RISK IN NEW ZEALAND DAIRY FARMING: PERCEPTION AND MANAGEMENT

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ABSTRACT

Many changes have taken place in New Zealand during the last 20 years. These changes have affected the dairy sector in its broadest sense, at both industry and farm level. After economic deregulation (1984), a survey was conducted in 1992 amongst a sample of pastoral New Zealand farmers to assess the perception of risk and the strategies most commonly used by them to manage risk. Dairy farmers were part of the total sample analysed. Since the 1980s agriculture, not only in New Zealand but world wide, has changed at a rapid rate with farmers facing a challenging environment. The identification of both sources of variation and management strategies for them has made risk management a high priority issue. Therefore there is a need to understand the critical aspects of the environment faced by New Zealand dairy farmers, to update our knowledge of how they are recognizing and managing risk. The main objective of this research was to assess farmers' risk perception and identify the main variables affecting risk in New Zealand dairy systems. To accomplish the objectives, the 1992 survey was replicated with another sample of dairy farmers. Additionally a logistic regression was used to analyse the ProfitWatch Database (Dexcel). The four most important sources of risk perceived by farmers in 2004 were from the market side of their operations (2), Human (1) and Financial (1). To control risk, farmers were mainly focused in the use of Production and Financial strategies. The risks perceived and the use of risk management strategies have changed significantly during the last twelve years. Now farmers perceive more risk in almost all the sources identified in the surveys and they also make more intensive use of almost all the strategies to cope with those sources of risk. Significant differences were also found in the perception of some of the risk sources of the different groups of farmers analysed (Sharemilkers vs. Owner-operators and; North Island vs. South Island dairy farmers). Finally the database analysis showed that of the seven variables included in the logistic regression to assess risk, measured as Return on Equity (ROE), only four of them were found to be significant for the model. In order of importance, these were: the Debt Servicing Capacity (DSC), the Debt to Asset Ratio (DTAR), the Asset Turnover Ratio (ATR) and the Operating Profit Margin (OPM). The findings of this research have confirmed that currently farmers are mainly concerned about the changes of prices, changes in world situation, accidents or health problems and changes in interest rates;

however to control risk they are both production- and financial-orientated. With this clear profile, it can be stated that indeed risk perception and the way farmers manage risk has changed during the last twelve years. Additionally, farmers perceive sources of risks and manage them differently, according to their specific situation (e.g. Ownership structure, Geographic location). The analysis of the database showed that increases in farm size were not associated with a decrease in risk (ROE). Also, the use of Farm Working Expense Ratio and Economic Farm Surplus as the main variables to evaluate cost control and profitability of dairy farms overlook more useful ratios of ATR and OPM. Finally, high levels of debt can lead to reduction in the risk faced by a dairy business if non-equity capital (money borrowed) is efficiently used and high levels of efficiencies, both capital and operational, are achieved.

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ABREVIATIONS

ATR	Asset Turnover Ratio
CoM	Cost of Milk
DSC	Debt Servicing Capacity
DTAR	Debt to Asset Ratio
E,V	Mean-Variance
EFS	Economic Farm Surplus
FSD	First Stochastic Dominance
FWER	Farm Working Expense Ratio
GFI	Gross Farm Income
HA	Effective Area
HGR	High Risk Group
IFCN	International Farm Comparison Network
Kg MS/Cow	Kilograms of Milk Solids produced per Cow
Kg MS/Ha	Kilograms of Milk Solids produced per Hectare
LIC	Livestock Improvement Corporation
LRG	Low Risk Group
MRG	Medium Risk Group
OE	Owner's Equity
OPM	Operating Profit Margin
ROA	Return on Assets
ROE	Return on Equity
SEU	Subjective Expected Utility
SRA	Stepwise Regression Analysis
SSD	Second Stochastic Dominance

CHAPTER ONE

1 INTRODUCTION

Agriculture world-wide is facing big changes. Changes in production characteristics, size of operations and geographic location are impacting on issues such as resource ownership and technology amongst others (Boehlje, 1999). New Zealand is not immune to these changes; the dairy industry, at all levels, has been involved in changes: mergers of cooperatives, new ownership structures at the farm level, increases in farm size and development of new areas for dairying that have led to the development of new strategies to produce milk.

New Zealand has always been characterised as a dairy producer and exporting country relying on a low input system based on pasture as the main source of feed, using cows with the ability to graze and harvest their food by themselves. However, in recent years many changes have taken place in the international market as well as in the local dairy sector. These have had an affect on both internal payout and other physical changes such as stocking rate, breed and the use of supplement.

Radical deregulation of the New Zealand economy began in 1984 and it altered the economic environment faced by pastoral farmers (Tyler and Lattimore, 1990 cited by Martin, 1994; Martin 1996; Martin and Shadbolt, 2000). The domestic market for milk and dairy products and the industry were completely deregulated in October 2001, then the New Zealand Dairy Board, the New Zealand Dairy Group and Kiwi Dairies were merged into one cooperative (formerly known as the Global Dairy Company now as the Fonterra Cooperative Group). Fonterra processes and markets 95% of New Zealand's milk and is owned by nearly 13,000 New Zealand dairy farmers. It also supplies 35-40% of the world dairy trade through mainly milk commodities - whole milk powder (28%), cheese (17%), butter (17%) and skim milk powder (12%) are their most important products. Since the company was formed, milk payout to farmers ($/kg Milk solid, inflation adjusted) has been: $5.31 (2000/2001); $5.50 (2001/2002) and $3.66 (2002/2003) (LIC, 2003).

As previously mentioned, the changes have not only affected the New Zealand dairy industry in it's structure but also the New Zealand dairy system itself. Variables

such as stocking rate, farm and herd size, and genetic composition (breed and quality) have been modified over the last 20 years, as farmers have developed new strategies to cope with the changes. These in turn have modified the classic New Zealand dairy system leading to a wide range of dairy systems currently operating. As a consequence of some of these changes, feed demand has increased which, combined with better farm management practices, have resulted in a trend of increases in both production per hectare and per cow during recent years. The classic New Zealand dairy system has been challenged and modifications have been made as feed supply has become the focus of those involved in the dairy business. The changes in physical variables have also impacted on the financial structure of the business. Historically, the aim to produce milk at lowest possible costs has been the main driver of the NZ dairy system. This is believed to be one of the ways to ensure a long-term viable system, however, the new environment faced by farmers imposes new constraints and requires they have a higher degree of knowledge in every single facet of the farming system.

The development of the dairy industry during the last fifteen years or so has been characterized by large growth rates, mainly in the South Island. For the last five years, the South Island has increased its production of milk solids as a percentage of the total in New Zealand from 22% in the 1998/1999 season to 28% in the 2002/2003 season (LIC, 2003). The use of new strategies, such as irrigation, has not only allowed the rapid expansion of dairy farms in the South Island but has also increased production levels sharply. Larger farms running more intensive systems have been developed. This situation has also been coupled with financial changes and the development of new ownership structures, such as equity partnerships. Through all the new dairy "systems" created over the last ten years, one common trait is shared; pasture is the main feed for the cows, therefore the measurement of kilograms of milk solids produced per hectare remains valid for further comparisons.

This new environment has brought new sources of risks for dairy farmers and is increasingly a very important issue in the decision-making process. Only in understanding the origin and nature of risk will we be able to develop efficient risk management strategies. There has been much theoretical research attempting to explain risk in a positivist way, which tries to explain decision-makers' choices under uncertainty through the development and application of different theories and decision rules. However, farmers' behaviour has been found to be far more complex than is assumed by the theories. In this sense, the psychological component, which

measures individuals' preferences, learning, and other unobservable factors influencing human behaviour, may have particular relevance to gaining an understanding of the risk behaviour of farmers (Musser & Musser, 1984); thus, understanding farmers' attitude towards risk and the way they adjust their farming operations can lead to the development of newer and more useful theories that may help to explain risk. Farm management research is critical as agriculture becomes more complex, because it can integrate the on- and off- farm variables that affect agricultural production. "On one hand the farm management researcher can incorporate component research, as generated for example by animal science, into sustainable and profitable farming systems. On the other hand, signals from consumers can also be accounted for by the design of farm production systems (e.g. to produce high quality, wholesome foods through systems which minimise usage of chemicals)" (Parker, Gray, Lockhart, & Townsley, 1994; p. 358).

In summary, all the changes New Zealand has faced over the last twenty years plus those changes in external conditions like the world trade market, free trade agreements, tariffs, policies and other factors have created a turbulent scenario for agriculture. The identification of these sources of uncertainty and their control, places risk management strategies as a high priority issue. Farmers have responded to the changes they have faced, according to their own situation (e.g. geographic location, ownership structure) developing different types of dairy systems to cope with these new constraints. Consequently there is now a wider range of dairy systems operating in New Zealand and there is no longer a "right" system to follow. There is a need to understand the critical aspects of this new situation, to update the knowledge of risk management in New Zealand and identify key issues in controlling those sources of variation. This information can be highly relevant for the government agencies and the New Zealand dairy industry in general.

Through the development of this current research, both issues, risk sources perceived as most important by dairy farmers and the management strategies developed by them to cope with those sources, will be addressed in order to compare them with the finding of a survey conducted in 1992 (Martin, 1994). Additionally, a more quantitative perspective will be put in place to analyse some of the financial factors affecting long-term viability of the system. Both analyses will provide useful insights from both the theoretical and practical points of view of risk and its

management in New Zealand dairy farming. The specific objectives of this research can be stated as follows:

- To analyse farmers' perception of their sources of risk and alternative risk management strategies, and how they may affect production levels

- To determine if there have been any changes in farmers' risk perception and risk management strategies in the last 12 years and what would explain those changes

- To identify any difference in the risk perceived and the management strategies used by farmers in different geographic location or ownership structures

- To identify the main drivers of risk in New Zealand dairy systems and how they behave over a period of time

- To characterize farms according to the level of risk they face and identify the differences between them

To accomplish the first three objectives, a survey amongst a sample of New Zealand dairy farmers was undertaken. This survey aimed to update the information gathered by Martin (1994) and looked for the differences in what farmers currently perceived and did about risk. Using geographic location of farmers (North and South Islands) and ownership structure of the farms (Owner-operators, Sharemilkers and Managers) as classification variables, the information gathered through the 2004 Survey was analysed. The simultaneous analyses of farmers in different locations or under different ownership structures have not been undertaken before in New Zealand.

To achieve the last two objectives above, the analysis of a database (ProfitWatch) was undertook. The database has both physical and financial information of a large number of dairy farms, and the analysis provided the basis for a study of a

theoretical approach to risk. This analysis sought to find critical factors affecting risk in New Zealand dairy systems, and to categorise the different levels of risk.

The outline of the thesis is as follows. In the literature review undertaken in Chapter Two, the core points of risk will be identified as well as the main approaches and methodologies for risk analysis. In this chapter some of the earlier research about risk sources and risk management strategies are presented, and they will be used for later discussion. Chapter Three describes the methodology used in the project stating the material employed and the framework proposed to analyse the information gathered. Chapter Four describes the main results of the analyses; and finally the main findings and their implications are considered in a discussion of each analysis undertaken (Chapter Five). Conclusions, further opportunities for research and future implications for the dairy sector are given in Chapter Six.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 NEW ZEALAND DAIRY SYSTEMS

Since the New Zealand economy is deregulated, it is exposed to the changes of international market. The International Farm Comparison Network (IFCN, 2003) reports New Zealand milk prices in the range of US$ 15-22 / 100 kg ECM (Energy Corrected Milk; 4% fat, 3.3% protein), one of the lowest milk prices received by any country. Therefore to be competitive and profitable, farmers must produce milk at low cost to remain in the dairy business. In fact, the low cost production system developed by New Zealand dairy farmers has achieved worldwide recognition. IFCN (2003) estimates that the cost of producing 1 kg of milk in New Zealand is lower than US$ 0.15 with one of the lowest operating costs in the world and more than 150 kg milk per hour of labour unit. Holmes et al. (2002) have estimated that the cost per Kilogram of Dry Matter (Kg DM) eaten per cow should be less than NZ$ 0.20-0.32 (US$ 0.14-0.22) in order to make a system profitable. The achievement of this level of cost makes the New Zealand dairy system one of the most technically efficient countries in milk production.

For many years the most common dairy system used by New Zealand dairy farmers was a seasonal all-grass system. In this system pasture is the main source of feed and cows, which calve in spring, have the ability to graze and harvest their own feed. To run a system like this requires high skill levels because the farmer has to match feed supply (pasture growth rates) closely with feed demand (animal requirements). Due to its very nature then, this system is considered a low-cost and low-input one. However many changes have taken place in the dairy sector in recent years that have had big impacts at the farm level. Farmers have responded to those changes by modifying their systems, and currently a wide spectrum of dairy farm systems exist in New Zealand, ranging from all grass systems with little or no nitrogen fertiliser and no bought in feed, to total confinement systems with a wide range of purchased feeds (Roche & Reid, 2002). Some of these new systems have also reduced

their seasonality, and split calving system is a relatively common practice with farmers aiming to increase days in lactation of the herd and capturing the premium paid (if any) by the company for winter milk (Crosse, O'Brien, & Ryan, 2000). Despite this wide range of dairy systems several authors mention that New Zealand's only advantage is its low cost of production based on pastoral farming (Deane, 1999; Hamilton, 1997) and this should be the focus of dairy farmers. In this sense there is an agreement in the literature that as pasture utilization is maximized costs will remain at low levels.

