.6% pre-tax and 5.6% post tax. A 40% forestry right yields a 7.5% pre-tax and 5.4% post-tax IRR to the landowner. Land values have improved since 1993. As the cost of the land required for forestry joint ventures increases relative to other costs the proportion of the timber net revenue that goes to the grantor increases. The agreement negotiated in the year 2002 will take into account the value of land and all costs associated with the establishment and tending of a forest at that time so it cannot be assumed that a 50% forestry right will be suitable then. It is always important to examine the post tax rather than the pre-tax returns when negotiating a forestry joint venture as the tax benefits in the early years are in most cases captured by the grantee. The annual and cumulative cashflows from the forestry right are illustrated in Figure 3. The annual net revenue averages $19682 from 1993 to 2030, the WACC is 67% of NOPAT through these years. The yield from forestry from 2030 reduces from the $167,390 gained in a wholly owned operation to $104,180 under a 50% forestry right. From the year 2030 the WACC represents 27.5% of net farm revenue.

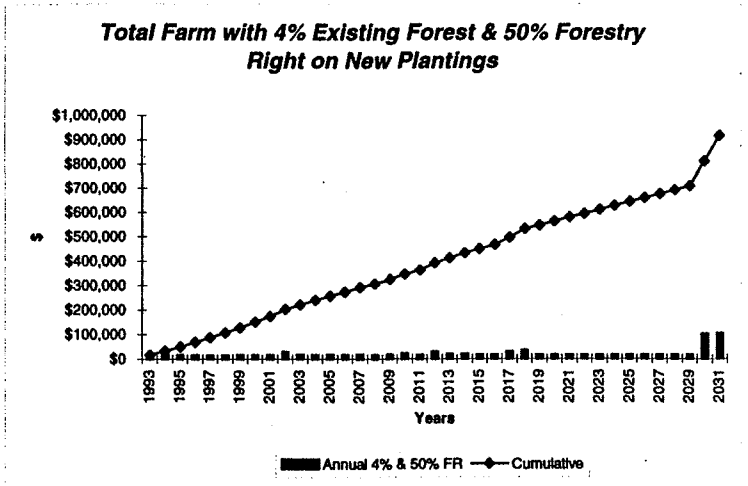

Figure 3 Annual & Cumulative Cashflows from Farming with 4% Existing Forest and a 50% Forestry Right on New Plantings

RISK MANAGEMENT

Pastoral farming systems in New Zealand are prone to both environmental and economic variability. The case study farm is particularly prone to dry summer conditions resulting in reduced livestock performance in the year of the drought and, often, subsequent years if the drought has affected the development of replacement stock. In 1993 the farm generated sufficient NOPAT to meet it's cost of capital with no surplus available for further development of the property or as a buffer against drought or market price decline in sheepmeat, beef or wool. From a risk management perspective the structure was not robust. It would have had difficulty handling the changes in beef prices that have occurred since 1993.

The sale of the existing immature trees on a forestry right provided an annual surplus of $18,500 due to the reduction in debt. A 4% interest in the trees could afford to be maintained to enable the farm owners to continue to have a stake in the trees, this was important to them. The surplus gained in the 9 years to 2002 provided a risk management tool, or buffer, against uncertainty (Table 2). Assuming the landowner's requirement of $30,000 does not change the WACC reduces as the surplus improves. However, replanting the harvested areas led to a decline in subsequent years putting the farm back into an untenable position.

Activity		WACC/NOPAT %	Average Annual Cashflow $
Farming		100.0%	0
Farming & Forestry	1993-2001	130%	-12864
	2002-2029	56%	44564
	2030...	27%	151220
Sale of 96% of Forest	1993-2001	72%	15620
	2002-2029	108%	-3050
	2030...	19%	167390
Sale of 96% of Forest	1993-2001	67%	19409
& 50% Forestry Right	2002-2029	67%	19772
	2030...	27.5%	104180

The surplus generated from the combination of selling 96% of the existing trees and developing the new plantings under a 50% forestry right provides a useful financial buffer for the farm right through to the year 2030. This is illustrated in Figure 4 in which the cumulative cashflows of the three options is graphed. To own the forests outright is the most profitable option but if existing debt precludes this option the cashflows of the 37 years preceding the establishment of a sustainable forestry system, and therefore the viability of the farm, can be improved through the use of forestry rights on both existing and new plantings of trees.

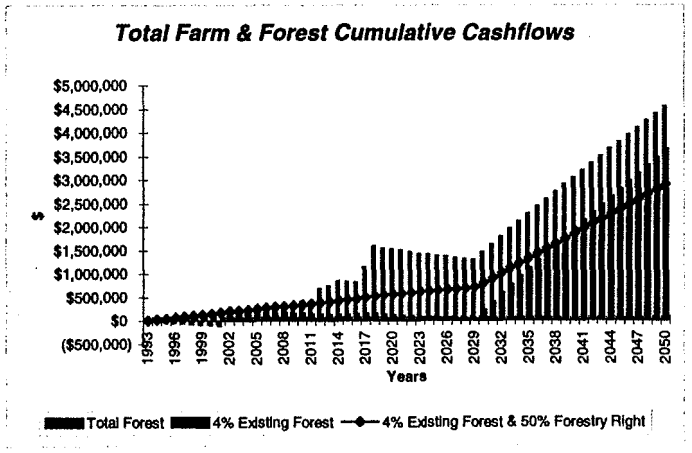

Figure 4 Cumulative Cashflows from three forestry ownership options on the case study farm

If the real returns of sheep and beef cattle farming continue to decline over time the buffer of $19,409 will provide not just short term protection against this decline but more importantly some funds with which to make changes to adjust to changing returns. For example, the better soils can be developed to improve the carrying capacity of the farm, more profitable livestock systems can be adopted and long or short term crops established if they are technically and economically feasible.

In the shorter term forestry also provides a useful risk management tool in that the harvest dates can be manipulated to counter variations in the market prices of both timber and other products produced by the farm. Harvesting can be brought forward or delayed to respond to market conditions, growth models can be used to extrapolate the yields at different tree ages and a simple exercise can be used to determine the costs and benefits of altering from optimal harvest dates. Apart from wool most farm products do not have the ability to be stored either pre or post harvest as well as timber.

CONCLUSION

While the solution of a sustainable annual yield of forestry is seen as a desirable result for pastoral farmers and one that will ensure land aggregation is not the only way to maintain an economic unit the method by which farms can achieve this result must be thoroughly examined. Short term cash flows must be compared with the medium and long term cashflows to understand the effect of decisions made today. Forestry plantings if followed with silviculture lock farms into long term commitments which must be properly understood and compared with the commitments likely under joint venture agreements.

The case study farm sold 96% of it's existing forests to realise capital and in the year 2002 will need to determine a strategy for replanting. At that time the relative profitability of the respective farming and forestry systems will need to be analysed as above to determine the best short and long term solution for the farm.

APPENDICES

APPENDIX I Middle Districts Farm Forestry Association Field Day Display '96

Year	Gross Farm Income incl. Forestry $000	Forestry Income $000	Forestry Income as % of GFI	Area Clearfelled Ha
1989/90	107	28	26	1.5
1990/91	156	60	38	5.0
1991/92	131	35	27	0.8
1992/93	157	48	31	0.6
1993/94	226	99	44	1.2
1994/95	168	79	47	1.7
1995/96 (estimated)	173	97	56	3.0

APPENDIX II Price and Cost Assumptions used in Cashflow

LOG RETURNS AND FORESTRY COSTS from "Guidelines for Investment in Forest Growing Projects" New Zealand Institute of Forestry Inc.

Log Grades	Price $/m3
P1	180
P2	115
S1S2	90
L1L2	70
S3L3	50
Pulp	40

FORESTRY COSTS

Annual Costs	**$/Ha**
Management & Admin.	50
Insurance	11
Repairs & Maintenance	2.50

Logging & Roading	**$/m3**
All log grades excl. pulp	30
Pulp (logged to Kariori)	50

Silviculture	**$/Ha**
Planting & Blanking	550
Pruning (3 lifts)& Thinning	1150

FARM DETAILS

1205 Ha extensive sand country
6500 stock units (3575 sheep stock units, 2925 cattle stock units)

1993/94 Accounts	Case Study Farm $	Case Study Farm $/s.u.	MWBES Model $/s.u.
Gross Farm Income	250,000	38.46	36.55
Total Farm Expenditure	203314	31.28	25.80
Farm Profit before Tax	46686	7.18	10.75
Economic Farm Surplus	83000	12.80	7.57
EFS/Total Farm Capital % (excl. trees)		6.9%	3.0%
Farm Cash Surplus	51686	7.90	10.76
Tax, Debt Repayments, Capital, Investments etc.	21686	3.30	4.09
Landowner's Drawings	30000	4.60	6.80

The major difference between the case study farm and the MWBES North Island Hard Hill Country model farm is that the case study farm is carrying more debt and it employs a manager.

Activity	Internal Rate of Return (IRR)	
	Pre-Tax	Post-Tax
Farming	7.0%	4.8%
Farming & Forestry	8.5%	6.3%
Sale of 96% of Forest	7.2%	5.5%
Sale of 96% of Forest & 50% Forestry Right	7.6%	5.6%
45% Forestry Right	7.6%	5.5%
40% Forestry Right	7.5%	5.4%

THE ROLE OF FINANCIAL ANALYSIS IN THE FARM MANAGEMENT CONSULTANCY PROCESS

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ABSTRACT

The role of financial analysis in the consultancy processes used by three *expert* New Zealand farm management consultants was investigated because little was known about this aspect of consultancy. A multiple-case study approach was adopted using semi-structured interviews and field observations. Qualitative data analysis techniques were used to analyse the data. The study revealed the place of financial analysis procedures employed by consultants when solving clients' problems. For example, accounts were analysed early in the process to identify potential problems and opportunities. However, financial analysis was only one component of the consultancy process, others being the ability to build rapport with the client, the application of farming systems knowledge and the capacity to tailor solutions to the client's circumstances. The findings reinforce the need to maintain the "holistic" case study based approach to farm management teaching at Lincoln and Massey Universities.

Keywords: *farm management, consultancy, problem solving, financial analysis.*

INTRODUCTION

Deregulation of the New Zealand economy and the restructuring of Government Departments and agencies had had a major impact on farm management advice to farmers (Gardner and Parker, 1993). There has been increasing individualisation and intensification of New Zealand farms, and an associated demand for a more personalised advisory service, together with user-pays for all consultancy. These factors have increased the demand for consultants who can provide sound farm management advice in a deregulated environment and increased the demand for financial advice from farmers.

