Implementing Sustainable Agriculture

Perceptions of Hill-Country Farmers in the Rangitikei District

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"All there is to thinking, is seeing something noticeable which makes you see something you weren't noticing which makes you see something that isn't even visible."

Norman Maclean
'A River Runs Through It'

Abstract

This thesis investigates the perceptions concerning the implementation of sustainable agriculture in hill-country farming in New Zealand, primarily by using a survey of farmers from the Rangitikei District.

A literature review identified three main groupings of approaches to sustainable agriculture: a production or economic based approach; a stewardship and intergenerational equity approach; and a social approach which emphasised social equity and rural community issues. It also stressed the importance of scale issues in sustainable agriculture with the analysis focussing on horizontal, vertical and temporal scales.

It appears that the 'ideals' of sustainable agriculture as outlined in the literature are not being translated into reality in New Zealand, and indeed the ideals of New Zealand farmers may not correspond to those presented in the literature. A conceptual framework was constructed to further investigate this issue of the gap between the ideal end-state of sustainable agriculture and the actual practices. A survey of 260 'conventional' farmers in the high-terraces and hill-country of the Rangitikei was selected to empirically test the conceptual framework. The viewpoints of these farmers were contrasted with those of: a small sample of certified organic farmers who ran similar land-uses on similar land-classes; and a sample of professional staff who were selected from the regional councils, central government, industry groups, a farmer organisation, a conservation organisation, scientists and academic staff. A 78 question survey ascertained farmers ideals with regard to sustainable agriculture, what they considered to be desirable sustainable farming practices; what they considered to be barriers to sustainable agriculture; and what implementation methods (eg. regulation, education, rates rebates) they considered to be acceptable. The actual farmers practices (eg. pesticide use, fertiliser use, agroforestry, erosion control) were also surveyed using a relative scale which measured change over the last five years.

The key findings of the sample survey were as follows. The overall preference for the 'hands-off' implementation methods, such as 'education' and 'further research' by all three groups. There was a lack of recognition of social characteristics of sustainable agriculture by the professional staff, compared to their acknowledgement of economic and environmental considerations. The practices undertaken by farmers had improved over the timeframe measured, although much of the change was for economic reasons as opposed to environmental considerations. The most commonly identified barriers by all the respondents were economic in nature.

The thesis concluded with a discussion of the policy implications of research findings. The most important policy implication discussed was whether the preferred methods for implementing sustainable agriculture (ie. 'education' and 'further research') could actually overcome the perceived barriers to achieving sustainable agriculture which were predominantly economic in nature. Some further suggestions were also made on further research directions; most notably that the factors identified in the conceptual framework need to be tested on a wider range of farm-types and other regions in New Zealand.

Acknowledgements

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I am also indebted to Farmlands Trading Company for providing the prize for the prize draw for the completed conventional farmer responses to the survey, which would have increased the response rate from this sample group, and allowed for greater analysis.

A sincere vote of thanks also goes to the various people who offered ideas and opinion, and provided a foil to run ideas past on potential reasons for the survey results. The different perspectives on agricultural sustainability issues that they brought to the discussion in the thesis was very useful.

To the farmers and staff from various organisations who completed the survey responses I am very grateful, for without whose effort there would have been no results to analyse within this thesis. The time these people took to write responses and their thoughtful answers provided, and comments offered, were varied and very interesting, and also highlighted the breadth of opinions held about the issue of agricultural sustainability.

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Glossary of Abbreviations

The following are the abbreviations used commonly throughout this thesis, along with their meaning in full.

BDGFA	-	Biodynamic Gardening and Farming Association
CRI	-	Crown Research Institute
ICRAF	-	International Centre for Research in Agroforestry
IFOAM	-	International Federation of Organic Agriculture Movements
IUCN	-	The World Conservation Union
LISA	-	Low-Input Sustainable Agriculture
MAF	-	Ministry of Agriculture and Fisheries
MfE	-	Ministry for the Environment
MUIED	-	Massey University Institute for Executive Development
NZBPCC	-	New Zealand Biological Producers and Consumers Council
NZFFA	-	New Zealand Farm Forestry Association
RMA	-	Resource Management Act 1991
SCGSLMR	-	Strategic Consultative Group on Sustainable Land Management Research
USDA	-	United States Department of Agriculture
WCED	-	World Commission on Environment and Development

Chapter One
Introduction

1.1 - Setting the Scene

The sustainability of the New Zealand agricultural system is important for a number of reasons. The contribution agriculture makes to the New Zealand economy continues to be very significant. Processed and unprocessed agricultural products comprise about 60% of nations export earnings in 1993 (MAF 1993a; Harding McPhail 1995). The direct contribution by the agricultural sector to GDP according to MAF (1995), was $5,153 billion in 1993/1994. Sustained production of agricultural produce is therefore important for the New Zealand economy, and the livelihoods of the rural community, that rely directly, or indirectly on the financial returns from agriculture.

The introduction of the Resource Management Act 1991 (RMA) also gives greater emphasis to the issue of sustainable agriculture, as agriculture critically depends on large amounts of inputs. The purpose of the RMA is the "sustainable management of natural and physical resources" (RMA 1991, p 21) and the resource use undertaken by agriculture must abide by this legislative requirement. The RMA offers a legislative framework to address the sustainability issues facing agriculture. The consideration of the needs of future generations is part of the definition of the term "sustainable management" used in the purpose of the Act (RMA 1991, p 21). The ability of future generations to use the resource-base on which agriculture depends is given added importance from the legislation.

Social dimensions are also important in considering sustainable agriculture. On one hand it is claimed that food and fibre is essential to the survival of human society. Hence, it can be argued that the ecological sustainability of agro-food systems is a necessary to ensure the long-term survival or sustainability of social systems. Conversely, viable communities in rural areas are in turn essential for ensuring that agricultural production is ecologically sustained over the long run. For example, the rural community, in the form of the farmers, are the stewards of the land placed under agricultural production, and as the stewards, they sustainably manage the use of the land to avoid degradation of the productive resource-base, to ensure that future production is also possible

1.2 - Extent and Scale of Agriculture in New Zealand

Agriculture has been since the advent of pastoral agriculture last century, a major land use in the New Zealand landscape. New Zealand's total land area comprises 27,053,400 hectares (Department of Statistics 1992a), and of this, agriculture covers 17,450,469 hectares (Department of Statistics 1992b). The scale of agriculture as a land-use means that it requires the use of a large amount of natural and physical resources, namely soil, and water to a lesser degree, in terms of total stocks used. MAF (1993a & 1994b) state that agriculture must comply with the concept of sustainable management as specified in the Resource Management Act 1991. The scale of the land used for agriculture illustrates the potential size of environmental effects and degradation that can occur. Stinner & House (1989) state that agriculture is one of the most powerful anthropogenic forces shaping change of the landscape. The extent of agricultural land use over the landscape, makes the need to comply with the RMA, more pressing.

The scale of the economic investment in the agricultural sector is also very large, Umbers (1994) and Withall (1995) stated that $24 billion was invested in farms and processing facilities in New Zealand. The amount of capital invested in the agricultural sector illustrates the financial risk, if agricultural profitability is threatened by major changes to agriculture. Ensuring a sustainable agriculture therefore, is important for the economic wellbeing of the rural community and the nation. MAF (1995) puts the contribution to GDP by the agricultural sector at $5,153 billion in 1993/1994.

1.3 - History of Agriculture in New Zealand

McLaughlan (1981, p 52) stated that the original Maori who settled in New Zealand, "more than a thousand years ago, brought with them the kumara, the taro, gourd, yam and paper mulberry - and perhaps some others that could not endure the climate here at all." McLaughlan (1981) then elaborated, by stating that of these the kumara did well. The farming practised by the Maori was subsistence agriculture McLaughlan (1981) argued, with a limited range of species and limitations on tools and storage methods for food. The use of sand added to the soil, to make the soil conditions more porous and suitable for kumara, was evidence of the organised production of food by Maori according to McLaughlan (1981).

The first sheep in New Zealand, according to MAF (1974) were two Merino that Captain Cook brought to the Marlborough region in 1773. But it was not until the 1840s that sheep became firmly established in the high country of the South Island.

Stephens (1976) claims that between the 1840s and 1860s, most of the open country suitable for grazing in both the North, and South Islands, were occupied and stocked. Much of the North Island was cleared through the use of burning, by the 1880s, states Stephens (1976), with a wide range in pasture quality and production. The initial burning of the land provided some fertility for pasture growth, from the resulting ash according to MAF (1974), but this fertility declined with time.

The forest provided protection from the erosive capacity of rainfall and the water movement that occurs after rainfall according to Howard (1940), in his book 'Agricultural Testament.' This removal of the forest cover made the soil more vulnerable to erosion. The efficient cycling by the natural system as described by Howard (1940) under the forest needs to be supplemented with artificial fertilisers when the hill-country is placed under pasture.

Stephens (1976) stated that the use of mixed farming methods of British origin failed in New Zealand due to climatic and soil conditions, which lead to the adoption of growing grass as the primary objective of agriculture. Stephens (1976) expanded on this, by claiming that this change did not happen quickly, as it was after the First World War that the agricultural sector of the nation depended mainly on pastoral agriculture.

In the North Island hill-country where bush was cleared, Stephens (1976) claims that farmers faced a constant struggle against the reversion of the land back into fern and scrub. After the Second World War, the number of planes and pilots able to aerial topdress the hill-country increased, and thus the fertility of this land could be increased. This aerial topdressing, says MAF (1974) allowed the application of fertiliser on land that was previously impractical, due to the steepness of the terrain and economic costs.

MAF (1974) claimed that the first use of a refrigerated ship to allow exporting of sheepmeat from New Zealand occurred in May of 1882, and proved a turning point in the sheep industry. McLaughlan (1981) revealed that the ship was called the Dunedin. This opened up the trade of sheepmeat to countries like England, as the shelf-life of the meat was extended greatly, through the use of refrigeration. The prices that could be fetched for the meat abroad, was greater than the prices obtained within the domestic market of New Zealand. The population in England at this time was expanding claimed McLaughlan (1981), but the production of livestock there was static, so prices increased. The 4,908 carcasses on the ship fetched £4,000 according to McLaughlan (1981), which about twice the price in New Zealand.

The first cattle came to New Zealand with Samuel Marsden in 1814, according to McLaughlan (1981). The use of beef cattle, MAF (1974, p 113) state, "has long been important in New Zealand's stock-based economy, but very few farms carry them alone." Beef cattle, MAF (1974) state, were used, especially before the advent of aerial topdressing, to break in large areas of the hill-country and improve this land for the grazing of sheep. With beef prices recently giving better returns than sheep meat, the popularity of beef cattle in the farming community is high.

The hard economic conditions of the 1980s in New Zealand had a large impact on agriculture. The lower rates of fertiliser use in the New Zealand from the early 1980s, due to lower farm incomes, had according to Edmeades (1992), lead to 75 percent of hill-country farms having less than optimum soil fertility. This drop in soil fertility could then lead to decreases in pasture stability, due to the ingress of weeds and increased soil erosion. This is not biophysically sustainable, as the continued loss of soil fertility cannot be sustained. The economic sustainability of this trend is also questionable, as the returns to the farmer in production quality and quantity must be reduced. This illustrates the links between the economics of farming, in this case the reduced farm incomes, and the biophysical aspects, in this case lowered soil fertility (Section 2.3).

Stephens (1976) stated that the Farmers' Union was established at the beginning of the century, and was amalgamated with the Sheep Owners' Federation in 1944, to form Federated Farmers. The Federated Farmers have been the organisation representing the views and interests of farmers around the country.

1.4 - Hill-Country Agriculture in New Zealand

MAF (1974, p 57) state that the "lower hill-country farms are a very important section of sheep farming in both the North and South Islands. They are important because of the large area of land that they occupy and because of the stock they supply to the low-country fattening farms." The stock raised on the hill-country, to be sold to the fattening farms on the flatter land, highlights the interrelationships between the different parts of the agricultural sector (horizontal scale in Section 2.4.1). The sustainability of the hill-country agriculture, impacts on the fattening farms to which they supply.

The wet, western flanks of the main axial ranges of the North Island, to the dry eastern rain-shadow of these ranges, states Blaschke *et al.* (1992) a scientist for DSIR Land Resources, creates a steep rainfall gradient. The northern and eastern parts of the country are also exposed to moist, northerly airstreams, that are associated with tropical cyclones and complex depressions, which according to Blaschke *et al.* (1992), can cause high intensity or sustained rainfall. Both of these types of rainfall events can cause considerable erosion and associated soil loss. The wet winter and spring of 1992 in the Manawatu-Wanganui region, with rainfall averages 50-240 percent above normal according to Matthews (1994) caused widespread erosion. The continuous, prolonged rainfall caused waterlogging of the soils, which reduces soil strength and make erosion more likely. The damage to farms around the Manawatu-Wanganui region was put at $9 million by Matthews (1994).

In the New Zealand hill-country, Trustrum & Blaschke (1992) state that within individual farms there will be some areas that can remain sustainable under pastoral land use, given the correct management practices, and other areas that cannot. This element of site-specificity to sustainability issues, suggests that land-use needs to be tailored to land-type. Wedderburn (1992) listed a number of factors that caused site specific variation in pasture production in the hill country. Slope affects the amount of moisture in the soil, as only about 20 percent of actual rainfall, is effective in the soil for plants. Slope aspect also affects soil temperature, with north facing slopes being the warmest, which in turn increases pasture productivity. Animals also 'camp' on the flatter ground, and the nutrients returned to the soil in their excrement, is therefore localised, thus affecting nutrient cycling. The seasonal variations in temperature and rainfall, and other cycles, then affect these site specific occurrences. The net result, of this according to Wedderburn (1992), is high variability in pasture productivity in the hill country. This site specificity of productivity capability, affects the ability of the pastoral system to be sustainable in these areas. The places with high productivity due to low slopes, good aspect and efficient cycling of nutrients, are likely to be more sustainable for pastoral use than steeper areas, on south facing slopes, that animals graze, but do not 'camp' on. Dodds *et al*. (1992) noted that the affect of slope aspect on pasture production in the New Zealand hill-country was greatest in winter and early spring. Alternative uses for land not sustainable under pasture need to be found, such as forestry.

Molloy (1988) claimed that land-development subsidies often made the marginal land in the New Zealand hill-country appear more attractive for agricultural use, than it really was. Physical land degradation, by agriculture, according to Steel (1991, p 207), is "most evident in, although not exclusive to, ... the eroded hill country of Northern Hawkes Bay - Gisborne - East Cape." This could lead to a reduction in the potential production of the land over time caused by the degradation, but technological advances such as better fertilisers and management practices may mask this decline in potential production (Derose *pers com.*).

Since deforestation in the hill-country, the pastoral land cover replacing the forest, has been more prone to erosion, according to research in Taranaki by Landcare Research scientist Derose *et al*. (1993). The soil transformed under pasture has also been shallower than the soil that existed under the forest land cover. All the post-deforestation hill-slides that occurred, in the Taranaki study area of Derose *et al*. (1993), were on slopes with a mean slop angle greater than 28°. This steep land will require correct land uses and careful management practices, if the erosion and soil loss is to be minimised.

1.5 - Origins and History of Sustainable Agriculture

Rodale (1990b, p 273) stated that the "issue of the sustainability of agriculture has been current for well over a century." This may be true within the scope of some research by authors such as Dana (1842) and King (1911), but the term has not had the wide recognition by the scientific community, political community and society in general, until very recently. Rodale (1990b) claims this early research, such as Dana (1842), related to the care of the soil and reduction in the use of chemical fertilisers. The early researchers such as Dana (1842) therefore had part of the concept of sustainability, but it was in many ways an early form of Low-Input Sustainable Agriculture (LISA). It merely considered inputs and minimisation of capital investment in these inputs. It did not consider the wide range of environmental and social effects of agriculture, that inhibit the implementation of sustainable agriculture (the three approaches of environmental, social and economic are outlined in Section 2.2).

Many early agricultural sustainability concepts were derived from King (1911) in 'Farmers of Forty Centuries' and Howard (1940) in 'Agricultural Testament.' King (1911) studied the paddy field agriculture of China and Japan, and concluded from the shear length of time this land had been cultivated, without apparent land degradation, some sort of sustainable system was implemented. Howard (1940) studied the loss in soil fertility in the western world since the Industrial Revolution, due to agricultural production. He compared the natural soil of a forest ecosystem to the modified soil under a human altered pastoral ecosystem. Rodale (1990a; 1990b) believes that Howard is generally credited as being the founding father of the organic agricultural movement. Organic agriculture according to MAF (1994b), has become one agricultural approach creating trends in the direction towards sustainability.

The concept of sustainability according to Weil (1990, p 129), should "integrate the economic, social, and environmental dimensions of agriculture ..." as "...recognition of the fact that all these aspects are interconnected." The rise in political and scientific interest in sustainable agriculture, with attention to the social and economic issues, along with the biophysical issues, has been a very recent occurrence. The farmers and people living in rural support towns need the income that agriculture provides. The social infrastructure in rural areas is dependent on the population employed in the farms and support services. Any notions of sustainable or alternative agriculture, according to Buttel (1993, p 175), were dismissed by the world's scientific community as "ideological, unscientific, utopian, too costly, or inconsistent with a productive agriculture." Increases in popularity of organic agriculture, by producers and consumers alike, in countries like New Zealand and the Netherlands according to Senanayake (1991), proves this incorrect. There has, however, been strong scientific support and research into soil and water conservation, which Kirschenmann (1991) argues are time-tested components of a sustainable system.

'he energy shortages of the 1970s, claims Harwood (1990, p 11) "shook our .onsciousness" about the limitations of the resources required for agriculture. ˏockeretz *et al.* (1981) stated that virtually all fertiliser and pesticide inputs in agriculture, require considerable amounts of fossil fuel in their manufacture.The reliance of fossil fuels for energy in agricultural systems, created instability in agriculture, when the supply and prices of these fossil fuels were volatile. The natural resources used in agriculture before this time did not appear at risk Brady (1990) asserted, and the idea of natural resource conservation was not high on the political agenda. These resource input scarcity and price volatility issues gave rise, argues Brady (1990), to economic pressures for practices such as minimum tillage of the soil. The economic pressure on the farmers forced the political pressure to generate research to minimise inputs. The minimisation of the use of a tractor to till the soil, resulted in savings in the cost of inputs, such as fossil fuel.

The 1980s in the United States also brought about another occurrence that shaped the direction of sustainable agriculture, the farm crisis. The farm crisis involved droughts and a high bankruptcy rates amongst farmers, which, according to Buttel (1993), created a need to minimise economic inputs. This would lead to a lowering of the capital investment requirements of farmers and farm debts. Again, economic pressures on farmers caused impetus to develop the sustainable (economically) technologies, that would relieve the economic stress and indebtedness that farmers faced.

The pressures created by the farm-crisis of the 1980s and the oil shocks of the 1970s, Madden & O'Connell (1990, p 61) state, increased the need for a "more cost-effective and environmentally benign agriculture." The growth in farmer interest in sustainable agriculture in the United States, argues Buttel (1993, p 178), contributed to a "growing pressure for more research." Therefore, the main thrust of research by the United States Department of Agriculture has been into Low-Input Sustainable Agriculture (LISA) and this is discussed in Chapter 3. The political pressure for minimising inputs due to the occurrences of the oil and farm crises, led to the need for scientific research.

Buttel (1993) stated that the growth of the worldwide environmental movement during the 1970s and 1980s accelerated the attention to the environmental impact of human activities, such as agriculture. The subsequent increase in public awareness, leading to political pressure, caused heightened expectations of agriculture by the general public, regarding environmental issues.

The preparation of the Brundtland Report by the World Commission on Environment and Development (WCED) (1987), gave the agricultural sustainability another push. Buttel (1993) claimed that there were a number of agricultural research policy reformers in the advisory panels and authors for the WCED, such as Robert

Chambers, Calestous Juma and Lester Brown. The Brundtland Report according to Buttel (1993, p 179), was "particularly influential in conceptualizing environmental degradation as an impediment to agricultural and overall economic growth." The links between agricultural production and the degradation it causes, threatening future agriculture are again emphasised.

Much of the recent attention of agricultural sustainability, has been fuelled by human health considerations according to Buttel (1993), as opposed to the ecological problems facing agriculture. Issues such as nitrate levels in ground- and surface-water, pesticides in water supplies and off-target applications of the pesticides, were raised by Francis (1990b) as receiving greater awareness amongst society. The human-health issues are are an important social component in agricultural sustainability, but cannot become the sole driving force in the agricultural sustainability debate, otherwise the resulting definition and implementation will be anthropocentric in nature.

These human issues have lead to an increase in the consumption of organic produce. Blakeley (1990b, p 11) claims that in "North America and Europe, green consumers are pushing environmentalism from its traditional niche in health-food stores and co-ops into mainstream supermarkets." Whether or not the current surge in 'green' consumerism will continue is a question often asked. Blakeley (1990a, p 8) stated that some marketing consultants suggest "that most of the baby-boom generation now have families; [and] they are said to have developed a new sense of social responsibility." This type of consumer lead demand, has flowed on to increases in organic agricultural production, which is one form of sustainable agriculture (MAF 1994b). Mason (1994), an organic farmer addressing the 1994 New Zealand Planning Institute Conference, stated that organic farming was not a fad. Although there is some self-interest in this statement, as he is an organic farmer, his knowledge of the durability and stability of the organic produce markets would have some validity. The generation of a Policy Position Paper by MAF (1994b) on 'Organic Agriculture' would indicate that the approach, and demand for the organic produce, will continue into the foreseeable future.

Crosson & Ostrov (1990) propose, there is a need to pay more attention to the development of alternative agriculture than has occurred in the past. The validity of these alternative approaches has been greatly questioned in the past, and need greater acceptance to become more widespread in their application. The Ministry of Agriculture and Fisheries position paper on Organic Agriculture (MAF 1994b), is an important recognition of the role it plays in the New Zealand agricultural sector.

Environmental trade barriers may be erected to exclude New Zealand agricultural trade, according to Pinnel (1994), the then Senior Vice President of Waikato Federated Farmers. This issue is reiterated by Sinner *et al.* (1993), with their statement of environmental standards often being used by a nation for trade protectionist purposes. MAF (1994a, p 9) claim that these environmental protection measures "can be distorted into trade barriers." MAF (1994a) conclude that the next round of trade negotiations will be centred on the environment, and any pressures placed on agriculture regarding the environment, will get stronger. This increasing world political pressure on agriculture, whether for environmental or protectionist purposes, creates the need for New Zealand to assess the sustainability of agricultural production. If this is not done, and agricultural production for the foreign markets is jeopardised, leading to lower earnings from agriculture.

1.6 - Sustainable Agriculture in New Zealand

In response to the concept of sustainable management and pressures applied from the introduction of the RMA 1991, an increase in research on sustainable agricultural approaches and technologies has occurred. New Zealand has a long tradition in research regarding soil and water conservation issues, and Schaller (1993) commented that these two practices are time-tested components of a sustainable system. Although, the rate of implementation of soil conservation efforts in the New Zealand hill-country is not satisfactory from the view of biophysical sustainability. (Derose *pers com.*) A longer-term view and decision-making timetable by farmers is required if sustainable agricultural practices, such as soil conservation, are to be effective. The effects of inappropriate land use in the hill-country, such as soil erosion, are according to Luckman (1994), a visible indicator that current agricultural practices are not sustainable.

The increase in public concern regarding environmental quality issues for agriculture according to Lowrance (1990), has not translated into changes in farm practices. Lowrance (1990) then expanded this by noting that agriculture had achieved a special status as viewed by society, as it was the only industry that provides the food we eat. This according to Warley (1990) enabled an extraordinary amount of support to be given to agriculture in the past. Horesh (1995) states that agriculture in New Zealand was given special status by urbanites, as farmers reflect the national culture. This reflection of the colonial and pioneering spirit of New Zealand disguises the fact that, according to Horesh (1995), the growing of food was now a purely commercial activity, like any other business. However, this romantic view of rural life, by those outside the rural community in the past, had lead to sustainability issues relating to agriculture remaining unquestioned. Buttel (1993) stated that attention paid to agriculture by society, regarding environmental issues has slowly, but surely, accelerated during the 1970s and 1980s. This attention needs to be translated into action to design and implement sustainable agricultural systems.

The Ministry of Agriculture and Fisheries responded to the need for sustainable agriculture, to undertake the sustainable management of resources used by agriculture, which is required under the RMA 1991. Agriculture, like any other sector of the economy using resources, is required to fulfil its legal responsibilities under the RMA. The Ministry drafted the policy proposal for "Sustainable Agriculture' in 1991, entitled Policy Position Paper 106 (MAF 1991a). In March of 1993 this paper was published by MAF (1993a) with consideration to the public submissions (a synopsis of these was published in MAF 1993b) on paper 106.

In September of 1991, the Ministry of Agriculture and Fisheries published a paper on 'A Proposed Policy on Organic Agriculture' (MAF 1991b). In June 1994 the 'Organic Agriculture Position Paper' (MAF 1994b) was released, which considered the public submissions on the original proposed policy, which were in turn summarised in MAF (1992a). The production of the policy paper shows the growing importance of organic farming in the New Zealand agriculture sector, albeit a small niche market. The premium prices fetched for organic produce in markets like Europe, show its importance. The Associate-Minister for Agriculture, Dennis Marshall stated in the press release of the position paper (MAF 1994c), that "organic farming can contribute to achieving more sustainable agriculture by improving environmental outcomes and increasing export opportunities."

At a field day held in Makahu, in the Taranaki hill-country, on sustainable land management issues, Trustrum & Blaschke (1992) stated that farmers were receptive to the concept that some areas were unsustainable for pastoral use. The authors also claimed the farmers recognised the links between soil erosion and farm productivity decline. The farmers also took on board the fact that some areas may have to be placed under forestry to be sustainable. The recognition of sustainability issues by the farmers is very encouraging for the achievement of sustainable agriculture. This recognition also extends to Federated Farmers, the organisation that represents the interest and views of New Zealand farmers. Jennings (1990), the past president noted that some of the past management practices in the New Zealand hill-country have been less than adequate, and require some alteration. This political acknowledgement of sustainability issues in agriculture is a very important initial step, as recognition and ownership of the problem, is essential to the implementation of sustainable agriculture.

In some erosion prone areas, Campbell (1992) from the Waikato Regional Council, considers that farmers may have to accept growing the most suitable vegetation, trees. The use of forestry by farmers in areas that are erosion prone and unsustainable under pastoral use raises one large problem. According to Trustrum & Blaschke (1992), the long-term financial commitment in forestry, in terms of the economic returns hinders the planting of trees, as few hill-country farmers have the initial capital investment required. McLaughlan (1981) stated that the back country farmers, are the most conservative and determinedly unregimented of New Zealand's farmers. This conservatism and resistance to change is one major impediment to alterations in land use or management practices required for the implementation of sustainable agriculture, such as increased use of forestry within pastoral farms.

In New Zealand there is now an increasing motivation amongst some of the rural community to deal with land and agricultural sustainability issues. Buttel (1993, p 178) maintained that a growth in interest in sustainable agriculture by farmers, has contributed to a "growing pressure for more research." In response to this need for information, in a format easily understood by farmers, Federated Farmers of New Zealand are preparing a resource kit on sustainable agriculture. The increase in popularity of the Land Care approach from Australia, where the local rural community tackle land management and agricultural problems is leading to it's greater application in New Zealand. The cooperative approaches, like Land Care, are being applied in Hawkes Bay and in the form of the Rabbit and Land Management Programme in Central Otago, involving close work between the scientific and council staff, and farmers. MAF (1991), Keeney (1993), and Campbell & Junor (1992) state that cooperation between the scientific staff, with their research knowledge and the farmers, with practical and anecdotal knowledge, is very important for achieving sustainable agriculture. This increase in cooperation between farmers and professional staff, highlights the increasing commitment to sustainability by all involved in the agricultural sector. Swaminathan (1991) argues that social organisation, in the form of cooperative approaches like Land Care, are as important as technical innovation, in the achievement of sustainable agriculture.

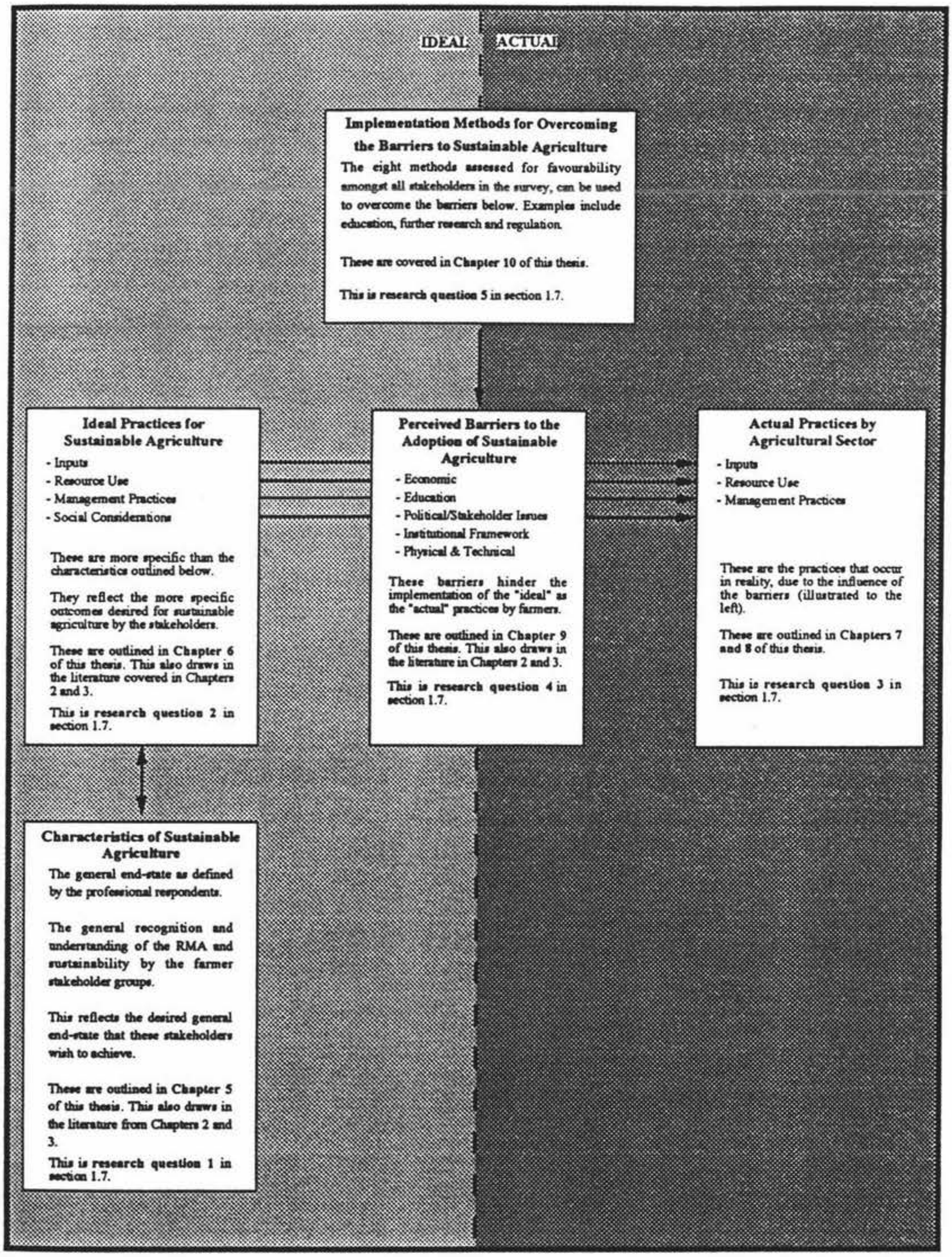
1.7 - Research Objective and Questions

The characteristics and considerations of sustainable agriculture according to the various authors studied in the literature review are outlined in Chapters 2 and 3. These reflect the "ideal" situation as seen by the authors. It appears these ideals are not being translated into reality in the agricultural sector of New Zealand, which leads to the main research objective of this thesis.

> **To determine the main barriers and constraints to the implementation of sustainable agriculture.**

The outcome to this seemingly simple research objective is contingent on the answers to a number of other questions, which are also the focus of the thesis (refer to Figure 1.1). Firstly, the word 'barrier' implies that there is some gap between what is actually being achieved versus what is ideally desirable. Hence, the first two research questions focussed on what are the perceived ideal characteristics and practices of sustainable agriculture.

FIGURE 1.1 - Interrelationships between different chapters of the thesis and research questions.



1 **What are the ideal characteristics of sustainable agriculture?**

The answer to this question will be informed by the literature and the professional staff respondents to the sample survey (the sample group used is outlined after these research questions). The characteristics from these respondents can be compared to those found in the literature covered in Chapters 2 and 3, and commonalities and differences discussed. This research question is shown in the lower-left of Figure 1.1.

2 **What are the desired practices for sustainable agriculture?**

The literature covered in Chapters 2 and 3 was used to construct 20 questions that related to reoccurring themes regarding various issues (the literature used to derive the individual questions is shown in Table 4.3). The questions covered issues relating to inputs, resource use, management practices and social considerations. These responses to these questions came from the samples of conventional farmers, organic farmers and professional staff. This is shown in central-left of Figure 1.1.

The next part of the thesis focussed on the actual practices of agriculture (in the sample survey areas), and analysed how these depart from the previously discussed ideal state of sustainable agriculture.

3 **What are the key features of the actual practices of agriculture and how have they changed over the last five years?**

The sample survey areas for the question are discussed after the research questions are outlined. The practices were queried under three major groupings: inputs; resource use; and management practices. This research question is shown in the central-right of Figure 1.1.

The next part of the thesis covers the difference, if any, between the 'ideal' and 'actual' practices. The perceived barriers that are potentially causing this gap between the desirable end-state and actual end-state are queried.

4 **Why has the 'ideal' of sustainable agriculture not being fully achieved in the sample survey? What are the perceived barriers to the adoption of sustainable agriculture?**

The professional staff, conventional farmer and organic farmer respondents were all queried on the barriers they perceived hindered the implementation of sustainable agriculture. These perceived barriers were compared to the barriers and other issues mentioned in the literature on sustainable agriculture. This research question is shown in the centre of Figure 1.1.

Finally, the thesis then focussed on what policy and planning mechanisms could be used to overcome some of the identified barriers. Hence, the following question can be addressed by primarily drawing on the results of the sample survey.

5 **What are the key implementation methods that could be used to address sustainable agriculture? How popular are these methods amongst landowners and professional staff and which are the most likely to be successful?**

The sample survey queried all the respondents on eight general methods, with the literature that covered the methods shown in Table 10.1. The favourability of the methods by the conventional farmers, organic farmers and professional staff was examined. The approval of the methods affects the resistance towards the use of the methods, and in turn will govern their overall effectiveness. This is shown in the upper-centre of Figure 1.1.

The answers to the research questions were obtained in part relying on a literature review (Chapters 2 and 3) and by depending on a sample survey. This sample survey involved a sample of 260 farmers from the high terraces and hill-country in the Rangitikei District. It also included a small sample of organic farmers, on similar land types, around the country. The professional sample came from council staff, government agencies, industry groups and some lobby groups. These staff were termed the 'professional staff' and covered a wide range, of affected groups. The viewpoints of the conventional farmers were contrasted against the organic farmers and the professional staff. The actual practices undertaken by the conventional farmers, measured on a relative scale, were contrasted against the actual practices of the organic farmers. The methodology, rationale and responses to the survey are outlined in greater detail in Chapter 4.

The stakeholders surveyed chosen have direct managerial control over agriculture, such as farmers/land managers and regional council staff. The sample also included central government and industry groups, who provide advice and research on issues affecting the agricultural sector. The survey did not include all potential stakeholders that may be influenced by rural land-use, such as recreational groups, as the relative level of knowledge they have about sustainable agriculture is lower, and they have no direct effect on land management decisions, as is the case with the land-owners. The wider stakeholder groups could be included in a future study, but in order to keep the sample manageable, they were not used in this research.

1.8 - Thesis Outline

The following chapter, Chapter 2, covers some problems associated with defining sustainable agriculture, along with the three schools of sustainability proposed by Douglass (1984), the objectives of sustainable agriculture proposed by Lowrance (1990), scale issues in agricultural sustainability and a definition chosen from literature that best covers the issues discussed in the chapter.

Chapter 3 covers some of the approaches undertaken towards increasing agricultural sustainability, such as organic agriculture, Low-Input Sustainable Agriculture (LISA) and agroecology. The chapter covers some of the different aspects of these various approaches.

The latter part of the thesis is concerned with the survey of the stakeholders in the sustainable agriculture debate, and the analysis of the results obtained. The relationships between the material within the chapters numbered 5, 6, 7, 8, 9 and 10 are illustrated in Figure 1.1.

Chapter 4 outlines the survey design and methodology. It discusses the survey, and how and who was surveyed. The demographic details of the resulting respondents are also covered in this chapter.

Chapter 5 covers the analysis of the introductory part of the professional staff survey which queries the characteristics of sustainable agriculture as they perceive them. In the case of the farmer respondents, this chapter covers the recognition and understanding of the RMA 1991 and its purpose, along with the term sustainability. This is shown in the lower-left of Figure 1.1.

Chapter 6 covers the responses from all stakeholders to the 20 attitudes questions about various issues covered in the literature on sustainable agriculture. The variations in responses are discussed and some possible explanations are offered. This is shown in the central-left of Figure 1.1.

Chapters 7 and 8 examines the actual practices that the conventional and organic farmers have undertaken in the last five years. The first of these two chapters covers the inputs and resource use practices. The second chapter covers the management practices undertaken. Analysis and possible explanations for the differences that exist in the degree of change in these practices are postulated. These are shown in the central-right of Figure 1.1.

Chapter 9 discusses the perceived barriers to sustainable agriculture that the respondents identified. The barriers are grouped into five general topics, and the barriers that are frequently mentioned by the respondents are discussed. This is shown in the centre of Figure 1.1.

Chapter 10 studies the favourability of the eight implementation methods by all the respondents. The methods covered are pollution charges, subsidies/taxes, grants, income tax rebates, rates rebates, regulation, education and further research. This is shown in the upper-centre of Figure 1.1.

The final chapter, Chapter 11, draws in the main conclusions from the survey analysis in the previous chapters, and implications for policy regarding the development and implementation of sustainable agriculture. The possible future research arising from the conclusions are also covered.

1.9 - Sustainable agriculture versus sustainable land management

The use of the term agriculture in this thesis does not imply strictly agriculture *per se*. The term sustainable agriculture is used in the majority of the literature reviewed for the thesis, and is correspondingly used in the thesis. But in many cases in the literature, the term does does not cover just agriculture, but also forestry, agroforestry and sometimes reversion back to scrub. This in effect is land-use, but keeping with the literature, the term sustainable agriculture is used.

Some of the different land use types that are proposed under sustainable agriculture, such as agroforestry, defy some of these categories. Is agroforestry classed as agriculture or silviculture? At what density of planting in relation to pasture use, does agroforestry become silviculture from agriculture? The issue is more one of appropriateness of land use. Therefore the term 'sustainable agriculture' has been used throughout the thesis, when in many cases it refers to the more all-encompassing term 'sustainable land management.'

1.10 - Limitations of the research

This research was based primarily on surveying the perceptions of 260 'conventional' farmers in the Rangitikei District, as well as smaller samples of organic farmers and professional staff. It is important to recognise the limitations of the research approach and be cautious about extrapolating the results from this sample survey.

Firstly, the research involved conventional farmers in only one area of New Zealand. The results and attitudes from these farmers may not be indicative of the views of different farmers elsewhere in the country. There may be peculiarities among the farmers in the Rangitikei area, that arise due to location or farming history in that area. The relatively close geographical proximity to Massey University may lead to an increased proportion of farmers with university qualifications, or have taken single papers in subjects pertinent to farming. The agricultural research generated by Massey University may filter into the farmers in the Rangitikei area through articles in the farming section of the newspaper, or from the actual research undertaken if this involves working on farms in the area. The example of Massey University is just one example of an influence that may affect the responses by the farmers in this survey, and they may be more aware about some issues than farmers elsewhere in the country. Therefore, the results of the survey can not be applied to farmers in the high-terraces and hill-country in other parts of the country.

Secondly, the response rate of nearly 60% indicates that 40% of the sample did not respond. Mayer & Pratt (1966) stated that few of published research results have a response rate that exceed 50%, and the often low response rates may lead to bias that are introduced due to the differences between respondents and non-respondents. A lower probability of response exists for persons in a sample who: are elderly; non-white in ethnicity; are male; are from lower socioeconomic groups; may feel that they may be judged on their responses; or feel that they will provide inadequate responses to the survey (Hoinville & Jowell 1978; Britton & Britton 1951; Edgerton 1947; El-Badry 1958; Kemsley & Nicholson 1960; Mayer & Pratt 1966; Scott 1961; de Vaus 1990, 1995). The non-respondents to the survey in this thesis may have created a bias in the response, say, towards the better educated respondents.

The analysis in Appendix C illustrates that the majority of the conventional farmers hold secondary school level qualifications. Of the conventional farmer respondents (Figure C.6), the percentages for the highest level of qualification held were, 4% for Fourth Form, 23% for School Certificate, 15% for Sixth Form, 20% for University Entrance and 23% for an Under-graduate Diploma. Harding McPhail (1995, p 199) stated that "almost half (49%) of the males living in rural areas have no school qualifications compared to only 9% of rural females" which indicates that the sample may have better educated respondents than the average males in rural areas. The Harding McPhail (1995) quoted figure does not differentiate between the exact occupation of the males, as the farmers may have different patterns of education held, compared to the males in rural areas on the whole.

The bias in the sample in terms of better educated respondents in covered in Table 4.1, and the potential for education held by the respondents to hinder their ability to answer the survey was considered in the initial design stage. The survey was tested on experts with some knowledge of farmers and the rural sector, and the question wording was chosen for ease of understanding, to lessen the potential for bias due to the level of education held. The non-respondents may be the farmers who are more opposed to the idea of agricultural sustainability, and the sample of respondents is bias towards the farmers more in favour with the concept. Wilson (1992) in a survey of farmers attitudes towards indigenous forest areas in the Catlins area of the South Island, stated that non-respondents were involved in past forest clearing and they have been threatened by the question topics. Donald (1960) and Riley (1963) claimed that respondents who are interested in the survey topic are more likely to respond. In the case of the survey in this thesis, the farmers who are more interested about the topic of agricultural sustainability may be more likely to reply. Conversely, those farmers that are not enthusiastic about the concept of agricultural sustainability may be more likely to put the survey in the rubbish bin, rather than complete it, and subsequently return it. Schwirian & Blaine (1966) also stated that people that are more sympathetic to the topic tend to respond better.

Thirdly, the survey relies on self-reporting. This can create a 'halo effect' (Kidder 1981) with the respondents providing answers that they perceive to be true, but in fact may not be. The actual practices undertaken by the farmers rely on self-reporting as no statistical records exist for the types of practices (such as increases in fertiliser management or soil conservation works) and the self-reported values from the farmers can not be validated. The use of relative scale for the change in the level of these practices undertaken on the farms depends on the perceptions of the farmers themselves as to what degree they think these practices changed. One farmer, for example, could consider a level of change in a particular practice to be 'significantly increased,' whereas another farmer could consider the very same level of change in that practice to be merely 'increased.' The changes in the practices are simply relative, and give an overall indication of the change, not exact amounts of change.There is no better method for determining the change in practices, as often the farmers are the only people that know the changes that have occurred. The problems arise with their perceptions regarding the scale of change that occurred.

Fourthly, the suggested explanations of the results from the survey were generated from literature readings, personal opinion and discussion with staff from various organisations. To offer more complete and exact explanations regarding the motivations for the different groups responding to various questions requires further, more qualitative, research. Qualitative research Bryman (1988) argues, extends beyond description, to analysis. The qualitative approach allows for more 'deep' and 'rich' data compared to quantitative approaches Bryman (1988) maintained, and the term 'rich' related to the detail in the data possible with qualitative approaches. This qualitative approach could take the form of discussion or focus groups, whose participants cover the stakeholders included in the survey within this thesis. These focus groups could offer more qualitative information on the reasons why particular answers were offered.

Babbie (1975) stated that personal interviews cover complex issues (such as motivations for question responses) more adequately than a mail questionnaire. Layder (1993) claimed that qualitative approaches can be used to fill gaps in existing knowledge or confirming previous research or findings. In the case of this survey, the aim is to fill in the gaps in the knowledge, which are the motivations for the attitudinal answers given and actual practices changed. The focus groups would use a semi-structured approach to address a set of identified issues, such as why the responses occurred, and gain more detail about these issues. The focus group approach would use a less structured approach than the written questionnaire offers.

Chapter Two
Definitions of Sustainable Agriculture

2.1 - Problems in defining 'sustainable agriculture'

The term sustainability was labelled an "absent referent" by Dialogue Consultants Ltd (1992). If definitions are given, Dialogue Consultants Ltd (1992, p 9) state, that these definitions can be "so general as to be extremely vague, or are approached indirectly by way of examples." The brief definitions given can offer very little to aid the deduction of the precise meaning implied. Some of the definitions from the literature are included in Appendix A, and a few of these suffer from the generality point made by Dialogue Consultants Ltd (1992). The lack of detail adds little to their usefulness.

Dialogue Consultants Ltd (1992, p 10) went further to state that, as "an absent referent, sustainability is loaded with symbolic and emotional portent." This symbolic and emotional dimension to the term and it's use makes definition difficult, as the section on social approaches to defining agricultural sustainability illustrates (Section 2.2.3).

Plucknett (1990, p 36) asserts that sustainability "involves the complex interactions of biological, physical and socioeconomic factors and requires a comprehensive approach to research in order to improve existing systems and develop new ones that are more sustainable." MAF (1991a, p 3) stressed the need to integrate economic, social and environmental values into decision-making processes, because under a "policy framework for sustainable management, single purpose decisions are not acceptable." Due to the social and economic components of the term 'sustainable agriculture' as claimed by Plucknett (1990) and MAF (1991a), there will be value judgments regarding the extent and detail of these components in the resulting balance. Therefore the term 'sustainable agriculture' is value laden by default, as it reflects society's aspirations, in terms of economic and social considerations.

For this reason the definitions offered in the literature can be value-laden. Harwood (1990) by his own admission, offers a value laden definition, which he also claims is generic in nature (see Appendix A). Agricultural 'sustainability' is not simply a set of scientifically defined ends, although the ecological component may be defined in this manner. The economic and other social considerations move the 'sustainable' state away from the purely ecologically sustainable state, and Lefroy & Hobbs (1992) claim that a transitional state may be required as farmers to move towards a more sustainable agriculture. Any such definition must imply a balance between all the considerations involved in achieving agricultural sustainability, such as ecological, economic and social.

The concept of agricultural sustainability, asserts Schaller (1993, p 89), "does not lend itself to precise definition, partly because it implies a way of thinking as well as of using farming practices, and because the latter cannot be specified as final answers." Thus, sustainable agriculture is both a means and an end-state, and both characteristics do not lend themselves to precise definition according to Schaller (1993), which gives rise to problems. The generality of the term, and the breadth of it, as both means and end-state, makes definition difficult, as many types of agriculture proposed as 'sustainable' vary widely in approach (see Chapter 3), while aiming for the same end-state (sustainability). Whilst this can often explain why the definitions for the term are vague, it does not provide any justification for having vague and general definitions for sustainable agriculture.

The 'site-specificity' problem associated with sustainable agriculture is a major hurdle that must be addressed. Sustainable agricultural practices cannot according to Schaller (1993, p 91) be defined easily, "simply because no one can ever know precisely and finally which farming practices may be the most sustainable in every location and circumstance." The issues will need to be looked at farm-by-farm and catchment-by-catchment, in order to achieve sustainability. Stenholm & Waggoner (1990, p 14) stated that sustainable agriculture was not simply "a set of best management practices or simply a reduction in the use of agrichemicals. It is site-specific, management-intensive, and resource conserving." This site-specificity problem makes the development of precise indicators very difficult. The definition of sustainable agricultural practices, with consideration regarding what is sustainable at each site, will require great flexibility. This point was also noted by Pimental *et al.* (1989) and Edwards *et al.* (1993). Parr *et al.* (1992) discussed the difficulties in developing soil quality indicators due to variations in site-specific conditions.

Weil (1990, p 127) also alluded to the 'site-specificity' problem when he stated that because "agriculture involves site and situation specific processes, it is probably not possible to define sustainable agriculture in terms of specific practices." Problems arise, as the practices that may be sustainable at one site, may be totally unsustainable at another, due to the differing social, economic and environmental conditions. The end-result is that the requirements of 'sustainable agriculture' at one field or paddock, may differ greatly from a field in the adjoining farm, or even between fields within the same farm, due to the site-specific soil or slope considerations.

Schaller (1993, p 89-90) claimed that however it was defined, "a sustainable agriculture is generally regarded as an alternative to modern industrialised, or conventional agriculture, an agriculture described as highly specialised and capital intensive, heavily dependent upon synthetic chemicals and other off-farm inputs."

Thus, regardless of the detail in the definitions of 'sustainable agriculture', the main premise is its removal from conventional agriculture and any unsustainable practices, such as high-inputs (often non-renewable) and environmental effects (soil degradation). Although this creates another problem, as Keeney (1993, 806) claimed that the term 'conventional agriculture' can also be very difficult to define, due to the variation in practices used in modern agriculture. Knorr & Watkins (1984, p x) did define 'conventional agriculture' as "Capital-intensive, large-scale, highly mechanical agriculture with monocultures of crops and extensive use of artificial fertilisers, herbicides and pesticides, with intensive animal husbandry." This definition has some flexibility in the description of present, conventional farming, given the wide variation in land uses and practices implemented under the 'conventional agriculture' to cater for the Keeney (1993) argument.

From a biophysical, or thermodynamic, perspective, the achievement of agricultural sustainability is questionable, as the farm represents an open system. If the removal of mass in the produce, whether in the form of animals or vegetation, represents a loss from the system. As the energy requirements for present agricultural practices exceed the level at which solar energy inputs can satisfy, then the loss must be supplemented, often through the use of fossil-fuel derived inputs. The fossil fuels are used to close the entropy gap. Of the energy used at each step in the process, usually from non-renewable external fossil fuel inputs, much is lost as waste heat, which represents an unsustainable use of inputs. The aim of sustainable agriculture is to minimise the losses, whether in the form of non-renewable input use, soil erosion or environmental degradation to maintain the agricultural system for the greatest possible length of time.

Similarly sustainable economic growth cannot occur, argued Daly (1990) as a part (the human economic system) cannot grow within a finite whole (the global ecosystem). Therefore, the growth of the economy Daly (1990, p 1) stated "cannot be sustainable over long periods of time." The issue is one of time, and the temporal scale of sustainable agriculture is covered in Section 2.4.3. The biophysical and economic sustainability issues requirements discussed in these two paragraphs highlight the need for a temporal scale consideration. Agriculture may be perceived as sustainable if the temporal consideration is a few generations or fifty years, but not sustainable if the timeframe under consideration is many hundreds of years, or even longer.

Given these considerations, the achievement of agricultural sustainability may be impossible, and the goal unobtainable. The concept of agricultural sustainability within this thesis refers to the aim for an increased timeframe over which agricultural production can occur, which increases the length of time that future generations are able to provide for their food and fibre needs.

2.2 - Three schools of sustainability proposed by Douglass (1984)

Douglass (1984) outlined three main approaches to agricultural sustainability. A brief description of these is as follows:

1 - 'Sustainability as food sufficiency.' This approach considers the need to provide abundant food for society as the paramount aim of agriculture. This approach is production oriented and places emphasis on economic values.

2 - 'Sustainability as stewardship.' This approach considers the environmental implications of agricultural production, and aims to protect the resource-base for future generations and other species. This approach is aligned with biophysical sustainability concepts.

3 - 'Sustainability as community.' This approach is based on ideas of social equity, with the distribution of land, wealth and power being an integral part of sustainability. This is similar to the social approach of sustainability.

Yunlong & Smit (1994, p 49) in their review of sustainability in agriculture stated that the three schools of Douglass (1984) were "consistent with the three general definitions of sustainability proposed by Brown *et al*. (1987), namely ecological, social and economic." Senanayake (1991) came to this same conclusion. The alignment between the three ideas proposed by Douglass (1984) and the interpretations of Brown *et al*. (1987), Senanayake (1991) and Ruttan (1994a) is shown below in Table 2.1.

TABLE 2.1 - Comparison between Douglass (1984) approaches to agricultural sustainability and general terms used in sustainability literature.

Douglass (1984) Term	Interpretation against the general approaches to sustainability
Sustainability as food sufficiency	Economic based approach - production oriented
Sustainability as stewardship	Ecological approach (with some intergenerational issues) - biophysical and environmental considerations
Sustainability as community	Social approach - considers social equity issues.

Adapted from Douglass (1984), Brown *et al*. (1987), Senanayake (1991) and Ruttan (1994a).

Senanayake (1991, p 9) stated that the emerging theme was "the need to integrate the often conflicting needs of economic, social, and ecological values" in attempt to generate a working measure of agricultural sustainability. Xu *et al*. (1995) stated that a multi-objective approach to sustainable agriculture was required to resolve the myriad of issues facing the farmer, which are interconnected (see Table 2.2). The following sections (2.3 and 2.4) of this chapter relating to the scale issue and decision-making objectives in agriculture highlight the multitude of objectives involved, that require tradeoffs in order to achieve some of these objectives.

The Xu *et al.* (1995) comment is pertinent, as it reflects the need to consider the objectives and aspirations of all the stakeholders in the sustainable agriculture debate. Likewise, any research regarding these objectives according to Taylor (1990), Lockeretz (1991), Merrill (1983) and Francis & Madden (1993) also needs to be multi-disciplinary in order to meet the relevant and adequate information requirements of sustainable agriculture. The multi-disciplinary approach is a term often referred to in the literature, as in order to properly research the different aspects of sustainable agriculture, people with different expertise will be required to obtain the greatest knowledge base. Lockeretz (1991, p 107) argued that the multi-disciplinary approach must be used as a means and not an ends, as the term goes through periods of "faddism." Each field of expertise will have different priorities for consideration, and these will need to be carefully balanced, as Lockeretz (1991, p 108) suggested "multidisciplinarity in form does not guarantee multidisciplinarity in spirit." Question 19 in Table 4.3 covers the issue of the need for a multi-disciplinary approach, including farmers, and lists some of authors that consider it an important issue.

A more detailed description of the work by Douglass (1984), and pertinent comments by other authors follows in the next three sections of thesis, each covering a single approach mentioned by Douglass (1984).

2.2.1 - Sustainability as food sufficiency

This approach considers both food and fibre, although the heading above quotes the Douglass (1984) term, but it covers both food and fibre production issues.

This industrial approach to agriculture is justified according to Douglass (1984) by the need to meet the food demands of an expanding world population. The obvious problem encountered with this approach, which Douglass (1984) raised, is determining the exact nature and volume of future demand for food. The ways in which food will be utilised and consumed by society in the future is very difficult to predict. George (1990) also raised the issue of difficulties in determining wants and needs of future generations. If the provision of food to meet human food demand is the sole concern of this sustainable agricultural approach, and that future demand cannot be determined, then the approach does have an overriding flaw.

More innovative identification of market niches is required to find consumers for the increased production arising from this approach. Ikerd (1993) raised the point that agriculture must meet the current markets, and not create markets. This comment was made in the context that present agriculture had environmental problems associated with it, and producing more through the creation of more markets as societal 'wants' as opposed to 'needs' resulted in increased environmental impact. The Ikerd (1993) comment about creating further, new markets may be difficult to address as micro- and macro- economic sustainability (see Section 2.3) relies on marketing of agriculture, and finding new markets for produce.

To ensure that food sufficiency is maintained, Dahlberg (1991) claimed that any practices which degrade the productive potential of the land are not viewed as sustainable according to the food-sufficiency approach. Douglass (1984) stated that the land is the most important agricultural resource for the food sufficiency approach, as it determines the levels of agricultural production and therefore food provision. MAF (1993a) and Plucknett (1990) also identified the land/soil as the primary component of the resource-base, on which agriculture depends. The protection of this resource-base is crucial to the achievement of agricultural sustainability.

The need to increase food production and yields were mentioned by a number of authors. This is not implying that their approaches were solely food-sufficiency based, but that they had considerations that were aligned with this approach, at least in part. Plucknett (1990) stated that yield must be increased substantially in order to meet the needs of a growing population. Edwards & Wali (1993) argued we need sustained yield and food production on a per capita basis, which if population increases, implies an increase over present production. Francis (1990) and the IUCN *et al.* (1991) also claimed a need for increase in yields. This increase in production must be carried out in an environmentally benign manner, as Douglass (1984) stated that no degradation of the land (agriculture's resource-base) can occur, as this threatens future food/fibre production.

Douglass (1984) stated that a point creating some concern from this approach to sustainability, is the apparent lack of concern about any increasing environmental costs that may be associated with the increase in food production. This is a prime reason why multi-objective approaches suggested by Xu *et al.* (1995) are required, as the food-sufficiency approach must be balanced with the stewardship approach, to avoid environmental degradation.

Douglass (1984) also stated that the soil erosion that may result from increased intensity in land management practices and the unintended side-effects of fertilisers and pesticides, are not considered in this approach. Soil erosion tends to be blamed on weather patterns, rather than the land management practices that lead to vegetation cover changes. Derose *et al.* (1993) claimed that in the Taranaki hill-country, landslides occurred more frequently after deforestation and the soil under pasture was more shallow than the soil that previously existed there under indigenous forest.

So statements blaming weather patterns for the erosion occurring are not correct, as greater levels of erosion have occurred after the land was cleared of forest cover. The increased erosion occurring above the natural erosion levels, caused by human activities, is termed 'accelerated' erosion. The number of authors that mentioned the importance of soil conservation in sustainable agriculture were numerous, with Harwood (1990), Schaller (1993), Buttel (1993), Weil (1990) and Rodale (1990b), to name a few. The stewardship ethic once again can be included to address this and correct the balance in the approach of the agricultural system.

Ruttan (1994b) claimed that increasing the yields from agriculture will become increasingly more difficult over the next quarter century, than was the case in the immediate past. Ruttan (1994a) claimed that the incremental responses to the application of fertilisers have decreased. Thus more innovative research and responses will be required to find where any further productivity gains can be made in the agricultural system. This may place further stress on the system and threaten the resource-base on which agriculture depends, if productivity gains are subsequently made through degradation of the resource-base.

To meet any increase the future food demand by society, Smith (1990) stated that there were three main options; increase the total area farmed, restore any degraded or abandoned land, or intensify the productivity of present farm land. Each of the options has implications for ecological and economic sustainability outlined in Table 2.2 from the Lowrance (1990) work. Increasing the land area used by agriculture may require the use of increasingly marginal land, which can result in environmental degradation. Restoring degraded land may require external inputs, such as artificial fertilisers which may not be economically or ecologically sustainable. Increasing the intensity of the presently farmed land also could increase the intensity of adverse environmental effects, such as nutrient/sediment loads in streams, rates of accelerated erosion and rates of use of non-renewable, external resource inputs. All approaches may require further increases in inputs, which if based on present resource inputs, are often from non-renewable sources, which is not biophysically sustainable.

Douglass (1984) claimed that the aim of this approach is to leave future generations with the capacity to produce, but not necessarily the assurance of a sustainable resource base. Any approach that diminishes the importance of environmental costs and degradation is not ecologically or micro-economically sustainable under the Lowrance (1990) criteria in Table 2.2.

2.2.2 - Sustainability as stewardship

This approach outlined by Douglass (1984) is summarised by Dahlberg (1991, p 339) as "agricultural systems that are based on a conscious ethic regarding humankind's relationship to future generations and to other species." The integration of a stewardship ethic in sustainable agriculture was noted by IUCN *et al.* (1991), MAF (1993a), Luckman (1994), Cary *et al.* (1993), Keeney (1993), Weil (1990), Koeph (1989), MacRae *et al.* (1989), and Swaminathan (1991).

This approach does not equate directly to the 'ecological' approach to sustainability, of the three proposed by Brown *et al.* (1987), namely ecological, social and economic. The stewardship approach also includes recognition of social issues, in the consideration of the needs of future generations. The main reasons why this approach is however, primarily, ecological is the conscious ethic regarding the relationship between humankind and other species. This recognition of the effect that human activities have on the existence of other species, through ecosystem destruction or direct exploitation, is the important overriding component of a stewardship ethic.

Douglass (1984) stated that a different view of environmental costs was involved, as not only do environmental costs have effects on economics and production, they also affect the environment aesthetically and intrinsically, and thus cannot be calculated in economic terms. The need to consider intrinsic values is outlined in Section 7 of the Resource Management Act (1991), and is thus a legislative requirement. Aesthetic considerations in sustainable agriculture were mentioned by authors such as Nassauer (1989), Leopold (1949) and Weil (1990). Lucas (1987) and Reid & Wilson (1986) also considered the incorporation of aesthetic qualities in agroforestry and conservation forestry plantings in rural New Zealand. Aesthetic considerations are also a legislative requirement under the Resource Management Act (1991), with aesthetic conditions forming part of the definition of 'environment' used in the Act.

Douglass (1984, 11) also remarked that the ecological school of thought considers that nature in the long run, imposes definite limits on humankind's ability to produce food. These limits arise from the fact that finite levels of resources are available, and there are also limits to the amount of waste that can be assimilated into the environment without detriment. The 'Limits to Growth' study by Meadows *et al.* (1972) studied these environmental limits. The aim of the stewardship approach to sustainability is to keep within the limits imposed by the natural system. The minimisation of wastes resulting from agriculture was mentioned by Harwood (1990), Ikerd (1993), MacRae *et al.* (1989) and Wagstaff (1987).

Even the resources considered to be 'renewable' have limits on the rate at which they are replaced. In the case of soil, Plucknett (1990) stated that the loss of soil through erosion or a reduction in soil fertility by not replacing nutrients, represent the transformation of a renewable resource into a nonrenewable one. Douglass (1984) argued that this degradation of renewable resources such as soils, through inappropriate land management practices, leads to a reduction in the productivity of the land, which is not sustainable. These long-term considerations of the ability of the resource-base to allow production to occur forms one part of the Lowrance (1990) work and is termed agronomic sustainability (see Table 2.2).

Douglass (1984) claimed that the ecological approach to sustainable agriculture believes that sustainability depends primarily on two things: the availability of a renewable resource base, and the control of the resulting production from the resource base, to guard against depletion or degradation. The assumptions of the availability of a resource-base and also that this resource-base is not degraded forms a narrow focus for sustainability. There are no considerations for economic or social components, which again highlights the inadequacies of a single-objective approach.

The ecological sustainability of conventional agriculture could be questioned when ideas outlined by Odum (1971), regarding ecological succession are considered. The agricultural system uses the early stages of succession to obtain advantage from the high biomass production, which is used to feed animals or removed in crops/fruit or other produce. Hannon *et al.* (1993, p 253) stated that human intervention, in the form of agriculture, "reduced the ecosystem in given areas to a juvenile state, a state which seems to produce entropy at a lower rate than that of the natural climax condition." These juvenile systems are less able to dissipate their entropy to environment because they are less complex, in terms of species diversity. The early, developmental stages of an ecosystem also have according to Odum (1971), a low degree of species diversity. This in the case of agriculture, this is often represented by the use of monocultures, which, some of the authors listed under Question 1 in Table 4.3 highlight, may face greater risk from disease and predators, than a more diverse system. The chemical cycles in developmental systems notes Odum (1971) are open, and in for agriculture this means additions of artificial fertilisers are required to supplement the losses from this open (linear) system.

The stability of the developmental systems, to external perturbation claimed Odum (1971), was low. The onset of an extreme weather pattern on an agricultural system can often result in much greater soil erosion, than is the case for land under native forest (Derose *et al.* 1993), or even production forestry. The food chains, noted Odum (1971), were often linear and involved grazing. The system of pastoral agriculture involved biomass and nutrients from the soil, taken up by grass, which in turn is eaten by stock, and removed from the farm when subsequent processing of the animals occurs. The linear food chain and linear flow of nutrients, as previously mentioned requires inputs to offset any loss. These inputs, such as synthetic fertilisers, often originate from non-renewable sources and require fossil-fuel inputs in their manufacture.

2.2.3 - Sustainability as community

Dahlberg (1991, p 339) summarised this Douglass (1984) sustainability approach as "agricultural systems that are equitable." The consideration of social equity issues was made by Douglass (1984), Swaminathan (1991), George (1990) and Edwards & Wali (1993).

"Agricultural research has been especially negligent of the social aspect of sustainability" according to Brown (1989, p 99), who went further to state that the "social fabric must be strengthened if we are to keep alive the rural communities which are support base for the farmers and their families." It may be technically and economically feasible to have lesser rural support towns, but this argues Brown (1989) will increase the isolation facing farmers and may lower the rate of young returning to the farms. Harding McPhail (1995) stated the although the average age of the New Zealand farmers had decreased between 1976 and 1981, it had increased back to the 1976 level again by 1991. Harding McPhail (1995, p 199) outlined the average ages of the agricultural workforce in New Zealand, and the "youngest farmers are dairy farmers: male 42 yrs, female 40 yrs. Sheep farmers average 47 yrs (male) and 45 yrs (female); while the oldest group are beef farm owners 54 yrs (male) 50 yrs (female). The average age of the total farm work force (including owners) was about 41 yrs in 1991." Policy and actions that will further increase the average age of farmers, which may hinder the implementation of long-term sustainable agricultural practices, will not add the implementation of sustainable agriculture.

The literature often stated that the farmer was an integral part of agricultural sustainability, and the farmers are an important resource in the implementation of agricultural sustainability. Weil (1990) stated that sustainable agriculture programmes should increase the number of people farming, in associated agricultural jobs and improve the working conditions of these people.

Beus & Dunlap (1990, p 598-599) stated that farming was a "way of life as well as a business" and Edwards *et al.* (1993) expressed a similar statement. These lifestyle and quality of life issues will also need to be incorporated into the definition and implementation of sustainability. Ikerd (1993) argued that quality of life was a product of human relationships with other humans and non-human elements within their environment. Clawson (1972) claimed that a byproduct of industrial agriculture has been the economic and social decline of rural communities. Thus the rural support towns with their schools, shops, banks and hospitals are, claims Brown (1989, p 99) "all important to improving the overall sustainability of our agricultural sector." Jackson (1984, p 213) also stated that sustainable agriculture, needed "rural communities if it was to survive and flourish." The social contacts within the rural community are needed for the dissemination of any information regarding sustainable agriculture and it's effectiveness. As the geographical proximity of those living in the rural areas is not high, the rural support towns and services feature as contact points. These then play a role in sharing of information, in this case, information regarding practical aspects of sustainable agriculture. The maintenance of a sense of community was claimed by Edwards *et al.* (1993) to be an important output of sustainable agriculture.

Agricultural sustainability, according to Stenholm & Waggoner (1990, p 16) is as important to "rural communities as for individual farmers" and part of this involves "an acceptable level of economic returns for those work and live in the community." The two main principles of the 'sustainability of community' approach stated by Douglass (1984) are: firstly, that the concept of natural justice or fairness is incorporated in the relationships between the rural community members; and secondly, participation of social decisions affecting the community, involves the community. The application of participatory approaches was mentioned by Campbell & Junor (1992), Keeney (1993) and Swaminathan (1991).

Douglass (1984, p 17) claimed that the 'sustainability as community' school draws on the ecological school of the thought for many of its ideas, as the "literature and symbolism of stewardship" is featured "heavily" in the ideas of sustainability as community school. Altieri (1987) however stated that even if the agricultural system is ecologically sound, it will only be sustainable if it is socially and economically sound. Again, single objective considerations and approaches are inadequate and unacceptable.

Douglass (1984, p 18) stated that social relations within the rural community under the 'sustainability as community' approach "should be cooperative rather than competitive to the fullest extent possible." The cooperation between the members of the rural community will allow for greater information sharing. Greater cooperation between the rural community and scientific staff was noted by a number of authors, such as IUCN *et al.* (1991), MAF (1991a), Francis & Madden (1993), Jennings (1990), and Edwards & Wali (1993). The use of community-based approaches to identify and resolve environmental problems according to Allwright (1992) allowed farmers to establish information and appropriate technology transfer needs.

The different levels (Lefroy & Hobbs 1992) of horizontal scale (Section 2.4.1) involved in the sustainable agriculture have different social issues, which Dahlberg (1988) stated have different motivations and goals. These levels need to represented in consideration of social sustainability issues, otherwise tradeoffs between levels (Wolf & Allen 1995) will not be readily accepted by the stakeholders, if they are not included in the decision-making. Therefore, staff from Regional Councils and central government research groups need to be involved, to ensure that the level of horizontal scale they represent (see Section 2.4 on scale issues) is also given consideration in the subsequent implementation of 'sustainable agriculture' and the resulting emphasis is not just on site-specific or productivity-based issues. Greater cooperation and participation is likely to achieve greater 'ownership' of the results by farmers and thus greater implementation, according to Edwards *et al.* (1993). The farmers can inform the technical staff where problems may arise in implementing any scientific recommendations. The farmers are also an important source of anecdotal information and local history (IUCN *et al.* 1991). Edwards *et al.* (1993, p 115) stated that "the experience, knowledge, and capabilities of rural people which are grossly under recognised and under utilised at present, represent a priceless resource." MAF (1991d) also acknowledge the value of experience held by farmers. Lockeretz (1991) suggested that innovations by farmers are important, and need to be integrated into research regarding sustainable agriculture. Berkes & Folke (1994) also considered the importance of this 'cultural capital' and the role that human and societal knowledge plays between the natural capital (environment and resources) and the human-made capital (objects produced by production). This farmer knowledge is, what Berkes & Folke (1994, p 140) term, "traditional ecological knowledge" and can be useful for "supplementing scientific knowledge."

Douglass (1984) argued that the self-interest between individuals within the community also extends to our relationship with nature, according to the alternative agriculture movement. If the needs of humans are to met by the natural world, then we must have a sense of duty for the preservation of the natural world in reply. Inter-generational equity issues come into consideration in this approach, as preservation of the natural world is important for the future generations who depend on this natural world. The consideration of intergenerational issues in sustainable agriculture was noted by Wynen & Fritz (1987), Swaminathan (1991) and IUCN *et al.* (1991). George (1990) outlined the difficulty in determining the exact wants and needs of future generations. George (1990, p 82) stated that if we have an obligation to the land in the form of a land ethic, then we also "owe it *as a matter of justice between generations* [author's italics]- to those persons who will come after us - to sustain the fecundity of the land, the purity of the water and of the air ..." Principles of 'natural justice' flow through some of the literature, and as previously mentioned, Douglass (1984) stated that one of the two main principles of the 'sustainability as community' approach was the concept of natural justice. George (1990) takes the concept one further step, to state that it applies not just within generations, but between them. The consideration of future generations is a legislative requirement of the Resource Management Act (1991) and this gives much legal weighting to the idea of considering future generations.

2.2.4 - Discussion

Douglass (1984) states that agricultural sustainability can be defined in more than the three ways he features (food sufficiency, stewardship and community). Douglass (1984) also notes that even from his three different approaches to agriculture sustainability, it has come to mean different things to different people. These three approaches , nevertheless, are often mentioned in literature regarding agricultural sustainability, and are used as the basic groupings of approaches taken, so their relevance is very high.

One aim could be to integrate the ideas and beliefs of all three. The concept of integrating the three schools of Douglass (1984) featured in the literature of Grove & Edwards (1993), Weil (1990), Stenholm & Waggoner (1990), Francis & Madden (1993), Hooper (1995), Lowrance (1990), Swaminathan (1991), Lefroy & Hobbs (1992), Edwards & Wali (1993), Senanayake (1991), Edwards *et al.* (1993) and Yunlong & Smit (1994). The 'Environment 2010' strategy from MfE (1995b) stated that one of the aims of the strategy was to integrate environmental, social and economic issues into decision making at all levels. As with the work of Lowrance (1990) in Section 2.3, where all of the author's four objectives of agricultural sustainability need to be balanced, all three schools of the Douglass (1984) work; economic, environmental and social, need to be integrated. As covered in the previous three sections (2.2.1, 2.2.2 and 2.2.3), all approaches offer valid ideas and arguments. The aim would be to integrate the environmental protection and avoidance of environmental degradation of the 'sustainability as stewardship' approach, with the production of high quality and value food of the 'sustainability as food sufficiency' approach and the social considerations considered by the 'sustainability as community' approach. The Wolf & Allen (1995) notion of the importance of tradeoffs is relevant. The resulting balance between the three approaches cannot favour the production approach at the expense of the environment or rural community, and nor can it favour the environment at the expense of the provision of food or the livelihoods within the rural community.

The tradeoffs may not be easy to resolve. As the notion of increased levels of production according to the 'sustainability as food sufficiency' approach may conflict with some stewardship principles, such as the protection of some elements of the wider environment. The ecological approach may consider that environmental bottom-lines or thresholds cannot be 'traded-off' as they are limits that cannot be exceeded, as future production is threatened (Ikerd 1990). This argument creates other problems with respect to agriculture, as if the agricultural systems cannot produce food and fibre for society, in order to protect the bottom-lines, then the system loses its utility and reason for existence (food and fibre provision). Harwood (1990) claimed some of the utility issues facing agriculture included its role to produce adequate amounts of safe and quality food. The bottom-line or threshold issue is important, as future production could be threatened, and this by default gives importance to the concept of 'production' within the consideration of future production. The issue would not cause concern unless something was potentially at risk, namely production. This illustrates the inextricable links between the environmental, social and economic components to agricultural sustainability, as in one case the environment on which the production occurs cannot be degraded (environmental), but the production is important for food and fibre for society and income for the farmers (social and economic). This is the main reason why all three approaches need to be considered in decision-making.

2.3 - Imperatives and objectives of agriculture

Lowrance (1990) stated that there were four types of objectives involved in the operation of an agricultural system. These four objectives are shown in Table 2.2 below. These objectives are the prime considerations and compelling aims motivating decision-making regarding agricultural sustainability, such as continued economic viability of the farm unit. The economic viability of farms is a political issue, as the farming community becomes vocal in times of harsh economic conditions, as Edwards *et al.* (1993) state that economic productivity is required for income for farmers (a simple political reality). Edwards *et al.* (1993) argue that if agriculture is to be sustainable, the farmers must perceive benefits for them and their families. Reganold *et al.* (1990) claimed that sustainable agriculture must be profitable if farmers are to implement it. The problematic nature of any political backlash that may occur from tradeoffs and decision-making was raised by Wolf & Allen (1995), which makes balancing these objectives more difficult. The Lowrance (1990) work highlights the need for multi-objective decision-making, with Xu *et al.* (1995) and MAF (1991a) stating that single purpose decisions are not adequate. Keeney (1993, p 806) also claimed that agricultural sustainability will not be achieved "through simple solutions."

TABLE 2.2 - Various types of objective involved in the agricultural system proposed by Lowrance (1990).

	Objective	Explanation
1	"*Agronomic sustainability* -	the ability of a tract of land to maintain productivity over a long period."
2	"*Microeconomic sustainability* -	the ability of a farm to stay in business as the basic economic unit."
3	"*Ecological sustainability* -	the ability of the life support systems to maintain the quality of the environment."
4	"*Macroeconomic sustainability* -	the ability of the national production systems to compete in both domestic and foreign markets."

These are the aims of modern agriculture and will need to be reconciled by any response to the issue of agricultural sustainability. The achievement of agronomic sustainability of a field, which pertains to the ability of that land to continue to produce, is essential for the microeconomic sustainability (economic viability of the farm). If the resource-base on which production depends, is threatened, then the ability of the farm to remain economically viable is also threatened. The aim of ecological sustainability is also important, because if the life-support systems such as air and water are affected by agricultural activity, then human life, and life of other species, that depends on the support systems, is threatened.

The achievement of ecological sustainability is also also essential for future use of these water and air resources by agriculture. This safeguarding of the life-support systems is outlined in section 5(2)(b) of the Resource Management Act (1991), and is therefore a statutory responsibility under the legislation. The microeconomic sustainability of individual farms is essential to ensure that the entire agricultural sector is viable, that is, macroeconomically sustainable, and produces food in internationally competitive marketplace. The achievement of agronomic sustainability is dependent, in part, on the achievement of microeconomic sustainability, as without adequate farm income, management practices and inputs that maintain the resource-base of agricultural production.

The achievement of ecological sustainability is also, in part, dependent on the achievement of microeconomic sustainable. For example, to fence off and plant forestry on an area of steep land that is eroding rapidly in the catchment of a stream or river, and affecting water quality, requires farm income to be diverted to the initial cost of fencing and planting. If the farm is not in a strong financial position, then money will not be available to meet the costs of the protection work, and the loss of income from the area grazed, even though it may not produce great amounts, becomes more difficult.

This highlights the linkages between short-term economics, the ability to divert money into protection works, and long-term ecological sustainability, beneficial environmental outcomes from the protection works. The long-term protection of the resource-base is essential for future agricultural production and microeconomic sustainability, and survival of the species that depend on the life-supporting capacity of the resources-base.

Thee are very strong linkages between the four objectives outlined by Lowrance (1990). Without ecological sustainability there will be no microeconomic sustainability, and thus no macroeconomic sustainability. Without microeconomic sustainability, there will be no ecological sustainability, as farmers cannot afford to undertake sustainable practices, such as soil conservation measures. The microeconomic sustainability (continuation of production and subsequent farm income) is according to Edwards *et al.* (1993), related to agronomic sustainability (the biological processes that allow production).