Holmes et al. (2002) mention some of the advantages and disadvantages that New Zealand has as a dairy producer country. Amongst the advantages are:

- Industry structure. The cooperatives operating in New Zealand allow farmers to spread the risk they face. The structure is totally co-ordinated and integrated and is focused on maximising the returns to the owners (farmers)
- The ability to produce milk at low cost from grazed pasture
- The sharemilking system and equity-sharing arrangements
- Healthy, fertile and high genetic merit cows from sires proven in New Zealand

On the other hand the disadvantages of New Zealand for as a dairy producer country are:

- Highly dependant on both world market prices and climatic conditions
- Short lactations and low yields per cow. One of the main weaknesses identified within NZ dairy system is the rapid decline in milk production during the second part of lactation
- Extremely seasonal pattern of milk production that creates inefficiencies in the use of the dairy factory's capacity and seasonal variations in milk composition
- The scarcity of a pool of alternative feed sources, apart from pasture, of high quality and at low price

2.1.1 Changes in New Zealand Dairy System

One of the most evident changes in New Zealand dairy farms has been that of stocking rate. It has been increasing for the last 20 years from 2.1 cows/ha in the early 1980s then reaching a peak in 1998/99 (2.7 cows/ha) to finally drop to 2.61

cows/ha in 2002/03 (LIC, 2003). Stocking rate within a farm determines the overall feed demand on that farm. Once the farm is optimally stocked, scope to further increase output per unit of land in pasture-only systems is limited because pasture supply is the limiting factor which is highly dependant on climatic conditions. It is also relevant to mention that average effective farm size for the last 10 years has increased by 50% (LIC, 2003). As a consequence of the increases in these two variables, average herd size has increased by 58% from the 1992/93 to 2002/03 season.

The genetic composition of cows has also changed within New Zealand herds. In 1962/63 Jersey bulls were largely preferred (almost 80%), however during the seasons 2001/02 and 2002/03 less than 30% of the inseminations were made from Jerseys bulls; this trend has been the opposite for Holstein Friesian since the use of these bulls have become more common in New Zealand's herds. Currently more than 60% of the inseminations used in New Zealand come from Holstein Friesian (table 2-1).

Table 2-1. Changes in insemination in New Zealand (adapted from LIC, 2003)

	Percentages	
Year	Jersey	Hosltein Friesian
1962/63	>70%	<20%
1990's	<30%	>60%

The change in genetics has not been only in breed but also in genetic merit (Breeding Worth). LIC (2003) estimates that the genetic merit for all breeds (Jersey, Holstein Friesian, Jersey/Holstein Friesian cross and Ayrshire) has increased over the last 15 years. For all the cows in New Zealand for the season 2001/02 the BW were over $125, which is considerable higher than the BW for the 1987/88 season where the values were all about $20. Therefore the current cows produce more milk and they are more efficient than 20 years ago. This potential of New Zealand dairy cows to produce high yields has been reported several times. Kolver (2001) mentions milk yields of approximately 700 kilograms of milk solids (kg MS) from NZ Holstein Friesian cows fed with total mix ration in a confinement system, and from cows feeding at pasture Kolver (2001) reports milk solids yields of 508 kg MS. The selection of the New Zealand dairy cow has been extremely efficient over the years, and most farmers want to use this high-potential yield animals achieved through the selection process.

With bigger farms, larger animals and more animals per hectare that are able to produce high milk yields, feed supply has become the main challenge, as in a pasture-based system feed availability is determined by climatic conditions. Climatic variation has a major effect on pasture growth rate which influences to a large extent the farmers' ability to feed the herd, especially in spring and in the second half of lactation. During autumn and summer in the North Island, the rate of decline in milk solids production per herd can be as high as 19%/month compared with a theoretical decline of 7%/month (LIC, 1997 cited by Harris, Clark, Waugh, Copeman, & Napper, 1998).

Deane (1999) suggests that over the last 40 years researchers have focused on improving the efficiency of pasture systems mainly through:

- Breeding: to improve genetic merit
- Improvements in pasture utilisation: through increases in stocking rate and better pasture management practices
- Efficiencies of scales: through increase in farm size and average herd size as well
- Maintaining low average farm operating cost

All these improvements plus the increase in using Holstein Friesian breed have influenced largely the trends in kg of milk solids per cow and per hectare in New Zealand over time. From the period 1992/93 to 2002/03 the national averages have increased from 259 to 315 kg MS/cow (+21.60%) and from 653 to 828 kg MS/ha (+26.80%) (LIC, 2003). Since high genetic merit cows have higher dry matter intakes and higher gross efficiency (produce more grams of milk solids per kilogram of dry matter) most farmers want to use this genetic potential. In order to fulfil the higher feed requirements of high yielding cows, the use of supplements has been suggested as a way to increase productivity and profitability in the current systems through increases in yield per cow and per hectare. In this sense Deane (1999) believes that an increase in output through improving animal efficiency is the biggest opportunity to maintain the long-term viability of the dairy farm business. However increasing the reliance on the use of supplements to reduce seasonality, to reduce climatic dependence and to increase production in New Zealand dairy systems, may well carry other kinds of risks associated with the price and availability of that extra feed.

2.1.2 Extra sources of feed in New Zealand dairy systems

In New Zealand there has been some debate about the use of supplements within the dairy system (Deane, 1999; Hamilton, 1997, 2002; Kuriger, 2002; McGrath, 1997, 1999; Roche & Reid, 2002). Deane (1999) states that from this debate there has been concern that increases in feed supply through the use of supplements will result in large amounts of pasture being wasted without a significant lift in production and profitability. Hamilton (1997), when mentioning the effect of supplement on profit, suggests that when feed is purchased there is a long delay between purchase and use, resulting in an undesirable effect on winter cash flow. Deane (1999) also suggests that on the other hand some people believe that strategic use of supplements in New Zealand dairy systems provides the opportunity for significant increases in profit. Despite these differences, in the current dairy systems operating in New Zealand, pasture is still the cheapest source of feed available and higher pasture growth and utilisation are the key for high profit (Clearwater & Wright, 2003; Holmes et al., 2002; McGrath, 1997).

Although purchased feed in New Zealand dairy systems has not been a large proportion of the total expenses, Deane (1999) and Rauniyar & Parker (1999) mentioned that feed and grazing cost have been increasing since late in the 1980's and "had doubled as a proportion of total cash expenses and of farm income by 1996/97" (Rauniyar & Parker, 1999, p. 11). Additionally, Penno (1998) suggests that farmers have increased the use of supplementary feeding, opted for more off-farm grazing and used more nitrogen fertiliser to boost pasture production and therefore increase the overall feed supply.

Deane (1999) and McGrath (1999) suggest two ways of increasing milk production through the use of supplements either: (a) increasing stocking rate or (b) increasing the days in milk of the herd by calving the cows earlier or drying-them off later. The literature shows that it is more efficient to dry-off the cows later but there are risks associated with the changes of pasture cover and cow condition score at dry-off, because they may affect farm performance during the winter period and next lactation (Penno, Holmes, Macdonald, & Walsh, 1998; Penno, McGrath, Macdonald, Coulter, & Lancaster, 1999; Pinares & Holmes, 1996).

Although most of the time pasture is a well-balanced feed for lactating cows, Clark (1993) identified that the energy content of pasture is usually the limiting factor and supplementation of pasture with pasture silage, maize silage, hay or concentrates,

may need to occur early in spring. In optimally stocked systems the aim in adding supplements is to add energy during periods of deficit, thus purchased feed can increase milk production (Macdonald, 1999). On the other hand, many profitable dairy systems with high stocking rates use supplements to address feed deficits deliberately created by achieving high pasture utilisation and high per cow and per hectare production.

The inclusion of supplements within a system is determined by the relationship between its cost price and milk payout. Although new technologies have been focused on increasing crop yields per hectare in order to reduce cost of crop production (Deane, 1999), at higher supplement prices the chances to include them within the systems are reduced. One example is given by the IFCN (2003). For the period 2001-2002 they reported increases in cost in New Zealand dairy systems; the reason for this is that during 2002 the milk prices in national currency reached their highest levels ever in nominal terms. Additionally these high milk prices led to increases in on-farm expenditure in 15-20% on many farms (MAF, 2002). In particular the increases were on wages, feed, fertiliser, repairs and maintenance and capital items (especially plant and machinery) that increased average costs of production (IFCN, 2003; MAF, 2002).

Due to all these changes and since all the current systems have evolved from a pasture-based system, all of them have a common feature: pasture is always included in the cow's diet, therefore it is very difficult to define what is a high input system. Additionally what one person would consider a high input system, another may consider to be normal or even low input.

From the literature there seems to be more agreement about the definition of low input system. In general terms a low input system is one optimally stocked considering only the feed that can only be provided by pasture. Deane (1999) suggests that a high input system is achieved when, after maximizing pasture utilization, supplementary feeds are used to further increase stocking rate. Similarly Roche & Reid (2002) suggest that a high input system would be one that is optimally stocked (like an all pasture system) but which carries more cows per hectare.

2.1.3 Full economic costing in the dairy system

Due to all the changes faced by dairy farmers in recent years, profitability has become a focus of dairy researchers, advisers and farmers alike. Because New Zealand

dairy cows have high potential yields, there is a request for better nutrition to use that potential, while still maintaining or improving profitability. Roche & Reid (2002) believe that research combined with farmers experience, in recent years, has helped the development of systems that use supplementary feeds to increase both pasture utilization and milk solids production per hectare and at the same time improve farm profitability. However the same authors also suggest there is very little room to reduce costs further on New Zealand farms when milk pay out declines. McGrath (1999) suggests that, to have a viable systems, all the inputs into the systems must generate a financial return. As a general rule some authors suggest that to be profitable, farm working expenses (FWE) must be controlled below 40-50% of gross farm income (Hamilton, 1997; McGrath, 1997). Research conducted in the United States (Langemeier & Jones, 2001) found that the major contributor to downside risk, in a sample of diary farmers from Kansas, was the Total Expense Ratio[1]. Despite the differences between the United States and New Zealand dairy systems, is clear that controlling expenses is a critical aspect to reduce downside risk and assure the survival of the business.

Roche & Reid (2002) states that to increase profits, low costs are only one aspect; volumes of sales are also important. They also suggest that if cost per unit of output (kilograms of milk solids) is minimised then total milk solid production dictates the potential economic farm surplus (EFS). However McGrath (1997) considers that higher and higher production does not mean more and more profit, and pasture utilization is the key to achieve high economic performance. In this sense, Hamilton (1997) says, low input does not necessarily mean low output. Low input, he says, is about prioritising expenditure to gain the best profit margin while gaining a high output. On the other hand Leslie (2001) and Roche & Reid (2002) mentioned that in general farmers have increased their expenditure. Leslie (2001) estimated that the increases in variable costs, from 1989/1990 to 1999/2000 period have been 71% highlighting that the pasture and supplement items in the same period have increased by more than 100%. The same author also identified that the increases in fixed expenses for the 10-year period he studied was explained mainly by the increase in interest which is the result of increases in total liabilities (178%). This last point is extremely important as a risk source to be considered in the decision-making process.

[1] Total Expense Ratio = (Total Expenses) ÷ (Gross Farm Income)

Roche & Reid (2002), based on the analysis of the ProfitWatch database, pointed out that the top 25% farmers in the South Island increased their expenditure by 21% to increase economic farm surplus (EFS) per hectare by 67% compared with the average South Island dairy farmer. So for high input systems, total expenditure and milk production are big issues. Comparing the period 1988-1997 with 1978-1987 Deane (1999) found that although farmers spent more on feed, grazing and fertiliser, their total cash expenses as a proportion of the income were lower in 1988-1997 than 1978-1987. So, instead of detracting from "low cost" systems, the extra money spent in those items already mentioned allowed the dairy farmers to maintain their systems at low costs. Similarly McGrath (1997) affirms that profitable farms are high producing farms that use cows to convert all the grass they grow into milk, controlling on-farm working expenditure under 50% of Gross Farm Income.

Not only expenditure must be borne in mind when farming. Shadbolt & Gardner (2003) proposed that for analysing a farming enterprise it can be divided into two businesses, the farming business on one hand and the property business on the other; the measurement of success in each one of them differs from the other. To measure success in the property business the changes in assets value over the time is commonly used; however the effective, efficient and sustainable use of resources are the spontaneous effect of successful farm businesses. If the overall performance of the system is assumed to be the aggregate effect of the two businesses, then there is a conflict between the measurements that can mislead the appreciation of that performance, since the success in one of the businesses (e.g. capital gains) can cause a measure of failure in the other (e.g. reduced return on assets), when it might be possible that both businesses are performing well. Therefore the overall performance of the business should be determined by the sum of the returns of the farming business, the operating profit after tax, and the capital gains or losses from the property business. The authors concluded that it is not recommended to use one or two measures in isolation, since there are a relevant number of financial measures to be used. In this way, liquidity may be suitable to analyse the problems related to land investment but it is certain not suitable to calculate efficiency as it only includes cash costs. In order to estimate the profitability of the farming business the IFCN (2003) proposed what it called *Entrepreneur's profit*, that is the deduction from the returns of the farm business all the cash costs plus the depreciation, but without considering the opportunity costs involved.