In response to this change in requirements for a career in consultancy, the financial analysis content of undergraduate farm management courses at Massey University has been increased. The curricula in this subject domain includes gross margin analysis, accounts analysis, partial budgeting, cashflow and cash forecast budgeting and investment appraisal. However, academic staff were concerned that little was known about the process used by farm management consultants to provide financial advice to clients which a review of the literature confirmed. The role of financial analysis in the consultancy processes used by three *expert* farm management consultants was therefore investigated. This paper presents the findings of this study and discusses the implications for farm management teaching.

METHOD

A multiple case study approach was adopted because it was the most appropriate method for collecting in-depth information about processes (Yin, 1989). Time and resource constraints limited the sample to three farm management consultants from the lower half of the North Island. The criteria used to select consultants was expertise in farm management consultancy and skills in financial analysis (Table 1). The case studies were based on a "typical" first-up visit scenario where the client has asked the consultant to identify the problems and opportunities confronting the farm business.

Table 1. Description of farm management consultants.

	CONSULTANT		
	A	**B**	**C**
Qualifications	VFM	Dip.Agr Dip.Val	BAgrSc
Experience (years)	32	26	25
Type of client	Sheep/Beef	Sheep/Beef	Sheep/Beef
Client base (approx.)	42	50	24

A semi-structured interview protocol was designed and tested in a pilot study. The protocol was refined and became the principal method for data collection. Consultants were interviewed for approximately two hours about the consultancy process for the first visit to a new client. The interview was taped and relevant documents collected. The tape was transcribed and analysed using qualitative data analysis similar to that advocated by Dey (1993). A summary of the information was sent to the consultants as a case report for verification. A follow-up interview was undertaken if information was missing from the transcript.

Once the case reports were verified, a field visit was undertaken to observe each consultant with a client. Field notes were taken and the consultancy process observed and compared with the case report. The consultants were interviewed after the visit to discuss discrepancies between the case report and the actual visit, and to clarify points noted during the field visit. A final case report was submitted to each consultant for verification. The case reports were then compared and contrasted to develop a generalised model of the consultancy process and to highlight differences between consultants. The model was then compared with findings reported in the literature.

RESULTS AND DISCUSSION

The role of financial analysis in the consultancy process

Financial analysis was identified as a component of the problem solving process employed by the consultants (Figure 1). The problem solving framework included eight steps (gather information, problem identification, generate alternatives, analyse alternatives, choose an alternative, plan implementation, implementation, evaluation). These could be depicted sequentially, but are in reality, iterative in nature. The financial analysis procedures used by consultants in a typical "first up" visit were accounts analysis, cash forecast budgeting and gross margin analysis. Partial budgeting, cashflow budgeting and investment appraisal were used in a much more limited sense and for this reason were not included in the model. Accounts were analysed mainly to identify possible problems or opportunities, whereas cash forecast budgeting and gross margin analysis were used in most steps from problem identification through to the choice of the best alternative.

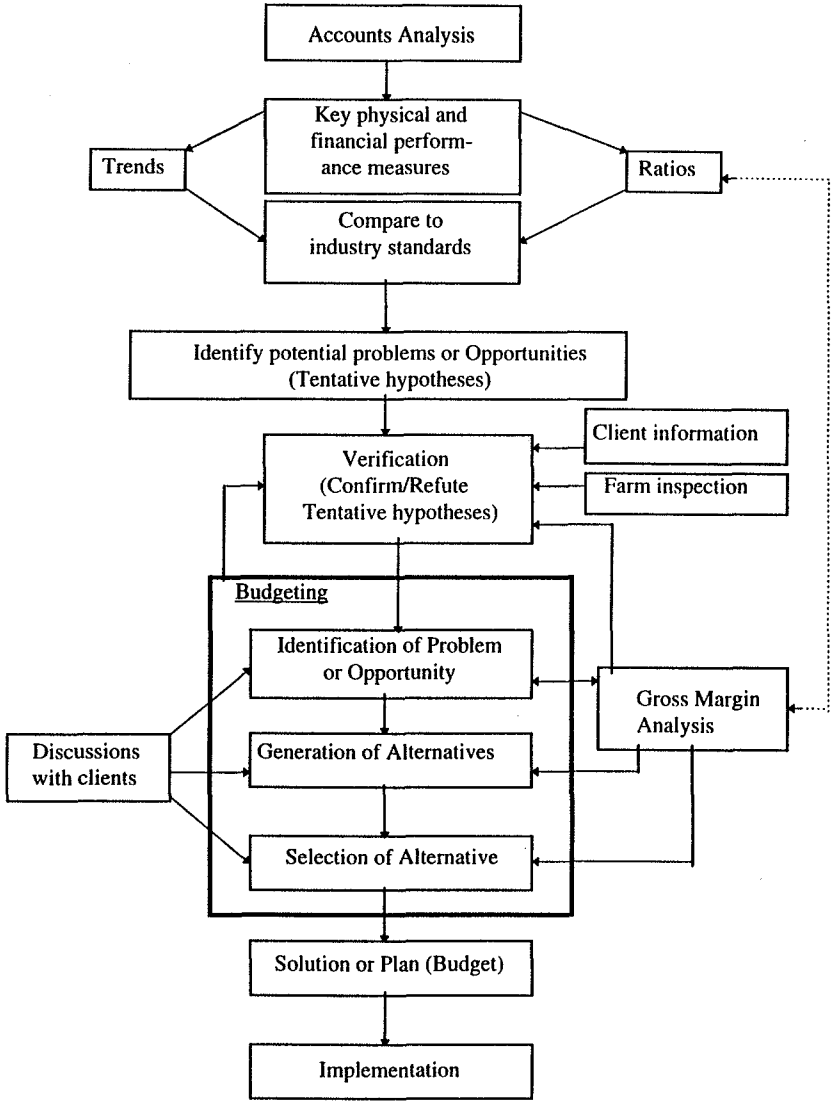

Figure 1. Role of financial analysis in the consultancy process.

All consultants analysed the accounts for the previous 3-5 years to identify possible problems or opportunities. Key performance indicators were calculated to establish trends, or significant deviations from industry standards derived from the NZMWBES, MAFPol, or from the consultant's own data base. The information was used to formulate tentative hypotheses where potential problems or opportunities might exist for the client's business.

> ***"You ask for their financial statements for the last year or two and analyse them for equities and performance, physical performance as well as financial. And then endeavour to seek the weakness in the system from that analysis."***

> ***"If you're doing this sort of thing more or less all of the time then the parameters within which you are expecting the values to fall are almost instinctive."***

> ***"You're not flying blind when you are analysing accounts so you know more or less what you ought to be expecting."***

This financial analysis process is similar to that advocated by Barry *et al.* (1979). The first step is to select measurable criteria as indicators of financial performance. Desirable standards or norms are then specified for each criterion. A feedback system is then established that keeps management informed of the current situation. A decision is made as to the threshold levels that can be tolerated for deviations from the norms or standards. The final step in the process is the specification of a corrective course of action to be taken should the deviations exceed the tolerance levels. Other authors (Penson *et al.* 1982; Osburn & Schneeberger, 1983; Frengly & Uriate, 1992; Kay & Edwards, 1994) have discussed the role of accounts analysis in evaluating the financial position of the business relative to its objectives, measuring economic performance, controlling the business and evaluating alternative strategies for controlling resources. Accounts analysis served a similar role in the consultancy process, evaluating the financial position of the farm and measuring economic performance. Key performance indicators calculated by the consultants are summarised in Table 2. All consultants calculated physical ratios such as stocking rate, lambing percentage, wool per sheep stock unit and sheep to cattle ratio. While little mention is made of physical ratios in the literature, the consultants rated these (or stock performance levels) highly for farm business analysis.

> ***"The most important things are just the performance levels, stock performance levels and the resultant gross incomes that they're making from the different policies. I think that in the area of analysis* [physical performance]*, one can actually help considerably because price variation is such in the meat and wool sector to make annual comparisons on a purely financial basis fairly nebulous in reality."***

Table 2. Ratios used by the case study farm management consultants.

Ratio	Case A	Case B	Case C
Physical indices[1]	YES	YES	YES
Financial indices			
Economic Farm Surplus (EFS) indices	YES[2,3]	YES[3]	YES[3]
EFS as % of income	NO	YES	NO
EFS as % return on total farm assets	YES	NO	YES
EFS as % return on productive assets	NO	NO	YES
EFS less IRB[4] as % return on equity	NO	NO	YES
EFS as % return on assets	NO	NO	YES
Equity (%)	NO	YES	YES
Real net return as % of going concern worth	NO	YES	YES
Real net return as % of business capital	NO	YES	YES
Gross return to land and buildings	NO	YES	YES
Return on equity	NO	YES	YES
Current ratio	NO	NO	YES
Acid test	NO	NO	YES
Source of farm standards	Own client data-base NZMWBES	Own client data-base	MAFPol monitor farms NZMWBES

[1] Includes su/ha, wool/su, wool/ha, sheep:cattle ratio, lambing %.
[2] Wages of management not included.
[3] Also includes associated income and farm working expenditure indices expressed in $/su and $/ha terms.
[4] IRB - interest, rent, bailment.

The accounts analysis generated financial performance measures, on a per stock unit and per hectare basis. Farm working expenditure and debt servicing were expressed as a percentage of gross income, using a common method. However, economic farm surplus (EFS) and some other business performance indicators were not calculated identically by all consultants. This may create confusion if farmers and rural lenders receive proposals from numerous consultants. The New Zealand Society of Farm Management (NZSFM) has recommended a standard procedure for calculating both financial and physical performance measures (Garland, 1991).

All three consultants calculated physical indices (Table 2), but Case A used few financial performance indicators and Case C, in particular, used a wide range of financial measures. The reason for this difference is an area for further research.

A comparison of the performance measures used by the consultants with those described in the literature (Barry *et al.*, 1979; Penson and Lins, 1980; Penson *et al.* 1982; Barry *et al.* 1988, Gill, 1990; Johnston and Frengly, 1990; Schall and Haley, 1991; Frengly and Uriate, 1992; Kay and Edwards, 1994) revealed a number not used by the New Zealand consultants. These include the operating profit margin ratio, the interest coverage ratio and the capital replacement and term debt replacement margin. Much of the financial analysis literature originates from the USA, and this may explain some of the differences.