The social considerations, aside from profitability, are given no consideration here. This is the one major shortfall in the work by Lowrance (1990). The consideration of economic state of the individual farms and entire agricultural sector, along with the agronomic (production) and ecological (environmental) considerations will be required in devising a definition. In the work by Lowrance (1990), no consideration is given to infrastructure of the rural community, and the importance of rural services (such as schools), apart from the pure economics of the provision of these services.

Food security (Swaminathan 1991) and other issues, such as the safety of the food produced by the agricultural sector (MAF 1993a; IUCN *et al.* 1991; Parr *et al.* 1992) are prime considerations, that would be grouped under the term 'social sustainability.' Altieri (1987) and Edwards *et al.* (1993) stated that agriculture will only be sustainable if it is economically and socially sound. Social sustainability is not an objective of an agricultural production unit *per se*, so it is not covered by Lowrance (1990). This is the main reason for the inclusion of both work by Douglass (1984) and Lowrance (1990) in this thesis, as the different ideas posed by authors compliment each other, and the overlapping concepts offer a more complete consideration of the agricultural sustainability issue. Social sustainability may well be important for the survival of the rural community, in terms of the schooling for children on the farms and other services for those living on the farms, but these are not imperatives in farm decision-making like continued farm economic viability, for example. Table 2.3 in the next section, discusses the levels of scale at which these objectives operate and constrain agriculture, and the achievement of sustainable agriculture.

Ikerd (1990, p 18) queried the balancing of economic and ecological sustainability when he asked "are [ecologically] sustainable systems necessarily profitable? Are profitable systems necessarily [ecologically] sustainable? The answers to these questions depend on whether one talks about the long or short run or about an individual farm or society in general." Long-run considerations of the micro- and macro-economic, and ecological sustainability of the agricultural system pose many questions. Little is known about the long-term profitability of sustainable systems (or exactly what systems are sustainable). For example, the returns of agroforestry or mixed uses such as forestry and pastoral land-uses are unclear, which does not encourage farmers to implement these land-uses. This uncertainty is reflected in the answers to the stakeholder survey in the latter part of this thesis, especially those regarding the need for further research in Chapter 10.

The need for microeconomic (farm-scale) sustainability again raises site-specificity issues (see Section 2.1). Lowrance (1990, p 59) stated that the "farm is the level at which microeconomic sustainability must be evaluated." The continued economic viability at the farm-scale must be aligned with the ecological and agronomic sustainability of the farm also. The Douglass (1984) 'sustainability as food sufficiency' approach stated that future production (micro-economic sustainability) depending on the preservation of the productive resource-base (agronomic sustainability). The economic sustainability of individual farms can vary depending on debt levels/servicing, management approaches and other factors. Reganold *et al.* (1993) highlights the differences between farms that can cause problems when assessing profits. Thus, microeconomic sustainability is site-specific, and identifying it requires detailed analysis, farm-by-farm. Reganold *et al.* (1990) stated that farmers must be shown that sustainable agriculture is profitable, if they are to subsequently implement it.

It is claimed that agricultural activities must not affect the environment and life-support systems. Lowrance (1990, p 51) asserted that "ecological sustainability is a necessary condition to achieve long-term sustainability at the field, farm, or national level." Using land management practices that lead to environmental degradation is ecologically unsustainable. Lowrance (1990, p 51) went further to state that "degradation of environmental quality through management practices that pollute soil, water, and air precludes the ecological sustainability of a landscape or regional agricultural system." Ecological sustainability may not be socially sustainable in the case of agriculture. The levels of production achievable within the constraints of ecological sustainability may not provide food security or social utility. But, any agricultural production that degrades the ecological resource base on which agriculture depends, is not sustainable. This again highlights the complex tradeoffs and considerations required when examining the issue of agricultural sustainability. Wolf & Allen (1995) state that agricultural areas may be used in an ecologically unsustainable manner in order to provide sustainability at another scale. For example, certain fields within a farm may be used unsustainably to achieve farm-scale microeconomic sustainability.

The concepts of food security and utility and other social aspects, along with economic considerations, such as profit, may well mean that low-input agriculture is not sustainable. If it does not meet society's expectations in terms of food production and profitability, then it will not be sustainable. These social considerations need to be overlaid on the work of Lowrance (1990). Therefore, the work of Lowrance (1990) is not a complete structure to achieve sustainable agriculture, but provides a guideline for the consideration of the various decision-making imperatives for agriculture. These will need to be accounted for in the achievement of sustainable agriculture.

2.4 - Issues of scale in sustainable agriculture

There are issues operating at different scales within agriculture, and these place constraints on the definition and achievement of sustainable agriculture. Weil (1990, p 126) claimed that the "degree of integration [involved] also sets the sustainable agriculture approach apart from more conventional approaches." Weil (1990) then went further to state that there were horizontal, vertical and temporal (time) scale considerations to sustainable agriculture. Lefroy & Hobbs (1992, p 22) argued that "one of the big stumbling blocks in the definition of sustainability is that of scale." Lefroy & Hobbs (1992, p 22) then went further to argue that the term "sustainability is meaningless unless spatial and temporal scales are defined." The following sections outline the vertical, horizontal and temporal scales in agriculture, and any subsequent considerations of sustainable agriculture.

2.4.1 - Horizontal scale

The horizontal scale of agriculture is shown in Table 2.3, with the dominant constraint at each scale and an example. The various levels and dominant constraints shown within Table 2.3 are adapted from Lefroy & Hobbs (1992), who modified the work of Lowrance *et al*. (1986). The horizontal scale in agricultural sustainability was also recognised by Edwards *et al*. (1993).

TABLE 2.3 - Horizontal scale within agriculture and dominant constraint at each level.

	Level of Scale	Dominant Constraint	Example
1	Global Level	Ecological	CO2 pollution or biogeochemical processes
2	National Level	Economic and Social	Agricultural sector economic viability
3	Regional Level	Economic and Social	Support services and processing
4	Catchment or Landscape Level	Ecological	Water resources
5	Farm Level	Economic	Farm-scale economic viability
6	Field Level	Agronomic	Soil properties affecting production

Lefroy & Hobbs (1992) offered a single dominant constraint for each of the levels in the horizontal scale. However, Wolf & Allen (1995, p 8) criticised the use of a single criteria at each scale level, as "if it were somehow singularly correct." The constraints offered by Lowrance (1986) and Lefroy & Hobbs (1992) may not be the correct constraints in every circumstance, but are often the dominant constraint, in most instances. The table nevertheless, does illustrates the different levels in the horizontal scale, and the different possible constraints that are involved at each level.

At the global scale (1), the major constraint facing agriculture is ecological, such as the CO_2 emissions from agricultural sources, or a reduction in environmental quality. Another possible constraint that exists at this level of scale is the issue of trade blocks and the impact these can have in social and economic terms, in relation to the affect on agricultural trade. At the national scale (2) the major constraints are economic and social. The macroeconomic sustainability of agriculture, as shown in Table 2.2, proposed by Lowrance (1990) is the most notable example. The economic viability of the agricultural sector is the main consideration at this level, along with social considerations like the provision of safe and affordable food and fibre for the nation, termed 'food security' by Swaminathan (1991).

At the regional level (3), the major constraints are again economic and social. The consideration of issues such as the economic livelihood of the rural support services/towns within the region, and the effect on this that any changes in agriculture may have. The social issues include the people within the region who are employed in the farms, or in the rural support towns, who may be affected directly or indirectly by changes in agriculture. This level of scale is similar to the national scale previously mentioned, but in this case the scale is more detailed, with the links to the agricultural sector more direct and closely interrelated. At the catchment scale (4), the dominant constraint is ecological. The life-support systems of the waterways and other ecosystems need to be maintained for future generations. This parallels the concept of ecological sustainability in the Lowrance (1990) work shown in Table 2.2, where the activities of agriculture cannot affect the ecological processes that other sectors of society or other natural systems, require for their survival.

At the farm scale (5), the dominant constraint is economic. This is the micro-economic (farm-scale) sustainability outlined by Lowrance (1991), which allows for the continued profitability of the farm (see Table 2.2). The farm must be profitable, otherwise undertaking of environmental protection works or maintenance of the biophysical or ecological aspects of the farm (such as soil fertility) cannot occur, due to the lack of farm finances. At the field scale (6), the dominant constraint is agronomic. This constraint relates to the continuation of the productivity of the land for agricultural purposes (again covered in Table 2.2). The soils and other resources central to agricultural production cannot be degraded, otherwise future production is jeopardised.

There are close interrelationships between the different levels in the horizontal scale. The maintenance of soil fertility (agronomic sustainability at the field scale) as mentioned above is dependent on economic returns at the farm scale. If the constraints exist at one level (economics at the farm-scale), then constraints at another level may also be affected (agronomic sustainability at the field scale). Thus, any decisions regarding agricultural sustainability must consider the implications at all levels in this horizontal scale. Stinner & House (1989) argued that inputs used in agriculture were supplied from areas originating far from the farm in geographical terms.

Wolf & Allen (1995, p 7) state that tradeoffs are required, and involve "denying sustainability at a particular scale in order to achieve it at other levels" The achievement of farm-scale economic sustainability may require the use of some fields within that farm to be used in an agronomically unsustainable manner. Similarly, in order to achieve ecological sustainability at the catchment scale, some farms may not be microeconomic sustainable under given criteria for land-use within that catchment. Ikerd (1990, p 23) stated that "tradeoffs are the key to decision-making, the key to evaluating the sustainability of farming systems." Wolf & Allen (1995) asserted that selecting the scales at which sustainability was denied in order that it be achieved at another, where political backlash may occur, is problematic. Wolf & Allen (1995, p 7) state that "there is no such thing as a system that is sustainable at all levels." The tradeoffs to determine which levels are forfeited in order to achieve sustainability at other levels requires balancing the views of all the stakeholders affected by agriculture.

The results to the survey in the latter part of this thesis represent the different levels of scale at which stakeholders operate and thus answer the questions with regard to that scale and the issues they consider paramount. The farmers look at the agronomic sustainability at the field scale, such as the maintenance of soil fertility, and also the microeconomic sustainability of their farm. The Council staff look at the various levels of the horizontal scale, such as the watershed level with the (ecological sustainability issues such as water quality) and the social and economic issues at the regional scale. The industry representatives, lobby groups, Central Government staff concentrate more at the national scale, with macroeconomic sustainability of the agricultural sector, food and fibre quality/safety issues and foreign trade aspects.

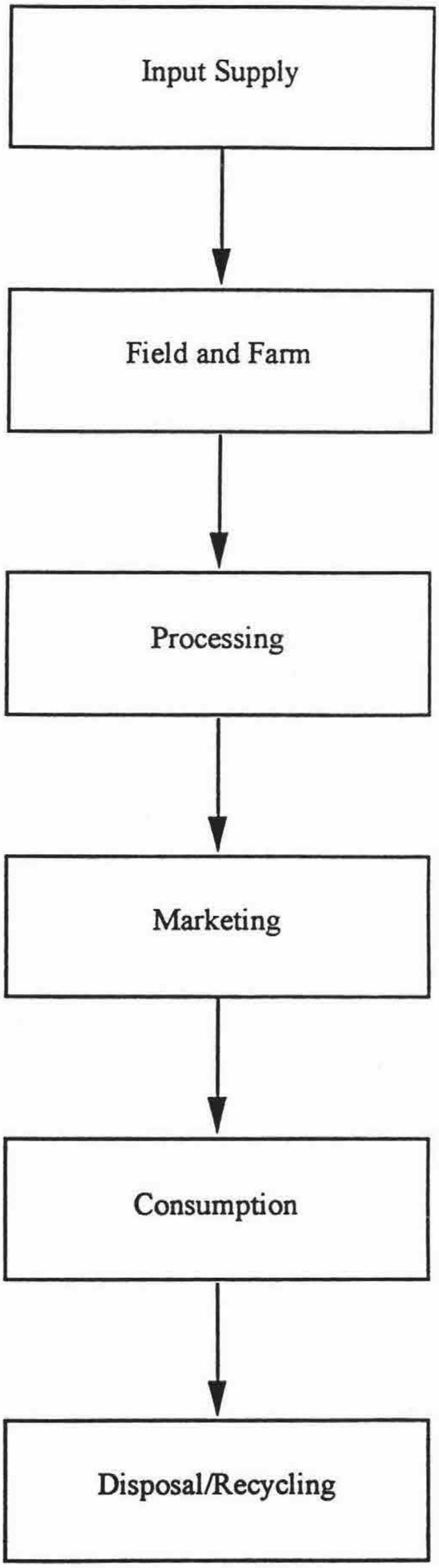
Obviously there exceptions to this, as farmers will consider regional water quality issues and national industry representatives realise that the individual farm-scale units form the basis of the agricultural sector. However, each stakeholder has a dominant responsibility to consider the interests at one scale over the others. Dahlberg (1988) highlights the goals held by the stakeholders at various levels in the horizontal scale and the ethics/values that give motivation to these goals. Farmers for example, wanted to make money and have a high quality of life due to individualism and had a stewardship ethic due to moral concern. There appears to be conflict between the beliefs held, with individualism and moral concern for the wider community requiring action in order to achieve one goal that precludes some achievement of the other. The agricultural sector wanted increased production due to the need for economic growth and an economically viable agricultural sector.

2.4.2 - Vertical scale

The vertical scale in agriculture as discussed by Weil (1990) refers to the stages in the agricultural sector that exist before and beyond the 'farm-gate', but nonetheless affect the achievement of sustainable agriculture. Figure 2.1 overleaf shows the scale discussed by Weil (1990) and some comments on the generalised nature of the diagrammatic representation of the steps mentioned. The flowchart is simply illustrating the text of Weil (1990) and is not intended to show all the feedback loops and interrelationships within the system. Rather, it is used to highlight the fact that issues on the farm form only a part of the considerations of sustainable agriculture. Any impact on farm-practices, and the resulting level of production can flow on to other steps in the agricultural sector, such as processing. This in turn can affect the towns that rely on the processing facilities for employment and income. This also highlights the links between the vertical and horizontal scales of agriculture. The actions in the horizontal scale at the farm field level (farm in vertical scale) can impact on the horizontal scale at the regional level (through impacts in processing facilities in the vertical scale). The Stinner & House (1989) comment regarding inputs used in agriculture, which were supplied from areas far from the farm in geographical terms, is also relevant to discussion relating to the linkages between the horizontal and vertical scales, as inputs in the vertical scale, are supplied from off-site sources, in the horizontal scale.

In order to achieve agricultural sustainability the activities undertaken before and beyond the farm-gate must be sustainable. The inputs used, must be from sustainable, or renewable sources. Some of the approaches to agricultural sustainability outlined in the following chapter consider that on-farm or internal substitutes should be used as opposed to external inputs. The consideration of issues beyond the farm-gate was considered by a number of authors in the literature regarding agricultural sustainability, and these are listed in Figure 2.1. Difficulties arise when all of these steps need to be considered, as the issues involved become more widespread and resolution is also problematic due to the greater number of stakeholders. The increased number of stakeholders, with individual concerns highlights the pertinence of the Wolf & Allen (1995) comment regarding political backlash.

FIGURE 2.1 - Vertical integration in the agricultural sector requiring consideration for sustainability issues.



The figure represents a very generalised view of the vertical integration that exists in the agricultural sector, adapted from Weil (1990). The issues beyond the 'farm-gate' in agriculture, such as processing and consumption, were mentioned by a number of authors, including Weil (1990), Ikerd (1993), Swaminathan (1993), Schaller (1993) Blakeley (1990b), MAF (1993a), Dobbs & Cole (1992), Stinner & House (1989), Wolf & Allen (1995) and Francis (1990).

The figure represents the agricultural system as a linear process. But in reality, the financial returns to the farmer from the consumer, via the processor, is cyclical. These returns are then used to purchase more inputs and the production system continues. The aim of Figure 2.1 is to illustrate the vertical integration in agriculture that must be considered to achieve agricultural sustainability.

In terms of agricultural production, the farm/field level represents just one part of the agricultural system. The other levels also need to be considered to ensure the achievement of agricultural sustainability.

Any changes at the farm-scale level (such as agricultural practices), affect the other steps in the process. Other steps, such as inputs supply (fertilisers) and processing (freezing-works) are often undertaken in and provided by the rural support towns. So any impacts on these (in terms of employment and income) affects the regional and national scales shown in Table 2.3.

2.4.3 - Temporal scale

There must also be a temporal, or time, component to sustainable agriculture. Weil (1990, p 127) stated that sustainable agricultural systems "must be projected in the time dimension over entire rotations, and long-term (decades, centuries) resource and social cycles." Sustainability, by definition, was also claimed by Ikerd (1990) to be a long-term concept. The state of the resource-base in 100 years on which agriculture depends, is important for the provision of safe and affordable food and fibre for society at that time. Ikerd (1990, p 18) asserted that the "term sustainability, must by definition, refer to farming systems that are capable of maintaining their productivity and utility indefinitely." The long-term preservation of the resource base on which production systems are based is imperative.

Ikerd (1990, p 18) maintained that systems which "fail to conserve the resource base eventually lose their ability to produce. Systems that fail to protect the environment eventually lose their reason for existence. Farming systems that fail to provide an adequate food supply at reasonable cost lose their utility to society. And finally, systems that are not commercially competitive will not generate the profits that are necessary for economic survival." There may well be some balancing between the achievement of environmental preservation and commercial competitiveness. As previously mentioned, these occur at different levels of the horizontal scale and require tradeoffs to ensure that sustainability occurs at certain levels, with a loss of sustainability at other levels. The ecological and economic sustainability issues outlined in the Ikerd (1990) quote are covered in the vertical and horizontal scales previously discussed, but even these two scales need to be considered over the long-term, therefore in the temporal scale.

The temporal considerations for the rotations in the agricultural system vary, depending on the production system, from a few years for sheep and cattle, through to decades for forestry. This is just for one rotation or cycle. Once longer-term considerations, covering numerous cycles, or multiple-use, such as agroforestry with different simultaneous rotations within the one farm unit, the complexity of the temporal considerations can increase greatly.

Weil (1990, p 127) suggested that by "its biological and social nature, agriculture is not static. A sustainable agriculture must be capable of continually evolving, while preserving the social and natural resources upon which it is based." Therefore, any definition developed for sustainable agriculture must have an inherent flexibility in order to cope with the dynamic nature of agriculture. This temporal flexibility must allow for changes in practices and technologies that offer a greater opportunity to achieve agricultural sustainability. This point was recognised by Keeney (1993), who stated our definition of what constitutes 'sustainable' practices will change with time. Societal demand, in terms of food quantity and quality, and environmental quality in rural areas will also change with time. Therefore the definition of sustainable agriculture will need to change over time to meet any adaptions in society's expectations. Schaller (1993, p 92) stated that "because sustainability means 'forever', and because good science requires it, the door must be always left open to new and better information on what could be the most sustainable combinations of practices." Any response to achieving sustainable agriculture must have this flexibility in the temporal scale as an integral concept. As society's needs from sustainable agriculture and techniques/practices implemented for sustainable agriculture may change in the long-term timeframe that is involved with, and implied by, sustainability.

Other temporal factors that affect agriculture, such as weather and pest cycles must be given consideration in sustainable agriculture. The consideration and management of risk posed by climatic conditions and possible future variations was mentioned by a number of authors such as Ikerd (1990), MAF (1993a), Dahlberg (1991), Weil (1990) and Edwards & Wali (1993). Blakeley (1990a) maintained that the concept of 'knowing your region' was important in relation to sustainable agriculture, and part of this was to understand the climate, with temporal cycles in weather patterns forming a component of this. The understanding of pest cycles over time is part of developing an Integrated Pest Management (IPM) programme. Rather than relying on synthetic pesticides, the better timing of biological controls (predator species and pathogens) and cultural controls (crop rotations) were mentioned by the IUCN *et al.* (1991) as forming part of an IPM programme.

Due to the temporal scale of agricultural sustainability, and the pressures of achieving the ecological sustainability objective of Lowrance (1990), agriculture may not be microeconomic sustainable in the short-term. Lefroy & Hobbs (1992) suggested that indicators be set at present, desirable and transitional. Lefroy & Hobbs (1992, p 23) claim that the "transitional represents a realistic compromise while desirable level remains as a target to focus whatever flexibility exists in the farm business in the future." This concept acknowledges the dynamic nature of agriculture and any process that intends to achieve sustainable agriculture. Lefroy & Hobbs (1992, p 23) went further to state that "as we will never have perfect knowledge of ecological processes, sustainability will remain a moving target."

2.5 - Comprehensive definition of Sustainable Agriculture

Using the material covered in this chapter regarding the Douglass (1984) approaches to agricultural sustainability, Lowrance (1990) objectives of agriculture, site-specificity and scale issues, the assessment of the definitions offered in the literature can be undertaken. There is some overlap between the work of Douglass (1984) and Lowrance (1990), as some of the objectives identified by Lowrance (1990) could be grouped under the Douglass (1984) general approaches to sustainable agriculture. The aim is to find a definition that considers the reoccurring themes in the agricultural sustainability debate, which are covered by Douglass (1984) and Lowrance (1990).

Appendix A includes ten of the definitions reported in the literature. These vary widely in length, detail and quality, and Table 2.4 shows the definitions with the reference to the material covered in this chapter. The recognition of the concepts within the definitions is indicated simply by the use of a 'tick' for yes and 'cross' for no. The degree to which they are covered is not shown, as the development of detailed criteria for this assessment would go beyond the intended purpose of the material included in Appendix A. The use of Table 2.4 and the discussion in Appendix A is to show the variation in possible definitions of the single term. Obviously, the degree to which the definitions cover certain issues from this chapter varies widely, with some only paying a brief mention to a certain issue, whereas another definition may devote an entire section of the definition to that issue. But even lengthy attention to an issue does not guarantee adequate reference to the issue, which again adds difficulty to the assessment.

The chosen definition is very comprehensive. The decision to select a comprehensive definition was made because many of policy documents produced recently are also using comprehensive approaches. The 'Environment 2010' document (MfE 1995b) are using an approach that assimilates environmental, social and economic considerations. The MAF (1993a) approach to, and definition of, agricultural sustainability (definition in Appendix A) is also reasonably comprehensive, and Table 2.4 shows it also covers many of the issues outlined in this chapter, at a national level. The IUCN *et al.* (1991) in 'Caring for the Earth' also include comprehensive consideration of the social and economic issues, along with environmental issues. The consistent use of a comprehensive approach by these various organisations would indicate that an attempt to define and implement sustainable agriculture will need to include acknowledgement and considerations of the wide range of issues in a comprehensive manner.

The concept of integrating the three different schools of agricultural sustainability outlined by Douglass (1984) was discussed in Section 2.2.4. This concept featured in the literature of Grove & Edwards (1993), Weil (1990), Lowrance (1990), Francis & Madden (1993), Hooper (1995), Edwards & Wali (1993), Swaminathan

(1991), Stenholm & Waggoner (1990), Lefroy & Hobbs (1992), Edwards *et al*. (1993), Senanayake (1991) and Yunlong & Smit (1994). The definition offered here, aims to integrate the environmental, social, and economic issues under the different approaches of Douglass (1984), in a comprehensive manner, and considers agriculture as a dynamic system.

The end-result may well be very subjective, but the most comprehensive definition to address the issues in this chapter is from Weil (1990, 127) and is shown below.

> "An agricultural program, policy, or practice contributes to agricultural sustainability if it:
>
> 1. Enhances, or maintains, the number, quality, and long-term economic viability of farming and other agricultural business opportunities in a community or region.
>
> 2. Enhances, rather than diminishes, the integrity, diversity, and long-term productivity of both the managed agricultural ecosystem and the surrounding natural ecosystems.
>
> 3. Enhances, rather than threatens, the health, safety, and aesthetic satisfaction of agricultural producers and consumers alike.
>
> Using this definition, certain inputs or practices may be judged "sustainable" in one situation but not in another, or at one point in the evolution of a system, but not at a later point. Such a definition treats sustainable agriculture as a dynamic system and is operational despite our imperfect knowledge of the system."

The Weil (1990) definition is very detailed, lengthy and a little 'wordy.' If the definition was to be used for farmers or other areas of application (educational institutions), then it may need a little simplification. This is not say that these groups lack the ability to understand the issues involved, but rather, in terms of implementation the definition may be a little too long or detailed, and could be simplified and edited to suit the particular circumstances. It may require editing or altering, depending on the target group or area of implementation, nevertheless, the definition does include all the issues covered in this chapter (see Table 2.4).

TABLE 2.4 - Comparison of definitions of 'sustainable agriculture'

	Weil (1990, 127)	Douglass (1984, 25)	Harwood (1990, 4)	MAF (1993a, 4)	Technical Advisory Committee (1988)	National Research Council (1989)	Schaller (1989)	American Society of Agronomy (1988)	MacRae *et al.* (1989)	Youngberg (1986)	Wynen & Fritz (1987)	Springett (19??)
Site-specificity issues Chapter 2.1	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Douglass (1984) Chapter 2.2												
'Sustainability as food sufficiency'	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓
'Sustainability as stewardship'	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
'Sustainability as community'	✓	✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✓
Lowrance (1990) Chapter 2.3												
Agronomic sustainability	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗
Microeconomic sustainability	✓	✓	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗
Ecological sustainability	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
Macroeconomic sustainability	✓	✗	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗
Scale considerations Chapter 2.4												
Vertical scale	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓
Horizontal scale	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓
Temporal scale	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗
Food-security issues Chapter 2.1	✓	✗	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓

Chapter Three
Alternative Approaches to Sustainable Agriculture

Beliefs on how to achieve sustainable agriculture vary widely and are contingent on which philosophy of sustainable agriculture is recognised. At one extreme Schaller (1993) claimed that the view was held that agriculture only needed to be 'fine-tuned' and at the other extreme, the view was that sustainability would not be achieved until conventional agriculture was essentially redesigned. This is reflected in the variation of approaches offered to achieve 'sustainable agriculture.' Merrill (1983, p 187) claimed that in "one sense the 'purists' and the 'realists' represent the two ends of a viable continuum of management practices within alternative agriculture." Merrill (1983, p 187) stated that the 'purists' felt some inputs had absolutely no place in alternative agriculture, while the 'realists' claimed that present agriculture represented systems "thoroughly out of ecological balance" and therefore required some inputs to remain economic.

Dobbs & Cole (1992) stated that much of the debate regarding the different approaches to sustainable agriculture had centred around farm yields, farm profits and environmental effects. Social considerations have not featured. Again, this illustrates a lack of balance shown between the three approaches of Douglass (1984) (Section 2.2). The debate has centred around, the 'sustainability as food sufficiency' approach (yields and income) and the 'sustainability as stewardship' approach (environmental effects), with little or no regard to the 'sustainability as community' approach and its associated social considerations.

Beus & Dunlap (1993) stated that all the different approaches to alternative agriculture shared the similar ideological elements, such as reduced environmental impacts or lowered use of external resources inputs. Ikerd (1990, p 21) stated that the various approaches to sustainable agriculture have one thing in common, in that they "challenge the concept of profit maximisation as the *dominant* factor in farm decision-making." The premise of profit maximisation is represents mainstream neoclassical theory (Klaassen & Opschoor 1991), and this reflects the extreme mentioned by Schaller (1993) that an entire redesigning of agriculture, including the overarching economic paradigm. Although, the United States Department of Agriculture (USDA) approach, low-input sustainable agriculture (LISA) is primarily oriented towards input-minimisation, to ensure profit maximisation. But most of the other approaches do question the achievement of profit as the 'be all and end all' of farm decision-making.

Reganold *et al.* (1990, p 115) stated that sustainable agriculture did not imply a return to "pre-industrial revolution" methods, but rather was a combination of traditional conservation techniques and modern technologies.

Merrill (1983) stated that the various proponents of alternative agriculture did not always agree about the details of their different approaches. Buttel (1993, p 185) suggested that proponents of "sustainable agriculture should actively and vigorously debate the virtues of the various approaches, but should also recognise that the other approaches have the potential to contribute." The aim is to integrate the different ideas and assess the contributions that each group of research can make to the debate and progression of sustainable agriculture. The key for achieving a satisfactory response to sustainable agriculture will be multidisciplinary in approach, and a number of different approaches to sustainable agriculture will need to be implemented. Buttel (1993, p 184) argued that "diversification of sustainable agriculture research is an insurance policy against possible failure or limitation of any one approach." So just as the proponents of sustainable agriculture claim that the biological diversity offered by sustainability gives protection against unforeseen threats to monoculture farming operations, research diversity will protect against threats to, and problems faced by, any one single approach. The different approaches also represent the cultural diversity in views (Berkes & Folke 1994; Gadgil 1987; Gadgil & Berkes 1991). This cultural diversity provides the variation in skills and knowledge that may provide information on sustainable agricultural practices.

The approaches outlined in this chapter vary widely in their nature. The approach taken by the USDA, which is Low-Input Sustainable Agriculture (LISA), is grounded in large amounts of research undertaken in recent years, which is still ongoing. Some of the other approaches, such as biodynamic farming, have been used in the past, and are more a populist movement of agriculture. Scientific analysis regarding the preparations used in biodynamic farming is very difficult, and their effectiveness may never be proven (Palmer *pers com.*). These approaches, although not sourced in scientific research, offer a belief system, and many of their practices, such as fallowing, crop rotation and other near-organic processes, do offer many advantages in soil quality over their conventional counterparts (Reganold *et al.* 1993). Thus these approaches cannot be dismissed due to lack of scientific evidence regarding the preparations. These systems offer important considerations of the social component of agricultural sustainability (Section 2.2.3), such as factors associated with social wellbeing. These farmers may feel that practices are 'right' in terms of positive environmental outcomes. The minimal use of external, artificial inputs, would suggest that some of their practices are more aligned with sustainability, than conventional practices that are heavily reliant on fossil-fuel based inputs. An approach, such as agroforestry, on steeper, more marginal land can offer increased sustainability, as they diversified production-base can provide more stable income for the farmer, which addressed the microeconomic sustainability issue, and the reduced erosion that can occur under areas of trees (Hicks 1989b), which are incorporated into the pastoral system.

The instances in which each of the approaches would be applied would vary. The use of agroforestry may be best suited for steeper hill-country, although shelterbelts may be used in horticultural operations on Class I to reduced wind erosion, and this is a form of agroforestry. LISA may have little application in the hill-country, where inputs, especially in the form of synthetic fertilisers, have been reduced greatly since the removal of subsidies (MAF 1993a). The site-specificity issues mentioned in Section 2.1 will play a large role in the farm-scale approach that is implemented in response to the need for sustainable agriculture. The different approaches outlined in this chapter may be implemented in a multitude of forms on individual farms, to suit the environmental, social and economic requirements at each farm. Boeringa (1980) argued that there were as many forms of agriculture as there were farms, as each varies slightly from the next in management style and approach.

The following chapter outlines six different approaches to sustainable agriculture. These six approaches are; low-input sustainable agriculture; regenerative agriculture; agroecology; biodynamic agriculture; organic agriculture; and agroforestry. They are listed, and discussed, in order to illustrate the diversity and variation in approaches.

3.1 - Low-Input Sustainable Agriculture

The 'farm crisis' of the 1980s in the United States, with serious droughts, high real estate related production costs, and the oil shortages that caused farm input costs to rise dramatically, shaped the definition of sustainable agriculture, according to Buttel (1993), with the focus on low-input sustainable agriculture (LISA). Francis & Madden (1993) stated that LISA funded projects began in 1988, as an initiative under the 1985 Food Security Act, better known as the 'Farm Bill.' The United States Department of Agriculture's (USDA) research and grants programme, known as LISA, claimed Madden & O'Connell (1990, p 61), responded to "an emerging interest by many farmers for a more cost-effective and environmentally benign agriculture." Ikerd (1990, p 21) claimed that "another reason for questioning greater reliance on external inputs is growing evidence of their external social or environmental costs."

Dahlberg (1991) also stated similar motivations for present interest in LISA. So while the early stages in the development of LISA addressed the need for minimising input costs due to rising farm debts, the present motivations are also due to an environmental ethic, as well as lowering farm input costs. The LISA acronym, according to Ikerd (1991) is a combination of two related, but different concepts, the first is low-input (to reduce any environmental impact of inputs and economic costs) and sustainable agriculture (recognition that the long-term productivity of farming relies on our ability to ensure agriculture is ecologically sound and profitable). The focus previously has centred on the low-input part of approach, with little focus on the sustainable agriculture part. Weil (1990, p 127) states that low-input alone is not an appropriate single criterion for assessing sustainability, but rather, "it is one of the several possible *means* of achieving the ends of sustainability."

The funding from LISA is allocated to projects that will result in readily accessible findings for farmers, although in the fiscal years 1989-1990, Congress only appropriated (US)$4.45 million to the LISA fund. This level of funding, according to Madden & O'Connell (1990, p 62), corresponds to "[US]$1.99 per farm; [and] it amounts to less than one-thousandth of the annual sales of pesticides in the United States." Reganold *et al*. (1990) and Hassebrook & Kroese (1990) stated that the level of funding from the USDA amounted to one half of one percent of the total USDA research and education annual budget. The level of funding is very low, and only small numbers of the proposals submitted for review, are accepted. These authors argued that the level of funding needed to increase, if the programme was to be successful.

The USDA, stated Schaller (1993, p 92), holds the opinion that conventional agriculture is basically environmentally sound, and "careful and efficient farming will ensure its sustainability, e.g. farmers should use only the amounts of fertiliser and pesticides actually needed." This minimisation of inputs approach is at the 'fine-tuning' end of the belief spectrum outlined by Schaller (1993), covered at the beginning of this chapter. Schaller (1993, p 93) stated that more "careful and efficient farming must be encouraged, but only as a hopeful starting point on the long journey to sustainability." This is consistent with the Lefroy & Hobbs (1992) concept in Section 2.4.3 suggesting that environmental indicators be set at present, desirable and transitional stages. The LISA approach would form a transitional stage before the agricultural system addressed other issues aside from the use of inputs, such as social and community issues. The lack of social considerations, outlined in Section 2.2.3 feature very rarely in LISA analysis. The other environmental issues covered in Section 2.2.2, that are not related to simply reducing inputs, such as degradation of the resource-base, also feature rarely.

The reduced inputs approach can in some cases offer profitable farming, as the costs of inputs are reduced, which in terms increases the profit margins. The results from farms undertaking LISA practices are often compared with their conventional counterparts, and Madden & O'Connell (1990) give an example where a LISA farm had the highest wheat production per acre in Story County, Iowa, along with reduced soil erosion and input costs, opposed to other farms in the area. Hassebrook & Kroese (1990, p 26) state that LISA practices can reduce or eliminate the use of petrochemicals with "modest, if any, yield reductions."

Stinner & House (1989) stated that main aim of past agricultural research was for yield maximisation, but with produce prices falling, and constant/increasing input costs, and rising land prices, had cut the profitability guiding the main assumption of this approach (maximum yield equates to maximum income). Soule & Piper (1992) stated that prices of fertilisers, pesticides and fuel all fluctuate with the oil prices, which created further uncertainty for farmers regarding input costs. Stinner & House (1989) alluded to sharply increasing costs of inputs, that had previously been relatively inexpensive, as lowering the profitability of current production practices.

The LISA approach aims for increased farm profits, not necessarily gross income. Madden & O'Connell (1990, p 64) quoted an 11 year study of Illinois farmers, that "found that farmers using the highest amounts of purchased inputs per acre harvested more bushels but earned less profit per acre compared with farmers using less input per acre." The decreased use of inputs on the LISA farms enabled them to have greater profits, as their outgoings were lower than their high-input counterparts.

The distinction between internal and external inputs was a concept first developed by Rodale (1988), and is a useful distinction to make, although external outputs cannot be entirely condemned. Although Weil (1990) maintained that the distinction between external and internal inputs is not always clearcut and easy to define. Ikerd (1990) stated that defining the boundary between low-input and high-input agricultural systems was difficult, as no division or point of clear separation exists. Ikerd (1990, p 18-19) then advocates the use of "lower-input" as a more appropriate term. The term LISA refers to lower-input, not no-input. Ikerd (1990, p 20) claimed that LISA "does not imply total elimination of external inputs, just lower use of external inputs."

Francis (1990b) stated that information was an essential internal resource in low-input sustainable agriculture, as it can be shared between farmers without reducing its value. Information is also renewable, as it can be applied in the field continuously, and even becomes more valuable with increased use (experience). Ikerd (1993, p 159) argued that knowledge can be created, in principle by, "just as effectively by the weak and poor as by the strong and rich." Thus substituting information and knowledge, as opposed to external inputs, is more socially equitable, as it is more readily accessible and able to be generated by all groups in society (social equity is an important part of agricultural sustainability, under the 'sustainability as community' approach of Douglass (1984) in Section 2.2.3).

Pimental *et al*. (1989) stated that fossil energy is an important primary input into agriculture. Patterson (1985, p 293) stated that the fuel inputs for New Zealand agricultural production is "almost entirely petroleum and diesel [and] is required to provide mechanical energy for tractors, harvesters, road vehicles and other miscellaneous engines. Electricity is [also] required to operate milking equipment, shearing equipment, pumps, lights, and to heat water particularly on dairy farms." Patterson & Earle (1985) stated that the entire food production system of New Zealand was estimated to use about 28% of the nations primary energy. This energy use could be attributed to the different sections of the food system, with 36% from production, 28% from processing, and remainder from wholesaling/retailing, shopping and household consumption. Patterson & Earle (1985) stated that their research comparing New Zealand with the food systems in the United States and Sweden concluded that the greatest energy requirements came from post-production sectors. This reinforces the need to consider all the steps in the vertical scale of agriculture, as outlined in Section 2.4.2 and Figure 2.1, as the energy use on the farms, forms only part of the entire energy input into the food and fibre utilised by society. Patterson & Earle (1985) also found that New Zealand used proportionately more energy in the production sector, as much of the agricultural produce is exported in a relatively unprocessed form, which decreases the energy requirements of the post-production sectors, relative to the on-farm/production sector. These figures highlight the current levels of food and fibre production could not be maintained without the use of these, non-renewable fuels. The aim of LISA is to reduce these types of non-renewable resource inputs, which threaten the achievement of agricultural sustainability in the temporal scale. This may be more difficult in practice, than a simply statement of the aim of LISA would imply.

The LISA approach can use a number of soil and water conservation techniques to preserve these internal resources according to Pimental *et al.* (1989, p 16), although the "set of agricultural technologies, however, has to be selected and adapted to the particular environmental site of the region." Flach (1990, p 42) maintained that LISA farms can "be effective [soil] conservation systems because they provide soil cover during most of the year and because they can make better soils that have less runoff and more resistance to erosion." However, if this is to be achieved, it will need to be selected on a site-specific basis as mentioned by Pimental *et al.* (1989). J Williams (1990) stated that the adoption of LISA was attractive as it offered a potential reduction in externalities or negative consequences for society, such as soil erosion, chemical residues on agricultural produce and pollution of water supplies.

Ikerd (1990, p 19) stated that " if the socioeconomic dimensions of sustainability are ignored, low-input may appear to be synonymous with sustainability." The concepts of food security and utility, along with other social aspects (community issues), along with economic considerations, such as profit, may well mean that low-input agriculture is not sustainable. If it does not meet society's expectations in terms of food production and profitability, then it will not be sustainable. Ikerd (1990) states that neither lower inputs or higher profits are the sole measures of sustainability, as there are socioeconomic considerations that also need to be included. These would include the issues addressed in the Douglass (1984) approach of 'sustainability as community' covered in Section 2.2.3.

The range of approaches and diversity of technologies used in LISA, along with the site-specific nature of agriculture covered in Section 2.1, results in according to Ikerd (1990, p 20), "no [general] recipes for successful low-input, sustainable agricultural systems." The exact implementation at each site will vary, but past work and 'successful' implementation of LISA can be used as a model. Schaller (1990, p 12) maintained that the adoption of LISA did not imply returning to how farming was undertaken generations ago (ie. pre-industrial agriculture), before the widespread use of fertilisers, but rather, "it incorporates many modern, sophisticated, high-yielding practices, such as biological pest control."

Hassebrook & Kroese (1990, p 26) claim that in "spite of being woefully underfunded, this [LISA] program has been successful in stimulating a substantial amount of research with potential for developing a more economically, environmentally, and socially sound agriculture." The LISA funded projects will, according to Stenholm & Waggoner (1990), involve several years of development and analysis, before relevant and adequate results can be drawn out. But, Rodale (1990a, p 15) stated that increasingly there "is a greater body of evidence showing not only that low-input, sustainable agriculture works, but how it works and how it can be applied in wider agricultural situations." This according to J Williams (1990) will need to illustrate microeconomic sustainability to overcome the present perception held by farmers is that LISA will be unprofitable and risky in the immediate future

Altieri (1989) stated that by focussing on the low-input approach to sustainable agriculture, a number of biotechnologies will be proposed as viable alternatives to resolve the sustainability issue. These are not scale-neutral (more affordable for the larger farms) or capital-neutral (requires more input costs for farmers), and enhance the reliance farmers have on the private sector. This does have implications on vertical scale issues (Section 2.4.2) and community/social issues (Section 2.2.3). The reliance of the private sector for may be replacing one input (pesticides) with another (biotechnology), which still leaves the farmer vulnerable to fluctuations in input prices, which may increase. Information, and internal practices, would offer more stability to the farmer, rather than relying on external markets (which the farmer cannot control). Ikerd (1990, p 23) stated that reliance of external input markets by farmers embodies risks that inputs may "no longer be available at reasonable costs from external sources." The definition of sustainable agriculture in Section 2.5, offered by Weil (1990) selected against external inputs, that Weil (1990) stated, are not controlled by the farmer or the local community (such as fertiliser)

Summary of LISA

Lowrance (1990, p 52) using the objectives outlined in Section 2.3 and Table 2.2, stated that the guiding principles of LISA are "ecological, agronomic, and [micro]economic sustainability. These goals will be achieved by substituting skilled management, on-farm resources, and biological resources for purchased chemical and nonbiological inputs from off-farm sources." The LISA approach pays little attention to some of the issues covered in the stewardship approach (Section 2.2.2) of Douglass (1984), such as maintenance of life-support systems and avoidance of environmental degradation. The consideration of future generations is not necessarily implied by the LISA approach. The economic considerations are given prominence, as input-minimisation was initially motivated by cost reduction and profit maximisation. The social aspects (Section 2.2.3), aside from provision of jobs and livelihoods do not feature in LISA research, such as the role and importance of the rural community. The site-specificity issue is addressed in some instances, as comparisons are made between the yields of LISA farms in different instances, or locations. Food safety issues are addressed, as reduction of pesticide inputs, and residue levels are possible with the LISA approach. The New Zealand agricultural system is not as reliant on the large levels of synthetic inputs, to the degree that the United States agriculture is, which is where the bulk of the LISA research has taken place. The application of LISA to the hill-country agricultural system may be of little benefit until viable alternatives to fossil fuels can be offered. The principles underpinning LISA can be validated within the framework of thermodynamics. LISA represents a reduction of inputs into the system, which in turn leads to a reduction in the waste residuals or pollution leaving that system, termed the 'mass balance principle' (Ayres & Kneese 1969; Kneese et al. 1970; Victor 1972).

3.2 - Organic Agriculture

Barr & Cary (1992, p 195) stated that organic agriculture "started in England in the 1920s and 1930s, amidst the concern over arsenic residues in food." Rodale (1990, p 273) credited Howard as the founding "father of the worldwide organic agricultural movement." Organic agriculture has become one of the prime driving forces amongst alternative types of agriculture, in the path toward greater sustainability. Northburn (1940) was the first author to use the word organic as a term for an entire agricultural philosophy and practice (Harwood 1990). He proposed the ideas of integrated, decentralised and chemical-free agriculture (Harwood 1990).

The New Zealand Biological Producers & Consumers Council (1994:1, p (A)2) stated that organic production, which "includes such terms as biological husbandry, eco-agriculture, natural, sustainable, and biodynamic, seeks to produce food of optimum quality and quantity, and to manage productive ecosystems according to a total concept that endeavours to make them sustainable and non-polluting to the environment, while providing an appropriate level of income to the producer(s), families and communities."

The definition by the NZBPCC (1994:1) addresses many of the issues covered in the literature regarding sustainable agriculture. The food quality/safety issues were mentioned by MAF (1993a), IUCN *et al.* (1991), Parr *et al.* (1992), Keeney (1993), Jennings (1990), Harwood (1990) and Schaller (1993) amongst others. The avoidance of pollution produced by agricultural systems was mentioned by MAF (1993a), Zinn & Blodgett (1989), Keeney (1993), Lowrance (1990), Douglass (1984), Schaller (1993) and National Research Council (1989). The importance of income issues for the different levels of the horizontal scale (Section 2.4.1) was covered by Blakeley (1990b), Keeney (1993), Weil (1990), Ikerd (1990), Edwards *et al.* (1993), Lowrance (1990), Reganold *et al.* (1990) and Lefroy & Hobbs (1992). The use of total farming or systems approach was mentioned by Harwood (1990), Rodale (1990), Ikerd (1993), Weil (1990), Swaminathan (1991) and Edwards & Wali (1993). The use and maintenance of a productive ecosystem was discussed by Douglass (1984), Lowrance (1990), Dahlberg (1991), National Research Council (1989), MAF (1993a), IUCN *et al.* (1991) and Merrill (1983).

MAF (1991b) stated that produce could only be labelled 'organic' if it met the guidelines of the International Federation of Organic Agricultural Movements (IFOAM). The only two authorities that MAF (1991b) claim to certify the IFOAM standards, are the New Zealand Biological Producers and Consumers Council (NZBPCC), using the Biogro trademark, and the Biodynamic Farming and Gardening Association (BDFGA), using the Demeter trademark. MAF (1991d) stated that the NZBPCC was established in 1982 and the NZBPCC standards were ratified in 1988 by IFOAM inspectors (MAF 1991d). MAF (1994b, p v) state that most submissions on the 'Proposed Policy on Organic Agriculture' (MAF 1991b) considered the approach of using these two authorities to certify organic produce was "working well." Fisher & Tilbury (1990a) claim that the organic agriculture movement is small, with in most western markets, less than one percent of fresh produce is sourced from organic farms, and the figure for processed goods is even lower still.

MacKay *et al.* (1991) began a study of a farmlet that met the certification standards for organic production of the NZBPCC, against a conventional counterpart. The aim of research is to identify the constraints facing the chemical-free production on the organically farmed land, by using the conventional farm as a baseline or control, for performance. Fisher & Tilbury (1990a) state that organic production can be profitable, with the Levin Horticultural Research Centre achieving gross margin for sweetcorn of $790 a hectare, compared to $335 for the conventional equivalent.

Much of the arguments regarding organic agriculture are focussed on 'all or nothing' states Lockeretz *et al.* (1981), as if all farmers are to attempt this approach, or indeed go 'cold turkey' on inputs. Francis (1990) dispelled four myths that many hold about sustainable agriculture, with one referring to whether low-input farming meant having no synthetic external inputs on the entire farm. To be certified organic, the agricultural system must meet the NZBPCC standards, which does mean eliminating most conventional inputs.

A possibility, would be to have part of the farm certified organic, and reduce inputs for another part of the farm (which would not receive NZBPCC certification) is a possibility. These two areas have to be run separately, so that inputs and practices in the non-certified area have no impact in the certified area. This illustrates the possible variation in approaches that can be applied, with a small part of the farm used for purely organic farming. Fisher & Tilbury (1990d) state that as these blocks have to be run separately for organic certification, and discourages dual management. This may be too impractical for farmers, thus discouraging dual management within a property as a possible alternative. The site-specific nature of agricultural sustainability requires consideration, with regard to whether running two separate units within the farm meets the farmer's requirements, as Edwards *et al*. (1993) noted that farmers must perceive benefits for them if methods are to be implemented. Again, considerations regarding the ability and economic position of the farmer are important, as MAF (1993a) state that financial pressures can affect the ability of farmers to respond to ecological problems. The idea of a transitional stage in the implementation of sustainable agriculture, as proposed by Reganold *et al*. (1990) and Lefroy & Hobbs (1992) may be required to address this.

A report on organic farming was carried out by the United States Department of Agriculture in 1980 entitled 'Report, and Recommendations on Organic Farming'. The reports conclusions were summarised by Reganold *et al*. (1990, p 115) as stating that organic farms were more "energy efficient, environmentally sound, productive and stable and tends towards long-term sustainability."

Fisher & Tilbury (1990a) claim that demand for organic produce is increasing, with a premium price paid for the organic product over the conventional equivalent, as consumers perceive the product as healthier and more environmentally sound. Fisher & Tilbury (1990c) state that 10% is a conservative price premium for organic produce, above the price of the conventional equivalent. Blakeley (1990a) stated that the growing ranks of 'green' consumers in Britain came from all social classes, ages and regions. This dispels the myth that only the more wealthy of society buy the produce. Any person can have an environmental ethic that drives them to buy organic produce, although high-income earners are more able to purchase the produce, as they have a higher disposable income. There is an unmet demand for organic produce in Australia according to Conacher & Conacher (1991), and the ability to meet this demand has been hindered by problems associated with supply, lack of appropriate marketing outlets and lack of industry standards. Conacher & Conacher (1991) give the reasons for the increase in demand for organic food in Australia as diet and health issues, clean food issues, and environmental concern.

Blakeley (1990b, p 11) stated that in "North America and Europe, green consumers are pushing environmentalism from its traditional niche in health-food stores and co-ops into mainstream supermarkets." MAF (1991d) stated that in the United States consumer demand for organic produce in the late 1980s was based on environmental concern, as opposed to food safety and quality issues that drove demand in the early 1980s. Similar research in younger markets such as Australia showed consumer demand was driven by similar reasons to the United States in the early 1980s, and MAF (1991d) assumed that this would change to a basis of environmental ethic, as had happened in the United States.

Lamb (1989) undertook a study on awareness of organic produce markets in Christchurch, New Zealand. Lamb (1989) claimed that between May 1987 and December 1988, awareness of organic agricultural produce increased from 46% of households, to 65%, although of the total households surveyed (410), only 1.2% identified themselves as committed purchasers of organic produce. The awareness of the produce is increasing, but purchasing/consumption of organic produce did not increase correspondingly. Research is required to identify why the awareness has not transponded into increased consumption. Possible reasons could include lack of ease of access to products (at supermarkets), consumer apathy, lack of reliability or supply or lack of infrastructure to supply the retail outlets adequately. The premium price for the organic produce, above the price of its conventional counterpart may dissuade some potential purchasers.

Davies (1988) outlines the use of rotations with stocking of pastures, with longer rotations advocated to help grasses and herbs survive better. Davies (1988) also claims benefits from fallowing pastures, with part (one seventh) of the total farm area excluded from stocking from spring to autumn. The area left in fallow is moved around, until in the eight year, the same area that began the rotation of fallowing, is again in fallow. Fisher & Tilbury (1990b; 1990c) state that pest control in organic systems is preventative, as opposed to reactive. Although some natural sprays can be used, but must be well targeted as they have little residual effect and break down rapidly. Fisher & Tilbury (1990a) state that some inputs are permitted in organic farms, but these must meet the NZBPCC (1991:1) Certification Standards.

Reganold *et al*. (1990) stated that to reduce the application of pesticide inputs, the use of Integrated Pest Management (IPM) was required in alternative agricultural systems, such as organic farming. The practices that can be incorporated into an IPM programme are outlined in Section 3.3. Parr *et al*. (1992) state that the concept of soil quality is being incorporated into organic certification standards in the United States, with soil physical/chemical attributes being at least maintained, if not improved.

Summary of Organic Agriculture

The definition of organic production offered by the NZBPCC (1994:1, (A)2), which MAF (1991b) stated were the organisation that could certify food and fibre as 'organic' in a manner that was consistent with IFOAM, covers many of the issues addressed in Chapter 2. The paragraph following the definition at the beginning of Section 3.2 lists some of the authors that consider the individual concepts within the definition as important to agricultural sustainability are listed. The definition incorporates issues of food-safety, which is one of the main consumer motivations to purchase organic produce, especially as markets develop (Blakeley 1991b). The maintenance of productive ecosystems, by encouraging more sustainable practices, such as increased cycling of the minerals, as opposed to linear flows. This addresses the increased agronomic sustainability issue, by increased cycling, reducing the need for external inputs. There are thermodynamic limits to the effectiveness of this practice. According to the second law of thermodynamics the 'entropy' of matter at each successive stage in the agricultural system increases, and therefore the matter and energy is less useful as an input in the next stage (Georgescu-Roegen 1971; Binswanger 1993, Ruth 1993). The 'entropy gap' can only be closed through the infusion of equal or greater amounts of energy, either from solar, or other sources. The other sources, in the case of agriculture are fossil fuel inputs for energy or chemically bound energy, in such inputs as fertilisers. The avoidance of pollution of the surrounding environment is a key component of ecological sustainability as outlined by Lowrance (1990). The site-specificity issue is addressed in the certification process, as the farm history and intended land-use and practices are covered. The use of transitional stages in the certification process allows for residual levels of synthetic inputs in soil and pasture to be reduced. The economic viability of organic agriculture for the farmer, his/her family and the rural community are specifically mentioned in the definition, which gives recognition to microeconomic sustainability issues and also the implications of this on the economic well-being of the wider community. The production of an adequate quantity of food also addresses some of the sustainability as food sufficiency approach, although quality of food is important as overall yields. The premium prices obtained for organic produce can often offset any loss in production, that may or may not, occur.

3.3 - Regenerative Agriculture

Lyle (1994) and Edwards *et al.* (1993) claimed that it was Robert Rodale that first promoted the use of the term 'regenerative' in relation to land use, in his application of organic agriculture. Flach (1990) also stated that Rodale has been advocating regeneration, not just conservation, of the soil resource.

The goals of a regenerative agriculture are outlined by Lyle (1994, p 190) as:

- "A capacity for self-renewal;
- reasonable levels of productivity within the sustainable capacities of available energy, soil, and water;
- beneficial integration with the larger ecosystem including the human community;
- profitability as measured by accounting methods that include ecological and social costs as well as the internal costs included in conventional accounting;
- careful management of the landscape including the microbiotic community within the soil."

Lyle (1994, p 192) stated that the "appropriate practices and technologies for any region are the product of that region's climate, landscape, and human culture." This is aligned with the statements made by Schaller (1993), Stenholm & Waggoner (1990) and Pimental *et al.* (1989), that each site and the conditions found there (such as climate, soils ...) will ultimately determine what is 'sustainable agriculture' for that site (site-specificity in Section 2.1). Merrill (1983, p 186) stated that alternative agriculture was essentially individualistic and each "farm is considered unique and the methods or techniques and materials used are tailored to meet the specific needs of each farm."

Lyle (1994, p 194) stated that the "methods of regenerative agriculture are as diverse as their sources." This again illustrates the difficulty in defining the sustainable agriculture approaches past the initial, basic level, as the practices undertaken vary widely (due to the site-specificity issues mentioned above). Lyle (1994, p 194) however, claims there are five clear, interrelated "directions of change:

1. protection and revitalising the soil
2. planting for polycultural diversity
3. strategic pest control
4. interactive role of animals
5. integrated farming systems"

These 'directions of change' are well documented in the literature regarding sustainable agriculture. The inclusion of greater diversity, with animals, and planting (such as agroforestry) highlights the overlap and interrelationships between the different approaches to sustainable agriculture. Lyle (1994) states that regenerative agriculture can incorporate many ideas common to the other approaches, such as crop rotations, diversification of species in the production unit, and agroforestry. Protecting the soil in the implementation of sustainable agriculture was mentioned by IUCN *et al.* (1991), Parker (1990), Reganold *et al.* (1990), Harwood (1990), Merrill (1983), Schaller (1993), Buttel (1993), Rodale (1990b), Douglass (1984), Weil (1990) and MAF (1993a) to name a few. The inclusion of diversity in an agricultural system was noted by Reganold *et al.* (1990), Keeney (1993), Harwood (1990), Ikerd (1990), Swaminathan (1991) and Plucknett (1990). The use of integrated/strategic pest management, using long-term considerations (preventative as opposed to reactive) was covered by IUCN *et al.* (1991), Blakeley (1990b), Reganold *et al.* (1990), Swaminathan (1991), National Research Council (1989), Altieri (1989), Barr & Cary (1992) and Pimental *et al.* (1983) amongst others. The use of integrated farming systems was discussed by Edwards *et al.* (1993), Lockeretz (1991), Merrill (1983), MAF (1992c), Ikerd (1993) and Edwards (1990).

Regenerative agriculture states Lyle (1994) can include the use of Integrated Pest Management (IPM). The range of methods which may be used to control pest species under IPM, are outlined in IUCN *et al.* (1991), such as biological control (use of predator species), cultural controls (crop rotations/diversification) and the use of resistant species. Edwards *et al.* (1993) asserted that there was little understanding as to what degree, and what kinds of, biodiversity requirements are involved in successful IPM. Reganold *et al.* (1990) also claimed that planting times and tillage techniques could be used, along with the methods mentioned above. The aim of IPM, according to Lyle (1994) is to keep the pest levels beneath a tolerable threshold level established by the farmer. The National Research Council (1989, p 208) state that this economic threshold is "when the predicted value of the impending crop damage exceeds the cost of controlling the pest" which is essentially a cost-benefit analysis. This is aligned with the Lowrance (1990) microeconomic sustainability concept in Table 2.2. That is, action is taken when pest damage (potential lost earnings) exceed IPM costs (cost to avoid damage), which in turn maintains farm economic viability (microeconomic sustainability). Action is taken, as farm profit is achieved (returns on damage avoided, minus costs, equals profit), and if action is not taken, damage incurred affects farm income (and therefore microeconomic sustainability). National Research Council (1989, p 219) and Lyle (1994, p 205) stated that IPM has the potential to virtually eliminate pesticide use, although some use may be required in emergency situations in the foreseeable future.

Lyle (1994, p 10) outlined the philosophy behind the regenerative approach to sustainability, when he argued that the "first law of thermodynamics makes it clear that the one-way throughput system in unsustainable energy and materials cannot be created or destroyed, only transformed from one state to another. This means that, in order to be sustainable, the supply systems for energy and materials must be continually self-renewing, or regenerative, in their operation. That is, sustainability requires ongoing regeneration." The strong recognition of the limited temporal scale of present use of non-renewable resources is the main basis of regenerative agriculture. The use of fossil fuels to manufacture inputs and run vehicles is seen to be flawed, because when the resources are depleted, the system will require much alteration, as new substitutes will need to be found. The agricultural system is driven by the use of energy from two sources; solar (fixed through photosynthesis), which is renewable and fossil fuels, which are not renewable. The fossil fuels are used to supplement the gap between the maximum energy input that the sun is able to provide, and societys need for output. An increase in the effectiveness or efficiency of human use of the solar energy could substitute, in part, some of the present levels of fossil fuels. As the entire agricultural system relies heavily on these non-renewable resources, new alternatives will be required to maintain soil fertility, manage pest populations and run vehicles, which are all presently done with the aid of fossil fuels.

Freudenberger (1986) defines 'regenerative agriculture' as including considerations of the rate of use and regeneration of essential resources, and the rate of waste production produced by the agricultural system should remain within the capacity of the earth to support and absorb these wastes. Regenerative agriculture, states Freudenberger (1986) should also provide an acceptable quality of life for humans that can be sustained indefinitely.

Dahlberg (1991, p 338) claimed that regenerative agriculture "casts a wider net through through the uses of ecological hierarchy theory." The aim of regenerative agriculture is for regeneration over the long-term, not only of the cropping or pastoral systems, but also for rural communities, landscapes and regions. This approach as outlined by Dahlberg (1991) gives important recognition to the linkages and interrelationships between the scales. The reference to farms, rural communities and regions is recognition of the horizontal scale in Section 2.4.1 (Table 2.3). The different objectives of Lowrance (1990) in Table 2.2 are also able to be considered within this approach, with ecological issues at the landscape level and economic/social issues at the regional level. The long-term consideration also implies a temporal element (Section 2.4.3).

The regenerative approach can be widened stated Dahlberg (1991), to include the entire food system - from production, processing, preservation, distribution, preparation, consumption, recycling and disposal. The investigation and consideration of the entire food cycle is recognition of the vertical scale in agriculture shown in Figure 2.1, as it considers the agricultural process beyond the farm-gate (the authors that noted the importance of recognition of the vertical scale in implementing sustainable agriculture are shown in Figure 2.1).

Lyle (1994, 10) outlines the characteristics of regenerative systems as:

- "operational integration with natural processes, and by extension with social processes;
- minimum use of fossil fuels and manmade chemicals except for backup applications;
- minimum use of nonrenewable resources except where future reuse or recycling is possible and likely;
- use of renewable resources within their capacity for renewal;
- composition and volume of wastes within the capacity of the environment to reassimilate without damage."

The consideration of energy use in the Lyle (1994) characteristics of regenerative systems is important, as Lovins & Lovins (1982) calculated that United States agriculture uses on average 2 calories, for every calorie produced. This is just an average figure, and for some produce types, the value is much greater, and obviously as this is an average figure, for some produce types, the value will be lower. The important issues from the Lovins & Lovins (1982) work is the energy inefficiency of current agricultural production in the United States. The current rate of energy use in agriculture does not compare favourably with the regenerative approach.

Lyle (1994, p 192) states that regenerative agriculture incorporates past "preindustrial" agricultural practices, and learns from the mistakes and successes of these. The preindustrial practices are not without fault either (Lyle 1994), and Hillel (1992) outlines some of the environmental degradation that has occurred due to past agricultural land use, and is occurring, due to present agricultural land use.

Lyle (1994) claimed it took 2 to 4 years for farms to produce adequate yields when changing from conventional to regenerative practices, and gave the example of Fred Kirschenmann. His farm produced good yields in the first year due to favourable weather conditions (Lyle 1991), but the second and third years were more difficult, with yields increasing in the fourth year, and even further in the fifth, and since then the yields have been better. This illustrates the problems that can be faced in the short-term, when farms are in the transitional stage. Reganold *et al.* (1990) and Lefroy & Hobbs (1992) discussed the need for a transitional stage in the implementation of sustainable agriculture, to reduce potential economic hardship for farmers.

Lyle (1994) admits that a lot more research is required on regenerative agriculture. Lyle (1994) proposes many questions that future research must answer, such as shaping economic and social processes to be compatible with the complexity of regenerative systems, making better use of on-site energy and defining the sustainable production levels for a farm, given the site-specific nature of parameters that control that sustainable threshold (such as soils, slope, and the ability to assimilate waste).

Summary of Regenerative Agriculture

The agronomic sustainability concept of Lowrance (1990) is included in the regenerative approach by considering productivity within the capacity of water, soil and energy. The use of these resources beyond their sustainable capacity is avoided, so the life-support capacity of these resources must be maintained. The ecological sustainability concept is included in the beneficial integration with the wider ecosystem, which is important recognition of the effects that agriculture can have on the wider environment. The economic sustainability is widened to include internalisation of externalities, such as environmental and social costs of agricultural production, in the accounting of costs of the resulting produce. The approach is site-specific, with Lyle (1994) making reference to the diversity in responses, to suit the climatic, soil and other local differences that may occur. The microeconomic and macroeconomic sustainability issues of Lowrance (1990) are included in the Lyle (1994) definition of regenerative agriculture, under the need for profitability. The main issue absent from the Lyle (1994) definition is the safety of food and fibre produced from regenerative systems. The sustainability as community approach of Douglass (1984) features lightly in the definition, but simply states that agriculture needs to be integrated with the human community, which offers little detail.

3.4 - Agroecology

Francis & Madden (1993) and Ikerd (1993) stated that agroecology is a combination of agriculture with ecology. Edwards *et al.* (1993) stated that agroecology was a relatively new discipline that combined the techniques and paradigms of ecology with the practices of agricultural science. Francis & Madden (1993, p 131) claimed that it joins the science of crop/livestock production together with the study of natural systems to aid in designing "managed ecosystems." Edwards *et al.* (1993) stated that both agricultural science and ecology had contributed to present knowledge of agroecosystems.

Dahlberg (1991) proposed that agroecology is an approach that studies the methods by which traditional Third World and indigenous agricultural systems achieve sustainability through social, economic and technological adaptions to the local environment. Again, this study of the diversity in social adaptations of agriculture to the natural environment, represents the cultural diversity in views (Berkes & Folke 1994; Gadgil 1987; Gadgil & Berkes 1991).

The study of traditional agroecosystems to understand why they have persisted is an important role of of agroecology states Edwards *et al.* (1993), and they propose that biological diversity and nutrient cycling mechanisms are the two main reasons for traditional agriculture's ability to be sustained over time. These traditional systems also have relatively low amounts in inorganic supplements (inputs) and incorporate crop rotations and other cultural practices.

A major feature of traditional agroecosystems Edwards *et al.* (1993, p 104) noted, was the how well adapted the farming practices were to the local conditions, and the authors termed this adaption to the local environment "site specificity." Edwards *et al.* (1993) stated that in conventional agroecosystems, the use of pesticides had replaced the crop rotations and natural biodiversity as methods to control pests and diseases, while inorganic fertiliser inputs had replaced biological nutrient cycling. The result Edwards *et al.* (1993) claimed was an increased reliance on chemical inputs. Soule & Piper (1992) stated that prices of fertilisers, pesticides and fuel all fluctuate with the oil prices, which created further uncertainty for farmers regarding input costs. Edwards *et al.* (1993) propose that a key alternative to future dependence on chemicals is maximise the contribution of biodiversity to pest control, through such techniques as IPM.

Altieri (1987) states agroecology as an approach that defines, classifies and studies agricultural systems from a strong ecological and social perspective. Altieri (1989, p 38) states that agroecology should "delineate the ecological principles necessary to develop sustainable production systems" (recognition of the 'ecological sustainability' objective outlined in Table 2.2).

Agriculture, claims Ikerd (1993, 153), represents an attempt to enhance the productivity of a natural system to favour humans (to produce adequate food supplies and income for farmers). Edwards *et al.* (1993) argued that agricultural ecosystems are kept at the early successional stages of development to take advantage of the high production to biomass ratios (Dover & Talbot 1987), to maintain these desired adequate production levels. Hassebrook & Kroese (1990) state that there is a wide range of information and research available from an 'agroecosystem approach' from which farmers can select the practices that will work to achieve their desired result.

Altieri (1989) claimed that the environmental movement in the United States had contributed greatly to the development of agroecology, with concern regarding adverse environmental effects of toxic substances, such as pesticides. The 'Silent Spring' by Carson (1963) discussed the impact of chemical residues within the food chain, and this book is often accredited with starting the 'conservationist movement.' Stinner & House (1989) stated that increasing public awareness and concern regarding adverse environmental effects has been focussed on agriculture. The development of IPM had been aided by by this attention to pesticide use, and Altieri (1989) stated that the move had been away from control of pests by pesticides; to greater understanding of crop and pest ecology and use of complimentary practices (outlined by IUCN *et al.* 1990) and discussed previously in Section 3.3)

Perceiving the problems of sustainable agriculture as purely technical problems associated with production, neglects the fundamental reasons why agriculture is unsustainable claims Altieri (1989), which include the socio-economic determinants that govern what is produced, how it is produced and who it is produced for. Altieri (1989) states that agricultural policy should include consideration of the social and economic factors that cause the interest in more sustainable agricultural systems. This is also recognition of the vertical scale in agriculture (Figure 2.1), with the consumers and other vested interests in the agricultural system receiving consideration.

The political realities of adoption of alternative agricultural methods and practices was noted by Altieri (1989), as the reasons for adopting the alternative methods would vary, some for economic reasons (the premium prices for organic produce for example), while some others would adopt them for social, moral or environmental reasons (land ethic for example). Altieri (1989, p 40) went further to state that these motivations and political determinants need to be considered "at the point when the basic scientific questions are asked and not just at the moment when the technologies are delivered to society." The political realities require examination early in the process, as the development of technologies and practices, can be done with the regard to the practicalities of implementation, and what, if any, political realities, that hinder this implementation. These political realities, such as lack of expertise to aid its dissemination, complexity of technologies, or farmer resistance, can be considered and addressed/ overcome by the resulting technologies/practices developed.

The importance of political considerations, in agricultural sustainability was suggested by Edwards *et al.* (1993) and Grove & Edwards (1993). It was also noted by Buttel (1993, p 176) who claimed that social sciences such as "political science can play an equally important and constructive role in understanding and assessing agricultural sustainability" as the physical sciences. These considerations of reasons for adoption of alternative methods need to be considered argues Altieri (1989), to ensure that the resulting agriculture is equitable and addresses other social issues covered in Section 2.2.3. Agroecologists must continue with their multidisciplinary research and training efforts according to Altieri (1989), so there will be an increased understanding of the complex factors governing agricultural sustainability.

The MAF Technology Agroecology Programme has researched the viability of organic/biological production in New Zealand. The use of new technology can be incorporated into agroecology MAF (1991d) state, but these cannot be used to 'fix' any single problem, as the new agroecology approach will inherit the same problem as conventional farming. Kirschenmann (1991) also commented on the drawbacks of relying on the 'technological fix' and stated a similar argument that it did not offer long-term solutions. Technology not only fixes problems, but can also create new problems, and increase the rate of environmental and social degradation. The use of technology also creates problems associated with uncertainty, as the exact time of arrival of the new technology is not known, and cannot be guaranteed it will even arrive. The potential adverse impact of the new technology may not be known, and are difficult to anticipate.

Summary of Agroecology

The agronomic sustainability objective of Lowrance (1990) is an important consideration of agroecology, as this approach aims to study indigenous systems, and other examples of sustainable agriculture, to deduce why they are sustainable. (cultural diversity in Berkes & Folke 1994; Gadgil & Berkes 1991; Gadgil 1987) Agroecology also considers the ecological sustainability, and the impact of agricultural on the wider environment (MAF 1992c). This approach does not only consider the agronomic/ecological aspects of sustainability, but also examines what role the social and economic attributes of those systems have in achieving sustainability. The site-specificity issue is a central consideration of the agroecology approach, as the study of the adaptions to the practices which were incorporated to compliment the local environmental conditions. This kind of study Hassebrook & Kroese (1990) state can provide farmers with information on practices that address their requirements for sustainability. The wide variety of research carried out under the agroecology approach, has allowed such issues of food safety to be incorporated into the approach, and MAF (1992c) in their agroecology programme have the aim of reducing pesticide residue levels on horticultural produce, as international regulations become increasingly stringent.

3.5 - Biodynamic Agriculture

Harwood (1990, p 6) stated that biodynamic agriculture was the "first organised and most well-defined" movement of alternative agriculture, which arose from the lectures given by Rudolf Steiner, the founder of anthroposophy, in 1924. Koeph (1989) agreed, stating that biodynamics was the oldest alternative agriculture movement in the world. The term biodynamic agriculture states Boeringa (1980, p 27) "suggests that on one hand there is concern for the reinforcement of life-processes in nature (biological) and on the other for the operation of forces that have an effect on nature (dynamic)."

Gunning & Cullen (1983, p 2) defined biodynamic agriculture based on the lectures of Rudolf Steiner, as a philosophy that "advocates non use of any synthetic agricultural chemicals, application of herbs and preparations in homeopathic doses, recognition of cosmic influences and sowing and application of substances at appropriate seasons in relation to the moon or sign of zodiac." This is not a comprehensive or precise definition, but Boeringa (1980) stated that there was no set definition for biodynamic agriculture, and in practice the approach varied widely.

Koeph (1989) maintained that farmers in Germany were concerned about the declining quality of agricultural products and seeds. They approached Rudolf Steiner for advice. Steiner then gave a series of eight lectures between the 7th and 16th of June in 1924, at the Koberwitz estate in Silesia, in old East Germany. These lectures according to Koeph (1989), became the backbone for the biodynamic movement.

Koeph (1989) stated that the biodynamic movement was the first to use the marketing of certified food in 1928. The 'Demeter' trademark according to Koeph (1989) is used in many countries around the world, and MAF (1991b) stated that Demeter is the label for certification by the Biodynamic Farming and Gardening Association (BDFGA) in New Zealand. MAF (1994b, v) state that most submissions on the 'Proposed Policy on Organic Agriculture' (MAF 1991b) considered that the approach of using the BDFGA as an organisation to provide certification was "working well."

Reganold *et al*. (1993) compared the financial performance and soil quality of similar biodynamic and conventional farms in New Zealand, that had the same soil types and only differed in management practices. Reganold *et al*. (1993), stated that the biodynamic farms they compared to conventional counterparts, the biodynamic farms had soils of higher biological and physical quality, and were as financially viable on a per hectare basis.

The basic principles of biodynamic farming according to Harwood (1990), include:

1 Sound farming and gardening techniques, regardless of how old or new they may be. The incorporation of both old and new technologies/practices in the implementation of sustainable agriculture was noted by Rodale (1990), Ikerd (1990, 20) and MAF (1991d),

2 Principles such as diversification, recycling, avoidance of chemical use, decentralised production and distribution - which are all ideas held by other alternative agricultural movements. Some of the authors that discussed the importance of diverse systems are listed in Section 3.3. The minimal use of chemicals inputs was noted by Swaminathan (1991), Blakeley (1990a), Reganold *et al.* (1990), Keeney (1993), Buttel (1993), Wagstaff (1987) and Wynen & Fritz (1987).

3 The specific biodynamic measures and concepts as they have evolved from the spiritual teachings of Steiner.

The last point, states Harwood (1990) separates the biodynamic movement from the other alternative agricultural movements. Reganold *et al.* (1993) states that biodynamic agriculture differs from organic agriculture through the use of eight specific preparations. They include, claims Harwood (1990, p 7) the "stimulation and regulation of complex life processes by biodynamic preparations ... consideration of cosmic and terrestrial forces on biological organisms." Koeph (1989, p 21) asserted that the life processes in soil and plants are stimulated by the use of "small quantities of preparations made from herbs and other substances." Boeringa (1980) and Koeph (1989) outline the soil treatment and compost preparations used in biodynamic agriculture. The amounts of preparations used are very small, with Boeringa (1980, p 34) suggesting that only additions of the preparation in the order of "2-3 g per 10 tons" of compost are used. The scientific validity of the effectiveness of the preparations has not been proven either way (Palmer *pers com.*).

Koeph (1989) stated that diversification of the production base of the farm was an important part of farm organisation within biodynamic agriculture. The use of crop rotations is also part of biodynamic farming according to Koeph (1989), with the design of the rotation considering the biological, economic and human constraints that exist in the individual farm, and incorporating these into the design of the rotation. This recognition of site-specificity issues (outlined in Section 2.1) is important. Boeringa (1980, p 32) stated that "in reality agriculture is a creative principle leading to multifarious forms. There are as many forms as there are farms. There is thus no rigid definition of biodynamic agriculture." The variation in the application of biodynamic agriculture is aligned with the literature regarding the individualistic and site-specific nature of alternative agriculture by such authors as Merrill (1983), Schaller (1993), Stenholm & Waggoner (1990) and Pimental *et al.* (1989).

Barr & Cary (1992) stated that the biodynamic movement were not always as anti-chemical as organic farmers. Podolinski (1985) claimed that the judicious use of artificial fertilisers may be necessary to achieve a productive balance on the farm.

Boeringa (1980, p 26) argued that "biodynamic agriculture is not a fixed system of ways and means to which reference is made, but is primarily concerned with a development of insights based on practical research." Boeringa (1980, p 27) stated that biodynamic agriculture was based on cooperation between humankind and the earth, which is expressed in two forms; the first, is that "the earth provides mankind with food and thus the opportunity for physical existence and cultural development" and the second is that "mankind works constructively with nature and cultivates the earth so that it may continue to provide food." This complex relationship between humankind and the earth (human food produced from the earth) and secondly we must protect the resource-base (so future production of food can occur). The first part of this relationship, food provision, in the future, is dependent on the second, our ability to work with nature to allow future food production (a stewardship concept). The importance of a stewardship ethic in sustainable agriculture is discussed in Section 2.2.2, with the authors who noted its relevance are listed. These two forms of cooperation between future food provision, and stewardship of the resource-base, highlights the inseparability of the stewardship ethic from agricultural sustainability. It also highlights the temporal considerations (Section 2.4.3), as action now, in the form of stewardship, will have a positive outcome in the future, over the temporal scale (as future generations will be able to produce food and fibre).

Boeringa (1980, p 32) stated the importance of social interaction with other steps in the agricultural sector shown in Figure 2.1, and "cooperation with fellow-producers, manure and fodder enterprises, consumers, processing industries and those providing tools and apparatus." This recognition of the vertical scale in agriculture (refer to Section 2.4.2) and cooperative approaches outlined by MAF (1991a), Douglass (1984), Jennings (1990), IUCN *et al.* (1991), Francis & Madden (1993), and Edwards & Wali (1993) is an important aspect of the biodynamic approach.