2.2 CHANGES IN THE INDUSTRY AND POLICIES

New Zealand entered the post World War II era with a highly protectionist system in place. Government intervention was intensified in the economy through the late 1970s and into the early 1980s in an attempt to retain the prosperity of the 1950s (Rayner, 1990). Some commentators argue that various newly industrialised countries have used this system successfully as a means of establishing domestic industries. On the other hand there are strong doubts about whether this protection was a necessary condition for the growth achieved. Rayner (1990) believes that in any case, this policy was probably not appropriate for a country such as New Zealand, because it is a small and isolated country without a domestic market sufficiently large to allow for the economies of scale required for efficient production.

From the period 1972-1984 many changes affected the New Zealand economy. Some of these were: the United Kingdom joined the European Community in 1973 and the subsidies to agriculture in Europe began to affect the world market; in New Zealand inflation started to rise in 1972 with the commodity boom, and climbed up to around 15% per year in the early 1980s; unemployment rose exponentially to levels that had not been seen since the depression; net overseas debt increased from approximately nil in 1973 to around 50% of New Zealand's GDP by 1984 (Rayner, 1990; Silvestone, Bollard, & Lattimore, 1996).

The year 1984 is a key one in New Zealand economy. At that time the economy was subjected to tight control and a scale of government intervention greater than at any time since the war. The Labour Government, elected in July 1984, started a major program of economic liberalisation. The changes to the New Zealand economy during the 1980s were notable for the extent of the reforms, their consistency and for the low level of liberalisation from which they began (Silvestone et al., 1996). Most of the roles the government had in agriculture changed dramatically. Amongst the changes in the policies, additionally to the announcement made by National Government in June 1984 that the Supplementary Minimum Price (SMP) scheme for wool, meat and dairy was to finish at the end of the 1983/84 season, the Labour Government announced that concessionary farm development loans would be terminated and that other loans at concessionary rates would be progressively brought into line with market rates. Subsidies on fertiliser and noxious weed control were to be ended. In 1985/86 partial

cost recovery was introduced for services provided by MAF including inspection, animal health, quarantine and advisory services. Probably one of the most important changes for farmers was the fact that the Rural Bank was required to progressively commercialise its activities. From November 1984 it had to increasingly switch its reliance on government funding to funds raised on private sector financial markets. To pay for those market-price funds, interests on concessional lending to farmers were annually increased to close the gap with market interest rates which were at the time rising as well. Rising interest rates coupled with falling income led to a rural debt crisis (Tyler & Lattimore, 1990).

Since deregulation many changes have been developed in New Zealand agriculture. Probably one of the most important changes has been the increase of land value. From the year 1983 to 2003 the increase in dollars per hectare (inflation adjusted) has been round 13% (LIC, 2003). The increase is even more evident when land is valued in terms of dollars per kilograms of milk fat produced, as figure 2-1 shows.

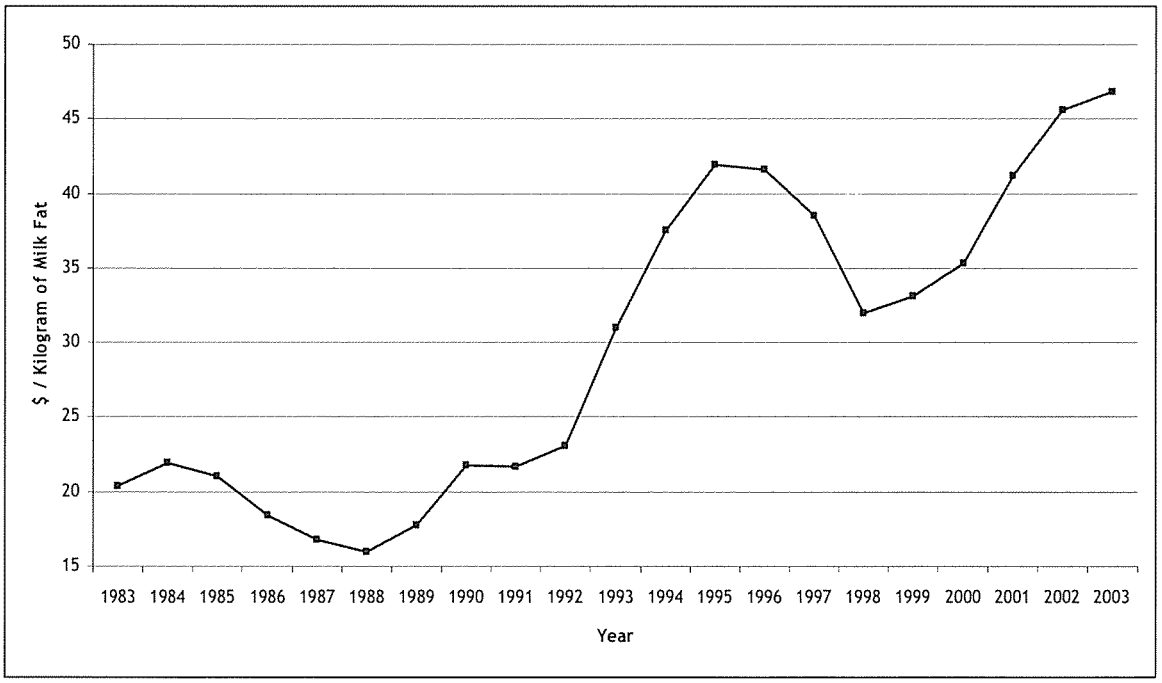

Figure 2-1 Changes in land values in dollars per kilogram of milk fat produced (LIC, 2003)

From figure 2-1 it can be seen, that the average value of the kilogram of milk fat produced has increased by 129% during the last 20 years. This is in part explained by the increases in kilograms of milk fat produced per cow (Kg MF/cow) by 25%, stocking rate (cows/ha) by 19% and bigger herds by 111% (LIC, 2003). The increase in land value per hectare coupled with increases in average farm size (+73%) and decreases in payout (-33%) for the period 1983-2003 have lead to a reduction in operating profits for dairy farms over the last 20 years(LIC, 2003).

New Zealand's local dairy market and the industry were completely deregulated in October 2001. On that date and after several months of negotiation between the New Zealand Dairy Board and the cooperatives Kiwi Dairies and New Zealand Dairy Group, all agreed to merge into one big cooperative formerly known as the Global Dairy Company, now as the Fonterra Cooperative Group. Currently in New Zealand there are three dairy cooperatives operating: Fonterra, Tatua and Westland. Of these three Fonterra is the largest one receiving and processing about 95% of the milk produced in New Zealand. Although the trend in milk prices has been more or less stable during the last 10 years, since the 1970s up to early in the 1990s milk payout had a strong trend downward and milk prices dropped to the lowest level in 1990/91 season with $3.04/kg MS (inflation adjusted) (figure 2-2). As a consequence of all the changes during this period, the margins at farm level were squeezed. In order to cope with that situation, farmers responded to those changes doing modification to their systems and, as a consequence of that, the typical New Zealand dairy system diversified into different ones.

Figure 2-2 Trend in milk payout for milk solids ($/kg MS) since 1973/1974 (inflation adjusted) (LIC, 2003)

The forecast for the international market of dairy commodities for the next four years (OECD, 2003) suggests that the prices as well as production will improve. Table 2-2 presents the averages for production, prices and consumption for the 2005-2008 period. This situation will certainly have impacts on New Zealand dairy farmers, as the economy is highly influenced by the international market. However if international milk prices increase, and the New Zealand dollar gets stronger at the same time, the effect of better prices may well be offset by the latter and the farmers will not capture the benefits of those higher prices. Considering this, there is now more uncertainty and thus more risk associated within the wider range of dairy systems present in New Zealand.

Table 2-2. Average variations forecasted for production, consumption and prices of dairy commodities for the international market, period 2005-2008 (OECD, 2003)

Dairy commodity	Production	Consumption	Price
Butter	+2.3%	+2.2%	+1.8%
Cheese	+2.1%	+2.1%	+1.6%
Wholemilk powder	+2.8%	+2.8%	+1.4%
Skimmilk powder	+1.2%	-0.7%	+1.5%
Casein[1]			+2.2%

[1] Information not available for Production and Consumption

In consequence, the environment that New Zealand dairy farmers now face with increased business risk, demands knowledge and skills in financial management to identify the different sources of risk that are affecting them. It also demands long-term planning and effective monitoring to take measures to protect the business against these risks (Martin, 1994; Martin & Shadbolt, 2000; Meuwissen, Huirne, & Hardaker, 2001; Rauniyar & Parker, 1999). Nowadays, additional to the risk associated with production such as climatic conditions, pest and diseases and others, farmers are required to take into consideration both financial and market risks as other components of the system. Agricultural policies and their instruments (tariffs, quotas, direct payments, environmental and animal welfare programs, etc) have a significant impact on farm development and the economic results for farms; the reason for this is that policy makers in different countries or regions seek to achieve different goals (IFCN, 2003).

As it can be seen, all these changes have had big impacts on the environment that dairy farmers now face, therefore the identification and management of different risk sources is highly important under this completely new scenario.

2.3 RISK IN AGRICULTURE

2.3.1 Introduction

Farming, by its very nature, is a gamble, so risk is almost the most important player in the farming game. Risk in agriculture is captured essentially by the variability of expected returns. This risk is a function of variability in output prices,

production, input prices and input quantities (Blank, Carter, & McDonald, 1997). Zwart & Lattimore (1990) and Fleisher (1990) proposed that the major reasons that explained market instability in agriculture are:

- The biological uncertainty and perishability associated with agricultural production
- Lags in the production process
- The associated short-run elasticity of supply
- The relatively inelastic demand facing producers
- The small scale nature of agricultural production

In the middle 1970s risk in agriculture in the United States started to become an issue and since then many efforts have been addressed in this field to quantify and manage risk in agriculture, especially in United States as well as in Australia. Barry & Fraser (1976) recognized the effect or irregular influences on intra-year price variation for some commodities (crops and livestock) in the United States during the period 1959-1974. They mention that the reduction in asset liquidity faced by farmers at that time was due to a more rapid growth of physical assets relative to financial ones, in addition as total debts per farm increased by over 1200% between 1950 and 1975 this also revealed further the loss of liquidity. Similarly Jolly (1983) and Boehlje & Eidman (1983) describe the situation during the 1970s in the States which is similar to New Zealand's situation in recent years: land values and rent rapidly rose; expansion in land, facilities and equipment occurred at a rapid rate; changes in financial markets made the cost of the debt for this expansion more sensitive to short run changes in interest rates. As a result of these changes, new entrants to agriculture and those pursuing rapid expansion in their businesses become extremely vulnerable to changes in prices, costs and production. This dynamic environment is constantly challenging dairy farmers to develop new models to cope with risk in order to have long-term viable systems.

Despite the variable nature of agriculture, Zwart & Lattimore (1990) suggest that it is not clear if those changes provide sufficient justification for the level of intervention frequently observed in some countries. For many years some countries have controlled agriculture, developing policies that are specially designed to reduce production fluctuation and to control price and income variability at farm level

(Moreddu, 2000). One of the reasons cited in the literature for this is that when young farmers get into the agriculture business through borrowing money to buy land, their objective should be to lower their debt/equity ratio to a safe level as soon as possible in order to avoid threat to the business. Therefore with government intervention some or all the risk is transferred to the State and farmers are able to take more financial risk than they otherwise would have taken (Johnson, 1990). Arrow, cited by Barry & Fraser (1976), suggests that the government can effectively pool risks over numerous and diverse activities. However one of the most important issues in state intervention is to assess the ability that new policies can have to stabilise farmer's income without providing support to farmers, in particular the more distorted forms of support (Moreddu, 2000). In many countries of the world, the governments still have a considerable influence over agriculture in different ways, moreover, as Moreddu (2000) mentions "there has been a movement away from market price support towards direct payments to farmers" (p. 46) in order to reduce farm income variability. In this way the programs and policies developed in United States in order to control risk in agriculture through the access of farmers to loan rates and target prices for commodities, have encouraged financial leverage and hence greater financial risk-taking (Featherstone, Moss, Baker, & Preckel, 1988). Featherstone et al.(1988, pp. 579) concluded from their work that these types of programs have their own problem:

"It is a paradox that policies intended to make farming less risky may have led to more risk for farm proprietors. The likelihood of greater risk is enhanced by policies intended to make credit more readily available. Risk-reducing and income augmenting farm policies may have unwittingly contributed to the fragility of agriculture".

Thus, agricultural subsidies are still a world-wide common practice in many countries in order to ensure farmer's income, however the consequence when the supports are removed is that the situation goes into reverse and then all or most of the risk has to be born by the farmers. Dutch farmers are now facing a similar situation faced by New Zealand pastoral farmers in the middle 1980s. During recent years in the Netherlands, farmers have been increasingly confronted with international market prices which generally means lower and more fluctuating prices (Huirne, 2002).