Some indicators associated with debt in the USA differ from those in New Zealand. For example in the USA, the Farm Financial Standards (Boehlje, 1996) suggest a firm calculate its repayment capacity as follows:

Net farm income from operations
+ Non farm income
+ Depreciation
- Income Tax
- Personal drawings
= Debt repayment capacity

In contrast, the NZ consultants focused their analyses on debt servicing as adopted by rural lenders as follows:

$$\frac{\text{Interest + Rent + Bailment Fees}}{\text{Gross Income}} \times \frac{100}{1}$$

A commonly accepted "guide" to a prudent level of debt servicing is that it should not be more than 25-30 percent of gross income. Consultants however, recognised limits to this guideline.

> ***"I've got clients who are at 50 percent at the moment, but we're continuing because we can see light at the end of the tunnel. ...we talk through the options, ...explain that they are in a very vulnerable position to any changes in climatic, personal or financial events.... Some are in strife at 15 percent, others are banging away there at 50 percent because they've got real faith in their own ability."***

The two measures, debt servicing and debt repayment capacity are quite different. Debt servicing, the New Zealand measure, indicates ability to pay interest on debt whereas the USA criterion is concerned with capacity to repay debt.

The financial statement analysis, compared with standards or norms and examined over time, enabled consultants to formulate tentative hypotheses concerning potential problems and opportunities confronting the client. The comparative analysis techniques used by the consultants were similar to those reported in the literature (Bernstein, 1974; Penson and Lins, 1980; Penson *et al.* 1982; Schneeberger and Osburn, 1977; James and Stoneberg, 1986; Gibson and Frishkoff, 1986; Barry *et al., 1988*; Frengly and Uriate, 1992; Kay and Edwards, 1994). These include time series analysis, cross-sectional analysis and the use of averages.

Time series analysis is concerned with trends in the financial performance of a client over time (Penson and Lins, 1980; Penson *et al.* 1982; James and Stoneberg, 1986; Frengly and Uriate, 1992; Kay and Edwards, 1994). The consultants used accounts over three to five years to identify trends and determine deviations from the "norm".

Cross-sectional analysis is the comparison of a farm business with similar farms for the same year (Penson and Lins, 1980; Penson *et al.*, 1982; James and Stoneberg, 1985; Frengly and Uriate, 1992; Kay and Edwards, 1994). Standards used by the consultants for this work were derived from their own data base, such as a Farm Improvement Club (Baker, 1993), or from the NZMWBES (The New Zealand Sheep and Beef Farm Survey 1993-94) or MAFPol (MAF Farm Monitoring Report, North Central, July 1995) databases.

There has been an on-going debate about the role of farm standards in the farm management literature (Cooper, 1995). Candler and Sargent (1962) were highly critical of farm standards because there was "a complete lack of published theoretical underpinning". They were critical of the supporters of farm standards and noted that such individuals believed that there was some "ill-defined relationship" between farming success and the ratios they calculated. They argued that "the more carefully such hypotheses are defined, the more efficiently relevant statistics can be collected and manipulated. With a properly specified hypothesis, the possibility of rejecting the hypothesis on the basis of observations, would convert the study of farm standards from an art to a science". Candler and Sargent (1962) went on to compare the farm standards approach to "an attempt to drive a car, without any knowledge of the car's inner mechanism, in order to optimise the driver's reactions". They also dismissed the argument "that because successful extension is often based on the use of farm standards, hence farm standards use useful".

The results of this study support the arguments of Candler and Sargent's paper. Farm standards by themselves were of little use to the consultants involved in this study. The farm standards only become useful when placed within the context of the consultant's "theoretical" or conceptual knowledge of the farming systems they were dealing with. This "provided" the "theoretical underpinning" identified by Candler and Sargent (1962) as being so important in the use of farm standards. This knowledge has been developed through tertiary education and many years of field experience.

The tentative hypotheses developed from accounts analysis were confirmed or rejected by evidence collected during farm inspection and through discussion with the client (Figure 1). For example, accounts analysis may suggest that a change in cattle policy is likely to improve

the profitability of the client's business. However, information collected during the inspection may indicate that the land is not suitable for other classes of cattle or the farmer does not have the necessary skills to operate a different policy. Conversely, the consultants may collect information during these steps which override initial findings from the analysis of accounts. Little is written in the literature that explicitly links accounts analysis with problem/opportunity identification.

> ***"The financial analysis is only going half way. It's a question of what are you going to do with it."***

The consultants collected additional information to identify problems and opportunities during the farm inspection. This information included, for example, the farm family, their goals and relationships, the state of the farm resources, the farmer's management system, knowledge, skills, motivation and attitudes. In much the same way as hypotheses were developed from accounts analysis, consultants used the farm inspection to gather evidence to confirm or refute their "other" tentative hypotheses. By the end of the farm inspection, the consultants had normally narrowed their initial large set of potential problems and opportunities down to a much smaller sub-set.

> ***"Of course all the time that you are doing this*** **[the analyses and budgets]** ***you are sizing up the person and the plans have got to relate to their skills and abilities and to the aims and objectives*** **[of the farmer]** ***and those sorts of things."***

During the next step of the process, the consultants developed a cash forecast budget with the client for the coming year (Figure 1). The budget reflected the client's physical and financial plan for the next twelve months, and provided a focus for discussing with the client, problems and opportunities identified from the accounts analysis and farm inspection. An improved farm plan was developed on this basis.

The income side of the cash forecast budget was dealt with first. If the accounts analysis and farm inspection suggested the desirability of changing the livestock enterprises, gross margin analysis was used to assess the financial implications of alternative livestock policies. These

were discussed with the client and a decision made as to whether or not to change livestock policies. A similar process was undertaken for farm working expenses, debt servicing, taxation, drawings and capital expenditure. Potential problems and opportunities identified through the accounts analysis and verified during the farm inspection were discussed during the formulation of the cash forecast budget. The client was asked to confirm or deny that a problem or opportunity existed. If a problem or opportunity was confirmed by the client, the consultants provided a set of alternative solutions to the problem. These were discussed with the client and a solution tailored to the client's situation. The final output from the process was a cash forecast budget for the coming year which represented an improved plan (physical and financial). The literature (Frengly and Uriate, 1992; Kay and Edwards, 1994) discusses the use of cash forecast budgets or pro-forma analysis and their role in planning and developing improved plans. However, there is no literature on the consultancy-client interaction in developing an improved plan. The role of gross margin analysis in the consultancy process in relation to enterprise analysis is similar to that reported in the literature (Kay and Edwards, 1994).

CONCLUSIONS

The study found the principal financial analysis methods employed by consultants during a "typical" "first-up" visit were accounts analysis, cash forecast budgeting and gross margin analysis. Accounts were analysed mainly to identify possible problems and opportunities and to initiate the problem solving process. In contrast, cash forecast budgeting and gross margin analysis were used not only to identify problems and opportunities, but also to generate alternatives for an improved farm plan.

Physical and financial performance measures were used to analyse strengths and weaknesses in a farm business. However, consultants differed in the range of financial measures used and the method of calculation. Further research in this area, and the adoption by the profession of uniform procedures for the calculation of financial performance measures is recommended.

Expert consultants employed skills other than financial analysis when identifying and solving problems (and opportunities) confronting their clients. These include the ability to: develop rapport with the client (see Rogers *et al.* 1996); use financial and non-financial information to

develop tentative hypotheses about potential problems and opportunities; know what information to collect to confirm or refute these tentative hypotheses; generate alternatives; and analyse these alternatives with the client in order to tailor the solution to the client's circumstances. These skills require that the consultant has a deep knowledge and understanding of farming systems, in their broadest sense, and expertise in systems analysis (see Rogers *et al.* 1996). This study has implications for the design of courses taken by undergraduates wishing to become consultants. They suggest that students need to obtain knowledge and skills, not only in financial analysis, but also in interpersonal communication and farming systems analysis. In general, the study reinforces the view long-held by farm management lecturers at Lincoln and Massey Universities.

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THE ROLE OF STOCK AND STATION FIRMS IN THE FARMING ENTERPRISE

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ABSTRACT

To quantify the role the stock and station firms play in the business enterprise of the New Zealand farmer, a mail survey of rural box-holders was carried out in the Manawatu/Rangitikei region. The questionnaire sought information about the respondents, their farming enterprises, the firms they did business with, their perceptions of the products and services provided by stock and station firms, their attitudes toward the firms and their agents, and areas in which the firms could improve their services to farmers. Findings from the survey illustrate the competition the firms face in the buying and selling of livestock and the provision of products and other services, the importance of the farm management advice they provide, and farmers future requirements of the firms. These are reported in this paper.

Keywords : stock and station firms, rural services, farmers' expectations.

INTRODUCTION

Stock and station agencies are a major contributor to New Zealand's rural economy and have provided services to rural districts since early European settlement (Guerin et al., 1989). They have played an important role in agricultural development, through the provision of services for livestock transactions, seasonal finance and farm merchandise. However, the economic circumstances of New Zealand farmers, particularly those in the sheep and beef cattle sectors, have altered dramatically since 1984 due to Government reform and changes in international markets (Dobson and Rae, 1990). These changes have exposed farmers to greater competition and risk, and have impacted on the type of services they require from agribusiness firms such as stock and station agencies. It seems inevitable then that if the stock and station firms are to remain competitive and service future needs of the agricultural production sector, they will need to change. Anecdotal evidence from farmers and industry employees suggests that farmers often have strong opinions about the value of stock and station firms, their agents, and the services they provide to farmers. There is however no published research describing the views of farmers (the clients) about the services provided by, or required from, these firms. This lack of information prompted the survey of farmers reported in this paper.

SURVEY METHOD

Preliminary discussions were held with the branch managers of Wrightsons Ltd, Williams and Kettle Ltd, and Elders Pastoral Ltd, to develop concepts for a mail questionnaire, and to obtain knowledge about the stock and station industry. A mail survey was adopted because it provided greater coverage than other methods, avoided interviewer bias, and allowed respondents to complete the questionnaire at their own leisure (Erdos, 1983).

The selected survey area (Manawatu and Rangitikei District Council's regions combined) contains 12.4% of the sheep, 3.36% of the dairy cattle and 7.4% of the beef cattle numbers in the North Island (Agriculture Statistics, 1995), and covered the area from Hunterville in

the north to Foxton in the south and west of Marton through to the Tararua and Ruahine Ranges. A random sample of 320 farmers was selected from the New Zealand Post Rural Delivery listings in the Universal Business Directories (1995) for the region. This represented approximately 10% of the addresses listed (3600) for the Manawatu/Rangitikei area. Statistics NZ (1995) reported 2847 farmers in the study region, thus about 80% of the addresses were expected to be farmers.