Summary of Biodynamic Agriculture

The biodynamic agriculture approach has very similar practices to the organic approach, and is the BDFGA is one of the two certifying agencies for organic produce (MAF 1994b). The organic practices, do improve soil biological and physical quality as mentioned from the research of Reganold *et al.* (1993). The exact scientific validity of the role the preparations have in the biodynamic system cannot be proven. The biodynamic approach can offer microeconomic sustainability, as costly inputs are minimised and premium prices can be fetched for the produce, which is certified with the Demeter trademark. The agronomic sustainability objective outlined by Lowrance (1990) is considered in the biodynamic approach, as Koeph (1989) maintained that the productivity of the soil is preserved or improved, with farm sourced animal manures used for nutrient cycling. The ecological sustainability issue is incorporated in the view that the farm is part of the wider environment (Koeph 1989). An important part of the biodynamic approach according to Harwood (1990) and Koeph (1989) is the diversification of the production base. The authors that referred to the possible increased stability, ecological and economically, of diversification were mentioned in Section 3.3. There is important linkage between the farm and other steps in the vertical scale of the agricultural sector (Section 2.4.2), such as processing operators and consumers. The 'sustainability as community' approach of Douglass (1984) is considered by the biodynamic approach as the individuals and families on the farms are part of a larger community, and should take a wider world view (Koeph 1989). The approach offers site-specific responses, as Boeringa (1980, 32) stated that the approach varied widely in application. The biodynamic approach does have some theoretical basis in the use of of systems diversity, through diversification of the production-base, which offers some resilience. The use of increased nutrient cycling over the long-term contradicts the second law of thermodynamics, and as previously mentioned (in the summary of Section 3.2) an 'entropy gap' will need to be met through the use of external inputs. The biodynamic approach does offer a strong and highly valuable form of cultural capital when compared against the work of Berkes & Folke (1994), Gadgil (1987) and Gadgil & Berkes 1991.

3.6 - Agroforestry

Definitions of exactly what agroforestry means vary, but the IUCN *et al.* (1990, p 114) suggested that agroforestry systems "include trees as a main component in a multi-crop production process." Nair (1983, p 334) stated that regardless of the definition, it is "generally agreed that agroforestry represents a concept of integrated land use that is particularly suited to marginal areas and low-input systems." Nair (1983) claimed that the aim of most agroforestry systems was to optimise the interaction between the woody components with the animal or crop components, to achieve a production level that is preferable in terms of total quantity output, and diversity of output products, compared to the the production usually achieved from the same available resources (under a single focus production system - for example, just pastoral use). The basic premise of agroforestry, argue Steppler & Lundgren (1988) is that it is a land use system that lessens adverse environmental effects, while providing multiple products/income sources for the user.

Steppler & Lundgren (1988, p 146) and Reid & Wilson (1986, p 8) both quote a comprehensive definition of agroforestry from the ICRAF which has gained widespread international acceptance. This definition is: "Agroforestry is a collective name for all land use systems and practices where woody perennials are deliberately grown on the same land management unit as agricultural crops and/or animals, either in spatial mixture or in temporal sequence. There must be significant ecological and economic interactions between the woody and non-woody components." The definition included references to the mixture of woody perennials and crops/animals, in a spatial mix or temporal cycle. This definition gives a high degree of flexibility, as both horizontal and temporal scales are included in the possible agroforestry applications (Sections 2.4.1 and 2.4.3, respectively) This enables the implementation of agroforestry to include a multi-tiered system, with the use of trees and animals grazing under them, or separate areas under forestry and pastoral use within the farm. Similarly, it can also include trees at one point in time, and animals at another future point in time, over the same area, when the trees mature and are harvested.

Nair (1983, p 335) stated that the major difference between forestry and agroforestry was that the periodicity of harvest of economic produce, varied greatly between the two systems, and that while "forestry plantations usually aim at total harvest of a single end-product at the end of the production cycle, the woody perennials of agroforestry may be subjected to repeated periodic harvest of multiple products, such as wood, fodder, and fuel." Lyle (1994) also noted the diverse range of uses for the woody plants in agroforestry. Steppler & Lundgren (1988, p 147) termed these trees that are able to provide a diverse range of uses, "multi-purpose trees (MPTs)." Steppler & Lundgren (1988, p 147) state that the MPTs provide a "more than one product to the user - the farmer." These include the benefits outlined by the IUCN *et al.* (1991), who claimed that trees in pastoral systems can provided shade/shelter for stock, fodder for animals, provide nutrients for soil (biologically fixed nitrogen), soil conservation qualities and windbreak/shelterbelt benefits. Reid & Wilson (1986) also outline the multitude of benefits that trees can contribute, when combined with a pastoral system.

Steppler & Lundgren (1988) argue that because the trees within an agroforestry system can be trimmed to provide fodder for stock, the growth configurations of agroforestry will differ from plantation forestry. But in areas that have separate plantations of forestry, for example, where pastoral land-use may not be agronomically or microeconomically viable, then management may be similar to plantation forestry, but on a much smaller scale. This illustrates the wide variation in possible methods and management practices involved in agroforestry systems to address the horizontal and temporal scales of sustainable agriculture (Sections 2.4.1 and 2.4.3). Reid & Wilson (1986, p 8) state that the variation in possible combinations with trees and crops/animals, the precise definition of agroforestry can be difficult, once past the initial "combination of agriculture and forestry."

The diversity in the products from the farm under agroforestry, lessen the financial risk to the farmer, due to the variation in sources of resulting possible income for the farmer. Ikerd (1990, p 20) claimed that risk is "another important but often overlooked consideration in diversification. Risks are far greater in a specialised farming system than in a diversified farming system with the same basic level of uncertainty in each system component." There will be exceptions to this, but Ikerd (1990, p 21) stated that the general relationship held that "diversified systems yield more stable returns over time than do specialised systems" (recognition of the temporal scale - Section 2.4.3) Keeney (1993) discussed the economic vulnerability of monocultures, with the reliance a single specie for production and income. Both Reid & Wilson (1986) and Stenholm & Waggoner (1990) also agreed that the diversity within an agriculture system, such as agroforestry, offers more stability, ecologically and economically. Reganold *et al.* (1990) stated that diverse systems are less susceptible to adverse microeconomic effects of a flooded market or depressed prices for a product. The likelihood of poor produce prices for all the various produce (timber and sheepmeat/wool for example) from the farm is a lot lower than for just a single form produce (just the sheepmeat/wool).

Agroforestry can be used on poorer quality land, according to Reid & Wilson (1986), where pastoral use may be marginal. But the productivity and returns from the forestry on the poorer land, will not be as high as the higher quality sites. Reid & Wilson (1986) state that the trees may grow more slowly, produce less and require greater levels of management than on better land. But, nevertheless the diversity in production may be more ecologically, agronomically and microeconomically sustainable than pastoral use alone.

The use of agroforestry on formerly forested, marginal land should be considered according to IUCN *et al.* (1991). In New Zealand, research has shown that landslides have occurred more frequently after deforestation (Derose *et al.* 1993; Hicks 1990), and deforestation also increases the threshold slope angle, above which landslides will occur (Derose *et al.* 1991). The use of agroforestry may assist the avoidance of increased incidence of landslides, but IUCN *et al.* (1991) claim that agroforestry may not be an acceptable substitute for full forest cover in some areas, so some plantation or protection forestry may be required. Again, the site-specificity issues covered in Section 2.1 require consideration on a farm-by-farm, and paddock-by-paddock, basis. The incidence of soil erosion that occurs when the trees are harvested, leaving the soil exposed, may be unacceptable in terms of adverse environmental effects.

Steppler & Lundgren (1988) state that there is a lack of knowledge about the long-term productivity and profitability of agroforestry systems, and this knowledge is required if farmers are to adopt this land-use system. Edwards *et al.* (1993) commented that sustainable agriculture would have to offer perceived benefits for farmers and their families, if it is to be widely adopted. The need for further research was noted by the respondents to the survey in Chapter 10 as an important implementation method for achieving sustainable agriculture, ackowledging the lack of information regarding certain issues.

Reid & Wilson (1986, p 7) claim that agroforestry has "become an important part of a new thrust to develop more sustainable land use to replace destructive techniques" used in agriculture in the past. This would aid in the avoidance of future destructive consequences of agriculture, if land-use is matched to land-type (Blakeley 1990a; Jennings 1990; Ikerd 1990; and Luckman 1994). Swaminathan (1991) proposed that a systems approach was required for sustainable agriculture, which involved integrated attention to crop and livestock farming and to agroforestry. Steppler & Lundgren (1988) and Reid & Wilson (1986) both state that agroforestry is not an simple antidote for resolving the environmental problems of agriculture, but an alternative land-use approach that should be used alongside other land-uses.

The labour required for agroforestry may not be acceptable for farmers who are aiming to lower labour inputs Reid & Wilson (1986) state, and as careful tending and management of the trees is required to fetch the premium prices for the resulting timber (Reid & Wilson 1986). Therefore agroforestry may not be acceptable under some assessments by farmers of their microeconomic sustainability (Table 2.2) requirements, which again illustrates the temporal scale components in sustainable agriculture, with short- versus long- term tradeoffs required.

The late Neil Barr was credited with establishing the New Zealand Farm Forestry Association (NZFFA), by Reid & Wilson (1986) and Hocking (1996), and was president for the first eight years. The members of the NZFFA provide valuable information on their experiences of converting to agroforestry systems in various publications such as newspaper, newsletters, journals and books. An organisation that is committed to a concept, such as the NZFFA to agroforestry/farm-forestry, is very important. These organisations give much impetus to the implementation and further application, due to the enthusiasm of its members. It also offers the practical, farmer innovations that Lockeretz (1991) considered crucial. It also helps disseminate the important knowledge (MAF 1991d; Edwards *et al*. 1993) to other, interested farmers.

Summary of Agroforestry

The use of agroforestry will vary greatly, as planting trees alone on Class I horticultural land could not justified under the 'sustainability as food sufficiency' approach of Douglass (1984), and would not make economic sense either. The use of trees in the form of shelterbelts (a type of agroforestry) on this land could be justified to lower the wind-run, with benefits in terms of decreased wind erosion and increased soil temperature. In steeper land the use of forestry blocks on parts of the farm (vary land-use in the horizontal scale - Section 2.4.1), could offer increased economic, agronomic and ecological sustainability as outlined by Lowrance (1990). The site-specificity issue is addressed, as the types of trees used and how they are used, will be determined by site-specific factors, such as slope, soil type, climate, farm economics and management regime. The 'sustainability as stewardship' is addressed by agroforestry, as the trees in some cases may mature and be ready for harvest, when the next generation benefit through farm succession. Future generations may enjoy increased environmental quality (reduced soil erosion) and the aesthetic implications of trees in the rural landscape.

Chapter Four
Methodology for Survey Design, Process and Analysis

This chapter begins with an outline of the reasons why a mail survey was selected for the original research component of the thesis. Following from this, the process used, including the rationale for the design of the survey, the mailout technique, collation and coding of the data obtained from the survey responses and subsequent analysis of this information is discussed.

4.1 - Why a survey?

Brown (1989) stated that the term sustainability in relation to agriculture was an interesting concept, as it captured a diverse set of concerns regarding agriculture. Francis (1990) stated that the popularity of the term sustainable agriculture presented problems, as it represents many things to many people. The ambiguity of the use of the term was outlined in Section 2.1 and hinders possible implementation, as various stakeholders perceive a different end-state when they refer to and discuss the same term. Lee (1994) argued there is a need for consensus about the term amongst the stakeholders in agriculture. The survey would aim to identify the range of concerns held by various stakeholders in agriculture regarding the sustainability issue. Yunlong & Smit (1994) maintained that there is a broad consistency amongst the definitions of sustainable agriculture. The aim of a survey would be to elicit identification of the commonalities and differences in the definitions held by the stakeholders.

Keeney (1990) agreed with the Francis (1990) statement, when he claimed that the definition of sustainable agriculture differed widely according to the viewpoint of the person or organisation involved. Batie (1988) stated that agricultural issues are constantly placed on the agenda of non-agricultural interests, such as environmental groups, urbanites and governmental agencies. This highlights the increased number of stakeholders involved in resource management issues, and under the RMA 1991, greater consultation is required, involving this increased range of stakeholder groups. The survey could be used to cover a wide range of different stakeholders, at different levels in the horizontal scale (Section 2.4.1), to discover any variation in their concerns, according to the level of scale that they represent.

There are advantages and disadvantages in the use of mail surveys as a research technique, which must be acknowledged. Massey University Institute for Executive Development (1994) listed some of these advantages and disadvantages. These are shown in Table 4.1, with comments relevant to the survey carried out in this thesis.

Considering the advantages and disadvantages outlined in Table 4.1 regarding the use of mail surveys, it is the best technique in this instance. This is due to the cost involved in such as large and geographically scattered sample, covering a contentious issue such as sustainable agriculture (the anonymity is good) and a lack of interviewer bias in covering a wide range of issues in the survey.

4.2 - Survey design and piloting

The process used for the survey is shown in Figure 4.1. The flowchart in Figure 4.1 briefly outlines each step in the survey process, from initial design, through to the explanation of the results of the analysis. Each step in Figure 4.1 has a number in the box referring to the section number in this chapter, where the step is explained in greater detail.

The design of the survey aimed to elicit a number of interrelated attitudes and practices held by a wide range of stakeholders involved in agriculture. Figure 4.2 illustrates the linkages between the different elements within the survey, and a brief rationale for each element. Figure 4.2 also includes the relevant subsection number for the following discussion regarding each of the individual elements within the survey.

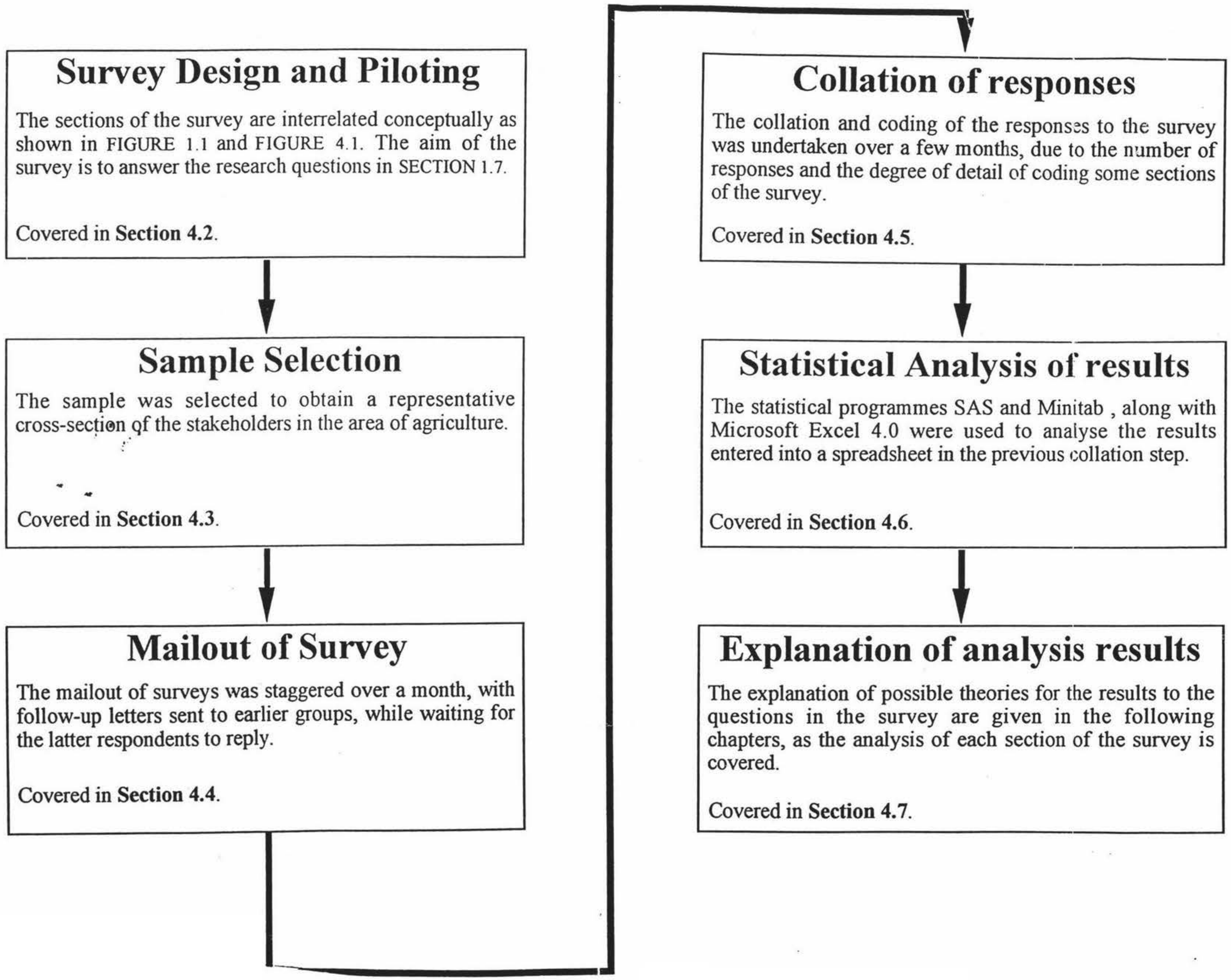
The survey was designed over a period of months, with a process of input from various people, and constant revision where necessary given comments from this external input. The overall wording of the survey gave regard to the Altieri (1989) comment relating to the consideration of political realities at the initial stages of the research (survey design), rather than at the implementation stage (when survey responses are received by potential respondents). Wilson (1992, p 124) in his survey of indigenous forests within farmland in the Catlins areas of the South Island of New Zealand, stated that the majority of non-respondents to his survey were involved in the past clearing, and may "felt threatened by the questions."

Renzetti & Lee (1993, p 5) defined a sensitive topic as "one that potentially poses for those involved a substantial threat, the emergence of which renders problematic for the researcher and/or the researched the collection, holding and/or dissemination of research data." The topic sustainable agriculture to farmers could be potentially a sensitive topic, as they may feel that if agriculture is to become more sustainable, then it was unsustainable in the past, which is 'wrong.'

TABLE 4.1 - Advantages and disadvantages of mail surveys (adapted from MUIED 1994, 73)

	ADVANTAGES
1	**"Relatively cheap"** The survey enabled a wide range of people to be included in the sample for relatively low cost. The use of freepost envelopes meant that only the returned surveys had their postage paid, non-returned surveys lead to no incurring of mail costs.
2	**"Good response rate possible"** The survey did achieve a good response rate for the conventional farmers (58.3%) considering the contentious nature of the issue, that is, sustainable agriculture. The response rates for the organic farmers (83.3%) and the professional staff were also high.
3	**"Good for widely dispersed samples"** The very wide geographic distribution of the stakeholders surveyed, meant that a mail survey was an effective approach. The wide distribution of the conventional and organic farmers could be well covered by a mail survey, and the professional staff came from all parts of the country.
4	**"Allows respondents to reflect on their answers"** The respondents are able to ponder their answers to the questions, as they can take the survey at their own pace, and are not rushed by an interviewer.
5	**"No interviewer bias"** The questions in the survey were asked in a consistent form for all respondents. No prompts or tone of voice from an interviewer to offer any bias in the manner that respondents answer the questions. Part II of the all the surveys asked for opinions on ideas from the literature on sustainable agriculture, but this was not stated in case some some respondents may have responded differently knowing that it was based on research or academic readings.
6	**"Allow for presentation of visual concepts"** No photographs or diagrams were used in this particular survey, which is what the comment refers to. But, the depiction of the five point scales (Tables 4.2, 4.4 and 7.1) used in the survey, as a continuum between strong agreement to strong disagreement, strong approval to strong disapproval, and significantly increased to significantly decreased within the questions, within this mail survey, made answering them easier.
7	**"Good response for some sensitive subjects"** The mail survey was useful is the case of the topic of sustainable agriculture, as the anonymity of the responses by farmers (especially) and professional staff to a currently sensitive subject, helped to ensure a good response rate.
	DISADVANTAGES
1	**"Slow - minimum of six weeks for fieldwork"** The time spent sending out the surveys and waiting for replies, then following up with another cover letter and copy of the survey was time consuming.
2	**"Assume literate respondents"** The questions in the survey had to be worded carefully to ensure a wide range of respondents (with all levels of formal education) are able to respond to the survey.
3	**"Response bias in favour of better educated respondents"** The lack of interviewer prompts and technical nature of the survey, means that a bias develops in the responses, towards the better educated members of the sample. The potential respondents in this sample with higher formal education, are more likely to respond, than their lesser educated counterparts.
4	**"No interviewer to probe or clarify answers"** The result of this, is that some answers are given with comments by respondents that are not entirely clear. Suggesting explanations for these unclear statements is made more difficult, due to this lack of clarity.
5	**"No guarantee of identity of respondent"** Even though the surveys were sent to the addresses of the conventional and organic farmers, there is no guarantee that the person responding, is the person that was identified as part of the sample. In the case of the professional staff, as a senior staff member at the organisation distributed the surveys to their staff, the sample group does lack identity, beyond the overall organisation. The inclusion of an 'occupation' statement in the survey helps address this a little.
6	**"Sampling frames sometimes unavailable or inadequate"** This is related to number 5 above, where the identification of the specific farmer/landowner or particular staff member at an organisation is difficult. The lack of an exact sample frame will introduce some bias, due to the geographically diverse sample in this survey, it would be difficult to identify the sample frame by any method, including telephone surveys or face-to-face, as achieving a constant diversity of respondents/occupations from each organisation would be difficult, if not impossible.

Figure 4.1 - Survey methodology.



Renzetti & Lee (1993) stated that it is not uncommon to approach a topic (in this case sustainable agriculture) with caution, due to the sensitive nature of the topic, only to find those initial impression misplaced. That was the case with this topic, although some negative responses were received, the topic was answered by the farmers, with great interest and honesty. The responses and answering of questions was not as problematic as first thought, which the good response rate reflects.

The following is a brief description of each section in the survey, and a rationale for the section.

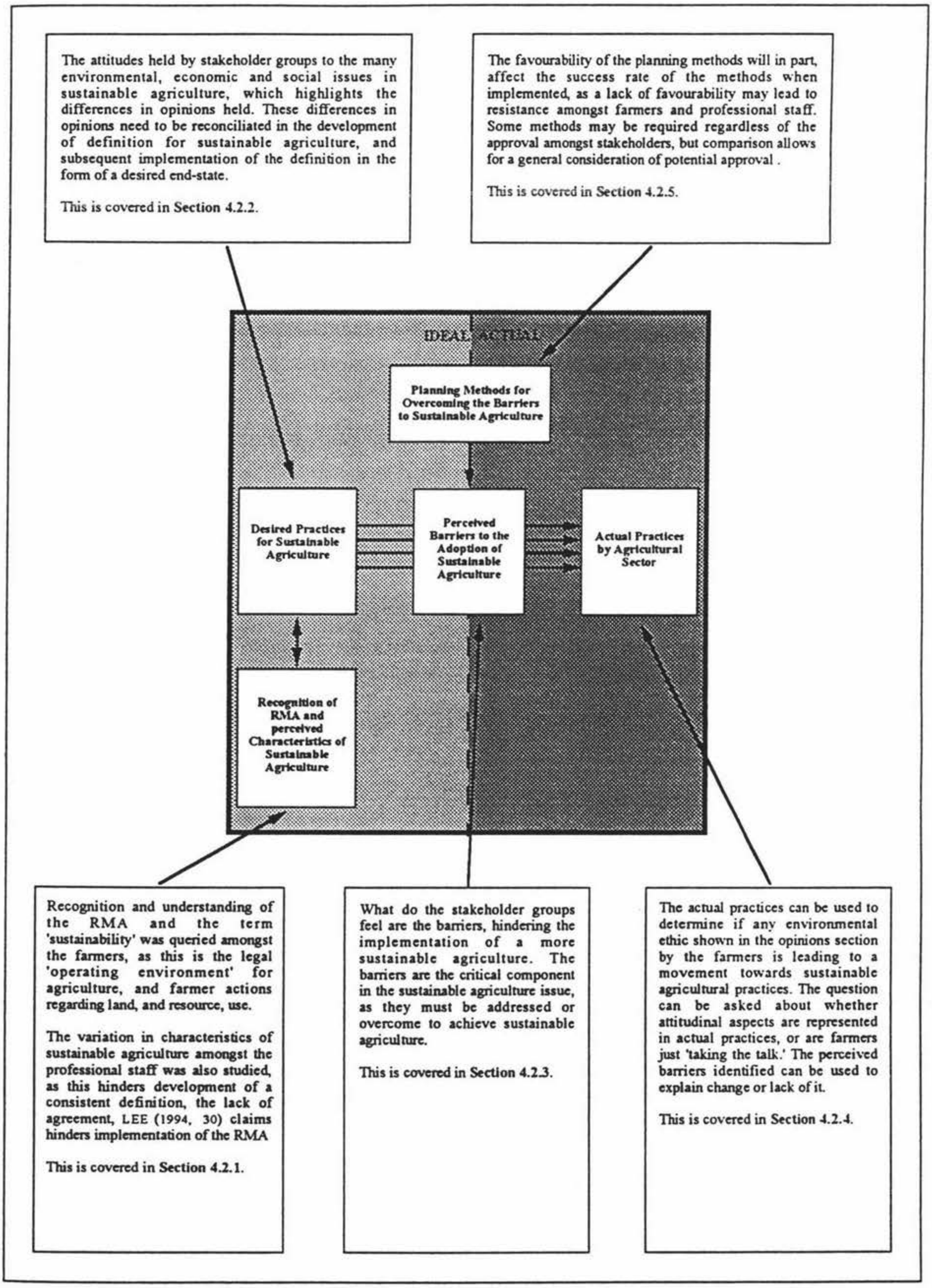
4.2.1 - Characteristics of sustainable agriculture and farmer recognition of the RMA

The first section, Part I, of the survey mailed to the conventional and organic farmers were general, and used as an introduction to the topic by posing some broad questions (page B4 in Appendix B). The initial question asked the respondent whether "agriculture needs to become more environmentally friendly?" and then further questions were asked regarding whether the farmer had heard of the Resource Management Act and what they perceived the purpose of the act as. The understanding held by the farmers about the term sustainability then followed.

These questions were used to identify the farmer knowledge of the legislation that relates to their agricultural land-use, and the central term to the act which is 'sustainability' in relation to the management of natural and physical resources. As the RMA is the legal 'operating environment' for resource use, its recognition and knowledge amongst farmers (as resource users) is important.

The initial section of the survey sent to professional staff asked for the main characteristics of sustainable agriculture as they perceive them (page B15 in Appendix B). The term "main characteristics of" was used, as opposed to "definition of" as the concern was that the respondents would quote the MAF (1993a, 4) definition too frequently. This definition is included in Appendix A, and there is no fault with the definition as such, but the respondents quoting this definition would not illustrate the variation in perception of the term, once past the basic definitional stage, as discussed in Section 2.1. The question aimed to identify the issues/concerns the respondents perceived as important, such as energy use, economic viability or community issues.

FIGURE 4.2 - Rationale for survey sections.



4.2.2 - Stakeholder attitudes to ideal practices

These issues in Part II of all the surveys asked the respondents their opinions on various questions. Part II of the surveys for the conventional and organic farmers is shown in page B5-B7 in Appendix B, and the identical Part II of the professional staff survey is shown on page B16-B18 in Appendix B. The opinions of the respondents to the questions used the five point scale Likert scale shown in Table 4.2. Each of the points in the scale were assigned a label as shown in Table 4.2. Boote (1981, p 58) claimed that fully labelled scales tended to have less skewed responses and thus "do a better job of discriminating." The respondents have a greater idea as what each point in the scale represents, and are less likely to answer with an extreme response. The use of a Likert scale Babbie (1975) states is to provide analysis between relative replies to a statement by the respondents to the survey. The aim of the questions was to identify the commonalities and variation in responses to issues which arose from the literature on sustainable agriculture. The authors that mentioned or discussed the issues in each of the 20 questions within Part II of the surveys are shown in Table 4.3. The questions reflect just some of the reoccurring themes that run through the literature on sustainable agriculture, with some question topics receiving mention by many authors.

TABLE 4.2 - Scale for response to questions for Part II of all surveys and response value assigned.

QUESTION RESPONSE	RESPONSE VALUE
Strongly Disagree	1
Disagree	2
Undecided	3
Agree	4
Strongly Agree	5

A large number of possible questions were identified in the drafting stages of the generation of the survey. The questions that covered topics that were either too abstract, or technical, or both, were dropped in the initial stages. The final questions that were included in the survey covered a wide range of the issues involved in agricultural sustainability, and addressed the issues of Douglass (1984) and Lowrance (1990), such as a balance of economic, environmental and social issues.

The questions could have been more detailed, and included definitions for 'marginal land' or 'agroforestry' (as given in Section 3.1), but this adds extra problems. This could add to the length, or technicality of the survey, both of which could hinder a good response rate. Also the definitions to these terms vary widely, and by using a definition a potential respondents does not agree with, creates further contention and argument. Even if a particular land-class was chosen as 'marginal' there is still no guarantee that the survey respondents will know what the land class actually appears like, and the potential uses for that land. Again, as previously mentioned, the aim was to achieve a good response rate. Appendix C illustrates the formal education levels of the respondents, and the use of a very technical survey would bias the responses in favour of the better educated in the sample (above the bias that already exists as shown in Table 4.1)

The questions in the survey should be designed to vary the response given on the five point scale, for the different questions. For example, the respondent with a strong environmental ethic may respond with 'strongly agree' with a question regarding the importance of the preservation of native habitats, but then in the next question disagree with a question asking if accelerated erosion was acceptable. These two responses illustrate the consistency held in opinions from this theoretical respondent. The use of these internal consistency checks was largely avoided, as again no antagonism was desired between the farmer respondents and our survey method. If the farmers felt that the questions were designed with a constantly changing tense or reverse meanings, then they may perceive some sort of trickery in the survey design and be reluctant to answer. Similarly, the survey was designed to be relatively easy to answer, to ensure a good response rate. The use of internal consistency checks could make the survey more difficult to answer.

4.2.3 - Barriers to adopting sustainable agriculture

The barriers that hinder the adoption of sustainable agriculture are integral to the survey, and indeed the actual implementation of sustainable agriculture. The barriers to sustainable agriculture receive mention in some of the literature, with Blobaum (1983), Schroeder (1990) and Blakeley (1990b) to name a few. Figure 4.2 illustrates that the barriers are central to the sustainable agriculture issue, as these impede any environmental ethic held by the farmers from being implemented in the form of beneficial and desirable agricultural practices.

The question was open ended, and asked for the respondent to list what they considered to be the barriers to sustainable agriculture, with no prompt given as to whether they should be environmental, economic or social barriers.

4.2.4 - Actual practices undertaken by farmers

The farmers were asked to rate the change in agricultural practices undertaken on their farms over the last five years on a five point Likert scale (shown in Table 10.1). The rationale for the five point scale and the survey question is discussed in Section 10.1, and the practices were grouped in three main headings as can be seen on pages B8-B9 in Appendix B.

The aim of this section of the survey was to reveal whether the actions of the farmers matched any environmental ethic or beliefs held in attitudinal part of the survey (Section 4.3.2). The list of practices was generated from various texts and external input, but as it will not be complete, a few extra lines were offered for respondents to list any further practices, and relevant levels of change, they considered pertinent.

4.2.5 - Implementation methods to overcome barriers

A list of eight general implementation methods was offered for the respondents to rate in terms of approval. The methods are only generic, as the end result will need to be tailored to suit each particular application of sustainable agriculture, due to the site-specificity issues in Section 2.1. The level of approval for each of the implementation methods was prompted with the use of a five-point Likert scale shown in Table 4.4.

TABLE 4.4 - Scale for response to questions for Part III of all surveys and response value assigned.

QUESTION RESPONSE	RESPONSE VALUE
Strongly Disapprove	1
Disapprove	2
Neutral	3
Approve	4
Strongly Approve	5

The questions were aimed to find the general level of approval of each of these general methods by all the stakeholders. This section of the conventional and organic farmers survey is shown on page B7 in Appendix B, and for the professional staff on page B18 in Appendix B. The authors that mentioned the use of these eight planning methods in terms of sustainable agriculture are shown in Table 8.1 and the methods are each briefly described in Section 8.1.

4.2.6 - Personal details of respondent

The last section in the all the surveys asked for personal details about the respondent, that were used to analyse results to the other parts of the survey. The demographic details of the survey response sample is included in Appendix C, with a brief rationale for the personal details and a description about how the results were coded for the statistical analysis. The demographic details of the respondents to the survey are also included in Appendix C.

4.2.7 - Piloting of the survey

The draft of the survey was piloted on a number of people before it was mailed out to reduce potential problems in the format. A number of people looked at, and completed, the survey. This was to check that the terminology was suitable, for the wide range of respondents, with differing levels of knowledge about the topic and different levels of education. The degree of difficulty in filling in the survey was assessed, with modifications made to simplify the questions and responses where necessary.

The length of time taken to fill in the questionnaire was also studied, with different people, to judge if it was too long or difficult. The length of time required to answer the survey is an important issue, as some may not fill in the survey if appears too long, or start to fill the survey out and stop, as the length of time taken is too great. Even in the printing stages, after the survey had been piloted, an error in Question 2 of the attitudinal part of the survey was undetected, and a line was subsequently left off the question. So a careful piloting and drafting process was not infallible. There were one of two terms that were used in the survey that the pilot study did not detect as difficult, but a few respondents queried.

The pilot sample was very small, but provided detailed information regarding the survey design and useful feedback on potential problems and suitable changes. The persons involved had practical knowledge about the sample group, including the farmers and aided with information to solicit the greatest amount of information.

The variety of questions covered in Part II of the survey, as Table 4.3 shows, offered a number of issues to be covered. The lack of concentrating on one particular aspect of agricultural sustainability, with the inclusion of questions on social, economic and environmental considerations, would offer greater interest for most involved. The high response rates to the survey and questions would indicate that the topics covered were of interest and topical.

4.3 - Sample selection

The sample group for the survey was chosen with three main stakeholder components. These components were selected to represent the diversity is agricultural and non-agricultural interests in the sustainable agriculture issue as discussed in Section 4.1. Each of these components in the sample are discussed below.

The farmer sample included 260 farmers in the Rangitikei electorate. These were selected from the electoral list, and cross-referenced with a telephone book and map/atlas.

A sample of organic farmers certified as organic under the New Zealand Biological Producers and Consumers Council (NZBPCC) standards were used as a comparison against their conventional counterparts. The NZBPCC as mentioned in Chapter 3 are one of the only two authorities that MAF (1991b) claim are able to certify organic standards, using the Biogro trademark. The farmers selected were from similar land types and farming operations as those included in the conventional sample. Due to the small number of suitable farmers, that had the same land-uses, on the same land-types, the survey was only sent to six organic farmers.

A sample was also selected from many organisations involved in agriculture aside from farmers. These were termed the professional staff in the analysis, for the want of a better term. This sample included regional councils in New Zealand, plus the four unitary authorities, to include the regional level of scale discussed in Section 2.4. At the national level, Federated Farmers, a producer board, MAF Policy, Royal Forest and Bird and Agriculture New Zealand were also included. A small sample of scientific and academic staff were also included.

The breadth of groups surveyed in this stakeholder group would reflect the width of stakeholder groups outside of the farmer sample, with an agricultural interest group such as Federated Farmers balancing a group like Forest and Bird. The views of the conventional farmers were contrasted with those held by the organic farmers and the professional staff.

4.4 - Mailout of survey

The surveys and associated covering letters (in Appendix B) were mailed out and followed up in a staggered fashion over a month long period. The initial mail out went to 260 individual conventional farmers, identified in the previous step, with a copy of the farmer survey (pages B3-B11 in Appendix B) and a covering letter (page B1 in Appendix B), along with a freepost preaddressed envelope for them to send back their completed survey. The conventional farmers were offered the chance of going into a prize draw if they returned the completed survey by a set date.

Then while waiting for the conventional farmers to reply, the surveys (pages B14-B20 in Appendix B) were sent to the organisations for the professional staff sample component, from which the senior staff member selected in the previous step, distributed the surveys to their staff. Each survey distributed had a covering letter (page B13 in Appendix B), and freepost envelope, stapled to it, to explain the purpose of the survey, and for ease of reply, respectively. At the same time, a copy of the farmer survey (pages B3-B11 in Appendix B) was sent to the six organic farmers, with a covering letter (page B2 in Appendix B) asking for their cooperation.

Then while waiting for the professional staff and organic farmers to respond, a further 160 surveys and covering letters were sent to the conventional farmers who did not respond to the first mailing. The prize draw was extended to allow for their responses.

The following is a brief description of the response from each stakeholder component to the survey.

Of the 260 conventional farmers surveys, 140 responded with completed surveys and a further 10 were returned that were no longer farming, or were incorrectly addressed and were subsequently returned to sender. At the time the survey was undertaken, New Zealand Post had just implemented an increased charge for rural mail delivery. Some farmers did not wish to pay this charge, and thus problems arose in terms of them receiving their mail. The fact that other farmers selected may no longer by farming, and duly failed to return a survey and other farmers not receiving the survey mailed out, it was determined another 10 would not be included in the sample. The response rate can then be calculated from a sample of 240, with 140 responses, as 58.33%.

Of the six certified organic farmers, five responded with a completed survey return. The small sample was a concern as far as what statistically significant analysis could be taken from the results. The latter chapters in the thesis illustrate, even given the small sample size, the statistical programmes still detected differences between the responses from the organic farmer sample and the conventional farmer sample.

The professional staff from the organisations were sampled by sending a number of surveys to a staff member holding a suitable senior position, and they were asked in a covering letter (page B12 in Appendix B) to distribute the surveys to staff they considered to be relevantly knowledgeable. The response rates varied from these organisations, as the senior staff member would only distribute how many surveys they thought could be answered, which varied between organisations. Some only sent one or two back, whereas others sent six or seven. The resulting sample would hopefully reflect the personnel who would get involved in issues affecting/involving agriculture within these organisations, as similar delegation by the senior staff member would occur when agricultural issues were addressed by that organisation. The total responses from this group was 84. As the senior staff of the organisations contacted, were used to distribute the sample, a response rate cannot be generated.

Given the fact that this was an unsolicited mail survey, regarding what is presently a rather contentious issue amongst the farming community, sustainability, the response rate was considered to be very good. Kirk (1995, p 7) stated that response rates for mail surveys were typically between 10% and 45%.

Even though the survey achieved a good response rate, there are still some bias and errors in the response. The conventional farmer sample may have peculiarities pertinent to the location of group of farmers within the Rangitikei area. The reasonable geographic proximity to Massey University may cause it to have greater levels of education at the university or agricultural college as it was in the past. The close proximity may increase the likelihood of past surveys regarding agricultural issue or topics or contact with the university that may lead to an increased level of knowledge about certain issues. The survey sample of farmers may not be indicative of farmers on the high terraces and hill-country elsewhere in the country, or even farmers as the whole.

As mentioned earlier in the thesis, the stakeholder sample does not represent all the possible stakeholders, but those with greatest managerial control over land use decisions, such as the farmers, regional council staff and industry groups. The sample of the professional staff is mostly determined by who the senior staff member delegated the surveys to.

A good response rate, especially from the farmers could be explained by a number of reasons.

1 **The use of a good covering letter.**
All the covering letters (pages B1, B2, B12 and B13 in Appendix B) explained many crucial points: the importance of the research; the importance of the response from the person reading the covering letter; how the respondent may benefit from the research; the short length of time required to answer; how a freepost envelope was enclosed (no cost involved to reply); anonymity of responses; urgency of response; and appreciation for their time. The letter was printed with the university letterhead, which further states importance of the research. The name of the conventional farmer and organic farmer was hand-written on the envelope and covering letter, which increases the personalisation of the survey, and also increases the appearance of the

importance of the respondents opinions and ideas on the issues covered in the survey. The use of an effective covering letter was noted by May (1993), de Vaus (1995) Warwick & Lininger (1975).

2 **The use of double-siding the printing of the survey.**
This makes the survey appear a little shorter than it may in fact be.

3 **Use of a Freepost envelope.**
These means that there is no cost born by the respondent in sending back the survey. The envelope was also preaddressed as well, so this increases the ease at which respondent can reply. All a farmer had to do was place the survey in the envelope and leave it in the mailbox for the rural delivery (ease of response may also have been appreciated by the professional staff too). This was noted by Warwick & Lininger (1975) and de Vaus (1995).

4 **Topical issue.**
The issue of sustainability is very important for agriculture, and topical at present, and this was a chance for views to be revealed (especially farmers). Much is made of what farmers 'think' about sustainability issues and comments made on the management practices undertaken on farms, but the survey offered the farmers a chance to respond on various environmental, economic and social issues in sustainable agriculture.

5 **Research undertaken by student at Massey University.**
The image of the university as a past agricultural college and the present agricultural research undertaken by staff and students helped with responses. The university has a good image for research amongst the agricultural sector. Some of the respondents with higher levels of formal education had studied at Massey University.

6 **The use of a prize draw for completed responses.**
The completed surveys returned by the farmers went into a prize draw for vouchers at the Farmlands chain of agricultural supply stores. The assistance of Farmlands was appreciated in this offer, and the rate at which some responses same back (within a couple of days from when they went mailed out) suggested that the prize draw did offer some incentive. This use of some sort of economic incentive was noted by de Vaus (1995).

7 **Follow-up letter**
The conventional farmers who did not reply had another letter, survey and freepost envelope sent to them to reinforce the importance of their views and that there were no 'right' or 'wrong' answers to the questions. This was noted by de Vaus (1995) to increase response rates.

8 Time of year.

The short period between when the surveys were mailed out and the return dates, before the Christmas/New Year period may have prompted quicker replies. This is especially the case with the farmer respondents as the prize draw eligibility specified an early return date. As for the professional staff, the impending Christmas break and the need to clear the 'in-tray' before this holiday period may have increased the response rate.

9 Anonymity of responses

The mail survey approach allows anonymity in response, and respondents may be less inhibited to reply to the survey, with frank and honest answers.

4.5 - Collation of survey results

The next stage of the survey process involved collating the results from all survey responses. Each respondent had their answers entered across one line in a spreadsheet. This resulting spreadsheet was large, with 224 respondents and 227 columns of data (50,848 cells in total).

The answers for Part II (Section 4.2.2) on opinions regarding sustainable agriculture, and Part III (Section 4.2.5) on the implementation methods, were simply coded with the number circled by the respondent for the answer, in the two different five-point scales.

The different characteristics for sustainable agriculture by the professional staff were listed. Each of the 53 characteristics shown in Table 6.2 was assigned a different column in the spreadsheet. Then a simple binary code was used for these responses, if the respondent noted a particular characteristic, a 1 was placed in their row under that column, and a 0 (zero) was used if that particular characteristic was not mentioned.

This same binary code was used for the 96 barriers to sustainable agriculture that were identified by all the stakeholder groups, which are listed in Tables 9.1, 9.2, 9.3, 9.4 and 9.5, with each having a separate column in the spreadsheet.

The answers by the conventional and organic farmers to the questions regarding the RMA 1991 and the term sustainability involved more subjective scaling. Table 4.5 shows the codes used in the spreadsheet for the responses to the first introductory questions, which asked if agriculture needs to become more environmentally friendly. This was designed to warm the respondent to the theme of the survey and to pose a very general question on the survey topic.

TABLE 4.5 - Scale for coding of question 'Do you think agriculture needs to become more environmentally friendly?'

QUESTION RESPONSE	RESPONSE VALUE
Yes	3
Undecided	2
No	1

The next question asked the farmer respondent whether they had heard of the Resource Management Act 1991. The responses to this question were easy to code according to Table 4.6.

TABLE 4.6 - Scale for coding of questions asking 'Have you heard of the Resource Management Act' and 'have you heard of the term sustainability.'

QUESTION RESPONSE	RESPONSE VALUE
Yes	1
No	0

The next question asking if the respondent had heard of the term sustainability, was also coded by the yes or no responses as shown in Table 4.6.

The detail to these two questions, which in the case of the RMA, asked for an outline of the main purpose of the RMA, and in the case of the term sustainability, it asked for the respondents understanding of the term (as can be seen on page B4 in Appendix B). This involved a subjective judgment of the responses to the two questions. In the case of the purpose of the RMA a number assigned according to that shown in Table 4.7, with a 'good' answer being a word perfect or thereabouts recital of the purpose as defined in the RMA, using the terms natural and physical resources. An 'average' answer was given for a response that showed less knowledge of the RMA, but still recognised it was the legislation about sustainable management. A 'poor' answer was given for a response that was little more than the rewording of the title of the act, for example, 'it is the act for the management of our resources.' A respondent was assigned a 1 for 'no' answer, and in this case, the respondents often stated they had heard of the act, but did not know its purpose (the honesty in some answers was great).

TABLE 4.7 - Scale for coding of questions on 'outline the purpose of the Resource Management Act' and 'please describe your understanding of the term sustainability.'

QUESTION RESPONSE	RESPONSE VALUE
Good answer	4
Average answer	3
Poor answer	2
No answer	1

The respondents understanding of the term sustainability was assigned with the same codes as for the RMA question as shown in Table 4.7, but obviously the answers were assessed with different criteria. A 'good' answer mentioned comments such the use of resources at a rate that does not preclude the future use of the resources, and also mentioned the balance of economic, environmental and social considerations. An 'average' answer used just one of the three approaches above (outlined in Douglass (1984) in Section 2.2), with no balance with other considerations. A 'poor' answer for this question stated very little, with no long-term consideration included or mention of a social, environmental or economic component. Again, the 'no' answer response is self-explanatory, with no understanding of the term illustrated beyond the yes or no to 'have you heard of the term sustainability.'

4.6 - Statistical analysis of survey results

The statistical analysis of the results and subsequent explanations offered for the responses, undertaken for each of the survey sections are shown in Table 4.8. The table illustrates how each section was described and analysed.

The characteristics of sustainable agriculture identified by the professional staff in **Part I** of their surveys (page B15), were simply listed in Table 5.1 with the number of responses (in number and percentage form) that mentioned each particular characteristic.

The conventional farmers and organic farmers **Part I**, covering the RMA and sustainability (page B4 in Appendix B) was analysed using the 'frequency histogram' function in Microsoft Excel 4.0 and the ANOVA command in SAS. The 'T-Test' command in SAS was used for analysis of responses to the agricultural practices questions for binomial variables such as gender.

TABLE 4.8 - Methods of statistical analysis and explanation of sections of the survey.

Section of Survey	Stakeholder Group	Information	Description	Statistical Analysis	Explanation of Statistically Significant Results
Part I	Professional Staff	Perceived characteristics of sustainable agriculture **Chapter 5.1**	Tabulated Responses and Grouped under reoccurring generic themes	N/A	Discussed commonly occurring characteristics and reasons for this (sample group)
Part I	Conventional Farmers and Organic Farmers	Recognition and understanding of RMA and term 'sustainability **Chapter 5.2**	Frequency Histograms	F-Tests and T-Tests (significant differences between means)	Use of non-parametric test to understand the linkages of intervening variables **Appendix D**
Part II	All Groups	Ideal practices section **Chapter 6**	Frequency Histograms	F-Tests and T-Tests (significant differences between means)	Use of non-parametric test to understand the linkages of intervening variables **Appendix D**
Part III	All Groups	Favourability of implementation methods **Chapter 10**	Frequency Histograms	F-Tests and T-Tests (significant differences between means)	Use of non-parametric test to understand the linkages of intervening variables **Appendix D**
Part IV	Conventional Farmers and Organic Farmers	Actual agricultural practices **Chapters 7** and 8	Frequency Histograms	F-Tests and T-Tests (significant differences between means)	Use of non-parametric test to understand the linkages of intervening variables **Appendix D**
Part V Part IV	Conventional Farmers and Organic Farmers Professional Staff	Perceived barriers to sustainable agriculture **Chapter 9**	Tabulated generically with individual tallies for each of the three stakeholder groups	N/A	Describe commonly occurring barriers and the main stakeholder groups these came from.

The results of the questions in **Part II** and **III** (pages B5-B7 for farmers and pages B16-B18 for professional staff in Appendix B) of all survey responses were analysed against the demographic attributes of the respondents (which are discussed in Appendix C). This was done with the use of the 'frequency histogram' command in Microsoft Excel 4.0 and also the 'ANOVA' command in SAS. The 'T-Test' command in SAS was used for analysis of the binomial variables such as gender.

The agricultural practices queried in **Part IV** of the surveys for the conventional and organic farmers (pages B8-B10), were assessed using the 'frequency histogram' function in Microsoft Excel 4.0 and the ANOVA command in SAS. The 'T-Test' command in SAS was used for analysis of responses to the agricultural practices questions against the binomial variables such as gender.

The barriers to sustainable agriculture identified by all the respondents (page B10 for the farmer survey and page B19 for the professional staff survey) were all grouped under generic titles and listed in Tables 9.1, 9.2, 9.3, 9.4 and 9.5. The number of times each of these barriers were mentioned by the conventional farmers, organic farmers and professional staff, is indicated on the tables. The rationale and generic themes for the different tables is discussed at the beginning of Chapter 9.

4.7 - Explanation of analysis of survey results

The statistical tests used just give mean responses for different classes within the demographic details of the respondents and signify whether the differences in the means are significant. The mere existence of statistically significant differences is of limited use, unless a possible explanation can be offered for the occurrence of these differences.

The subsequent explanation and discussion about the characteristics of, and perceived barriers to, sustainable agriculture outlined in the responses to the surveys, is also important. These do not have mean responses analysed statistically, but the tables of barriers and characteristics allow comparison between the barriers perceived by the three stakeholder groups and subsequent explanation of these. This can illustrate the variation in views held by the different stakeholders, and also address the relevance of the characteristics and barriers mentioned in the survey responses.

The statistically significant results are discussed in the following chapters, with the format arranged as discussed in Section 1.7.

Chapter Five
Ideal Characteristics of Sustainable Agriculture and the Resource Management Act

The following chapter outlines the initial Part I of the surveys sent to the conventional and organic farmers, and the professional staff in two separate sections. The first, Section 5.1, discusses Part I of the professional respondents' survey regarding their perceived characteristics of 'sustainable agriculture.' The second, Section 5.2 covers the survey section for the conventional and organic farmers, on the RMA 1991 and the concept of sustainability.

5.1 - Perceived Characteristics of 'Sustainable Agriculture'

In Part I of the professional staff survey, shown in Appendix B, on page B15, the professional staff respondents were asked to outline the characteristics of 'sustainable agriculture' as they perceived them. All the perceived characteristics of sustainable agriculture that were mentioned by the professional staff in Part I of the survey are shown in Table 5.1. The question asked them to 'Briefly identify the main characteristics of sustainable agriculture.' The following section contains the discussion about the characteristics mentioned by 7 (8%) or more respondents. The five generic groupings for the following discussion are the same as the groupings, and subsequent numbering system, within Table 5.1.

5.1.1 - Biophysical Considerations

The need to maintain the productive capacity of the resource-base was noted by 45% of the respondents. The maintenance and conservation of the resource-base on which agricultural production is dependent, is of the utmost importance, if anything close to the state of sustainable agriculture is to be achieved. The need to achieve this is outlined in sections 5(2)(a) and 5(2)(b) of the RMA 1991. This is aligned with the both, the concept of 'sustainability as food sufficiency' as proposed by Douglass (1984) covered in Section 2.2.1, and also the concept of 'agronomic sustainability' proposed by Lowrance (1990), which was included in Section 2.3.

Avoiding or minimising environmental degradation was outlined in 24% of the responses. This point was discussed by MAF (1993a), Luckman (1994), Douglass (1984), Weil (1990) and Edwards & Wali (1993). The environmental degradation issue equates to section 5(2)(c) of the RMA 1991. How this degradation can be determined or measured is not known.

TABLE 5.1 - Perceived characteristics of sustainable agriculture by professional staff respondents.

	Characteristic	Responses	
5.1.1	BIOPHYSICAL		
1	Maintain the productive capacity of the resource-base	38	(45%)
2	Includes reversible effects	1	(1%)
3	Avoid/minimise environmental degradation	20	(24%)
4	Minimise external inputs	13	(15%)
5	No off-site adverse effects	20	(24%)
6	Need to consider cumulative effects of agriculture	1	(1%)
7	Involves nutrient cycles - not linear flows	5	(6%)
8	Consider environmental carrying-capacity - match land-use to land-type	18	(21%)
9	Minimise energy inputs	3	(4%)
10	Protect indigenous environment/habitat	5	(6%)
11	Natural biodiversity is high	3	(4%)
12	Protective measures are included - windbreaks and water-supplies for stock in case of extreme events	5	(6%)
13	Enhance environmental quality	5	(6%)
14	Efficient use of resources	4	(5%)
15	Use of naturally resilient species/strains	1	(1%)
16	Use of crop rotations	2	(2%)
17	Consideration of aesthetic effects/aspects	2	(2%)
5.1.2	SOCIAL		
18	Maintain the integrity of the rural community	10	(12%)
19	Increase the level of knowledge of the agricultural system	1	(1%)
20	Does not affect cultural values	2	(2%)
21	Considers and includes social infrastructure - schools etc...	6	(7%)
22	Considers off-site infrastructure - road networks	2	(2%)
23	Supports social networks in the rural community	2	(2%)
24	Includes a stewardship ethic	5	(6%)
25	Considers consumer safety issues of food/fibre	8	(10%)
26	Cooperate with agricultural and wider rural community	2	(2%)
27	Rural lifestyle issues given consideration	2	(2%)
28	Consider the needs of future generations	15	(18%)
29	Have regard for the wide range of stakeholders involved	2	(2%)
30	Results in satisfied and healthy customers	8	(10%)
31	Develop a suitable infrastructure - labour, knowledge	2	(2%)
32	Need to reconcile the major and competing land-uses	1	(1%)
5.1.3	ECONOMIC		
33	Accommodates fluctuations - in production, commodity prices, demand for income, weather/climatic events and changes	6	(7%)
34	Need to maintain or boost food and fibre production	17	(20%)
35	Careful marketing of resulting produce	4	(5%)
36	Contain pest numbers and diseases (plants and animals)	6	(7%)
37	May involve multiple land-uses (e.g. pastoral & forestry) to give a diverse and stable income base	7	(8%)
38	Internalise the externalities - e.g. the cost of soil erosion	2	(2%)
39	Incorporate a Quality Assurance programme	1	(1%)
40	Conventional practices may not be suitable	4	(5%)
5.1.4	OVERARCHING THEMES		
41	Entails a biophysical sustainability component	40	(48%)
42	Entails a social sustainability component	21	(25%)
43	Entails an economic sustainability component	39	(46%)
44	Need all of the above three to be integrated/balanced	7	(8%)
45	Very little is 'sustainable'	3	(4%)
46	Involves monitoring the State of the Environment	4	(5%)
47	Sustainability is a moving target defined by society at that point in time	1	(1%)
48	Requires a 'systems' approach as opposed to "reductionist"	3	(4%)
5.1.5	SPECIFIC RESOURCES MENTIONED		
49	Soil	41	(49%)
50	Water	27	(32%)
51	Air	5	(6%)
52	Energy	2	(2%)
53	Climate	1	(1%)

The minimisation of external inputs into the agricultural system was mentioned on 13 occasions (15%). This point was first made by Rodale (1988) and is often mentioned by the authors, such as IUCN *et al.* (1990), MAF (1991), Keeney (1993) and Ikerd (1990). The recognition of this issue by the sample group is important, as internal cycling of resources, rather than flows of external inputs into the agricultural system, will be important in the achievement of sustainability. This is difficult, as the distinction between external and internal is not always clear cut and easy to define (Weil 1990). The onsite or internal inputs that are substituted for the external inputs need to be environmentally benign, and more sustainable, otherwise the changes are ineffectual. The problem that arises from these issues is, how far can the inputs be reduced, and what substitutes or management practices can compensate for the changes?

The minimisation or avoidance of off-site effects was noted in 24% of the replies. Off-site effects are important as they are covered in the RMA 1991 in subsection 5(2)(c), as "avoiding, remedying, or mitigating any adverse effects of activities on the environment." This is not a particularly outstanding component of agricultural sustainability on the part of the respondents, but more a statutory requirement under the RMA. It is consistent with the concept of 'ecological sustainability' proposed by Lowrance (1990), which was included in Section 2.3. It is also recognition of the horizontal scale in sustainable agriculture (Section 2.4.1), the off-site effects from agriculture considered, along with the impact of agriculture that occurs on the farms.

Of the respondents, 18 (21%) mentioned the need to consider the carrying-capacity of the land, and match land-use with the land-type. The concept of environmental carrying-capacity is a fundamental consideration in achieving ecological sustainability and was mentioned by IUCN *et al.* (1990), Blakeley (1990a), Keeney (1993) and Ikerd (1990). The sustainable management of land-use, may well be an issue of appropriateness, with the land-use matching the capability class and carrying-capacity of the land. This may in some cases preclude agricultural use, and for example, forestry may be more sustainable, both economically and ecologically.

5.1.2 - Social Considerations

Maintenance of the integrity of the rural environment was mentioned by 10 respondents (12%). This point covers many of the more detailed issues covered in Table 5.1 of the characteristics, such as cultural values, social infrastructure, social cohesion and sense of community in rural areas. As mentioned in Section 5.1.4 on the overarching themes, the social considerations do not feature as frequently as environmental and economic considerations. The section of Table 5.1 on social considerations, clearly shows fewer references to social characteristics in that section, than characteristics under the economic and environmental sections. The statement, referring to the 'integrity' of the rural environment is very vague, and what it actually refers to, and whether it can be measured, is not exactly clear.

The consideration of consumer food and fibre safety issues was noted on 11% of occasions. Although placed under the social considerations, it is in some ways a production-oriented response, as the issue is about the produce that results from the agricultural system. The considerations of the off-site community issues in the agricultural system, in this case the consumers, is the reason why this is placed in this section. This consideration of the off-site consumers is a recognition of the vertical scale in agriculture (Section 2.4.2), although there are production and legal issues involved with safety and human health - a statutory requirement. Food and fibre safety issues were mentioned by many authors, including Harwood (1990), Jennings (1990), Schaller (1993), Weil (1990) and Buttel (1993). This also represents section 5(2) of the RMA 1991, which states that 'sustainable management' means to enable "people and communities to provide ... for their health and safety."

Fifteen of the responses (18%) outlined the consideration of needs of future generations. This is outlined by the RMA 1991, and is a statutory requirement for many who responded to the survey, so its inclusion is hardly surprising. But what exactly "reasonably foreseeable needs of future generations" (RMA 1991, p 21) means, is unclear. Intergenerational equity issues are an important component of the 'sustainability as community' and 'sustainability as stewardship' approaches of Douglass (1984) outlined in Sections 2.2.2 and 2.2.3. The need for the inclusion of intergenerational issues in agricultural sustainability was noted by Wynen & Fritz (1987), Swaminathan (1991), IUCN *et al*. (1991) and George (1990).

The result of satisfied customers from the agricultural industry was noted by 10% of the respondents. This is similar to the safety issues comment, but concentrates on satisfaction of the customer, that is, supplying a product of quality, that meets the needs and desires of the customer. Again, like the food/fibre safety issues, the issue is production-oriented to a degree. This is encouraging though, as it considers the issues in the agricultural system beyond the 'farm-gate', such as the end-product, and customer satisfaction that is derived from it (vertical scale in Section 2.4.2).

5.1.3 - Economic Considerations

The need for sustainable agriculture to maintain or boost the food and fibre production from the system was mentioned in 20% of responses. The industrial or production driven approach to agriculture is justified by the need to meet the food demands of an expanding world population (Douglass 1984). This is outlined in Section 2.2.1, regarding the Douglass (1984) school of 'sustainability as food sufficiency' approach to agricultural sustainability. To ensure that food sufficiency is maintained, any practices that degrade the productive potential of the land are not going to be viewed as sustainable, according to Dahlberg (1991). Any increase in production will need to be carried out in an environmentally benign manner, or current adverse effects of agriculture will be intensified. The increase may be seen by some as a way to increase farm incomes (thus increase microeconomic sustainability), but more carefully marketed 'clean-green' produce may increase farm-incomes, without any great increase in production, through the attainment of premium produce prices from customers willing to pay for the produce.

The inclusion of multiple land-uses within the agricultural system, giving rise to a more diverse and stable income base was outlined in 8% of the replies. A diverse production base can have a 'cushioning' affect of commodity price fluctuations on farm incomes. So if the commodity price of one part of the production systems falls, the remaining stable commodity prices will lessen any affect on farm-incomes, overall. The need for diverse and stable agricultural production systems was noted by Keeney (1993), Harwood (1990), Weil (1990), Ikerd (1990), Swaminathan (1991) and Plucknett (1990). The multiple land-uses also have some additional benefits to counter natural fluctuations (such as weather, pests or disease), which can reduce farm-income if they occur, and lead to diminishing production levels. In "Caring for the Earth" by the IUCN *et al*. (1991), the use of diversification and rotation of crops was stated as minimising pest numbers to an economically acceptable level. Reganold *et al*. (1990, p 118) stated that a "biologically diverse farming system is also less susceptible to the economic woes of a flooded market or a fall in prices for a single crop." Wide-ranging benefits can be derived from diverse production systems, all benefiting the farmer.

5.1.4 - Overarching Themes

The inclusion of a biophysical component in the sustainable agriculture was noted by 48% of respondents. They referred to items such as soil properties (Organic Matter Content, pollutants, and structural properties) and other considerations like soil erosion. The factors are listed in the "Biophysical" section of the characteristics table (Table 5.1) and in the earlier Section 5.1.1.

The social component featured with less in the returns (with 25% of respondents referring to anything resembling a social component). The factors which are mentioned, are included in the social part of Table 5.1 and in the earlier section on social characteristics (Section 5.1.2). The lesser importance placed on social aspects of agricultural sustainability, and to the social questions in Section 6.4, about attitudes and perceptions to sustainability is a concern. Some respondents dismissed 'out-of-hand' the questions on social issues (such as the importance of services like rural schools), and queried their inclusion in the survey. MAF (1993a, p 11) state that rural communities are essential to the achievement of sustainable agriculture as "agricultural production cannot be sustained without an adequate human resource."

Blakeley (1990a, p 7) argued that sustainable agriculture required the inclusion of a "social dimension". This included landscape issues, community viability and lifestyle issues. Keeney (1993, p 806) noted that the sustainable agriculture needed to be "socially acceptable." The SCGSLMR (1995) also considered that the inclusion of a social component to research on sustainable land management was important.

The need for economic sustainability in sustainable agriculture was noted on 39 occasions (46%). Ikerd (1990, p 21) stated that if agriculture is to be sustainable, it "must first and foremost be profitable." This interrelationship between profitability (microeconomic sustainability) and ecological sustainability was also made by Schaller (1989), MacRae *et al.* (1989) and Schaller (1993). The recognition by the survey respondents that agriculture needs to be profitable to be sustainable is encouraging. If the farm does not make money, then the implementation of environmental protection works, or initial outlay required for sustainable practices becomes difficult, if not impossible (outlined in the objectives of agriculture in Section 2.3).

Specific reference to the need for the inclusion and balancing of all three components listed above was mentioned in 7 replies. The lack of recognition for the need to balance and reconcile the differences that may arise is of concern. Weil (1990) claimed that the economic, social and environmental aspects of agriculture should be integrated in any definition of sustainable agriculture. The definition he proposed (Weil 1990), included considerations for these issues. The American Society of Agronomy (1988) definition included economic and social considerations, along with the biophysical and environmental. Sustainable agriculture according to Plucknett (1990, p 36) "involves the complex interactions of biological, physical and socioeconomic." Edwards & Wali (1993, p xi-xii) stated there was a need for the "thorough integration of ecological, economic and policy paradigms." MAF (1991a) stated that it should provide policy advice that explicitly considers economic, social and environmental implications when generating policy regarding sustainable management of the resources used in New Zealand's primary industries. The MAF (1993a) definition of sustainable agriculture gives explicit reference to the maintenance of economic viability of agriculture and the cultural and social wellbeing of people and their communities. The three approaches of Douglass (1984), which are similar to the overall approaches to sustainability, namely environmental, social and economic, were covered in Section 2.2. As discussed in Section 2.2.4, one aim by many authors is to integrate these three different considerations. This featured in the literature of Weil (1990), Grove & Edwards (1993), Stenholm & Waggoner (1990), Francis & Madden (1993), Lefroy & Hobbs (1992), Hooper (1995), Swaminathan (1991), Lowrance (1990), Edwards & Wali (1993), Edwards *et al.* (1993), Yunlong & Smit (1994) and Senanayake (1991). The 'Environment 2010' strategy from MfE (1995b) stated that one of the aims of the strategy was to integrate environmental, social and economic issues into decision making at all levels. This need for integration of the different schools of thought as specified by central government (MAF, SCGSLMR and MfE) and overseas (IUCN *et al.*) is not receiving consideration by the professional staff.

5.1.5 - Specific Resources Mentioned

In the characteristics section, specific references to resources were mentioned. Often these references were detailed (such as soil pH, soil organic matter content or BOD level in water), and were grouped generically, such as soil and water in this case. If no effort was made to categorise the references, the table of specific references would be very large, with low numbers of references to individual, detailed resource indicators.

The most common resource cited was soil, by 41 respondents. Issues such as degradation, fertility loss, and erosion were high on the agenda of many of the respondents in their workplaces (Regional Councils, scientists and academics), so the result is hardly surprising. Also the amount of research undertaken in the past about soil resources is high, and this raises awareness of the issues amongst the professionals. The soil resource is referred to in section 5(2)(b) of the RMA (1991, 21). References to the importance of soil and soil conservation in sustainable agriculture were made by IUCN *et al.* (1991), Reganold *et al.* (1990), Harwood (1990), Buttel (1993), Rodale (1993) and Edwards & Wali (1993)

Water was referred to on 21 occasions in the replies. Again, this is the responsibility of many of the respondents, as is soil. It is outlined in the RMA, in the same subsection 5(2)(b) as soil. The consideration of the water was mentioned by, amongst others, IUCN *et al.* (1990), MAF (1991a; 1993a), Keeney (1993), Harwood (1990), Schaller (1993), Weil (1990) and Plucknett (1990)

The air resource was only noted by 5 respondents. This resource is also included in the very same section of the RMA as the two aforementioned resources. Pollution and discharges of odour by agriculture are important issues for sustainability. With little recognition given to the air resource, these issues would appear to be given little or no consideration by the respondents. Pollution from vehicles using fossil fuels is important for agriculture, especially the off-farm pollution, in processing, packaging and transportation. New Zealand was a signatory to the CO_2 convention to reduce the emissions of this gas. References to the consideration of air pollution in sustainable agriculture were made by Lowrance (1990) Rodale (1985), MAF (1991a; 1993a).

Energy was cited in only two replies. Given the fact that "energy" is listed under the definition of "natural and physical resources" in the RMA (1991, p 14), the very poor recognition of the importance of energy is a concern. Energy use, especially from non-renewable sources, was noted as important by a number of authors as affecting the future viability of agriculture. The authors who stated energy efficiency considerations in agricultural sustainability included Hillel (1991), Blakeley (1990b), Reganold *et al.* (1990), Keeney (1993), Douglass (1984), Lowrance (1990) and Plucknett (1990). Reliance on non-renewable energy sources, such as fossil fuels threatens the future viability of agriculture. This use of non-renewable resources for energy in agriculture was noted by Harwood (1990), Schaller (1990), Weil (1990), Edwards & Wali (1993), Wagstaff (1987) and Freudenberger (1986). The pollution from fossil-fuels adds to CO_2 and other emissions. If New Zealand is to meet its obligations to the convention on CO_2 emissions, then the use of energy which causes these emissions, including agriculture, must be reduced.

Specific reference to climate as a resource, and input to the agricultural system, was made on only one occasion. Given the importance of climate as an input to the agricultural system (rainfall, sunshine hours, minimum frost days amongst others), the lack of recognition is worrying. The fluctuations in climate can cause production levels to increase or decrease, depending on favourable or unfavourable fluctuations. Severe frosts can lead to increased lamb mortality rates at vulnerable stages of their lives. Warmer conditions at the same periods, can lead to lower than normal losses of lambs, leading to potential increases in production, if the increased stock numbers flow through the production cycle. This type of consideration and management of risk (such as that posed by climatic variations) was mentioned by some authors such as Ikerd (1990), and MAF (1993a). MAF (1991a, p 8) claimed that sustainable agriculture needed the "ability to adapt to climatic ... risks." Dahlberg (1991) mentioned that agriculture, like other sectors of the economy, will need to grapple with the issue of possible climate change in the future. Edwards & Wali (1993) stated that future changes in climate could alter the distribution of agricultural practices. Blakeley (1990a, p 7) maintained that the concept of "Knowing your region" was important is sustainable agriculture, and part of this was to understand the climate.

5.2 - Awareness of the Resource Management Act and the Term Sustainability

The initial Part I of the survey sent to the conventional and organic farmers asked question regarding the environment, the RMA 1991 and sustainability concepts. Part I of the farmer surveys can be seen in the copy of the survey sent to these respondents which is included in Appendix B of this thesis on page B4.

All the questions in this section are shown with the significant determinants to responses in Table 5.2. The table shows the relevant F-Ratios and levels of significance, between the demographic details of the respondents, and the responses they gave.

The following is a discussion on the relationships between responses and demographics of the sample group that are statistically significant in Table 5.2. Overall, the responses for the questions in Part I of the farmers surveys, regarding the RMA 1991 and the term Sustainability did not differ greatly according to the demographic data. The problem with the differences between stakeholder groups, is the small sample of organic farmers, as previously mentioned.

5.2.1 - Does agriculture need to become more 'environmentally friendly'

Both the conventional and organic farmers overwhelmingly agree that agriculture needs to become more "environmentally friendly." Of the conventional farmers who responded to the question, 104 (78%) agreed with the statement, and 11 (8%) disagreed, and 18 (14%) were undecided. All four of the organic farmers who responded to the question, agreed with the statement.

FIGURE 5.1 - Conventional and Organic farmers responses to 'Does agriculture need to become more environmentally friendly.'

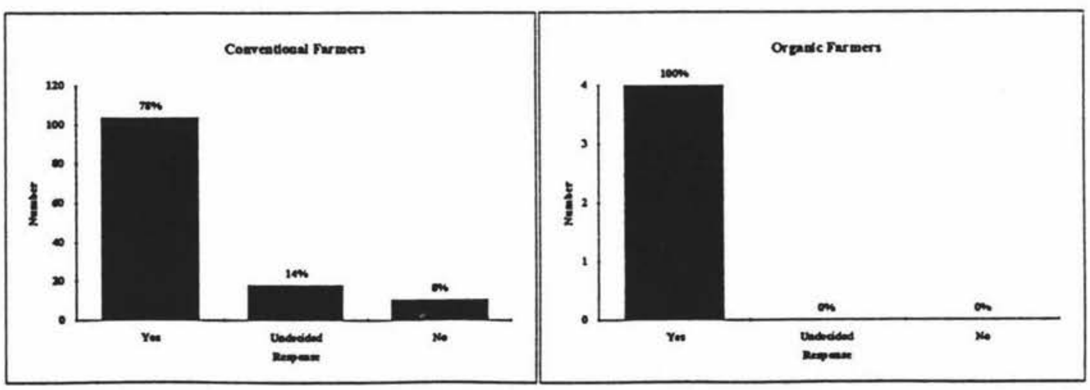


TABLE 5.2 - F-Ratios and Levels of Significance for questions in Part I of the conventional and organic farmer surveys.

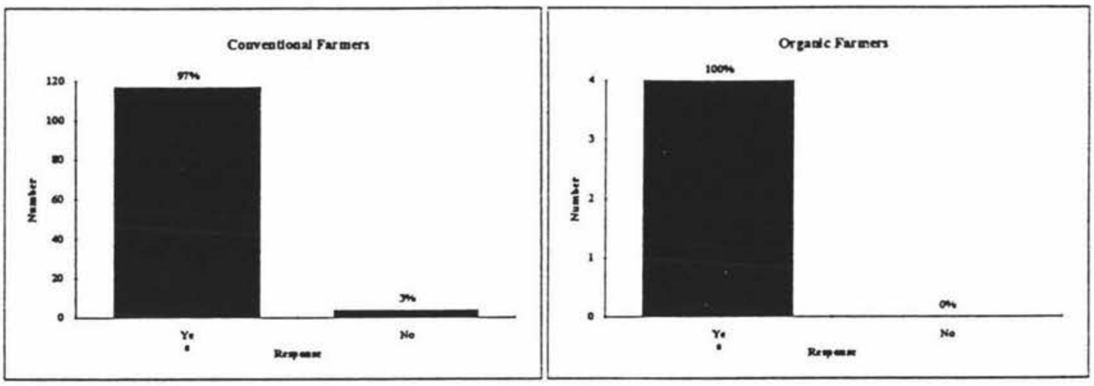
	Question	Age		Education		Farm-Type		Farm-Size		Professional Affiliations		Stakeholder Group		Gender	
		<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05
1	Does agriculture need to become more environmentally friendly?														
2	Have you heard of the RMA?														
3	Please outline the main purpose of the RMA			F=1.80 p=0.0683				F=2.12 p=0.0837					F=4.27 p=0.0410		
4	Have you heard of the term sustainability?														
5	Please outline your understanding of the term sustainability						F=2.12 p=0.0340		F=3.06 p=0.0198						

The level of agreement amongst the farmers that agriculture does indeed need to become more "environmentally friendly" is encouraging, and has advantages for the environment, rural communities and the agricultural sector in general, if agriculture was to become more 'environmentally friendly' or sustainable.

5.2.2 - Resource Management Act

Almost all of the respondents had heard of the RMA 1991, and this is illustrated in Figure 5.2.

FIGURE 5.2 - Conventional and Organic Farmers responses to 'Have you heard of the RMA?'



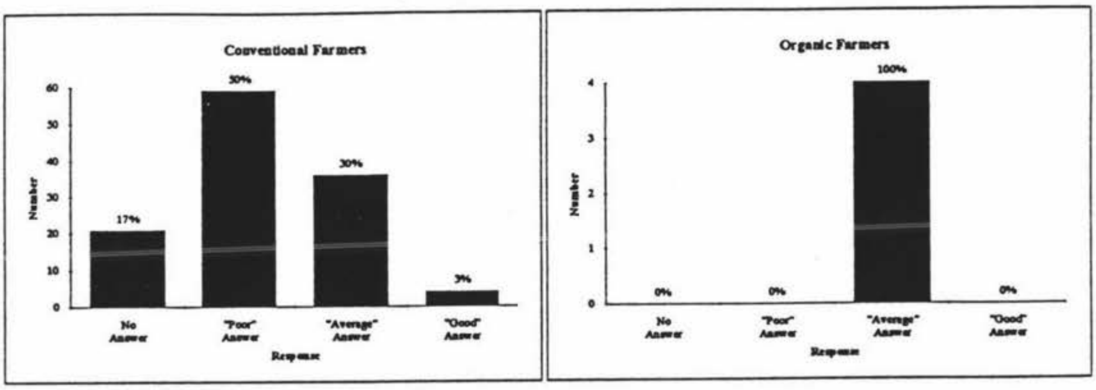
Of the conventional farmers, 117 (97%) had heard of the RMA, and 4 (3%) had not. All 4 of the organic farmers who answered this section had heard of the RMA. The level of recognition of the RMA is encouraging, as they know that there is legislation covering activities and the related resource use, such as farming.

The level of knowledge about the purpose of the RMA and greater detail about what is needed to meet the requirements of the RMA are more important. The answers to this question (shown in Figures 5.3, 5.4 and 5.5) were not as satisfactory as the recognition of the existence of the legislation.

5.2.3 - Purpose of the Resource Management Act

The level of knowledge of the purpose of the RMA differed according to the two groups of farmers. For the question 'Please outline the main purpose of the Resource Management Act', the membership of stakeholder groups was a significant determinant ($F=4.27$, $\rho=0.0410$) to the statement. The responses by the conventional farmers were slightly lower, with a mean of 2.18, than the organic farmers, with 3.00.

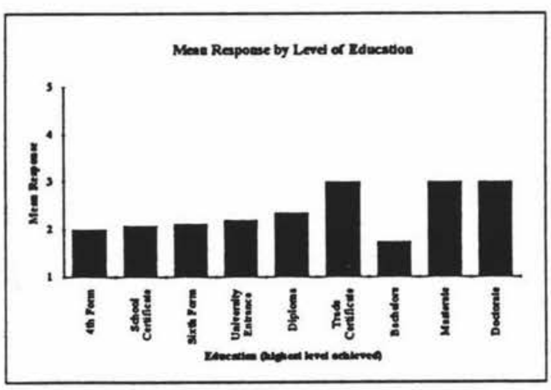
FIGURE 5.3 - Conventional and Organic farmers responses to 'Please outline the main purpose of the Resource Management Act.'



The greater level of awareness of the purpose of the RMA by the organic farmers could be explained by the Biogro standards for Certification being aligned with the concepts outlined in the RMA 1991. The standards of certification often are worded stronger and in more detail than the RMA 1991, but refers to the law of the land being the minimum requirements, and where mentioned, the specified Biogro standards are more stringent than national standards. Obviously, where the national laws are more stringent, then they supersede the Biogro standards. The aim is for compatibility between the overriding philosophies of the certification process for the NZBPCC and the RMA 1991.

For this same question on the purpose of the RMA 1991, the level of education of the respondent also determined the response, but only moderately ($F=1.80$, $\rho=0.0863$). As the level of education increases, the knowledge of the RMA's purpose by the respondent, also increased, as shown on Figure 5.4 below.

FIGURE 5.4 - Responses to 'Please outline the main purpose of the Resource Management Act' by education level of respondent.