New Zealand's seasonal pastoral systems rely heavily on external variations; costs and prices fluctuate depending on global production, the climate, currency exchange rates, economic growth and product access to different markets (Martin & Shadbolt, 2000) and all these uncertainties are risk sources for farmers. One of the

most distinctive traits of the New Zealand dairy industry is the fact that it is based on cooperatives. Under this structure, the disadvantages related to the relative small size and competitive environment of most producing firms is offset by a larger size, commodity specialization and greater market power through larger numbers of suppliers, thereby improving their market expectations. This multiple ownership in a cooperative helps to spread business risk over a large number of stockholders as well. Additionally, marketing by the cooperative can pool prices helping to stabilize the shareholder's price expectations. The cooperative's knowledge of commodity flows, larger size and specialized management may even raise expected returns (Barry & Fraser, 1976; Moreddu, 2000).

2.3.2 Basic Concepts

2.3.2.1 Risk and uncertainty

One of the reasons why awareness of risk is important in agriculture is that every decision has its future consequences which are, often, unknown. When such decisions have a significant impact on the overall business performance then managing risk is imperative in agriculture. In business it is well accepted that profit is the reward for risk taking, therefore anyone in agribusiness must be prepared to bear some risk.

There are many definitions of risk and uncertainty available in the literature and some more useful than others. Barry (1984) and Huirne (2002) recognize that Knight was one of the first economists to classify the degree of knowledge in decision situations. Working from logical possibilities he proposed three major categories: perfect knowledge, risk and uncertainty. In his book he stated that perfect knowledge exists when the decision outcomes are known with certainty. Then the difference between risk and uncertainty is based on the fact that with uncertainty the decision-maker does not know the probabilities of the likely outcomes and neither might be able to identify the possible outcomes. On the other hand, under risk, the decision-maker knows both the alternative outcomes of the decisions and the probability of each outcome.

Hardaker et al. (1997) define uncertainty as "imperfect knowledge" (p. 5), therefore under uncertainty one could affirm a value-free statement simply implying imperfect knowledge of the future. On the other hand the same authors define risk as

"uncertain consequences, particularly exposure to unfavourable consequences" (p. 5), and in this case the decision-maker indicates preferences for alternative consequences that might involve adversity or losses. Olson (2003) mentions that risk and uncertainty refer to variation and change and both of them cannot be completely controlled. He makes a very subtle distinction when defining the two terms, so for him risk is "when the decision maker knows all the possible outcomes of an action and the objective probability of each outcome"; and uncertainty is "when the decision maker knows part or all the possible outcomes, but can not quantify the probabilities" (p. 293).

2.3.2.2 Classification of Risk

Gabriel & Baker (1980), Hardaker et al. (1997) and Huirne (2002) classified risk into two main components: business risk and financial risk. Business risk is the risk inherent in the firm, independently on how it is financed, and it is reflected in the variability of the net operating income or net cash flows, e.g. the higher the coefficient of variation of net cashflows between years, the greater the business risk. Business risk incorporates at least five types of risks, as follows (Hardaker et al., 1997; Olson, 2003; Sonka & Patrick, 1984):

- Production risk. All the variables that may affect the yield of the business are in this category. In others words this category includes everything related to the unpredictable nature of the weather and to the uncertain performance of crops and livestock (Meuwissen, Hardaker, Huirne, & Dijkhuizen, 2001)
- Market risk (or Price risk). It includes variability in prices for both output and inputs and the uncertain availability and quality of the latter (Gabriel & Baker, 1980; Meuwissen et al., 2001). Additionally, farmers know when prices are changing, and that therefore may create the opportunities to expand the business or to leave it altogether, thus leading toward to new market situations
- Technological risk. Technological advances continue to create new breakthroughs in technology (Backus, Eidman, & Dijkhuizen, 1997), so this type of risk is present when current investments on assets may be off-set by technological improvements in the future or in the impact of new technologies on farm profit. Technology can reduce risk to farmers because they have more control on the production process, however it has also

enabled farmers to produce in more extreme conditions and thereby creating new sources of risk

- Legal and Social risk (Institutional). The issues from this source of risk fall mainly in four areas: business structure and tax and state planning, contractual arrangements, tort liabilities, and statutory compliance, including environmental issues (Olson, 2003). The latter is highly relevant considering the increase in importance of environmental issues and food safety concerns that may limit the potential for input management to reduce production risk (Moreddu, 2000)
- Human resource risk. This is associated with the labour and management functions of farming. This is especially relevant in New Zealand considering the business structure (sole farm operator) as well as the availability and reliability of labour

The aggregate effect of all these sources of risk (business risk) will influence the variability of farm business performance such as the net operating income of the business; therefore business risk affects the ability of the producer to meet his/her commitments. If the net operating income of the business fails to meet its commitments in several years then the survival of that business is threatened.

On the other hand, financial risk results from the method of financing the firm. The fixed financial obligations associated with debt financing and cash leasing mean that a share of the operating profit must be used to meet these commitments before the owners of the equity capital can take their reward. The effect of financial risk is reflected by adding variability of the net cash flows of the owners of equity (Boehlje & Eidman, 1984; Gabriel & Baker, 1980; Hardaker et al., 1997; Martin, 1994; Olson, 2003). Financial risk is the margin for debt protection and it does not mean risk only for the farmer (borrower) but also for the lender, which will be reflected in the interest rate at which the money will be borrowed. The use of borrowed funds to provide some capital for the farm means that a portion of the operating profit will have to be used to meet that commitment, therefore financial risk magnifies the business risk from the equity holder's point view through an effect known as leverage (Collins, 1985; Hardaker et al., 1997; Johnson, 1990; Jolly, 1983). Leverage decisions have a major importance in financial management and have profound effects on expected profitability, risk and liquidity (Barry, Ellinger, Hopkin, & Baker, 2000). In

fact Gloy & Baker (2002) conclude that "access to financial leverage is important when making risk management strategy choices" (p. 1141) and thus the effect of financial leverage must be taken into account when risk management decisions are made.

The effect of leverage on total risk has been referred as the *Principle of Increasing Risk* which is defined as "the tendency for total risk to become greater at an increasing rate as the relative amount of non-equity (debt or capital lease) capital used in a business expands" (Boehlje, 2004; p.1). The principle states that the increases in the leverage ratio (the proportion of non-equity capital in the business over the total capital involved in the business) will result in an increase not only in the potential return on equity capital, but also in the potential losses that can occur if prices or productivity are below expectations. Therefore as leverage increases, so does total risk relative to business risk, and the degree of increase is directly related to leverage, and thus financial risk (Barry & Baker, 1984; Boehlje & Eidman, 1984). Furthermore, as leverage increases (or the use of increasing amounts of debt with a given level of equity) the impact on either gains or losses is asymmetric. Table 2-3 presents three different situations where a farmer can borrow different amounts of non-equity capital. Looking at the table, in situation 1 the farmer has chosen not to borrow money, therefore no matter what the cost of capital borrowed is, his/her Return on Assets (ROA) will be the same as Return on Equity (ROE). The situation changes as the farmer increases the amount of non-equity capital used in the business (situations 2 and 3). As the table shows, when ROA is positive and greater than the cost of non-equity capital (15% vs. 9% respectively) ROE is greater as the amount of money borrowed increases, in other words as leverage increases it magnifies ROE. However, when ROA is less than the cost of non-equity capital, then the situations are reversed. For no levels of debt (Situation 1), there are no changes, and ROA is equal to ROE; yet as the level of debt increases, situations 2 and 3, the losses are greater than the gains.

Table 2-3 The effect of leverage on Return on Equity (ROE) for a business farm (From Boehlje, 2004)

	Situation 1	Situation 2	Situation 3
Equity capital used in business	$200,000	$200,000	$200,000
Nonequity capital used in the business	$0	$200,000	$400,000
Total capital used in the business	$200,000	$400,000	$600,000
Income when Return on Assets (ROA) is 15%			
Returns to total capital used	$30,000	$60,000	$90,000
Cost of nonequity capital (9%)	$0	$18,000	$36,000
Total return on equity capital used	$30,000	$42,000	$54,000
Rate of Return on Equity (ROE)	15%	21%	27%
Income when Return on Assets (ROA) is -15%			
Returns to total capital used	-$30,000	-$60,000	-$90,000
Cost of nonequity capital (9%)	$0	$18,000	$36,000
Total return on equity capital used	-$30,000	-$78,000	-$126,000
Rate of Return on Equity (ROE)	-15%	-39%	-63%

Therefore if the interest rate at which the capital is borrowed is less that the return on capital, the margin is gained by the holder of the equity capital. A highly leveraged firm then can accumulate equity more rapidly and expand its operation at a faster rate if it is generating higher returns on borrowed capital than the interest rate. This could be the situation of a young farmer getting into agriculture, who has high debt commitments in relation to equity. However, due to the fixed nature of the interest payments, a highly leveraged firm will also lose more money if the rate of return on capital is less that the interest rate of borrowed funds (Boehlje & Eidman, 1984). In summary, the potential losses of highly leveraged firms can be greater than the potential benefits from the capital borrowed.

Olson (2003) mentions that financial risk has four main components:

a) The cost and availability of debt capital,
b) The ability to meet cash flow needs,
c) The ability to maintain and grow equity, and
d) The increasing chance of losing equity by larger levels of borrowing against the same net worth.

While internal and external forces affect the first three components, the last one is very much determined by the farmers' decision on how much debt they take on compared with their equity (Olson, 2003).

The magnitude of the risk is determined by three elements: its character, its extent and timing. The first one is related to the area of the business (farm) that is exposed to risk: financial, business, environmental, etc; the second is related to whom is likely to be affected by risk and the size of the risk, and the last is related to the time when the risk is likely to occur. Considering these, risks can be classified as ordinary (small) or extraordinary (calamity or catastrophic) depending on their frequency and the extent of the losses or potential impact, and they vary according to natural conditions, farm structures and production practices (Gough, 1990; Moreddu, 2000; Olson, 2003).

2.3.2.3 Risk Management Process

Once the risk sources have been identified, risk management has to be put in place in order to manage and control those sources of risk. Risk management is the "systematic application of management policies, procedures and practices to the tasks of identifying, analysing, treating and monitoring risk" (Hardaker et al., 1997, p.12). This is a process that the decision-maker should go through in a systematic and cyclical way (figure 2-3). The Australian and New Zealand Standards (AS/NZS, 1999) define risk management as "the term applied to a logical and systematic method of establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risks associated with any activity, function or process in a way that will enable organizations to minimize losses and maximize opportunities" (p. 1). Similarly (Patrick, 1992) defines risk management as "a variety of responses which may reduce the probability of an unfavourable event occurring and/or reduce the adverse consequences if the event occur". However these responses have costs associated, since in the process of avoiding potential losses the decision-maker also loses potential benefits.

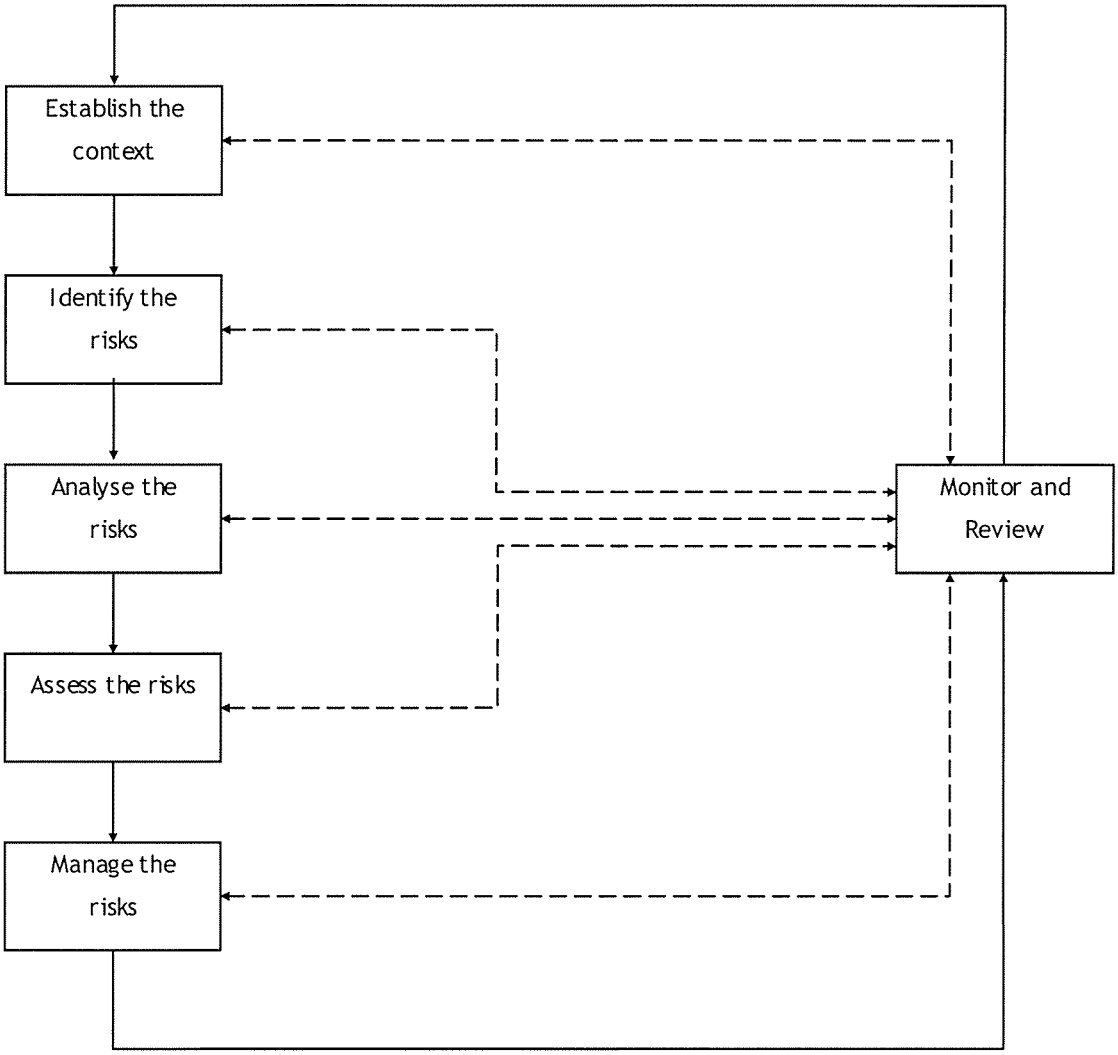

Figure 2-3. An outline of the steps in risk management (Hardaker et al., 1997)