The questionnaire was divided into six sections. The first sought background information on farm ownership, total area farmed, age and gender, the major enterprise, and the principal decision maker. The second section asked respondents to identify the range of services used in the farming business, and the company or companies providing the service(s). The third section sought the respondent's opinions of the firm's services, by providing a statement and seeking a response on a scale of one (strongly disagree) to five (strongly agree), with the opportunity to comment. The fourth section related to company loyalty and attitudes, again with the opportunity for comments. The fifth section sought respondent's opinions of agent's knowledge of services and products, their professionalism and attitude toward women farmers. The final section sought information on farmers' future requirements of services and products from stock and station firms.

The questionnaire was pre-tested with eight local farmers. The farmers were all male, based in the Manawatu area and were involved in a range of enterprises (dairying, arable, sheep breeding, prime lamb production and beef cattle finishing). All had considerable farming experience and a knowledge of the stock and station industry. Comments from the pre-test farmers were incorporated in the design of the final questionnaire.

The questionnaire was mailed out in June 1995. After four weeks 113 questionnaires had been returned. A further 11 questionnaires were returned following a reminder letter, giving a response rate of 39%. Thirty-five respondents indicated they were not farming, leaving 89 questionnaires (28%) suitable for data analyses. No follow-up with non-respondents was conducted to determine the extent of any bias in the data set.

Data were coded once all questionnaires were received. Where open-ended questions had been asked or comments made, each response was allocated a category with a nominal value. Data were subjected to descriptive statistics using the SPSS/PC+ (Version 5.0.1) package.

RESULTS AND DISCUSSION

The primary source of income for the 89 respondents analysed was: sheep production (43%), dairying (24%), beef (17%), and other (16%; cropping (5), deer (1), grazing (1) and off-farm employment (7)). The seven respondents whose primary source of income was off-farm, were on properties of less than 50 hectares, and of these five owned less than 10 hectares. The sheep farms averaged 265 ha, the beef cattle farms 85 ha, the dairy farms 186 ha and others 67 ha in area. Eighty respondents were male, seven were female, and two responded jointly as partners. Of the 89 respondents, five were less than 30 years of age, 11 were from 30 to 40, 34 were from 40 to 50, and 39 were over 50 years - 82% were over the age of 40 years. In terms of land tenure, 70 respondents (79%) owned or part-owned land, three were farm managers, four were sharemilkers and three leased land. The remaining nine farmers were involved in a mix of sharefarming, leasing or managing properties.

Respondents' requirements for, and use of, various services and products provided by stock and station firms are summarised in Table 1. Most respondents used the firms for the buying and selling of livestock, although smaller companies and independents, including some based outside the survey area, were also used for this purpose. A total of 24 businesses which bought and sold livestock were identified, and of these, three were stock and station firms and eleven were meat processing companies. One third of the respondents used more than one firm for the trading of livestock, and respondents identified nearly eighty stock and station firms and other companies, organisations and individuals who play a role in their business activities.

Table 1 Services and products used by the respondents in their farming business.

Service/Product:	Used by Respondent (n)	Provided by Stock and Station firms (n)	(%)	Responses (n)
Livestock sales and purchases:				
stock sales - stores	49	37	(76)	89
prime	55	23	(42)	88
culls	57	27	(47)	88
stock purchases	66	42	(64)	88
Animal health products	78	19	(24)	88
Merchandise products	74	30	(41)	88
Wool sales	49	33	(67)	87
Seasonal finance	31	4	(13)	88
Grain & seed sales	29	7	(24)	88
Fertiliser	69	22	(33)	88
Farm management advice	24	2	(8)	86

Two thirds of the wool growers sold wool through the stock and station firms, but only 24% of the grain growers sold their grain through this outlet. The number of outlets identified in the study region, for wool and grain were 13 and 14, respectively. Table 2, however, shows that less than half of the sheep farmers thought that they obtained the best returns for wool by using the stock and station firms. This suggests not only that growers are not maximising their returns (knowingly accepting a lesser price from the firms) but also that more farmers may sell to other wool buyers in the future to improve their returns.

Table 2 Farmer perceptions of stock and station firms.[1]

Statement	% in agreement [2]	Major income source : Sheep (Percentage within each group).	Dairy	Beef	Other	(n)	Mean score
Firms provide an essential service for the buying and selling of livestock.	77	78	80	69	75	86	4.09±.09
The livestock services provided are better than the independents.	30	35	35	25	8	86	3.07±.12
The cheapest place to buy animal health products is from a firm.	30	39	0	31	55	83	2.83±.14
The firms merchandise prices are competitive.	57	62	42	50	75	85	3.52±.12
The wool grower gets the best returns from the firms.	39	46	8	54	27	74	3.14±.13
The major firms offer excellent farm management advice.	20	22	17	21	17	81	2.75±.11
Finance from the firms is provided at competitive terms.	16	26	6	21	0	79	2.87±.10
The firms are flexible in their lending policies.	23	25	18	31	18	78	2.97±.10
The firms provide employment opportunities for young people.	46	53	50	33	42	82	3.44±.09
The agents have a high standard of professionalism.	68	80	67	47	70	79	3.72±.10
The agents are well trained for the job.	64	71	61	50	70	80	3.79±.09
The agents go out of their way to be helpful.	78	80	81	75	70	78	4.01±.10
The agents treat women farmers equal to men.	20	33	19	13	0	70	2.81±.14
Overall the major firms are vital to the future of NZs agricultural and horticultural industries.	68	78	55	60	55	84	3.77±.09

[1] In the table the term 'firm(s)' refers to the stock and station firms.

Ordinal scale of 1 to 5, where 1=strongly disagree, 2=moderately disagree, 3=neutral (no particular feelings), 4=moderately agree, 5=strongly agree.

[2] "Strongly agree" and "Moderately agree" are combined for the "% in agreement" column.

Nineteen of the respondents bought animal health products from the stock and station firms, 22 bought from merchandise companies and 37 from veterinarians (Table 1). Respondents purchasing these products, identified 15 sources from which animal health products could

be purchased. The majority of these were veterinarians. Other types of merchandise products could be obtained from 11 sources and fertiliser was available from 16 outlets. Less than one third of the respondents thought that the stock and station firms provided the least expensive animal health products, and just over half considered the firms' prices for merchandise to be competitive. No dairy farmers considered the stock and station firms to be the cheapest source of animal health products. One dairy farmer commented that "I would like to see (firm) carry more dairy items."

The majority of respondents (77%) agreed that the stock and station firms provided an essential service for the buying and selling of livestock (Table 2), with dairy farmers being more positive (80% agreed) about this aspect than beef cattle farmers (69%), although historically dairying has not been a significant sector for the stock and station industry. The firms are now addressing this neglected area of trade with the employment of agents with dairying expertise, the development of grazing contracts, and the provision of products and advice to assist dairy farmers to increase production (Wrightson, 1995).

Historically finance, particularly seasonal finance, has been an important area of business for the stock and station firms. Nimmo (1992) claimed that the major firms have moved to mortgage lending and offer term and seasonal finance on a "one stop shop" basis, and are fully competitive. The results of this survey show otherwise: the majority of respondents (87%) sourced their funds from trading banks, possibly because only 16% of the respondents (13) agreed that the stock and station firms provided finance at competitive rates (Table 2). Of these 13, nine were sheep farmers and three were beef cattle farmers. Nimmo also claimed that some farmers obtain seasonal finance from more than one seasonal lender, whereas the current study revealed only one of the 89 respondents borrowed seasonal finance from more than one source. This suggests that whilst farmers are not necessarily loyal to one stock and station firm, they appear to be loyal to their "banker".

When the results for finance were evaluated by age groups, of the 16 farmers under 40 years of age, only four (25%) required seasonal finance, whereas of those over 40, 38% did so. Sheep farmers felt more positive about the competitiveness of the stock and station

firms finance rates (26%), than beef cattle farmers (21%) or dairy farmers (6%) (Table 2). Of those who agreed that firms provided finance at competitive terms, 54% farmed areas less than 50 ha, 15% between 50 and 200 ha, and 31% over 200 ha. The group who least used seasonal finance were the beef cattle farmers (13%), although this may well have changed since the survey was completed, due to the low returns for beef in 1996.

Just over a quarter of the respondents thought that stock and station firms should provide a farm management consultancy service on a fee paying basis, with one respondent wanting ".....a credible farm management service...". Younger respondents were more in favour of this service than their older peers. One fifth of the respondents thought the firms offered an excellent service on farm management advice, although the question did not distinguish between a firm's consultancy service and the free advice given by the agents. Nevertheless, the positive response indicates that farmers see stock and station firms and their agents as having knowledge that is worth paying for, and this represents an area of possible expansion for the firms.

Overall 68% of respondents believed agents had a "high standard of professionalism", 64% agreed that they "are well trained for the job", and 78% believed that the agents "go out of their way to be helpful". While 80% of the sheep producers agreed the agents were "highly professional", only 47% of the beef cattle producers thought likewise. Similarly, 71% of the sheep producers agreed that agents were well trained for the job but only 50% of the beef cattle producers agreed. The lower figure for the beef cattle respondents may reflect the falling returns for beef at the time of the survey.

Respondents identified the qualities of a good agent. In particular they thought agents should: be knowledgeable (43), provide good service (30), be honest and trustworthy (26), be reliable (16), and be a good communicator (15). The attitude of some agents toward women farmers however, should be of concern to the stock and station industry. Only 20% of farmers agreed that agents treat female and male farmers in a similar manner (Table 3). While 37% of the respondents indicated that "women farmers are comfortable in dealing with the firms' agents", 86% of the comments on the attitudes of the agents toward female

clients compared with male clients, were largely negative. Typical comments in this respect were: "Because of the attitudes towards my wife, who is the major seller at stock sales, we found a firm who treats her as an equal", and "There should be more women agents". These results are consistent with Shaw's (1993) work which claimed, "Women are still faced with rural service people who are rude, insult their intelligence, or just ignore them in their dealings and discussion" and "Women have often expressed their concern at being ignored, if not totally, then until they have proven themselves, and at being treated as if they have no knowledge and skills. They have also commented that rudeness and insults from rural service industry staff will mean a company will lose clients." The same view is expressed in the 1993 edition of Situation and Outlook for New Zealand Agriculture, which claimed women running businesses in rural areas "...have greater difficulty in obtaining finance from (male) bank managers and service from (male) agribusiness agents than do men.".