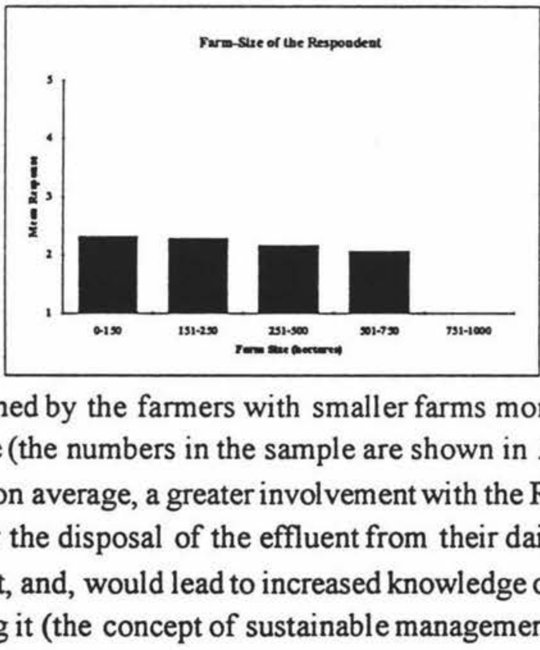


This relationship could be explained by the fact that as the farmers become more educated, the likelihood that they would come into contact with discussion regarding the RMA was increased. Korsching *et al.* (1983) found a link between the education levels of farmers and the implementation of soil conservation in Iowa in the United

States. The authors linked the education of the farmers with their innovativeness, which affected the rate at which they implemented soil conservation practices. The education of farmers may lead to increased reading of printed material which can inform them about the RMA and its purpose. Increased education may give increased ability to understand the material on the RMA. The attendance at institutions of higher education may indicate that they are more intelligent than the lesser educated farmers, which can again affect they ability to comprehend the material available to them on the RMA, from newspapers, bulletins and other sources. The links between education and behaviour of farmers about soil conservation and resource management issues was also covered by Carlson *et al*. (1994)

The farm-size of the respondent was also a reasonable determinant in the understanding they had of the purpose of the RMA ($F=2.12$, $\rho=0.0837$). The smallest farm-size had the highest level of knowledge about the RMA's purpose (mean=2.32), and the largest farm-size class had the lowest (mean=1.00).The respondents with the largest farm-size class offered little or no answer to this question, even though they had heard of the RMA. Figure 5.5 below illustrates the mean responses for the various farm-size classes.

FIGURE 5.5 - Responses to 'Please outline the main purpose of Resource Management.' by farm-size of the respondent.



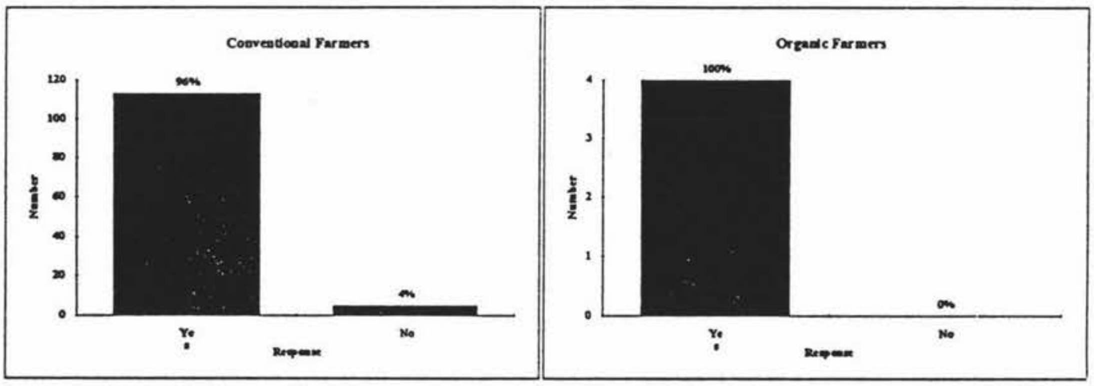
This could be explained by the farmers with smaller farms more often being dairy farmers in the sample (the numbers in the sample are shown in Appendix C). Dairy farmers would have, on average, a greater involvement with the RMA as they require resource consents for the disposal of the effluent from their dairy sheds. The need for a resource consent, and, would lead to increased knowledge of the RMA, and the purpose underpinning it (the concept of sustainable management of the natural and physical resources). The farmers in the sample that also include pigs in the farming operation would need a similar understanding to deal with the effluent, and again these were the farmers with smaller operations in terms of farm-size.

5.2.4 - Understanding of the term sustainability

The question was asked of the conventional and organic farmers if they had heard of the term sustainability and to outline their understanding about the meaning of the term. The greater majority of the conventional and organic farmers had heard of the term sustainability. Of the conventional farmers, 113 (96%) had heard of the term and 5 (4%) had not. Again, all 4 of the organic farmers who answered this section had heard of the term.

The difference is not statistically significant as shown on Table 5.2, and the graphs in Figure 5.6 below, but the high level of recognition of the term by both stakeholder groups, is encouraging. This makes the education about the term a little easier, as the general recognition of the term is there. For this reason, the graphs of the responses by both the conventional and organic farmers is shown below.

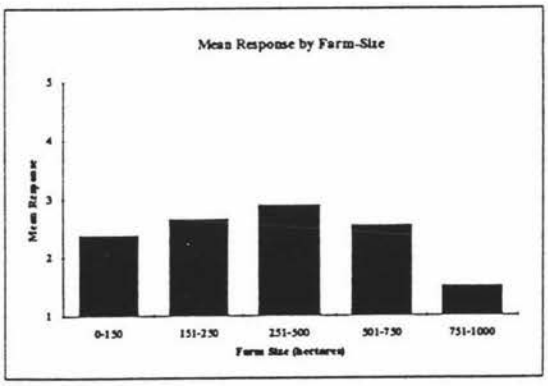
FIGURE 5.6 - Conventional and Organic farmers responses to 'Please outline your understanding of the term sustainability'



For the question 'Please outline your understanding of the term sustainability', the farm-type of the respondent was a notable determinant ($F=2.12$, $\rho=0.0340$) for the answer given. The sheep and the cattle farmers had a lower understanding of the purpose of the RMA 199, with means of 2.00 and 2.50 respectively, as compared to the more diverse farming operations, which had means between 2.75 and 3.00. The more traditional farmers had a lower level of understanding, and the relationship between farm-type and education outlined in Appendix D could explain this. The more traditional farm-types, like sheep and cattle farmers, had lower levels of education than their counterparts with more diverse operations. The lower education levels of the sheep and cattle farmers may explain the lack of awareness about the purpose of the RMA 1991.

The farm-size of the respondent was strongly correlated to their level of understanding about the term "sustainability" (F=3.06, ρ=0.0198) The mid-size farms (251-500 ha) had the greatest knowledge (mean=2.90), the smallest (0-150 ha) had less (mean=2.39) and the group with the largest farm-sizes (751-1000 ha) had the lowest level of knowledge (mean=1.50). This is shown in Figure 5.7 below.

FIGURE 5.7 - Responses to 'Please outline your understanding of the term sustainability' by farm-size of the respondent.



The 'peak' in responses around the mid-sized farms in the classification could be explained by the barrier between intensive and extensive farming. The farms between 251-500 hectares are at the boundary between intensive and extensive farming, and the agronomic and microeconomic sustainability of their operation becomes an important consideration. The size means that intensive use becomes difficult, as the scale of the work required (improving water for stock and fencing) may not be realistic, but the economics of a more extensive, less intensive, type of land use could be marginal. The land may becoming more marginal for the requirements of intensive agriculture, and agronomic sustainability issues may be highlighted to the farmer. The pressures operating on the farmer, between the need to remain economically viable and investment requirement of capital works to increase intensity, and the agronomic/ecological effects of this increased intensity, may mean that these farmers are more aware of sustainability issues.

Chapter Six
Desirable Practices for Achieving Sustainable Agriculture

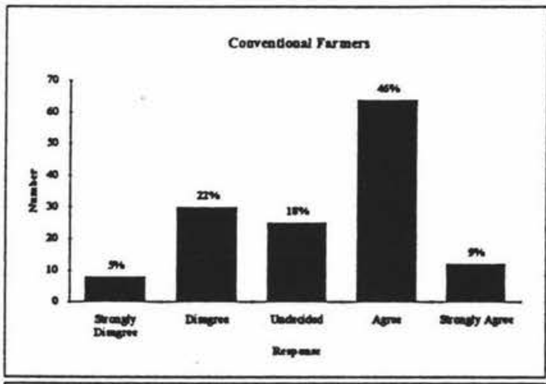
The questions in Part II of all the surveys were asked to elicit the attitudes on the ideal practices that the stakeholder groups hold (included in Appendix B on Pages B5-B7 for the two farmer groups and Pages B16-B18 for the professional staff). All of the questions to this section of the survey, included in the survey sent to the conventional farmers, organic farmers and professional staff, are shown in Table 6.1. The literature from which each of the topics for the questions originated is shown in Table 4.3 in the methodology chapter.

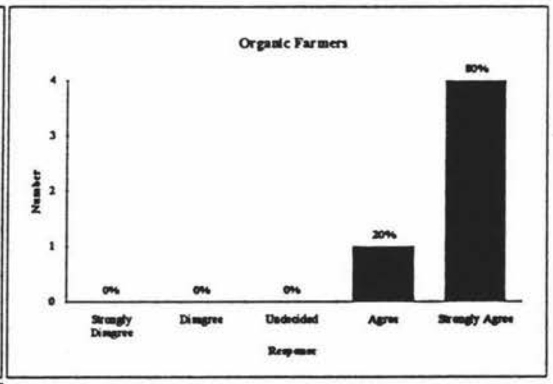
The following is discussion about the statistically significant relationships between the reply given by the respondents and their demographic details. The discussion about the questions and the statistically significant relationships is grouped under four generic headings. These headings reflect the three groupings under the practices discussed in Chapters 7 and 8, and are; Inputs, Resource Use, and Management Practices. The fourth grouping is under 'Specific Attitudes to Sustainable Agriculture Issues.' The social issues covered in this component of sustainable agriculture are very important, as shown in the literature review in Chapters 1, 2 and 3, and the opinions of the respondents regarding these issues needs to be revealed.

6.1 - Inputs

The literature on sustainable agriculture often covers issues regarding the use of inputs in agriculture. The economic, agronomic, ecological and human health implications of the use of synthetic inputs is often discussed. The advocation of the substitution of internal (on-farm) inputs as opposed to external (often non-renewable) resource inputs. The temporal sustainability (Section 2.4.3) of using non-renewable inputs is often questioned, and authors such as Keeney (1993), Hayward (1990), Harwood (1990), Schaller (1993), Douglass (1984), Weil (1990), Swaminathan (1990), Edwards & Wali (1993), Plucknett (1990), Youngberg (1986), Freudenberger (1986), Wagstaff (1987) and Wynen & Fritz (1987) mentioned the lack of long-term stability of using these products. The need for an increase in efficiency, and overall decrease in use, of external resource inputs was noted by the IUCN *et al.* (1990), MAF (1991), Blakeley (1990a), Harwood (1990), Kirschenmann (1991), Buttel (1993), Ikerd (1993), Edwards & Wali (1993), National Research Council (1989) and Rodale (1988). The use of resources that are sourced from off-site areas, and the resulting removal of produce from the farm (in the form of animal and plant products) represents a linear flow that is not agronomically/ecologically sustainable. The aforementioned authors maintain that greater use of internal resources, and cycling is more sustainable over the long-term, although realistically accept that some external inputs will be required to off set the loss from the system, in the form of the animal and plant products.

Question 7 asked the respondents whether they agreed with the statement that 'Reliance on non-renewable resources, such as fertilisers, threatens the long-term viability of agriculture.' Table 6.1 reveals that membership of stakeholder group, was a significant determinant in the reply given (F=4.85, ρ=0.0087).The conventional farmers had a mean response of 3.30, and the professional group had a very similar mean of 3.32. The organic farmers were much stronger in their replies, and their mean was 4.80, indicating a greater level of agreement with the statement. This is shown on Figure 6.1 below.





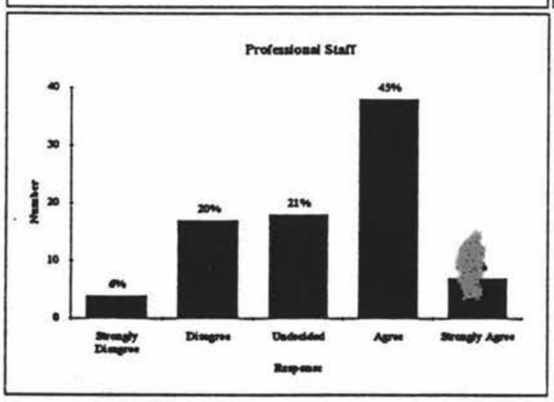


FIGURE 6.1 - Responses to Question 7 - "Reliance on non-renewable resources, such as fertilisers, threatens the long-term viability of agriculture." by membership of stakeholder group of the respondent.

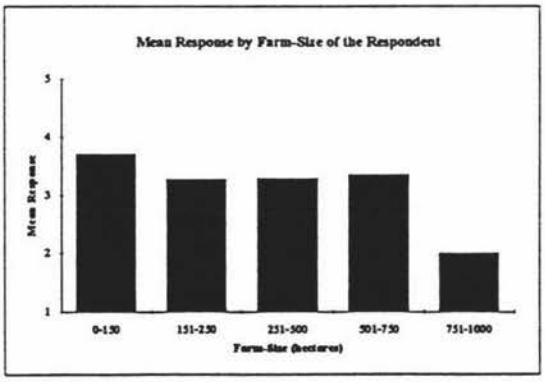
The organic farmers response could be explained by their move away from traditional, non-renewable fertilisers and other inputs. The move is toward the use of organic methods and greater nutrient cycling and efficiency, as opposed to linear nutrient flows supplemented from external resource inputs. This is one of the basic tenets of organic production, and is outlined in the "Certified Bio-Gro Organic Production Standards" by the NZBPCC (1994:1, (A)2). As the organic farmers surveyed were accredited with certification by these standards, their philosophies would need to mirror those set out in the standards.

	Question	Question Type	Age		Education		Farm-Type		Farm-Size		Professional Affiliations		Stakeholder Group		Gender	
			<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05
1	"Agricultural systems involving monocultures are more susceptible to pests/diseases than polycultural agricultural systems."	Management Practices				F=2.53 p=0.0212								F=7.31 p=0.0008		
2	"Agroforestry gives a greater return."	Management Practices	F=2.21 p=0.0690													
3	"Current soil erosion rates are an acceptable byproduct of agricultural land-use."	Resource Use												F=6.09 p=0.0027		
4	"The use of marginal land involves practices that are not economically sustainable."	Resource Use		F=2.54 p=0.0413												
5	"The use of marginal land involves practices that are not environmentally sustainable."	Resource Use												F=3.34 p=0.0373		
6	"Soil is a finite resource unless managed carefully."	Resource Use														
7	"Reliance on non-renewable resources, such as fertilisers, threatens the long-term viability of agriculture."	Inputs								F=2.59 p=0.0397				F=4.85 p=0.0087		
8	"Energy intensive agricultural enterprises, which use high energy inputs in relation to the products they yield, are not environmentally sound."	Inputs														
9	"Some loss of short-term profit may be required to ensure long-term commercial returns."	Social Considerations						F=2.53 p=0.0106				F=3.18 p=0.0086				
10	"Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly."	Social Considerations	F=2.20 p=0.0703									F=3.24 p=0.0078		F=6.76 p=0.0014		
11	"Human health risks from food and fibre produced by agriculture will become increasingly important in the future."	Social Considerations												F=4.10 p=0.0179		
12	"Rural-residential development on good quality soils is not environmentally friendly."	Resource Use														
13	"Social and community services, such as schools in the rural community are essential to its survival."	Social Considerations				F=2.02 p=0.0463								F=5.36 p=0.0053		
14	"Efficient cycling of nutrients within agricultural systems is required for environmental reasons."	Inputs														
15	"Efficient cycling of nutrients within agricultural systems is required for economic reasons."	Inputs														
16	"Conservation of native habitats and species within agricultural areas is important."	Resource Use					F=1.69 p=0.0976									
17	"Sustainable agriculture systems substitute higher levels of knowledge for external resource inputs."	Inputs					F=1.94 p=0.0528									
18	"Information requirements for 'environmentally friendly' agricultural systems are higher due to the knowledge and management requirements."	Management Practices		F=2.75 p=0.0294				F=2.20 p=0.0265								
19	"A team approach is required for environmentally friendly agriculture, to best understand the agricultural system."	Social Considerations														
20	"The farmer should be central to the research and development required to make sustainable agriculture a practical reality."	Social Considerations														

The conventional farmers had a mean similar to the professional staff. This could be explained by the notion that the professional staff are meant to reflect the opinions of the greater public in their positions. The scientists, council staff, educationalists and industry personnel surveyed should have opinions that mirror the public, as they represent the public interests. The conventional farmers and professional staff are more mainstream in their opinions than the organic farmers, who hold a different perspective on the use of non-renewable resources in agriculture, as they support the principles of organic production discussed in the previous paragraph. The mean of 3.32 from the professional staff is particularly high, and shows little understanding of the sustainability issues involved in the long-term use of non-renewable resources. The poor recognition of problems associated with the eventual depletion of these resources inputs, hinders the attempts to find renewable substitutes. The lower mean of 3.30 of the conventional farmers illustrates the education required to highlight sustainability issues, associated with the core problems of unsustainable practices that are based on the use of non-renewable resource inputs.

The reply to Question 7 on the "Reliance on non-renewable resources, such as fertilisers, threatens the long-term viability of agriculture" was also correlated notably with the farm-size of the farmer respondents (F=2.59, ρ=0.0397). The lowest farm-size (0-150 ha) had the highest level of agreement with the statement (mean=3.72). The classes in the middle had means about 3.30 (151-250 ha = 3.27, 251-500 ha=3.28 and 501-750 ha=3.35), and the largest farm-size (751-1000 ha) had the lowest mean response, with 2.00.

FIGURE 6.2 - Responses to "Reliance on non-renewable resources, such as fertilisers, threatens the long-term viability of agriculture" by farm-size of the respondent.



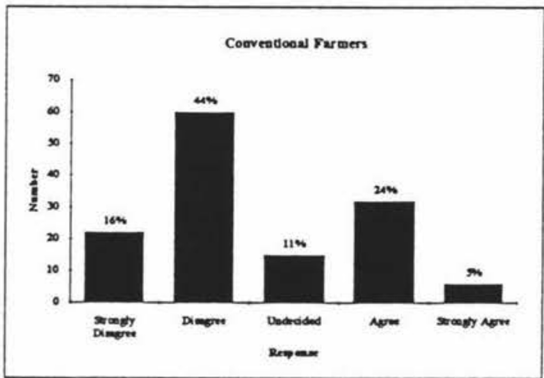
This relationship could be explained by the scale of the change required from non-renewable external inputs to natural cycling in larger farms. This increased scale of change would be a much more daunting task for larger farm operations, than it would be the case for a smaller operation. Thus, the farmer may have responded to the question, by relating the question topic to their own situation, and the subsequent level and scale of change in their practices that could be required.

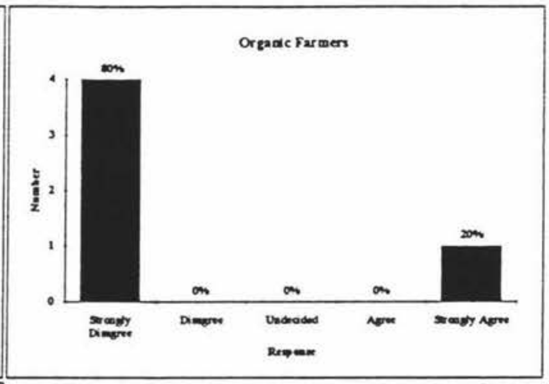
Question 17 in Table 6.1, which asked if "Sustainable agriculture systems substitute higher levels of knowledge for external resource inputs" was reasonably correlated to the farm-type of the respondent ($F=1.94$, $\rho=0.0528$). The sheep and sheep/cattle farmers had lower means, with 3.38 and 3.30, but the sheep/cattle/deer farmers had the lowest mean with 2.91. The sheep and the cattle farmers could have a lower mean as the they are more conservative and traditional in their operations, which may hinder their view towards changing to lower input systems The lower education levels of the sheep and cattle farmers compared to the other farmers as shown in Appendix D could also explain the lower level of agreement. The lower level of education may mean that they have had less contact with these alternative ideas or read less about various agricultural management techniques. The deer farmers often rely on higher levels of inputs and the ability to substitute or change the levels of input use, is lower. The question may then be answered by the deer farmers with reference to their own situation, and they are therefore less enthusiastic than some of the other farm-type respondents. The more mixed operations had the highest levels of agreement, between 3.50 and 4.50. They probably have substituted knowledge and minimised inputs to lower their costs, in order to create diverse farming systems, and still maintain an economic farming operation. The use of large amounts of resource inputs for the parts of their operations could risk microeconomic sustainability, and they may have used knowledge and management as opposed to inputs.

6.2 - Resource Use

Issues relating to the use of natural resources, such as soil, in sustainable agriculture featured widely in the literature. Dahlberg (1991), Douglass (1984), MAF (1993a) and Plucknett (1990) identified the importance of the natural resources base, such as land/soil, as the primary component of the resource-base, on which agriculture depends. They maintained that the protection of this resource-base is crucial to the achievement of agricultural sustainability. The number of authors that mentioned the importance of soil conservation in sustainable agriculture were numerous and Harwood (1990), Schaller (1993), Buttel (1993), Weil (1990), Rodale (1990), IUCN *et al.* (1991), Reganold *et al.* (1990), Douglass (1984), Lowrance (1990), Edwards & Wali (1993), Plucknett (1990), National Research Council (1989), Schaller (1989), and Youngberg (1986), to name a few. The minimisation of adverse environmental effects of marginal agricultural land-use was noted by IUCN *et al.* (1991), Jennings (1990) and Edwards & Wali (1993).

Question 3, which queried if "Current soil erosion rates are an acceptable byproduct of agricultural land-use" was strongly correlated to the stakeholder group of the respondent ($F=6.09$, $\rho=0.0027$). The responses for conventional farmers were highest (mean=2.54), so their level of agreement with the statement that current soil erosions **are** acceptable, was higher. The professional group disagreed with the statement (mean=1.98), and the organic farmers had a higher level of disagreement, with a mean of 1.80. The professional group, and the organic farmers to a greater extent, were less accepting of the current soil erosion rates associated with agriculture and the results are shown on Figure 6.3 below.





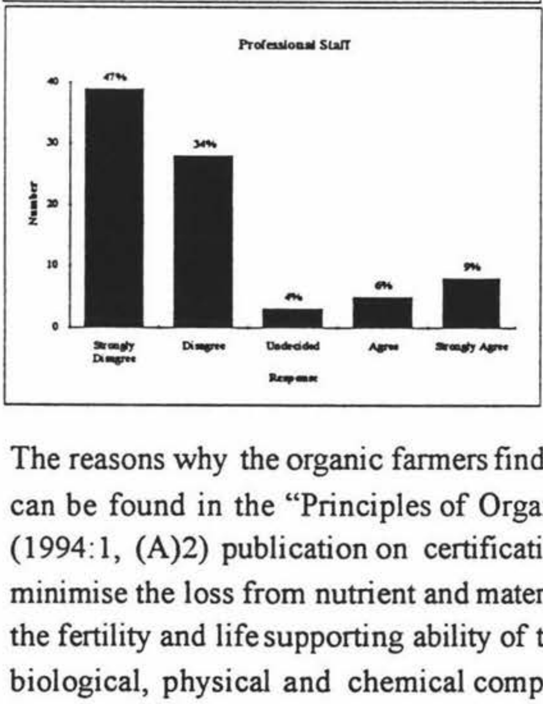


FIGURE 6.3 - Responses to Question 3 - "Current soil erosion rates are an acceptable byproduct of agricultural land-use." by membership of stakeholder group of the respondent.

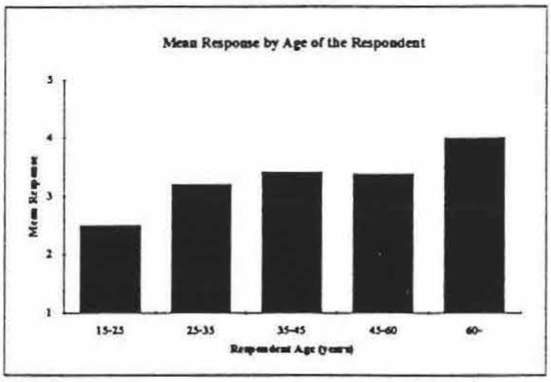
The reasons why the organic farmers find the current soil erosion rates unacceptable can be found in the "Principles of Organic Production" outlined in the NZBPCC (1994:1, (A)2) publication on certification standards. The farming systems must minimise the loss from nutrient and material cycling, and also "Sustain and enhance the fertility and life supporting ability of the production medium [soil], including its biological, physical and chemical components" (NZBPCC (1994:1, (A)2). Soil erosion would contradict both of these principles, as it promotes loss of materials in the first principle and does not sustain or enhance anything outlined in the second principle. Again as mentioned previously, the organic farmers were certified by this organisation, and therefore their beliefs on issues covered in the certification standards, should reflect the NZBPCC (1994:1) standards.

The professional group also finds the current rates of soil erosion unacceptable. This could be due to their occupations, by which, many of those surveyed work for Regional Councils and other institutions whose mandate requires management of the soil resource. The importance of soil to the professional staff respondents can be seen in Section 5.1 of this thesis, where the soil resource was mentioned by 49% of respondents when prompted for the characteristics of sustainable agriculture (Table 5.1). Therefore its degradation, in this case through erosion, is unacceptable. Also the professional staff do not have to bear any of the costs associated with the change to new systems that conserve the soil resource, and avoid soil erosion. The land-owners would bear these costs, and it would be easier to forge an opinion on an issue when someone else will bear the costs involved.

The conventional farmers disagreed with this statement the least. There are two distinct "peaks" in the distribution of their responses as shown in Figure 6.3. There were few farmers who 'sat on the fence' on this issue, as they either agreed or disagreed. The large number of those farmers who created the peak around disagreed, outnumbered those whose answer peaked around agreed. The grouping around agree could be a reflection of the views of the 'conservative old guard' mentioned as perceived barrier to sustainable agriculture in the barriers chapter by the professional staff. It was noted that the views of these farmers differ from the rest of society, and even the agricultural community as a whole. This second grouping lowered the lower level of agreement with this statement, than was the case with the organic farmers and professional staff. There could be a number of possible explanations for this. They could have less of an environmental ethic than the other two stakeholder groups, but this view may be a little cynical. There could be commercial realities at work, with part of the Bio-Gro 'sales-pitch' being environmentally sound and fetching better prices, this allows them to recoup the costs of erosion prevention practices or planting. Thus, the organic farmers appear to find erosion more unacceptable, whereas the conventional farmers do not use this view as part of a marketing approach. There could also be traditional perceptions involved. "Erosion is a natural process, the level to which it is accelerated is the issue" and "erosion is part of evolution" were stated by two of the farmers in their returns. The first statement is true, and accelerated erosion is the issue. But we do not know the extent to which the erosion has been accelerated, above the natural, geological erosion. Therefore the degree of exacerbation of the problem is often unknown. This type of statement by farmers may also promote apathy towards the issue, if the fact that there is a natural element to the phenomena. The view may then be taken, that human action is of little consequence in the cause of soil erosion.

Question 4, regarding "The use of marginal land involves practices that are not economically sustainable" was significantly related to the age of the respondent ($F=2.54$, $\rho=0.0413$). Figure 6.4 overleaf illustrates that as the age of the respondent increased, so did the level of agreement with the statement.

FIGURE 6.4 - Responses to "The use of marginal land involves practices that are not economically sustainable" by age of the respondent.



The possible explanation for this could be that increased experience by older respondents tells them that the economic returns from marginal land are not sustainable. The older respondents may also have a greater environmental ethic, want to leave more for their children and grandchildren. The 60- age group are all from the farmer groups and this may mean that the older farmers have a different ethic, than even the younger farmers.

Membership of stakeholder group was a notable determinant for Question 5, which asked if "The use of marginal land involves practices that are not environmentally sustainable" (F=3.34, ρ=0.0373). The level of agreement was highest amongst organic farmers (mean=4.20) and lowest with conventional farmers (mean=3.28) as seen on Figure 6.5 below. The professional group had a mean that lay between these at 3.63.

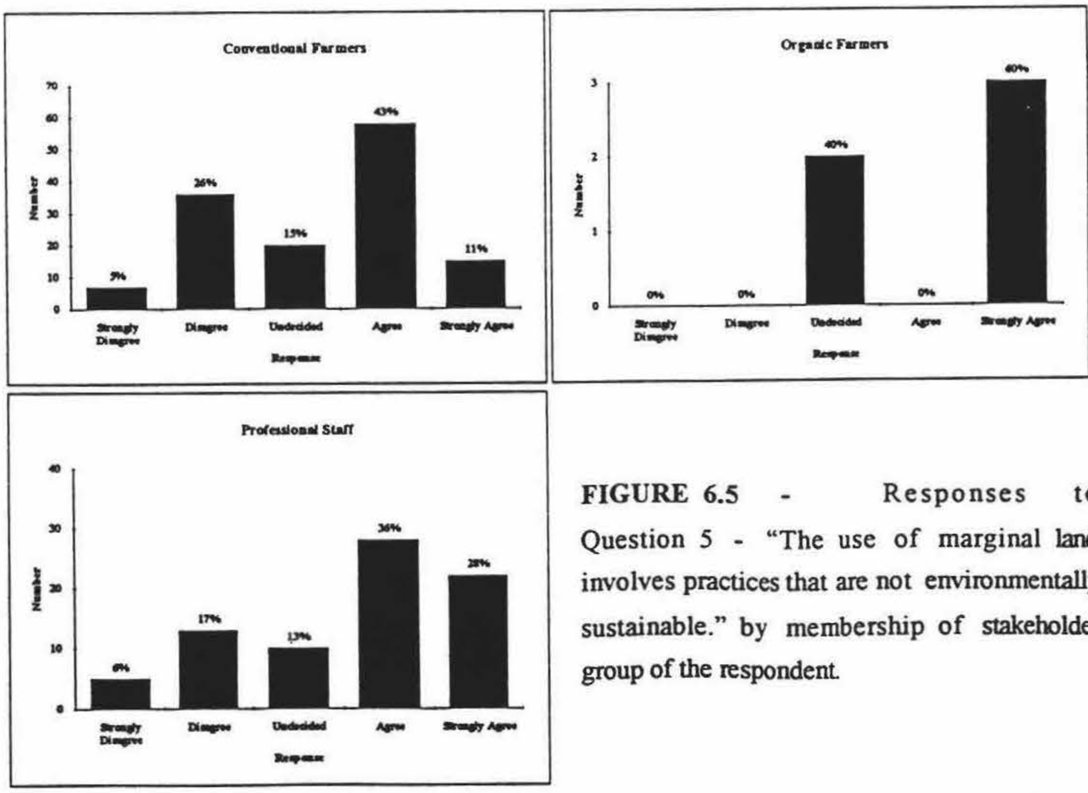


FIGURE 6.5 - Responses to Question 5 - "The use of marginal land involves practices that are not environmentally sustainable." by membership of stakeholder group of the respondent.

The use of marginal land may involve practices and inputs that conflict with the principle of organic production that Bio-Gro adhere to, thus their level of agreement with the statement that the use of marginal land is environmentally unsustainable could arise. This use of marginal land, like soil erosion mentioned earlier in this chapter, may contradict the principles of organic production outlined in the Certification Standards of Bio-Gro (NZBPCC 1994:1).

The professional group had a slightly weaker level of agreement with the statement, and take a more balanced and pragmatic approach to the issue, and are not as eager as the organic farmers to label current uses as unsustainable. The definition of environmentally unsustainable held by the professional group may not be as strong as that held by the organic farmers, and they view the current situation differently.

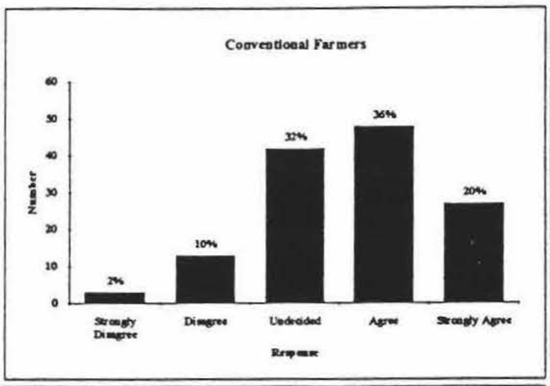
The conventional farmers had the lowest level of agreement with the statement. This could be explained by the two distinct groupings that can be seen in the conventional farmers graph above (Figure 6.5). Very few farmers were undecided about the statement (15%). The respondents to the question either agreed (43%) or disagreed (26%). The second 'pole' of more 'conservative' group of farmers, who disagreed within the sample, would have lowered the mean of the conventional farmer group. This could be the same group that agreed in Figure 6.3, that current soil erosion rates are acceptable.

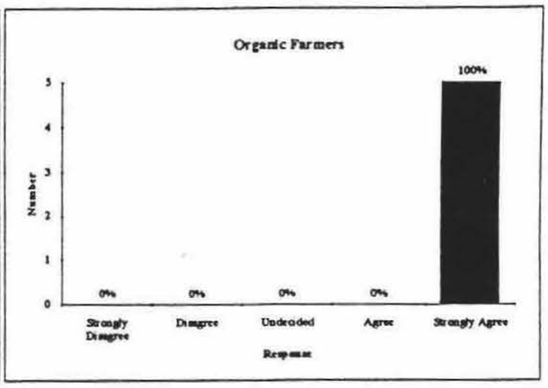
As shown in Table 6.1, the responses to Question 16 asking if the "Conservation of native habitats and species within agricultural areas is important" had farm-type of the respondent as a moderate determinant ($F=1.69$, $\rho=0.0976$). As the production system run by the farmer became more diverse, the mean increased slightly. The means for the Sheep, Cattle and Sheep/cattle farmers lay between 4.00 and 4.30. The mean for the very mixed operations (including sheep/forestry/cattle ...) was 5.00. The more diverse farming operations may appreciate the importance of diversity within the system, and this includes the native species within any system. The level of significance is 0.0976 for this relationship, and is not highly statistically significant when using the 0.1 level of significance, so making sound comments about the relationship difficult.

6.3 - Management Practices

Question 1 which queried whether "Agricultural systems involving monocultures are more susceptible to pests/diseases than polycultural agricultural systems" was very strongly correlated to the stakeholder group of the respondent ($F=7.31$, $\rho=0.0008$). The conventional farmers had the lowest mean at 3.62, and the professional group were in slightly more agreement with the statement,. with a mean of 3.91, but the organic farmers had the greatest level of agreement, with a mean of 5.00. Figure 6.6

below shows the difference between the distribution of the responses by the stakeholder groups.





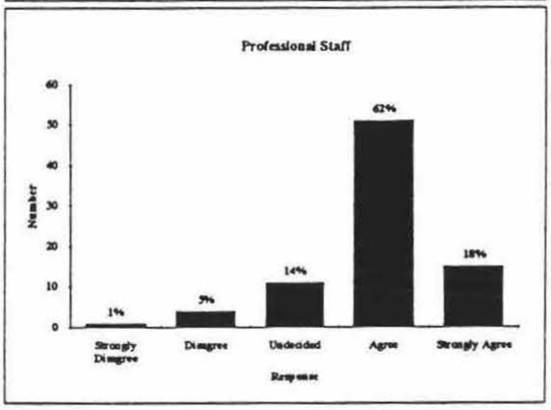


FIGURE 6.6 - Responses to Question 1 - "Agricultural systems involving monocultures are more susceptible to pests/diseases than polycultural agricultural systems." by membership of stakeholder group of the respondent.

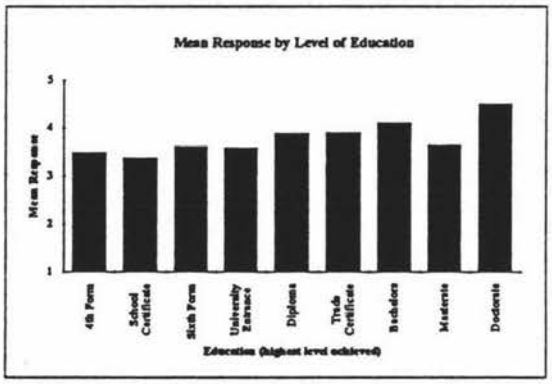
The organic farmers all responded with "Strongly Agree", and the resulting mean at 5.00, was very high. The higher response rate than the other stakeholder groups could be explained by the basic principles of organic production. The NZBPCC (1994:1, (A)2) outlines that the "use ... of ... sound rotations using diverse stock and cropping strategies" is part of the "basis of organic agriculture and horticulture." So the use of diversity (polycultures) to overcome pest and disease problems, rather than the use of pesticides and other chemical controls, is encouraged.

Of the conventional farmers, 32% were undecided, and 36% agreed and 20% strongly agreed. The large number of undecided respondents may have lowered the mean. The reason for the large number of undecided answers may be the difficult question topic (reasonably technical and a little abstract). Alternatively, the lack of information (published in a form readily accessible and readable for the farmers), on the subject may also create indecision surrounding the topic. The use of traditional, single species could also be a problem (such as sheep), and adapting to new, diverse systems may be daunting, especially with the lack of information for the farmers, as previously mentioned.

The mean of the professional group lies between the two farmer groups. A high number of the respondents did agree with the statement (62%) which gives the mean result overall of 3.91 slightly below that of 'Agree' at 4.00. This could be due to the fact that the professional group have a little more experience and understanding in the area, and perceive that diversity gives protection against disease/pests, like the stability found within natural, mature (diverse) systems (Odum 1993). When the professional staff were asked for their opinions about the characteristics of sustainable agriculture, discussed in Section 5.1, some of the respondents mentioned characteristics aligned with this question. Examples of this include the use of crop rotations (2% mentioned this) and high biodiversity (6% mentioned this). Although the frequency which these were mentioned in Section 5.1 and shown on Table 5.1 is not high, it does illustrate that the professional staff have awareness of the vulnerability of monocultures to pests and diseases.

Question 1 which queried if "Agricultural systems involving monocultures are more susceptible to pests/diseases than polycultural agricultural systems." was also strongly related to the level of education of the respondent ($F=2.53$, $\rho=0.0212$). Figure 6.7 below shows the mean response for each level of education.

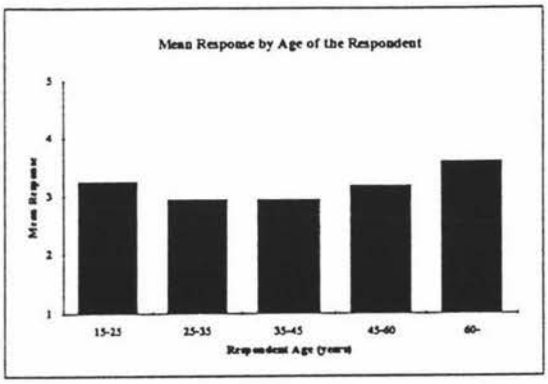
FIGURE 6.7 - Responses to "Agricultural systems involving monocultures are more susceptible to pests/diseases than polycultural agricultural systems." by the level of education held by the respondent.



The general trend in Figure 6.7, is for agreement with the question to increase as education increases. The more educated respondents may have encountered information and research on the stability that diverse systems offer against pests and diseases in the course of their study (such as the literature covered in chapters 2 and 3). The most notable exception to the general trend, is the decrease for the Masterate level respondents. The mean for these respondents is 3.65, compared to 4.11 for the Bachelor respondents and 4.50 for the PhD respondents. The lower mean is difficult to explain and may be based on their particular courses of study undertaken, which could be more business courses (MBAs) as opposed to science courses, and the material covered had little coverage of subjects such as diversity in natural or agricultural systems, and the benefits this can offer in terms of pest resistance.

Question 2 asking if "Agroforestry gives a greater return", had the age of the respondent as a moderate determinant of the answer given ($F=2.21$, $\rho=0.0690$). Figure 6.8 overleaf shows that the youngest group have a higher level of agreement, with the middle age groups less in agreement, but the 45-60 and 60- age groups are the most enthusiastic about the economic returns of agroforestry.

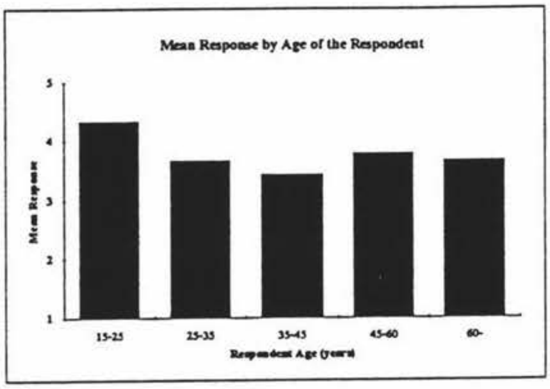
FIGURE 6.8 - Responses to "Agroforestry gives greater returns" by age of the respondent.



The younger respondents (15-25 years) had a mean of 3.25 and the oldest two groupings, 45-60 and 60- years, had means of 3.16 and 3.61 respectively. The age groups between, that is 25-35 and 35-45 years had the same, lower mean of 2.94. The youngest group could be positive towards agroforestry, as they are all in the professional group, and may have finished university study and other education that views the use of agroforestry and forestry in an encouraging light, with the increased export opportunities that forestry will offer in the future. This group could be the most innovative, looking at the application of different land-uses in the search for sustainability, not just traditional agriculture or forestry, but mixed uses, like agroforestry.The oldest group of the 60- year old respondents (all farmers), are the most positive towards the economics of agroforestry as they have experience in agriculture and have seen how uneconomic a single-species production system, such as sheep or even sheep/cattle can be. They could also wish that they had planted some trees earlier in their farming career, and now would receive the payoffs as they move into retirement. The current newspaper advertising of forestry investments as ideal for retirement savings could further encourage this view. The 25-35 and 35-45 age groups being the least positive about the economic investments of agroforestry is puzzling, as the farmer respondents in these age groups would gain most from the economic returns from this investment. The returns when the trees matured would occur before or during early retirement, if indeed farmers ever retire! They could however, lack the enthusiasm to change their farming operation. There could be a lack of interest in agroforestry by the professional group, which masks any interest by the farmers. As previously mentioned in the survey design chapter, it is doubtful how much can be drawn from the results of the question, as the line left off the end of the sentence, results in a very vague question.

The age of the respondents was a significant determinant of the response to Question 18, "Information requirements for 'environmentally friendly' agricultural systems are higher due to the knowledge and management requirements" ($F=2.75$, $\rho=0.0294$). The results are shown in Figure 6.9 below.

FIGURE 6.9 - Responses to "Information requirements for 'environmentally friendly' agricultural systems are higher due to the knowledge and management requirements" by age of the respondent.



The youngest respondents (15-25 years) had the highest mean, with 4.33. The mean response for each age group then declined with increasing age, with a slight peak for the 45-60 years age group. The youngest group (all from the professional group) could have been affected by the recent university education they have received, and thus thought that the knowledge required to understand sustainable systems will be higher, or at least different. Maybe they are also more innovative due to changing education system and idealistic views from the education system. The 45-60 and 60- age groups also were slightly higher than if the trend of decreasing level of agreement were to continue, as Figure 6.9 shows. These two older groups could be a reflection that better information is required for farmers to make decisions about sustainable systems. The lack of information in a format understood by farmers was mentioned as a barrier to the implementation of sustainable in Table 9.2. The lack of published research and research in a format understood by professional staff, and farmers (as the older groups of 45-60 and 60- are comprised mainly of the conventional farmers as Appendix C and D shows) and this may be reflected in the replies shown in the above Figure 6.9, where the respondents consider that information requirements are higher (and they are not receiving these higher levels of information).

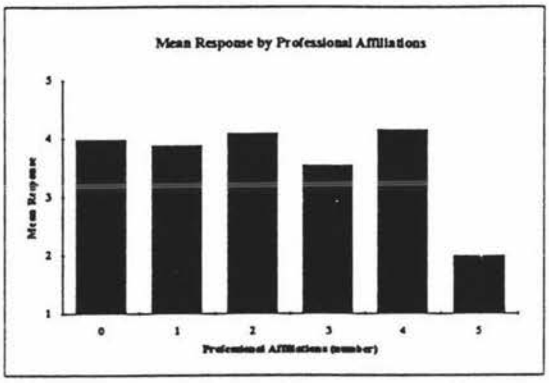
The response to Question 18 which asked if the "Information requirements for 'environmentally friendly' agricultural systems are higher due to the knowledge and management requirements" had farm-type of the respondents as a significant determinant ($F=2.20$, $\rho=0.0265$). The mean for the cattle farmers (at 4.00) was higher than the sheep farmers (3.625) and the sheep/cattle farmers (3.688). The more management intensive nature of cattle farmers could explain their perception that information requirements for sustainable agriculture will be high, to suit their management style.The financial value of the cattle makes management more intensive, as pugging (physical compaction) damage to the soil from cattle in wet conditions is higher due to the weight of the animal, and the financial worth of the animals means that drenching can be carried out more often, with animal weights also checked. The more diverse farming operations were in greater agreement than the cattle farmers, but due to the small numbers, their responses are not statistically significant.

6.4 - Specific Attitudes to Sustainable Agriculture Issues

The importance of social and community considerations in sustainable agriculture has been mentioned frequently throughout the earlier parts of this thesis. The Douglass (1984) 'sustainability as community' approach outlined in Section 2.2.3 highlighted many issues, such as lifestyle issue, livelihood (which extends beyond simply income) and the role of community linkages. The consideration of social equity issues was made by Douglass (1984), Swaminathan (1991), George (1990) and Edwards & Wali (1993). Brown (1989) Ikerd (1993), Clawson (1972), Jackson (1984) and Edwards *et al.* (1993) stated the importance of the rural communities in achieving sustainable agriculture. Beus & Dunlap (1990) and Edwards *et al.* (1993) stated that farming was a way of life as well as a business. The application of participatory approaches was mentioned by Campbell & Junor (1992), Keeney (1993) and Swaminathan (1991). The need for greater cooperation between the rural community and scientific staff was noted by a number of authors, such as IUCN *et al.* (1991), MAF (1991a), Francis & Madden (1993), Jennings (1990), Edwards & Wali (1993) and Allwright (1992). IUCN *et al.* (1991), Edwards *et al.* (1993), MAF (1991d), Berkes & Folke (1994), Gadgil & Berkes (1991) and Gadgil (1987) stated that farmers are an important source of anecdotal information and local history. The consideration of intergenerational issues in sustainable agriculture was noted by Wynen & Fritz (1987), Swaminathan (1991), IUCN *et al.* (1991) and George (1990).

There was a strong correlation between the response to Question 9, about "Some loss of short-term profit may be required to ensure long-term financial returns", and the number of professional affiliations held by the respondent ($F=3.18$, $\rho=0.0086$). This is shown in Figure 6.10 overleaf.

FIGURE 6.10 - Responses to "Some loss of short-term profit may be required to ensure long-term financial returns" by the number of professional affiliations held by the respondent.

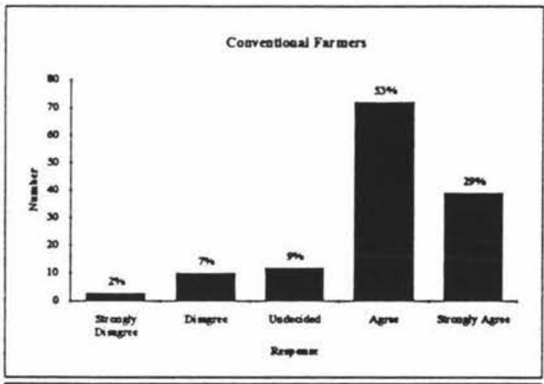


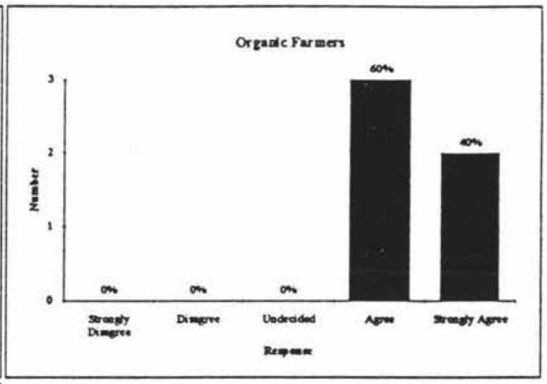
The mean for the respondents with 3 professional affiliations fell below that of the other groups, at 3.55. The general trend of the relationship is that as the number of professional affiliations held by the respondent increases, the level of agreement with the statement decreases. The number of professional affiliations held by a respondent, indicates the level of participation they have in their industry according to Korsching *et al*. (1983), which in turn affects their level of innovativeness. These respondents with a greater number of professional affiliations could hold the view that no loss of short-term profit is required to achieve long-term, farm-scale economic sustainability. The trend is as clear as the level of significance would indicate, as the respondents with 5 professional affiliations are low in number (see Appendix C).

Question 9 about loss of profit was also significantly related to the farm-type of the respondent ($F=2.53$, $\rho=0.0106$). Sheep, cattle and sheep/cattle farmers all had means about 3.85 to 3.92, which indicates a moderate level of agreement, but the sheep/cattle/deer farmers had a mean of 4.23. The "very mixed" farmers had a mean response of 5.00, the highest of any of the farm-types. The remaining farm-types did not have significant statistical differences in their responses.

All of the average responses for the farm-types are reasonably high (all above 3.85), with varying levels of agreement with the statement, with no groups disagreeing with the statement on average. The philosophy that one has to 'spend money to make money' could also apply to the response to the question. The need for capital input into the farming operation could be perceived as aiding the future returns that could be fetched from that agricultural system. The farmers with diverse farming systems, would for the most part, have forgone some profit in the past as they diversified their operations, and subsequent income may have been more stable and may have increased, as the different produce cycles begin to reap financial rewards. The farmers as they have been through the diversification process, with a loss of short-term loss for long-term gain, so they can relate to, and more strongly agree with, the question topic. The sheep/cattle/deer and "very mixed" farming operations may have a wider profit-base and can afford to lose a little income, as the diversity of their production will cushion any loss.

The response to Question 10, "Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly." was strongly correlated to the stakeholder group of the respondent ($F=6.76$, $\rho=0.0014$). The conventional farmers had the lowest mean (3.99), signifying a lesser extent of agreement with the statement. The organic farmers and the professional group had virtually identical mean responses, with 4.40 and 4.41 respectively. The distribution of responses for each of the stakeholder groups is shown in Figure 6.11 below.





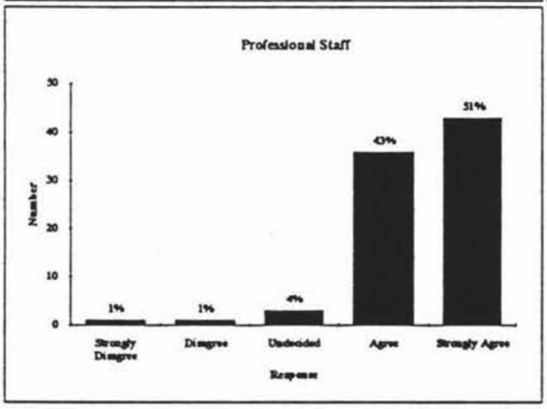


FIGURE 6.11 - Responses to Question 10 - "Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly." by membership of stakeholder group of the respondent.

The professional group could be in favour of the education and extension concept as their jobs involve working with the rural community, and these methods would seem attractive to carry out their roles. The use of education and participative approaches is in vogue at present, and this would also increase the level of agreement with this question. The use of participative education and research allows for more information on sustainable agriculture, through practical farm-scale, 'hands-on' research and helps achieve ownership of the results by the landowners involved.

The organic farmers could be in favour of the method as they may have been educated about the organic production methods themselves and now feel that they have made the 'right' move and thus approve of education as a means to implement agricultural sustainability.

The conventional farmers had the lowest mean, although at 3.99 it equates to 'Approve' in the five point scale, so they had a lesser level of agreement, but did not disagree. They could perceive education as informing as opposed to enforcing, which would find some favour. Although the concept still may imply that they would be told what to do with 'their' land. The barriers mentioned in Table 9.3, whereby 'Greenies' and councils were telling farmers what to do with their land was mentioned by 11 and 3 farmers, respectively. These barriers being mentioned reflects the independence some farmers wish to have in the decisions made about resource management issues on their land, and this again is reflected by a lower approval for education in Question 10 than the other two stakeholder groups.

Question 10 on the need for "Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly." also had the number of professional affiliations held by the respondent as a significant determinant ($F=3.24$, $\rho=0.0078$). Figure 6.12 below shows the positive relationship between the number of professional affiliations held, and the enthusiasm for extension research.

FIGURE 6.12 - Responses to "Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly." by professional affiliations held by the respondent.

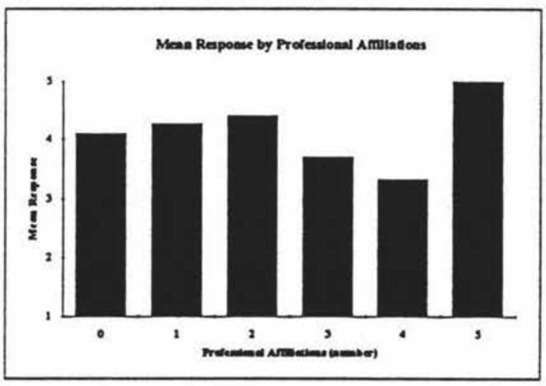
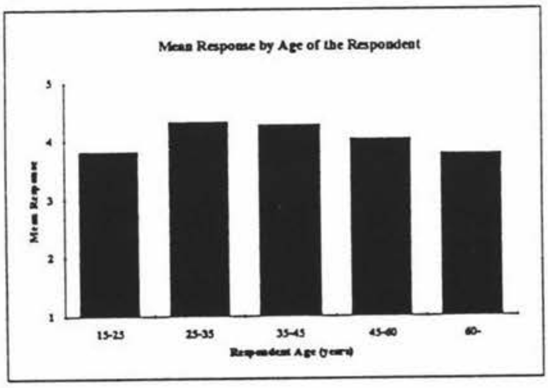


Figure 6.12 above shows, as the number of professional affiliations increase from 0, to 1, and then 2, the mean increases from 4.10, to 4.27, and then 4.41. Then the respondents have 3 professional affiliations, the mean drops to 3.70. The respondents with 4 professional affiliations have a mean of 3.33, then the last group has a mean of 5.00. The trend on the graph is generally a positive one, as the number of affiliations held increases, so too does the favourability of education and extension. Again, as previously mentioned, Korsching *et al.* (1983) stated that membership of professional organisations and participation in the agriculture industry, was a reflection of innovativeness. The increased level of participation reflected by increased membership in professional affiliations, may mean these respondents are more receptive to participative approaches to implementing

sustainable agriculture, such as extension research and education. The fact that the respondents with 3 and 4 affiliations could have lower means is difficult to explain. The respondents with 5 professional affiliations were low in number, and the statistical significance of this high mean is uncertain.

Question 10 which asked if "Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly" was also moderately correlated to the age of respondent (F=2.20, ρ=0.0703). The mean for the youngest group, 15-25 was lower at 3.83, then increased to 4.33 for the 25-35 bracket, then to 4.28 for the 35-45 and 4.04 for the 45-60 group and finally 3.78 for the 60- group. Figure 6.13 below shows the mean response for each of the age groups in the survey.

FIGURE 6.13 - Responses to "Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly" by the age of the respondent.



The youngest group had a mean that equates nearly to 'Agree', then the next group had a higher mean. From the peak at the 25-35 age group, the means then declined as can be seen on the graph, with the oldest group having the lowest mean. The oldest group were mainly farmers, and they may be a little more conservative about the benefits of extension and education. Why the 25-35, followed very closely (0.05 less) by the 35-45 groups were most in agreement could be due to them getting the greatest benefits, with more time to see the results, more likely in their lifetimes then the the older groups, as can be seen with the Land Care groups in Australia. The Land Care programme took 10 years before the real benefits of the approach in land management results came to fruition. This age group is also young, and may have the enthusiasm and energy for the effort required to undertake a successful and productive education and extension programme.

Question 11, which asked if "Human health risks from food and fibre produced from agriculture will become increasingly important in the future." was significantly correlated to membership of stakeholder groups (F=4.10, ρ=0.0179). The means for the conventional farmers (3.86) and the professional group (3.90) were very similar. The organic farmers were in greater agreement with the statement, with a mean of 5.00. Figure 6.14 below shows the distribution of the responses from the different stakeholder groups to this question.

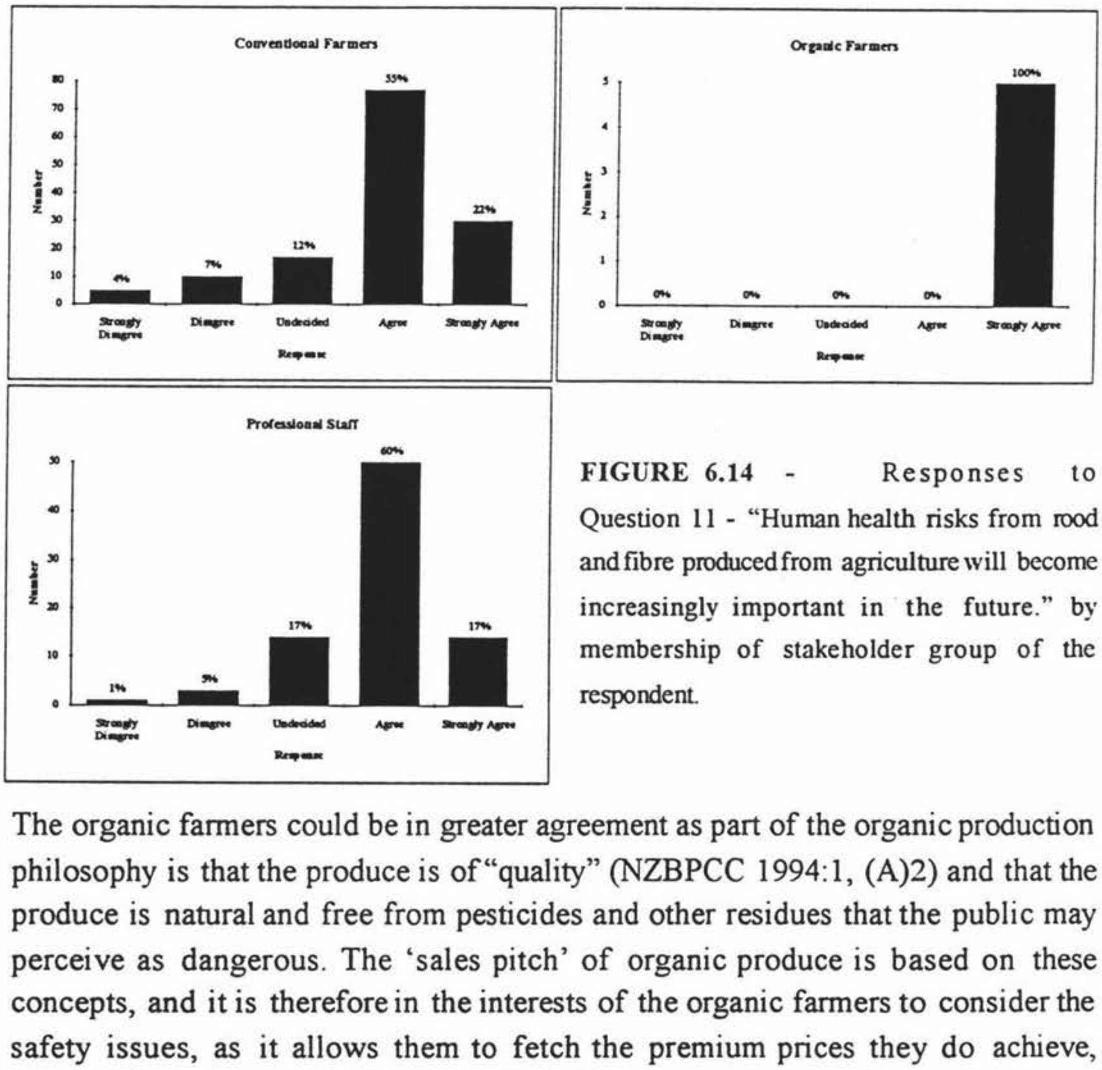


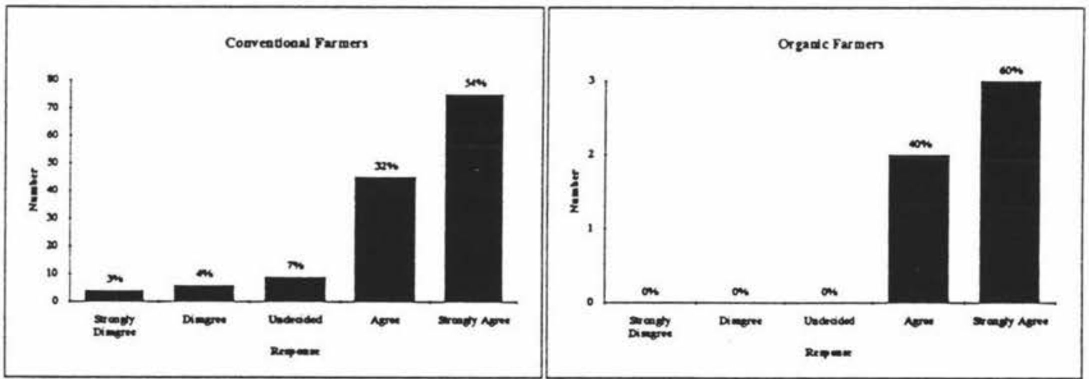
FIGURE 6.14 - Responses to Question 11 - "Human health risks from rood and fibre produced from agriculture will become increasingly important in the future." by membership of stakeholder group of the respondent.

The organic farmers could be in greater agreement as part of the organic production philosophy is that the produce is of "quality" (NZBPCC 1994:1, (A)2) and that the produce is natural and free from pesticides and other residues that the public may perceive as dangerous. The 'sales pitch' of organic produce is based on these concepts, and it is therefore in the interests of the organic farmers to consider the safety issues, as it allows them to fetch the premium prices they do achieve, compared to the conventional product equivalent.

The conventional farmers and professional group have means that are close to 'Agree' or 4.00. But some did query the question, such as "What health risks?!?" and "Only as the media persuades the public." which came from conventional farmers, although some were heartily in agreement with statements like "Always should be." The professional group were in some cases a little skeptical, with one respondent stating "The appropriate standards are in place re[garding] testing for meat residues etc - awareness may increase by consumer - risks should be less over time." and this statement is true. Consumer perception of a product is powerful. If they perceive a product as harmful, no amount of publicity will change their mind.

Royal (1990) summed this up when he stated that in effect, perception becomes reality. Thus perceived risks of a product can be as damaging to an industry such as agriculture, as real risks. It can reduce demand, if not halt demand entirely. The importance of safety issues surrounding food and fibre cannot be underestimated in the future of agriculture. The reporting on these issues needs to be balanced, and cannot be 'sensationalist' or involve 'scaremongering' otherwise agricultural sustainability is threatened, as the conventional farmers referred to in the comment about the media on the previous page.

Question 13 which asked if "Social and community services, such as schools in the rural community are essential to its survival." had stakeholder group membership as a strong determinant ($F=5.36$, $\rho=0.0053$). Figure 6.15 below shows that the mean for the professional group was the lowest, at 3.86. The means for the conventional and organic farmer groupings was significantly higher, with 4.28 and 4.60 respectively.



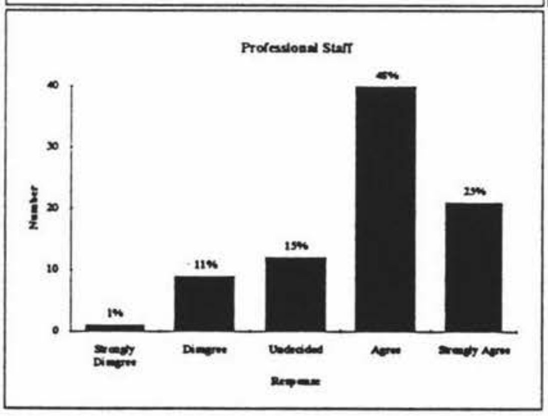


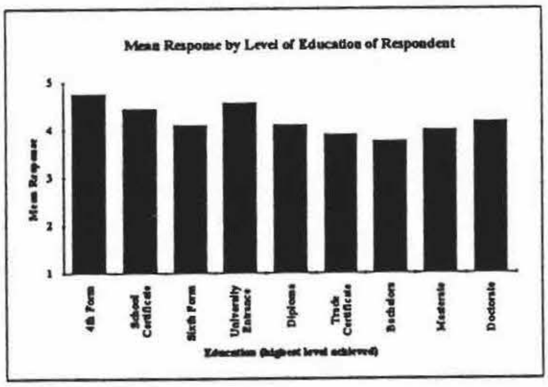
FIGURE 6.15 - Responses to Question 13 - "Social and community services, such as schools in the rural community are essential to its survival." by membership of stakeholder group of the respondent.

The graphs above clearly illustrate that the conventional farmers and organic farmers answered the question with a greater level of agreement than the professional group. This probably reflects the fact as they live in the rural community and rely on these services, they placed greater worth on their importance and value. If these services were lost, this would affect them and their quality of life, and thus they relate the question to their own situation. A cynical view could be that they almost have a vested interest in the question topic, as they use these services.

Of the professional group, only 25% of this group answered with "Strongly Agree" as opposed to 55% of the conventional farmers and 60% of the organic farmers, lowers the resulting mean. Many of the respondents would not live in rural areas, and thus may not be as affected by the issue in the question, and therefore do not answer with the same enthusiasm. The characteristics of sustainable agriculture proposed by the professional staff in Chapter 5.1, covered in Table 5.1 reveal that social considerations did not rate as highly as biophysical and economic components of sustainability. The respondents only referred to a social component in 25% of replies. The lack of recognition of social aspects of sustainable agriculture in the characteristics section, could explain the lower importance placed on social services by the professional group than the conventional and organic farmers, in this section. This discussion may seem harsh, as all three groups did have high levels of agreement with the statement, as the graphs on the previous page show the high distribution of the results for each stakeholder group. The mean response of the professional staff to this question was high, but not as high as the conventional and organic farmers.

Question 13 which queried if "Social and community services, such as schools in the rural community are essential to its survival." was also strongly related to the level of education of the respondent (F=2.02, ρ=0.0463). Figure 6.16 below shows the mean response for each level of education.

FIGURE 6.16 - Responses to "Social and community services, such as schools in the rural community are essential to its survival." by the number of professional affiliations held by the respondent.



The higher mean responses for the lower levels of education (only the secondary school education) could be explained by the fact that the bulk of these respondents were farmers. This relationship in Figure 6.16 is reflecting the distribution of results in Figure 6.15, with the higher mean response for the farmer respondents over the professional staff. Again, the farmer respondents live in the rural communities and place higher important on the services provided there, such as schools. The lower mean responses for the higher levels of education (the tertiary level qualifications), could be explained by this group comprising mainly of the professional staff. As

Figure 6.15, the professional staff placed less importance on the rural services, such as schools, as opposed to the farmers. Therefore when these respondents are grouped according to education level, the mean responses in Figure 6.16 reflect the relationship shows in the previous Figure 6.15.

Chapter Seven
Actual Practices and Sustainability Implications: Inputs and Resource Use

The conventional and organic farmer respondents were asked about changes in the levels of practices on their farms in the last five years. This section of their survey was called Part IV, and is shown on Pages B8-B9 in the copy of the farmer survey included in Appendix B of this thesis. The following is a brief description and rationale for the question design and subsequent analysis.

7.1 - Description and Rationale for Survey Questions

The agricultural practices queried were grouped into three main generic groups within the question. The first six practices were termed '**Inputs**' which included all the common agricultural inputs, such as fertilisers, pesticides and drenches. The second group of three practices were termed '**Resource Use**' which consisted of water use, land clearance for pasture and energy. The third, and final group of twenty practices were termed '**Management Practices**' which covered such activities as planting forestry, shelterbelts, increased fertiliser management and soil conservation works.

The farmers were asked to rate the change in each practice on a five-point scale. The respondents circled the value that corresponded to the level of change in their farms, with these values shown in Table 7.1 on the following page.

The five points scale uses simple definitions of different levels in the practices, as assigning exact values to the change would be impossible. For example say there is a steep hill-country farm, called Farm A and flatter farm on more rolling land, called Farm B. To define fertiliser use on the land in kilograms per hectare would mean little when comparing the effects of use on Farm A against that on Farm B. As the runoff from the steeper Farm A into waterways could be higher, than would occur on flatter Farm B given the same application rate. In the case of grazing levels in stock units per hectare on steep Farm A against flat Farm B. The resulting levels of environmental effects that would occur from intensive grazing on flat Farm B would be much lower than for steep Farm A for the same stocking rate (erosion may occur if grazing removes too much pasture which provides some protection against erosion). So the value would rate the same for two farms, but the environmental effects could be much higher on the steeper Farm A than on the flatter Farm B.

Therefore, the question used a five-point scale that rated relative change for the farm, given previous use. Subsequently the scale would select against one farm over another given the differences in land classes or other attribute that may affect the rates of use of these practices. The aim was to define the level of change on the farm compared to previous levels of that particular on the farm before the five year period defined.

TABLE 7.1 - Scale for level of change in agricultural practices for Part IV of farmer surveys and response value assigned.

LEVEL OF CHANGE	RESPONSE VALUE
Significantly Decreased	-2
Decreased	-1
Same/Unchanged	0
Increased	1
Significantly Increased	2

The period of time over which the question queried change was selected as five years. This is a short period of time in terms of activities undertaken on a farm, but the period was selected to coincide with changes in resource management legislation. The aim was to see if the changes in ethics outlined in the RMA 1991 had affected farmer behaviour, and the practices undertaken on the farms. The respondents often noted that they had carried out certain activities 10 years ago, or even before that, so the ethics and activities obviously extend back before the changes in legislation. The problem with a longer timeframe (say 10 or 15 years) is that the rural decline of the mid eighties would affect the levels of activities carried out on farms, thus for example, economic factors would affect lowered pesticide use, as opposed to a change in environmental ethics. The five year period was selected as it placed a definite timeframe for consideration in the question, and would not be affected as greatly by external considerations, such as cycles in fluctuations in agricultural commodity prices.

Then below each of the groups of practices, a few lines were left for the respondent to briefly state why the changes in the practices (if any occurred), took place. The reasons given varied between economic, environmental, human health and any combination of these. The reasons offered by the farmers for the practices they changed are often covered within the discussion about the survey results in this chapter.

The results for each practice were analysed according to the demographic attribute data for each respondent. The SAS programme was used using the ANOVA command. This process was outlined in chapter 4 which outlined the survey and analysis methodology and rationale.

The analysis of the three groups of practices is divided between this chapter, Chapter 7, and the following Chapter 8. This chapter is divided into two parts, each corresponding to a different group of agricultural practices within the survey question. Section 7.2 covers the 'Inputs' part of the question, with the statistically significant results shown in Table 7.2. The 'Resource Use' practices are covered in section 7.3, with the statistically significant results shown in Table 7.3. The final group, termed 'Management Practices' are covered in the following Chapter 8, with the practices shown with the statistically significant relationships in Table 8.1.

The three tables (7.2, 7.3 and 7.1) illustrate 50 relationships that were found to be statistically significant between the 0.00 and 0.10 level. There were 33 relationships found to significant between the 0.00 and 0.05 level and 17 between the 0.05 and the 0.10 level. Due to the large number of significant relationships, all the figures that correspond to the analysis in both Chapter 7 and Chapter 8 are included in Appendix E. The relevant figure for the relationship discussed within the text is given a precise page reference for the location of that figure in Appendix E.

7.2 - Analysis of practices termed 'Inputs'

The following discussion covers the relationships found to be significant by the statistical analysis between the changes in the level of agricultural practices termed 'Inputs' in Part IV of the farmer surveys and the demographic attributes of the respondents. All of the 'Inputs' practices queried for the level of change by the respondents, are shown in Table 7.2. The table shows the F-Ratios and levels of significance between the levels of practices and the demographic attributes of the respondents.

7.2.1 - Pesticide use

The use of pesticides, and the changes in this level of use was significantly correlated to membership of stakeholder group ($F=10.52$, $\rho=0.0015$). This is shown in Figure E.1 on page E1.

The mean for the conventional farmers was -0.045, which shows a slight decrease. Reasons offered for the decrease included economic (lack of finance to allow purchase and application of pesticides) and environmental (such as spray drift and effects on other non-target species). Personal health reasons were also mentioned by some respondents. Only 6% of the conventional farmers increased application of pesticides. This illustrates the effect of many factors operating on the farmers, such as microeconomic constraints they face, or the change in environmental ethic and concerns over human-health issues. The reduction in pesticide use means that environmental effects, such as impact on non-target species or pollution of surface-and ground- waters is less likely to occur. The other benefits may be increased health of farm workers because of lowered contact with the pesticides, and less likelihood of pest species obtaining resistance to the pesticides through their over-use.

The mean for the organic farmers was -1.60, which illustrates a significant fall in pesticide use. The reasons offered were certification for Bio-Gro organic farming standards, which forbid the use of the common commercial pesticides, and also environmental considerations. The Bio-Gro standards allow the use of organic alternatives on a restricted basis, which means with permission. The single respondent who stated 'Same/Unchanged' had not used any pesticides for longer than the 5 year period, so the 'nil-use' situation was unchanged. This does increase the mean of the organic farmer responses however, even through the respondent does not use any pesticides. The use of natural diversity and other integrated approaches to pest management that the organic agriculture approach uses has the same benefits for sustainable agriculture as the lowered pesticide use by the conventional farmers mentioned on the previous page.

This response to the pesticide use question also had the number of professional affiliations as a moderate determinant ($F=2.80$, $\rho=0.0720$). This is shown in Figure E.2 on page E1.

The figure very clearly illustrates that as the number of professional affiliations held by the respondent increases, the level of pesticide use decreases (the mean becomes a larger negative number). The reason for this could be that, as the respondent has more professional affiliations, he/she gains more information. A respondent with a greater number of affiliations, may in this case use this information to decrease the use of pesticides to a greater degree than a respondent with a lesser number of professional affiliations. The work by Korsching *et al.* (1983) claims that membership and participation in professional organisations was related to innovativeness, which determined the rate at which soil conservation practices were adopted. In this instance, the membership in these organisations leads to an increase in pesticide minimisation practices (a decrease in overall use).

7.2.2 - Fertiliser use

The change in fertiliser use had stakeholder group membership as a significant determinant ($F=7.66$, $\rho=0.0064$). The mean for the conventional farmers was 0.25, showing a slight increase in the amount of fertiliser applied. The organic farmers had a mean of -1.00, showing a greater decrease in fertiliser used. This is shown in Figure E.3 on page E2.

TABLE 7.2 - F-ratios and levels of significance for reported practices termed 'Inputs' in conventional farmer and organic farmer surveys.

	Question	Age		Education		Farm-Type		Farm-Size		Professional Affiliations		Stakeholder Group		Gender	
		<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05
1	Pesticide use									F=2.08 p=0.0720			F=10.52 p=0.0015		
2	Fertiliser use				F=2.84 p=0.0068						F=3.70 p=0.0036		F=7.66 p=0.0064		
3	Energy use			F=1.92 p=0.0642							F=2.56 p=0.0304				
4	Fungicide use										F=2.52 p=0.0322		F=13.59 p=0.0003		
5	Drenches/internal paracitiside use		F=2.57 p=0.0406				F=2.37 p=0.0161						F=32.03 p=0.0001		
6	Pour-on/external paracitiside use				F=2.99 p=0.0046		F=2.68 p=0.0068		F=2.53 p=0.0441				F=35.00 p=0.0001		

The reasons offered for the increase in fertiliser application by conventional farmers often was that the economic conditions/climate now allowed the use of fertiliser, and there was a need to increase soil fertility. The notion that 'you have to spend money to make it' was implied. Without fertiliser application, soil fertility is lowered, and this amounts to degradation of the resource base. Of the respondents, 31% had 'Increased' and 9% had 'Significantly Increased' which illustrates some increase in farm income, or a need to increase soil fertility. Increased fertiliser applications, if not managed correctly may increase nutrient loadings in streams through the runoff carrying sediment with fertiliser nutrients absorbed or nutrients in suspension.

The organic farmers had an overall decrease in fertiliser use, with a mean of -1.00. The respondents answering with 'Same/Unchanged' had not used fertilisers for over 5 years, which increase the mean response. The reasons given for the responses were Bio-Gro certification and environmental issues, such as runoff and pollution of waterways. The reduction in fertiliser use by the organic farmers will have implications in lowered nutrient levels in runoff that ultimately ends up in streams. The use of natural and slow-release alternatives lessens the likelihood of excessive application of fertiliser which a leached from the soil into groundwater. The awareness of the external environment is part of the certification process, with attention paid to issues such as runoff and effects on streams and ground-water, even if these are off-site.

The increase in fertiliser use by the conventional farmers is substantiated by the increase in fertiliser use for the Manawatu-Wanganui region in the Department of Statistics' 'Agriculture Statistics' publications. The amount of solid fertiliser used in the year to June 1990 was 148,957 tonnes (Department of Statistics 1992b), increasing to 159,862 tonnes in the year to June 1992 (Department of Statistics 1994) and to 195,537 tonnes in the year to June 1993 (Department of Statistics 1995b). The fertiliser use increase, according to the statistics would appear to be greater than the mean of the conventional farmers from Rangitikei would indicate at 0.25, when the increase overall from the region is a 30% increase between June 1990 and June 1993. This increased use of course could well be assigned to land elsewhere in the region, aside from the terraces and hill-country of the Rangitikei electorate.