Several steps have been identified in the decision-making process that are affected by risk management. Herbst cited by Sonka & Patrick (1984) mentioned six main components in this process, listed in order: (1) define problems and goals; (2) get ideas, make observations and list major alternatives; (3) analyse the alternatives and determine the outcomes; (4) decide which alternative to select; (5) act on the decision; and (6) bear responsibility for the outcome.

Risk management *per se* involves choosing a strategy or a set of strategies to reduce the effect of risk on income or welfare and to ascertain the most suitable solution to be implemented (Moreddu, 2000). As the sources of risk differ with location, time and other factors, different risk management strategies are appropriate

for different farmers, thus this is an individual process that should take place at the farm household level. In general terms the aim of these strategies is to help farmers to reduce the variability of the expected results of the business and maximize their opportunities, however Boehlje & Eidman (1983) go further in the aim of risk management mentioning that its focus should not only be to control or manage the variability in income but to protect the firm from failure or termination. They mentioned the contrast between the traditional approach in farm survival and risk management, the former is more focused on production and marketing strategies to reduce operating risk, the latter approach they proposed though is more focused on changes in the composition of assets, equity based and the pattern of resource ownership.

Sonka & Patrick (1984) consider that "an action is considered risk reducing if, when repeated numerous times, it lowers the variability and expected level of income compared to alternative actions. If an action both reduces income variability and increases expected income, it is unclear whether such a decision is made to increase profit or reduce risk" (p. 101). In a similar way, AS/NZS (1999) define risk reduction as "the selective application of appropriate techniques and management principles to reduce either likelihood of an occurrence or its consequences, or both" (p. 4).

Boehlje & Trede (cited by Sonka & Patrick, 1984) classified these strategies in three different groups depending on the organizational areas of the farm business: production, marketing and financial responses.

- **Production Responses.** As the variability in yields, and therefore in income, differs among regions and enterprises, enterprise selection and location play a big role in the variability of cash flows within the farm business. Specialisation and diversification have opposite effects on income levels and variability at the farm level (Moreddu, 2000). Specialisation may increase income through a reduction in fixed costs and better managerial expertise (e.g. dairy farms) but increases income variability. On the other hand, diversification reduces income risk especially when the commodities produced have different yield and price risk. These issues have been researched by Langemeier & Jones (2000) and Purdy, Langemeier, & Featherstone (1997). Among other responses, Martin & Lee (1990) mentioned that modification of technical practices may well be used as an informal

insurance scheme. These may include an excess investment in machinery, maintaining feed reserves and precautionary animal and plant health measures. To reduce problems with hired labour two strategies that may reduce the risk at this level are: substitution of capital for labour and the development of a system reward structure.

- **Market Responses.** The aim of these responses is to reduce price variability by selecting enterprises with low expected price variability (Sonka & Patrick, 1984). Barry & Fraser (1976) mention that market responses to risk may include combinations of inventory management and forward commitment on prices and production with other participants in the commodity market. Inventory management refers to the production and storage policies that can reduce risk through greater flexibility, e.g. Flexibility in storage may allow the farmer to hold commodities and sell them when the prices improve. Similarly, sequential harvesting and marketing for different crops may also generate a similar effect. In the case of livestock, greater frequency in marketing requires feeding programs and less seasonality in production. This last point is extremely important in New Zealand considering the strong seasonal pattern in milk production, therefore the reduction in risk through this strategy could well generate benefits for both the industry, in terms of better use of the capacity of milk processor plants, and as well as for the farmers.

- **Financial Responses.** Financial responses "reflect the capacity to accept risks in marketing and production or to spread these risks among those with financial claims on the firm" (Barry & Fraser, 1976; p. 290). Barry & Fraser (1976) suggest that in a more uncertain market environment, it seems reasonable to use financial responses to manage risk with the objective of making the financial environment more stable and predictable. However the use of financial strategies to manage risk has its disadvantages in relation to liquidity (Boehlje & Eidman, 1983). Although highly liquid assets have a relatively low cost of maintenance they do have a high opportunity cost for the farmer. Moreover, the reliance on credit, in order to get the most liquid asset which is cash, only shifts a substantial portion of the firm's financial

control to its lender. Considering the utility of liquid assets in terms of financial risk management, credit reserves must be large enough to provide additional loans to meet financial obligations in periods of adversity, and flexible enough to convert excessive short-term debt into longer term debts (Moreddu, 2000).

Despite the large number of risk management strategies available for farmers, the feasibility of risk response appears to vary greatly according to different variables such as farm size, major enterprise and quality of management, as well as the age and educational level of the farmer (Barry & Fraser, 1976; Martin & Lee, 1990; Martin & McLeay, 1998). Depending on how the managers respond to the changes in the environment that may affect their farms, Jolly (1983) classifies risk responses in two broad ways according to their primary function in controlling risk: those that attempt to control risk exposure and those attempting to control risk impact. These strategies will frequently be independent of one another (Jolly, 1983). Hardaker et al. (1997), Huirne (2002) and Meuwissen, Hardaker et al. (2001) classify strategies to reduce risk in two categories: those taken within the farm and those developed to share risk with others.

Following the classification proposed by Jolly (1983), the strategies that attempt to control risk exposure rely on the fact that the farmers have to choose which set of probability distributions the farm business will confront. In other words, risk strategies that attempt to control risk exposure will try to manipulate the probability of the performance of the business with the aim of reducing its variability. This can be done by either smoothing out yields and prices or by cutting out troughs of their distribution (Martin, 1994; Martin & Shadbolt, 2000). Some strategies to control risk exposure are: enterprise selection, diversification, marketing strategies; all of which try to reduce either price or yield fluctuation. Other strategies are: methods to reduce the variability of production such as disease control and irrigation; and volume of business or scale of the operation, that seeks to increase the performance of the firm. Finally, insurances cut the likely troughs in the price or yield distribution.

The second major strategy (controlling risk impact) has no relationship with the probability distribution of the firm, rather they influence the capability of the business to absorb the unfavourable downturns or exploit favourable events (Martin, 1994; Martin & Shadbolt, 2000). Within this category we can find strategies such as: the

choice of financial structure, reducing leverage; maintaining availability of credit and cash reserves; business organization, leasing arrangements; lifting net operating income through higher prices and/or yields.

Some risk management strategies cited by the literature are described below (AS/NZS, 1999; Backus et al., 1997; Barry & Fraser, 1976; Boehlje & Eidman, 1984; Fleisher, 1990; Hardaker et al., 1997; Huirne, 2002; Just, Wolf, & Zilberman, 2003; Meuwissen et al., 2001; Moreddu, 2000):

a) Collection and analysis of information. As Just et al.(2003) state "individuals facing uncertainty will often seek information in order to reduce the risk of poor quality decision" (p. 201). Therefore the main effect of information within the decision-making process is that it leads to better decisions in a risky world. Patrick (1992) mentioned two sources of information for farmers: Farm records and Off-farm information. Barry & Fraser (1976) suggest that farmers will value more highly flows of new market and financial information as price and income risk increase in agriculture because that will update and improve their expectations of the future. However not only quantity of information is required but quality and the decision-maker's ability to interpret that information (Just et al., 2003). As knowledge increases there will be two effects on subjective probabilities distributions for an event, firstly the dispersion of the distribution will be reduced, and secondly there is likely to be a shift in the location of the distributions, as the decision-maker will make some adjustment to his/her beliefs (Hardaker et al., 1997).

b) Diversification. The idea of this strategy is to reduce the risk of the overall return by selecting a mixture of activities that will have net returns with low, negative or no correlations between them; however, diversification can also mean a mix of locations, therefore production risk is spread across different units. It is important to mention that adding more enterprises to the business would generally further reduce risk, but the marginal risk reduction becomes smaller as the number of enterprises increases (Sonka & Patrick, 1984). With diversification, other strategies can be added such as spreading sales during the season through management of supply, but totally spreading the sales does not allow to farmers to utilize their information and marketing skills (Sonka & Patrick, 1984). There may also agronomic benefits with

diversification such as those in crop rotation amongst others (Williams & Schroder, 1999).The opposite strategy (specification) increases efficiency in terms of knowledge, machinery utilization but it also increases significantly the overall risk, as there is no chance to absorb a downturn of the business with other activities (Moreddu, 2000). Purdy, Langemeier, & Featherstone (1997) mentioned that increased emphasis on business focus or specialization is the product of the industrialization of agriculture. The same authors from the analysis of a database with 320 farms in Kansas, found that farms running both crop and livestock enterprises tended to have less variability in financial performance than running single enterprises. They also found that specializing in swine and dairy production decreased the variability and increased the mean of financial performance, and that the economies of scale also play a key role in determining that.

c) Flexibility. Flexibility refers to the ease and economy with which the farming business can adjust to farming circumstances (Hardaker et al., 1997). Hardaker et al.(1997) mention strategies that can be adopted by farmers to enhance flexibility are: (a) asset flexibility, that means investing in assets that have more than one use; (b) product flexibility, refers to a business yielding one or more products, or when a business produces only one product but with more than one end use; (c) market flexibility, which is the situation when a product is sold in different markets to avoid the influence of the same risks; (d) cost flexibility, is organizing the production process keeping fixed costs as low as possible to ensure higher variable costs only when it is necessary, and; (d) time flexibility, farmers rarely face dichotomous decisions like whether to invest or not, so the decisions are related to time constraints or when they have to invest to catch an opportunity, and in this sense, the speed with which adjustments are made within the farm are crucial for the success of the business.

d) Transfer of risk along the food chain. In general terms agriculture has become more integrated (Boehlje, 1999; Boehlje, Doehring, & Sonka, 2004; Fulton, 1995; Moreddu, 2000), and within this integration we can find that the most common strategy is vertical integration. There are different ways how a farm can be vertically integrated. One situation is when a farmer grows his own cereal and forage to feed his livestock, a sort of self-contained farm. Another

way is when a farmer or farmer's organization extends the control of the operation beyond the farm gate (or vice versa). In the poultry industry this kind of integration is common, where a company controls the whole process. Other kinds of vertical integration are production contracts and marketing contracts. Both of them eliminate price risk and thus the farmers have to deal with only production risk and others that may arise. Under a production contract, the level of integration is lower as the contractor does not own the supplier but controls the production process. In the market contract, a buyer and a farmer agree on a certain price and a certain quantity to be delivered in the future. From her report Moreddu (2000) concludes that integration between public and private institutions is a key aspect in order to manage risk.

e) Market risk management. For those commodities where futures markets exist, farmers can use futures contracts or options to minimise price variability. Futures contracts consist of the producer's promise to deliver a specified volume of production at a certain time, place and price. Under this kind of agreement price risk is eliminated and the farmer has to deal with production risk only. Studies had been done regarding this tool as an efficient way to reduce price risk, but some of them have concluded that although this is available, farmers do not use them mainly because of lack of knowledge. This situation reflects the need for two policies: the development of new products or the modification of those that already exist to make them more understandable for farmer, and secondly to increase farmer's education to enable them to use these tools (Hall, Knight, Coble, Baquet, & Patrick, 2003; Meuwissen et al., 2001).

f) Insurance (risk pooling). Arrow (cited by Barry & Fraser 1976) suggests that the government can effectively pool risk and spread its costs of risk bearing over such a large number of tax payers as to reduce these costs towards zero. However, Hardaker, Huirne, & Anderson (1997) and Meuwissen, Huirne, & Hardaker (2001) suggest that sharing the risk is both a more effective and realistic way of controlling it. Risk pooling can be done by groups of farmers, cooperatives or marketing boards, usually with regard to the price risk. The effect of insurance is that premiums collected from a large number of clients

can be pooled and then it might be used to compensate for losses to individuals when they occur.