Table 3 Respondents opinions on the attitudes of the stock and station firm's representatives (agents) toward female clients.

Statement: "The reps treat women farmers in the same manner as men farmers."

	Response (%)[1]			
Age (years)	Agree	Neutral	Disagree	(n)
<30	0	40	60	5
30 - 40	10	50	40	10
40 - 50	19	54	27	26
>50	28	28	26	39
Average	20	46	34	70

[1]Ordinal scale of 1 to 5, where 1=strongly disagree, 2=moderately disagree, 3=neutral (no particular feelings), 4=moderately agree, 5=strongly agree.

"Strongly agree" and "Moderately agree" are combined, as are "Moderately Disagree" and "Strongly Disagree".

Farmer loyalty to a firm or its agents and the farmers overall attitude towards them were also assessed. When farmers were asked which they considered to be more important to their business, the firm or the agent, 79 responded, with 62 (78%) indicating the agent was more important, and only 7 (9%) responding that it was the firm. The remaining 10 felt one was as important as the other. Of those under 40 years of age, 90% felt the agent was more important, compared with 76% of those over 40. These results confirm the high profile agents have as their representatives, and that the firm's training programme for agents should emphasise the significance of the relationship between the agent and the client. The results also indicate that firms should not underestimate the value of their agent in attracting business.

If one firm could meet all the requirements of the farmer, nearly two-thirds of the 85 respondents (61%) indicated they would "stick with that firm", with the remainder indicating they would prefer to deal with more than one firm. Many respondents commented they believed competition between firms was important in the industry. More than one third claimed they used one firm only, and of these 20 (33%) had done so for more than 10 years (two farmers had remained loyal to one firm for 55 years). Comments on why loyalty had changed from one firm to another, showed pricing and competition were the main reasons. "I do not regard stock firms as a major influence in my business as am prepared to do the 'homework' for myself to hunt out ones with skills in specific areas or the best price , so I see the competition as the most essential factor in the rural service industry." Service and staff loyalty were also mentioned as reasons.

Respondents identified market information, both for livestock and farm products, as an area where stock and station firms could improve their service (Table 4). Several respondents asked for regular information bulletins on livestock and product prices, and a high proportion (69%) expressed interest in using computers for sourcing this information.

The following was a typical comment ..."A monthly newsletter giving unbiased market information eg. stock prices, meat schedules, fertiliser costs, finance rates, monthly merchandise specials, and predictions of what might happen in the market place."

This area of communications should be investigated further by the firms.

Table 4 Methods by which stock and station firms could improve their services to farmers.

Percentage agreeing the firms should provide:	Age of Respondents (years)				Respondents	
	<30	30-40	40-50	>50	(n)	(Average)
more market information on livestock and other farm product prices.	50	100	88	88	81	88
more advice or guidance on the buying or selling of livestock, or other farm products.	100	91	78	79	82	82
a fee paying service to assist in farm management decisions.	40	36	29	16	78	26
a computer network for livestock and product prices.	80	80	84	46	72	69

Comments on additional services or products that could be provided included : "More stock firms should have their merchandise stores open on Saturday mornings."; "Maybe a leaflet on what they do have to offer and what services they provide."; "....perhaps including portable weighing of stock on farms"; Two respondents felt there was a political role for the stock and station firms, to support farmers in lobbying in such areas as better beef or lamb prices or influencing Treasury. When the results in Table 4 were evaluated by farm type, the most positive group were sharemilkers with 100% agreeing to each of the first three suggestions, and the majority were positive about the computer network.

Two statements in the questionnaire related to: the employment opportunities for young people in the stock and station firms, and the future role of the firms in agriculture and horticulture (Table 5).

Table 5

Statement	Response (%) Agree	Neutral	Disagree	(n)
The major stock and station firms provide good employment opportunities for young people with an interest in agriculture and horticulture.	46	48	6	82
Overall, the major stock and station firms are vital to the future development of NZ's agricultural and horticultural industries.	67	25	7	84

Nearly half of the respondents agreed the firms provided good employment opportunities for young people and two-thirds agreed the firms are vital for the development of New Zealand's agricultural and horticultural industries. The high response rate and the low number of negative responses for these two statements, confirm the influence stock and station firms have in rural communities.

CONCLUSION

A survey undertaken on farmer views of stock and station firms confirmed that they play a significant role in the farming businesses, but a number of areas were identified, which the firms need to address if they wish to continue in that role. The stock and station firms face strong competition from smaller companies and independent agents, and in many cases farmers use more than one firm to support their farming activities. In some areas where stock and station firms have traditionally played a major role (e.g. finance or merchandise), they are no longer viewed by farmers as being competitive, and where farmers are no longer committed financially to the firms, the obligation to use their other services is lessened. Stock and station firms will need to re-evaluate their target market and improve their competitiveness if they wish to remain providers of rural finance to farmers. Further, while agents generally have a good reputation for servicing their clients, it is clear that an improvement in the way they work with women farmers is necessary. Farmers would also

like stock and station firms to provide improved market information, and an opportunity exists to provide specialist farm management advice to clients. Multi-skilled agents who can provide financial and technical advice on farm management, along with the use of technology for communications in stock and merchandise reports (prices and predictions), as well as the traditional stock and station firm services, could help the industry expand its client base. Overall the survey results indicate that stock and station firms face strong competition from other providers of products and services, and that they will need to continually upgrade these if they are to remain a significant feature of New Zealand agribusiness in the medium term future.

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Towards an Economically Optimal Level of Control for Rooks in Canterbury*

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This paper presents a dynamic bioeconomic model of pest control for a population of rooks in Canterbury. Optimal control theory provides the theoretical framework for the development of the model, which is then solved using non-linear programming. The relevant decision maker in the context of this empirical problem is the Canterbury Regional Council, whose objective is to minimise the sum of discounted control costs and rook inflicted damage over time. Decisions to control rooks are made yearly, and are restricted to either undertaking or not undertaking a single control activity. A unique contribution of this model is the inclusion of a 'bait shy' population, which develops when birds are exposed to sub-lethal doses of control. State variables therefore include a population of susceptible and a population of "bait shy" rooks, and the solution procedure determines the optimal control strategy through time. Numerical results from the model, subject to specific parameter values, highlight several important aspects regarding timing and efficacy of control.

* The authors wish to thank Rob Phillips and Paul Cornelius of the Canterbury Regional Council for making time available and providing us with the necessary background information on which this study is based.

I. Introduction

Rooks (*Corvus frugilegus*) were introduced into New Zealand as means of controlling pasture insect pests (Flynn, 1979). Since that time, however, the birds themselves have become a major nuisance to producers of commercial crops in areas where rook densities are high and invertebrate populations low. Consequently, efforts to manage rook numbers began in 1945. There are important externalities associated with the control of this relatively intelligent, highly mobile pest, which have resulted in the involvement of local government authorities and the expenditure of public money. In Canterbury, for example, the Regional Council completely controls the rook eradication programme.

II. Rooks in Canterbury: The Empirical Problem

The establishment of rooks in Canterbury began with two liberations: one in 1871 involving five birds, and the other comprising thirty-five birds in 1873 (Bull, 1957). Both of these liberations occured in Christchurch. Although the protected status of rooks was completely removed in 1919 (Flynn, 1979), population numbers increased to between 7000 and 10,000 birds by 1947 (Bull, 1957). The successful population growth during this period was assisted by favourable changes to the rook's habitat. While the conversion of pasture to arable land reduced invertebrate food supplies, commercial crops provided rooks with a ready substitute (Flynn, 1979). The removal of scrub and bush complemented the presence of suitable nesting trees such as *Pinus radiata, Eucalyptus sp.*, and *Cupressus macrocarpa* in creating conditions that were similar to the rooks' natural habitat (Bull, 1957).

The rook diet includes invertebrates, animal flesh from scavenging and predation of other birds nestlings, walnuts, acorns, cereals (usually in stubble fields), pulses, and grasses and clovers (Coleman, 1971; Purchas, 1976). Food availability is a major determinant of the

rook's diet and feeding ranges (Coleman, 1971). While invertebrates are the preferred food source, in the event of dry summers or cold winters the availability of invertebrates declines and rooks spend more time eating cereals and pulses (Coleman, 1995).

Rooks foraging on commercial crops can cause damage at all stages of plant development; planting, sprouting and maturing (Porter et al., 1994). According to Purchas (1980), rooks spend 6% of their feeding time eating newly sown or ripening crops during the summer and less than 2% during other seasons. At low population numbers the impact of rooks is therefore negligible (Coleman, 1971). As the population increases, however, significant agricultural damage can result. Rookeries are re-occupied in early spring as breeding activity increases (Coleman, 1971). Eggs are laid between the end of August and beginning of November, depending on food availability (Coleman, 1972). Although brood sizes range from 1 to 6 chicks, no more than 4 chicks fledge from any one brood (Coleman, 1972). The breeding success of rooks has been observed to range from 12% to 38% in Canterbury (Coleman, 1972), suggesting without ongoing control rook populations could become problematic.

Coordinated control efforts, which included shooting, felling nesting trees, poisoning, trapping and scaring, began in 1945 and resulted in both large numbers of rooks killed and the extension of their breeding range through the fragmentation of rookeries (Bull, 1957). In the late 1950's rook control was undertaken by the Ministry of Agriculture and Fisheries (Canterbury Regional Council, 1991). Under the Animal Pest Destruction Act 1967 rooks were declared a pest of local importance in Canterbury and responsibility for control moved to the several Pest Destruction Boards covering the region. In 1989 the Canterbury Regional Council became responsible for undertaking control programmes as part of a reorganisation of local government. Control by the Regional Council has continued under the new

legislative framework provided by the Biosecurity Act 1993. The area currently affected by rooks comprises three distinct sub areas; the Canterbury Plains bounded by the Waimakariri River to the north and the Rangitata River to the south, Banks Peninsula, and Kaikoura . Under the current control regime which began in 1992 the rook population has been reduced from an estimated 5,559 birds to less than 100 at the beginning of 1996.