This use of fertilisers was also correlated reasonably strongly to the number of professional affiliations held by the respondent ($F=3.70$, $\rho=0.0036$). This is shown in Figure E.4 on page E2.

The general trend in the figure is a negative relationship between professional affiliations and fertiliser use. The initial trend is for a slight increase in fertiliser use as professional affiliations increase from 0, to 1 and then to 2. After this, the trend then becomes reversed and as the number of professional affiliations increase, the level of fertiliser use by the respondent decreases. The number of professional affiliations would increase the information that the respondent comes into contact with, and correspondingly the respondent has chosen to decrease fertiliser use. The environmental benefits from this are the same as the decreased fertiliser use achieved by the organic farmers discussed previously.

The response to changes in fertiliser use also had education of the respondent as a significant determinant of the answer given ($F=2.84$, $\rho=0.0068$). This is shown in Figure E.5 on page E2.

It is difficult to place an overall trend in results shown in the figure, as there appear to be wide fluctuations in responses. Generally, for the higher qualifications, from Under-graduate Diploma upwards, the mean response is higher than for the lower levels of education (Secondary School qualifications). The higher education respondents may be more production-driven, using the philosophy that 'you have to spend money to make it' or conversely see farming without replacement of nutrients used as resource depletion or degradation.

7.2.3 - Energy use

The number of professional affiliations held by the respondent was a strong determinant in the response given to changes in energy use as an agricultural practice ($F=2.56$, $\rho=0.0304$). This is shown in Figure E.6 on page E3.

The general trend is for energy use to decrease, as the number of professional affiliations increase. Again the work by Korsching *et al.* (1983) becomes relevant. Membership and participation in professional organisations in their research was related to innovativeness, which determined the rate of adoption of soil conservation practices. In this instance, the membership in professional organisations leads to a decrease in the use of energy. This will have environmental benefits in the lowered use of fossil fuels and other energy sources that may be non-renewable or require building more hydroelectric dams to provide more electricity.

Overall, the numbers who increased or decreased their energy use was not as significant as the other inputs. The majority of conventional farmers (76%) had the 'Same/Unchanged' level of energy inputs, and 50% of organic farmers specified the same answer. Difficulties arise when trying minimise the energy inputs, especially the non-renewable sources, such as petrol and diesel, as there are no viable alternatives to these. In connection with this issue, an organic farmer mentioned in the barriers section of their survey that fossil fuels were the alternative with which to run farm machinery, which is not sustainable (see Table 9.4).

The use of energy as an agricultural practices also had the highest level of education of the respondent as a moderate determinant of the response ($F=1.92$, $\rho=0.0642$). This is shown in Figure E.7 on page E3.

The figure in Appendix E shows a negative relationship between the education level of the respondent and energy use as a practice on their farm, in the initial part of the distribution. As the level of education increased up to University Entrance, the mean response for 'energy use' decreased. Then from the Under-graduate Diploma to higher qualifications, the level of energy use then increased as the level of education held by the respondent increased. Again like the results for Figure E.5, this could be explained by the higher education respondents may be more production-driven, using the philosophy that 'you have to spend money to make it.' The assumption may be based on the idea that the use of greater inputs in the agricultural system will yield greater outputs and financial returns for the farmer.

7.2.4 - Fungicide use

The use of fungicide as an input to the agricultural system was very strongly correlated to membership of stakeholder groups ($F=13.59$, $\rho=0.0003$). The mean for the conventional farmers was -0.35, which indicates a slight decrease, and the mean for the organic farmers was -1.60, which shows quite a considerable fall. The resulting distribution for the conventional and organic farmers are shown in Figure E.8 on page E3.

Of the organic farmers, 80% responded with 'Significantly Decreased' to the question, and 20% responded with the unchanged at nil use. Again this increases the mean response in a small sample, but the mean decrease overall is noticeable. The reasons given for the change were Bio-Gro certification, and some considered the chemicals to be 'Unhealthy and uneconomical.' The wider view of the environment as previously mentioned is considered when Bio-Gro certification is undertaken. The use of natural diversity and other approaches to prevent situations that require the use of fungicide. The effects on the wider environment through the use of such materials as fungicides are also taken into consideration.

The conventional farmers also decreased their use of the input, but not by as greater margin. Reasons offered include various economic, personal health and environmental aspects of chemical use. Some farmers no longer felt the need to use fungicides. The wide range of motivations for discontinuing the use of fungicides is encouraging, with personal health and environmental considerations featuring strongly.

The number of professional affiliations held by the respondent was also a significant determinant to the change in use of fungicides on the farm run by that respondent ($F=2.52$, $\rho=0.0322$). The mean responses for the various levels of professional affiliations held is shown in Figure E.9 on page E4.

The basic trend of this relationship, is that as the number of professional affiliations increase, the use of fungicides as an input, decreases. Again, as previously mentioned, the work by Korsching *et al.* (1983) claims that membership and participation in professional organisations was related to innovativeness, which determined the rate at which soil conservation practices were adopted. The membership in these organisations leads to an increase in the amount of information that a farmer receives, and thus can affect the resulting behaviour. In this case it appears that increased information leads to decreased use of fungicide use. The information they receive may either discuss alternative actions to replace the use of this agricultural input or they no longer see a perceived need for this input. The result is a positive relationship, in terms of reduced environmental impact that could occur.

7.2.5 - Drenches/internal paracitiside use

The response in levels of use of drenches/internal paracitisides was very strongly related to the stakeholder group of the respondent ($F=32.03$, $\rho=0.0001$). The distributions of responses for the conventional and organic farmers are shown in Figure E.10 on page E4.

The mean for the conventional farmers was 0.09, indicating a very slight increase, while the organic farmers had a mean of -2.00, indicating a very significant decrease.

Again, like many of the other inputs, the organic farmers decreased the use of drenches/internal paracitisides to obtain Bio-Gro certification, and also based on human and animal health issues.

The conventional farmers had a very slight increase overall, but as Figure E.10 illustrates a close to 'Normal' distribution. Reasons offered for the decrease in use were lack of perceived need and the greater use of other products and approaches that also worked. The general economics of using drenches was also mentioned (did it increase animal weights - thus give a return for that initial outlay for drench?). Resistance to paracitisides by the parasites was mentioned by conventional farmers for decreased use and this resistance/tolerance to the product made its use pointless. Reasons offered for any increases in use by the respondents were based on animal health and economic issues (better quality stock means better returns).

Changes in drenches/internal paracitisides also had the farm-type of the respondent as a significant determinant (F=2.37, ρ=0.0161). Sheep/cattle farmers had a very slight mean increase (0.06), sheep farmers were slightly greater with a mean of 0.13, and cattle farmers had an increase of 0.29. The sheep/cattle/deer farmers also had a higher mean increase of 0.13. The more mixed operations that include forestry and small amounts of cropping, had decreases (varying between -1.00 and -2.00). The sheep/cattle/deer farmers could have a higher increase in use than the other farm-types due to the increased susceptibility to certain parasites by deer. Thus the caution on the part of the deer farmers may lead to increased use, with no risks to stock being afforded. The cattle farmers could have the highest mean response due to the facial eczema threat that these animals face.

The respondent's age also figured strongly in the response given for drench/internal paracitiside use (F=2.57, ρ=0.0406). The mean response for each of the age classes are shown in Figure E.11 on page E4.

The trend of the relationship is for high use for the young respondents (mean of 1.00), then decreasing as age increases , to the point where 35-45 year-old respondents had a mean of -0.24, and then the use increased, to the point where the oldest respondents (60- years old) had a mean of 0.10.

The youngest groups (15-25 years and 25-35 years) could have higher means as they want healthy stock, which will return good profits to the farm. The middle age group (35-45 years old) could have the experience that states drench resistance becoming a problem and realisation of environmental and human health issues are also involved. The oldest groups (45-60 and 60+ years old) could increase their application due to ease of use and animal health issues. The distribution of results is very variable and speculating on the reasons for the fluctuations in the mean response becomes difficult.

7.2.6 - pour-on/external paracitiside use

The stakeholder group of the respondent was extremely strongly correlated to the use of pour-on/external paracitisides (F=35.00, ρ=0.0001). The mean of the organic farmers was -2.00, and the conventional farmers was 0.29, and the distribution of the results are shown in Figure E.12 on page E5.

Of the conventional farmers, 48% had the same/unchanged level of use, 32% increased and 6% significantly increased. Reasons for increased use were ease of use, animal health issues, experimentation with new products and economics. Reasons for decreased use (with 4% 'Significantly Decreased' and 10% 'Decreased') included the lack of perceived need and a dislike of chemicals.

The organic farmers mentioned the certification of their farm by Bio-Gro and dislike of chemicals as the reasons for changes in external paracitiside use, with all the 5 respondents having 'Significantly Decreased' their level of pour-on/internal paracitiside use of the last 5 years.

The reaction to changes in pour-on/external paracitisides also had the farm-type of the respondent as a significant determinant in the response (F=2.68, ρ=0.0068). The sheep farmers had a mean of 0.25, the cattle farmers 0.14, and sheep/cattle farmers 0.30. The sheep/cattle/deer farmers had a mean of 0.54, being the group with the largest overall increase. Again, like internal paracitisides, the more diverse operations showed mean decreases (from -1.00 to -2.00). The resulting means for each of the farm-types mimics that for the drench/internal paracitiside use covered in Section 7.2.5 previously. The sheep/cattle/deer farmers could have a higher increase in use than the other farm-types due to the increased susceptibility to certain parasites by deer, as was the case with the internal parasites. Thus the caution on the part of the deer farmers, due to the expensive nature of stock, may lead to increased use of pour-on/external paracitisides, as they do not want any risks to their stock. The sheep farmers could have a higher mean response due to the farmers wish to maintain, and not threaten, the quality of the wool they produce.

The farm-size of the respondent was also a significant determinant in the use of pour-on/internal paracitiside (F=2.53, ρ=0.0441). The relationship between the farm-size of the respondent and the use of pour-on is shown in Figure E.13 on page E5.

As the respondent's farm-size increases the use of pour-on increases, which could be due to ease of use. As larger farms have higher stock numbers, and pour-ons make the job a lot easier and less time consuming, their use could increase. The largest farm-size had a mean decrease in the use of paracitiside use, which is difficult to explain as it deviates from the trend followed in the remainder of the figure. This could be explained by the costs involved, due to the scale of this task any unnecessary use of pour-ons amounts to a sizable quantity of money. This, combined with the time and effort required getting stock into yards to carry out the task, would appear pointless if the use is unwarranted. Any resistance by parasites to the use of these inputs is a sizable loss of income and capital from the farming system, especially in larger farms. With enhanced management of paracitisides, the need for their use could be lowered, if the timing of the applications is better managed.

The change of use of pour-on/external paracitisides was also strongly correlated to the level of education received by the respondent (F=2.99, ρ=0.0046). The relationship is shown in Figure E.14 on page E5.

The general trend shown on the figure is for an increase in the use of pour-on/external paracitisides as the highest level of education held by the respondent increases. The main deviation from this trend is for the PhD respondents. In this case there was only one respondent with a PhD, who was an organic farmer and as the analysis of Figure E.12 earlier in this chapter shows, they all responded with 'Significantly Decreased' as they had certification of Bio-Gro. Therefore the lowered mean response for the PhD level of education can be explained by an interrelationship with another demographic attribute of that respondent. As mentioned above, when education increases, the level of pour-on use also increases. The trend could be explained by the increasing levels of education giving the respondents the belief that increased use of this type of paracitiside will result in more healthy and better stock, which give higher returns to the farmer.

7.3 - Analysis of practices termed 'Resource Use'

The following discussion covers the relationships found to be significant by the statistical analysis between the changes in the level of agricultural practices termed 'Resource Use' in Part IV of the farmer surveys and the demographic attributes of the respondents. All of the 'Resource Use' practices queried for the level of change by the respondents, are shown in Table 7.3. The table shows the F-Ratios and levels of significance between the levels of practices and the demographic attributes of the respondents.

7.3.1 - Clearing scrub for pasture on steep land

As Table 7.3 illustrates, there were no significant relationships found between the stakeholder demographic attributes and responses given to this question.

TABLE 7.3 - F-ratios and levels of significance for reported practices termed 'Resource Use' in conventional farmer and organic farmer surveys.

	Question	Age		Education		Farm-Type		Farm-Size		Professional Affiliations		Stakeholder Group		Gender	
		<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05
1	Clearing scrub for pasture on steep land														
2	Water resource use								F=3.02 p=0.0205		F=2.70 p=0.0233				
3	Loss of native habitat														

7.3.2 - Water resource use

The response regarding the use of water resources was strongly correlated to the number of professional affiliations held by the answerer ($F=2.70$, $\rho=0.0233$). The distribution of the mean responses for the different levels of professional affiliations is shown in Figure E.15 on page E6.

The general trend is that as the number of professional affiliations increase, the level of water use decreases. The exception is the increase for the respondents with 5 professional affiliations, for whom the mean response increases to 1.00. Although there was one single farmer respondent with 5 professional affiliations and he stated that he made "better use of what was already there." What exactly this implied is difficult to fathom, but the general implication is that more efficient use of the water resources on the farm was undertaken. The information that the respondents with greater affiliations could inform them about the limited nature of water resources, and more efficient and better use use of the water that is found on their farms is required. The water use by farmers responding to this survey may be related to the work by Korsching *et al.* (1983), which claimed that membership and participation in professional organisations was linked to the innovativeness of farmers. The increasing innovativeness of the farmers with greater numbers of professional affiliations could transpond into increasing the efficiency, and decreasing the overall, water use on their farms.

Water resource use also had the farm-size of the respondent as a significant determinant in the reply given ($F=3.02$, $\rho=0.0205$). The resulting distribution is shown in Figure E.16 on page E6.

If a 'line of best fit' was drawn through Figure E.16, an overall negative trend can be seen. As farm-size increases, water resources use tends to decrease. The level of significance of 0.0205 appears much higher than the trend on the figure would indicate. The variation in the mean responses for each of the farm-size classes in the figure is small, so commenting on differences is difficult. Utilising water and the construction of new water systems is capital intensive and expensive. As farms get larger, these costs become higher (to carry out the same increase relative to farm-size) and it may become difficult to find the capital outlay required to expand water supplies, from farm income.

7.3.3 - Loss of native habitat

As Table 7.3 illustrates, there were no significant relationships found between the stakeholder demographic attributes and responses given to this question.

Chapter Eight
Actual Practices and Sustainability Implications: Management Practices

The conventional and organic farmer respondents were asked about changes in the levels of practices on their farms in the last five years. This section of their survey was called Part IV, and is shown on pages B8-B9 in the copy of the farmer survey included in Appendix B of this thesis. This chapter outlines the analysis undertaken on the third, and final group of twenty practices which were termed '**Management Practices**.' This covered such activities as planting forestry, shelterbelts, increased fertiliser management and soil conservation works.

The farmers were asked to rate the change in each practice on the same five-point scale as the practices studied in the preceding chapter. The respondents circled the value that corresponded to the level of change in their farms, with these values shown in Table 7.1 on the previous chapter.

All 20 practices are shown in Table 8.1 with the statistically significant relationships that exist between the demographic details of the respondents and the responses to the questions regarding changes in the practices.

Due to the large number of significant relationships, all the figures that correspond to the analysis in this chapter are included in Appendix E. The relevant figure for the relationship discussed within the text is given a precise page reference for the location of that figure in Appendix E.

8.1 - Analysis of practices termed 'Management Practices'

The following discussion covers the relationships found to be significant by the statistical analysis between the changes in the level of agricultural practices termed 'Management Practices' in Part IV of the farmer surveys and the demographic attributes of the respondents. All of the 'Management Practices' queried for the level of change by the respondents, are shown in Table 8.1. The table shows the F-Ratios and levels of significance between the levels of practices and the demographic attributes of the respondents.

TABLE 8.1 - F-ratios and levels of significance for reported practices termed 'Management Practices' in conventional and organic farmer surveys.

	Question	Age		Education		Farm-Type		Farm-Size		Professional Affiliations		Stakeholder Group		Gender	
		<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05
1	Riparian planting									F=2.12 p=0.0669					
2	Agroforestry														
3	Space planting (10-50 stems ha)		F=4.71 p=0.0037												
4	Production forestry						F=3.18 p=0.0017	F=2.19 p=0.0740		F=2.01 p=0.0814					
5	Conservation forestry planting								F=2.75 p=0.0312		F=2.28 p=0.0499		F=7.43 p=0.0072		
6	Planting windbreaks/shelterbelts					F=1.74 p=0.0868				F=2.20 p=0.0582			F=8.50 p=0.0041		
7	Retiring steep land						F=3.95 p=0.0003				F=3.12 p=0.0108				
8	Retiring gully land														
9	Physical-erosion prevention structures in stream beds														
10	Contouring and physical land works								F=4.54 p=0.0019						
11	Living-dead barriers to soil erosion on slopes					F=1.79 p=0.0842					F=4.87 p=0.0004		F=12.13 p=0.0007		
12	Oversowing/direct drilling														
13	Cultivating across slopes											F=2.88 p=0.0920			
14	Sediment traps in streambeds	F=2.33 p=0.0768													
15	Feed crop rotations		F=3.25 p=0.0140				F=2.32 p=0.0189								
16	Intensive grazing		F=2.69 p=0.0337						F=2.84 p=0.0270	F=2.02 p=0.0792					
17	Fenced riparian strips for stock exclusion						F=2.58 p=0.0090	F=2.38 p=0.0558							
18	Pesticide management programmes					F=1.99 p=0.0531				F=2.01 p=0.0811		F=3.47 p=0.0647			
19	Integrated Pest Management (IPM) programmes														
20	Increased fertiliser management						F=2.20 p=0.0258					F=2.77 p=0.0980			

8.1.1 - Riparian Planting

The management practice of Riparian planting was moderately correlated to the professional affiliations held by the respondent ($F=2.12$, $\rho=0.0669$). This is shown in Figure E.17 on page E7.

The relationship on the Figure E.17 is positive. As the number of professional affiliations held by the respondent increases, the amount of riparian planting on their farm over the last five years also increases. The work by Korsching *et al.* (1983) claims that membership and participation in professional organisations was related to innovativeness, which determined the rate at which soil conservation practices were adopted. In this instance, riparian planting, which is a classic soil conservation method for streambank erosion increases in application as the number of professional affiliations increase. The results of this survey question mirror the work by Korsching *et al.* (1983). The membership of these organisations obviously delivers more information to the farmers on the virtues of riparian planting as a responsible farming practice.

8.1.2 - Agroforestry

As Table 8.1 illustrates, there were no significant relationships found between the stakeholder demographic attributes and responses given to this question.

8.1.3 - Space Planting

The change in use of space planting (10-50 stems hectare) had the age of the respondent as a significant determinant in the reply ($F=4.71$, $\rho=0.0037$). This is shown in Figure E.18 on page E7.

The trend shown between the age of the respondent and the amount of space planting on the farm owned by that respondent in Figure E.18 is negative. There was no data for the respondents aged 15-25. The mean responses for the age classes of 25-35 and older decreased as age increased. The greatest amount of space-planting forestry is occurring in the farms owned by the 25-35 year old respondents, with the 45-60 and 60- age groups planting a little, with means of 0.08 and 0.05 respectively. The reason why the 25-35 year olds would be planting trees, when the other groups are planting little or none, could be that they will be able to reap greater rewards from the tree planting. The 25-35 year old respondents will not be too old when the trees mature and are harvested, and are subsequently able to reap the financial returns, whereas the older respondents may not. This group may also have the enthusiasm and youth required to diversify the farming operation, and get into the long-term investment that forestry represents.

8.1.4 - Production Forestry

The amount of production forestry carried out on the farm is reasonably correlated to the number of professional affiliations held by the respondent ($F=2.01$, $\rho=0.0814$). This is shown in Figure E.19 on page E8.

There are two trends in this figure. The mean level of production forestry increases as the professional affiliations increase from 0, to 1 and then to 2. The level then increases from a lower level at 3, then to 4 and finally 5 professional affiliations. Although the trend is not continuous, this could be explained by the level of significance only being 0.0814. Again, a 'line of best fit' would show an overall increase in the use of production forestry on the respondent's farm as the number of professional affiliations held, increases. The greater level of information that they receive in the newsletters and publications from these affiliations, translates to the implementation of this agricultural land-use.

The amount of production forestry undertaken on the farm of the respondent is also moderately related to farm-size ($F=2.19$, $\rho=0.0740$). This is shown in Figure E.20 on page E8.

There would appear to be threshold at 151-250 and 251-500 hectare farm-sizes with increases of 0.63 and 0.43 respectively. Then as farm-size increases from this point, the level of production forestry is lower and then decreases for the 751-1000 hectare farms. The smallest farm sizes 0-150 hectare farms had lower increase of 0.32.

The reason for the lower mean response for increasing production forestry for the smaller farms might be that they are too small to provide the levels of capital investment required. Another potential reason may be that they are not able to support the loss of land to production forestry from other agricultural uses, due to their limited overall farm-size. This would make it increasingly more difficult to endure the subsequent loss of income from the lost production from these uses that would result, until the trees matured and were harvested. The 151-250 hectare, and the 251-500 hectare farms to a lesser degree, could be the farm-sizes that can afford to put aside land for forestry and the have the required capital to buy the seedlings and plant them. The largest farm-sizes (501-750 hectares and 751-1000 hectares) could be too large to undertake similar sized (as a percentage of overall farm area) forestry plantings. The reasons for this could be the daunting scale of the project or that forestry at this scale is too capital intensive to undertake. Forestry at this larger scale could involve to much farm capital in a longer-term production cycle (as opposed to shorter production cycles offered by sheep and cattle).

The respondent's farm-type is also a significant determinant for the undertaking of production forestry on a farm ($F=3.18$, $\rho=0.0017$). Of the respondents to the survey, the sheep farmers had a mean of 0.25, the cattle farmers' mean was 0.86, and the sheep/cattle farmers had a mean of 0.31. The other more mixed operations had higher mean increases (between 1.00 and 2.00). The cattle farmers may have increased their levels of production forestry by a greater level than the sheep and sheep/cattle farmers, because of the higher beef schedule recently. This has given better returns and farm income for the beef farmers as opposed to the sheep farmers. The cattle farmers with higher farm-income levels, enables them to have the capital investment required for production forestry. Similarly, more mixed farming operations may have a more diverse and stable income base, which provide the capital for increases in production forestry planting.

8.1.5 - Conservation Forestry

The change in conservation forestry planting on farms had membership of stakeholder group as a substantial determinant ($F=7.43$, $\rho=0.0072$). The mean for the organic farmers was 1.00, as opposed to 0.28 for the conventional farmers. The distribution of responses for the two stakeholder groups is shown in Figure E.21 on page E8.

The difference in means could illustrate a different ethic or ability to plant the trees for conservation purposes. The conventional farmers may not have the land to plant for soil conservation purposes in the amounts that the organic farmers have. The difference may lie in the soil conservation ethic held by the two stakeholder groups. Increasing the amounts of trees planted on the property is part of the Bio-Gro certification process. The increase in plant diversity, both aerial and subterranean, that results from these plantings is valued by the organic approach. As the trees are planted for soil conservation purposes, not for harvesting, any clearing of the vegetation cover which exposes the soil to erosion, is avoided.The soil erosion and environmental degradation that can be avoided by planting trees with no intention of harvesting them, is a reflection of the ethic required under Bio-Gro certification.

The level of conservation forestry that was undertaken on the respondents' farms also had professional affiliations as a significant determinant ($F=2.28$, $\rho=0.0499$). The mean responses for each level of professional affiliations held is shown in Figure E.22 on page E9.

Again, the trend is for an increase in conservation forestry planting as the number of professional affiliations increase. The mean for no professional affiliations was 0.28, then increased very slightly to 0.29 for 1 professional affiliation, falling slightly for 2 professional affiliations to 0.14. The level of increase in conservation forestry planting for 3 professional affiliations was 0.42 and a mean response of 0.67 for 4 professional affiliations. The only farmer respondent with 5 professional affiliations gave an answer of 2, hence the high mean. The value of 2 cannot be considered statistically significant, as there was one single respondent in that class. The remainder of the figure however shows an overall slight increase in mean responses as the number of professional affiliations increase. The fall at 2 affiliations is difficult to explain, but may be a statistical anomaly in the trend. Again the work by Korsching *et al.* (1983) is very relevant. Membership and participation in professional organisations in their research was related to the adoption rate of soil conservation practices. In this instance, the membership in professional organisations leads to a increase in one of the more difficult soil conservation practices, in terms of financial penalties that the farmer undertakes. The use of land for conservation planting involves a total forfeiture of income from the land where it is undertaken. Firstly, the farmer loses the income from the previous land-use, such as pastoral agriculture, then secondly they receive no income from the tree subsequently planted, as these are left standing for soil conservation purposes, not for harvesting for production.

The farm-size of the respondent was also a strong determinant in the amount of conservation forestry planting undertaken ($F=2.75$, $\rho=0.0312$). As can be seen in Figure E.23 on page E9, as farm-size increased, the amount of conservation planting undertaken decreased.

The potential reasons for the negative relationship between farm-size and the undertaking of conservation forestry are varied. The larger farms may have carried out conservation planting in the past, before the five year study period of the survey. Alternatively, the farmers with smaller operations could consider conservation forestry to be more important, than the those with larger farms. As previously covered (in Section 8.1.4) the amount of production forestry undertaken was also correlated to the farm-size of the respondent. Again, the reasons for conservation forestry planting and production forestry planting on the larger farms could be similar. The largest farm-sizes (501-750 hectares and 751-1000 hectares) could be too large to undertake similar sized (as a percentage of overall farm area) conservation forestry plantings. The reasons for this could be the daunting scale of the project or that conservation forestry at this scale is too capital intensive to undertake, especially as the trees are not harvested so there are no direct financial returns. The larger classes of farms in this survey are reasonable big (between 500 and 1000 hectares), and the retirement of land into conservation forestry would be a psychologically daunting task.

8.1.6 - Planting Windbreaks/Shelterbelts

The undertaking of planting windbreaks/shelterbelts by the survey respondents was very strongly correlated to membership of stakeholder group ($F=8.50$, $\rho=0.0041$). The mean for the conventional farmers was 0.35, indicating a slight increase, while the mean for the organic farmers was 1.20. The distribution of responses for both the stakeholder groups can be seen in Figure E.24 on page E9.

The conventional farmers had increased the amount of shelterbelts planted on their farms, with 27% responding with 'Increased' and 5% with 'Significantly Increased.' The organic farmers however have increased the levels of planting by a greater amount. The use of shelterbelts in organic agriculture, as with other agriculture types, is important. In organic agriculture the shelterbelts are used as 'refugee islands' for beneficial insects in the agricultural system, with mixed vegetation used in the shelterbelts, like toi-toi. The different levels of vegetation used within the windbreak provide refuge for species, provide protection from the wind, with each storey in the shelterbelt performing a role. The shade offered by the trees is important for animal health and welfare, and also leads to an increase in soil temperature (as chilling by cold wind is lowered). All of these issues are given consideration in the initial certification process for Bio-Gro, and this flows through to the actions of the organic farmers who achieve this certification.

The use of windbreak/shelterbelt planting was also reasonably correlated to the number of professional affiliations held by the respondent ($F=2.20$, $\rho=0.0582$). The mean responses for each professional affiliation class in the survey are shown in Figure E.25 on page E10.

The distribution in the figure is another difficult one to explain. The lower levels of professional affiliations (0, 1, 2 and 3) all have reasonably low levels of shelterbelt planting. The higher number of professional affiliations (4 and 5) have higher levels of planting. Although as previously mentioned there is only one respondent with 5 professional affiliations, therefore the result from this class is not statistically significant. The two 'clusters' of results in the figure are not as clear as the significance level (0.0582) would indicate. Again the work by Korsching *et al.* (1983) is relevant. Membership and participation in professional organisations in their research was related to the adoption rate of soil conservation practices. Shelterbelts are often used to prevent wind erosion, but they serve many roles, such as providing shade and shelter for stock, feed for stock in times of low pasture availability and they may also have value as timber when they mature.

The respondents' farm-type was also a moderate determinant in the level of planting windbreaks/shelterbelts (F=1.74, ρ=0.0868). The sheep farmers had a mean of 0.13, the sheep/cattle farmers had a mean of 0.33, and the cattle farmers had a mean of 0.86, which was significantly higher than the aforementioned. The more mixed operations had a spread of means between 0.33 and 1.50. The reasons why cattle farmers had undertaken more windbreak planting could again be due to greater farm income. This greater farm income allows for the capital required to plant the trees, and fence them for stock exclusion. If the shelterbelts are not fenced the trees may not develop, as the young trees get eaten by the stock when they are young and most succulent. These fencing costs can be quite high, especially when added to the costs of the plant materials.

8.1.7 - Retiring Steep Land

The number professional affiliations held by the respondent was a strong determinant to the retirement of steep land (F=3.12, ρ=0.0108). The mean responses for the professional affiliation classes can be seen in Figure E.26 on page E10.

The general trend is that as the number of professional affiliations held by the person increases, the amount of land retired also increases. The mean responses for 0 professional affiliations and 1 professional affiliation were both 0.17. The mean responses for 2 and 3 professional affiliations were higher at 0.43 and 0.33 respectively. The mean for 4 and 5 professional affiliations were 0.00 and 2.00. Although as previously mentioned, there was only one respondent with 5 professional affiliations, so the mean of 2.00 is not significant. These means would tend to indicate that the lower classes (0 and 1) have low levels of land retirement, then the land retirement increases as professional affiliations increase to 2 and then 3. Although, the 0.00 result for 4 professional affiliation goes against the basic positive relationship. The low level of respondents with this number of affiliations may affect the reliability of the mean of 0.00.

The retirement of steep land also is significantly correlated to farm-type of the respondent (F=3.95, ρ=0.0003). Sheep and sheep/cattle farmers had means of 0.25 and 0.23 respectively. The mean for the cattle farmers, and the more mixed operations were 0.00. The mean for the sheep/cattle/forestry was 1.33, which could be explained by the land being retired in the forestry use covered by the more diverse operation. The cattle farmers may not retire as much land, as they would not run land as steep as the sheep farmers because cattle are not as able to cover the difficult terrain like sheep. The sheep farmers could be retiring more land because they are using this steeper country more than the other farm-types and it is becoming less economic to run under pasture. Poor returns from sheep may be exacerbating this trend.

8.1.8 - Retiring Gully Land

As Table 8.1 illustrates, there were no significant relationships found between the stakeholder demographic attributes and responses given to this question.

8.1.9 - Physical Erosion Prevention Structures in Streambeds

As Table 8.1 illustrates, there were no significant relationships found between the stakeholder demographic attributes and responses given to this question.

8.1.10 - Contouring and Physical Land Works

The response to contouring and physical landworks as an agricultural practice had farm-size as a notable determinant ($F=4.54$, $\rho=0.0019$). The mean responses for each of the farm-size classes can be seen in Figure E.27 on page E10.

The basic trend for the mean responses in Figure E.27 is vaguely U-shaped, although the trend is not very clear. The mean response for the smaller farms (0-150 ha) is an increase of 0.24. Then as farm-size increases, the amount of physical land works on the farm decreases, as the 151-250 hectare farm-sizes had a mean of 0.06 and 251-500 hectares had a mean of 0.04. These means are very close to zero, and indicate little mean change for these farm-sizes over the last five years. The largest farm-size, 751-1000 hectares, had the largest increase for this practice, with a mean of 0.80. The smaller farms may have to undertake land works out of necessity, as they have got a limited amount of land, and need to get the greatest amount of production off it. Although the larger farms had a mean of 0.80, the standard deviation for the responses was 0.83. This high variation in the responses to the question means that no statistically significant conclusions can be drawn from the high mean for the largest farm-size.

8.1.11 - Living/dead barriers to soil erosion on slopes

The membership of stakeholder group was a very significant determinant in the response to changes in the use of living/dead barriers to soil erosion on sloping land as an agricultural practice ($F=12.13$, $\rho=0.0007$). The distribution of responses for each of the stakeholder groups can be seen in Figure E.28 on page E11.

The mean for the conventional farmers was 0.04, indicating little change (96% responded with same/unchanged). The mean for the organic farmers was 0.40, with 40% having 'increased' the soil erosion barriers.

The organic farmers significantly higher mean could be explained by the initial investigation of a farming property that is to be certified. The initial investigation covers soil erosion and other issues that could affect the sustainable operation of the farm. Thus, any agricultural practices that can be implemented to avoid/minimise any adverse effects (such as soil erosion) are encouraged and subsequently these practices are included in the certification process. The small number of organic farmers in the stakeholder group sample does exaggerate the high mean increase for this stakeholder group compared to the conventional farmers. Although, having stated that, only 4% of the conventional farmers had 'Increased' this practices, with the remainder having the same level of this practice. This represents a very small section of the sample group, which is disappointing.

The level of use of living/dead barriers to soil erosion on slopes was also very strongly correlated to the number of professional affiliations held by the respondent ($F=4.87$, $\rho=0.0004$). The mean responses for each level of professional affiliations can be seen in Figure E.29 on page E11.

The general trend is for a slight increase in the use of barriers to soil erosion, as the number of professional affiliations increase. As there was only one farmer respondent with 5 professional affiliations, the high mean of 1.00 for this class is not statistically significant. The remainder of the graph shows a very slight increase in the use of barriers to soil erosion on slopes as the number of professional affiliations increase. However, the relationship shown in the figure is not as significant as the F value and ρ from the SAS analysis would indicate.

The use of soil erosion barriers on slopes also had the farm-type of the respondent was also a reasonable determinant of the change in levels of this practice ($F=1.79$, $\rho=0.0842$). The sheep farmers had a mean of 0.25, and the sheep/cattle/deer farmers had a mean of 0.15, indicating a slight increase in this practice by these two groups. The remaining farm-type had means of about 0.00 to 0.03, signifying no real change at all. The sheep farmers may have the highest mean as the are more likely to graze the steeper land than the other farm-types, as sheep are more able to graze the steeper and more difficult terrain. If the sheep farmers are more likely to graze this sloping land, then there is a greater likelihood that they will require soil erosion barriers on sloping land. As previously covered in Section 8.1.7, sheep farmers are more likely to retire steep land than other farm-types. This also had the same suggested explanation, which is the greater likelihood of grazing steep land in the first instance.

8.1.12 - Oversowing/direct drilling

As Table 8.1 illustrates, there were no significant relationships found between the stakeholder demographic attributes and responses given to this question.

8.1.13 - Cultivating across slopes

The practice of cultivating across sloped had membership of stakeholder groups as a reasonable measure of response ($F=2.88$, $\rho=0.0920$). The distribution of responses for the two stakeholder groups can be seen in Figure E.30 on page E11.

The mean for the conventional farmers was 0.01, revealing little change in the practice, while the mean for the organic farmers was 0.40, indicating a moderate increase. One of the organic farmers had significantly increased this practice which increased the overall mean response, so again the small number in the organic farmer sample affects the statistical significance of the results. Of the conventional farmers, 10% had 'Increased' this practice which is encouraging. Cultivating across slopes reduces the levels of soil erosion that occurs on the bare soil, as the water is impeded from flowing downslope, as the furrows are following the contours of the land. If the water received on the soil surface as rainfall was able to flow as runoff in furrows cultivated downslope, it would carry soil in suspension more easily and result in erosion.

8.1.14 - Sediment traps in streambeds

The use of sediment traps in streambeds to had the age of the respondent as a modest determinant of response ($F=2.33$, $\rho=0.0768$). The mean responses for each class of the respondents' ages can be seen in Figure E.31 on page E12.

The means for the 25-35 and 35-45 age groups were low (0.06 and 0.08 respectively). But the means for the other groups were 0.00, with 0.00 as standard deviation, indicating no variation from the same/unchanged level of practice. There was no data for the 15-25 year old respondents. Many of the older respondents wrote next to this practice that they had done that "years ago" and other statements to that effect. This may explain why the older respondents have lower levels of this practice than their younger counterparts. The younger respondents (25-35 and 35-45 years old) may carry out this practice now, at a similar age that the older respondents were when they undertook the construction of sediment traps.

8.1.15 - Feed crop rotations

The response to changes in use of feed crop rotations as an agricultural practices was strongly correlated to the farm-type of the respondent ($F=2.32$, $\rho=0.0189$). The sheep farmers had a mean of -0.25, indicating a drop in the practice. The sheep/cattle and sheep/cattle/deer farmers had means of 0.26 and 0.23 respectively. The cattle farmers had a mean of 0.57, indicating the greatest increase in the use of this practice compared to the other operation types. The more mixed operations showed no change, or means that were not statistically significant.

The poor economic returns obtained from sheep in recent years may preclude the use of crop rotations. The effort and expense involved may not give satisfactory returns to the farmers that can be attributed to the use of these rotations. The higher means for the sheep/cattle and sheep/cattle/deer farmers may be that they recognise that diversity makes economic sense (as they have a diverse production base), then this may flow through into increased diversity in their feed practices for their stock. The cattle farmers had the highest mean with 0.57, which may again be explained by the returns for cattle farming being more favourable, relatively, to the other production types. The cattle farmers may then be able to receive better returns that can be directly attributed to the use of feed crop rotations, as any practice that results in better quality animals, will give better economic returns to the farmer. This in turn will increase the likelihood of the practice being used, as it makes good management sense.

The change in use of feed crop rotations also had the age of the respondents as a strong determinant ($F=3.25$, $\rho=0.0140$). The mean responses for each class of the respondents' ages can be seen in Figure E.32 on page E12.

The distribution of responses is not entirely clear, with what appears to be two peaks in this distribution. The mean response for the 15-25 year old respondents was 0.00, with a mean of 0.53 for 25-35 year old respondents, and 0.06 for 35-45 year old respondents. The mean then increases to 0.36 for the 45-60 year old respondents, and then decreases to 0.00 for the respondents aged 60- years old.

The high mean for the 25-35 year old respondents could be explained by a combination of education and youth and enthusiasm. This group may have the youth and enthusiasm that would be required to change feed management practices, to achieve results. These younger farmer respondents are also more educated than their older respondents, with increased likelihood of university education. This may then translate into increased knowledge about the benefits of feed crop rotations in animal health and soil physical properties. The high mean increase for respondents aged 25-35 years old is more significant given the high mean farm-size for this group as opposed to the age groups shown in Appendix D. The high mean of 0.36 for the 45-60 year old respondents may be an indication of the experience that this group has about the possible benefits of feed crop rotations, due to the length of time that they have been farming. The fall in the mean to 0.06, which indicates little change for the 35-45 year old respondents is puzzling. This group may not have the education/enthusiasm of the younger group, or the level of experience of the older group, and their mean level of change in this practice is subsequently lower.

8.1.16 - Intensive grazing

The practice of intensive grazing was significantly correlated to the farm-size of the respondent ($F=2.84$, $\rho=0.0270$). As the farm-size increased, the intensity to which grazing had changed, decreased. This can be seen in Figure E.33 on page E12.

The reasons for this trend could vary. The smaller farms may have increased grazing intensity by the greatest amount to remain economic, in difficult operating environment of agriculture at present. Also, as the farm-size increases, the costs involved in increasing grazing intensity also increase, such as the purchase price of new stock. This could become prohibitive in the case of the larger farms and thus the intensity of grazing does not increase by as greater amount. The scale of change of grazing intensity required as the property size increases could become psychologically daunting for the land-owner and this affects the likelihood of the practice occurring. Also, the large farms are more extensive-grazing operations, as opposed to smaller intensive-grazing operations. Subsequently, increasing the grazing intensity is not physically possible due to the land-classes often involved, such as steep land and less fertile/productive soils.

Intensity of grazing also had the age of the respondent as a strong determinant ($F=2.69$, $\rho=0.0337$). The general trend is that as age increased, the intensity of grazing decreased. The relationship between age and intensive grazing can be seen in Figure E.34 on page E13.

The reasons for decreasing levels of intensive grazing as the age of respondent increases could be explained by a number of reasons. There could be decreasing enthusiasm about running larger and more intensive stock herds as the age of the respondent increases. Their experience could also tell them that the returns do not justify the extra expenditure and effort involved in increasing stock numbers, and also any environmental degradation is also unwarranted. The older respondents may also have developed an environmental ethic, as they have seen the effects of overgrazing. The younger groups could have the enthusiasm required to increase grazing intensity. The remarkable point regarding the highest mean increase of 0.65 for the respondents aged 25-35 years, is their high mean farm-size as shown in Appendix D. The mean farm-size for these respondents is 1273 hectares, which is three to four times the mean farm-size for the other respondents. The scale of undertaking for this group to increase grazing intensity is very large.

8.1.17 - Fenced riparian strips for stock exclusion

Changes in the level of use of fenced riparian strips for stock exclusion was moderately correlated to the farm-size of the respondent ($F=2.38$, $\rho=0.0558$). This can be seen in Figure E.35 on page E13.

The trend in the figure is not entirely clear, but as farm-size increases, the level of fencing riparian strips for stock exclusion decreases. The smaller farms, between 0-150 hectares and 151-250 hectares had means of 0.36, and the largest farms of 751-1000 hectares had a mean of 0.20. Between the smallest and the largest, the results fell to 0.10 for the 251-500 hectares and the 501-750 hectares had a mean of 0.00. The gradual fall between 251-750 hectares could be explained by the prohibitive costs of fencing riparian strips at the large scale. The costs of the fencing is high, and the amount of land retired from productive use also increases. This would be daunting in terms of fencing costs, of lost production value and the sheer scale of land retirement involved. The farms between 751-1000 hectares had a mean of 0.20, but the standard deviation was over 0.40, which makes the mean response statistically questionable, considering the low number of respondents with this farm-size. The small land-owners may have a different environmental ethic which compels them to retire and fence more land surrounding streams, than their counterparts with larger farms.

The use of fenced riparian strips for stock exclusion also had farm-type as a significant determinant of the reply ($F=2.58$, $\rho=0.0090$). The means for the sheep, cattle and sheep/cattle/deer were 0.25, 0.29 and 0.23 respectively. The mean for sheep/cattle farmers was slightly lower at 0.15. The more mixed operations had means between 0.00 and 2.00. Why the sheep/cattle farmers had a lower mean than the other major groups is difficult to explain, as the analysis in Appendix D shows, this group was the best educated on average and had more professional affiliations than some of the more 'traditional' farming approaches. Therefore, education is not causing the difference, nor would economic reasons appear to affect the outcome, as the beef schedule offers better returns than many forms of agriculture at present. The low mean is concerning in one regard, as the cattle beasts are larger animals than sheep and deer, and if these are allowed to feed right up against stream margins, the potential for erosion and damage by stock is increased.

8.1.18 - Pesticide management programmes

The increased use of pesticide management programmes by the respondents was strongly correlated to the stakeholder group ($F=10.52$, $\rho=0.0015$). The mean for the conventional farmers was 0.11, showing a slight increase, as can be seen in Figure E.36 on page E13. The organic farmers had a mean of -0.40.

The fall in pesticide management by the organic farmers could be explained by the reduction in the use of pesticide inputs in order to become certified by Bio-Gro, which was discussed in Section 7.2.1 and shown in Figure E.1 on page E1. The mean level of pesticide use for the organic farmers was -1.60, which illustrates a significant fall. If the use of pesticides is reduced or eliminated, then the need for their management is also similarly reduced or eliminated. The Bio-Gro standards allow the use of organic alternatives on a restricted basis.

The increase in pesticide management by the conventional farmers could be explained by a change in environmental ethic, such as recognition of excessive pesticides on the environment. There could also be economic motivations here, with the notion that excessive pesticide use is wasteful and unnecessary, as the costs to the farmer bear no real returns. The reason could also be human health related, such as the perceived risk of the pesticides on farm workers. The better management of pesticides by the conventional farmers is an encouraging sign. This could form part of an interim or transitional step towards a greater decline in their use, and better alternatives being developed.

The level of change in pesticide management programmes also had the number of professional affiliations held by the respondent as a moderate determinant ($F=2.01$, $\rho=0.0811$). This relationship is shown in Figure E.37 on page E14.

The trend shown in figure is very vague, but there appears to be a slight increase in pesticide management programmes as professional affiliations increase from 0, to 1 and then 2. Although the mean of -0.67 for 4 professional affiliations goes against the trend, but due to a high standard deviation the mean is not statistically significant. The mean responses of 0 for 3 and 5 professional affiliations is puzzling. Basically good practices are increasing as professional affiliations increase as farmers here more about advantages of better management. This trend only occurs up to, and including 2 professional affiliations. The high level of significance of 0.0811, does mean that the conclusions drawn from this are far from 'water-tight.'.

The farm-type run by the respondent was also a fair determinant to change in pesticide management programmes ($F=1.99$, $\rho=0.0531$). The means for sheep, sheep/cattle and sheep/cattle/deer farmers were 0.13, 0.12 and 0.15 respectively. The mean for cattle farmers was lower, at 0.00. The means for the more mixed operations ranged between -1.00 and 1.00, but were not statistically significant. The lower use of pesticide management programmes by the cattle farmers be explained by the lower overall pesticide use by this farm-type as opposed to the other groups. If the need for pesticides is lower for this farm-type, then the need for the management of the resource input will subsequently, also be lower.

8.1.19 - Integrated Pest Management (IPM) Programmes

As Table 8.1 illustrates, there were no significant relationships found between the stakeholder demographic attributes and responses given to this question.

8.1.20 - Increased fertiliser management

The practice of increased fertiliser management had the membership of stakeholder group of the respondent as a moderate determinant of the answer ($F=2.77$, $\rho=0.0980$). The mean for the conventional farmers was 0.61, showing a modest increase. The mean for the organic farmers was 0.00. The distribution of the two stakeholder groups can be seen in Figure E.38 on page E14.

Of the conventional farmers, 42% remain with the 'same/unchanged' level of the practice, but 41% had 'increased' and 12% significantly increased' the management of the fertiliser they use. The changes in this practice would be the most significant and obvious of all the practices queried in this survey. The farmers made comments along the lines of "used the same or less, amount of fertiliser, but more carefully." This could be due to the environmental or economic considerations, as excessive or unrequired fertiliser is not only a possible environmental pollutant, but also a waste of capital investment input for the farmer. This is because the fertiliser is wasted, as it does not increase soil fertility or production (ie. give returns to the farmer). Increased management of fertilisers will have flow through to positive environmental effects, as nutrient loads in surface runoff and streams should lower, as the excessive fertiliser use is hopefully avoided. The buildup of nutrients in groundwater through leaching should also be lowered, so excessive nitrate levels in groundwater should also be avoided.

Of the organic farmers, most (60%) replied with unchanged as they had not used commercial fertiliser since before their certification period for Bio-Gro. The respondent who stated 'significantly increased' noted that the types of fertilisers used, changed to organic alternatives. Therefore better management of organic alternatives was occurring. The respondent who stated 'significantly decreased' also changed the corresponding amount of fertiliser inputs by the same margin, so no management of fertilisers was required if they were no longer used.

The response to the use of increased fertiliser management had farm-type as a notable determinant ($F=2.20$, $\rho=0.0258$). The means for sheep, sheep/cattle and sheep/cattle/deer farmers were 0.50, 0.54 and 0.46 respectively. The mean for cattle farmers was 1.14, signifying a considerable increase. The means for the more mixed production systems ranged between -1.00 and 2.00, but none were statistically significant. All the farm-types had increased their levels of fertiliser management, which is encouraging. The cattle farmers would have increased their levels of fertiliser management by such as large margin as this type of farming is more management intensive than the other types listed. The respondents who farmed sheep would have a less management intensive operations. The cattle farmers would carry out tasks like drenching and weighing their animals to achieve the best results in terms of liveweights, which in turn determines the economic returns they receive. The management of fertiliser applications forms part of this intensive management regime, and thus has been increased by a sizable amount.

8.2 - Summary of analysis of practices covered in chapters 7 and 8.

Overall, the agricultural practices undertaken by the conventional and organic farmer respondents had improved in terms of environmental outcomes. The Likert-scale is merely a relative one, and does not indicate the actual levels of change, or the previous level before the change. The scale does give a general indication as to the direction of change, and some indication of the degree of change.

The conventional farmers improved some types of input use, such as slightly decreased pesticide use and decreased fungicide use. The use of some inputs had increased, such as pour-on/external parasiticide use and fertiliser use. Fertiliser management had increased greatly (mean=0.61), which indicates the increased use in fertiliser was undertaken with greater awareness of effectiveness in terms of pasture growth, and losses to leaching. Some beneficial practices, such as shelterbelt use and conservation forestry had increased, by 0.35 and 0.28 respectively.

The organic farmers had changed their practices by larger margins. The use of all the inputs had decreased, with fertiliser use decreased by a mean of -1.00, while the reductions in drench and pour-on use were the most dramatic, with both having a mean result in change of -2.00. The reduction in input use by the organic farmers was much greater than that for the conventional farmers. A possible explanation for this would be the certification standards they operate under. If the NZBPCC standards prohibit the use of most commercial inputs, then in order to be certified organic producers, then they must abide by these regulations. The use of conservation forestry and shelterbelts increased greatly, by a mean of 1.00 and 1.20, respectively. The certification process encourages planting extra trees in the agricultural system for a number of beneficial reasons, such as shelter for stock, or lowering wind speeds, which in turn increases soil temperature, and they can harbour beneficial predator species.

As the age of the farmer respondents increased, they were more likely to use drenches/internal parasiticides and less likely to undertake the practice of space planting. The first could be explained by the ease of use of these products, and this was often noted by respondents, along with animal health reasons, for the increasing use of these products. The latter decline in the practice of space-planting could be explained by the older respondents may not be able to reap any of the potential financial rewards of these plantings, or they may lack the enthusiasm to undertake the tree planting.

As the education level of the farmer respondents increased, the use of fertiliser inputs increased and pour-on/external parasiticide use increased. This may be due to the education they received, which promotes production-based, input-driven agriculture. The pour-on use increases were often acknowledged by animal health considerations and ease of use issues. The use of fertiliser is a difficult issue, as agricultural degrees cover material regarding the nutrient use, either by different crops, or through pasture consumed by stock, and the fertiliser required to replace this loss. If fertiliser is not used, then the nutrient loss (in the form of crops of stock off-site) will lead to a gradual decline in soil fertility over time, which is not agronomically sustainable (Section 2.3). The excessive use of fertiliser is not encouraged, as it is not utilised by the plants, and either passes through the soil to groundwater or in runoff. These both have environmental consequences, and the wasted fertiliser is an economic loss to the farmer, as it results in no increase in production.

As the farm-size of the respondent increased, pour-on/external parasiticide use increased. The ease of use issues again are important, especially with big farms, where carrying our tasks like this, occur on a large scale and involve a large number of animals. The use of water resources also decreased as farm-size increased, which may be scale-related again. The size of installing water systems and infrastructure for stock at these scales may be large, and with poor recent economic returns for farming, the cost of this type of work may be prohibitive. The undertaking of fenced riparian strips and conservation forestry decreased as farm-size increased. The scale of work required to undertake increases of these practices, and the amount of land that could be lost to fenced riparian strips in a large property, along with the cost issue may hinder the larger farms from undertaking these practices.

The practices also varied depending on the different farm-types of the respondents. The sheep farmers had the highest increases in the retirement of steep land and use of soil erosion barriers. This result seems logical, as sheep farmers are more likely to be occupying the steeper land and thus they may be more likely to run their farms on the steeper land and therefore they could be more inclined to retire this land, and use soil erosion barriers, due to greater exposure to these potential problems (such as soil erosion). The cattle farmers had the highest use of internal parasiticides (mean=0.29) and fertiliser management (mean=1.14). These farmers are usually more management-intensive in their farming operations, and attention to such aspects as fertiliser management seems logical. This management can often involve greater checks on animals, such as liveweights, and to drench the cattle when weighing them adds little to the overall task, and can be undertaken while the stock are in the cattleyards. The greater financial worth of a individual cattlebeast, compared to a sheep for example, means that relatively, animal health concerns can increase, purely on economic basis alone. Any reduction in animal health can reduce its weight or lead to death, which affects farm income. The cattle farmer respondents also had the greatest increase in the use of production forestry (mean=0.86) and windbreak/shelterbelts (mean=0.86). The better economic returns for cattle in recent times (compared to sheep farming), may offer increased farm income that allows for these practices to be undertaken and further diversification of the farm production-base. The sheep/cattle/deer farmers had the highest use of external parasiticides (mean=0.54), and this could be explained by the increased susceptibility of deer to disease.

As the number professional affiliations held by the farmer respondents increased, a number of beneficial practices increased (production forestry, conservation forestry, riparian planting and the retirement of steep land), and the use of some inputs decreased (such as the use of fertilisers and pesticides). The management of pesticide inputs also increased as the number of professional affiliations held increased. Korsching *et al.* (1983) stated that the professional affiliations related to the innovativeness of farmers, and the rate at which they adopted soil conservation practices. The information and material they obtain from the organisations they are affiliated to, or members of, has lead to beneficial outcomes in terms of changes in practices. These can be both environmental, and economic, such as greater use of production forestry, which can diversify the farm production/income base and also lower erosion rates on steeper land. The management of pesticide inputs to the farming system also increased as the number of affiliations held increased.

Chapter Nine
Perceived Barriers to Achieving Sustainable Agriculture

The last part of every survey (as shown in Appendix B) asked the respondent to identify the constraints to adopting more 'environmentally friendly' or sustainable agriculture as they perceived them.

All the barriers that were identified by the conventional farmers, organic farmers and professional staff were entered in the database of results. The frequency that each of the 96 barriers were mentioned by the three stakeholder groups were then summed and grouped into tables according to generic themes. The tables were used to make the wide ranging barriers easier to comprehend and analyse.

The five themes for each table are as follows:

Economic Barriers - This covers the barriers that concerned issues such as farm economics required to enact sustainable agricultural practices and other economic issues. These are shown in Table 9.1.

Education Barriers - This covers such issues as the lack of understanding about agricultural sustainability issues, lack of research and information for landowners. These are shown in Table 9.2.

Attitudinal Barriers - This covers issues such as lack of political urgency, antagonism between stakeholder groups and lack of ownership of environmental problems associated with agriculture. These are shown in Table 9.3.

Institutional and Legal Barriers - This table covers topics such as infrastructural requirements to enact sustainable agriculture, land-ownership issues and monitoring systems. These are shown in Table 9.4.

Physical & Technical Barriers - This covers topics such as lack of alternative fertilisers and pesticides that are sustainable, the need for correct land management practices and the site-specific nature of sustainable agriculture. These are shown in Table 9.5.

The tables show the barrier mentioned, and the number of occurrences in surveys by each of the stakeholder groups and the total number of times the barrier was noted.

The discussion in following sections is focussed on the barriers in the tables that were mentioned on more than 7 occasions, which as there were 229 respondents in total, equates to 3% of the respondents. This value may appear low, but was chosen due to the fact that the completion of the prescriptive or 'open-ended' questions did not occur as often as for the 'multi-choice' questions, which used the five-point Likert scale. Therefore, to get an adequate amount of barriers to discuss in this chapter, the minimum number of occasions the barrier was mentioned, was selected as 7.

The barriers in the five tables outlined previously are in following sections, with the section number corresponding to the relevant barriers table.

9.1 - Economic Barriers

All the barriers under this heading that were noted under the question regarding barriers to sustainable agriculture are listed in Table 9.1, with the number of mentions each received. Economic barriers to the adoption of sustainable agriculture or alternative agriculture was noted by MAF (1993a) and Reid & Wilson (1986). The following discussion surrounds the barriers that received more than 7 comments by different respondents.

Lack of income to meet the initial economic costs of sustainable agriculture was the most frequently mentioned barrier in the survey responses. As Table 9.1 shows, 39 conventional farmers, 4 organic farmers and 19 of the professional group, noted this barrier. The costs involved will need to be met and the ability of farmers to pay will affect any change and implementation of new methods. Where some agriculture may be microeconomically marginal, such as in the hill-country, any changes that require capital outlay, may not occur if the farmer cannot afford the capital outlay. MAF (1993a) mentioned this barrier as an impediment to communities responding to the need for change. Ervin & Ervin (1982) and Reid & Wilson (1986) both mentioned economic barriers to the implementation of alternative and sustainable agriculture.

This leads into another frequently mentioned barrier, that agricultural produce prices must reflect the costs. So any changes to land management or other practices, must be passed on to the consumer, in the produce prices. This should offset the lack of income over the long-term barrier, but may aid little in the short-term economic outlay required.

TABLE 9.1 - Economic barriers to the implementation of sustainable agriculture identified by all survey respondents.

	BARRIER	CONVENTIONAL FARMERS	ORGANIC FARMERS	PROFESSIONAL STAFF	TOTAL
1	Lack of income to meet the economic costs of sustainable agriculture	39	4	19	62
2	Market returns from sustainable ag. produce	7	0	15	22
3	Prices of sustainable agricultural produce must reflect costs	11	0	13	24
4	Loss of production in the short- to medium-term	11	2	12	25
5	Lack of finances and need to service mortgages	3	1	3	7
6	Small farms becoming uneconomic	2	0	0	2
7	Charges for rural services	1	0	0	1
8	Cost and lack of farm-labour to implement change	2	0	5	7
9	Lack of government funding for solving issues	1	1	4	6
10	Current monetary policy	2	1	4	7
11	Wildly fluctuating commodity markets and prices - cannot plan for the future	2	0	5	7
12	Who bears the costs involved?	2	0	8	10
13	Human greed	2	0	1	3
14	Lack of economic incentive	0	0	15	15
15	Preoccupation with economics by farmers	0	0	4	4
16	Market has not demanded change	0	0	6	6
17	Unrealistic land prices cause problems - force intensive and unsuitable uses onto marginal land	0	0	2	2
18	Bank policies/assessments do not favour/ appreciate slow production systems such as cattle	0	0	1	1
19	Poor marketing of agricultural produce	1	0	0	1
20	Environmental protection works not cost effective	3	1	3	7
21	High initial costs - implications of this	2	0	2	4
22	Need better, more aggressive marketing of "Green" produce - get premium prices	0	0	2	2
23	Cannot risk international competitiveness	0	0	1	1
24	Lack of contract supply - thus agriculture is price or production driven, not contracted to supply a market programme	0	0	1	1
25	Risk associated with change - economic, production, social	0	0	2	2

The market returns from sustainable agricultural produce was mentioned on 22 occasions. The reality of the barrier may be queried, as organic produce earns premium prices, above that fetched by the conventional equivalent. Organic agriculture is used only as a possible example of sustainable agriculture, whether or not it is sustainable is open to debate. Nevertheless, the organic produce earns a minimum of 20 percent above the conventional equivalent. In some cases, the prices can be up to 800% above the conventional prices, like yoghourt or lamb for example, especially in the overseas markets. The organic produce uses the notion of 'clean-green' to get premium prices.

The loss of production in the short- to medium- term was mentioned by 25 respondents. Whether it is true cannot be determined. Stinner & House (1989) stated that the adoption of alternative agricultural practices may lead to a decrease in yields, net farm income may increase (due to lowered input costs and increased produce prices). But if premium prices are obtained for the produce, any reduction in production, could be masked by the overall increase in farm-income, due to the higher prices fetched for the lesser produce output. The short- to medium- term loss of income can threaten farm profitability, and does provide a financial constraint to the adoption of sustainable techniques by landowners, as they cannot afford this loss of income and the corresponding threat to farm economic viability. The IUCN *et al.* (1990) stated that off-farm income sources may be required to supplement on-farm income fluctuations and shortages. The implementation methods discussed in chapter 10 would need to be used to overcome this barrier, and make sure farm economics remained favourable.

The question of exactly who bears the cost of any sustainable agricultural practices enacted was mentioned by 10 respondents. Strangely enough, the barrier was noted by 8 professional respondents and only 2 conventional farmers. Any sector of the economy or industry that does not pass on the costs of production to the consumer is not going to be profitable. If microeconomic (farm-scale) sustainability is to be achieved, then the costs incurred by the farmer must be passed on to the consumer.

The lack of economic incentive to change to sustainable agricultural practices was noted by 15 respondents (all from the professional group). Apart from price incentives, it is difficult to determine what incentives are needed to alter farmer behaviour. The use of rates-rebates and other methods covered in chapter 10 could be used, but market returns must play a role. As the analysis and discussion in chapter 10 shows, the methods were received with various levels of enthusiasm by the farmers, so a mix will be needed to achieve the required incentive, and they were not enthusiastic about grants as a financial incentive.

The fact that environmental protection works are often not cost effective was mentioned on 7 occasions (3 conventional farmers, 1 organic farmer and 3 professional staff). How exactly the 'cost-effectiveness' can be measured and over what time period (temporal scale in Section 2.4.3) is the central issue of this barrier. In terms of long-term ecological sustainability, the measures may often be profitable, but in the short-term, say a few years (typical financial planning periods), the costs may seem high. The 'pay-offs' of environmental protection works are long-term, and may seem prohibitive in the short-term, which does little to aid their adoption.

The lack of finance and the need to service mortgages was referred to in 7 replies (3 conventional farmers, 1 organic farmer, and 3 professional staff). The need to pay off mortgages and other financial commitments means that the farmer often has little capital to invest in changing to sustainable technologies. Even if the farmer has the 'correct' environmental ethic and wants to be 'green', if the financial obligations, such as mortgages, mean that cash-flow is low, then change may not occur. Hughes' (1991, p 499) statement "How can you be green if you're in the red?" encapsulates the philosophy of this barrier.

The cost/lack of farm-labour to implement change to the sustainable system was noted in 7 returns (2 conventional farmers and 5 professional staff). Whether labour requirements may, or may not be higher for sustainable systems is unknown. The labour requirements may be different, with different relevant skills required of farm-workers to enact sustainable systems. This may be expensive, as it could be in relatively short supply. Then again, the requirements for sustainable agriculture are not terribly complex, and much of the research outlined in chapters 1, 2 and 3 illustrates that sustainable agriculture is based on age-old principles and practices, with a little understanding of natural systems and processes.

Current monetarist policy was mentioned as a barrier by 7 respondents (2 conventional farmers, 1 organic farmer and 4 professional staff). There are aspects of current economic policy that put pressure on agriculture, that may already be microeconomically unsustainable (Section 2.3), such as the 'user-pays' principles, the high New Zealand dollar which means exporters earn less for their produce and the high mortgage rates make the effects of the earlier mentioned barrier of financial commitments more profound. All of these affect the ability of the individual farms and the agricultural sector to make money - thus affect micro- and macro-economic sustainability of the agricultural sector (Section 2.3).

Wildly fluctuating commodity prices for agricultural produce, which can make long-term economic planning/decision-making difficult was noted in 7 replies (2 conventional farmers and 5 professional staff). The fluctuation in price leads to fluctuations in farm-income. This lack of certainty in farm income means that sustainable practices or environmental protection works are difficult to plan for.

These works require input over a number of years and when the capital required may not be available in the next, or following years due to fluctuating income, planning for these environmental protection works becomes very difficult. The response by farmers can be price or production driven agriculture, which can cause problems. To counter uncertain prices, the farmer produces as much as is possible, to maximise income, especially critical when commodity prices are low. The higher production levels can exceed the carrying-capacity of the land, or cause environmental problems due to increased concentration of stock, and land-use. Lack of certainty about commodity prices also places stress on the farmer, as budgeting/planning to meet the fixed costs/commitments, such as mortgages becomes harder.

9.2 - Education Barriers

All the barriers under this heading that were noted under the question regarding barriers to sustainable agriculture are listed in Table 9.2, with the number of mentions each received. The educational barriers facing the implementation of sustainable agriculture and alternative agriculture was mentioned by Reid & Wilson (1986), MAF (1993a), Reganold *et al.* (1990), Blobaum (1983) and Ervin & Ervin (1982). The following discussion surrounds the barriers that received more than 7 comments by different respondents.

The lack of understanding of the term 'sustainable agriculture' by the council staff and decision-makers was noted on 10 occasions (9 of which were conventional farmers). The perceived lack of understanding could be related to the current clamour to define the term sustainability and sustainable agriculture in light of the RMA 1991. The fact that sustainable agriculture is still very much in its infancy as far as research goes, compounds the problem. The lack of balance in the perceived characteristics of sustainable agriculture outlined in Section 5.1 illustrates the lack of social considerations, and the integration of environmental, social and economic aspects of sustainable agriculture as outlined by MAF (1993a), IUCN *et al.* (1991), SCGSLMR (1995) and MfE (1995b).

The lack of published research was mentioned in 25 responses (10 by conventional farmers and 15 by professional staff). The lack of good research, with practical recommendations that can be implemented will not change in the short-term, as the time required to study an agricultural system and its long-term sustainability implications will take many years.

TABLE 9.2 - Education barriers to the implementation of sustainable agriculture identified by all survey respondents.

	BARRIER	CONVENTIONAL FARMERS	ORGANIC FARMERS	PROFESSIONAL STAFF	TOTAL
1	Lack of understanding of the term by councils/ decision-makers	9	0	1	10
2	Very little published research	10	0	15	25
3	Need to define the term sustainable ag.	3	0	0	3
4	Lack of knowledge by farmers	8	0	17	25
5	Need for consultation	8	0	6	14
6	Need for education/ advice	18	0	19	37
7	Need change in attitudes/ more thought about the issues required	13	1	17	31
8	"Brainwashed" into pesticide and fertiliser type conventional production	1	2	0	2
9	Media needs to be used more positively to highlight the issues	1	0	2	3
10	Better records about the use of drenches and pesticides need to be kept	3	0	0	3
11	Need more research about sustainable agriculture and it's implications	1	0	16	17
12	Farmer ignorance	0	0	9	9
13	Research has gaps and is incomplete	0	0	9	9
14	Public attitudes /expectations of process for achieving sustainable agriculture	0	0	5	5
15	Networks required amongst farmers to disseminate information	0	0	6	6
16	Networks required between Councils and farmers to disseminate information	0	0	19	19
17	Lack of money for education	0	0	6	6
18	Lack of awareness of problems/issues by land-managers	0	0	16	16
19	Low levels of education amongst farmers	0	0	3	3
20	Lack of agreement as to what 'sustainable agriculture' means on the ground	0	0	11	11
21	Conflicting information from MfE and MAF	0	0	3	3
22	Research not in 'farmer-friendly' or usable format	0	0	7	7
23	Time taken to get results from education hinders its implementation	0	0	2	2
24	What is the role of research? - to produce new information or change	0	0	1	1
25	Need decision-support systems to assess the different land use options	0	0	1	1

Another barrier mentioned was that the research on sustainable agriculture is not complete and has 'gaps' and this was noted in 9 replies (all professional staff). The study of land-use fulfilling the requirements of the RMA 1991, and sustainable agriculture in general is in its infancy, subsequently gaps in research are inevitable. The use of better consultation between the decision-makers, farmers and scientists about what gaps actually exist, will hopefully allow the scientists/researchers to endeavour to fill these gaps.

The need for more research about sustainable agriculture and its implications was mentioned by 17 respondents (1 conventional farmer and 16 professional staff). The need for more research as a planning response to sustainable agriculture was covered in chapter 10. So there were obviously some respondents in agreement with this implementation method, as they mentioned it in the barrier part of the survey in addition to the implementation methods question. There are many parts of the sustainable agriculture system, that professional staff perceive to require further research. This must be addressed, because if they perceive a lack of information and research, then their education programmes will not be as effective as possible. The programmes require sound detail and information to aid farmers in their decision-making and implementation of sustainable agriculture.

The lack of knowledge about sustainability issues by farmers was outlined in 25 survey replies (8 conventional farmers and 17 professional staff). This is a problem that needs addressing, as the current concern by farmers about the implications of the RMA 1991, and what effect the concept of sustainable management will have on the way they farm, needs to be spelt out. If this is not done, the levels of antagonism between professional staff and farmers will continue. These antagonism barriers are mentioned in Section 9.3 and Table 9.3.

Another barrier mentioned by 7 of the respondents (all from the professional group) is the lack of research in 'farmer-friendly' format. If the farmers are made aware of the issues and possible land-management/agricultural options, then they may be more willing to change. Rawlings (1995) quoted Gordon Stephenson, a farmer from Putaruru, who stated that there was a need for technical information on how farmers should manage their resources. The application of technical information should be in a format that farmers can understand and apply to their farms. If the advice is too technical and cannot be understood, it is doubtful that the information will be translated to change to sustainable agricultural practices. Taylor (1990) stated the importance of information being in a form that is easily transferable to the end-users, the farmers.

The need for consultation was mentioned in 14 replies (8 conventional farmers and 6 professional staff). This will aid the identification of the issues involved in sustainable agriculture, as all involved hold knowledge important to achieving sustainability, such as the anecdotal information held by farmers. This process may involve off-site members of the community affected, such as down-stream farmers or other landowners who have land which receives the sediment deposited by floods which originates from upstream. This consultation cannot become preoccupied with the short-term, practical or productivity issues, but also needs to consider the long-term sustainability issues, such as ecological or environmental considerations.

The need for education for the farmers was noted by 37 respondents (18 conventional farmers and 19 professional staff). Obviously the two main groups in the agricultural sustainability debate are in agreement that more information is needed by farmers about sustainability issues, through education programmes. Conversely, the professional group need information about the rural community's aspirations, which forms an important social component of sustainable agriculture.

A change in attitudes is required according to 31 respondents (13 conventional farmers, 1 organic farmer and 17 professional staff). The comments were often broad, but comments related to a lack of environmental ethic amongst some in the agricultural community and some unrealistic aspirations from urbanites regarding sustainability issues. The development of concepts like agricultural sustainability, and new legislative frameworks like the RMA 1991 require some attitudinal change to allow this change to occur. Legislative change will achieve little on its own, it requires change in attitudes amongst those who implement it and are affected by its implementation.

The need for networks between council staff and farmers to allow dissemination of ideas was specified by 19 respondents (all from the professional group) This is closely related to the other barriers mentioned earlier in this section. This will allow better education and consultation processes, and hopefully improve the knowledge levels and attitudes held by farmers. It can also allow the anecdotal information held by the farming community to be transferred to the local government staff. There will be little gained by more research and information in a 'farmer-friendly' format if this information cannot be transferred effectively to farmers.

The lack of awareness of sustainability problems/issues by land-managers was mentioned by 16 respondents (all of which were from the professional group). This problem/barrier is of concern, as farmers are not recognising the pertinent problems/issues, which means that that those issues will not be raised in participatory approaches, unless it is initiated by the council and other professional staff. Concentration on certain issues by farmers (short-term production and economic examples) will hinder progress to achieving sustainable agriculture. Increasing the awareness of the problems is the first important step in addressing the problems. The problems cannot be addressed by landowners if they fail to recognise that a problem exists.

The lack of agreement as to what 'sustainable agriculture' means on the ground was noted 11 times (by the professional group). The conflicting information is very confusing, and hinders the implementation of sustainable agriculture. If the stakeholders in the sustainable agriculture debate cannot agree on the meaning of the term, then getting to implementation stage will not occur. The definition and implementation of sustainable agriculture is ambiguous by nature, and open to debate. As mentioned earlier in this thesis, the definition has been wide and varied, and due to site-specificity issues and localised social aspirations, the term 'sustainable agriculture' will never be set in concrete. But having stated that, the confusion needs to be reduced, so action can be taken on recommendations by all involved, although disagreement will still occur.

Farmer ignorance towards sustainable agriculture was mentioned in 9 responses (all professional staff). The statements by the respondents often concerned ignorance towards issues involved with sustainable agriculture, which hinders progress towards change (which can often benefit the farmer). The term ignorance was used as opposed to lack of knowledge and lack of awareness, with the wording by the respondents often stronger than simply a lack of awareness. The comments usually referred to a more deliberate denial of the issues involved, over lack of recognition *per se*.

9.3 - Attitudinal Barriers

All the barriers under this heading that were noted under the question regarding barriers to sustainable agriculture are listed in Table 9.3, with the number of mentions each received. Attitudinal barriers to sustainable and alternative agriculture were noted by Reid & Wilson (1986), MAF (1993a), Ervin & Ervin (1982), and Blakeley (1990a). The following discussion surrounds the barriers that received more than 7 comments by different respondents.

The use of plans by Councils that are too prohibitive/restrictive was mentioned on 9 occasions (8 of which were conventional farmers and 1 was a professional person). Again, the farmers see external control (in this case by Councils) as a barrier. The farmers view towards regulation as a implementation method to achieve sustainable agriculture is shown in chapter 10, and the result was not positive. Conversely, if concern is not shown by the farmers towards the perceptions of agriculture by urbanites and the overseas community, then potential consumers will not buy agricultural produce, based on their perceptions. Farmer consideration of the customers perceptions is very important for the marketing of agricultural produce, as growing environmental awareness amongst society will transfer to their purchasing decisions.

TABLE 9.3 - Attitudinal barriers to the implementation of sustainable agriculture identified by all survey respondents.

	BARRIER	CONVENTIONAL FARMERS	ORGANIC FARMERS	PROFESSIONAL STAFF	TOTAL
1	"Greenies" telling land owners what to do with 'their' land	11	0	0	11
2	"Dictatorial" councils telling land owners what to do with "their" land	3	0	0	3
3	Council plans prohibitive/restrictive	8	0	1	9
4	Costs involved with resource consents	3	0	1	4
5	Pressure groups - such as Greens and Business Round-Table	1	0	1	2
6	Lack of Central Government urgency	1	1	10	12
7	Antagonism between Regional/District Councils and Farmers	3	1	4	8
8	Different levels of enthusiasm amongst farmers	1	0	2	3
9	Antagonism/inequality between rural and urban dwellers	2	0	1	3
10	Pressure from agricultural suppliers and chemical companies	1	1	1	3
11	The belief by land owners that they have the "right" to use their "own" land in whatever way they wish	1	0	4	5
12	Lack of ownership of the problems associated with sustainable agriculture	0	0	11	11
13	Farmers sticking to tradition and unwilling to change/lack innovation in some areas	0	0	16	16
14	Issues involving short-term economics versus long-term ecological sustainability	0	0	14	14
15	Conservative "old guard" in ag. community - views differ from society and even the rest of ag. community	0	0	7	7
16	Some claims by environmentalists lack credibility - discredits other sound claims	0	0	1	1
17	Iwi and Treaty of Waitangi issues	0	0	1	1
18	Inconsistencies between subdivision provisions in District Plans and agriculture in Regional Plans	0	0	1	1
19	Cultural issues	0	0	3	3
20	Lack of environmental/stewardship ethic held by farmers	0	0	7	7
21	Faith in science and technology to solve the problems that face agriculture	0	0	1	1
22	Lack of people able to effectively lead a multi-disciplinary team to solve problems	0	0	1	1
23	Aging farm-population - lack energy to change	0	0	2	2
24	The benefits are to the community, but the costs are born by the farmer.	0	0	1	1
25	Lack of stringent controls for development on marginal land in District/Regional Plans	0	0	1	1
26	Plans that allow residential development on good quality soils.	0	0	1	1
27	Short-term political time-frame - does not encourage long-term change	0	0	3	3
28	Society undervalues food	0	0	1	1
29	Unstable/ and political science funding and research environment - research cannot focus	0	0	2	2
30	Retiring land affects the rural population - cannot find new jobs or alternatives	1	0	1	2

The 'greenies' telling the land owners what to do with 'their' land was quoted by 11 respondents (all of which were conventional farmers). This idea of being told how to manage and farm 'their' land did not meet with approval, judging by the tone of the comments in the responses. Outside influence and control over the farmers is unpopular amongst farmers. Some outside influence may well be inevitable due to consultation in the attempt to define and implement sustainable agriculture debate and the inclusion of community expectations in agriculture. These expectations need to be realistic, otherwise the result will be antagonism between the parties involved and this will achieve little. Cox *et al.* (1988) discussed the pressures between maintaining private property rights, and external control and regulation to achieve desirable environmental outcomes. The private property rights which allow for continued microeconomic sustainability through self-determination and the farm decision-making process. In other cases, issues such as inter-generational equity, and social equity, may require some external influence, either through regulation or education, in order for farmers and other stakeholders to be aware of such issues.

Lack of urgency from Central government was mentioned by 12 respondents (1 conventional farmer, 1 organic farmer, and 10 professional staff). The lack of direction and solutions being offered by central government means that local government has to implement the change. The problem of sustainable agriculture, is that the research required is bigger than most (if not all) councils can address. The costs involved in the research to define or identify issues and parameters will prohibit local government action and thus require central government action.

Antagonism between regional and district council staff, and farmers was mentioned in 8 replies (3 conventional farmers, 1 organic farmer and 4 professional staff). Issues such as plans and rules were mentioned and lack of service provision. One respondent mentioned that he paid a levy to the Regional Council for rabbit control, and he had just carried out some planting for soil conservation purposes, as he considered it was the 'right thing to do' and in line with stewardship. A problem with rabbits eating these seedlings developed, and if he was to take care of the rabbit problem himself, as the council did not, he had to pay for poison licence to do this. He said that it was unsatisfactory to pay for the problem, when he had to carry out the role himself. Situations like this need to be rectified otherwise they cause further antagonism between the farming community and councils, and may hinder participatory approaches from running smoothly and effectively. This is especially the case if the farmer discusses the problems with others (like in this survey) and the public knowledge of the problem becomes widespread. This in turn annoys other members of community, not directly affected by the problem, impacting on their view of the organisation involved.

Lack of ownership of the problems involved with sustainable agriculture by the land managers was mentioned in 11 replies (all by professional staff). The problems/issues involved with sustainable agriculture, once identified, need to be accounted for. Subsequently, some responsibility for the problems needs to be taken by the farmers, if they are to be resolved. Farmers will need to realise that some of the problems/effects of agriculture are of their doing, and action is required on their part to remedy them. Campbell (1989) stated that one of the benefits of the use of Landcare groups in Australia was that the rural community were encouraged to recognise and "own" the land management problems around them.