Choosing among all these responses is a very complex decision. Part of this complexity is determined by the fundamental risk-returns trade-off that is involved with most of these responses. It is not usually the situation where a decision does not reduce risk without simultaneously reducing average profits or return from the business (Musser, Patrick, & Ullerich, 2002). Figure 2-4 suggests that the first options or risk management strategies to be implemented in the firm should be those that involve a relatively low expenditure or are easier and from which large reductions in risks may be obtained (AS/NZS, 1999).

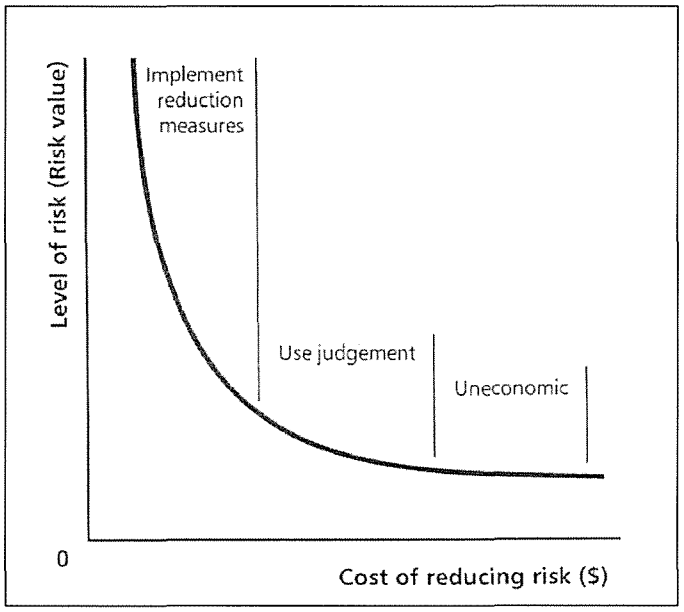

Figure 2-4. Cost of risk reduction measures (AS/NZS, 1999)

2.3.2.3.1 Risk constraint and risk balancing effect

The level of risk farmers feel they can comfortably tolerate varies between individuals. In the literature this level of total risk (business plus financial risk) at which the decision-maker feels comfortable is called *risk constraint* (Gabriel & Baker, 1980). The lower the risk constraint for a farmer the more risk averse he/she is. The ability to deal with different risk constraints depends on some characteristics like the age of the farmers, level of education, geographic location, socio-economic variables and others (Bogges, Anaman, & Hanson, 1985; Martin & McLeay, 1998; Patrick, Wilson,

Barry, Bogges, & Young, 1985; Wilson, Luginsland, & Armstrong, 1988). If for any reason this risk constraint is changed by a fluctuation in either business or financial risk, then the farmer will do some readjustments in order to bring the total risk he/she is facing to the levels which he/she feels they can cope with; this concept is known as the *risk balancing effect* (Collins, 1985; Featherstone et al., 1988; Gabriel & Baker, 1980; Johnson, 1990). Gabriel & Baker (1980) acknowledging that the pattern of resource allocation in the production process, and therefore the levels of production, can be affected because new source of risks in the production area, suggested and proved that farmers make financial adjustments leading to decreased or increased financial risk in response to the rise or fall in business risk. In fact Martin & Lee (1990) suggest that this may well have been the situation for New Zealand farmers prior to the 1984 deregulation. Before deregulation all the subsidies were reducing some of the business risk and some financial risk as well, such as interest rate, therefore this situation allowed farmers to make management decisions to increase either business or financial risk up to the maximum level of risk constraint.

2.4 RESEARCH METHODS AVAILABLE FOR RISK ANALYSIS

2.4.1 Introduction

In social and behavioural sciences there are two major science models or paradigms known as *positivist/empiricist* and *constructivist/phenomenological* approaches respectively (Tashakkori & Teddlie, 1998). A paradigm is defined as the worldviews or beliefs systems that guide the researcher (Guba & Lincoln, 1994 cited by Tashakkori & Teddlie, 1998). The positivist approach underlies what are called quantitative methods while the constructivist approach underlies qualitative methods (Burns, 2000; Tashakkori & Teddlie, 1998). The difference between them is not quality but procedure. Making the distinction between qualitative and quantitative research is frequently unhelpful and misleading, and it is more helpful to distinguish two stages of the research: collecting data and analysing data (de Vaus, 2002).

The quantitative approach is based on the collection and analysis of data that are commonly numerical. On the other hand qualitative research is based on a "recognition of the importance of the subjective, experiential 'lifeworld' of human

beings" (Burns, 2000, p. 11). The differences in procedures are manifested not only in quantification, but also a reflection of different perspectives in knowledge and research objectives (Ghauri, Grønhaug, & Kristianslund, 1995). For this reason during the last three decades there has been some disagreement regarding which approach is the better for social studies, the so-called *qualitative-quantitative debate* (Tashakkori & Teddlie, 1998). For many years scientists from either side criticized each others' approach, reaching a point known as the incompatibility thesis that recognizes the incongruity between the two approaches (Smith & Heshusius, 1986 cited by Tashakkori & Teddlie, 1998). Burns (2000) says that by the end of the 1970s researchers began to agree that both approaches were needed, since neither methodology can answer all the questions and explore every issue.

In an attempt to end the paradigm debate, some social scientists have proposed that both qualitative and quantitative methods are indeed compatible (Burns, 2000). This *pragmatism* approach contains elements of both the qualitative and quantitative approaches (Tashakkori & Teddlie, 1998). Therefore combining both methods in doing research results in a powerful tool that will fully utilize the advantages of each one, while simultaneously overcoming their weaknesses (Bryman, 2001; Burns, 2000; Ghauri et al., 1995; Tashakkori & Teddlie, 1998; Yin, 2003). The differences between qualitative and quantitative methods are set out in table 3-1.

Table 2-4. The differences in emphasis in qualitative and quantitative methods (from Ghauri et al., 1995)

QUALITATIVE METHODS	QUANTITATIVE METHODS
• Emphasis on understanding	• Emphasis on testing and verification
• Focus on understanding from respondent's/informant's point of view	• Focus on facts and/or reasons of social events
• Interpretation and rational approach	• Logic and critical approach
• Observations and measurements in natural settings	• Controlled measurement
• Subjective "insider view" and closeness to data	• Objective "outsider view" distant from data
• Explorative orientation	• Hypothetical-deductive; focus on hypothesis testing
• Process orientated	• Result orientated
• Holistic perspective	• Particularistic and analytical
• Generalisation by comparison of properties and contexts of individual organism	• Generalization by population membership

As in other fields, for many years risk analysis was undertaken as a monomethod study (Tashakkori & Teddlie, 1998), that is from an econometric point of view. However, since the perception of the risk plays a fundamental role within the decision-making process, the qualitative approach has also now been added. Currently risk analysis commonly uses a mixed methodology defined as "studies that are products of the pragmatist paradigm and that combine the qualitative and quantitative approaches within different stages of the research process" (Tashakkori & Teddlie, 1998, p. 19). In the first stage, qualitative analysis is often used to obtain an initial general indication of the level of risk. Then it may be necessary to undertake a more specific quantitative analysis (AS/NZS, 1999). Gough (1990) states that no single approach to estimating perceived risk is clearly superior to the others in all situations, so both qualitative and quantitative methods must be combined to get a good understanding of the problem being studied.

2.4.2 Qualitative Methods

The qualitative approach is becoming more common in social studies since the human element is now recognised as a critical and determining factor in the definition of truth and knowledge, as qualitative methods are both flexible and unstructured (Ghauri et al., 1995). This approach places stress on the validity of multiple meaning structures and holistic analysis, as opposed to the criteria of reliability and statistical compartmentalisation of quantitative research (Burns, 2000). Although in qualitative analysis the number of observations is low, several aspects of the problem can be analysed, allowing an in-depth insight of the phenomenon studied (Ghauri et al., 1995; Yin, 2003). AS/NZS (1999) suggests that the qualitative analysis is used:

- As an initial screening activity to identify risks which require more detailed analysis;
- Where the level of risk does not justify the time and effort required for a fuller analysis; or
- Where the numerical data is inadequate for a quantitative analysis.

2.4.3 Quantitative Methods

These methods involve working with numbers to develop particular understanding of situations, they rely on the analysis of the data collected in a proscribed way to develop that understanding. The usefulness of the quantitative analysis relies on the use of numerical values to ascertain consequences and likelihood, using data from a variety of sources (AS/NZS, 1999). As quantitative methods are older than qualitative ones, the range of quantitative techniques available is vast.

AS/NZS (1999) suggest that, after obtaining a general indication of the level of risk through a qualitative analysis, it may be necessary to undertake more specific quantitative analysis. The main strengths of these methods rely on precision and control. Control is achieved through the process of sampling and design; precision through quantitative and reliable measurement (Burns, 2000).

2.5 RISK APPROACHES IN AGRICULTURE

Starr et al. (cited by Gough, 1990) defines four measures of risk:

a) Real risk: determined when the future circumstances are fully developed
b) Statistical Risk: determined by the current available data
c) Predicted risk: predicted analytically through systems models structured from historical data
d) Perceived risk: seen intuitively by individuals

The first of these is a theoretical concept as it will only be determined at some stage in the future. The next two measures can be grouped under the so-called objective estimation. Finally the last approach of risk is absolutely dependent on each individual.

Considering the above description of risk measures, the literature available about risk management applied to farm economics can be classified from two major points of view: the econometric or theoretical (technical concept) and the practical insight of risk (social concept) (Bar-Shira, Just, & Zilberman, 1997; Gough, 1990). Most of the literature has focused on the first point of view. In this, three interrelated disciplines can be found (Just et al., 2003): the behaviourist (what do the decision-makers do?),

the positivist (Why do the decision-makers do it?) and the normative or prescriptive (what should the decision-maker do?). The econometric point of view, or technical concept of risk, is mainly based on the application and development of theories that try to explain and rationalize the decision-making process under uncertainty. On the other hand, and despite the importance and the implications of practical insights of risk for governments, policy makers and promoters of new risk management strategies, there is a lack of literature available on the social aspect of risk, for example in risk perception, especially in the farming field (Meuwissen et al., 2001). The approach that deals with the practical implications of risk tries to provide empirical insight into the farmer's perception of risk sources and risk management strategies preferred by them, as well as find social variables that may be related with these perceptions and responses. These two concepts of risk do not necessarily conflict with each other (Gough, 1990), and they can be used as complementary approaches. In fact Jolly (1983) states that "Farm or risk management can also be improved by noneconomic disciplines as well. An understanding of how individuals process information or perceive risk is critical for the development of risk management techniques and supporting educational programs" (p. 1112).

2.5.1 Econometric or technical concept of risk

The econometric or technical concept of risk is based on the decision analysis and it assumes that most people dislike risk or try to reduce exposure to risks (risk aversion) and farmers are no exception (Hardaker et al., 1997; Huirne, 2002; Meuwissen et al., 2001; Nadiminti, Mukhopadhyay, & Kriebel, 1996). This last paradigm contrasts with the vision of Antle (1983) as he suggests that it is not evident that farmers are risk averse, and thus risk preferences are difficult to measure. Similarly, Backus, Eidman, & Dijkhuizen (1997) mention that most empirical studies have shown that farmers are mostly risk neutral or slightly risk averse. In this sense Musser et al. (2002) suggested that most people are moderate risk takers, and farmers' attitude to assume risk is not significantly greater than the population.

Decision analysis is the process that seeks to rationalize choice in an uncertain world. Hardaker et al. (1997) suggest that through this process risk decisions are broken down into separate judgements that assess the uncertainty of such decisions on one hand and also assess the preferences for consequences of the decision-maker on

the other (figure 2-5). The most practical way of bringing risk into decision analysis in farming is through the use of sensitivity analysis. This is a basic tool that can be used to estimate the effect of a specified change in price, production level, interest rates or combinations of changes in those variables on the outcome of concern (Boehlje & Eidman, 1984), so the decision-maker can rank the probable outcomes.