The past 50 years of coordinated effort has highlighted several problems associated with rook control. Rooks are very mobile pests capable of causing crop damage over large areas, and feeding ranges during the non-breeding season can extend to 20km (Coleman, 1995). Any reduction in bird numbers is therefore beneficial to an affected region. However, past experience has shown that rook control by individual farmers has been ineffective and has probably contributed to the rook problem by fragmenting colonies and shifting them into new areas (Bull, 1957; Flynn, 1979). Rooks are also prone to bait shyness (Flynn, 1976), which can be defined as the behavioural trait, either learned or non-learned, of avoiding toxins or baits. A consequence of bait shyness is that rook control undertaken by isolated individuals is highly likely to reduce the effectiveness of that control method for other producers in the future.

The difficulties mentioned above have important implications for how the rook control problem is viewed economically. Past work by Bhat et al. (1993) suggests that the economic objectives of neighbouring land owners and the pest's population dynamics are both factors upon which the economic effectiveness of individual pest control depends. With respect to rook control three externalities may exist. Firstly, a land holder independently undertaking a successful rook control operation can not exclude adjoining land holders with similar economic objectives from enjoying the benefits of lower rook numbers. It is therefore possible that adjoining land holders may become *free riders* by benefiting from control

without incurring any of the costs. Secondly, the application of control technology which is ineffective at killing a large percentage of a target population will disperse the rook population over a wider area, due to the bird's propensity to spread when disturbed. In this situation adjoining land holders who do not undertake control may face a *negative diffusion externality* through the actions of a controlling land holder. The negative diffusion externality associated with rooks has the reverse diffusion dynamics to that described for beavers by Bhat et al (1993). In their study the externality arose from the beavers tendency to diffuse to less-densely populated habitat which resulted in a pest flow from uncontrolled to controlled land. The third externality arising from independent rook control is also a consequence of using ineffective control methods. Birds surviving a control attempt may be more difficult to control in the future due to bait shyness. Bait shyness effectively increases the costs for other land holders undertaking future rook control.

The above externalities imply that individual control is not likely to be socially optimal. The literature on the economics of pest control, where a pest has the characteristics of a common property resource, suggests that centralised control is required in order to internalise externalities and thereby achieve outcomes which are more socially optimal (Feder and Regev, 1975; Tisdell, 1982; Bhat et al, 1993). Economic justification for centralised control supports earlier recommendations from rook control experts who claimed that coordinated control was necessary for greater control effectiveness (Flynn, 1976; Purchas, 1976). The Canterbury Regional Council has responded to the need for centralised control by stating that rook control is "a highly specialised area of pest control" (Canterbury Regional Council, 1993) and prohibiting independent control activities. The Biosecurity Act 1993 provides the Council with a favourable legislative environment within which to carry out

rook control activities, which include inspection and monitoring, advice and education, and service delivery. A pest management rate is used to fund these services.

III. Past Work

In a recent survey of the literature, Hone (1994) acknowledged the importance of economic analysis of vertebrate pest control activities, but discovered that very little work had been undertaken to that date. Of the economic analyses that have been carried out, a common objective seems to be the evaluation of existing control programmes using cost-benefit analysis. Two examples which illustrate this dominant view on the role of economic analysis in vertebrate pest control over the last decade are Collins et al.'s (1984) evaluation of black-tailed prairie dog control in the rangelands of South Dakota, and the evaluation by Vickery et al. (1994) of possible control methods to reduce the damage that brent geese inflict on crops in Britain. Cost benefit analysis is not restricted to evaluating large scale public control programmes. Dolbeer (1981) uses a cost benefit framework in his micro-level analysis of blackbird damage control for cornfields in Ohio.

The literature on invertebrate pest management provides the greatest contribution to the economic theory of pest control. The concept of *economic threshold,* defined as the pest density at which control measures should be initiated to avoid reaching the economic injury level, has been an integral part of this analysis following an early paper by Stern et al. (1959). The *economic injury level* is the lowest pest density level at which economic damage would be caused.

Entomologists and economists have since developed the economic threshold concept along two distinct lines (Mumford and Norton, 1984). Entomologists have sought to use the concept to identify a "rule of thumb" for use in pest control decisions. The objective of their

research is to determine the pest population level at which control should be applied. Economists, on the other hand, have used marginal analysis to identify an optimal level of pest control and hence an economically optimal pest population level. Headley (1972a: p.105) defined the optimal pest population level as "the population that produces incremental damage equal to the cost of preventing that damage".

The early development of the economic threshold concept proceeded from the simple static Headley model to include both the level and timing of control as variables (Hall and Norgaard, 1973). A dynamic formulation of the model followed, which gave rise to the notion of a variable threshold (Hueth and Regev, 1974). Shoemaker (1979) established multi-dimensional economic thresholds that took into account environmental conditions and population densities. More recent development includes the flexible threshold of Harper et al. (1994), which incorporates variable economic and production conditions together with a stochastic dynamic pest population.

No consensus exists as to which of the two approaches is more relevant to pest control decisions in the field. The entomologist's approach is perceived to provide a practical solution, while the economist's approach has been recognised as offering a more theoretically efficient solution (Mumford and Norton, 1984; Pedigo et al., 1986). Entomologist's concerns that the theoretical consistency gained from using the economist's approach would be "at the expense of biological and practical reality" (Mumford and Norton, 1984: p.172) were founded on doubts regarding the data requirements of large optimisation and simulation models (Pedigo et al, 1986). In order to reach a compromise between practicality and efficiency some studies have incorporated the entomological threshold concept within a more rigorous economic framework (Moffitt et al., 1984; Moffitt et al. 1987; Davis et al., 1992; Yu et al., 1994).

Mathematical modelling has been vital to the development of optimal pest control policies. Shoemaker (1976), for example, used dynamic programming to establish a management strategy for alfalfa weevil. Recent studies involving insect control (Harper et al., 1994), vertebrate control (Huffaker et al., 1992; Bhat et al., 1993) and weed control (Pandey and Medd, 1991; Gorddard et al., 1995) have also shown that the application of optimisation methods can produce more efficient pest control strategies. An example of the successful use of simulation methods in pest control is found in a study of horn fly control by Gordon et al. (1984).

In addition to the economic threshold concept, the pest control literature can be distinguished by the unit of analysis adopted. Most of the invertebrate pest control studies have been conducted at the farm level (Moffitt et al., 1987). This emphasis arises from a belief that improvements to decision making at this level were required in order to achieve greater aggregate effectiveness in pest management (Stern et al., 1959; Headley, 1972b; Norgaard, 1976; Norton, 1976). The use of farm level economic analysis in many pest control studies has been associated with short range spatial and temporal decision parameters (Pedigo et al. 1986). These decision characteristics, often relevant for invertebrate pest control, reflect the fact that control costs and benefits accrue largely to the individual farmer.

In some situations, however, pest control activities exhibit the characteristics of a public good. This occurs where there is non-rivalry in consumption of pest control activities and/or non-excludability from the benefits of control. In these situations independent control action is unlikely to lead to socially optimal outcomes and therefore requires some form of collective control. Applied studies recognising the public good aspect of pest control generally involve highly mobile pests. Bhat et al. (1993) used a region affected by beavers as the unit of analysis upon which to evaluate a centralised control strategy. A regional approach

was also adopted by Davis et al. (1992) and Collins et al. (1984) in studies which evaluated public agency control of grasshoppers and prairie dogs respectively. With respect to avian pest control, Dolbeer (1981) highlighted the need to undertake a regional economic analysis of blackbird control in order to justify publicly funded research and management programs. The study by Vickery et al. (1994) of control methods for reducing damage caused by protected brent geese also recognises that public funding requires the inclusion of a social perspective in the economic evaluation.

The literature reviewed above provides valuable guidance on how the rook problem can be approached. The need for centralised control, resulting from the economic consequences of the spatial characteristics of rooks, suggests the adoption of a regional level of analysis. In addition the population and behavioural dynamics in the rookery imply that control activities applied in one time period will impact the effectiveness of control in the future. The rook control problem is therefore fundamentally dynamic in nature.

In the following section a bioeconomic model of the rook control problem is developed within an optimal control framework. There are several reasons why optimal control is considered most suitable for this empirical problem. The rook control problem can be captured in a model of low dimension, permitting the application of optimisation techniques. Apart from the interaction between rook population growth and crop yields, and bait shyness and control, we can abstract away from complex ecosystem dynamics. The solution procedure also provides interesting economic information through the determination of shadow values. Finally, non-linear equations such as rook population growth can be handled directly by optimal control.

IV Empirical Model

The objective of this study is to find a more efficient level of centralised rook control in Canterbury. The study focuses on temporal dynamics and does not explicitly incorporate spatial dynamics. The region, which is confined to the susceptible area between the Rangitata and Waimakariri Rivers, contains several rookeries which cause crop damage approximately in proportion to their aggregate population size. The Council's objective is taken to be the minimisation of the sum of discounted control costs and rook inflicted damage costs over time (eq. 4.1). Decisions to control rooks are made yearly and are restricted to either undertaking or not undertaking a single control activity. Control activities are applied to the rookery and the effect of any control activity is assumed to impact the rook population after that year's breeding season. Definition of the variables and parameter values used in the model are contained in Table 1.

4.1 Objective Function

The rook control model is represented mathematically as follows,

$$(4.1) \qquad \underset{C_t}{Minimise}\ V_t = \int_0^T e^{-\delta t}[C(C_t, NS_t, S_t) + D(NS_t, S_t)]d_t$$

Subject to:

$$(4.2) \qquad \frac{\partial NS}{\partial t} = g(NS,S;r,K) + f(S_t,\beta) - h(C_t, NS_t, S_t;\alpha,\beta)$$

$$(4.3) \qquad \frac{\partial S}{\partial t} = h(C_t, NS_t, S_t;\alpha,\gamma) - f(S_t,\beta) - m(S_t,\mu)$$

$$(4.4) \qquad NS(0)=NS_0$$

$$(4.5) \qquad S(0) = S_0$$

Table 1 Variable Definition & Parameter Values

	Definition	Value
NS_t	Population of susceptible rooks (per hectare)	#
S_t	Population of bait shy rooks (per hectare)	#
r	Intrinsic growth rate of rook population	20%
μ	Natural Mortality Rate	5%
K	Carrying capacity for rooks (per hectare)	0.5
X_t	Total rook population (per hectare)	#
F	Seed weight per kJ of metabolic energy (grams/kJ)	0.118
E	Average daily energy required per bird (kJ/day)	450
FT_1	Percentage of feeding time spent on seeds (Autumn)	2%
FT_2	Percentage of feeding time spent on seeds (Spring)	2%
FT_3	Percentage of feeding time spent on seeds (Summer)	6%
N_1	Number of feeding days (Autumn)	32
N_2	Number of feeding days (Spring)	48
N_3	Number of feeding days (Summer)	32
W	Crop sowing weight (grams/ ha)	179,221
Y	Crop harvest yield (grams/ ha)	5718,400
M_t	Crop gross margin ($/ha)	873
γ	Control effectiveness	95%
α	Bait shyness	10%
z	Control cost parameter	0.02066
δ	Annual discount rate	6.5%
β	Bait shyness period decay	1%

Each period's costs are separated into those due to rook inflicted damage, D_t, and those incurred through the application of rook control activities, C_t. Both cost components are discounted by the annual discount rate δ. Agricultural crops susceptible to rook inflicted damage were assumed to be confined to cereals (wheat, barley, and oats), maize, and peas. The damage function therefore reflected per hectare values of sowing weight (W), harvest yield (Y), gross margin (M_t), and the metabolised energy per food item (F) for each crop in proportion to the area within the region in which it is currently being cropped. The area of land susceptible to rook damage was calculated to be approximately 74,000 hectares. The percentages of this land relating to crop types were 84.8% for cereals, 0.2% for maize, and 15% for peas. Sowing rates and harvest yields were obtained from the Lincoln University Financial Budget Manual (1995).