A barrier outlined in 16 returns (all by professional staff) was farmers sticking to tradition and being unwilling to change. This will be a barrier if new ideas and land-uses are proposed. If a block of marginal land within a farm would be more economic under forestry, it will still require willingness on the part of the farmer to implement the land-use change (assuming he/she has the capital for it). Even smaller changes than land-use, such as modifying production methods still requires innovation and enthusiasm on the part of the farmer if they are to occur.

Issues involving short-term economics against long-term ecological sustainability were quoted on 14 occasions (all professional staff). This major tradeoff is a very real barrier to sustainable agriculture. As mentioned in Section 9.1, the economic barriers to sustainable agriculture need to be addressed. Ikerd (1990, p 23) stated that the tradeoffs made in agriculture will often involve "long-run [ecological] sustainability on the one hand and greater short-run profitability on the other." Ikerd (1990, p 18) also stated that sustainability "by definition, is a long-term concept." The main issue is a short-term versus long-term view. The costs involved in developing the long-term sustainable systems must be accounted for in the short-term through commodity prices (as mentioned in Section 9.1), and this is the real issue with this barrier.

The 'conservative old guard' in the agricultural community was mentioned by 7 respondents (all of whom were professional staff). They noted that these farmers had views that differed from the rest of society, and even the rest of the agricultural community. This conservative group within the agricultural community may have been reflected in some answers to questions in the survey (Figure 6.5 in Chapter 6.2 and Figure 10.10 in Chapter 10.2.6). This group may lack innovation and willingness to change, compared to the rest of the farmers in the agricultural community, and could be more resistant to new ideas and policies.

The lack of an environmental or stewardship ethic held by farmers was noted in 7 replies (all professional staff). The lack of an environmental ethic may make dealing with sustainability issues difficult. The understanding, and enthusiasm to deal with, issues associated with sustainability will be related to the ethic held by the farmers.

The beliefs and attitudes held by farmers affect their behaviour. Ajzen & Fishbein (1977, p 888) stated that the emerging position of social psychology "reaffirms the importance of attitudes" in the relationship between attitude and action. They also stated that attitudes were only one factor in the determination of behaviour, but this nevertheless highlights the importance of attitudes. So an environmental ethic (set of attitudes) will affect the ability of farmers to implement sustainable practices and approaches to agriculture.

9.4 - Institutional and Legal Barriers

All the barriers under this heading that were noted under the question regarding barriers to sustainable agriculture are listed in Table 9.4, with the number of mentions each received. The following discussion surrounds the only barrier that received more than 7 comments by different respondents.

The need for the development of an infrastructure to support sustainable agriculture was outlined in 9 replies (1 conventional farmer and 8 professional staff). The fact that sustainable land-use will require the involvement of many different organisations, gives urgency to the need for inter-organisational cooperation. This includes different government ministries (Agriculture, Forestry and the Environment and Department of Conservation) and councils (various levels). The interaction between all of these, which have their own agendas, will require a 'balancing act'. Then the agricultural companies (suppliers, producer boards, and supporting services) also need to be involved, as sustainable agriculture runs from the farm through to the consumer (a large part exists beyond the farm-gate). The development of this infrastructure will not be very easy and the contacts/networks between all of these stakeholder groups will take time to develop. Developing an infrastructure to deal with all the groups, that have vested interests, will be very difficult, but is required so development towards sustainable agriculture is not 'piece-meal' and solely concentrated with on-farm/productivity issues.

TABLE 9.4 - Institutional and legal barriers to the implementation of sustainable agriculture identified by all survey respondents.

	BARRIER	CONVENTIONAL FARMERS	ORGANIC FARMERS	PROFESSIONAL STAFF	TOTAL
1	How will Sustainable Agriculture be policed and managed?	3	0	1	4
2	Insufficient legal framework to foster an environment for sustainable ag.	2	0	3	5
3	Need structure/infrastructure support sustainable agriculture	1	0	8	9
4	Loss of social and community services in rural areas	1	0	1	2
5	Lack of road maintenance - disadvantages rural areas	1	0	2	3
6	Use of fossil fuels - non-renewable	0	1	0	1
7	Subtle manipulation by money-lenders about using certain types of chemical and practices - farmers cannot change even if they want to	0	1	0	1
8	The current "family-farm" ownership setup - does not allow ease of access to young farmers into the industry	0	0	5	5
9	Self-regulation does not work effectively - will need some regulation and compulsory requirements	0	0	1	1
10	Need a monitoring system	0	0	4	4

9.5 - Physical & Technical Barriers

All the barriers under this heading that were noted under the question regarding barriers to sustainable agriculture are listed in Table 9.5, with the number of mentions each received. The following discussion surrounds the barriers that received more than 7 comments by different respondents.

The lack of alternative pesticides and fertilisers that are acceptable for sustainable agriculture was mentioned on 14 occasions (8 conventional farmers and 6 professional staff). Whether there is a genuine lack of alternatives, or simply a lack of awareness of the available alternatives is probably the issue. The alternative may well vary according to what is stipulated as 'sustainable agriculture.' As in Section C of the Bio-Gro standards of certification (NZBPCC 1994:1, (C)1-4), the pesticides and fertilisers that they consider acceptable according to organic production are laid out. The document outlines a set of inputs which they consider acceptable for their definition of safe and sustainable agriculture. The definition of 'sustainable agriculture' at a national or regional level will need the explanation of what is acceptable and what is unacceptable in terms of practices and inputs (such as pesticides and fertilisers). The organic standards by Bio-Gro have been developed in an attempt to define alternatives. This is a task that would need to be paralleled to implement sustainable agriculture, with alternative inputs/practices that are aligned with the subsequent definition of sustainable agriculture.

TABLE 9.5 - Physical/technical barriers to the implementation of sustainable agriculture identified by all survey respondents.

	BARRIER	CONVENTIONAL FARMERS	ORGANIC FARMERS	PROFESSIONAL STAFF	TOTAL
1	Introduction of "faddish" production systems, such as goats - need more stable systems	1	0	1	2
2	Lack of alternative pesticides & fertilisers that are suitable/acceptable for sustainable agriculture	8	0	6	14
3	There is a need for the use of correct land management practices	1	0	3	4
4	Site-specific circumstances vary - causes problems for implementing change and plans for catchments	1	0	0	1
5	Loss of traditional, pest-resistant species	0	0	1	1
6	Over allocation of resources - water	0	0	1	1

9.6 - Summary of Perceived Barriers

The most frequently mentioned perceived barriers to agricultural sustainability were related to economic issues. Lack of farm income to meet the costs of changes practices or approaches was the most frequently mentioned of all the barriers identified with 62 respondents (27%). Other economic barriers were mentioned, although less frequently, such as produce prices from sustainable sources reflecting costs, loss of short-term production and who exactly bears the costs of implementing sustainable agriculture. These mirror some of the economic barriers, such as Reid & Wilson (1986) who highlighted uncertainties regarding the economic viability of alternative agriculture as an important issue, while MAF (1993a) noted the inadequacy of economic resources available for change, and Ervin & Ervin (1982) noted income constraints on small farms, and debt constraints as potential constraints to adopting conservation practices.

Another group of perceived barriers commonly noted were education related. The need for education and advice was mentioned by 37 respondents (16%). Other related barriers mentioned frequently were the lack of published research, need for general attitudinal change, lack of research relating to implications of sustainable agriculture, lack of knowledge of issues by farmers, the need for consultation, and the lack of networks between councils and farmers to disseminate pertinent information. The education barriers, like the economic barriers, were also frequently mentioned in the literature regarding sustainable agriculture. Reganold *et al.* (1990), MAF (1993a) and Blobaum (1983) all noted the lack of information was a barrier to adoption of more sustainable agriculture.

Attitudinal barriers were also noted with some regularity, although not as frequently as those regarding economic and education issues. The barriers mentioned included the lack of ownership of problems associated with agriculture, antagonism between environmentalists and farmers, lack of Central government urgency, farmers sticking with tradition/unwilling to change and considerations of short-term economics against long-term ecological issues differing between stakeholders. MAF (1993a) stated that there was an element to the community that failed to accept the need for change to sustainable agricultural practices. Reid & Wilson (1986) noted the attitudes and apprehensions of landowners, and government workers was a barrier. Ervin & Ervin (1982) noted that the need to forego short-term income for uncertain (long-term) benefits and farmers unwilling to change familiar practices as potential barriers.

Barriers relating to the institutional framework required for implementing sustainable agriculture were noted less frequently than the aforementioned barriers. These barriers related to the development of the infrastructure required for sustainable agriculture, legal framework issues, and the current family-farm setup. Blakeley (1990a) highlighted the need for an distribution system for organic produce as a barrier for future increases in New Zealand production. Fisher & Tilbury (1990a) noted the lack of coordination and infrastructure in the New Zealand organic food industry as a barrier to growth.

The barriers relating to technical and physical issues were, overall, the least frequently mentioned. The main barrier in this group was the perceived lack of alternative pesticides and fertilisers acceptable for sustainable agriculture. Reganold *et al.* (1990) highlighted the need for information on sustainable agriculture for farmers as a barrier.

Chapter Ten
Implementation Methods for Achieving Sustainable Agriculture

The survey respondents were queried on the level of agreement they had with the use of eight implementation methods that could be used to achieve sustainable agriculture. All of the potential methods for achieving sustainable agriculture queried for approval by the respondents to the survey, are shown in Table 10.2. The table shows the F-Ratios and levels of significance between the responses of approval and disapproval to the methods and the demographic details of the respondents. The following is a short justification for the methods chosen and the questions used, and a brief description of the methods.

10.1 - Justification And Description of Implementation Methods

The implementation methods used in the questions were deliberately general, and very much generic in nature. Defining specifics for these would be impossible within the scope of the survey, and the planning responses that would be applied to achieve sustainable agriculture would be tailored to the site-specific circumstances within a region, catchment or farm. The stating of what exactly are 'desirable practices' and the levels of rates rebates is not what the questions were designed for, and anyway, these are not for me to define. These will need to be determined to suit the site-specific requirements in the agricultural sector (Section 2.1).

The general level of agreement with the principle of these implementation methods was all that was sought within this survey. The eight particular implementation methods were based on comments within the literature reviewed for this thesis. The eight implementation methods and the authors who commented on their use are shown in Table 10.1.

The implementation methods and instruments implemented will need to be sound and effective in order to achieve policy objectives according to Sharplin (1987), and this is definitely the case with sustainable agriculture. A combination of the methods will be needed to achieve both the short- and long-term change required for increased agricultural sustainability.

A brief explanation of each of the eight implementation methods follows.

TABLE 10.1 - References for the eight implementation methods queried

NO.	METHOD	REFERENCES	
1	Pollution Charges	BUTTEL (1993, 183) MAF (1993a, 15)	SHARPLIN (1987, 8)
2	Subsidies for desirable practices, taxes for undesirable practices.	IUCN et al. (1991, 117) MAF (1993a, 15) REGANOLD et al. (1990, 121)	SHARPLIN (1987, 7) SHORTLE & DUNN (1986) WILLIAMS, J (1990, 29)
3	Grants	SHARPLIN (1987, 6)	
4	Income tax deductions or rebates.	MAF (1993a, 15) SHARPLIN (1987, 6)	WILLIAMS, J (1990, 29)
5	Rates rebates	SHARPLIN (1987, 6)	
6	Regulation	IKERD (1990, 21) IUCN et al. (1991, 116) LOWRANCE (1990, 52)	MAF (1993a, 15) SCHALLER (1990, 12) SHARPLIN (1987, 3)
7	Education	BROWN (1989, 99) CAMPBELL (1989, 19) CAMPBELL & JUNOR (1992, 21) CARY et al. (1993, 44) EDWARDS & WALI (1991, xii) FRANCIS (1989, 41) KEENEY (1993, 805) LUCKMAN (1994, 10)	MAF (1993a, 14) REGANOLD et al. (1990, 120) SHARPLIN (1987, 4) STENHOLM & WAGGONER (1990, 14) SWAMINTHAN (1991, 246) TURKINGTON (1991, 171) WILLIAMS, J (1990, 29)
8	More research	BARR & CARY (1992, 110) BATIE & COX (1994, 460) BRADY (1990, 31) BROWN (1989, 99) BUTTEL (1993, 183) CAMPBELL & JUNOR (1992, 21) CAMPBELL (1989, 19) DAHLBERG (1991, 338)	EDWARDS & WALI (1993, xii) IKERD (1993, 159) LEFROY & HOBB (1992, 23) MAF (1993a, 14) REGANOLD et al. (1990, 12) STENHOLM & WAGGONER (1990, 14) SWAMINATHAN (1991, 246) TAYLOR (1990, 46)

1 - Pollution Charges

The use of charges for the emission of agricultural pollutants could be used to lower this type of practice and it's adverse effects. The idea driving pollution charges Sharplin (1987, p 8) stated is that "because people do not pay for the right/opportunity to pollute as they do for other goods and services (such as raw materials and labour) there is no incentive to control their emissions." The 'polluter-pays' approach aims to halt adverse effects by attaching a financial penalty to the practice, and this penalty illustrates to the polluter, that there are costs associated with the pollution. To be effective the penalty needs to be high enough to make alternative costs of implementing a system to treat/recycling the pollutant, seem attractive. If the pollution charge is nominal, then it provides no incentive to change to practices that avoid the pollution. The pollution charges rather than a revenue source to the organisation to whom it is paid, should be an interim method. The exact level at which the charges are set could prove a problem, as it represents a value being placed on the environment to which the pollutant is discharged. This value may well not please all involved, as it may be too high for polluters and too low for other members of society those who use that environment, such as downstream users of waterways.

2 - Subsidies for desirable practices, taxes for undesirable practices

Although subsidies are not permitted under the new GATT agreement, until the real social and environmental costs of agriculture are met, it is effectively subsidised, with these costs born by future generations and the environment. The provision of cheap plant materials for soil conservation works or windbreaks, or free information/advice from council staff, provides a subsidised source of aid, to enact practices that are deemed desirable in that particular region. The use of taxes on undesirable practices can be used to financially penalise those farmers whose practices are deemed undesirable. The comparison between the desirable practices that are subsidised and the undesirable practices that have taxes attached to them, could highlight for the rural community, the changes in practices that are required to achieve agricultural sustainability. The comparison could provide a present state and ideal end-state to give direction to the changes in agriculture that local government and central government agencies desire. A problem with subsidies according to Sharplin (1987) is that they may pay for something people will do anyway, nullifying any direct response that could be attributed to the expenditure. In the case of sustainable agriculture the subsidies would be clearly targeted at practices and activities that are not occurring at present, and are not likely to occur until the economics of the change in practices appears more attractive.

3 - Grants

The provision of grants for the adoption of sustainable practices on farms could be undertaken in some instances. The use of grants can be seen as a 'hand-out', which may not be popular with the organisations giving the grant or the farmers receiving them (as they may not like receiving hand-outs). Attaching accountability to achieve end-results, like increased environmental quality, may be difficult as once the grant is made, retrieving the costs may be difficult. Benefits of the direct subsidies like grants according to Sharplin (1987, p 6) is that they are "explicit and able to be reviewed, - able to be better targeted, - [and] their cost is known." The effectiveness of the first grants can help assess whether further grants are worthwhile, and these can be targeted at specific agricultural practices and desired end results.

4 - Income tax deductions or rebates

The provision of tax rebates that could be claimed on farm earnings that involved practices that were sustainable could provide an economic incentive to change and make alternative agricultural approaches appear more attractive financially. The consideration of the environmental benefits of alternative agriculture need to be reinforced by economic recognition of these benefits. This is the opposite of the taxes applied to undesirable practices, which are a disincentive to use unacceptable practices. A problem with tax deductions is that they require constant review, as Sharplin (1987) commented that they are eroded in value over time by economic growth and inflation. To maintain their value and financial attractiveness, they will need revision to keep their value high enough to provide an incentive.

5 - Rates rebates

This is similar to the above, but reflects payment to local authorities (in the form of rates), as opposed to central government (in the form of taxes). The method would involve different rating levels for different agricultural land-uses, such as land retirement, minimising agricultural inputs, and alternative or organic agriculture, for example. Land retirement receiving rate relief has occurred in the past, but this could be extended to include other land practices, such as input minimisation. The use of streamside riparian planting or other practices resulting in beneficial agricultural outcomes could also receive lower rating levels. A problem would arise surrounding the complexity of the rating relief and placing values on practices, and particularly some practices over others. Which practices deserve greater rating relief and economic incentives than others? The political ramifications of this could make their generation difficult.

6 - Regulation

This involves the direct control of activities in agriculture through the use of rules in a plan or laws against the use of certain agricultural inputs. The use of resource consents for certain activities, or attaching conditions to these consents to avoid adverse environmental effects, could aid the achievement of beneficial outcomes. Setting laws for achieving outcomes has received lesser emphasis in recent years, with this type of interventionist approach less consistent with current political and economic thought. Regulation is still required, but the introduction of other options is often considered. Sustainable agriculture is not a static state and according to Keeney (1993), our view of sustainable practices will change. Rodale (1990) stated that the argument sustainable agriculture may never end, and thus any regulation will need to change to match our changing views. Changing the regulations regarding sustainable agriculture to meet our changing views and ideals, could be time consuming and expensive.

7 - Education

The use of education and information provision to the agricultural community regarding sustainability issues is increasingly used. Sharplin (1987, p 5) termed this 'moral suasion' and went further to state that education "should not be underestimated as a means of achieving environmental objectives." The Land Care type of approaches, involving extension research tailored to the agricultural community for which the information is required, is increasing in its application. When the rural community is involved in the identification and measurement of the sustainability issues, they are more likely to take 'ownership' of the problem and get involved in the resolution of the problems. The Land Care type of method is long-term, with many years taken to reap maximum benefits. The use of education can aid the generation of a greater environmental ethic amongst farmers, a longer-term time frame in their views and greater awareness of sustainability issues.

8 - Further research

More knowledge about the characteristics, and indeed the definition, of sustainable agriculture is required. The lack of information about the exact adverse effects of current agricultural practices and the advantages and economics of possible alternatives to conventional agriculture are needed. The research could be undertaken as a part of an education programme, or required for an education programme. Research that shows the environmental social, and economic advantages/ disadvantages of current agriculture and alternatives would be useful to highlight the choices that face farmers. What research is required, to what levels, about which topics is an important consideration, as the Vote: Research, Science and Technology is limited and any funds available for research is also limited. A mix of short- and long-term research is required to give a mix of results over the short- and long-term, to allow some action to occur now. Inaction until long-term studies are completed will only exacerbate any environmental problems that are sourced from agriculture.

TABLE 10.2 - F-ratios and levels of significance for responses to questions on planning methods by all respondents.

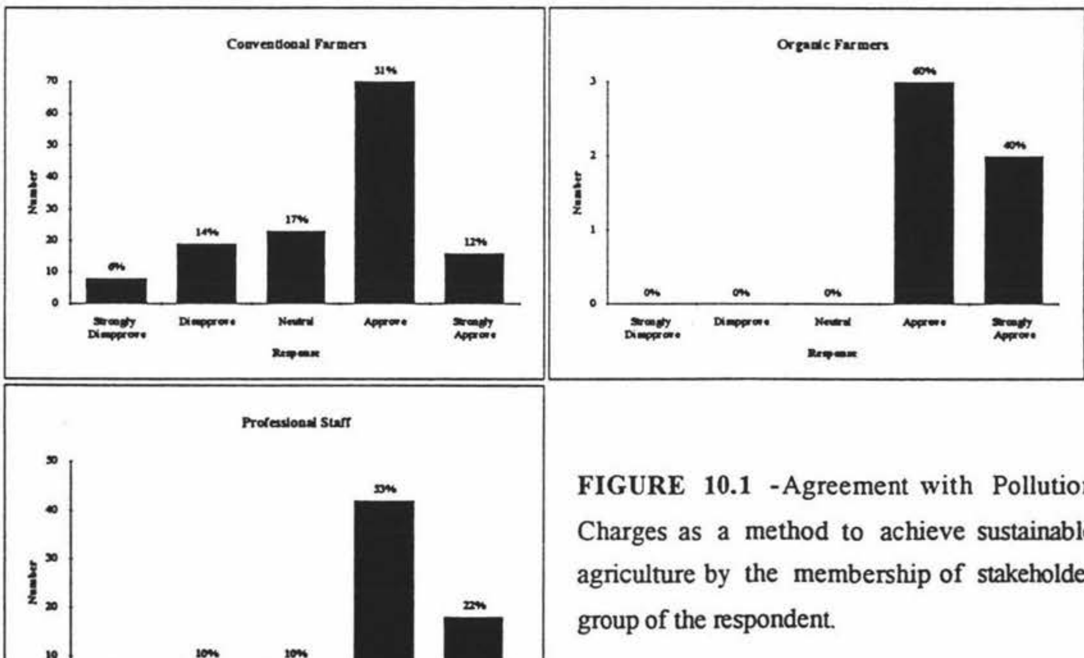
	Question	Age		Education		Farm-Type		Farm-Size		Professional Affiliations		Stakeholder Group		Gender	
		<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05	<0.10	<0.05
1	Pollution charges		F=4.80 p=0.0010										F=3.21 p=0.0422		
2	Subsidies for desirable practices, taxes for undesirable practices.									F=1.99 p=0.0808			F=3.19 p=0.0430		
3	Grants														
4	Income tax deductions or rebates	F=2.27 p=0.0632			F=5.23 p=0.0001								F=16.32 p=0.0001		
5	Rates rebates			F=1.79 p=0.0816									F=4.12 p=0.0175		
6	Regulation		F=4.55 p=0.0015		F=3.41 p=0.0011	F=1.93 p=0.0527			F=2.62 p=0.0386				F=14.22 p=0.0001		
7	Education		F=2.92 p=0.0221		F=2.47 p=0.0147								F=14.26 p=0.0001		
8	Further research					F=1.78 p=0.0789									

10.2 - Analysis of significant responses to implementation methods

The following discussion covers the relationships between the level of agreement with the implementation methods and the demographic attributes of the respondents found to be significant by the statistical analysis. All of the potential methods for achieving sustainable agriculture queried for approval by the respondents to the survey, are shown in Table 10.2. The table shows the F-Ratios and levels of significance between the responses of approval and disapproval to the methods and the demographic attributes of the respondents.

10.2.1 -Pollution Charges

The favourability of pollution charges by the respondents had membership of stakeholder group as a strong determinant of the response (F=3.21, ρ=0.0422). The mean response by the organic farmers (4.40) was considerably higher than both the conventional farmers (3.49) and the professional group (3.78). Figure 10.1 below shows the distribution of the responses for the three stakeholder groups.



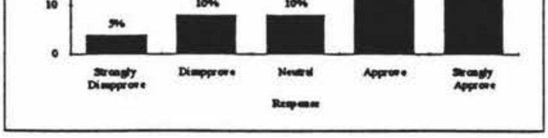


FIGURE 10.1 -Agreement with Pollution Charges as a method to achieve sustainable agriculture by the membership of stakeholder group of the respondent.

The distribution of the responses for the professional staff and the conventional and organic farmers as can be seen in Figure 10.1. The number of professional staff who disapproved with the use of pollution charges (5% Strongly Disapproved and 5% Disapproved) was less than the conventional farmers (7% Strongly Disapproved and 14% Disapproved). A similar number Approved with the use of Pollution Charges for the stakeholder groups (51% of conventional farmers, 60% of organic farmers and 53% of professional staff). The number of respondents in each stakeholder group that Strongly Approved of the use of pollution charges (12% of conventional farmers, 40% of organic farmers and 22% of professional staff), was the major cause for the variations in mean responses between the stakeholder groups.

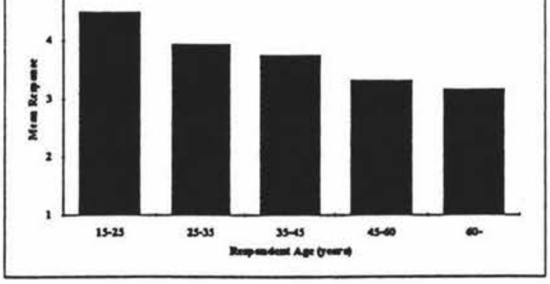
The reason for the higher mean response by the organic farmers could be that they consider the levels of pollution they produce are not significant and therefore they would not be penalised by pollution charges. They may also consider that the environmental costs of agriculture (such as pollution) need to be accounted for and the use of pollution charges would be a good method for achieving this.

The conventional farmers were least in favour of the use of pollution charges, and this could be that they prefer the 'hands-off' or the 'carrot' as opposed to the 'stick' (some farmers quoted the hands-off approaches are better and would be better received). The use of pollution charges being the interventionist, use of 'stick', which has lost favour.

The professional group had a mean response between these two farmer groups. The 'mix' of occupations and viewpoints of the respondents in the professional staff group would create a response that is less extreme then the two farmer groups. The respondents included scientists, council staff, educationalists and industry personnel. These all view agriculture and the environmental impacts it causes, from different views. The resulting responses to the need for pollution charges, would therefore also vary, depending on the view of the respondent (variation could occur between, for example, an industry representative or environmental planner for a regional council).

Approval of the use of pollution charges were also significantly correlated to the age of the respondent ($F=4.80$, $\rho=0.0010$). Figure 10.2 below shows the mean responses for the age groups covered in the survey.

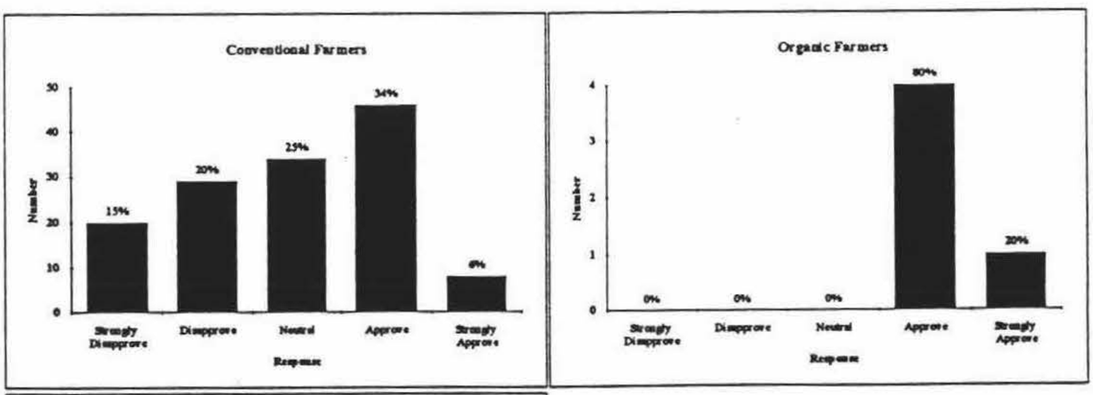
FIGURE 10.2 - Mean response for approval of Pollution Charges as a method to achieve sustainable agriculture by age of the respondent.



A very clear negative relationship exists between the age of the respondent and the favourability of pollution charges. As the age of the respondent increases, the level of approval for the use of pollution charges decreases. This could be explained by the younger respondents realising that the costs of environmental degradation must be accounted for and charges might dissuade polluters from continuing practices that cause adverse effects. The older respondents may not respond as favourably to such ideas, which are new and innovative ('polluter-pays' principles aligned with current market-led economics - equivalent to the concept of 'user-pays'), as these types of measures have not been used or promoted heavily in the past. The older respondents may not wish to the bear the costs, when they may not see the results of lowered pollution levels in their lifetime. The older respondents may favour the other 'hands-off' approaches, such as education (although they are less agreeable with these also, than the younger groups - as can be seen in the graphs and discussion later in this chapter).

10.2.2 - Subsidies for desirable practices, taxes for undesirable practices.

The subsidies/taxes method had the membership of stakeholder group of the respondent as a strong determinant of the response in level of approval (F=3.19, ρ=0.0430). Figure 10.3 below shows the distribution of responses by each of the stakeholder groups. Just what is "desirable" and "undesirable" would have to be determined by each region or even at a farm-scale, but it was the principle that was being tested here.



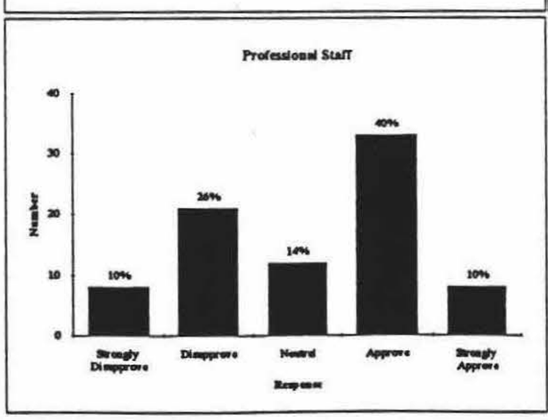


FIGURE 10.3 -Agreement with Subsidies for desirable practices, taxes for undesirable practices as a method to achieve sustainable agriculture by the membership of stakeholder group of the respondent.

The mean for the conventional farmers was 2.95, the professional group had a slightly higher mean of 3.15 and the organic farmers had a mean of 4.20.

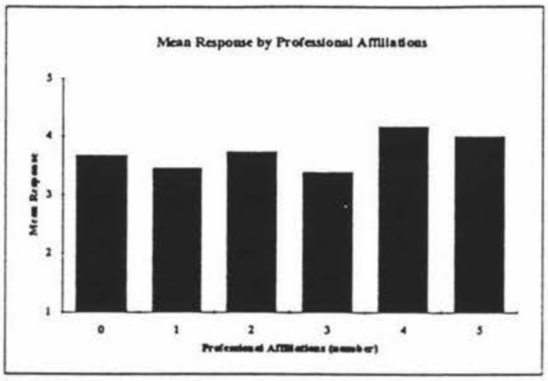
The conventional farmers had the lowest mean. Although 34% of the farmers 'Approved' of this method, 20% 'Disapproved' and a further 15% 'Strongly Disapproved' of the method. A number of comments were made by the farmers as "to who would decide what are 'desirable' and 'undesirable' practices". So some resistance could arise to this approach due to the fear that an urban bias could be placed on the standards, that are unrealistic for achievement as far as the farmers are concerned and this could disadvantage agriculture. Again, like some responses to questions in Chapter 6, there is a 'conservative' grouping within the conventional farmers, that tends to disagree with the sentiments shown by other members of the sample. The independence some farmers desire in the running of their properties may be evident in these answers also, as they do not want to be taxed for practices deemed as 'undesirable', especially when they are wary as to who decides what is in fact 'undesirable.'

The professional group had a higher mean, but although 40% responded with 'Approve', 26% 'Disapproved' of the practice. The two distinct groupings of response in this stakeholder group, as Figure 10.3 clearly shows, has lowered the mean. Again, the diversity of respondents surveyed in this group could explain the two groupings. There could also be two views about the use of subsidies to achieve sustainable agriculture. Those respondents who take the market-led ideology may think that no economic intervention, through the use of subsidies is required. Other respondents may think that some financial assistance for the farmers is required, to allow the implementation of any costly changes to agricultural practices or environmental protection works on the farms.

The organic farmers had an even higher mean, at 4.20, which shows a very high level of agreement. They may feel that financial penalties and incentives could best achieve change, as education and self-regulation are 'soft', and will not achieve sustainable agriculture. Sterner action (like financial penalties born by farmers who undertake undesirable practices) is required. Alternatively, they may feel that their current practices would be deemed desirable. Thus they would not be penalised by these types of measures, and may even receive financial rewards through the subsidies offered for the desirable practices.

The response to the subsidies and taxes method was also moderately correlated to the number of professional affiliations held by the respondent ($F=1.99$, $\rho=0.0808$). Figure 10.4 overleaf shows the mean response for each level of professional affiliations held.

FIGURE 10.4 - Mean response for approval of Subsidies for desirable practices, taxes for undesirable practices as a method to achieve sustainable agriculture by the number of professional affiliations held by the respondent.



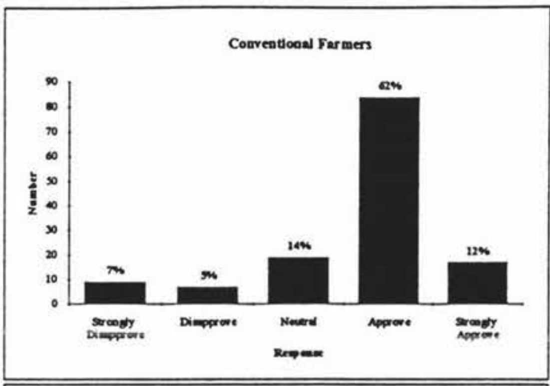
In the case of 4 and 5 professional affiliations, the responses are definitely higher than those with lesser affiliations, although the mean values for the lesser numbers did fluctuate. The level of information received by those with more professional affiliations is higher, and can affect responses to issues relating to these affiliations, such as these methods to agriculture. The overall relationship is a slight positive one, if a line-of-best-fit is placed through the graph. As the number of affiliations increases, the approval of subsidies/taxes method increase slightly. Korsching *et al.* (1983) proposed that the number of professional affiliations held by a respondent, indicates the level of participation they have in their industry, which in turn affects their level of innovativeness. The respondents with a greater number of professional affiliations in this case, could hold the view that financial incentives and disincentives are required for the implementation of sustainable agriculture on New Zealand farms.

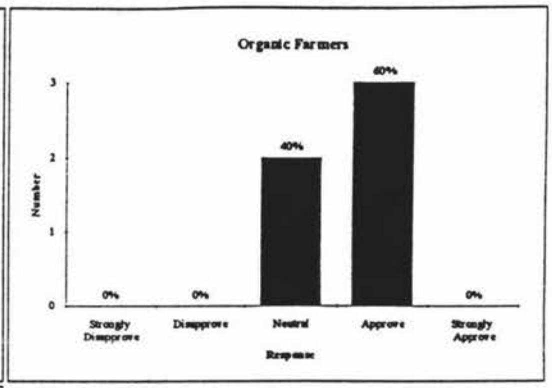
10.2.3 -Grants.

As shown on Table 10.2, there were no significant relationships between the responses and the demographic attributes of the respondents. The mean responses for grants compared to the other implementation methods covered in the survey are covered in Section 10.2.9, at the end of the chapter to highlight the overall favourability of the different methods.

10.2.4 -Income tax deductions or rebates.

The approval of 'Income tax deductions or rebates' as a method to achieve sustainable agriculture had membership of stakeholder group of the respondent as a very significant determinant ($F=16.32$, $\rho=0.0001$). Figure 10.5 overleaf shows the distribution of responses each of the stakeholder groups.





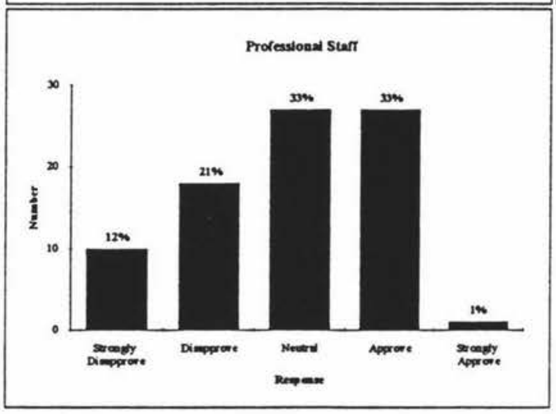


FIGURE 10.5 - Agreement with Income tax deductions or rebates as a method to achieve sustainable agriculture by the membership of stakeholder group of the respondent.

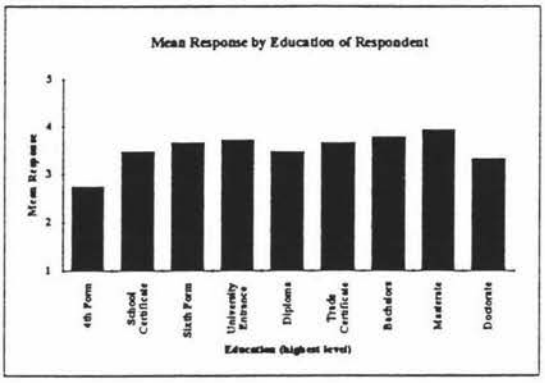
The means of the organic and conventional farmers were similar at 3.60 and 3.68 respectively. Of these two groups, 60% of organic farmers and 62% of conventional farmers responded with 'Approve'. A further 12% of conventional farmers responded with 'Strongly Approve'. The professional group were less enthusiastic about this method than the two farmer groups, with a mean of 2.89. Although, 33% responded with 'Neutral' and a further 33% responded with 'Approve', 21% responded 'Disapprove' and 12% 'Strongly Disapprove'.

The high mean responses for the conventional and organic farmer stakeholder groups may indicate that some economic incentive, such as income tax deductions are justified in return for more sustainable agricultural practices. Lowering the tax paid by farmers that practice sustainable methods would appear very popular amongst the rural community at the 'coal face' (in this case the farmers). Whether the approach would achieve change or the costs associated with lowering the tax rates for farmers is another issue.

Figure 10.5 above clearly shows that this method was not ideal as far as the professional group was concerned, with many responding negatively. The tax deduction approach could be perceived as inappropriate as it means a loss of income for central government, and may also be seen as 'interventionist' which is not in favour at present. The loss of tax revenue for the environmental outcomes achieved may also select against this method amongst the professional staff surveyed.

The response to the income tax deductions/rebates method was also very strongly correlated to the level of education received by the respondent ($F=5.23$, $\rho=0.0001$). The basic trend, as shown in Figure 10.6 overleaf, is that as the highest level of education held by the respondent increases, the approval of this method increases.

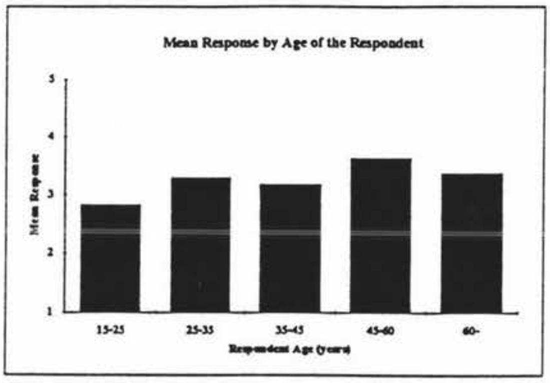
FIGURE 10.6 - Mean response for approval of Tax deductions or rebates as a method to achieve sustainable agriculture by highest level of education achieved by the respondent.



The graph shows a positive relationship between the highest level of education achieved by the respondent and their level of agreement with tax deductions/rebates. There are a few exceptions to this trend with the PhD respondents having a slightly lower level of agreement than the trend would indicate. The low number of respondents with a PhD qualification may cast doubts on the statistical validity of the response. As a general rule, as the level of education increases, the perception by the respondent that some financial incentive is required to enact some sustainable agricultural practices also increases. This cannot be explained by the analysis in Appendix D between education and stakeholder group. As the more highly educated respondents are sourced, in the larger part, from the professional group, they would be expected to be less in favour with this implementation method as was shown in Figure 10.5. These more educated members of the professional group may be more in favour with the use of subsidies/taxes than their lesser educated colleagues. The increased education that they received may tell them that some sort of economic incentive is required, especially to address the perceived economic barriers outlined in Chapter 9, as the education methods are unlikely to address these barriers in the short-term.

The response to the question about the approval of tax deductions/rebates also had the age of the respondent as a moderate determinant ($F=2.27$, $\rho=0.0632$). A weak relationship can be seen in Figure 10.7 overleaf, between age and the favouritism towards the use of tax deductions. As age increase, the favourability of tax deductions also increases, a slight positive relationship.

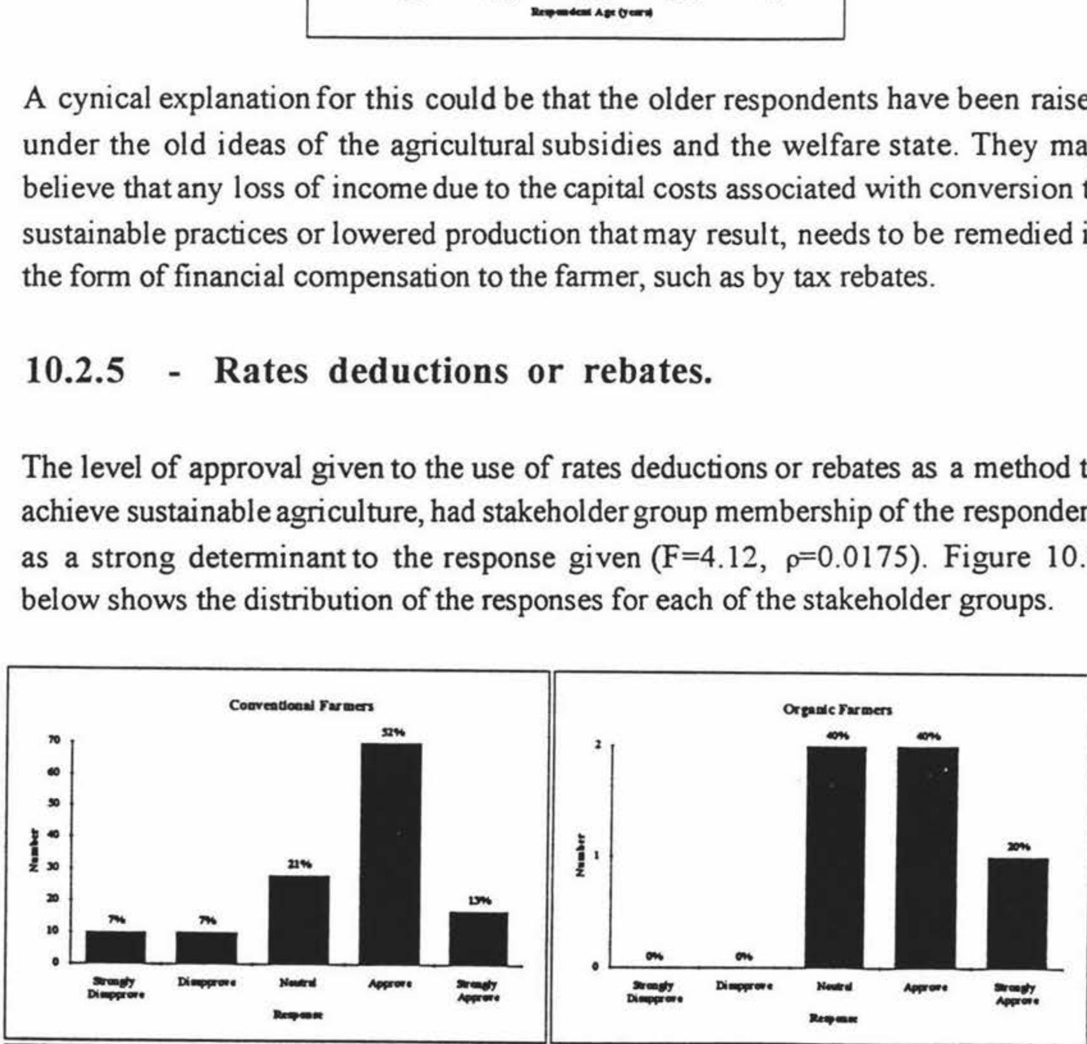
FIGURE 10.7 - Mean response for approval of Tax deductions or rebates as a method to achieve sustainable agriculture by age of the respondent.



A cynical explanation for this could be that the older respondents have been raised under the old ideas of the agricultural subsidies and the welfare state. They may believe that any loss of income due to the capital costs associated with conversion to sustainable practices or lowered production that may result, needs to be remedied in the form of financial compensation to the farmer, such as by tax rebates.

10.2.5 - Rates deductions or rebates.

The level of approval given to the use of rates deductions or rebates as a method to achieve sustainable agriculture, had stakeholder group membership of the respondent as a strong determinant to the response given (F=4.12, ρ=0.0175). Figure 10.8 below shows the distribution of the responses for each of the stakeholder groups.



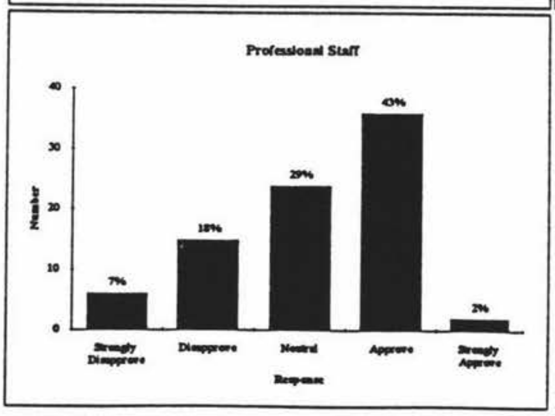


FIGURE 10.8 - Agreement with Rates deductions or rebates as a method to achieve sustainable agriculture by the membership of stakeholder group of the respondent.

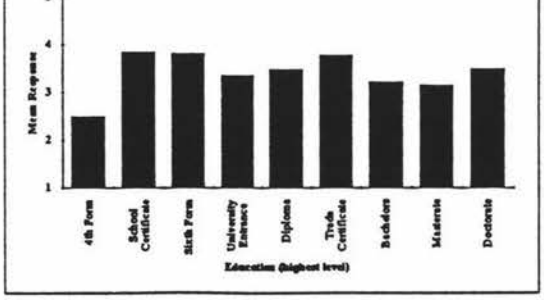
The two farmer groups were more favourable for this approach, than the professional group, with means of 3.55 and 3.80 for the conventional and organic farmers, respectively. Of the conventional farmers, 52% responded with 'Approve' and 13% with 'Strongly Approve'. Of the organic farmers 40% responded 'Approve' and 20% with 'Strongly Approve'.

The conventional and organic farmer groups obviously feel that rates for land retired from use or placed under some other sustainable practice, which results in better environmental outcomes, should be given a lower rate charge by the council. The farmers obviously reflect how their behaviour should be rewarded, in the answers they give. So some sort of 'carrot' may need to be used and obviously would be well received by the farmers. As the farmers will bear the financial costs associated with changes in practices, they obviously feel that some sort of financial reward for this change is required.

The professional group had the lowest mean, at 3.15. Again, like income tax deductions, this method could be seen as 'interventionist' and could result in lost revenue and income for the councils (whose staff make up a large part of this stakeholder group). They could also consider that the use of rates rebates will work, and could be very expensive for the resulting direction towards sustainable agriculture achieved, and be merely an expensive handout to the farmers.

The response to the question on approval of rates deductions or rebates to achieve sustainable agriculture was moderately correlated to the level of education of the respondent ($F=1.79$, $\rho=0.0816$). Figure 10.9 below shows the relationship between education and mean response given for the rates deductions and rebates method.

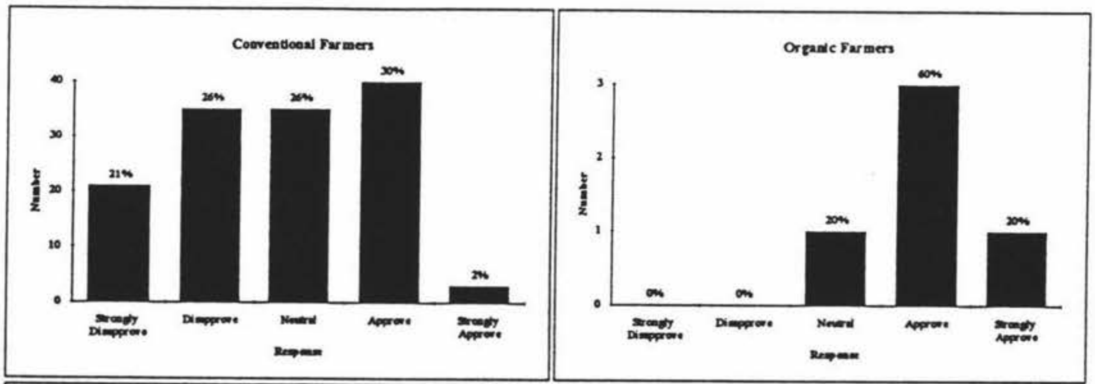
FIGURE 10.9 - Mean response for approval of Rates deductions or rebates as a method to achieve sustainable agriculture by highest level of education achieved by the respondent.



The pattern is not entirely clear, but it basically mimics the responses by the stakeholder groups. The lower levels of education have a higher mean response, and these are mainly the farmer respondents, who as shown in Figure 10.8, were more keen on the rates rebates than the professional staff. The professional staff, who have higher levels of education as covered in Appendix D, are less enthusiastic about rates rebates. This is reflected by the higher education levels (tertiary level qualifications) in the graph, which have lower means. The level of significance is 0.08, or 8%, so the result is not as statistically significant as others covered here, and the results shown in Figure 10.9 are not 'water-tight.'

10.2.6 - Regulation.

The stakeholder group of the respondent was a very strong determinant for the response to Question 6 about the use of Regulation to achieve sustainable agriculture ($F=14.22$, $\rho=0.0001$). Figure 10.10 below shows the distribution of the responses by each of the stakeholder groups.



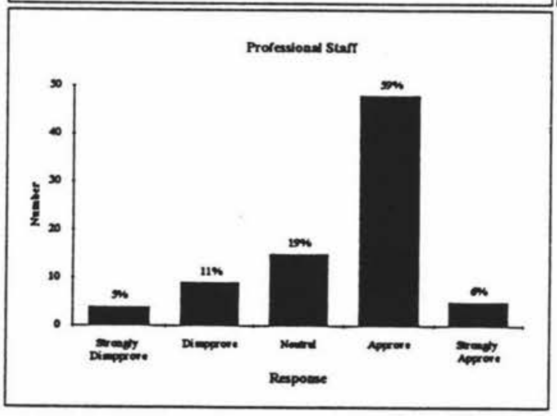


FIGURE 10.10 - Agreement with Regulation as a method to achieve sustainable agriculture by the membership of stakeholder group of the respondent.

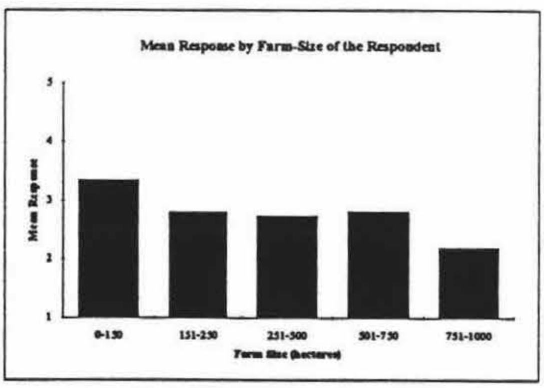
The mean for the conventional farmers was the lowest at 2.78. Of the respondents, 30% approved of regulation, 26% were neutral and 26% were disapproved and 16% strongly disapproved. Figure 10.10 shows, there is no single 'peak' in the distribution of the conventional farmer sample, as the results for Disapprove, Neutral and Approve, were all quite similar. But due to the numbers that disapproved and strongly disapproved, the mean was 2.78, which fell below 3.00, reflecting less than neutral overall. Again, this could be due to a 'conservative' faction within the agricultural community, or a general resistance to such 'interventionist' approaches by local and central government.

The professional group had a mean of 3.51, with 59% approving of regulation. Of the remaining respondents, 19% were neutral, 6% strongly approved, 11% disapproved, and 5% strongly disapproved. Obviously, a large amount of this sample believed that some sort of regulation was required, in at least some instances, in order to achieve sustainable agriculture. Many of the respondents come from occupations that implement regulatory responses to such land-uses such as agriculture, and would therefore have some level of approval for their use. These interventionist approaches are receiving less favour, and the mean level of agreement at 3.51 is not particularly high, so they may consider that the use of other implementation methods could also be required (see Section 10.2.9).

The organic farmers had the highest mean at 4.00. The respondents were either neutral (20%), approved (60%) or strongly approved (20%). The strong level of approval could be explained by the idea that any regulation would not impinge greatly on the organic farmers, as their standards are often more stringent than the national ones, such as residue levels at 10% of New Zealand or United States levels (NZBPCC 1994:1, (C)26). Although their standards are superseded of course by the laws of the land, and this is recognised in their standards (NZBPCC 1994:1, (A)2), and thus are moving standards and targets. Conversely the organic farmers could approve of regulation to achieve sustainable agriculture, as they consider it a better method to achieve some to agricultural practices. Especially in the case where self-regulation and other 'hands-off' approaches, such as education will not achieve the required results.

The farm-size of the respondent was a strong determinant in the response to regulation as an implementation method (F=2.62, ρ=0.0386). Figure 10.11 below shows the mean responses for each of the farm-size classes.

FIGURE 10.11 - Mean response for approval of Regulation as a method to achieve sustainable agriculture by farm-size of the respondent.

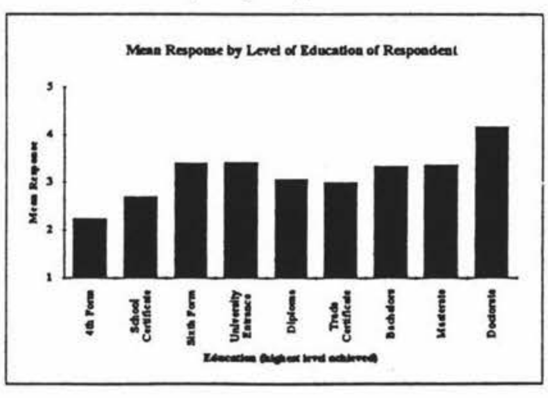


Respondents with the smallest farms-sizes were most positive about regulation (with 0-1560 ha having a mean of 3.35). The largest farm-sizes, that is 751-1000 ha, had land managers that were in least agreement with regulation, with a mean of 2.20. The farm-sizes between had a general decreasing trend. The farmers with the largest farms would appear to favour greater autonomy of their land, and less control by central and local government. They may feel that any regulation would unfairly affect them, due to the expanse of land they cover, and the scale of effects that changes in regulation could have on them, economically. These respondents with the larger farms could be described as the 'landed gentry' and could be more traditional in their views on implementation methods, and not in agreement with regulation and intervention.

The response to regulation was also moderately correlated to the farm-type of the respondent ($F=1.93$, $\rho=0.0527$). The sheep farmers mean was 2.88, cattle farmers responded with a mean of 3.14 and sheep/cattle farmers' mean was 2.78. Farm-type could be equated to work-environment, and these more traditional and conservative farm-types could reflect similar views from the farmers. The responses from the sheep/cattle/deer farmers was lower at 2.46. The reason for this is difficult to fathom, as the analysis in Appendix D regarding interrelationships between demographic attributes, would give no clues to this lower figure for the sheep/cattle/deer farmers. The greater investment they have in their farming operation could explain any resistance to regulation that may affect it. The increased levels of inputs used in deer farms, over other farm-types could place threats on it from any potential regulation regarding these inputs and their effects. The more mixed farming operations responded with higher means, between 4.00 and 5.00. These respondents could be a little more 'open-minded' to the implementation methods in comparison to the more conservative groups discussed above.

The level of education attained by the respondent was also a significant determinant in the response to regulation ($F=3.41$, $\rho=0.0011$). Figure 10.12 below shows the relationship between education and favourability of regulation as an implementation method to achieve sustainable agriculture.

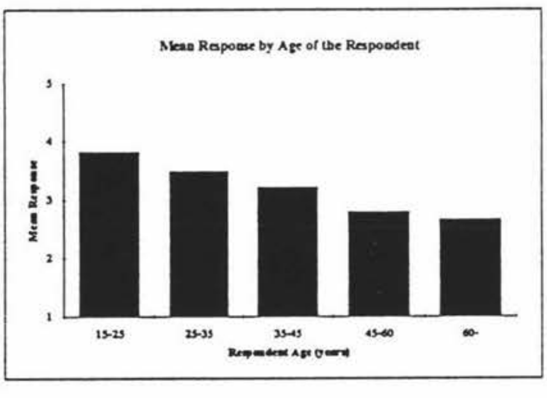
FIGURE 10.12 - Mean response for approval of Regulation as a method to achieve sustainable agriculture by highest level of education achieved by the respondent.



The general trend in Figure 10.12 is a positive one, with approval of regulation increasing as the level of education held by the respondent increases. The exception (again) is at Diploma and Trade Certificate area, where the approval level falls, as can be seen on Figure 10.11. The variation could be explained by the fact that many of those with lower levels of education are farmer respondents, and the higher levels are mostly the professional group. Therefore the stakeholder group membership comes into play - as previously mentioned, the professional group are more in favour with this method, than the farmers. So the higher levels of education should be more in approval, and this is the case. The PhD respondents had the highest level of approval, with a mean of 4.17, and these were mainly the academics and scientists. The research they undertake and their experience may tell them that regulation is required.

The age of the respondent is also strongly correlated to the reaction to regulation as a method ($F=4.55$, $\rho=0.0015$). Figure 10.13 below shows the relationship between the age of the respondent and the level of agreement with regulation as an implementation method.

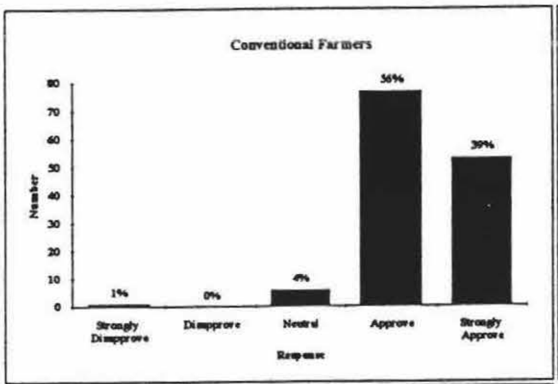
FIGURE 10.13 - Mean response for approval of Regulation as a method to achieve sustainable agriculture by age of the respondent.

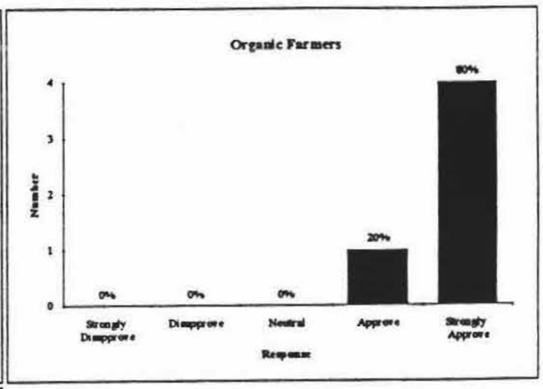


So as Figure 10.13 clearly shows, as the age of the respondent increases, the level of approval of regulation decreases. The analysis and discussion in Appendix D illustrates the higher than expected number of older respondents in the conventional farmer sample, and less than expected numbers of professional staff in the older groups. The older respondents reflect the conventional farmer stakeholder group, and would be less keen on regulation and intervention by the councils and central government (as mentioned previously in Figure 10.10). The younger respondents were plainly more enthusiastic about the approach, and were mostly recent graduates from university. The education they receive for their field may influence their response to the question.

10.2.7 - Education.

The responses to education as a method to achieve sustainable agriculture had membership of stakeholder group as a very strong determinant (F=14.26, ρ=0.0001). Figure 10.14 overleaf shows the distribution of the responses by the stakeholder groups.





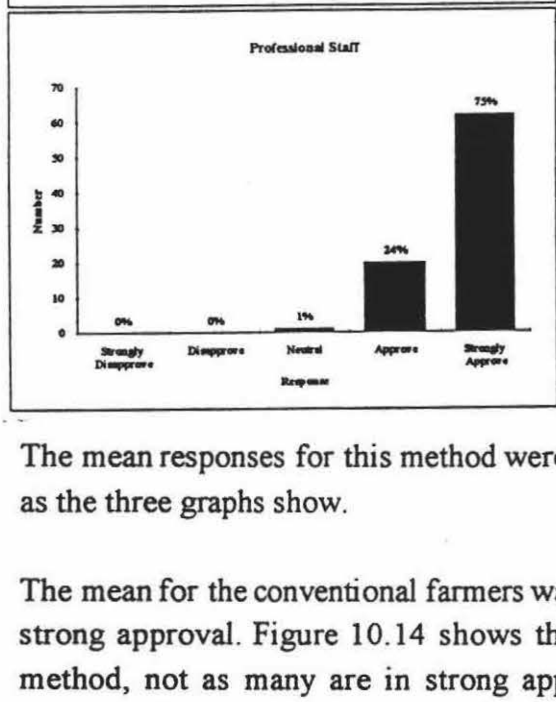


FIGURE 10.14 - Agreement with Education as a method to achieve sustainable agriculture by the membership of stakeholder group of the respondent.

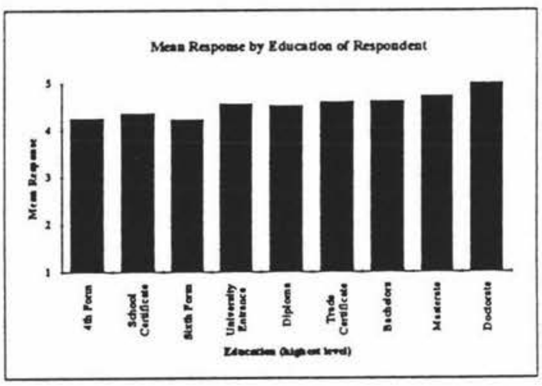
The mean responses for this method were very high for all three stakeholder groups as the three graphs show.

The mean for the conventional farmers was 4.32, with 56% in approval and 39% in strong approval. Figure 10.14 shows that although many farmers approve of the method, not as many are in strong approval as with the other two stakeholder groups. They are still not as enthusiastic with education, and could equate education with being told what to do with 'their' land (see Chapter 9 and Table 9.3). The independence that farmers want in decision making about their farms could flow through into this lowered agreement with education (although they are positive about it), compared to the organic farmers and the professional staff.

The means for the organic farmers and the professional group were very similar, at 4.80 and 4.73 respectively. Of the respondents, 80% of the organic farmers and 75% of the professional group, strongly approve of education, and 20% of the organic farmers, and 24% of the professional group, approve. The two stakeholder groups are obviously in strong approval of a more participatory approach such as education. The professional staff could see education as a cooperative approach between the landowners and council and scientific staff. They may perceive this approach as being better received by the farmers, as opposed to the more confrontational methods like regulation. If the rural community is involved in the identification of the sustainability issues, they are more likely to take 'ownership' of any problems and subsequently get involved in the resolution of the problems.

The response to education as an implementation method to achieve sustainable agriculture also had the highest level of education achieved by the respondent as a substantial determinant ($F=2.47$, $\rho=0.0147$). Figure 10.15 below shows the relationship between education level and agreement with education as an implementation method.

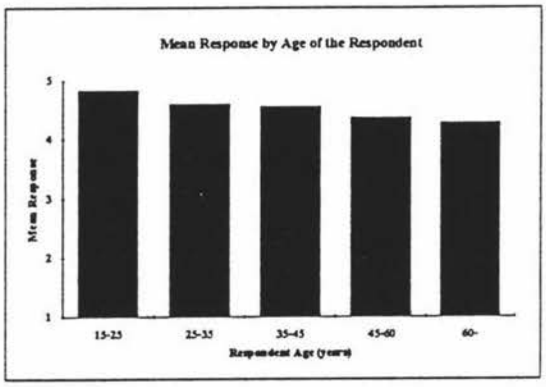
FIGURE 10.15 - Mean response for approval of Education as a method to achieve sustainable agriculture by highest level of education achieved by the respondent.



The relationship between the level of education achieved by the respondent and the level of agreement with education as an implementation method is obviously positive. The mean values for each of the levels of education attained are high, but still increase. The minimum mean response shown in Figure 10.15 is 4.25 for Fourth Form as highest level achieved (the lowest level in the figure), but this still equates to a value greater than 'Agree' on the five point scale. The highest value was 5.00 for the PhD respondents, with all 6 respondents in this class responding with 'Strongly Agree', explaining the very high mean. The education classes between these two extremes had increasing levels of agreement with education as an implementation method, as the highest qualification level increased. The only education class in Figure 10.15 to alter from the positive trend was the Sixth Form Certificate level, whose respondents had a mean of 4.22, which was slightly lower than the previous School Certificate class with 4.36. Korsching *et al.* (1983) found that education was associated with innovativeness in the adoption of soil conservation programmes. A similar parallel can be drawn between the work of Korsching *et al.* (1983) and the question topic in Figure 10.15. Education programmes are receiving a greater level of use in approaching the issue of sustainable land management and the innovativeness of the respondent will determine their enthusiasm for education as a means to achieve sustainable agriculture, and therefore their answer to this question.

The reaction to education as a planing method was also significantly correlated to the age of the respondent (F=2.92, ρ=0.0221). Figure 10.16 overleaf shows the relationship between the education level achieved by the respondent and the mean response to the question.

FIGURE 10.16 - Mean response for approval of Education as a method to achieve sustainable agriculture by age of the respondent.



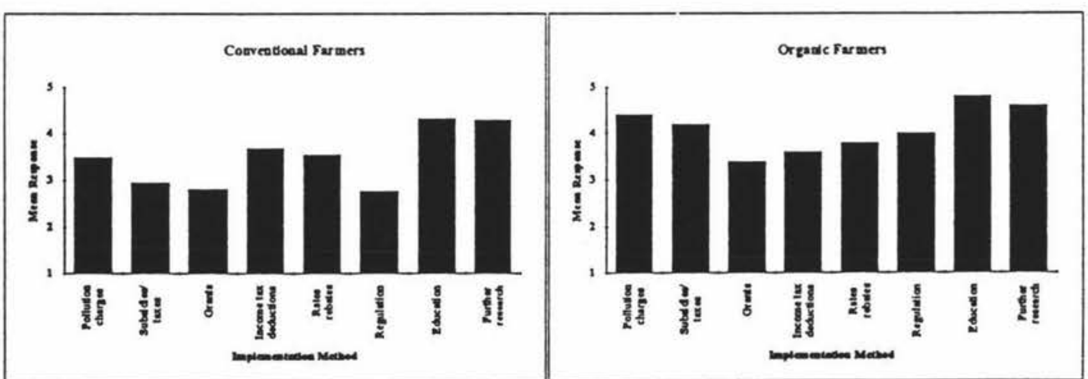
As the age of respondent increases, the level of approval of education decreases. The level of approval is still very high (4.25), higher than that of most (if not all) other methods. The older respondents are less enthusiastic about education, than the younger respondents and this could be explained by the analysis in Appendix D which illustrates that the older respondents have a lower level of education than the younger respondents. The relationship between education level achieved and the agreement with education as shown in Figure 10.15 on the previous page could affect the responses of the older groups. The older groups have a disproportionate number of conventional farmers, as shown in Appendix D, and Figure 10.14 previously discussed shows the conventional farmers were less in agreement with education than the other two stakeholder groups. The conventional farmers did have a high mean response at 4.32, the mean response was slightly lower than for the organic farmers and professional staff, who make up a disproportionately higher proportion of the younger age groups. The mean for the conventional farmers at 4.32, is similar to the values for the older age groups in Figure 10.16, with a mean response of 4.37 for the 45-60 age group and 4.28 for the 60- age group. The lower education levels for the older respondents and the numbers of conventional farmers in these age groups would explain the lower mean responses.

10.2.8 - Further research.

The response to the need for further research to achieve sustainable agriculture, had farm-type of the respondent as a moderate determinant ($F=1.78$, $\rho=0.0789$). As the following values show, all the farm-type classes had high mean responses, but there was variation amongst them. The means for sheep, sheep/cattle, and sheep/cattle/deer farmers were 4.00, 4.30 and 4.23 respectively. The mean for cattle farmers was higher at 4.71, so this group obviously felt that more information is required about agricultural sustainability regarding their farming operations. These farmers may desire further information about the sustainability implications of farming larger animals (bull-beef) on their land. The more mixed agricultural operations had farmers who had mean responses of between 3.00 and 5.00. The numbers in these classes are lower, and the statistical significance of the responses is not high. Also of note was the mean response response of 5.00 for the sheep/cattle/forestry farmers. This could be due to the lack of information about the long-term microeconomic and ecological sustainability issues of forestry and agroforestry, a point frequently noted adjacent to the agroforestry question in Part II of the survey, which was discussed in Chapter 6.3 of this thesis.

10.2.9 - Overall favourability the methods queried.

The mean responses to the eight different implementation methods queried in the survey, by each of the stakeholder groups, are shown below in Figure 10.17.



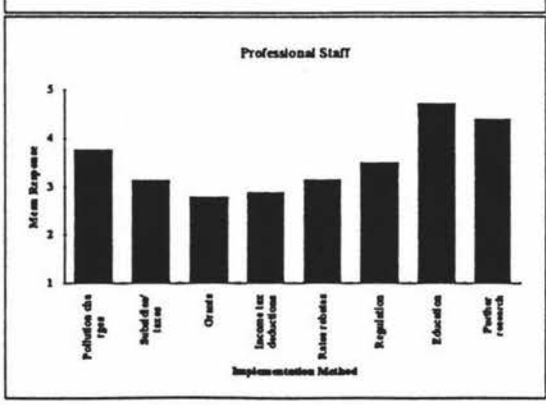


FIGURE 10.17 - Mean responses to implementation methods to achieve sustainable agriculture by the membership of stakeholder group of the respondent.

The distribution of the three stakeholder groups indicates the education and further research approaches are more favourable with all three groups than the regulatory approaches. This may be as these options are seen as the 'soft' options, especially by the farmers, and the results is 'business as usual' with some attention paid to the information they received in the education programmes. Alternatively there may be a real commitment to the use of education as long-term change, and the desire for more information of sustainable agriculture, and exactly how the farm practices can be changed to become more sustainable, is high.

The need for research is an obvious point of agreement amongst all groups. This is also reflected in the education barriers in the Chapter 9, with the need for more, practical, "farmer-friendly," research is recognised by many as a pressing need.

The use of pollution charges, as a means to 'internalise the externalities' is received reasonably well by all three stakeholder groups, considering it is a relatively new idea, aligned with the market-led approach. This approach is less favoured by the conventional farmers, than the other two stakeholder groups.

The use of economic incentives, the various forms such as grants, tax deductions, rates rebates, are overall, better received by the conventional farmers and organic farmers, than by the professional staff.

The mean responses for the conventional farmers were 3.68 for income tax deductions and 3.54 for rates rebates. The professional staff had mean responses of 2.89 for income tax deductions and 3.16 for rates rebates. The organic farmer sample was small, nevertheless their mean responses were 3.60 for income tax deductions and 3.80 for rates rebates. The organic farmers mean response for income tax deductions was similar to their conventional counterparts. The rates rebates mean response however was higher for the organic farmers than the conventional farmers. The two farmer groups had higher mean responses than the professional staff for these two implementation methods.

The farmers may well feel that as they incur costs associated with implementing farm-level change in management practices, that the costs should be born by a wider part of the community, as a wider segment of the community get the benefits of a more sustainable agriculture. The converse argument often offered, is that the wider community suffer the effects on an unsustainable agriculture in the form of sediment loads in streams/rivers, pesticide drift, residues on produce, pollution of groundwater by excessive nutrient levels, and as such they bear the costs of the problems associated with current production. These people may feel that the farmers should bear the costs to change practices that affect the wider community and environment, to ensure these things are not to be degraded or adversely affected, and also farmers have an agriculture that can continue to produce.

These arguments are both valid, but if the costs associated with change are too great and the farmers are unable to meet them, then the required change to achieve sustainable agriculture will not occur. Many of the perceived barriers covered in Chapter 9 were economic in nature and the economic methods discussed here may be needed to address them. These economic methods are not favoured amongst the professional staff, and as they come from regional and central government areas in the large part, these methods represent a reduction in income for their organisations and they may not favour this. They may also feel that the economics of the changes in practices, such as increased produce prices of 'clean-green' image will off-set the initial costs, and the farmers should not be subsidised through lowering taxes or rates.

Interestingly, the use of grants was viewed as the least favoured approach by all three stakeholder groups (conventional farmers mean was 2.81, just above 2.77 for regulation, the most unpopular approach). All the three groups did not like the use of grants, and as mentioned earlier in the chapter, the grants may be seen as a 'hand-out.' The conventional farmers disliked the method greatly, and past experience with such approaches may make them wary of it, or they do not like the idea of getting a 'hand-out' to add them achieve sustainable agriculture.

The regulation method is more favoured by the professional staff than the conventional farmers. The organic farmers are not particularly worried by the regulation methods, as in many cases their certification standards are more stringent than national regulations (although these laws supersede their regulations if they are more stringent naturally). The conventional farmers may favour more independence in their farming, free from regulation and control. The professional staff, with the mean of 3.51, is still a lot lower than their mean responses for education and further research, with 4.73 and 4.41, respectively. This again reflects the increased favourability for the 'hands-off' approaches, and long-term methods such as education, as opposed to the short-term approaches, such as the imposition of a regulatory control.

Chapter Eleven
Conclusions and Implications of Survey Findings

The following is an outline of the main conclusions from the survey of the stakeholders in sustainable agriculture, the implications of these findings on policy to implement sustainable agriculture, and where further research is required.

11.1 - Main Research Findings from the Sample Survey

The main research objective of this thesis related to understanding how the ideal of sustainable agriculture could be translated into actual practice. A conceptual framework (as shown in Figure 1.1) was constructed in order to address this research objective, as well as to provide a basis for the operationalisation of the sample survey. In order to understand the different components of this conceptual framework , a number of research questions were posed and investigated, which are now reviewed in this section of the thesis:

1 What are the ideal characteristics of sustainable agriculture? (Section 11.1.1)

2 What are the desirable practices for achieving sustainable agriculture? (Section 11.1.2)

3 What are the key features of the actual practices of agriculture and how have these changed over the last five years? (Section 11.1.3)

4 Why has the 'ideal' of sustainable agriculture not been fully achieved in the sample survey? What are the perceived barriers to the adoption of sustainable agriculture? (Section 11.1.4)

5 What are the key implementation methods that could be used to achieve sustainable agriculture? How popular are the these methods amongst landowners and professional staff and which are likely to successful? (Section 11.1.5)

The sample survey also questioned farmers in terms of their recognition of the Resource Management Act and their understanding of the term sustainability (reviewed in Section 11.1.6). The specific attitudes of the farmers and professional groups to specific sustainable agriculture issues was also queried (reviewed in Section 11.1.7).

11.1.1 - Ideal Characteristics of Sustainable Agriculture

The professional staff (from regional council, central government and sector groups) were queried on their ideal characteristics of sustainable agriculture.

The perceived characteristics of sustainable agriculture by the professional staff were predominantly biophysical (48%) and economic (46%), with lesser mention of social considerations (25%). This concentration on biophysical and economic considerations, may antagonise farmers who perhaps have a greater concern for the social aspects of sustainability, such as maintaining the daily rural mail delivery service. Arguments for the relevance and importance of the social school of agricultural sustainability are covered in Section 2.2.3.

Only 7 (8%) of the professional staff respondents noted the need to integrate the environmental, economic and social considerations. The need to integrate the three elements was raised by a number authors, which are listed in Section 2.2.4. The poor recognition of the social component, combined with an even greater lack of appreciation for the need to integrate the three overriding approaches, hinders full comprehension of the issues involved in the tradeoffs proposed by Wolf & Allen (1995).

The more frequently mentioned characteristics tend to mirror Part II of the RMA, such as avoiding adverse effects and considering the needs of future generations. The characteristics of sustainable agriculture as reported in the literature extend wider than those issues prescribed in the RMA, and a broader understanding by the professional staff of the characteristics is required. The natural resources given consideration in the characteristics of sustainable agriculture were predominantly soil (49%) and water (32%), with air (6%) and energy (2%) featuring fewer responses. A possible reason for this could be the organisations that the majority of the professional staff are sampled from, namely the regional councils, which have evolved from the old catchment board structures, whose past role was primarily concerned with soil and water conservation. The wider considerations under the RMA 1991, to include resources such as energy and air, may take a little time to develop and could occur through increased research and education regarding these resources and their importance in agricultural sustainability. The safeguarding of the life-supporting capacity of air in included in section 5(2)(b) of the RMA (1991, p 21), along with soil and water, so is given as much recognition in the RMA as the latter two resources. The definition of 'natural and physical resources' in section 2 of the RMA (1991, p 14) includes energy. The lack of recognition of energy as a resource used by agriculture is concerning, especially as most of the present energy inputs are from non-renewable sources. The need to reduce or avoid the use of non-renewable resource inputs, such as energy, was noted by a number of authors such as Keeney (1993), Harwood (1990), Schaller (1993), Weil (1990) and Edwards & Wali (1993), as reliance of these resources cannot be sustained, which threatens future production, as a large scale change of substitutes will be required. Greater recognition and understanding of the different resource inputs to agriculture is required to achieve sustainable agriculture, as all inputs need to be managed in a sustainable manner, not just soil and water.

11.1.2 - Desirable Practices for Sustainable Agriculture

All three stakeholder groups were questioned about what they considered to be the practices which would lead to sustainable agriculture.

All three groups (conventional farmers, organic farmers, and professional staff) had a high level of agreement with the question which asked if the "reliance on **non-renewable resources**, such as fossil-fuels and fertilisers, threatens the long-term viability of agriculture." The level of agreement was higher amongst the organic farmers (mean=4.80), while the conventional farmers professional staff had similar means, at 3.30 and 3.32 respectively. The avoidance of non-renewable resource inputs was covered in the last part of the previous section, and the recognition of this issue in relation to energy by the professional staff is low. Again, in this section of the survey, the professional staff had a lower perceived importance of the issue, along with the conventional staff. Perhaps these stakeholder groups need to be aware that major changes in future resource inputs will be required if current use continues, and exhausts the available sources of the inputs. Similarly, before exhaustion of the resources occurs, market scarcity will drive prices up, which creates further financial pressures on farmers. As the farm-size of the farmer respondents increased, the level of agreement with this question decreased. One possible explanation for this could be the scale of change required for the larger farms, to change from non-renewable to renewable resource inputs. They may have answered the question, with regard to the scale of change in the circumstances they face on their farm.