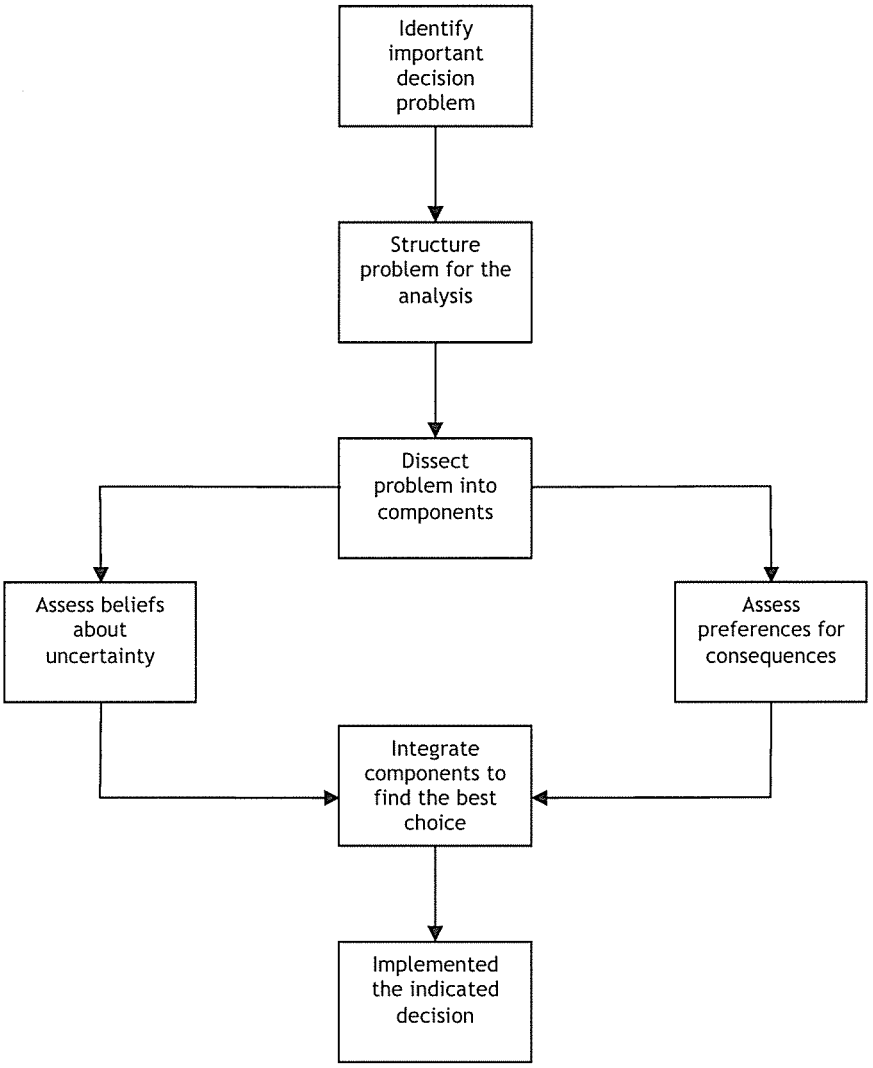

Figure 2-5. Outline of decision analysis (Hardaker et al., 1997)

Through the measurement of uncertainty with subjective probabilities, this approach can assess risk and rank risk preferences. In this sense during the 1940s John

von Neumann and Oscar Morgenstern provided the first axiomatic treatment of what is called Subjective Expected Utility (SEU) (Backus et al., 1997; Hardaker et al., 1997; Robinson, Barry, Kliebestein, & Patrick, 1984). The set of axioms is summarized as follows:

i. Ordering of choice. For any two actions, A_1 and A_2, the decision-maker either prefers A_1 to A_2, prefers A_2 to A_1, or is indifferent between them.
ii. Transitivity among choices. If A_1 is preferred to A_2, and A_2 is preferred to A_3, then A_1 must be preferred to A_3.
iii. Substitution among choices. If A_1 is preferred to A_2, and A_3 is some other choice, then a risky choice $PA_1 + (1 - P)A_3$ is preferred to another risky choice $PA_2 + (1 - P)A_3$, where P is the probability of occurrence.
iv. Certainty equivalent among choices. If A_1 is preferred to A_2, and A_2 is preferred to A_3, then there is a probability P that exists at which the decision maker is indifferent to having A_2 for certain or receiving A_1 with probability P and A_3 with probability (1 - P). Thus A_2 is the certainty equivalent of $PA_1 + (1 - P)A_3$.

If the decision-maker obeys these axioms, then a utility function can be formulated that reflects the decision-maker's preferences (Key cited by Robinson et al., 1984). In the SEU theory, decision-maker's risk preferences are related to the curvature of the utility of money function, and the utility is assumed to be a function of profit and other variables. The utility function (U) has two properties; e. g. considering a decision problem where from two choices there is only one choice to be made, the properties are:

i. $U(a_1) > U(a_2)$ if, and only if, a_1 is preferred to a_2; and
ii. $U(a_j) = E[U(a_j)]$, i.e., the utility of a risky prospect is its expected value

SEU hypothesis shows how to integrate the two components of utility (preferences) and probability (degree of belief) to provide a means of ranking of the consequences that the decision maker will have to face, allowing risky choices to be rationalized (Hardaker et al., 1997; Robinson et al., 1984). The prescriptive power of SEU means that it works for a specific decision-maker, or for a group of decision makers; whereas the descriptive analysis starts with the proposition that farmers (or decision-makers) tend to act as if they would always be trying to maximize Expected Utility (EU), giving it a behavioural perspective (Hardaker et al., 1997). As SEU is

based on the curvature of the utility of money function, the literature suggests that the absolute risk aversion generally decreases as wealth increases (Arrow; Cohn et al.; Gordon et al. cited by Barry & Fraser, 1976). As we see the EU is particular for each decision-maker, and to obtain or elicit it different approaches have been developed.

The assumption that everyone is risk averse can be perceived at a farmers' level as a friction that does not allow the efficient allocation of resources(Hardaker et al., 1997). Risk averse behaviour is assumed when the decision maker exhibits diminishing marginal utility for increases in expected wealth (Barry & Fraser, 1976). The greater the risk aversion the higher the difference between the expected monetary value and the risk averter's value, that is called *the premium*. Because the assumption that farmers are risk averse, there is a time lag between the new technology available for production and the time taken by farmers to apply this technology to their business (Barry & Fraser, 1976; Hardaker et al., 1997). Therefore under no risk, it is hypothesized that agricultural products would be cheaper because the lag in using new technologies would be shorter and the processes would be more efficient.

The degree of risk aversion can be measured in several ways. One of the most commonly used measures is the coefficient of absolute risk aversion or coefficient of Arrow-Pratt (Backus et al., 1997; Hardaker et al., 1997; Robinson et al., 1984), although other coefficients are also considered to measure risk aversion such as the coefficient of relative risk aversion or coefficient of partial risk aversion.

The elicitation of the SEU is the base for much of the decision analysis under uncertainty. As stated above, the model incorporates the preferences and the degree of belief of the decision-maker, so this is the most direct way to measure preferences. However, for several reasons the elicitation of SEU may not be sufficiently accurate. These include, shortcomings in interview procedures, problems in statistical information and individuals' lack of knowledge of their preferences (Hardaker et al., 1997; Musser & Musser, 1984; Musser et al., 2002). With all these problems, the elicitation of utility function is often not considered a useful approach (Backus et al., 1997; Patrick et al., 1985; Young, 1979). When the preferences are not completely known or the information available is minimal, then in order to rank choices without the specification of the utility function, other tools have been developed called efficiency criteria. The efficiency criteria consider the trade-off between the expected income and the dispersion of the outcomes (Boehlje & Eidman, 1984). The efficiency analyses depend on making some assumptions about preferences for a

particular class of decision makers. In this analysis all the various actions available for the class of decision makers can be divided into two mutually exclusive sets: an efficient set and an inefficient set (Hardaker et al., 1997; King & Robinson, 1984). The inefficient set of actions contains those actions that are dominated by (less preferred than) the actions in the efficient set. The optimal action will be among the alternatives of the efficient set. Despite its usefulness this analysis also has problems; King & Robinson (1984) mention that a major problem is the possible trade-off between the discriminatory power and general applicability. In this sense the authors recognize that efficiency criteria that place few restrictions on the preferences, and thus are applicable to a wide range of decision-makers, may not eliminate many choices from consideration. Conversely, criteria that identify small efficient sets will require more specific information about preferences.

Some of the efficiency criteria mentioned in the literature are: the mean-variance (E,V) efficiency; mean-standard deviation efficiency and the stochastic efficiency methods. The latter, unlike the previous two, are firmly based on the notion of direct expected utility maximization (Hardaker et al., 1997). The advantage of this analysis is that the outcomes are compared in terms of their full distribution and not only in terms of moments (such as mean, variance or deviation standard) so, since the comparisons are made at every single point of the distributions of the outcomes, computer programs are needed to make this task easier. Some of the literature about assessing efficient sets of strategies use this analysis to compare and determine from the efficient set which is the most suitable strategy for the decision-maker(s) (Beherengaray-Neto, 2001; Lien, 2003; Montes de Oca, 1999). Within the stochastic efficiency methods we find: first-degree stochastic dominance (FSD), second-degree stochastic dominance (SSD), third-degree stochastic dominance and stochastic dominance with respect to a function (Boehlje & Eidman, 1984; Hardaker et al., 1997; King & Robinson, 1984). From all the criteria analyses available, the most commonly used are:

a) The mean-variance efficiency. This is the most familiar and most widely used efficiency criterion (King & Robinson, 1984). The reason for this is that the mean and variance probability distributions are easy to work with and familiar to most analysts. In the E,V efficiency the decision-maker is assumed to be risk averse and also prefer more than less (e.g. wealth or income) and some restriction of the outcomes are also specified: they have to have normal

distributions or that the decision-maker's expected utility function has to be quadratic. Under these assumptions the decision-maker will prefer the choice A to B only if the expected value of the option A is greater than or equal to the expected value of the option B, and the variance of A is less than or equal to the variance of B. The problem with the E,V efficiency is that in agriculture the outcomes do not always have normal distributions, and as happens with second degree stochastic dominance, the assumption that the decision-maker is always risk averse may lead to the optimal decision being excluded from the efficient set.

b) Mean-standard deviation efficiency. This a variant of the E,V efficiency analysis, and in some ways it is easier to follow, but with the difference that instead of using the variance, the standard deviation is used which is the positive square root of the variance.

c) First-degree stochastic dominance (FSD). In FSD the restriction is that the decision-maker will always prefer more to less, therefore given two actions A and B, each with a probability distribution of outcomes, x, defined by cumulative probability distribution functions $F_A(x)$ and $F_B(x)$ respectively, A dominates B in a first-degree sense if $F_A(x) \leq F_B(x)$ for all x, with at least one strong inequality (Hardaker et al., 1997; King & Robinson, 1984). Graphically this condition means that the cumulative distribution of the dominant alternative must never lie above the cumulative distribution of the dominated alternative.

d) Second-degree stochastic dominance (SSD). When graphically the cumulative probability distributions of two or more alternatives overlapped, then FSD is not suitable for determining what is the optimal alternative. Under this scenario it is necessary to use SSD, because it has more discrimination power than the FSD. This analysis is applicable for all the decision-makers that are risk averse and for whom utility function is positive and has a decreasing slope. With SSD the outcome distributions are compared on the basis of the areas under their cumulative distribution probabilities.

Although SSD is more discriminatory than FSD it has also its own problems. One of them is the fact that SSD assumes that the decision-maker is always risk-averse. In this sense King & Robinson (1984) mention that there

is some empirical evidence from the literature that farmers, at times, exhibit preference for risk.

2.5.2 The practical insight or social concept of risk

As was previously mentioned, there is little literature in this field despite the importance and impact of it in governments, agencies, policy makers and promoters of new risk management strategies. Harwood, Heifner, Coble, Perry, & Somwaru (1999) have reviewed and summarized many of these studies undertaken in the United States. The importance of this branch of risk analysis is crucial "... because it focuses on measuring peoples' preferences (or attitudes), probabilities, intelligence, learning, and other components of decision making under risk, many of which are unobservable aspects of human behaviour falling outside the traditional focus of empirical economics research" (Musser & Musser, 1984; p. 82)

Perceived risk is "the individual or group, judgement or valuation of the magnitude and likelihood of the possible "bad" outcomes which may result from an action" (Gough, 1990, p.16). Mazur cited by Gough (1990) suggest there are two models to explain risk perception, the psychological model and the sociological model (Figures 2-6a and 2-6b).