Annual rook inflicted damage, D_t [$/ha], is formulated as,

$$(4.7) \qquad D_t = X_t * F * M_t * E\{\frac{1}{W}[(N_1 * FT_1) + (N_2 * FT_2)] + \frac{1}{Y}(N_3 * FT_3)\}$$

Values relating to rook feeding were taken from Purchas (1980). The average daily energy requirement for a rook was assumed to be 450 kJ. It was also assumed that the proportion of time spent feeding on crop seeds, which could vary seasonally, would contribute to the equivalent proportion of the rook's daily energy requirement. The total weight of damaged crop seeds per day per bird was calculated using the weight of crop seed per kJ metabolised energy (Purchas 1980: p.574). The susceptible period for sown seeds was assumed to be 32 days in autumn and 48 days in spring. The susceptible period for seeds on the mature plant was assumed to be 32 days in summer. The annual loss in harvest yield resulting from rook

damage was expressed in kilograms per hectare and then monetised by multiplying by an average gross margin per hectare using data from the Lincoln University Financial Budget Manual (1995). Seed destruction is, however, not the only damage caused by rooks. Porter et al. (1994) state that seedlings can be pulled out of the soil and the tips eaten on emerging plants, while mature maize can be trampled. This damage has not be incorporated into the analysis because at current rook population levels it is assumed to be negligible.

Data limitations make the estimation of the cost of control difficult. Only one data point is known which relates to the 1995/96 period. For this period cost of control was $64,000 and 1543 birds were killed out of an inltial population of 1641. In a previous study by Huffaker et al. (1992), which had similar data problems, a single data point was used to calculate a control cost parameter. The control cost parameter was incorporated in a functional form that reflected increasing cost of control as the population density decreased. This approach is adopted and results in the following functional form:

$$(4.8) \quad C(C_t, NS_t, S_t) = \frac{zC_t}{NS_t + S_t}$$

To achieve the desired relationship between population density and control costs the total population density for a given period appears in the denominator of equation 4.8. Although control is only effective against the susceptible population the cost of control function reflects the assumption that the total rook density impacts on control costs. The formulation of the cost function implies that the cost of control will tend towards infinity as population density approaches zero, making eradication prohibitively expensive. Empriical observation suggests that eradication will, in fact, be difficult due to the high mobility of rooks, difficulty in

accurately estimating numbers, and the possibility of encroachment into controlled regions from an uncontrolled region further south.

4.2 Equations of Motion

The annual change in rook population numbers is the difference between the biological growth of the rook population during the year and the number of birds killed. In a period when control takes place the population is separable into the following groups; birds killed through control activities (H_t), birds not killed due to technical inefficiencies of control, but are susceptible to control in the next period (NS_t), and birds that are bait shy (S_t). Two distinct sub-populations therefore exist in any period; birds that are not bait shy, and those that are. A logistic growth function is used to describe the dynamics of both rook populations where r = intrinsic growth rate, and K= habitat carrying capacity. Prior work by Coleman (1971, 1972) suggests that r = 0.2. The parametric value of K was based on a study by Bull and Porter (1975) which revealed that the highest rook population density recorded in New Zealand was 20,000 breeding birds over 6,000 km^2 of farm land in Hawkes Bay during 1969, or 0.33 birds per hectare. Additionally, Bull and Porter (1975) observed that the actual numbers of rooks maybe 50% larger than estimates using extrapolations from nest counts. To allow for population underestimates rook carrying capacity was increased by 50%. This resulted in an adjusted value for the rook carrying capacity of 0.5 birds per hectare. The initial population levels are given by $NS_0 = 100$ and $S_0 = 0$.

The period change in population numbers for each sub-population (eqs. 4.9 & 4.10) depends on the biological growth of the total rook population, the effectiveness of control technology (γ), the propensity for birds to become bait shy through exposure to control (α), the period reduction in bait shyness (β), and the decision to control (C_t). There is an

additional parameter representing natural mortality for the shy population (μ). The effectiveness of control technology is assumed to be constant. Bait shyness is assumed not to be genetically transferred and therefore decreases over time if birds are not exposed to further control activities. Birds that are exposed to a control activity and survive will become shy in the next period. When control is absent the susceptible population increases according to the total population biological growth rate plus the number of birds that have lost their bait shyness. The shy population declines through natural mortality and birds loosing their shyness. Alternatively, when control is administered the change in the susceptible population is a function of the effectiveness of control applied to new recruits of both populations and the previous period's susceptible population. The change in the shy population under these circumstances depends on the loss of bait shyness and natural mortality together with the propensity for birds in the susceptible population which are exposed to control to become bait shy.

$$(4.9)\quad NS_{t+1} = (1-\gamma C_t)[NS_t + r(NS_t + S_t)(1-\frac{NS_t + S_t}{K})] + \beta S_t$$

$$(4.10)\quad S_{t+1} = \alpha\gamma C_t[r(NS_t + S_t)(1-\frac{NS_t + S_t}{K}) + NS_t] + (1-\beta-\mu)S_t$$

To solve the model numerically the control problem was specified in a non-linear programming format by defining the state and control variables in each time period as activities. The equations of motion were then specified as non-linear constraints linking one time period to the next. The system was solved using GAMS/MINOS (Brooke, Kendrick and Meeraus, 1988) for non-linear optimisation on a mainframe computer. GAMS/MINOS uses a reduced gradient algorithm, combined with a quasi-Newton optimisation method and sequentially linearises the non-linear constraints.

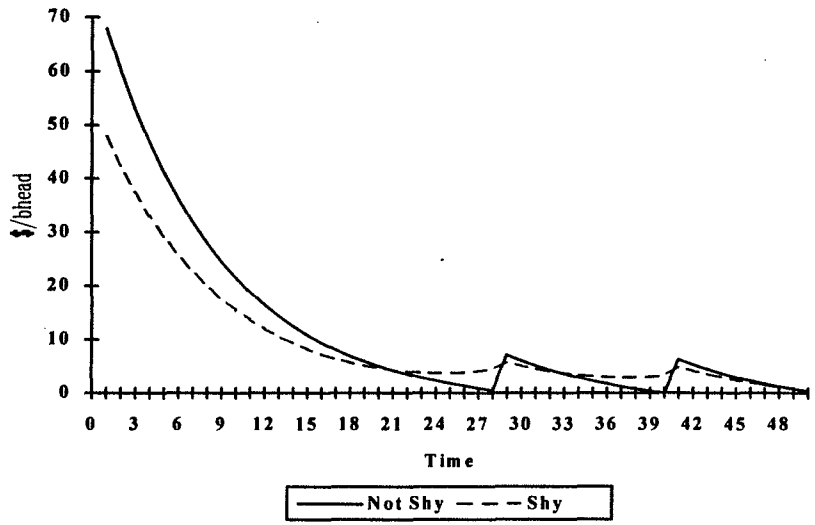
V. Results

Results of the empirical optimisation model using "base level" parameter values are displayed in Table 2. The base run resulted in two control operations, one in period 28 and the other in period 40. As a consequence of control, average rook numbers for the susceptible and shy populations were 3,132 and 298 birds respectively. A comparison between the net present values of total control costs and total damage clearly identifies the containment of control costs to relatively low levels through infrequent control activities. With respect to the average implicit values, which are the marginal values associated with the equations of

Table 2 Results of the Base Run

Number of Control Events	2
Control Periods	28; 40
NPV Total Damage	$11,679
NPV Total Control Costs	$2,437
Average Susceptible Population	3132
Average Shy Population	298
Implicit Values:	
Susceptible Population	$11.87
Shy Population	$9.39

Figure 1. Implicit cost of rooks



motion for each population, the susceptible population imposes a greater cost than the shy population. These values can be interpreted economically as the cost of adding an additional bird to each population. The dynamics of the implicit values for the two sub-populations are illustrated in Figure 1.

VI Sensitivity Analysis

Sensitivity analysis was undertaken with respect to parameters that were considered *a priori* to have potential to significantly influence results. This analysis was performed by changing the value of the parameter in question and holding all other parameters at their base run values. The results are displayed in table 3.

Increased Feeding Time

The effect of an increased feeding time on crops is obtained by adjusting the percentage of feeding time spent on crops up to 5% for autumn and spring and 10% for summer. The net present values of total damage and total control costs increased in response to greater foraging on crops and the shifting forward in time of control activities, respectively. Although 2 control events were administered the first occurs 5 periods earlier than in the base run and the second 6 periods earlier. The change in timing of control results in a significant reduction in the average numbers of both populations. The fact that lower average population numbers have not translated into a reduction in damage reflects the importance of feeding time in the damage function. The average implicit values for the two sub-populations are substantially higher than in the base run. This reflects the greater potential for incurring damage and earlier control.

Population Threshold

The final sensitivity analysis undertaken was to identify the impact of setting a threshold policy. A threshold for control at 200 birds was imposed by placing a constraint on the size of the total population. The imposition of the threshold resulted in 8 partial control events and complete control. The occurrence of this many control events dramatically increased discounted total control costs while reducing discounted damage to extremely low levels. Increased control frequency reduced average sub-populations to 110 for the susceptible birds and 15 for the shy birds. The larger average implicit values reflect the increased incidence of control and its effect on shyness. These results demonstrate the valuable contribution made by this method of analysis. The costs of applying a non-optimal

threshold on control are made explicit when compared to both the discounted damage costs and total control costs of the base run.