All three groups disagreed with the question "current **soil erosion** rates are an acceptable byproduct of agricultural land-use." There was a grouping within the conventional farmer sample that agreed, which indicates two groupings of respondents, with one component group more conservative in their responses. In the barriers section of the survey (summarised in Section 11.1.4) 8% of the professional staff mentioned this "conservative old guard" as a barrier to sustainable agriculture, as their views differ from the rest of society, and even the agricultural community in general. While most of the stakeholders, and indeed most farmers, recognise the sustainability implications of current soil erosion rates, there is still a faction that fail to realise the magnitude of the issue. The recognition of issues in sustainable agriculture will occur at different rates for various stakeholder groups, and in the case of the conventional farmers, some farmers have a greater awareness of soil conservation issues than others. The farms on which soil erosion is a greater problem, such as the steeper and more marginal areas, could lead to these landowners being more aware of the problem, as they experience soil erosion 'first hand' to a greater degree.

All three stakeholder groups agreed with the question asking if "the use of **marginal land** involved practices that were not economically sustainable." The mean of the organic farmers much higher at 4.20, compared to the professional staff (3.63) and the conventional farmers (3.28). Again, there was a grouping of more conservative farmers within the conventional farmer sample, who disagreed with the statement. The use of marginal land in New Zealand may require inputs that are not microeconomically sustainable (because of diminishing marginal returns), and this was raised by Blakeley (1990a) and Luckman (1994). The suggestion of alternative uses (eg. agroforestry or forestry) for the marginal land becomes more difficult if some stakeholders involved fail to recognise economic issues (eg, maximising farm viability) of using marginal land under pastoral use. The level of agreement with the question asking if "the use of marginal land involved practices that were not economically sustainable" also increased as the age of the respondent increased. The older respondents, especially those aged 60- (which were all conventional farmers), may have experience relating to use of marginal land, which lead them to increasingly agree with the question.

The question asking if "agricultural systems involving **monocultures** are more susceptible to pests/disease than polycultural agricultural systems" met with a reasonable level of agreement with all three stakeholder groups. The organic farmers were most in agreement (mean=5.00), professional staff at 3.91 and conventional farmers at 3.62. The use of diverse agricultural systems, with a multitude of species forms part of the organic agriculture approach, and is included in the NZBPCC (1994:1) certification standards, and this could explain their higher level of agreement. The professional staff at 3.91, which is close to a mean of 'agree' (4.00) on the Likert-scale, and their education and occupation could provide them with the experience that leads them to agree with the question. They are not as firmly in agreement as the organic farmers, whose farming philosophy and certification standards, encourage a more proactive approach to pests/diseases, such as the implementation of diverse systems, as opposed to the reactive use of pesticides as the numbers of pests increase.

11.1.3 - Changes in Actual Practices Undertaken and Resultant Sustainability Implications

For the most part, agricultural practices undertaken by the conventional and organic farmer respondents in the sample survey, had improved in terms of environmental outcomes over the last five years. The scale used in the survey, which only provides a general indication as to the direction of change, and some indication of the degree of change. The responses involve self-reporting by the farmers, and may involve the 'halo-effect' where the farmers perceive their practices to have improved more so than the really have. It is difficult to check the responses in this section, as they cannot be checked against collaborative evidence/data, as such practices are not recorded directly in other statistical publications (Agricultural Statistics, Yearbooks etc). The results in this section were analysed and discussed on the assumption that they were accurately and honestly reported by the farmers (and there is no reasons to consider otherwise).

The **conventional farmers** improved some input use, such as slightly decreased pesticide use and decreased fungicide use. The use of some inputs had increased, such as pour-on/external parasiticide use and fertiliser use. Although, the practice of fertiliser management had increased greatly (mean=0.61), which indicates the increased use in fertiliser was undertaken with more careful management. Some beneficial practices, such as shelterbelt use and conservation forestry had increased, by 0.35 and 0.28 respectively. The reasons offered for the changes in these practices varied. The increased pour-on/external parasiticide use increased due to animal health, and economic reasons. The increase in fertiliser use was noted for economic reasons, to maintain soil fertility and pasture production. The reasons for increased fertiliser management, shelterbelts and conservation forestry was not queried, but both economic and environmental reasons could be suggested for these, especially for increased fertiliser management. The economic advantages of fertiliser management, for example are reduced input costs by minimising losses and inefficient use, and environmental reasons include lowered losses of fertiliser to watercourses or groundwater.

The **organic farmers** had changed their practices by larger margins. The use of all the inputs had decreased, with fertiliser use decreased by a mean of -1.00, while the reductions in drench and pour-on use were the most dramatic, with both having a mean result of -2.00. The reduction in input use by the organic farmers was much greater than that for the conventional farmers. A possible explanation for this would be the certification standards they operate under. If the NZBPCC standards prohibit the use of most commercial inputs, then in order to be certified organic producers, they must abide by these regulations. The use of conservation forestry and shelterbelts increased greatly, by a mean of 1.00 and 1.20, respectively. One possible explanation is the certification process which encourages planting extra trees in the agricultural system for a number of beneficial reasons, such as shelter for stock, or lowering wind speeds, which in turn increases soil temperature, and they can harbour beneficial predator species. The certification standards must be implemented if the farm is to be certified 'organic' and wider issues, besides production levels are considered, which such as conservation forestry , may be incorporated into the farm environment. The certification standards was mentioned most frequently by the organic farmers as the reason for change, and also mentioned was a combination of certification standards, environmental concerns and economic reasons.

As the **age** of the farmer respondents increased, they were more likely to use drenches/internal parasiticides and less likely to undertake the practice of space planting. The first could be explained by the ease of use of these products, and this was often noted by respondents, along with animal health reasons, for the increasing use of these products. The latter decline in the practice of space-planting could be explained by the older respondents may not be able to reap the financial rewards of these plantings, or lack the enthusiasm to undertake the tree planting (especially if they do not get economic returns).

As the **education** level of the farmer respondents increased, the use of fertiliser inputs increased and pour-on/external parasiticide use increased. This may be due to the education they received, which promotes production-based, input-driven agriculture. The pour-on use increases were often acknowledged by animal health considerations and ease of use issues. The use of fertiliser is a difficult issue, as study towards agricultural degrees cover material regarding the nutrient use, either by different crops, or through pasture consumed by stock, and the fertiliser required to replace this loss. If fertiliser is not used, then the nutrient loss (in the form of crops or stock off-site removed off-site) will lead to a gradual decline in soil fertility over time, which is not agronomically sustainable (Section 2.3). The excessive use of fertiliser is not encouraged, as it is not utilised by the plants, and either passes through the soil to groundwater or in runoff. These both have environmental consequences, and the wasted fertiliser is an economic loss to the farmer, as it results in no increase in production. The increase in fertiliser management results in both economic and environmental advantages.

The **farm-size** of the respondent also affected practices undertaken. Larger farms reported greater increases in the use of pour-on/external parasiticide use in t relative scale from -2 to 2. For, example a farm of 501-750 hectares reported a mean increase from 3.00 to 3.76 on the relative scale; whereas a farm of 151-250 hectares only reported a slight decrease from 300 to 2.95. The ease of use issues again are important, especially with big farms, where carrying our tasks like this, occur at a large scale and involve a large number of animals. The the change in level of use of water resources also decreased as farm-size increased, which may be scale-related again. The size of installing water systems and infrastructure for stock at these scales may be large, and with poor recent economic returns for farming, the cost of this type of work may be prohibitive, with insufficient farm-income to provide the required capital investment. The change in the undertaking of fenced riparian strips and conservation forestry decreased as farm-size increased. The scale of work required to undertake increases of these practices, along with cost may hinder the larger farms.

The practices queried also varied depending on the different **farm-types** of the respondents. The sheep farmers had the highest increases in the retirement of steep land and use of soil erosion barriers. This result seems logical, as sheep farmers are more likely to be occupying the steeper land. Thus as they are more likely to run their farms on the steeper land, they could be more inclined to retire this land, and use soil erosion barriers, due to greater exposure to these potential problems (such as soil erosion). The cattle farmers had the highest use of internal parasiticides (mean=0.29) and fertiliser management (mean=1.14). These farmers are usually more management-intensive in their farming operations, and attention to such aspects as fertiliser management seems logical. This management can often involve greater checks on animals, such as liveweights, and to drench the cattle when weighing them adds little to the overall task, and can be undertaken while the stock are in the cattleyards. The greater financial worth of a individual cattle beast, compared to a sheep for example, means that relatively, animal health concerns can increase, purely on economic basis alone. Any reduction in animal health can reduce its weight or lead to death, which affects farm income. The cattle farmer respondents had the greatest increase in the use of production forestry (mean=0.86) and windbreak/shelterbelts (mean=0.86). The better economic returns for cattle in recent times, may offer increased farm income that allows for these practices to be undertaken and offers further diversification of the farm production-base. The use of shelterbelts may offer stock fodder and increased shade/shelter for the animals. The sheep/cattle/deer farmers had the highest use of external parasiticides (mean=0.54), and this could be explained by the increased susceptibility of deer to disease.

As the number **professional affiliations** held by the farmer respondents increased, a number of beneficial practices increased in the level of use (production forestry, conservation forestry, riparian planting and the retirement of steep land), and the change in some types of input use decreased (such as the use of fertilisers and pesticides). The management of pesticide inputs also increased as the number of professional affiliations held increased. Korsching *et al.* (1983) stated that the professional affiliations related to the innovativeness of farmers, and the rate at which they adopted soil conservation practices. The information and material they obtain from the organisations they are affiliated to, or members of, has lead to beneficial outcomes. These can be both environmental, and economic, such as greater use of production forestry, which can diversify the farm production/income base and also lower erosion rates on steeper land. The management of pesticide inputs to the farming system also increased as the number of affiliations held increased.

Overall, the practices undertaken the farmers changed for a number of different reasons, motivated by both economic and environmental issues. The use of pour-ons and drenches also changed due to animal health reasons. The farmers who reduced pesticide use noted human health concerns for their reasons. This demonstrates that farmers are not a homogeneous group, and different farmers are motivated by differing views on the issues involved, such as the environmental issues. Many of the conventional farmers changed their inputs for economic reasons (30%), and many for 'other' reasons such as animal health, ease of use ... (32%), and a few for environmental reasons (6%). The reasons for the resource inputs changes by the conventional farmers were economic (47%) and environmental (31%), and 'other' reasons, such animal health (increased water use for animal drinking water) were noted by 8%, and a combination of economic and other accounted for a further 8%. There were a number of sundry reasons that were received a few responses, and are not covered here, so the percentages for the different reasons discussed here do not total 100%.

The predominant reason offered by the organic farmers for the changes in inputs was Bio-Gro certification. The reasons for the changes in resource use by the organic farmers were mainly environmental, and economic to a lesser extent.

11.1.4 - Barriers to Sustainable Agriculture

The most frequently mentioned perceived barriers to agricultural sustainability were **economic**. Lack of farm income to meet the costs of changes practices or approaches was the most frequently mentioned of all the barriers identified with 62 respondents (27%). Other economic barriers were mentioned, although less frequently, such as produce prices from sustainable sources reflecting costs, loss of short-term production and who exactly bears the costs of implementing sustainable agriculture. These mirror some of the economic barriers from the literature, such as Reid & Wilson (1986) who highlighted uncertainties regarding the economic viability of alternative agriculture as an important issue, while MAF (1993a) noted the inadequacy of economic resources available for change, and Ervin & Ervin (1982) noted income constraints on small farms, and debt constraints as potential constraints to adopting conservation practices. Ervin & Ervin (1982, p 279) stated that "economic constraints play important roles in the decision to use effective soil conservation practices." This could be extended to cover other sustainable practices, such as using different inputs or practices, and the economic considerations involved in their development and implementation.

Another group of perceived barriers commonly noted were **education** related. The need for education and advice was mentioned by 37 respondents (16%). Other related barriers mentioned frequently were the lack of published research, a need for general attitudinal change, the lack of research relating to implications of sustainable agriculture, the lack of knowledge of issues by farmers, the need for consultation, and the lack of networks between councils and farmers to disseminate pertinent information. The education barriers, like the economic barriers, were also frequently mentioned in the literature regarding sustainable agriculture. Reganold *et al.* (1990) noted that the lack of information on sustainable practices for farmers hindered their adoption. MAF (1993a) also noted that access to relevant and affordable information was required. Blobaum (1983) noted that the lack of information was listed as a barrier to adoption of organic agriculture, in a survey of organic farmers in the United States. Ervin & Ervin (1982) also noted the lack of information was a barrier to conservation.

Attitudinal barriers were also noted with some regularity, although not as frequently as those regarding economic and education issues. The barriers mentioned included the lack of ownership of problems associated with agriculture, a degree of antagonism between environmentalists and farmers, lack of Central government urgency, farmers sticking with tradition/unwilling to change and considerations of short-term economics against long-term ecological issues differing between stakeholders. MAF (1993a) stated that there was an element to the community that failed to accept the need for change to sustainable agricultural practices. Reid & Wilson (1986) noted the attitudes and apprehensions of landowners, and government workers was a barrier. Ervin & Ervin (1982) noted that the need to forego short-term income for uncertain (long-term) benefits and farmers unwilling to change familiar practices as potential barriers.

Barriers relating to the **institutional and legal** framework required for implementing sustainable agriculture were noted less frequently than the aforementioned barriers. These barriers related to the development of the infrastructure required for sustainable agriculture, legal framework issues, and the current family-farm setup. Blakeley (1990a) highlighted the need for an distribution system for organic produce as a barrier for future increases in New Zealand production. Fisher & Tilbury (1990a) have previously noted the lack of coordination and infrastructure in the New Zealand organic food industry as a barrier to growth in that industry.

The barriers relating to **technical and physical** issues were, for the most part, the least frequently mentioned. The main barrier in technical and physical issues group was the perceived lack of alternative pesticides and fertilisers acceptable for sustainable agriculture. This is similar to the barrier discussed by Reganold *et al.* (1990) regarding sustainable practices, and the provision of information for farmers on acceptable examples. The provision of alternative inputs, and information on these alternatives is just as important as practices.

11.1.5 - Favourability of Implementation Methods for Achieving Sustainable Agriculture

The overriding conclusion of this section of the survey is that the 'hands-off' methods, such education and further research, generally were more favoured by all the respondents.

The use of **pollution charges** was more favoured by the organic farmers (mean=4.40), than the conventional farmers (mean=3.49) and the professional staff (mean=3.78). The organic farmers may perceive that their levels of pollution would be lower, and would result in lower pollution charges, which in turn would be reflected as a component of produce prices (compared to their conventional counterparts), if 'externalities' such as pollution were internalised in prices. The conventional farmers may have answered with less agreement as they may consider that they would be adversely penalised by these charges, on their practices that cause pollution (through any pollution charges they would incur). The conventional farmers did feel that current erosion rates were unacceptable in the attitudes section, but are unwilling to pay financial penalties for this erosion (if sediment loads in streams were considered was used as a pollution charge). The response to the use of pollution charges was also significantly negatively correlated to the age of the respondent. The older respondents may be less in favour with the current approach of market-led economics, and related concepts such as user-pays, and in this case polluter-pays.

The response to the use of **subsidies for desirable practices and taxes for undesirable practices** was correlated to stakeholder group, with conventional farmers least in favour (mean=2.95), and professional staff slightly higher in agreement, with a mean of 3.15, and the organic farmers in greatest agreement with a mean of 4.20. The organic farmers may feel that many of their practices would be deemed desirable, and result in subsidies, with few little incursion of taxes. The conventional farmers may feel that too many of their practices would be taxed, and were less favourable towards the approach. This overall result highlights the view that most desire the hands-off practices, with little intervention, such as taxes and subsidies. The subsidies for desirable practices and taxes for undesirable practices was also slightly positively correlated to the number of professional affiliations held by the respondent. This increased knowledge sourced from the professional affiliations may suggest to the respondents that economic incentives, such as taxes or subsidies, are required to address the perceived economic barriers, highlighted in Section 11.1.4.

The use of **income tax deductions** met with more favour amongst the conventional and organic farmers, with mean responses of 3.68 and 3.60 respectively, compared to a mean of 2.89 for the professional staff. The farmers may perceive that economic incentives or rewards are required if they change practices, especially if there are costs associated with this change. The professional staff may respond less favourably, as some are sourced from central government, and perceive tax rebates as a loss of income for the government (and their organisations). Also, as the level of education held by the respondent increased, the level of agreement with the use of tax deductions increased slightly. The analysis in Appendix D illustrates that the majority of the more educated respondents came from the professional group, and thus this correlation matches the mean responses from the different stakeholder groups for the same question. The response to the use of income tax deductions was also moderately positively correlated to the age of the respondent. The older respondents may still agree with the use of economic subsidies undertaken in the past, and feel that some sort of remuneration to compensate for the cost of conversion to sustainable practices is required.

The question relating to the use of **rates rebates** was also more well received by the conventional and organic farmers, with means of 3.55 and 3.80, respectively. The professional staff were less in favour, with a mean of 3.15. Again the farmers, who bear the costs of changing agricultural practices, may feel that economic remuneration, in the form of rates rebates, is required. The majority of the professional staff were sourced from regional councils, and this implementation method represents a reduction in income for their organisations, which they obviously do not support.

The responses to the use of **regulation** to achieve sustainable agriculture had stakeholder group as a strong determinant. The conventional farmers had the lowest mean, at 2.78, with professional staff having a higher mean at 3.51, and the organic farmers had the highest mean at 4.00. The conventional farmers had a split in their responses, with a more conservative grouping around disapproval. This again indicates the presence of the conservative group mentioned as barrier in Section 11.1.4 and reflected in the responses regarding the ideal practices questions in Section 11.1.2. The organic farmers may not be concerned about the use of regulation, as in many cases, their standards are more stringent than national regulations. Naturally, the laws of the land supersede the NZBPCC Certification Standards. The approval of regulation also decreased as farm-size of the farmer respondents increased. This could be explained the scale of intervention that could occur from regulation on the larger farming operations. The potential scale of change that could be required under any regulation could be large for these farmers, and thus they are less enthusiastic. The approval of regulation increased as education level of the respondent increased. Again, the analysis of the interrelationships between the demographic details in Appendix D indicates that the majority of the university graduates are from the professional staff, who were more enthusiastic (as mentioned earlier in this paragraph) than the conventional farmers, who comprise most of the lesser educated respondents. The level of favourability towards regulation decreased as the age of the respondent increased. The older respondents may favour the past lack of regulation, with regard to the adverse environmental impact of agricultural practices, and favour more independence and autonomy over the use of their land and their agricultural operations.

All stakeholder groups were in favour of the use of **education**, with the mean for the conventional farmers lightly lower at 4.32, than the organic farmers and professional staff, at 4.80 and 4.73 respectively. The high favourability amongst all the groups mirrors the trends in other parts of the survey, such as extension research in Section 11.1.7, and discussion of the use of Landcare type approaches under the barriers and characteristics section. The favourability of education as a planning method also increased, as the level of education held by the respondent increased. Again these higher educated respondents fall in the professional staff group, and this reflects their popularity for the approach. Alternatively they may feel that education they received, in terms of their formal qualifications offered benefits to them in terms of information about various issues, and education for farmers and other stakeholders regarding sustainable agriculture issues could also be advantageous. The level of agreement with the use of education decreased, as the age of the respondent increased. This again mirrors the decreasing favourability that the older respondents have for the other methods, and education is obviously no different. The older respondents may favour more independence, and disapprove of education on how to use 'their' land, which they may have farmed for 30-50 years.

11.1.6 - Recognition of the RMA and Sustainability Concepts

The two groups of farmers, conventional and organic, both overwhelmingly agreed that agriculture needs to become more environmentally friendly. The overall recognition of the RMA by both conventional and organic farmers was high, with most respondents having heard of the Act. But their understanding of the purpose of the RMA was not as high, with many respondents having little awareness of the purpose as the "sustainable management of natural and physical resources" (RMA 1991, p 21) and what the definition of 'sustainable management' exactly entails. The recognition of the term sustainability was high amongst both conventional and organic farmer groups. Their understanding of the meaning of the term was poor, with most of the respondents taking a single approach (as covered in Section 2.2), such as economic or environmental. Few respondents outlined a definition of sustainability that was primarily a consideration of ecological sustainability, that also included social and economic components (as discussed in Section 2.2.4). The lack of knowledge about the term sustainability, and how it relates to agriculture may affect understanding of more complex issues, when even the basic term is poorly understood. The development of indicators may be difficult, if their is poor understanding of the concept of sustainable management and little agreement about what it entails.

11.1.7 - Specific Attitudes to Sustainable Agriculture Issues

The responses to the question regarding "**extension research and education** with the rural community will be important to ensure that future agriculture is environmentally friendly" was dependent on the stakeholder group of the respondent, with all groups largely in agreement. The conventional farmers mean was lower at 3.99, with the organic farmers and professional staff had higher means, at 4.40 and 4.41, respectively. The reasonably high mean for the conventional farmers mirrors the greater favourability they have for the education approach as a implementation method (summarised in Section 11.1.5), as opposed to regulatory approaches. The level of agreement with the question regarding extension research and education was also positively correlated to the number of professional affiliations held by the respondent. The professional affiliations held can offer information to the respondent on relevant issues, and they may feel more research and information, especially practical, extension based research is required. MfE (1995a) highlighted the use of focus farms to provide information and this practical information could be incorporated into further extension research. The response to the question on extension research and education was also correlated to the age of respondent, with decreasing level of agreement as age increased. The older respondents were less enthusiastic about some of methods questioned in the implementation methods part of the survey (summarised in Section 11.1.5) and this is a consistent reflection of this, in the attitudinal section of the survey. The methods, such as extension research, will be more popular over time as the younger respondents (currently more accepting of the methods) age and form the bulk of the farming population.

The response to the question asking if "**human health risks** from food and fibre produced by agriculture will become increasingly important in the future" was significantly correlated to stakeholder group of the respondent. The organic farmers had the highest mean with 5.00, and the means for the conventional farmers and professional staff were very similar, at 3.86 and 3.90, respectively. The food and fibre safety issue is an important aspect of the organic approach, and the certification process for Bio-Gro, as this forms part of the marketing for the 'healthy' organically sourced produce. The importance of food & fibre safety issues was raised by MAF (1993a), Reganold *et al.* (1990), Swaminathan (1991) and Hayward (1990). The main purpose of the agricultural system is provide food and fibre for society, and obviously the food and fibre subsequently provided by agriculture must be safe for society. MAF (1994a) stated that food safety issues were important in relation to trade access, and if this potential for trade access is to be realised, greater awareness of the issue by the conventional farmers and professional staff is required. The marketing of the produce on the 'clean-green' on-farm production methods highlights the importance of recognising the linkages in the vertical scale covered in Section 2.4.2.

The question asking if "**social and community services**, such as schools, in the rural community are essential for its survival" was correlated to stakeholder group of the respondent. The conventional and organic farmers in greater agreement, with means of 4.28 and 4.60 respectively, compared to 3.86 for the professional staff. The conventional and organic farmer respondents, reside in the rural areas more so than the professional staff respondents, and use the rural community services to a greater extent, and value their importance, accordingly to a greater degree. The role of social and community services in agricultural sustainability, such as quality education, health and support services, especially in terms of the social sustainability component, was noted by Brown (1989), MAF (1993a), and Plucknett (1990). The level of agreement with the social and community services was also negatively correlated to the level of education of the respondent. This can be explained by the analysis of the interrelationships between demographic details of the respondents in Appendix D, which indicates that the majority of the respondents with higher levels of education, especially university level, were from the professional staff. This response by the professional staff again reflects the lack of recognition of social considerations in the characteristics section (summarised in Section 11.1.1).

11.2 - Policy Implications

The poor understanding of the purpose of the RMA and the term sustainability mean further education is required. The RMA needs to be highlighted to the farmers as a rigorous framework to develop sustainable agricultural practices in the marketing of the produce. The 'clean and green' image needs to be based on factual information and not rhetoric. The image of the RMA as another piece of legislation to make farmers' lives more difficult hinders its implementation.

The lack of social considerations in the characteristics of sustainable agriculture perceived by the professional staff will impact on the achievement of cultural and social aspects. The lack of recognition of social issues may also cause antagonism between the professional staff and the rural community, if they feel that their social wellbeing is not taken into account.

The grouping of conventional farmers with a more conservative viewpoint, who have extreme responses to some of the attitudes questions, and are noted by some professional as a barrier to sustainable agriculture may lengthen the time taken to implement sustainable agriculture. The level of resistance may lead this group to be, what Korsching *et al.* (1983) terms laggards, in adoption of better land management practices.

The high level of agreement with extension research, which has the potential to produce practical research, which farmers may adopt more readily, has definite prospects. The favourability of this type of approach, that works with the rural community, such as focus farms (MfE 1995a), may gain greater acceptance of results, and increased likelihood of this becoming transformed into action.

The lower agreement with the importance of food and fibre safety issues by conventional farmers and professional staff has potential trade implications. MAF (1994a) state that in a post-GATT Uruguay Round environment, assurances on the safety of our produce is very important, and perhaps MAF needs to stress the importance of this issue a little more clearly with these stakeholder groups.

The lack of recognition of the importance of rural social services by the professional staff (mirroring the lack of social characteristics earlier) needs to be addressed. These rural services may play a role in the dissemination of information regarding agricultural sustainable. The schools may play an important role in the education of the younger members of the rural community (future farmers and decision-makers), and MAF have recognised the importance of educating the youngsters by developing a resource kit for schools on sustainable land management.

The favourability of education and further research as methods to achieve sustainable agriculture would indicate that these could be met with less resistance. In some cases these 'hands off' methods may not produce adequate results, and may not react to practices or land uses that result in off-site effects quickly. These approaches cannot be focussed solely on production based issues on the farms (the field and farm level in the horizontal scale in Section 2.4.1), but also look at wider environmental issues (at a regional, national and global level in the horizontal scale). The use of regulation, or pollution charges, may be required, even if they are less popular, if the other approaches do not achieve adequate results.

The main barriers mentioned are economic in nature, but the economic methods are not well received, which creates a paradox. The favourability of the education approach may not address the economic problems, even if the education indicates that the sustainable practices are economically viable over the long-term, but yet still do not solve the short-term lack of finances, which hinder change. If the economic barriers are not addressed, then no level of education will achieve change as the hindrance of the economic barriers still remain (lack of initial farm income to implement change).

The older respondents are generally less in favour of most methods, whereas younger farmers are more receptive to a wider range of methods to achieve sustainable agriculture. This bodes well for the future of sustainable agriculture, but causes a short-term problem with the existing generation of older farmers.

The lack of research and information and the need for advice and education has many implications for many levels of policy. The need for relevant, high quality research, in a 'farmer friendly' format that can be translated into action is important. The issues that this research should cover needs to be identified by all the stakeholders involved. The research can form part of a consultative and participative approach, between farmers, CRIs, council staff, MAF and other relevant persons.

As the farm-size increased, the level of desirable practices (conservation forestry and fenced riparian strips) decreased. The size of the these larger farms, and the scale of change required, may hinder the rate at which these farmers adopt practices. The policy used to address sustainable agriculture needs to incorporate considerations that the rate of adoption will vary, depending on level of farmers ability and income to implement change, and the scale of this change.

The link between professional affiliations and desirable practices, highlights the usefulness of organisations (such as NZFFA, NZBPCC...) that have newsletters, journals and conferences, which provide farmers with practical information regarding practices, which they can implement on their farm. The provision of similar information by central and regional government, regarding wider sustainability issues and practices, could result in better management practices. The practices such as, better fertiliser management, were changed on an economic basis, along with environmental considerations. The other practices which could be more profitable for farmers need to be highlighted, and could achieve greater results due to a number of beneficial outcomes (both economic and environmental), although these economic benefits must be realistic.

The level of awareness of resource inputs, mostly from non-renewable sources, by the professional staff, hinders the achievement of agricultural sustainability. Developing indicators for sustainable energy use, and implementing energy conservation and efficiency programmes, to reduce this non-renewable resource input, if the policy-makers fail to recognise that the general issue exists.

11.3 - Further Research

The development of indicators for the characteristics of sustainable agriculture need to be developed. The indicators to measure sustainability implications of agriculture on resources, such as soil and water, and social and economic considerations. Once the characteristics have been defined as important in the implementation of sustainable agriculture, indicators to define the desired sustainable end-state of these characteristics need to be generated. The social and economic indicators may prove difficult, as different economic circumstances (debt loading and servicing) experienced by different farmers creates different expectations of acceptable economic returns and needs to remain microeconomically sustainable (Section 2.3).

Greater understanding is required of the role that rural services play in the lives of individuals and communities in rural areas. The effect that schools, hospitals and other services have in the quality of life of the rural community needs further research, as the links in rural communities may affect the dissemination of information regarding sustainable agriculture. The resulting sense of community may also play a role in the cooperation between people in rural areas, which is important for the development of Landcare type participative approaches.

The practices studied in the survey used a simple relative scale, and more detailed levels of change in practices, to give an indication of movement towards sustainable agriculture is required. The above indicators reflect that sustainable agriculture is an 'end' state, but in reality is also a means (Section 2.1), with inputs and management practices, so levels of these inputs and practices need to be studied also.

The effectiveness of the different planning methods needs to be documented and researched. The use of education in one area, for example, needs to be studied, to identify the strengths and weaknesses of the approach, and how the method could be improved in further applications. The use of the less favourable methods such as regulation and pollution charges could be undertaken, while studying how they are received and how the perceived impact of these methods could be softened. These methods although unpopular, may be more effective in some circumstances, and the reasons for this need to be researched. Whether the 'hands-off' methods such as education will achieve change needs to be studied. The favourability of these methods amongst farmers may be due to the view that these represent a 'business as usual' approach, with little change required, and some attention paid to the information they receive, but no real obligation to change.

The barriers need to be researched, to discover the exact levels of economic barriers that face farmers. The long term viability of different inputs and management practices need to be studied, and compared to the initial cost barrier to highlight the potential long-term benefits, which may encourage farmers to overcome the barriers.

The level of information, about the returns and environmental benefits of such practices as forestry blocks in farms needs to be increased, and made readily available for farmers. To overcome the education and information barriers, the most effective forms of information and levels at which the information is pitched needs to be recognised.

The use of in-depth focus groups is required to explore some of issues, such as reasons for the changes in practices and greater detail regarding the barriers to sustainable agriculture. This will offer a greater understanding of the issues involved, and reduce the level of speculation relating to possible reasons for actions by the farmers and the role the barriers role and how these can be addressed.

Further research is required on other areas of New Zealand, beside the Rangitikei area, and cover other types of agricultural land-use, such as the vineyards and the wine industry, which may have vastly different issues depending on land use and locale. The other land types found in other areas of the country need to be studied, which creates different issues, even for similar production types as this survey covered.

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Appendix A
Examples and critique of 'Sustainable Agriculture' definitions proposed in the literature

A.1 - Explanation

The following are some definitions of 'sustainable agriculture' chosen from the literature covered in the thesis. They are only a sample of the definitions offered, but reflect the diversity in usefulness, adequacy and detail shown in the range of definitions from various authors.

Table 2.4 shows the definitions and issues discussed in that chapter of this thesis, with the ticks and crosses shown in Table 2.4 indicating whether or not the definition covers the issues in Chapter 2. The definitions in Table 2.4 are then included in this appendix, with discussion following them regarding the which parts of the definition meet the issues in Chapter 2. The level of satisfaction with which the definition meets the issues in Chapter 2 is purely subjective, and there is no use of criteria to judge to the degree to which the definitions cover the issues/objectives in Chapter 2. The aim is simply to show the diverse range of definitions offered by the authors and the variation in flexibility and recognition of issues by some of the definitions proposed.

A.2 - Definitions and brief critique

Douglass (1984, p 25) gives a definition of 'sustainable agriculture' as:

> "Agriculture will be found to be sustainable when ways are discovered to meet future demands for foodstuffs without imposing on society real increases in the social costs of production and without causing the distribution of opportunities or incomes to worsen."
> Douglass (1984, p 25)

The definition includes the three schools of sustainability offered by Douglass (1984) obviously, as this definition is from the same author in the same piece of work. The consideration of 'sustainability as food sufficiency' approach of Douglass (1984) is shown in the meeting of future demands of foodstuffs, and also through the distribution of opportunities or incomes. The 'sustainability as stewardship' approach of Douglass (1984) is also shown in the avoidance of imposing any increases in the real costs of agriculture, which could include environmental degradation, as this is born by society in the future. The 'sustainability as community' approach of Douglass (1984) is covered in the consideration of the avoidance of imposing on society real increases in the social costs of production, and the distribution of opportunities can include community and social considerations.

The only Lowrance (1990) objective of agriculture considered in the Douglass (1984) definition is the microeconomic sustainability concept, with the distribution of opportunities or incomes, included in the definition. The definition of Douglass (1984) includes a consideration of the temporal scale of agricultural sustainability, with future demands of foodstuffs, although this is not as the Weil (1990) definition in Chapter 2, to include considerations of changing production methods or evolution of the agricultural system.

Harwood (1990, p 4) gives a definition of "sustainable agriculture" as:

> "an agriculture that can evolve indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favourable both to humans and to most other species."
> (Harwood 1990, p 4)

The Harwood (1990, p 4) definition includes all three approaches agricultural sustainability outlined by Douglass (1984). The 'sustainability as food sufficiency' approach is shown in the evolution towards greater human utility by agriculture. The 'sustainability as stewardship' approach is shown in the efficiency of resource use and a balance with the environment favourable both to human and to most other species. The 'sustainability as community' approach is less obvious, but human utility could include considerations of community issues and requirements for microeconomic sustainability.

None of the Lowrance (1990) objectives are mentioned in the definition directly. A temporal scale consideration is reflected in the inclusion of the wording implying indefinite evolution of agriculture, which gives flexibility over time to allow greater social utility, while balancing with environmental considerations. This shows that 'sustainable agriculture' under this definition will not be fixed in time, but rather, would be a changing end-state.

MAF (1993a, p 4) gave a definition of 'sustainable agriculture' which was adapted from the Australian Standing Committee on Agriculture, Working Group on Sustainable Agriculture, which they proposed for New Zealand:

"Sustainable agriculture is the use of practices and systems which maintain or enhance:

. the ability of people and communities to provide for their social and cultural wellbeing;

. 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 1993a, p 4)

The MAF (1993a, p 4) definition covers all the three approaches to agricultural sustainability outlined by Douglass (1984). The 'sustainability as food sufficiency' approach is included in the provision of quality and safe food and fibre, while protecting the agricultural resource base, which is imperative for future production, along with economic viability considerations. The 'sustainability as stewardship' approach is covered by the enhancement of the the natural resource base of agriculture, and other ecosystems influenced by agricultural activities. The 'sustainability as community' approach is included in the maintenance or enhancement of the ability of people and communities to provide for their social and cultural wellbeing. The four Lowrance (1990) objectives are included in the MAF (1993a, p 4) definition. The agronomic sustainability objective is covered by the maintenance or enhancement of the resource base of agriculture, which is similar to the wording of the Lowrance (1990) objective. The concepts of microeconomic sustainability and macroeconomic sustainability are included in the consideration of the maintenance or enhancement of the economic viability of agriculture. The exact scale of this consideration is not given, and thus the considerations could be applied to both the farm scale (microeconomic sustainability) and the national scale (macroeconomic sustainability). The Lowrance (1990) objective of ecological sustainability is included in the definition under the maintenance or enhancement of other ecosystems influenced by agricultural activities.

The Swaminathan (1991) concept of 'food security' is covered in the MAF (1993a, p 4) definition through the maintenance or enhancement of the quality and safety of food and fibre provided by agriculture. There is no mention of site-specificity issues of agricultural sustainability, but in the original MAF (1991a, p 1) Public Discussion Paper, the issue of sustainable agriculture was stated as being addressed from a "national policy perspective rather than advocating specific farm-level responses." Thus, from MAF (1991a) a recognition of site-specificity is given, although it is not relevant to, and discussed in, the MAF (1993a) definition.

The Technical Advisory Committee (1988) gave a definition of 'sustainable agriculture' as:

> "Sustainable agriculture should involve the successful management of resources for agriculture to satisfy the changing human needs while maintaining or enhancing the natural resource base and avoiding environmental degradation."
> Technical Advisory Committee (1988)

The Technical Advisory Committee (1988) definition does include the three main approaches to agricultural sustainability outlined by Douglass (1984). The 'sustainability as food sufficiency' approach is included in the mention of the maintenance of the natural resource base. As discussed in Chapter 2, the maintenance of the resource base on which agriculture is dependent is a critical consideration in the 'sustainability as food sufficiency' approach, as the resource base determines future production levels, which is the primary aim of this approach. The 'sustainability as stewardship' approach is encompassed in the avoidance of environmental degradation, which must form part of stewardship ethic. The 'sustainability as community' approach is alluded to in the statement regarding agriculture's ability to satisfy changing human needs, which can encompass both economic income for farmers, and livelihoods for rural communities, along with food provision for society.

The Lowrance (1990) objectives that are mentioned in the Technical Advisory Committee (1988) definition are agronomic and ecological sustainability. The maintenance of the natural resource base is essential for the ensuring the long-term productivity, and therefore agronomic sustainability, of agriculture. The concept of ecological sustainability is covered by the reference to maintaining or enhancing the natural resource base and avoiding any environmental degradation (the definition does not specify just the agricultural resource base, so it could include the wider natural system). The macro- and micro-economic sustainability concepts were not mentioned directly, but could be covered in meeting changing human needs.

A resemblance of a temporal scale consideration is reflected in the Technical Advisory Committee (1988) definition by the wording "changing human needs", although the changing of agricultural practices, as new practices evolve and the flexibility required to incorporate these changes are not mentioned. The changes in environmental end-state desired by society could be incorporated into the "changing human needs" statement, although this is not very clear.

The Swaminathan (1991) concept of 'food security' could be covered in the Technical Advisory Committee (1988) definition, by the reference to changing human needs encompassing food and fibre requirements of society.

A report by the National Research Council (1989, p 27) defined 'alternative' agricultural systems as:

> "Alternative agriculture is any system of food or fibre production that systematically pursues the following goals:
>
> . More thorough incorporation of natural processes such as nutrient cycling, nitrogen fixation, pest-predator relationships into the agricultural production process;
>
> . Reduction in the use of off-farm inputs with the greatest potential to harm the environment or the health of farmers and consumers;
>
> . Greater productive use of the biological and genetic potential of plant and animal species;
>
> . Improvement of the match between cropping patterns and the productive potential and physical limitations of agricultural lands to ensure long-term sustainability of current production levels; and
>
> . Profitable and efficient production with emphasis on improved farm management and conservation of soil, water, energy, and biological resources."
>
> National Research Council (1989, p 27)

The term alternative agriculture is often used in agricultural literature as a substitute for the term sustainable agriculture. Beus & Dunlap (1990, p 594) proposed that alternative agriculture included "organic agriculture, sustainable agriculture, regenerative agriculture, ecoagriculture, permaculture, bio-dynamics, agroecology, natural farming, low-input agriculture, and others." Reganold *et al.* (1990) stated that because a farm is alternative (that is, it differs from conventional operations), this does not mean it is necessarily sustainable. Keeney (1993) stated that defining 'conventional agriculture' was difficult, as the conventional practices vary widely from locality to locality, and even between neighbouring farms.

Nevertheless, as the definition offered by the National Research Council (1989, p 27) incorporates many of the issues in Chapter 2 (as Table 2.4 illustrates), it has been included in this appendix as one possible definition of 'sustainable' agriculture.

The National Research Council (1989, p 27) definition does cover two of the approaches to agricultural sustainability outlined by Douglass (1984). The 'sustainability as food sufficiency' approach is encompassed by ensuring the long-term sustainability of current production levels. This does not however enable flexibility for increasing production levels if future food and fibre demand increases, which is the main aim of this Douglass (1984) approach. The other approach mentioned in the definition is the 'sustainability as stewardship' school of Douglass (1984), with the conservation of soil, water, energy and biological resources. A true stewardship ethic goes beyond the conservation of resources, and includes the issues covered in Section 2.2.2. The 'sustainability as community' approach is not mentioned in the National Research Council (1989, p 27) definition, with no reference to social or rural (or wider) community issues.

The National Research Council (1989, p 27) definition includes three of Lowrance (1990) objectives, namely microeconomic, agronomic and ecological sustainability. The agronomic sustainability concept is defined in the National Research Council (1989, p 27) definition by "ensuring long-term sustainability of current production levels", which is very similar to the wording of Lowrance (1990) in Table 2.2. The ecological sustainability objective of Lowrance (1990) is covered in part by the conservation of soil, water, energy and biological resources in the National Research Council (1989, p 27) definition. Although, as Lowrance (1990) defined ecological sustainability as "the ability of the life support systems to maintain the quality of the environment" the mere conservation of the aforementioned resources may not entirely meet the objective, but will form part of it. The microeconomic sustainability concept is included in the reference to profitable production, which implies a continuation of farm economic viability, the Lowrance (1990) microeconomic sustainability objective.

The temporal scale consideration in the National Research Council (1989, p 27) definition is the wording "long-term sustainability". This is very vague, and only refers to the long-term sustainability of current production levels, with no reference to changes in food and fibre demand over time, changing agricultural practices, or changes in desired the environmental end-state.

The National Research Council (1989, p 27) definition does include some elements of the Swaminathan (1991) concept of 'food security, in the reference to long-term sustainability of current production levels. There is a clear reference to safety of food and fibre for the consumers, which is part of the Swaminathan (1991) concept. It does not refer to increases in, or changes to, demand of food and fibre by society, and subsequently meeting them.

Schaller (1989) defines 'sustainable agriculture' as:

> "... an agriculture that is, and will continue to be, profitable for farmers, that will conserve soil and water resources and protect the environment, and that will assure adequate and safe food supplies."
> Schaller (1989)

The Schaller (1989) definition of 'sustainable agriculture' covers two of the three approaches to agricultural sustainability outlined by Douglass (1984). The 'sustainability as food sufficiency' approach is included in the wording of "assure adequate and safe food supplies". This offers some flexibility to meet changes in future food and fibre demand, the overall aim of this Douglass (1984) approach. The other approach mentioned in the Schaller (1989) definition is the 'sustainability as stewardship' school of Douglass (1984), with the conservation "of soil and water resources". Although a stewardship ethic would go beyond the conservation of just the resource-base of agriculture (soil and water) and the Schaller (1989) definition also includes the protection of the environment, which again forms part of a stewardship ethic. Although the detail in the Schaller (1989) definition is missing. The 'sustainability as community' approach is not mentioned in the Schaller (1989) definition, like the National Research Council (1989) definition, with no reference to social or rural (or wider) community issues. Although the continuation of farm profitability will allow some social sustainability, as it provides livelihoods and income for rural areas and rural support towns that are in part dependent on the spending of farm income.

The Schaller (1989) definition includes the Lowrance (1990) objective of agronomic sustainability, in the conservation of soil and water, the primary components of the resource-base on which agriculture is dependent. The objective of ecological sustainability outlined by Lowrance (1990) is covered in the inclusion of the phrase regarding the protection of the environment, which must include protecting "the ability of the life support systems to maintain the quality of the environment", which is how Lowrance (1990) defines ecological sustainability. The Lowrance (1990) objective of microeconomic sustainability is also included in the Schaller (1989) definition, in the first statement defining sustainable agriculture as agriculture that will continue to be profitable for farmers. The definition does not include any reference to continued economic viability of the entire agriculture sector, which Lowrance (1990) terms macroeconomic sustainability.

The Schaller (1989) definition includes a consideration of the temporal scale of agricultural sustainability, as the definition begins with defining sustainable agriculture as an "agriculture that is, and will continue to be, ..." Therefore all the considerations of the definition are given the context of both the present and the future. Thus the economic viability, resource management, food provision, environmental protection and food safety issues are all to be considered on a temporal scale.

The concept of 'food security' proposed by Swaminathan (1991) is covered in the Schaller (1989) definition through assuring both adequate, and safe, food supplies. The Schaller (1989) definition includes both the food safety and adequate production levels to meet demand, which some definitions fail to do.

The American Society of Agronomy proposed a definition of 'sustainable agriculture' at their Annual Conference in 1988 as:

> "A sustainable agriculture is one that, over the long term,
> (1) enhances environmental quality and resource base on which agriculture depends,
> (2) provides basic human food and fibre needs,
> (3) is economically viable, and
> (4) enhances the quality of life for farmers and society as a whole."
> American Society of Agronomy (1988)

The American Society of Agronomy (1988) definition includes all three schools of sustainability proposed by Douglass (1984). The consideration of 'sustainability as food sufficiency' approach by Douglass (1984) is covered in (2) of the definition where 'sustainable agriculture' provides the basic human food and fibre needs, and enhances the resource base on which agriculture depends, over the long term. The 'sustainability as stewardship' approach outlined by Douglass (1984) is included in (1) of the American Society of Agronomy (1988) definition with the enhancement of environmental quality and resource base. The 'sustainability as community' approach of Douglass (1984) is covered in (4) whereby 'sustainable agriculture' enhances the quality of life for farmers and society as a whole. As discussed in Section 2.2.3, quality of life issues of farmers and other people residing in rural communities forms part of the 'sustainability as community' approach.

The American Society of Agronomy (1988) definition of 'sustainable agriculture' includes all four of the Lowrance (1990) objectives of sustainable agriculture. The agronomic sustainability objective is covered in (1) with the enhancement of the resource base on which agriculture depends, over the long-term. This is very similar to the wording of the Lowrance (1990) objective, shown in Table 2.2. The concept of microeconomic sustainability outlined by Lowrance (1990) is included in (3) of the American Society of Agronomy (1988) definition which states that agriculture is economically viable. This consideration of long-term economic viability of agriculture does not include any specific mention of the entire agricultural sector. The exact scale of this consideration is not given, as the reference is to "A sustainable agriculture is ...", which mean at the farm level or at the entire national sector level. Thus the economic viability consideration could be applied to both the farm scale (microeconomic sustainability) and the national scale (macroeconomic sustainability). The American Society of Agronomy (1988) definition includes the Lowrance (1990) objective of ecological sustainability in (1) where a sustainable agriculture enhances environmental quality, which is similar to the wording of the Lowrance (1990) objective in Table 2.2.

The temporal scale in the American Society of Agronomy (1988) definition covers all the considerations outlined in the definition, as the wording begins with "A sustainable agriculture is one that, over the long term, ..." This then means that all the following parts of the definition must be given a long-term component to any considerations.

The American Society of Agronomy (1988) definition includes one element of the Swaminathan (1991) concept of 'food security, with the reference in (2) to providing basic human food and fibre needs. There was however no specific reference to safety or affordability issues regarding the food and fibre produced by that 'sustainable agriculture', which formed part of the concept of 'food security' proposed by Swaminathan (1991).

MacRae *et al.* (1989) proposed a definition of 'sustainable agriculture' as:

> "Sustainable agriculture is a philosophy and a system of farming. It has rooted in a set of values that reflects a state of empowerment, of awareness of ecological and social realities, and of one's ability to effective action. It involves design and management procedures that work with natural processes to conserve all resources, promote agroecosystem resilience and self regulation, minimise waste and environmental impact, while maintaining or improving farm profitability."
> MacRae *et al.* (1989)

The MacRae *et al.* (1989) definition covers two of the approaches to agricultural sustainability outlined by Douglass (1984). The 'sustainability as stewardship' approach is covered by inclusion of the provision regarding the minimisation of environmental impact, which forms a part of stewardship. The statement relating to the awareness of ecological realities is more aligned with the 'sustainability as stewardship' approach, than simply the reference to minimising environmental impact. The 'sustainability as community' approach is included in the MacRae *et al.*

(1989) definition under the statement regarding a state of empowerment and the ability of individual to take effective action, in order to achieve sustainable agriculture. There is no direct reference to 'sustainability as food sufficiency', as production levels and meeting society's food and fibre requirements are not included in the definition. The economic approach to sustainability is included in the maintenance or improvement of farm profitability.

Three of the Lowrance (1990) objectives are included in the MacRae *et al.* (1989) definition. The agronomic sustainability objective is covered by the reference to working with natural processes to conserve resources, promoting agroecosystem resilience/self regulation and minimising waste. The concepts of microeconomic sustainability is included in the consideration of the maintenance or improvement of farm profitability. The Lowrance (1990) objective of ecological sustainability is included in the MacRae *et al.* (1989) definition in the statements regarding understanding ecological realities and the use of management practices that work with nature to conserve all resources and minimise environmental impact.

The MacRae *et al.* (1989) definition has no mention of scale issues or the Swaminathan (1991) concept of 'food security'.

Youngberg (1986) defined 'alternative agriculture' as:

> "The goal of these [alternative agricultural] systems is to produce nutritious and high quality food at reasonable cost while conserving fossil fuel and other scarce resources, reducing soil erosion and degradation and minimising adverse effects on the environment. The methods used to achieve these goals emphasise naturally occurring mechanisms for controlling weeds, diseases, and insect pests and the efficient use of on-farm sources of plant nutrients and organic matter."
> Youngberg (1986)

Again like the the definition offered by the National Research Council (1989) for 'alternative agriculture' this Youngberg (1986) definition has been included in this appendix as it addresses many of the issues in Chapter 2, and the term alternative agriculture is often used as a substitute for the term sustainable agriculture.

The Youngberg (1986) definition covers two of the three approaches to agricultural sustainability outlined by Douglass (1984). The 'sustainability as food sufficiency' approach is included in the statement regarding the goal of alternative agricultural systems to produce nutritious and high quality food at reasonable cost, to meet society's needs. The 'sustainability as stewardship' approach is covered by minimising adverse effects on the environment, along with conserving scarce resources. The 'sustainability as community' approach is not included in the definition, as was the case with the National Research Council (1989) definition of 'alternative agriculture.'

The Youngberg (1986) definition includes two of Lowrance (1990) objectives, specifically, agronomic and ecological sustainability. The agronomic sustainability concept is integrated in the Youngberg (1986) definition by "reducing soil erosion and degradation", which in itself is quite a narrow focus for agronomic considerations, but combined with the conserving of scarce resources (fossil fuels and finite fertiliser sources) the agronomic component is more clearly defined that other definitions. The ecological sustainability objective of Lowrance (1990) is covered partly by the minimisation of adverse effects on the environment, which may in turn affect environment quality, the maintenance of which is the main aim of this Lowrance (1990) objective. Again, like the National Research Council (1989) definition of 'alternative agriculture' there is no mention of macroeconomic sustainability or microeconomic sustainability issues. The lack of economic viability considerations at the farm and sector level is a major shortfall of the alternative agriculture definitions proposed.

The horizontal and vertical scale issues outlined in Sections 2.4.1 and 2.4.2 are considered by the Youngberg (1986) definition. The last statement in the definition advocates the efficient use of on-farm resources, as opposed to external resource inputs. The advocating of minimising the use of external resources acknowledges the fact that there are steps in the agricultural system beyond the farm-gate, that precede the on-farm agricultural production, namely input supply (see Figure 2.1). This also implies acknowledgement of horizontal scale, as the off-farm resources are supplied from external areas, which are distanced from the farm in the horizontal scale. This again illustrates the overlap and interrelationships between the horizontal and vertical scales, where acknowledging one scale, can imply the acknowledgement of the other.

The Swaminathan (1991) concept of 'food security' is covered in the Youngberg (1986) definition through the goal of producing nutritious and high quality food, at reasonable cost. The affordability of the abundant food supplied was an important component of the Swaminathan (1991) concept, as there was little point in producing food if society could not find it easily affordable. Food safety issues are not mentioned by Youngberg (1986).

Wynen & Fritz (1987) proposed a definition for 'sustainable agriculture' in a paper produced for the National Association for Sustainable Agriculture Australia (NASAA) as:

> "A system of agriculture able to balance productivity with low vulnerability to problems such as pest infestation and environmental degradation while maintaining the quality of land for future generations.
>
> In practice this involves a system which avoids or largely excludes the use of synthetically compounded fertilisers, pesticides, growth regulators, livestock feed additives and other harmful or potentially harmful substances. It includes the use of technologies such as crop rotations, mechanical cultivation and biological pest control; and such materials as legumes, crop residues, animal manures, green manures, other organic wastes and mineral bearing rocks."
> Wynen & Fritz (1987)

The Wynen & Fritz (1987) definition does cover two of the approaches to agricultural sustainability outlined by Douglass (1984). The 'sustainability as food sufficiency' approach is encompassed by the statement of "a system of agriculture able to balance productivity with ..." This brief statement does not give sufficient detail regarding flexibility for increasing production levels if future food and fibre demand increases, which is the main aim of this Douglass (1984) approach. Although the protection of the quality of the land for future generations (and thus giving them the ability to provide agricultural produce) is also included in the definition, another important part of the 'sustainability as food sufficiency' approach. The other school mentioned in the definition is the 'sustainability as stewardship' approach of Douglass (1984), with the avoidance of environmental degradation and maintaining the quality of the land for future generations, which is a prime component of a stewardship ethic, although it should extend beyond just the land. The 'sustainability as community' approach is not mentioned in the Wynen & Fritz (1987) definition, with no reference to any social or rural community issues.

The Lowrance (1990) objectives that are mentioned in the Wynen & Fritz (1987) definition are agronomic and ecological sustainability. The definition includes the concept of agronomic sustainability where it states that the productivity of agriculture must be balanced with environmental considerations and maintaining the quality of the land, which implies that the resource base on which productivity is created, must be protected. The concept of ecological sustainability is covered by the reference to avoiding any environmental degradation and maintaining the quality of the land for future generations. Although, the Lowrance (1990) definition of ecological sustainability goes beyond just the land, to include all the environment. The macro- and micro-economic sustainability concepts were not mentioned.

Like the Youngberg (1986) definition, the Wynen & Fritz (1987) definition includes considerations of the horizontal and vertical scale issues, which were outlined in Sections 2.4.1 and 2.4.2. The second paragraph in the definition recommends the the use of internal substitutes for resource inputs, and greater internal cycling (through the use of legume crops, practices such as crop rotation and organic waste) as opposed to using external resource inputs. Advocating more internal practices, as opposed to external resources, acknowledges the steps in the agricultural system beyond the farm-gate (see Figure 2.1). Again, like the Youngberg (1986) definition, this also implies acknowledgement of the horizontal scale, as the off-farm inputs are sourced from external areas, which are distanced from the farm in the horizontal scale.

The concept of 'food security' proposed by Swaminathan (1991) is covered by the Wynen & Fritz (1987) definition through excluding the use of harmful or potentially harmful substances in the agricultural system. The definition does not state harmful to humans specifically, but the pesticides and additives mentioned as examples have been queried on safety issues, but little proof of harmful health effects has not been uncovered. The statement includes an element of the 'precautionary approach' as potentially harmful substances are also excluded from use, which may be unfounded. The provision of adequate and affordable food and fibre by the agricultural system is not included in the Wynen & Fritz (1987) definition, which is an important part of the Swaminathan (1991) term, besides safety issues.

Springett (19??) proposed a definition of 'sustainable farming' as:

> "Sustainable farming will be farming which uses all our knowledge and technical ability to ensure that we all are well fed with food that is of a high quality, and live in an environment which will continue to function and will provide us with clean air and water in both our cities and and our countryside. All costs (monetary, environmental and social) will be identified and internalised, including the costs associated with the production and disposal of material used in production, storage, transport, processing and retailing. Recognising the true costs of agriculture should result in a major revision of agricultural and environmental economics."
> Springett (19??)

The Springett (19??) definition includes all three schools of sustainability offered by Douglass (1984). The consideration of 'sustainability as food sufficiency' approach of Douglass (1984) is encompassed in the statement enabling society to be well fed with food of a high quality. The 'sustainability as stewardship' approach of Douglass (1984) is also incorporated by the statement relating to to allowing the environment to continue to function and provide clean air and water. The environmental costs of agriculture are also to be identified according to Springett (19??), and internalised into produce prices. The 'sustainability as community' approach of Douglass (1984) is covered in the identification, and internalisation, of any social costs associated with agriculture.

The only Lowrance (1990) objective included in the Springett (19??) definition is the ecological sustainability concept. The statement pertaining to the environment functioning, and providing clean air and water for cities and countryside must be aligned with the Lowrance (1990) concept which outlines the maintenance of life-supporting systems that provide environmental quality (Table 2.2), under which unpolluted air and water resources must be included.

The Springett (19??) definition does consider the horizontal and vertical scale issues outlined in Sections 2.4.1 and 2.4.2. The definition includes reference to the other steps in the agricultural system beyond the farm-gate, from Figure 2.1, such as transportation, processing, storage and retailing. The consideration of the costs (environmental, social and economic) associated with these other steps in the vertical scale, beyond the farm-gate was more detailed that most, if not all, of the other definitions. The horizontal scale of agriculture received mention in the provision of clean air and water for the city areas, as well as the countryside. This recognition of water and air quality issues originating in rural areas having a wider impact that in just the rural areas of origin, is important in agricultural sustainability.

The Springett (19??) definition includes some elements of the Swaminathan (1991) concept of 'food security, under the reference to provide enough food for society to be well fed, with food of a high-quality. The Springett (19??) definition considers both the adequate provision, and quality issues associated with the food provided by agriculture. The definition does not consider safety issues, just the amount and quality produced (although safety would form part of quality by most assessments). Nor does the definition consider the fibre produced by agriculture, just the food produced.

Appendix B
Copies of Surveys and Covering Letters from Thesis Sample Survey

B.1 - Covering Letter mailed with Conventional Farmer Survey

Grant King
FREEPOST 15
Department of Resource and Environmental Planning
Private Bag 11222
Massey University
PALMERSTON NORTH

25 November 1994

Dear

Please find attached a survey on farmers' ideas on sustainable agriculture. It is being conducted for my Masterate in Planning at Massey University.

- This will only take **10-15 minutes to complete**.
- The results are very important for my thesis and my results are eagerly anticipated by some council and scientific staff.
- All completed surveys that are returned by **9 December 1994** will go into a draw under police supervision, for a $400.00 voucher redeemable at any Farmlands Trading Society Limited outlet. The odds of winning are better than Lotto! I would like to thank Farmlands for their sponsorship of this survey.
- The views held by farmers such as yourself are very important for the study and assisting central and local government in planning for the agricultural sector.

All returns will be confidential and privacy of information supplied is guaranteed. The results of individual returns will not be published. Instead only overall totals will be reported in my thesis.

Please return the completed survey in the enclosed postage paid and addressed envelope no later than 9 December 1994 to be eligible for the prize draw.

Thank you for your time and assistance.

Yours sincerely

Grant King

B.2 - Covering Letter mailed with Organic Farmer Survey

Grant King
FREEPOST 15
Department of Resource and Environmental Planning
Private Bag 11222
Massey University
PALMERSTON NORTH

9 December 1994

Dear

Please find attached a survey on farmers' ideas on sustainable agriculture. It is being conducted for my Masterate in Planning at Massey University.

A sample of farmers that have been certified by the Biogro organisation was included in the survey, as the numbers of people growing organically is increasing and MAF have introduced a Policy Paper on Organic Agriculture. Both of these factors reflect the increasing importance of this type of land-use in the agriculture sector.

- ✎ Please take **10-15 minutes** out of your busy schedule to complete this survey.
- ✎ The results are very important for my thesis and my results are eagerly anticipated by some council and scientific staff.
- ✎ The views held by farmers such as yourself are very important for the study and assisting central and local government in planning for the agricultural sector.
- ✎ All returns will be confidential and privacy of information supplied is guaranteed. The results of individual returns will not be published. Instead only overall totals will be reported in my thesis.

Please return the completed survey in the enclosed postage paid and addressed envelope no later than **19 December 1994**.

Thank you for your time and assistance.

Yours sincerely

Grant King

B.3 - Conventional Farmer and Organic Farmer Survey

Sustainable Agriculture

Survey

Please return to:

FREEPOST 15
Grant King
Resource and Environmental Planning
Massey University
Private Bag 11222
PALMERSTON NORTH

by 9 December in the supplied pre-addressed and postage paid envelope.

PART I - AGRICULTURE AND THE ENVIRONMENT

Do you think that agriculture needs to become more environmentally friendly?
[Please tick the appropriate box]

Yes ☐
Undecided ☐
No ☐

Have you heard of the Resource Management Act? If so, please outline the main purpose of the Resource Management Act below. If not, go on to the next question.

____
____
____
____
____
____

Have you heard of the term sustainability? If so, please describe your understanding of the term below. If not, go on to the next question.

____
____
____
____
____
____

PART II - GENERAL OPINIONS ON SUSTAINABLE AGRICULTURE

Respond to the following statements, by circling the appropriate number according to this scale:

Strongly Disagree	SD	1
Disagree	D	2
Undecided	U	3
Agree	A	4
Strongly Agree	SA	5

		SD	D	U	A	SA
1.	Agricultural systems involving monocultures are more susceptible to pests/diseases than polycultural agricultural systems.	1	2	3	4	5
2.	Agroforestry gives a greater commercial return.	1	2	3	4	5
3.	Current soil erosion rates are an acceptable byproduct of agricultural land-use.	1	2	3	4	5
4.	The use of marginal land involves practices that are not economically sustainable.	1	2	3	4	5
5.	The use of marginal land involves practices that are not environmentally sustainable.	1	2	3	4	5
6.	Soil is a finite resource unless managed carefully.	1	2	3	4	5
7.	Reliance on non-renewable resources, such as fossil-fuels or fertilisers, threatens the long-term viability of agriculture.	1	2	3	4	5

		SD	D	U	A	SA
8.	Energy intensive agricultural enterprises, which use high energy inputs in relation to the products they yield, are not environmentally sound.	1	2	3	4	5
9.	Some loss of short-term profit may be required to ensure long-term commercial returns.	1	2	3	4	5
10.	Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly.	1	2	3	4	5
11.	Human health risks from food and fibre produced by agriculture will be increasingly important in the future.	1	2	3	4	5
12.	Rural-residential development on good quality soils is not environmentally friendly.	1	2	3	4	5
13.	Social and community services, such as schools, in the rural community are essential to its survival.	1	2	3	4	5
14.	Efficient cycling of nutrients within agricultural systems is required for environmental reasons.	1	2	3	4	5
15.	Efficient cycling of nutrients within agricultural systems is required for economic reasons.	1	2	3	4	5
16.	Conservation of native habitats and species within agricultural areas is important.	1	2	3	4	5
17.	Sustainable agricultural systems substitute higher levels of knowledge for external resource inputs.	1	2	3	4	5

		SD	D	U	A	SA
18.	Information requirements for "environmentally friendly" agricultural systems are higher due to the knowledge and management requirements.	1	2	3	4	5
19.	A team approach is required for environmentally friendly agriculture, to best understand the agricultural system.	1	2	3	4	5
20.	The farmer should be central to the research and development required to make sustainable agriculture a practical reality.	1	2	3	4	5

PART III - WAYS OF ACHIEVING SUSTAINABLE AGRICULTURE

Rate the following methods for achieving sustainable agricultural practices using the scale:

Strongly Disapprove	SD	1
Disapprove	D	2
Neutral	N	3
Approve	A	4
Strongly Approve	SA	5

		SD	D	N	A	SA
1	Pollution charges	1	2	3	4	5
2	Subsidies for desirable practices, taxes for undesirable practices.	1	2	3	4	5
3	Grants	1	2	3	4	5
4	Income tax deductions or rebates	1	2	3	4	5
5	Rates rebates	1	2	3	4	5
6	Regulation	1	2	3	4	5
7	Education	1	2	3	4	5
8	Further research	1	2	3	4	5

PART IV - AGRICULTURAL PRACTICES

From the following list of practices circle the number that corresponds to the level to which you have altered these practices in the **last five years**. The scale is:

Significantly Increased	SI	2
Increased	I	1
Same/Unchanged	S	0
Decreased	D	-1
Significantly decreased	SD	-2

A - Inputs

	SD	D	S	I	SI
Pesticide use	-2	-1	0	1	2
Fertiliser use	-2	-1	0	1	2
Energy Use	-2	-1	0	1	2
Fungicide use	-2	-1	0	1	2
Drenches/internal parasiticide use	-2	-1	0	1	2
Pour-on/external parasiticide use	-2	-1	0	1	2

What were the reasons for the changes that occurred:

____

____

____

____

____

B - Resource Use

	SD	D	S	I	SI
Clearing scrub for pasture or [illegible]	-2	-1	0	1	2
Water resource use	-2	-1	0	1	2
Loss of native habitat	-2	-1	0	1	2

What were the reasons for the changes that occurred:

____

____

____

____

____

	SD	D	S	I	SI
C - Management Practices					
Riparian planting	-2	-1	0	1	2
Agroforestry	-2	-1	0	1	2
Space Planting (10-50 stems ha)	-2	-1	0	1	2
Production forestry	-2	-1	0	1	2
Conservation forestry planting	-2	-1	0	1	2
Planting windbreaks/shelterbelts	-2	-1	0	1	2
Retiring steep land	-2	-1	0	1	2
Retiring gully land	-2	-1	0	1	2
Physical erosion-prevention structures in stream beds	-2	-1	0	1	2
Contouring and physical land works	-2	-1	0	1	2
Living-dead barriers to soil erosion on slopes	-2	-1	0	1	2
Oversowing/direct drilling	-2	-1	0	1	2
Cultivating across slopes	-2	-1	0	1	2
Sediment traps in streambeds	-2	-1	0	1	2
Feed crop rotations	-2	-1	0	1	2
Intensive grazing	-2	-1	0	1	2
Fenced riparian strips for stock exclusion	-2	-1	0	1	2
Pesticide management programmes	-2	-1	0	1	2
Integrated Pest Management (IPM) programmes	-2	-1	0	1	2
Increased fertiliser management	-2	-1	0	1	2

Some blank lines have been inserted so you can add any further practices you consider relevant, and rank them according to the same scale.

	SD	D	S	I	SI
______________________	-2	-1	0	1	2
______________________	-2	-1	0	1	2
______________________	-2	-1	0	1	2
______________________	-2	-1	0	1	2
______________________	-2	-1	0	1	2

PART V - BARRIERS/CONSTRAINTS TO SUSTAINABLE AGRICULTURE

What constraints to adopting more "environmentally friendly" or sustainable agriculture can you identify.

PART VI - PERSONAL DETAILS

Gender: Male ☐ Female ☐

Age:
15-25 ☐
25-35 ☐
35-45 ☐
45-60 ☐
60- ☐

Occupation: ______________________________

Education: ______________________________
(List all qualifications) ______________________________

Location: ______________________________

Farm type: ______________________________

Farm size (hectares): ______________________________

Professional Affiliations: ______________________________
(eg. Fed. Farmers) ______________________________
____

B.4 - Covering Letter mailed to Senior Staff Member at Organisations covered by Professional Staff Sample

Grant King
FREEPOST 15
Resource and Environmental Planning
Massey University
Private Bag 11222
PALMERSTON NORTH

30 November 1994

Dear

Please find attached some copies of a survey on sustainable agriculture that I am conducting for my Masterate in Planning. The survey has been sent to the various stakeholders in the agricultural sector.

Could you please give these copies of the survey to your staff that are involved in the area of agriculture and land management.

- This will only take **10 minutes to complete**.
- The results are very important for my thesis and the results are eagerly anticipated by various people involved in agriculture.
- The views held by people such as yourself are important for the study.
- All returns will be confidential and privacy of information supplied is guaranteed. The results of individual returns will not be published. Instead only overall totals will be reported in my thesis
- Please send the completed surveys in the enclosed Postage Paid and addressed envelopes **no later than 19 December.**

Thank you for your time and assistance.

Yours sincerely

Grant King

B.5 - Covering Letter mailed with Professional Staff Survey

Grant King
FREEPOST 15
Resource and Environmental Planning
Massey University
Private Bag 11222
PALMERSTON NORTH

30 November 1994

Dear Sir/Madam,

Please find attached a copy of a survey on sustainable agriculture that I am conducting for my Masterate in Planning. The survey has been sent to the various stakeholders in the agricultural sector.

✎ Please take **10 minutes** out of your busy schedule to complete this survey.

✎ The results are very important for my thesis and are eagerly anticipated by various people involved in agriculture.

✎ The views held by people such as yourself are important for the study.

✎ All returns will be confidential and privacy of information supplied is guaranteed. The results of individual returns will not be published. Instead only overall totals will be reported in my thesis

✎ Please send the completed surveys in the enclosed Postage Paid and addressed envelope **no later than 19 December**.

Thank you for your time and assistance.

Yours sincerely

Grant King

B.6 - Professional Staff Survey

Sustainable Agriculture

Survey

Please return to:

FREEPOST 15
Grant King
Resource and Environmental Planning
Massey University
Private Bag 11222
PALMERSTON NORTH

by 19 December in the supplied pre-addressed and postage paid envelope.

PART I - AGRICULTURE AND THE ENVIRONMENT

Briefly identify the main characteristics of sustainable agriculture.

PART II - GENERAL OPINIONS ON SUSTAINABLE AGRICULTURE

Respond to the following statements, by circling the appropriate number according to this scale:

Strongly Disagree	SD	1
Disagree	D	2
Undecided	U	3
Agree	A	4
Strongly Agree	SA	5

		SD	D	U	A	SA
1.	Agricultural systems involving monocultures are more susceptible to pests/diseases than polycultural agricultural systems.	1	2	3	4	5
2.	Agroforestry gives a greater commercial return.	1	2	3	4	5
3.	Current soil erosion rates are an acceptable byproduct of agricultural land-use.	1	2	3	4	5
4.	The use of marginal land involves practices that are not economically sustainable.	1	2	3	4	5
5.	The use of marginal land involves practices that are not environmentally sustainable.	1	2	3	4	5
6.	Soil is a finite resource unless managed carefully.	1	2	3	4	5
7.	Reliance on non-renewable resources, such as fossil-fuels or fertilisers, threatens the long-term viability of agriculture.	1	2	3	4	5
8.	Energy intensive agricultural enterprises, which use high energy inputs in relation to the products they yield, are not environmentally sound.	1	2	3	4	5

		SD	D	U	A	SA
9.	Some loss of short-term profit may be required to ensure long-term commercial returns.	1	2	3	4	5
10.	Extension research and education with the rural community will be important to ensure that future agriculture is environmentally friendly.	1	2	3	4	5
11.	Human health risks from food and fibre produced by agriculture will be increasingly important in the future.	1	2	3	4	5
12.	Rural-residential development on good quality soils is not environmentally friendly.	1	2	3	4	5
13.	Social and community services, such as schools, in the rural community are essential to its survival.	1	2	3	4	5
14.	Efficient cycling of nutrients within agricultural systems is required for environmental reasons.	1	2	3	4	5
15.	Efficient cycling of nutrients within agricultural systems is required for economic reasons.	1	2	3	4	5
16.	Conservation of native habitats and species within agricultural areas is important.	1	2	3	4	5
17.	Sustainable agricultural systems substitute higher levels of knowledge for external resource inputs.	1	2	3	4	5
18.	Information requirements for "environmentally friendly" agricultural systems are higher due to the knowledge and management requirements.	1	2	3	4	5

		SD	D	U	A	SA
19.	A team approach is required for environmentally friendly agriculture, to best understand the agricultural system.	1	2	3	4	5
20.	The farmer should be central to the research and development required to make sustainable agriculture a practical reality.	1	2	3	4	5

PART III - WAYS OF ACHIEVING SUSTAINABLE AGRICULTURE

Rate the following methods for achieving sustainable agricultural practices using the scale:

Strongly Disapprove	SD	1
Disapprove	D	2
Neutral	N	3
Approve	A	4
Strongly Approve	SA	5

		SD	D	N	A	SA
1	Pollution charges	1	2	3	4	5
2	Subsidies for desirable practices, taxes for undesirable practices.	1	2	3	4	5
3	Grants	1	2	3	4	5
4	Income tax deductions or rebates	1	2	3	4	5
5	Rates rebates	1	2	3	4	5
6	Regulation	1	2	3	4	5
7	Education	1	2	3	4	5
8	Further research	1	2	3	4	5

PART IV - BARRIERS/CONSTRAINTS TO SUSTAINABLE AGRICULTURE

What constraints to adopting more "environmentally friendly" or sustainable agriculture can you identify.

PART V - PERSONAL DETAILS

Gender: Male ☐ Female ☐

Age:
15-25 ☐
25-35 ☐
35-45 ☐
45-60 ☐
60- ☐

Occupation: ______________________________

Education:
(List all qualifications)
____
____
____

Location: ______________________________

Professional Affiliations:
____
____
____

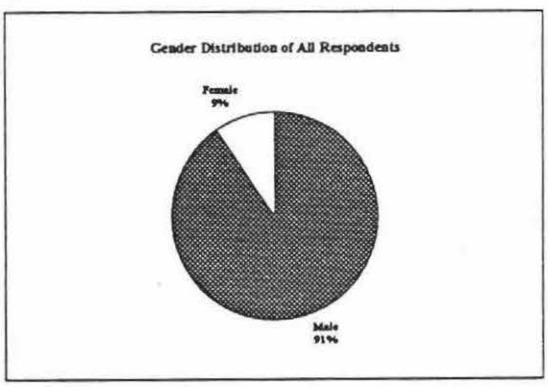
Appendix C
Rationale for Demographic Details and Distribution of Resulting Sample

This appendix describes the demographic breakdown of the sample, and discusses why each of the demographic variables was used in this survey.

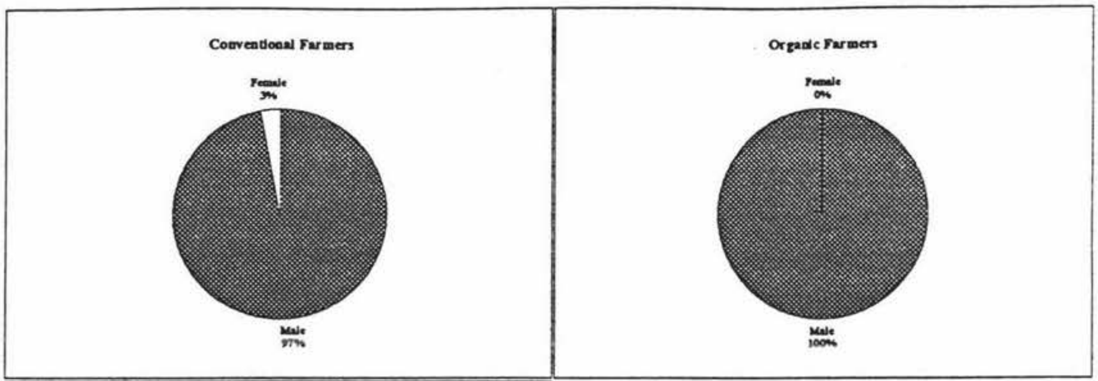
C.1 - Gender

This very much a standard demographic detail queried in a survey. Figure C.1 illustrates the gender distribution of the entire survey sample. The sample obviously has a bias in favour of males (91%) against females (9%).

FIGURE C.1 - Gender distribution of entire sample.



As Figure C.2 indicates, the bulk of the females in the overall sample came from the professional staff, where 20% of the respondents were female. This value was determined by the senior staff member contacted, who disseminated copies of the surveys to staff they considered appropriate (Section 4.4). The organic farmers sample was selected from the person listed in the NZBPCC list of certified producers.



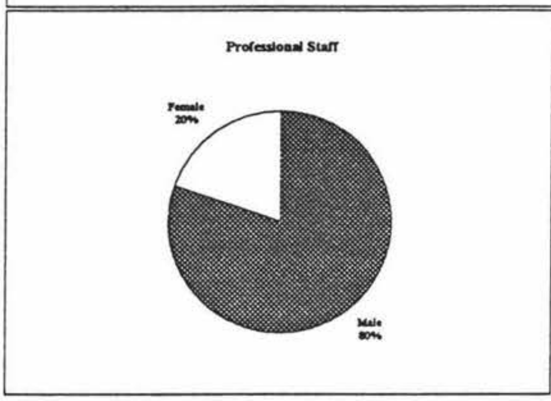
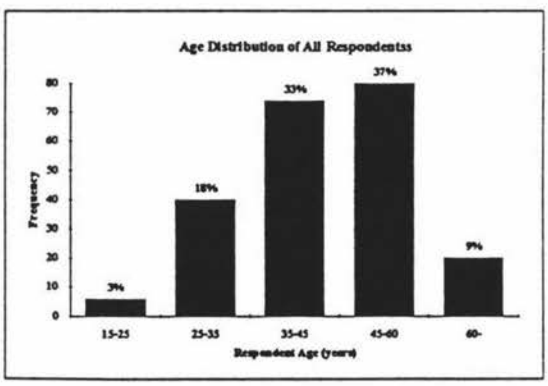


FIGURE C.2 - Gender distribution of resulting respondents from each stakeholder group.

C.2 - Age

Again, this is a standard demographic detail. Korsching *et al.* (1983) used it in their study of adopter characteristics of soil conservation measures. Wilson (1992) also considered age to be linked to attitudes to forest areas within farms. The age distribution of the entire sample is shown in Figure C.3, with five categories used; 15-25, 25-35, 35-45, 45-60 and 60-.

FIGURE C.3 -Age distribution of entire sample.



The majority of the respondents aged 45-60 and all of the respondents aged 60- in the overall sample, came from the conventional farmer sample, as can be seen in Figure C.4. The total of the sample aged 35-45 was split between the professional staff and the conventional farmers, with the professional staff contributing slightly more. There were no professional staff in the 60- age class, due to the retirement age policies of the organisations surveyed. Only 6% of the professional staff respondents were in the 15-25 age class, which may reflect the length of time taken to achieve adequate tertiary education to obtain the relevant positions in these organisations.

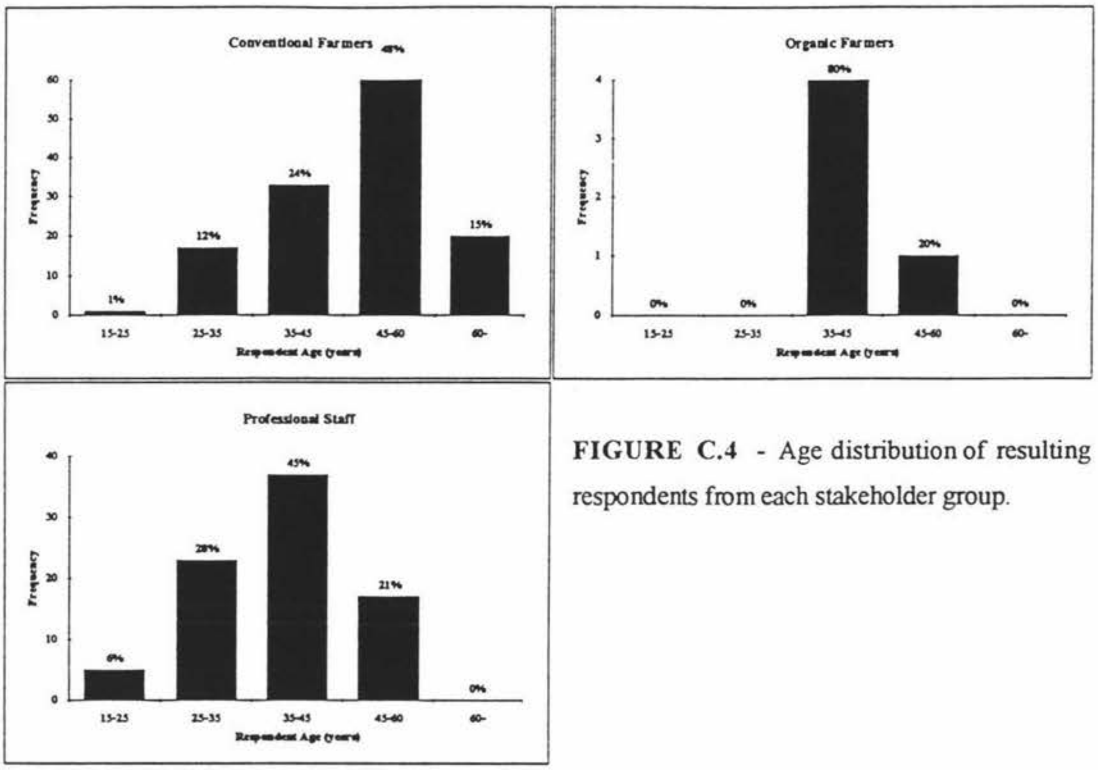


FIGURE C.4 - Age distribution of resulting respondents from each stakeholder group.

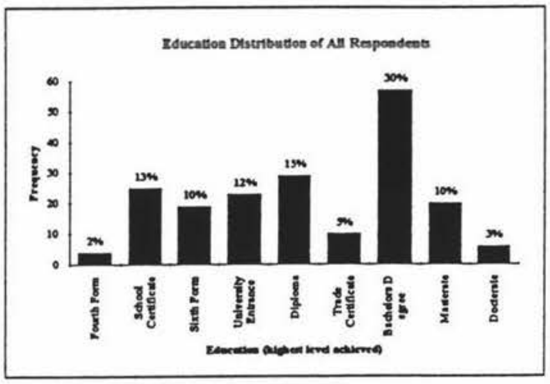
Figure C.4 shows that the age distribution of the conventional farmers has a tendency to bias towards the older age classes (reflecting the increasing age of farmers in New Zealand covered in Section 2.2.3). The organic farmer sample is small, but centred on the 35-45 year age class. The professional staff sample has a bias towards the younger respondents (28% aged 25-35) in a sample that has some resemblance to a 'normal' distribution, except for the lack of 60- year aged respondents as previously mentioned.

C.3 - Education

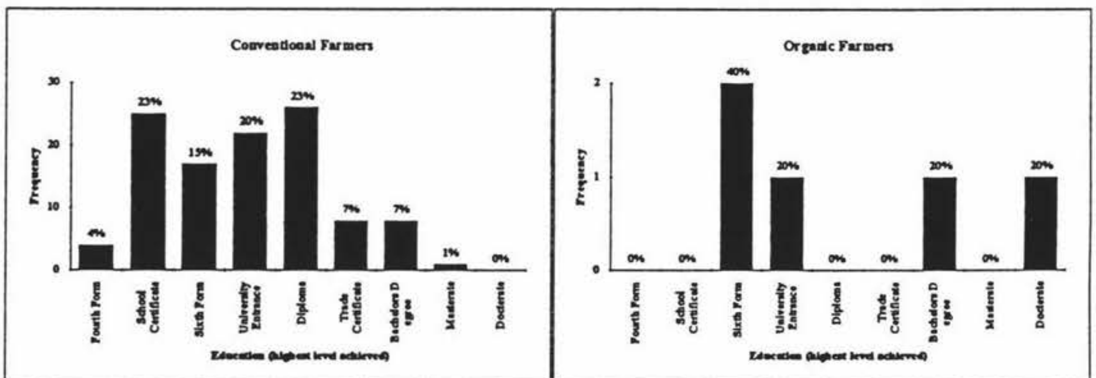
The link between education and attitudes to soil conservation and other environmental issues on farms was discussed by Korsching *et al.* (1983), Wilson (1992) and Ervin & Ervin (1982). The question merely asked for the highest levels of qualification achieved, and these were graded in a sequence (not continuous, as early stages represent subsequent years of secondary schooling, while latter stages represent PhDs, which can take many years for the one stage in the sequence). But the aim was to grade from lower levels of education, through to higher levels, as shown in Figure C.5. The individual graphs in Figure C.6 illustrate the professional staff having higher levels of formal education, as they comprise the majority of the

Bachelors, Masterates and PhDs in the total sample (Figure C.5) The conventional farmers have, on average, lower levels of formal education, and they are represented in the distribution of the entire sample (Figure C.5) as the secondary school level and under-graduate diploma level respondents.

FIGURE C.5 - Education distribution of entire sample.



The organic farmer sample was small, with education levels ranging between sixth-form certificate to PhD.



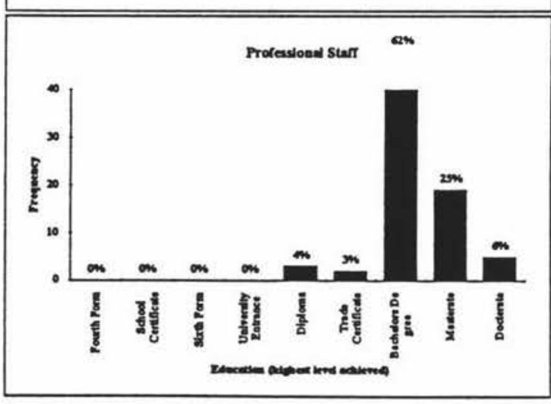
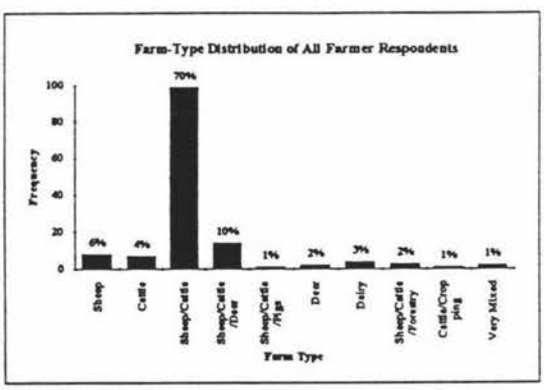


FIGURE C.6 - Education distribution of resulting respondents from each stakeholder group.

C.4 - Farm-Type

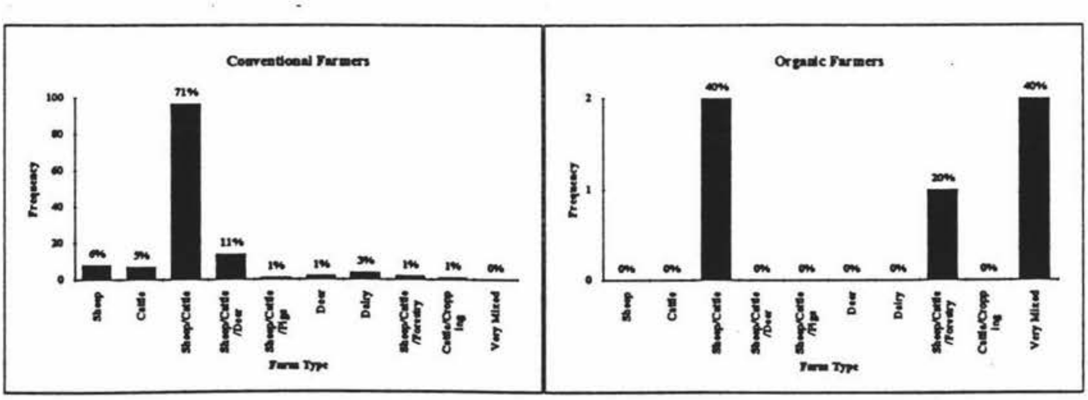
The farm type of the conventional farmers and organic farmers was also queried The importance of farm-type was considered, as this affects the intensity of land-use, types of land used, intensity of management required and types of management practices. The diversity of the production base of the respondent's farm may also affect their attitudes and answers to the survey. These varying characteristics of land-use are discussed under the 'site-specificity' issues in Section 2.1, and affect the requirements of sustainable agriculture at each individual farm, and thus the land-owners perceptions Figure C.7 indicates the majority of all farmers surveyed (both conventional farmers and organic farmers) were sheep/cattle farmers. This reflects the land-use in the Rangitikei, which the Department of Statistics (1995a, p 362) state is "semi-intensive sheep and beef in the hill country of Rangitikei."

FIGURE C.7 - Farm-type distribution of entire sample.



The conventional farmer sample shown in Figure C.8 comprises the bulk of the entire farmer sample, and thus the conventional farmer sample mirrors the entire farmer sample. The organic farmer sample although it is small, as Figure C.8 shows, the farms represent more diverse farming systems than the conventional farmer sample.

FIGURE C.8 - Farm-type distribution of conventional farmer and organic farmer samples.



C.5 - Farm-Size

The farm-size of the conventional farmers and organic farmer samples were also asked. The size of the farm was noted by Pampel & Van Es (1977) as a determinant of the adoption of profitable commercial practices. The size of the farm may also reflect the intensity of use (intensive versus extensive) and this may impact on perceived problems and practices undertaken. The farm-sizes of the respondents, in hectares were grouped into five classes; 0-150 ha, 151-250 ha, 251-500 ha, 501-750 ha and 751-1000 ha. This enabled the attitudes and practices of the farmers to be assessed by farm-size. The use of the numerical hectare value would give insignificant mean values, as the number of farms with 350 ha size, may be only one, which is too low. There were 9 conventional farmers that had farm-sizes that were too big for the classes (above 1000 ha) and there was also 1 organic farmer who had a farm-size that was too large. Figure C.9 illustrates the distribution of farm-sizes for all the respondents. The bulk of the respondents had farm-sizes of 251-500 ha, and 151-250 ha.

FIGURE C.9 - Farm-size distribution of entire sample.

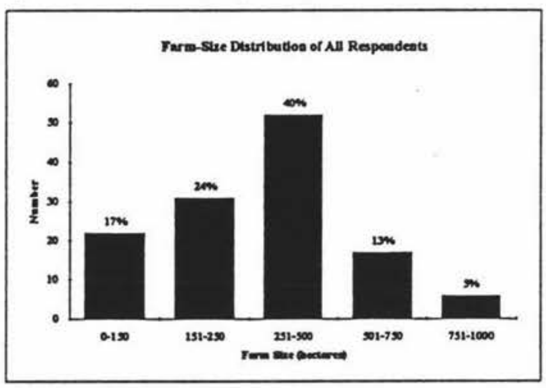


Figure C.10 shows the distribution of farm-sizes for both the conventional farmer and organic farmer samples. The organic farmer sample is small, but the farm-size tends to bias towards the smaller classes of farm-size. Table C.1 contains the average farm-size in hectares, along with the largest and smallest sizes. Again, the data indicates that the farms run by the conventional farmers, are on average larger (473.6 ha), than that of their organic counterparts (348.6 ha).

FIGURE C.10 - Farm-size distribution of conventional farmers and organic farmer samples.

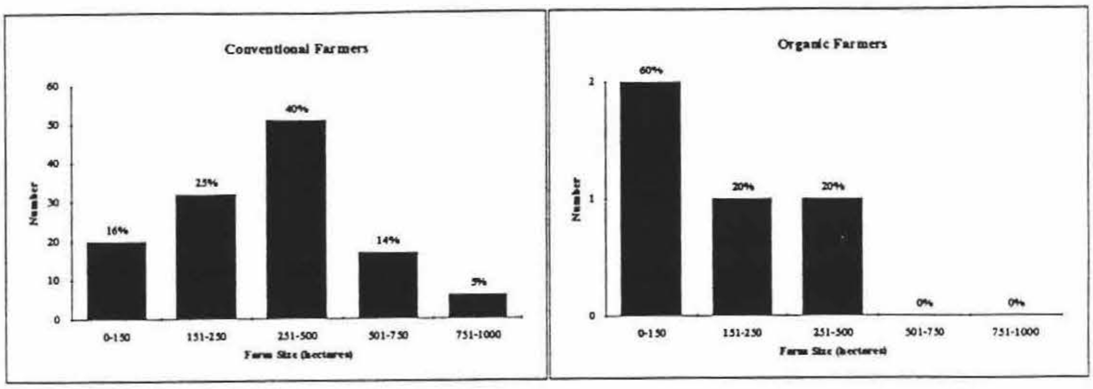


TABLE C.1 - Farm-size details of conventional farmer and organic farmer samples (hectares).

	Conventional Farmers	Organic Farmers
Average Farm-Size	473.4	348.6
Smallest Farm-Size	7	23
Largest Farm-Size	12000	1200

C.6 - Professional Affiliations

A question regarding the professional affiliations held by the respondents was asked as Korsching *et al.* (1983, p 429) stated that membership and involvement in organisations was related to the "innovativeness" of respondents in their survey on adopting soil conservation programmes. The involvement in professional organisations can preform an educational role, with contacts trough meetings, newsletters, conferences and journals, giving a potential point-of-contact with other farmers, or professional staff, who have knowledge and experience, which can increase farmers awareness and understanding of issues. The same can be said for professional farmers. Figure C.11 indicates that the number of respondents holding no affiliations was high at 39%, with the number holding an increasing number of affiliations, gradually decreasing.

FIGURE C.11 - Professional affiliation distribution of entire sample.

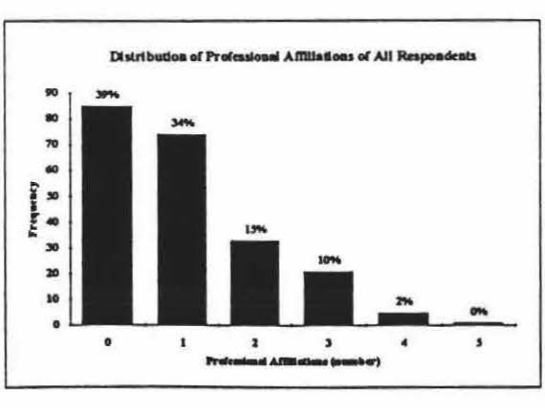
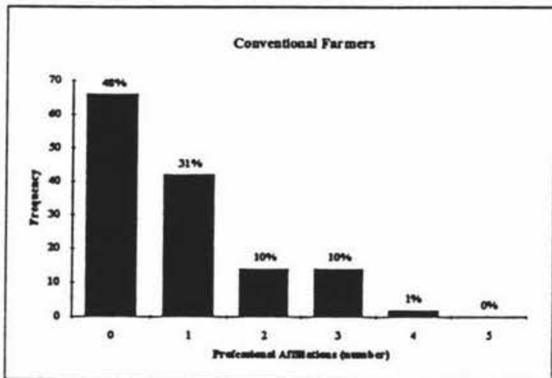
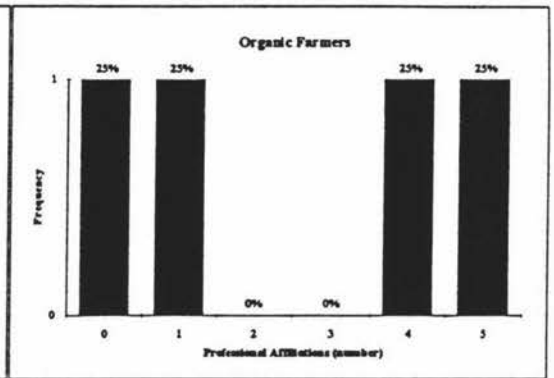


Figure C.12 illustrates that 48% of the conventional farmers had no professional affiliations, and 23% of the professional staff fell into the same category. The professional staff had, on average, more affiliations than the conventional farmers, with 40% having one professional affiliation and 24% having 2 professional affiliations. The numbers having 3 professional affiliations was similar between the stakeholder groups, covering 10% of the conventional staff, and 9% of the professional staff. The organic farmers sample had a wide range of results within the small sample, with one respondent each with 0, 1, 4 and 5 affiliations.





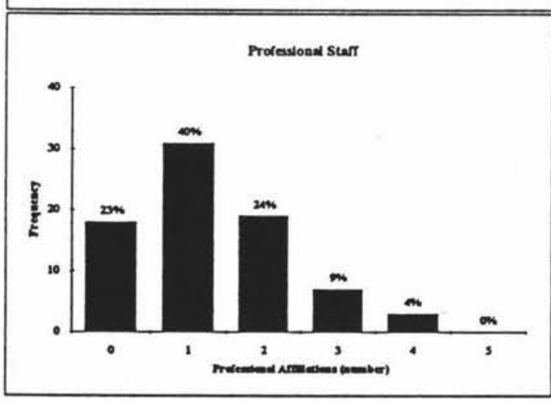


FIGURE C.12 - Professional affiliations distribution of resulting respondents from each stakeholder group.

C.7 - Occupation

The occupations of the respondents, in terms of the position they held, were coded for all the respondents. The results were too detailed, with small numbers in some of the classes, so the statistical analysis was statistically questionable. Therefore this demographic detail was not used in the analysis of the results, with stakeholder group used instead.

C.8 - Location

This gave coding for the organisation or location of the farm, where the respondent originated. Again, the results were too detailed and were of little statistical significance or value, and were not used in the analysis.

Appendix D
Analysis of Interrelationships Between Demographic Attributes of Survey Respondents

D.1 - Explanation and Justification for This Analysis

The following is the analysis that was undertaken to identify any interrelationships that may exist between the demographic details of the respondents to the survey. These interrelationships may explain why some results in the analysis chapters of the thesis (Chapters 5, 6, 7, 8, 9, and 10) occurred. For example, the mean farm-size for the respondent could vary according to the age of the respondent. Thus it may be the higher or lower average farm-size of the age-group to which the respondent belongs, as opposed to age *per se*, that affects the answer given by the respondent.

The statistics program Minitab was used to carry out a Chi-Square analysis between the stakeholder group, sex, age, education, farm-type and professional affiliations, of each respondent. The Chi-Square analysis was used as the dependent variable data for these six attributes was nominal. This means that the data had a set number of categories, but the intervals between the categories are not equal). The farm-size data (although not nominal in the hectare form) was included in this analysis by the use of the 5 size classes form used in the statistical analysis of Chapters 5, 6, 7, 8, 9 and 10. These classes with the relevant hectare numbers is shown in Table D.1 overleaf. These classes were applied to enable the use of the SAS 'ANOVA' command for analysis of the results from the various questions returned by the survey respondents.

The results for the Chi-Square analysis is shown in Table D.2. The blank boxes represent the instances where the statistics package found that no significant relationship exists between the two attributes. The significant relationships between attributes are shown with the significance level to which the statistics package calculated exists for that relationship. The significant relationships are discussed in the following Section D.2. The shaded boxes represent the same interrelationships on the other side of the matrix table. If these were shown they would simply mirror the results shown on the left of the matrix and to avoid duplication of the results, they are left shaded. The black boxes illustrate the intersection between the same demographic attribute in each axis of the table, and the subsequent analysis of the attribute against itself would give a 'nonsense' result, so is not undertaken.

TABLE D.1 - Classes used for analysis of the farm-sizes of respondents as a determinant for responses to survey questions.

FARM-SIZE CLASS	HECTARE VALUE
1	0-150
2	151-250
3	251-500
4	501-750
5	751-1000

The SAS statistics package was also used to analyse the stakeholder group, sex, age, education, farm-type, and professional affiliations, against the farm-size of the respondent. The use of the Analysis of Variance (ANOVA) was required as the dependent variable data (farm-size) is interval data. This means that the data has equal intervals between the categories (in this case farm-size is measured in hectares).

The results for the ANOVA analysis are shown in Table D.3. The shaded boxes represent the analysis undertaken in the Chi-Square analysis outlined above. The white boxes illustrate the data analysed by the ANOVA analysis. The only significant relationship shown in Table D.3 is discussed in section D.3 of this Appendix. The black boxes illustrate the intersection between the same demographic attribute in each axis of the table, and the subsequent analysis of the attribute against itself would give a 'nonsense' result, so is not undertaken.

D.2 - Chi-Square Analysis of Demographic Attributes

The significant relationships shown on Table D.2 are discussed in detail below. For these interrelationships, comments are made on the trends shown by the statistics and how these may affect the analysis undertaken in this thesis.

Stakeholder Group by **Sex (Column 1** by **Row 2)**
This was significant to the 0.001 level

Of the conventional farmers, 127 were male (118.93 expected) and 4 were females (12.07 expected). There were slightly more males in the sample of conventional farmers than expected. The expected number of females in the groups still was not high, and the male-dominated sample may well influence the way in which answers are given.

TABLE D.2 - Results table of chi-square analysis on interrelationships between demographic attributes of survey respondents

		Demographic Variable						
		1	2	3	4	5	6	7
	Demographic Variable	Stakeholder Group	Sex	Age	Education	Farm-Type	Farm-Size	Professional Affiliations
1	Stakeholder Group							
2	Sex	Significant to 0.001						
3	Age	Significant to 0.001	Significant to 0.001					
4	Education	Significant to 0.001	Significant to 0.001	Significant to 0.01				
5	Farm-Type	Significant to 0.001			Significant to 0.01			
6	Farm-Size							
7	Professional Affiliations	Significant to 0.001				Significant to 0.01		

Of the organic farmers, 4 were male (3.63 expected) and none were female (0.37 expected). One reply was by both partners and could not be classed. The small sample of organic farmers makes any comments on the gender balance in the survey sample difficult, as statistically significant conclusions cannot be drawn from such as small number.

For the professional staff, 66 were male (74.66 expected) and 20 were female (7.56 expected). There were more females in the group than expected, with greater involvement in this stakeholder group than the other two, more male-dominated, stakeholder groups. The ratio of females to males in this stakeholder group is still only 1 to 3, but the significantly higher ratio than the other two stakeholder groups may affect the answers given.

Stakeholder Group by **Age (Column 1** by **Row 3)**
This was significant to the 0.001 level.

Of the conventional farmers, the distribution of ages was skewed y a large number of older respondents. The number of conventional farmers in the 45-60 age group was 65 (50.62 expected) and 20 were aged 60- (12.20 expected). The numbers for the 15-25, 25-35 and 35-45 age groups were lower than expected. With 62.5% of the conventional farmer respondents aged over 45 years, the responses to the questions may be influenced by the older 'mind-sets' involved. Farmers do not retire - well known fact!!!!

For the organic farmers, 4 were aged between 35-45 (1.66 expected) and 1 was aged 45-60 (1.86 expected). There would appear to be a greater number in the centre of the age distribution, although again, it is difficult to comment on the age distribution when the numbers involved in the sample are so small.

Of the professional staff, 37 were aged 35-45 (27.21 expected), with only 17 aged 45-60 (30.52 expected) and none aged 60- (7.35 expected). The retirement policies held by most of the organisations from which the respondents came would preclude them from working into this highest age group. There were 5 respondents aged 15-25 years (2.21 expected) and 23 were aged 25-35 (14.71 expected), so a much higher number of younger persons work in the professional stakeholder group. Whether this reflects a higher rate of young people in this group or whether these younger people were made to fill out the survey by their superiors would be unknown (probably a mix of the two). A higher number of younger people in this group may affect the outlook given overall by this group, and how they view agricultural sustainability.

Stakeholder Group by **Education (Column 1** by **Row 4)**
This was significant to the 0.001 level.

Of the conventional farmers, 25 had School Certificate as the highest level of education achieved (14.38 expected), 17 had up to Sixth Form Certificate (10.93 expected), 22 had University Entrance (13.23 expected) and 26 had an Undergraduate Diploma (16.68 expected). These were all higher than expected, so there is a lower level of education amongst this group as opposed to the other two. Having said that, 8 had a Bachelors degree (32.78 expected) and 1 had a Masterate degree (11.50 expected). There are a number of farmers in the sample who hold university degrees, mostly in agriculture, which are becoming more common amongst the farming community. The levels of university education held by the farmers is not as high as the professional staff, but is reasonably reassuring. The increase in the level of education level of the farming community should increase awareness of sustainability issues, if these are taught in the curriculum.

For the organic farmers, 2 had Sixth Form Certificate (0.49 expected), 1 had University Entrance (0.60 expected) 1 had a Bachelor degree (1.48 expected) and 1 had a PhD (0.16 expected). There is a wide spread in this distribution, with higher than expected levels with low level levels of education and higher than expected numbers with higher levels of education. Again with the small sample, it only requires one or two farmers in one education class to make a difference between lower and higher levels than expected. The sample is too small to make a sound comment on.

Of the professional staff, as the highest level of education received, 0 had Fourth Form (1.60 expected), 0 had School Certificate (9.97 expected), 0 had Sixth Form Certificate (7.58 expected) and 0 had University Entrance (9.18 expected). There were therefore much lower levels of respondents with low levels of education than was expected (none in fact). 3 of the respondents had an Undergraduate Diploma (11.57 expected) and 2 had a Trade Certificate (3.99 expected), which indicates lower than expected respondents with this medium level of education. When it came to the higher levels of education, 48 of the professional staff respondents had a Bachelor degree (22.74 expected), 19 had a Masterate degree (7.98 expected) and 5 had a PhD (2.39 expected). There was a disproportionate number of highly educated people in this stakeholder group, and this higher level of training must affect the answers to questions, offered by this group in relation to those offered by the other groups.

Stakeholder Group by **Farm-Type (Column 1** by **Row 5)**
This was significant to the 0.001 level.

The large number of conventional farmers, compared to the number of organic farmers, upsets the results generated by chi-square analysis. The statistics involved in the chi-square table, mean that the large number of conventional farmer respondents, means that the actual values for each farm-type are closely matched to the expected number. The chances of differences occurring between the expected and actual are therefore slight.

Of the conventional farmers, the numbers of respondents for each farm-type, closely matched the expected number in almost all the cases, apart from the 0 'Very mixed' farms (1.93 expected). Again as explained above, the actual match the expected due to the bulk of the sample falling into the conventional farmers subsample.

Of the organic farmers there were 2 'Very mixed' farms (0.07 expected). But due to the small number in the organic farmer sample and the large number in the conventional farmer, drawing conclusions on the increased diversity amongst the organic farms as opposed to the conventional farmers would be very difficult.

Stakeholder Group by **Professional Affiliations (Column 1** by **Row** 7)
This was significant to the 0.001 level.

Of the conventional farmers, 66 had 0 professional affiliations (53.22 expected), 42 had 1 professional affiliation (46.42 expected) and 14 had 2 professional affiliations (13.17 expected). This indicates a low number of professional affiliations amongst the farmers, with 48% having no professional affiliations and 30% having only 1 professional affiliation. The lack of professional affiliations amongst the farmers hinders one possible source that they have for receiving information about pertinent agricultural research and sustainable agriculture issues.

In the case of the organic farmers , 1 had no professional affiliations (1.55 expected), 1 had 1 professional affiliation (1.35 expected), 1 had 4 professional affiliations (0.11 expected) and 1 had 5 professional affiliations (0.02 expected). There were a number with higher professional affiliations than the other farmer group, but again due to the small sample size, conclusions cannot be drawn from this.

Of the professional staff, 18 had no professional affiliations (30.14 expected), 31 had 1 professional affiliation (26.24 expected), 19 had 2 professional affiliation (11.70 expected), 7 had 3 professional affiliations (7.45 expected), 3 had 4 professional affiliations (2.13 expected) and 0 had 5 professional affiliations (0.35 expected). There were therefore lower numbers than expected with no professional affiliations, and higher than expected numbers with greater professional affiliations. The holding of professional affiliations is encouraged by many of the workplaces that the survey respondents work in, as the one going education and refresher courses in the latest issues and research facing the occupations that these people work in, are often offered by the sources of professional affiliations. The higher numbers held buy the professional staff again highlights the lack of these professional affiliations held by the conventional farmers.

Sex by **Age (Column 2** by **Row 3)**
This was significant to the 0.001 level.

Of the male respondents, 4 were aged 15-25 (5.44 expected), 27 were 25-35 (36.30 expected), 68 were aged 35-45 (64.43 expected), 79 were aged 45-60 (73.50 expected) and 18 were 60- (16.33 expected). The lack of younger male respondents is significant, especially the reduced level of those aged 25-35 than would be expected. The male sample is dominated by a large number of older respondents.

Of the female respondents, 2 were aged 15-25 (0.56 expected), 13 were aged 25-35 (3.70 expected), 3 were aged 35-45 (6.57 expected), 2 were 45-60 (7.50 expected) and 0 were aged 60- (1.67 expected). The lower number of females in the younger groups could be the result of Equal Employment Opportunities (EEO) now used in many organisations, whereas the older groups, with lower than expected levels of females, would register lower due to disadvantages offered under previous employment policies that may have discriminated against them.

Sex by **Education (Column 2** by **Row 4)**
This was significant to the 0.001 level.

Of the male respondents, 19 had Sixth Form Certificate (17.08 expected), 21 had University Entrance (18.88 expected), and 29 had an Undergraduate Diploma (26.07 expected). The higher than expected levels of these education types could be explained by the farmers in the sample, as this mirrors the higher than expected levels of these education types for farmers. 45 had a Bachelor degree (49.44 expected) and 13 had a Masterate degree (17.98 expected). The fewer than expected levels for the tertiary degrees could be explained by the offsetting due to the large number of farmers in the sample, which had increased levels of the lower education types as previously mentioned.

Of the female respondents, 2 had Sixth Form Certificate (2.53 expected), which does not vary from the expected value, and as the number is so small the conclusions that can be drawn from this are few. Of the remaining females in the survey sample, 10 had a Bachelor degree (5.56 expected) and 7 had a Masterate degree (2.02 expected). The high number of university degrees reflects the professional occupations of the female respondents (except for the 4 farmers). The high levels of education held by the female respondents would affect the responses to questions given.

Age by **Education (Column 3** by **Row 4)**
This was significant to the 0.01 level.

Of the respondents aged 15-25, 5 had a Bachelor degree (1.77 expected) and 1 had a Masterate degree (0.62 expected). There were no respondents with lower levels of education than a bachelor degree, which indicates a higher than expected level of education for this age group, although the small numbers involved, makes drawing firm conclusions on this, difficult.

Of the respondents aged 25-35, fewer than expected had secondary school level education as the highest qualifications achieved. Of the remainder, 8 had an Undergraduate diploma (5.41 expected), 16 had a Bachelor degree (10.63 expected) and 7 had a Masterate degree (3.73 expected). The higher than expected levels of tertiary education held by this group may reflect the answers given to questions in the survey. The lack of respondents in this age group with high-school education as the highest level would also affect the replies to questions.

Of the respondents aged 35-45, the numbers with secondary school education as the highest level obtained, was lower than expected. Of the remainder, 22 had a Bachelor degree (19.79 expected), 9 had a Masterate degree (6.94 expected) and 5 had a PhD (2.08 expected). Again the levels of education for this group are higher on average than expected, which would impact on the results given by this age group. The high number of PhD respondents reflects the age grouping of the scientists and academics in the survey sample.

Of the respondents aged 45-60 years, 15 had obtained School Certificate as the highest level (8.94 expected), 12 had up to Sixth Form Certificate (6.79 expected) and 10 had University Entrance (8.22 expected). The higher than expected number of respondents with high school education as the highest level of education achieved may well will affect results given. Of the 45-60 age group, 5 had a Trade Certificate (3.58 expected). When it came to university degrees, 12 had a Bachelor degree (20.38 expected), 3 had a Masterate degree (7.15 expected) and 1 had a PhD (2.15 expected). The fewer than expected respondents with higher education levels would change the responses given by this group.

For the respondents aged 60- years, the numbers who had secondary school education as the highest level achieved were a little higher than expected. The numbers achieving university qualifications was lower than expected, with 2 having Bachelor degrees (4.43 expected) and none with Masterate or PhD degrees (1.55 and 0.47 expected respectively). There were low numbers involved in the 60- age group, which makes the conclusions difficult, but overall, the levels of education achieved by this group was lower than the younger groups.

Education by **Farm-Type (Column 4** by **Row 5)**
This was significant to the 0.01 level.

Of the sheep farmers, 1 had School Certificate (1.09 expected), 2 had Sixth Form Certificate (0.83 expected), 1 had University Entrance (1.00 expected) and 1 had an Undergraduate Diploma (1.13 expected). The low numbers in this group make drawing any conclusions difficult, but the lack of university study appears to exist in this group.

Of the cattle farmers, 2 had School Certificate (1.52 expected), 1 had Sixth Form Certificate (1.16 expected), 2 had University Entrance (1.40 expected) and 2 had an Undergraduate Diploma (1.58 expected). Again, the low numbers in this sample make the results inconclusive, but the lower education levels mirror the low education levels for the farmers on the whole, as shown in the stakeholder group-education analysis.

For the sheep/cattle farmers, 4 had Fourth Form (2.78 expected), 17 had School Certificate (17.39 expected), 11 had Sixth Form Certificate (13.22 expected), 18 had University Entrance (16.00 expected), 19 had an Undergraduate Diploma (18.09 expected), 5 had a Trade Certificate (5.57 expected), and 5 had a Bachelor degree (5.57 expected). There was 1 respondent with a Masterate degree and none with a PhD (0.70 expected for each). There are no great variations from the expected values for this group, as this farm-type makes up the bulk of the farmer sample, and the chi-square statistics will favour the sample.

The more diverse farm-types had too few respondents to comment on, as the number that existed under each education type was less than the Minitab package recommended as statistically sound. Overall the education levels of the different farm-types matches the lower levels held by the farmers as a stakeholder group, which was covered previously in this section (Column 1 Row 4).

Farm-Type by **Professional Affiliations (Column 5** by **Row 7)**
This was significant to the 0.001 level.

Of the sheep farmers, 6 had no professional affiliations (3.68 expected) and 2 had 1 professional affiliation (2.47 expected). The sample size is small and makes firm conclusions difficult, but the overall low number of professional affiliations for sheep farmers is not good for the information flow that they may receive on issues, such as sustainable agriculture and better management practices.

Of the cattle farmers, 3 had no professional affiliations (3.22 expected), 3 had 1 professional affiliation (2.17 expected) and 1 had 2 professional affiliations (0.71 expected). Again the numbers with professional affiliations is low, although they do not appear that different from the expected levels. The small sample size makes these calculations difficult and inconclusive.

For the sheep/cattle farmers, 46 had no professional affiliations (44.66 expected), 32 had 1 professional affiliations (30.01 expected), 8 had 2 professional affiliations (9.97 expected) and 10 had 3 professional affiliations (9.77 expected). Only 1 respondent had 4 and none had 5 professional affiliations (2.09 and 0.70 expected respectively). These are low, but they are not as bad as the more traditional farmers, like the sheep and the cattle farmers discussed above.

Of the sheep/cattle/deer farmers, 5 had no professional affiliations (6.45 expected), 2 had 1 professional affiliation (4.33 expected), 4 had 2 professional affiliations (1.41 expected) and 3 had 3 professional affiliations (1.41 expected). The lower than expected number for the lesser number of affiliations and the higher than expected number for the greater number of affiliations shows an above average number of affiliations compared to the more traditional farmers discussed previously. The smaller number of farmers in this farm-type would make the results less than 100 percent conclusive.

The remaining more diverse farm-types had too few respondents like the education analysis (Column 4 Row 5) and the number under each farm-type was less than the values recommended by the Minitab package as statistically sound. Overall the levels of professional affiliations held by the farmers under the various farm-types, matches the lesser levels of affiliations held by the farmers as a stakeholder group, which was covered previously in this section (Column 1 Row 7). Overall, the more traditional farm-types (solely sheep or cattle), did have lower numbers of affiliations than the sheep/cattle and the sheep/cattle/deer farmers.

D.3 - Analysis of Variance (ANOVA) on Demographic Attributes against Farm-Size

The sole significant relationship that is shown on Table D.3 is discussed on page D 12. For this interrelationship, comments are made on the trend within the relationship shown by the statistics and how this may affect the analysis undertaken in this thesis.

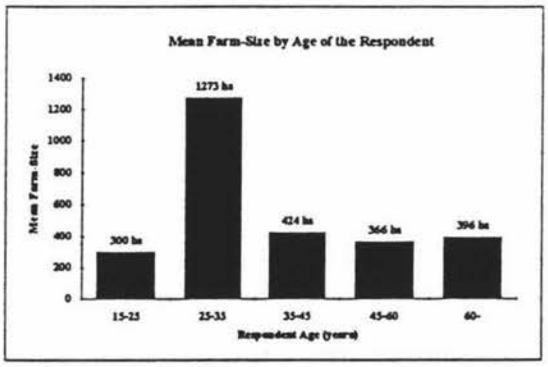
TABLE D.3 - Results Table of Analysis of Variance (ANOVA) on interrelationships between demographic attributes of survey respondents

		Independent Variable						
		1	2	3	4	5	6	7
	Dependent Variable	Stakeholder Group	Sex	Age	Education	Farm-Type	Farm-Size	Professional Affiliations
1	Stakeholder Group							
2	Sex							
3	Age							
4	Education							
5	Farm-Type							
6	Farm-Size			$F=2.56$ $\rho=0.0417$				
7	Professional Affiliations							

Farm-Size by **Age (Column 3** by **Row 6)**
This level of significance for this relationship was $F=2.56$ $\rho=0.0417$.

The only relationship found to be statistically significant by the SAS Analysis of Variance (ANOVA) was between age and farm-size. The mean farm-sizes for each of the age groups were, 300 hectares for the 15-25 year olds, 1273 hectares for the 25-35 year olds, 424 hectares for the 35-45 year olds, 366 hectares for the 45-60 year olds and 396 hectares for the 60- year olds. The significantly higher mean farm-size for the 25-35 age group can be seen below in Figure D.1.

FIGURE D.1 - Mean farm-size for each age-group using SAS ANOVA command.



The greatly increased farm-size for the 25-35 year olds may cause this age group to reply to questions in a different manner. They may well answer the questions with considerations to their larger farm properties that they run. The prospect of converting these larger properties to closed-systems, or reducing inputs, or changing to alternative agricultural systems may appear more daunting to this age group, as the scale or change and capital investment required may be too difficult.

Appendix E
Figures associated with the Analysis of Actual Agricultural Practices in Chapters 7 and 8

The following figures are from Chapters 7 and 8 on the reported agricultural practices by the conventional farmers and organic farmers. The figures are referred to in the text of these two chapters with the corresponding figure number and the page number within this appendix.

E.1 - Figures for Analysis of Practices termed 'Inputs'

FIGURE E.1 - Distribution of responses for changes in 'Pesticide use' as an agricultural practice by the stakeholder group of the respondent.

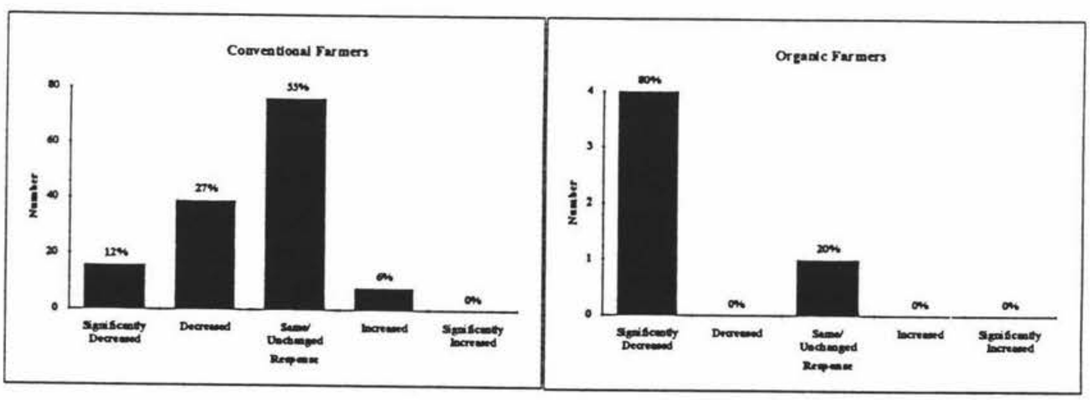


FIGURE E.2 - Mean response for level of change in 'Pesticide use' as an agricultural practice by the number of professional affiliations held by the respondent.

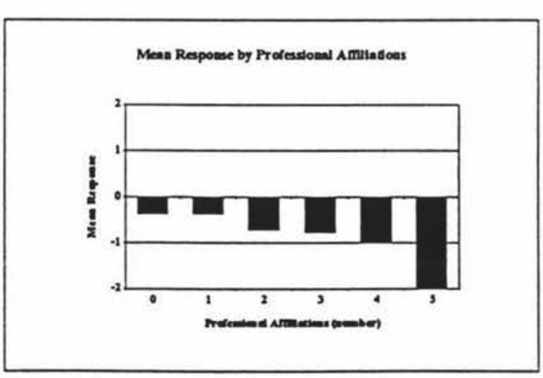


FIGURE E.3 - Distribution of responses for changes in 'Fertiliser use' as an agricultural practice by the stakeholder group of the respondent.

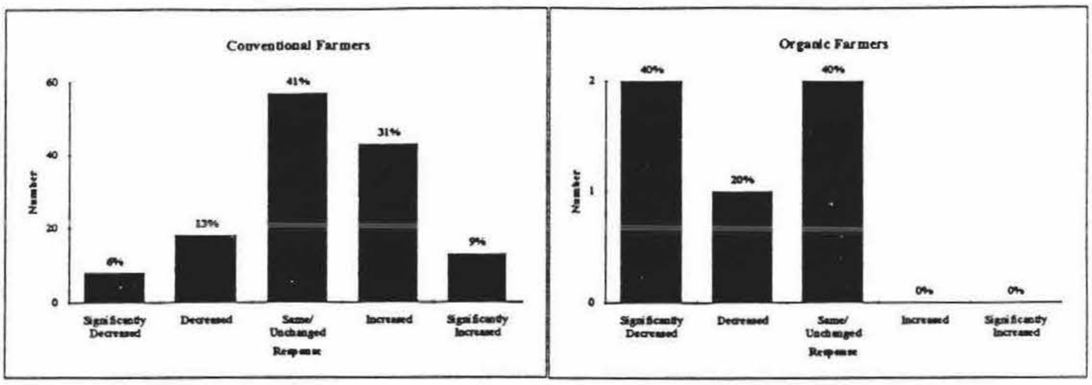


FIGURE E.4 - Mean response for level of change in 'Fertiliser use' as an agricultural practice by the number of professional affiliations held by the respondent.

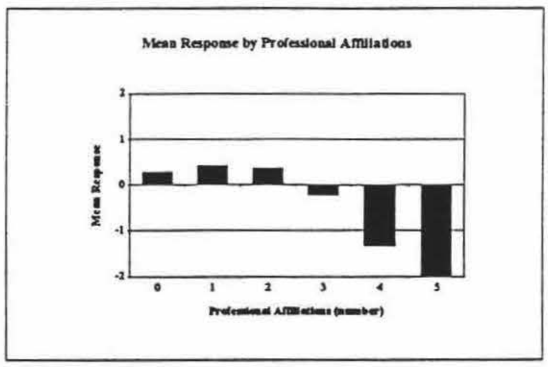


FIGURE E.5 - Mean response for level of change in 'Fertiliser use' as an agricultural practice by the highest level of education held by the respondent.

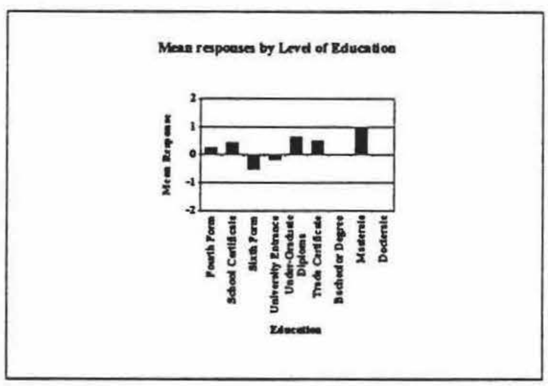


FIGURE E.6 - Mean response for level of change in 'Energy use' as an agricultural practice by the number of professional affiliations held by the respondent.

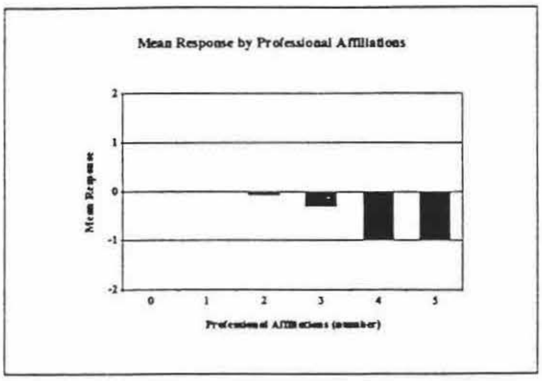


FIGURE E.7 - Mean response for level of change in 'Energy use' as an agricultural practice by the highest level of education held by the respondent.

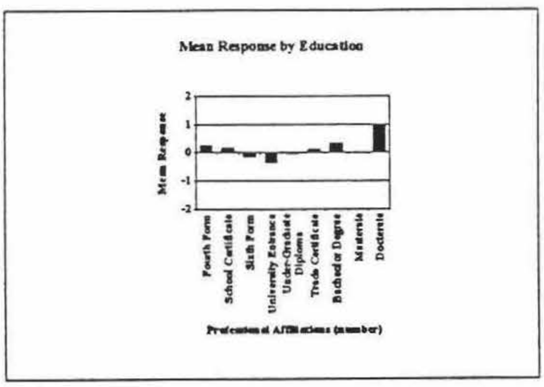


FIGURE E.8 - Distribution of responses for changes in 'Fungicide use' as an agricultural practice by the stakeholder group of the respondent.

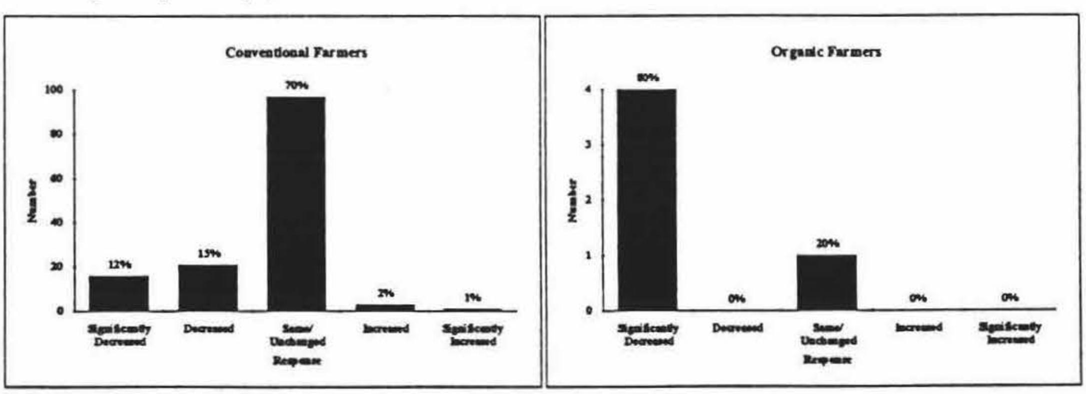


FIGURE E.9 - Mean response for level of change in 'Pesticide use' as an agricultural practice by the number of professional affiliations held by the respondent.

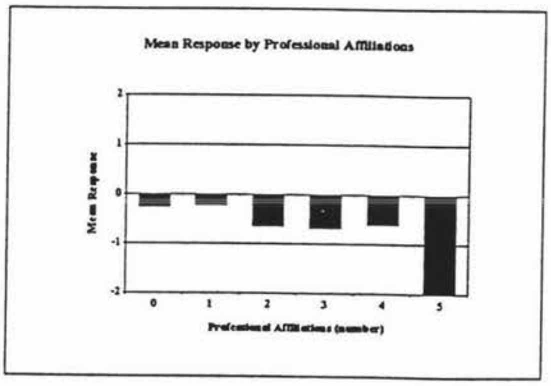


FIGURE E.10 - Distribution of responses for changes in 'Drenches/internal parasiticide use' as an agricultural practice by the stakeholder group of the respondent.

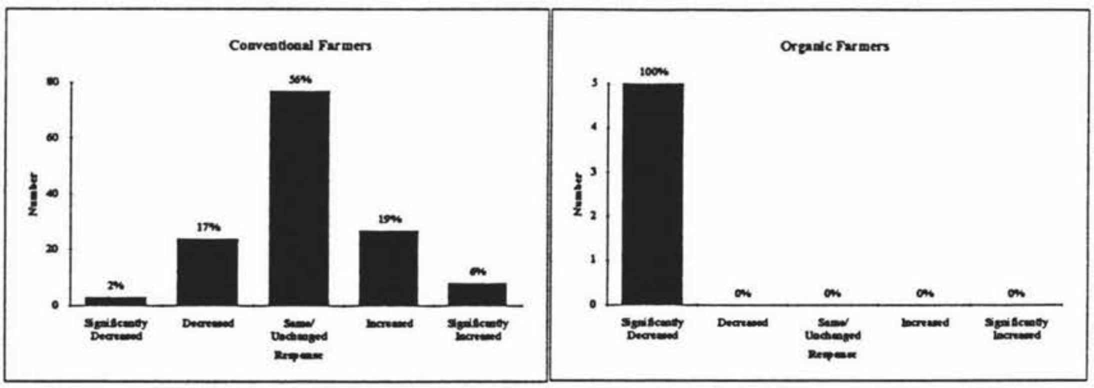


FIGURE E.11 - Distribution of responses for changes in 'Drenches/internal parasiticide use' as an agricultural practice by the age of the respondent.

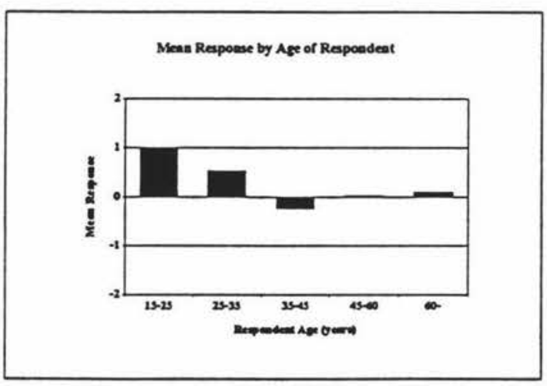


FIGURE E.12 - Distribution of responses for changes in 'Pour-ons/external parasiticide use' as an agricultural practice by the stakeholder group of the respondent.

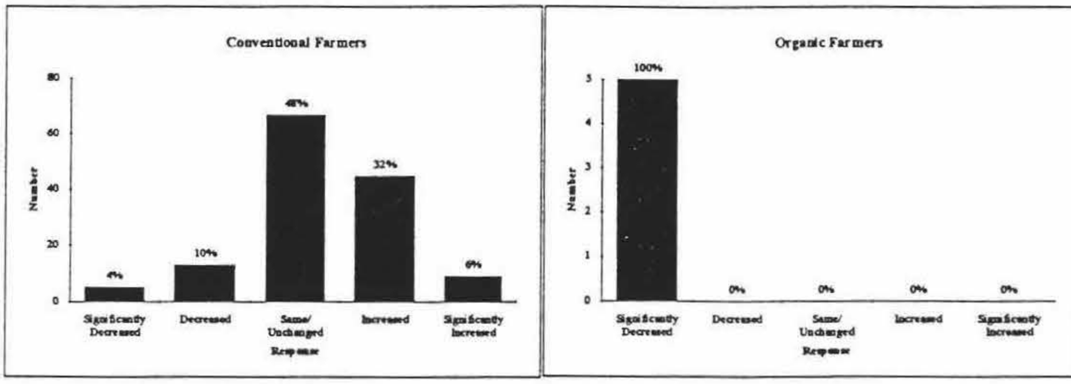


FIGURE E.13 - Distribution of responses for changes in 'Pour-ons/external parasiticide use' as an agricultural practice by the age of the respondent.

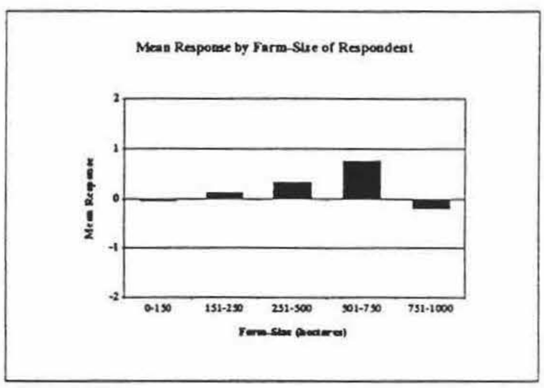
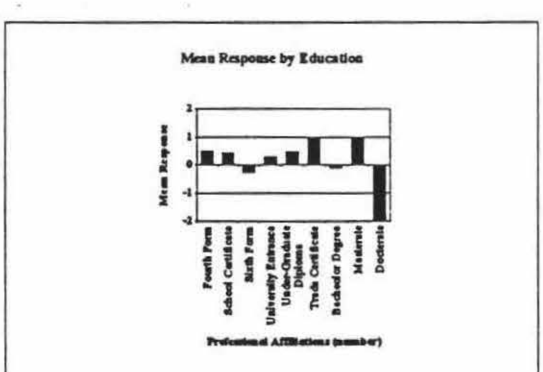


FIGURE E.14 - Mean response for level of change in 'Pour-ons/external parasiticide use' as an agricultural practice by the highest level of education held by the respondent.



E.2 - Figures for Analysis of Practices termed 'Resource Use'

FIGURE E.15 - Mean response for level of change in 'Water Resource Use' as an agricultural practice by the number of professional affiliations held by the respondent.

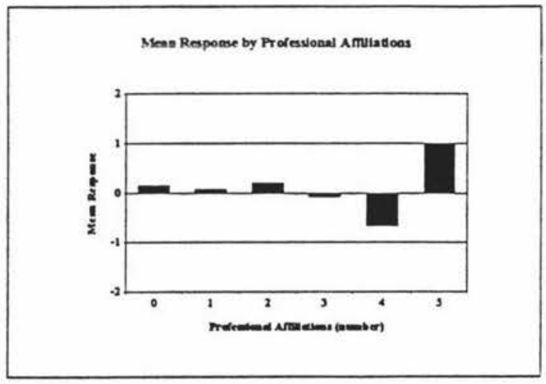
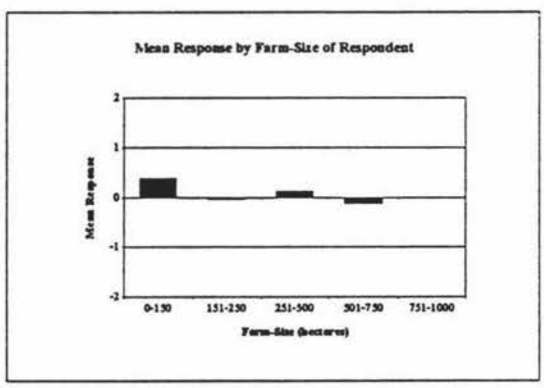


FIGURE E.16 - Distribution of responses for changes in 'Water Resource Use' as an agricultural practice by the farm-size of the respondent.



E.3 - Figures for Analysis of Practices termed 'Management Practices'

FIGURE E.17 - Mean response for level of change in 'Riparian planting' as an agricultural practice by the number of professional affiliations held by the respondent.

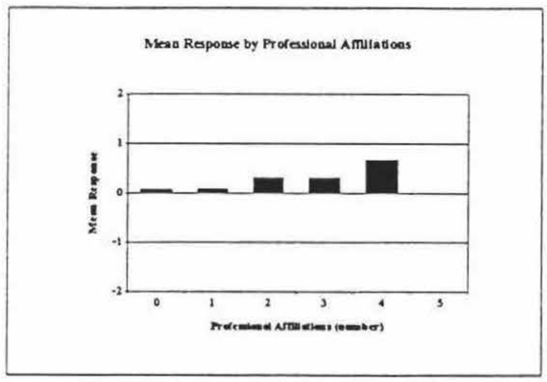
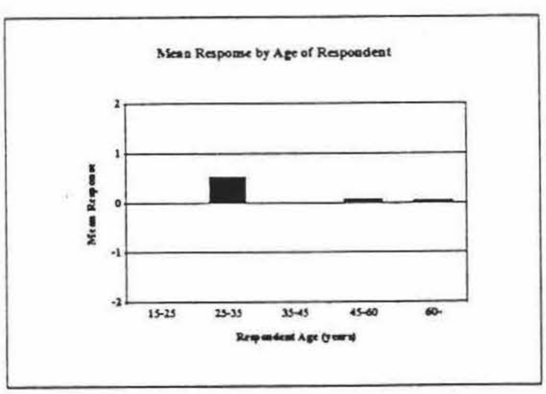


FIGURE E.18 - Distribution of responses for changes in 'Space planting' as an agricultural practice by the age of the respondent.



NOTE - There was no data for the 15-25 age group class in this Figure E.18.

FIGURE E.19 - Mean response for level of change in 'Production Forestry' as an agricultural practice by the number of professional affiliations held by the respondent.

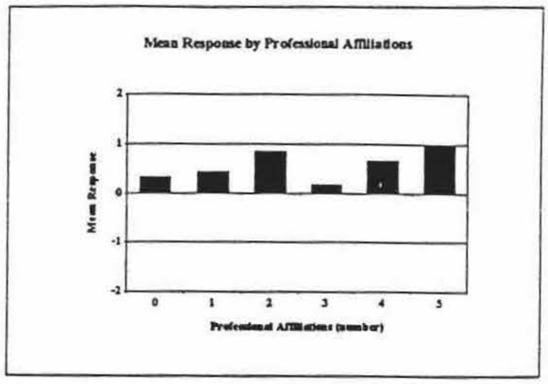


FIGURE E.20 - Distribution of responses for changes in 'Production Forestry' as an agricultural practice by the farm-size of the respondent.

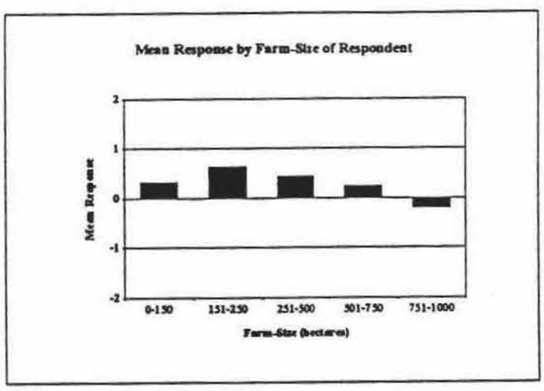


FIGURE E.21 - Distribution of responses for changes in 'Conservation forestry' as an agricultural practice by the stakeholder group of the respondent.

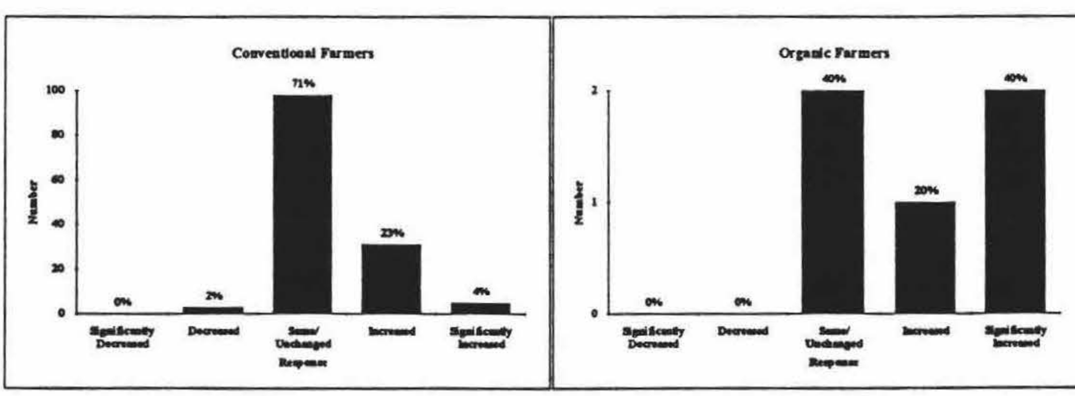


FIGURE E.22 - Mean response for level of change in 'Conservation forestry' as an agricultural practice by the number of professional affiliations held by the respondent.

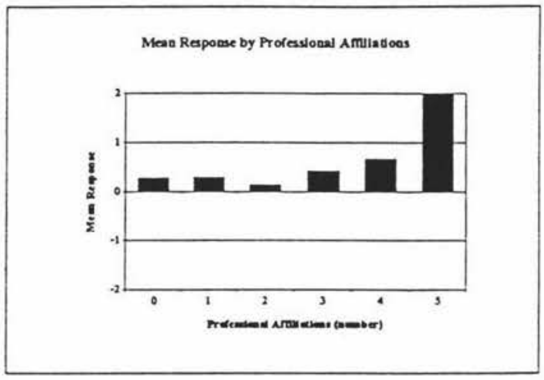


FIGURE E.23 - Distribution of responses for changes in 'Conservation forestry' as an agricultural practice by the farm-size of the respondent.

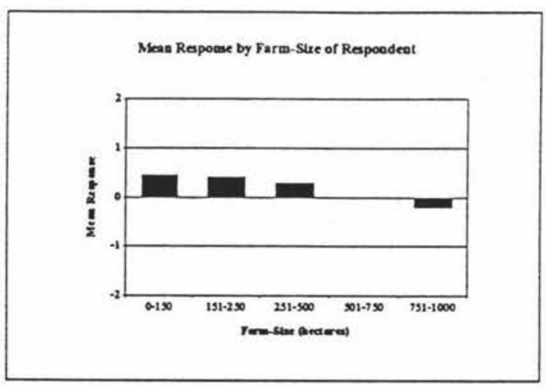


FIGURE E.24 - Distribution of responses for changes in 'Planting windbreaks/shelterbelts' as an agricultural practice by the stakeholder group of the respondent.

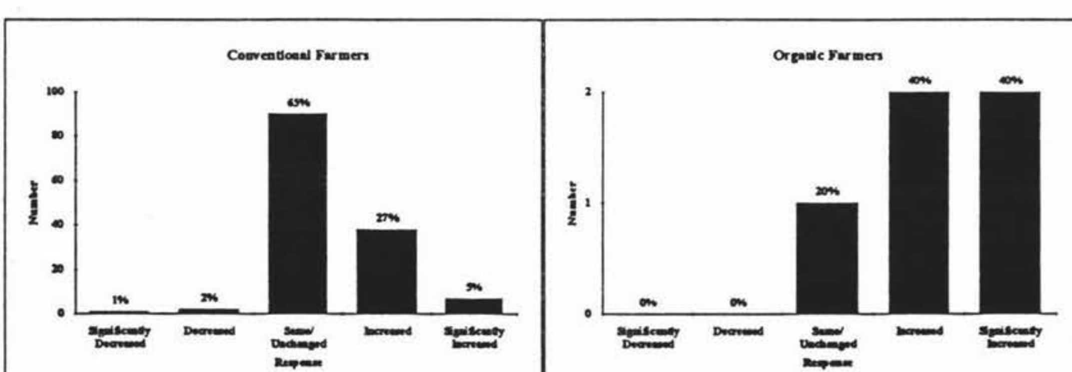


FIGURE E.25 - Mean response for level of change in 'Planting shelterbelts/windbreaks' as an agricultural practice by the number of professional affiliations held by the respondent.

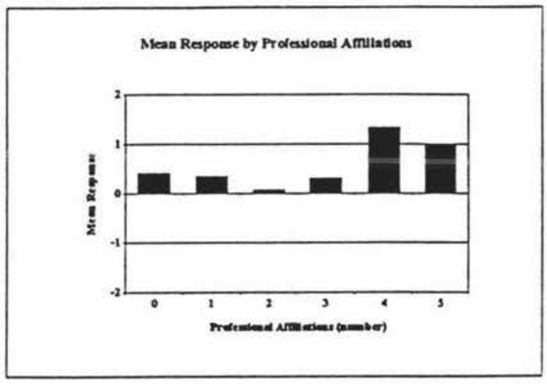


FIGURE E.26 - Mean response for level of change in 'Retiring steep land' as an agricultural practice by the number of professional affiliations held by the respondent.

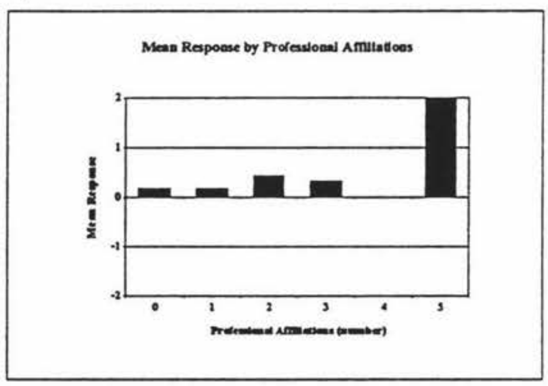


FIGURE E.27 - Distribution of responses for changes in 'Contouring and Physical Land Works' as an agricultural practice by the farm-size of the respondent.

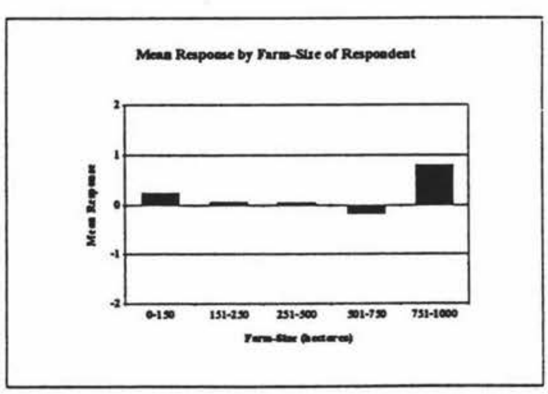


FIGURE E.28 - Distribution of responses for changes in 'Living/dead barriers to soil erosion on slopes' as an agricultural practice by the stakeholder group of the respondent.

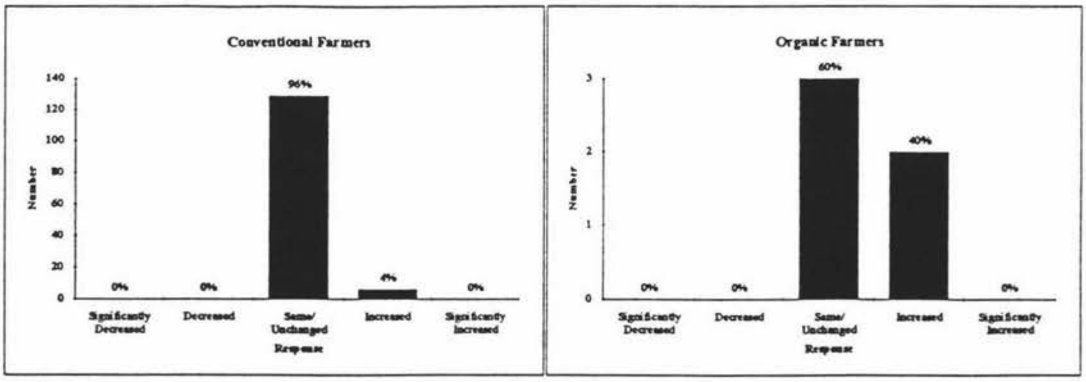


FIGURE E.29 - Mean response for level of change in 'Living/dead barriers to soil erosion on slopes' as an agricultural practice by the number of professional affiliations held by the respondent.

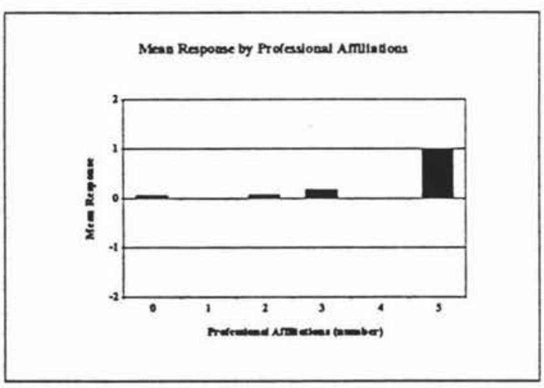


FIGURE E.30 - Distribution of responses for changes in 'Cultivating across slopes' as an agricultural practice by the stakeholder group of the respondent.

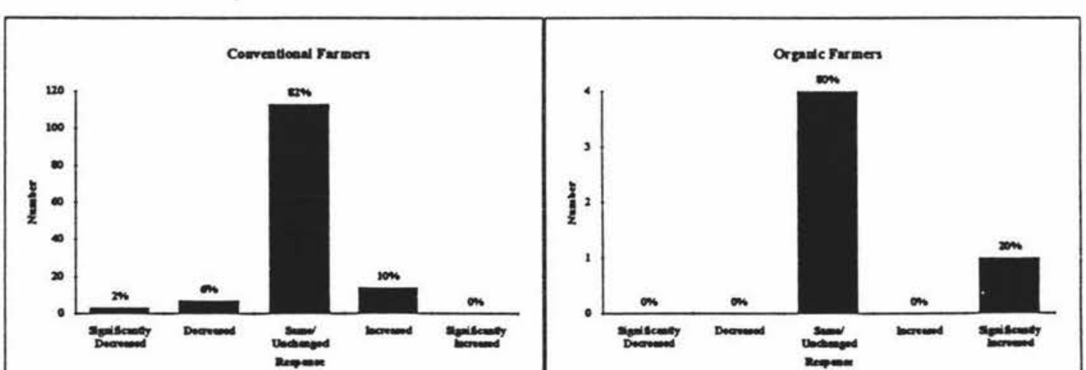
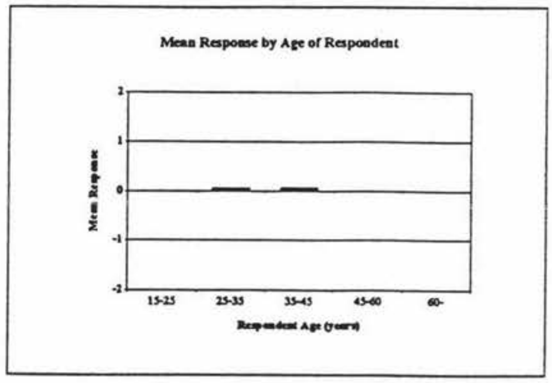


FIGURE E.31 - Distribution of responses for changes in 'Sediment traps in streambeds' as an agricultural practice by the age of the respondent.



NOTE - There was no data for the 15-25 age group class in this Figure E.31.

FIGURE E.32 - Distribution of responses for changes in 'Feed crop rotations' as an agricultural practice by the age of the respondent.

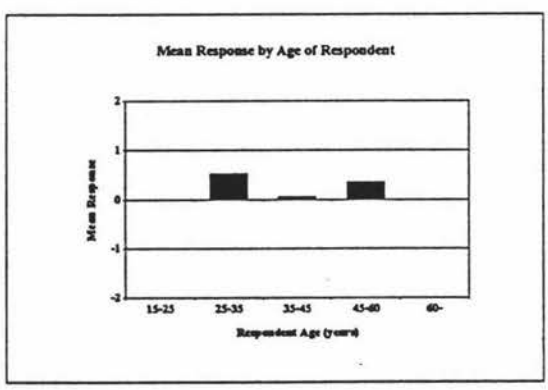


FIGURE E.33 - Distribution of responses for changes in 'Intensive grazing' as an agricultural practice by the farm-size of the respondent.

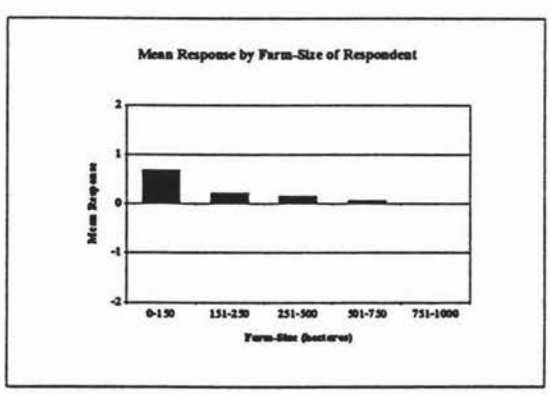


FIGURE E.34 - Distribution of responses for changes in 'Intensive grazing' as an agricultural practice by the age of the respondent.

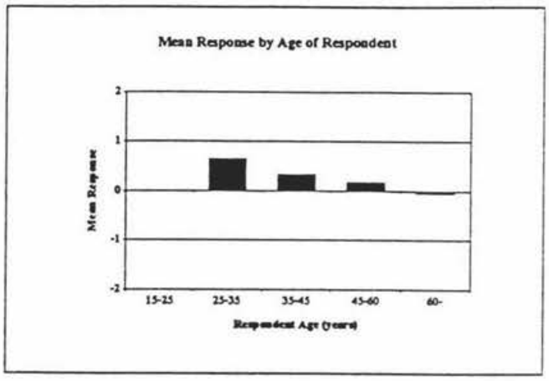


FIGURE E.35 - Distribution of responses for changes in 'Fenced riparian strips for stock exclusion' as an agricultural practice by the farm-size of the respondent.

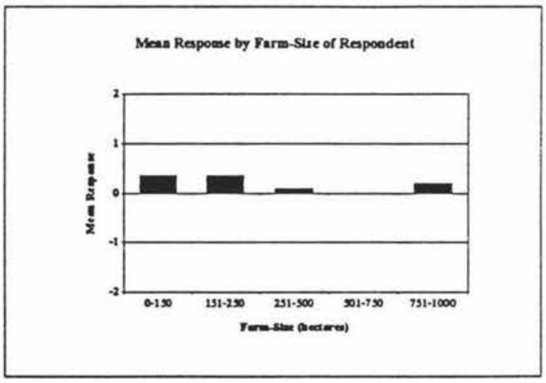


FIGURE E.36 - Distribution of responses for changes in 'Pesticide management programmes' as an agricultural practice by the stakeholder group of the respondent.

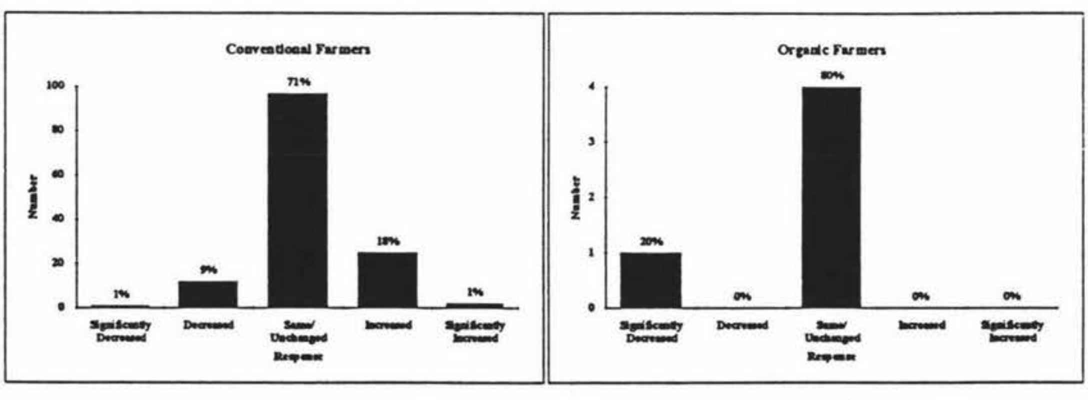


FIGURE E.37 - Mean response for level of change in 'Pesticide management programmes' as an agricultural practice by the number of professional affiliations held by the respondent.

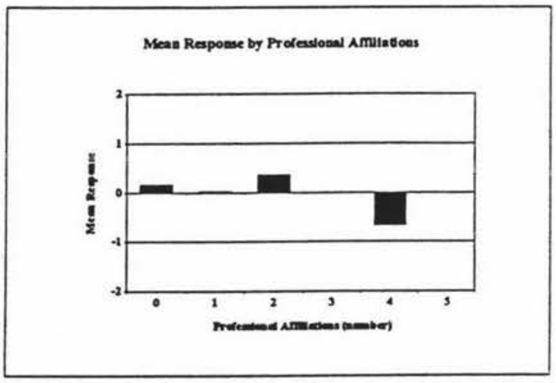


FIGURE E.38 - Distribution of responses for changes in 'Increased fertiliser management' as an agricultural practice by the stakeholder group of the respondent.