Table 3 Results of the Sensitivity Analysis

	Base Run	High FT	Threshold
Number of Control Events	2	2	9
Control Periods	28; 40	23; 34	3; 4; 12; 22; 28; 34; 44; 45; 48
NPV Total Damage	$11,679	$19,085	$761
NPV Total Control Costs	$2,437	$7,144	$886,181
Average Susceptible Population	3,132	2,108	110
Average Shy Population	298	159	15
Implicit Values:			
Susceptible Population	$11.87	$19.67	$3,074
Shy Population	$9.39	$17.58	$3,485

VII Discussion and Conclusion

The results presented above highlight several important aspects of the rook control problem. The first of these is that when population densities are low, rook control is more expensive relative to the damage that the birds inflict on commercial crops. Consequently, the cost of control 'drives' many of the model results in so far as control is put off for as long as possible. The identification of control costs as a dominant influence on the results emphasises the need for both the control cost and damage functions to be correctly specified.

Another general result is that the timing of control is not only important with regard to the magnitude of control costs, but it also determines the average rook numbers and therefore the amount of damage incurred. Bringing control events forward in time lowers average

population numbers of both sub-populations, but increases their implicit values by increasing total control costs and introducing shy birds into the population earlier in the time horizon.

The above results have important implications for rook control policy. Rook control clearly involves an economic tradeoff between control costs and the level of rook inflicted damage. The bioeconomic model presented in this paper makes this tradeoff very explicit. The model specification also facilitates an understanding of the dynamic effects of control on both susceptible and bait shy rook populations. In addition, the cost of non-optimal policies can be explored by constraining the model to maintain the total population at a sub-optimal level.

The bioeconomic model is only as good as the parameter values and specification used. While every attempt has been made to ensure both parameter values and model specification reflect accurately the empirical phenomenon, the lack of prior research on rook damage and control suggest future research into these areas is warranted.

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Do New Zealand Food & Beverage Manufacturers Plan for Product Recall?

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Introduction

May people will have read or heard the stories of food companies withdrawing their products from supermarket shelves. Despite some well publicised disasters, most recall activities are conducted beyond the gaze of the public.

This article presents the results from a series of non structured interviews with 20 food and beverage manufacturers and is aimed at providing some insight into recall activities. Since the sample size is relatively small and the subject firms were not randomly selected, readers are cautioned against drawing general conclusions.

Quality Control

From a business perspective, product recall is essentially a disaster minimisation exercise. Responsible firms will therefore introduce programmes that aim to control the quality of the product in order to reduce the potential for the need to recall products. It is therefore appropriate to make some comment about quality programmes and how the firms interviewed viewed them.

All food products carry an inherent risk to the consumer and represent a potential biological and business hazard to the processor. In order to minimise this hazard, food processors have introduced a variety of quality control programmes. Two popular programmes are Hazard Analysis Critical Control Points (HACCP) and the ISO 9000 series. The HACCP programme focuses on microbial or food technology aspects while the ISO programme relates more to consistency of output quality.

A number of the firms interviewed were actively involved in export and were either ISO 9002 accredited or seeking accreditation. Some firms currently selling only to the domestic market also had ISO accreditation. It is important to recognise that ISO accreditation forces a firm to have a management system focusing on a consistency of output quality. Thus a firm with ISO accreditation could be expected to make a product with less variation in design conformance.

Some firms interviewed saw little need to expend the energy and financial resources on a formal ISO programme and had instead introduced HACCP programmes or systems based on HACCP. These firms should reasonably be expected to produce a *safe* product though not necessarily a *consistent* product.

Eight firms from the sample of 20 advised they had ISO accreditation. All confirmed that they sought to produce a quality product and a number confirmed they had both ISO and HACCP based programmes. The larger firms tended to have both systems in place.

The Firms

The firms were categorised by two major criteria - one based on the degree of hazard inherent in the product and the other based on the size of the firm. A brief word of explanation is in order here.

To processors, all food products represent an inherent hazard but for the purpose of analysis it would seem reasonable to allocate processors to one of two basic groups. The first group would be processors that deal with either low hazard products or have a low hazard process. So a firm that has a secure manufacturing processes would be considered low hazard. Such firms may be typified by manufacturing processes that are highly mechanised and or include a cooking activity at or near the end of the manufacturing line e.g. canned vegetables, fish, pickle etc. They would also be classified as low hazard if minor errors in recipe were of no importance - slightly more corn in the corn flakes for example. The second group would include those firms that process highly hazardous products where faults in assembly have moderate to serious implications for the consumer. For example, food that is eaten raw or once cooked is eaten cold (small goods, ham etc.). This group also includes cases where a slight recipe modification is unacceptable though in itself might not pose a health risk to the consumer.

Size was determined not by staff numbers but by the managerial structure. Firms were considered small if the general manager/owner was also one of the line staff. This meant that quality issues were addressed by the person who had the most to lose from the error. Medium sized firms were ones run by managers who were not line staff but were themselves technically qualified in food science. In other words firms run by technocrats who though removed from day to day production were nonetheless technically proficient in the science of food. Large firms were classified as such if their management was typified by a non-technical command staff (GM, CEO etc.) who relied on second tier management or line staff for technical expertise. This data is represented in table 1.

Firm Size	High Hazard Product	Low Hazard Product	Total
Large	3	6	9
Medium	1	4	5
Small	2	4	6
Total	6	14	20

Table 1. Size and Degree of Hazard

The range of product represented by the firms in the survey is shown in table 2.

Product	Number of Firms
Small goods and cold fresh foods	6
Compound fruit & vegetable products	4
Frozen food	3
Drinks	5
Dry goods	2

Table 2. Product range.

It was assumed that small firms would have no formalised recall procedures nor formalised quality control measures while larger firms would have both. It was further assumed that firms dealing with hazardous products would have to a greater or lesser extent some degree of formalised quality measures irrespective of size.

Recalls

Firms were asked to declare whether they had occasion to recall products in the last five years. Eight indicated they had. This may seem an unusually high level. The question was interpreted by the firms in terms of a quality issue to the extent that the declarations were actually to the question "has any quality issue arisen that caused you to either recall a product, stop its release or release after consideration?". This was an important reinterpretation of a basic question because firms did not see events in such stark or black-and-white terms. For example one firm withdrew an otherwise good product purely as a precautionary move. The general results are tabulated in table 3.

Product	Reason for Recall	Comments
Compound vegetable in glass containers	Glass shard found in product by consumer.	
Beverage	Rumour of questionable substance in manufacture of packaging.	Unsold products reached use-by date and withdrawn.
Beverage	Unacceptable level of minor ingredient.	Safe for consumption but smelled bad.
Beverage	Glass shard found in bottle	Withdrawn before general release.
Small goods	Hepatitis outbreak in deli	
Meat product	Cross contamination after release.	
Beverage	Foreign object in container	None recalled due to short consumption cycle.
Dry goods	Incorrect labelling	
Dry goods	Recipe error	Product not withdrawn.
Frozen food	Poor handling resulting in partial thaw.	Withdrawn for esthetic reasons.

Table 3. Incidences of Product Recall

Firms were asked to declare the seriousness of these event in terms of their perception of consumer health. The glass shard examples were considered serious enough for firms to take immediate action. Most indicated that they would immediately withdraw the whole batch. Glass packaging was sited as quite problematic and given as the reason for moving to plastic containers. Moderate risk events were cross contamination or improper handling of goods. Determining risk in this area presented some difficulty. For example an obvious bad smell or a clearly visible foreign object act as warning devices to consumers not to proceed and thus the risk to the consumer would be low. In other cases invisible damage may be undone when in the hands of the final consumer by say cooking. Incorrect product description on a package was by-and-large not considered to represent a risk to the health of the consumer but would have been recalled for commercial reasons. A product that represents a low risk to the consumer may still represent a commercially hazardous situation to the manufacturer.

What became obvious during the interviews was that many firms were willing to weight up the benefits and costs of the event in terms of consumer risk and commercial hazard. Thus those firms who claimed a formalised policy or set of recall procedures appeared to be willing to modify the procedure depending on the likely publicity the event would attract. Two firms admitted that undue media attention had had them act in excess of what would under normal circumstances be required to make good the

damage. In effect their over reaction was not only due to a need to do something about the problem but to be *seen* to do something *that was acceptable in the eyes of the public*. This suggests that while the health of the public is a generally stated goal it is done so with a keen eye on sales.

The initiation of the recall was in five cases due to the insistence of the distributor and in two cases due to internal control mechanisms on the part of the manufacturer. Three cases were subject to media disclosure. Given the incidences of recall and the general ambiguity of cue and response, how formal are the recall procedures?.

Formalised Recall Procedures

The senior staff of nine firms claimed to have recall procedures documented as part of standing operating procedures. ISO accreditation requires such procedures so one firm has developed procedures on their own volition. Four other firms claim to have "publicised" procedures of varying sorts but not as part of a documented manual of procedures. Thus 13 out of 20 firms have some sort of formalised recall procedure. Only one of these firms claims to have developed these procedures based on past experience suggesting a high degree of preemptive planning. Seven firms, including all six small firms, have no formal recall procedures. Of these seven, three have either recalled product or stopped product before distribution. It also suggests that as firms become larger and more formalised so do recall procedures.

The motivation for introducing recall SOP's varies and is shown in table 4. - the over-count results from double declarations. Not all firms supply to supermarkets but all firms felt a compulsion to withdraw product "without question" if required to do so by the distributor. I got the distinct impression however that this feeling of compulsion was derived from the potential denial of a distribution outlet than to any intrinsic concern for the health of the public. A number of firms expressed irritation at "having" to recall products that were damaged due to poor handling once outside the factory door.

Motivation	Quantity
ISO requirements	9
Supermarket requirements	15
Good management practice	2

Table 4. Motivation for Recall.

Conclusion

This presentation asked the question "Do food & beverage manufacturers plan for product recall". The investigation showed that the food manufactures surveyed prefer to *plan* to produce a safe and consistent product as evidenced by the number with HACCP based safety programmes and or ISO accreditation. Within this framework, a large percentage have formalised plans dealing with recall of non-conforming product. Many claim to have developed these plans without the benefit of hindsight. These formalised procedures appear to be motivated by either ISO requirements, firm size or

both. It is difficult to tell which came first. In any event supermarkets insist their suppliers withdraw defective products.

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