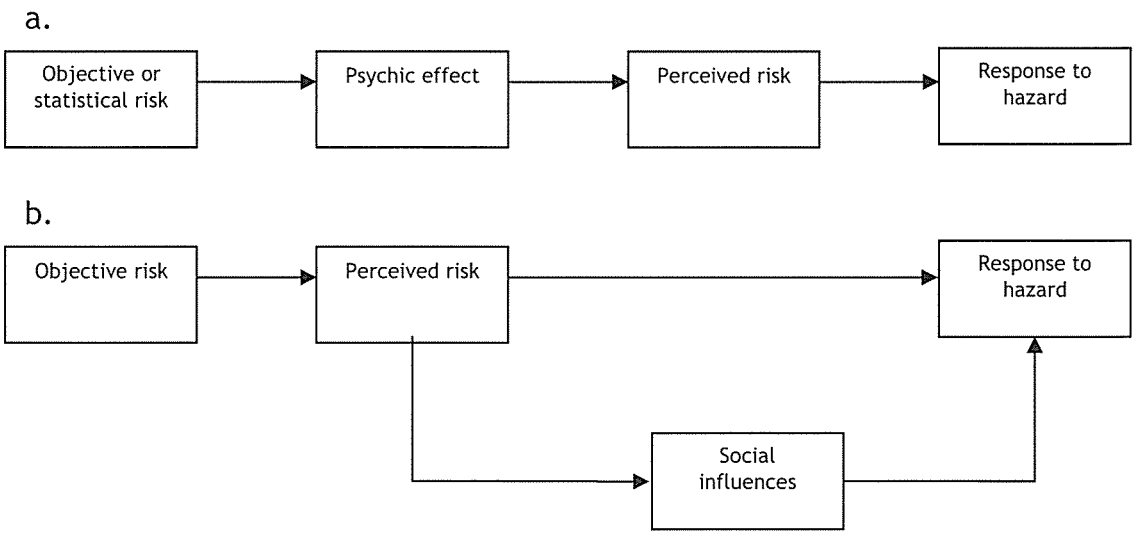

Figure 2-6. Psychological (a) and Sociological (b) models of perceived risk (Mazur, 1987 cited by Gough, 1990)

Research about risk perception showed that many of the public's reactions to risk are manifested from a sensitivity to technical, social and psychological qualities of hazard that were not well modelled in technical risk assessment (Chicken, 1996). In this sense a number of approaches have been used in estimating risk perception and these are classified in revealed preferences, implied preferences, expressed preferences and natural standards. Of those the most common approach used is the expressed preferences which involve questioning individuals and obtaining information directly from them. Through the development of questionnaires several risk sources and risk management strategies are listed and then sent to the agents (farmers) in order to rank them from the most to the least important, from the farmers' perspective. In this way, the collection of data will reflect the perception of risk sources and preferences. Fleisher (1990) suggests that the following factors affect the perceived riskiness of an action choice:

a) The expected value of distribution outcomes: Although the estimation of an expected value of a set of possible outcomes can be used to characterize that set of outcomes, it is very rare that the expected value will be equal to the outcome.
b) Dispersion of outcomes: The more disperse the outcomes of one activity are, the riskier it is and the farmers will perceive the risk of an action choice.
c) Time interval assumed: risk is always implicitly measured on a time interval, therefore the riskiness of an action may vary depending on the length of time considered. During that period of time the environment where farmers are working can change significantly thereby affecting their choices and risk associated with them (Backus et al., 1997).
d) Decision-maker's situation: only by looking at the entire situation in which the decision-maker is involved can we understand his behaviour about a risky action. Take, for instance, the risk perceived by a change of interest rates by two different farmers. One of them has enough cash reserves so he/she will not have to ask for credit to face a liquidity problem in the future, whereas the other farmer, with no cash reserves, will have to borrow money to face the same problem.
e) Scope for the analysis: only by looking at the wide range of options available for the decision-maker can we understand the choice he/she makes.

f) Level of aggregation: this factor affects the way the farmer sees his/her enterprise. One crop may have big fluctuations in yield, however, as a whole, the enterprise may have very stable performance.

As we see from the list above, risk perception will be closely connected with risk preferences, as the latter is a response of the former. The decisions that decision-makers make are largely determined by their perceptions of the risks inherent in the options available (Chicken, 1996), as Slovic, Fischhoff, & Lichtenstein (1982) say, "people respond to the hazards they perceive" (p. 463). The assessment of the perception of different sources of risk and ranking of the responses the farmers have developed to cope with those sources, allows to look at similarities and differences between groups with respect to perception and attitudes (Lien, Flaten, Ebbesvik, Koesling, & Steinar Valle, 2003; Martin, 1994; Meuwissen et al., 2001; Meuwissen et al., 2001; Patrick & Alexander, 2004; Peiter, Patrick, Baquet, Coble, & Knight, 2004). Additionally some of these studies have attempted to correlate the responses from farmers with specific traits of the farmers, such as educational level, financial position, age of the farmers, business structure, farm location and others (Bogges et al., 1985; Hall et al., 2003; Martin & McLeay, 1998; Martin & Shadbolt, 2000; Patrick et al., 1985; Wilson et al., 1988). A study from the United States has attempted to describe the educational need for risk management for a group of farmers and ranchers, in order to develop efficient extension programs (Fetsch, Bastian, Kaan, & Koontz, 2001).

Psychologists, during the 1960s, developed what they called the *choice dilemma scale*. Musser et al. (2002) adapting the choice dilemma scale to an agricultural version, proposed a questionnaire of twelve risky farm decision dilemmas to measure the willingness to assume risk. In the questionnaire, each choice dilemma has two options, the option with a more desirable outcome, which has a lower probability of success than the less desirable option. One response is not to choose the risky choice despite the probability of the outcome, on the other hand, the risky alternative can be chosen with different probabilities that they will work. The response selected will partially depend on the magnitude of gain and losses of the alternatives given, which are not specified. Nevertheless, the choice also depends on the respondent's willingness to assume risk. Thus, risk preferences influence the decision made by the respondent.

2.6 RISK ASSESSMENT IN FARM MANAGEMENT AND AGRICULTURAL ECONOMICS

2.6.1 Introduction

In order to understand real-world situations and solve significant agronomic, managerial, engineering and environmental problems, the integration and quantification of knowledge at the whole system level are required. Therefore, and despite the fact that the risk can be assessed from a theoretical point of view and/or from the social perspective, there is a chance of a mixture of both qualitative and quantitative information in the so-called models. Models are indeed the integration and quantification of the current knowledge based on fundamental principles and laws. In a philosophical definition a model is "a representation of a chosen reality" (Sherwood, 1983, p. 3). However in a more managerial definition, Powell & Baker (2004) say that modelling "is the process of creating a simplified representation of reality and working with this representation in order to understand and control some aspect of the world" (p. 1). Therefore a model is a simplified representation of the reality that defines the relationship between a set of input variables and one or more output variables.

A number of simulation models have been developed to assess the effect of different management strategies or new technologies on the final output of pastoral systems. In New Zealand these models have ranged from the use of statistical packages and simple spreadsheet (Keeling, Morris, Gray, & Parker, 1991; Laborde, Shadbolt, & Parker, 1998; Parker, Gray, Morris, & McCutcheon, 1992) to larger simulation software such as Stockpol® (Montes de Oca, 1999; Ogle & Tither, 2000) and @Risk® (Beherengaray-Neto, 2001; Dake, Squire, & Pollock, 1995). Despite the recognition of the limits of our knowledge about the dynamics of pastoral systems and its effect on financial return and risk, it has been argued that simulation models cannot substitute for field experimentation (McCall cited by Bywater & Cacho, 1994), however it can also be stated that simulation provides the capability to explore relationships that cannot be explored in any other way (Lajpat, Liwang, & Howell, 2002). As Bywater & Cacho (1994) suggest, production models help guide experimental research or extension programs and they have to be used in these ways (management research tools) and not as direct advisory or management tools. The same authors add that the most common objective with management models is to investigate the effects

of short or long-term management options with respect to their effects on the output (production, return and risk) of the system.

2.6.1.1 Software for risk analysis

There is a wide range of software packages on the market to be used for risk analysis, mainly for PC. Their use has been limited because they have been expensive, cumbersome to use and their computer requirements were substantial. However, since computers are now more readily available for everyone, this tool can now be used by all decision-makers.

One of the most popular software packages to analyse risk is @RISK® (pronounced "at risk") from Palisade Corporation. This is an add-in to Microsoft Excel or Lotus 1-2-3 that provides all the necessary tools for setting up, executing and viewing the results of risk analyses. Using either Monte Carlo or Latin Hypercube sampling and simulation, @RISK® combines all the uncertainty that can be identified in modelling a situation to analyse every possible outcome generating thousands of "what if" scenarios (Palisade, 1997). Despite the fact that it has the most sophisticated set of features of all the spreadsheet software packages for risk analysis, it still remains easy to use (Vose, 1996). This software plus BestFit® and RISKview Pro® have become one of the most powerful combinations suitable for risk analysis. BestFit® provides the capability of determining the best fitting distribution to a set of data; RISKview Pro® is used to preview any of the distributions that are available in @RISK®; the distributions can be selected from the screen and its parameters can be changed to look at the effect on the distribution's shape.

2.6.2 Modelling and assessing risk

Cacho, Bywater & Dillon (1999), following the philosophy suggested by Antle (1983) that the dynamic risk-neutral models are better than static risk-averse ones, developed through Monte Carlo simulation a dynamic grazing model with which they studied the effect of irrigation, stocking rate and drafting weight on profit and on meat and wool production. They made a comparison between deterministic and stochastic simulations and concluded that independently of the assumed risk attitude

of the decision-maker, it was important to consider the variability in a dynamic management model, in other words the stochastic nature of agricultural production. This concept is reinforced by the work of Ogle & Tither (2000), who used two software programs (RANGEPACK HerdEcon® and Stockpol®) to assess the risk that beef farmers would face in intensifying their systems, and concluded that the forecast with both average production and price parameters may mislead medium-term planning, which highlights the intrinsically variable nature of agricultural production. They also found that over a period of ten years the market effect over the total disturbance in cashflow was greater than the climatic effect.

Schmit, Boisvert, & Tauer (2001) measured the financial risk of New York dairy farmers running an intensive system with high yielding cows (average milk production of 16,495 lbs/cow or 7,482 kg of milk/cow), and found that the major contributors to variability in returns of those high input systems were the variabilities in the amount of purchased feed and in milk production. Milk price variability contributed substantially less. However, St-Pierre & Jones (2001) highlighted the importance in milk price volatility when forecasting the herd structure and milk production for risk management for a herd operating in Eastern United States. They also concluded that to be effective, risk management strategies must be addressed towards milk and input price volatility (price risk management) and variation in milk production per cow and in cow number (production risk management).

Using a database of 926 farm from Kansas from 1990 to 1999 to determine the important factors affecting downside risk, measured as the percentage of years with a negative return on equity, Langemeier & Jones (2001) found that the debt to asset ratio, the total expense ratio, age of operator and percentage of gross farm income derived from livestock production were significantly and positively correlated with downside risk. However, gross farm income was significant and negatively correlated with downside risk. Of all these factors they concluded that total expense ratio, gross farm income and the debt to asset ratio had the largest impact on downside risk. The practical implications of this work show firstly that controlling expenses is critical to manage downside risk, secondly that the effect of farm size in reducing risk is highly important as larger farms tended to have less downside risk and higher mean return on equity; and finally that the effect of debt to asset ratio in downside risk is extremely important as from all these three factors this is the most controllable.

Research in modelling for New Zealand dairy systems is not abundant. Laborde et al. (1998) using the beta-analysis tool (stochastic model from Microsoft Excel®) simulated three different scenarios for a split calving dairy farm in terms of the responses to the use of supplement and the probability of making profit with each one of these responses. They defined the responses of 59, 79 and 91 g MS/kg DM maize silage as bad, average and good scenarios and under these responses they analysed the financial performance of the farm considering the spring calving herd (with no milk premium paid) and autumn calving herd (with milk premium) to see the effect of milk payout. Montes de Oca (1999) using Stockpol®, modelled the risk for pastoral systems and developed a discrete stochastic model to evaluate the impact of variation on lamb production cost (risk exposure of the enterprise). In a similar way, and using both Stockpol® and @Risk®, Beherengaray-Neto (2001) studied the risk-return analysis of high performing organic and conventional meat systems. Dake et al. (1995) also using @Risk, quantified the trade-off between changes in farm income and downside risk. They aimed to show New Zealand farmers that through diversification, which is the combination of different enterprises, farm income level can reach a target at acceptable levels of risk.

Assessing risk from the social perspective has been undertaken in New Zealand by Martin (1994). She looked at the risk sources perceived to be most important for pastoral farmers, as well as the main strategies the farmers use to minimize those risk sources. Similar studies have also been undertaken in the United States (Bogges et al., 1985; Fetsch et al., 2001; Hall et al., 2003; Patrick et al., 1985; Wilson et al., 1988) and Europe (Lien et al., 2003; Meuwissen et al., 2001). In these studies, through the use of surveys they have captured the importance of perception to different risk sources and the use of risk management strategies. Additionally these studies have ranked the different risk management strategies used by farmers and they have also attempted to classify the different types of agricultural managers, considering different characteristics of the farms and the farmers as determinants for each group (Martin & McLeay, 1998).

CHAPTER THREE

3 NATURE OF THE RESEARCH

3.1 INTRODUCTION

Depending on what type of question a study seeks to answer, it can be categorised as exploratory, explanatory or descriptive. Although these purposes have their distinctive characteristics, there are large overlaps among them (Yin, 2003). When research is focused to answer the "what" questions, then an exploratory study is required; as there is very little information about the topic being investigated in this type of study, the objective here is to develop hypotheses or propositions which can later be studied (Blaikie, 2000; Ghauri et al., 1995; Yin, 2003). On the other hand, explanatory studies seek to account for patterns in observed social phenomena, attitudes, behaviour, social relationships, social processes or social structures (Bulmer, 1986 cited by Blaikie, 2000). Explanatory case studies seek to answer the "how" and "why" questions (Ghauri et al., 1995; Yin, 2003). Finally, the nature of descriptive studies attempts to present an accurate account of some phenomenon, the distribution in some population, the patterns of relationships in some social context at a particular time, or the changes in those characteristics over time (Bulmer, 1986 cited by Blaikie, 2000).

3.2 RESEARCH STRATEGY

Yin (2003) establishes that there are five different research strategies: the experiment, surveys, archival analysis, history and the case study. They differ according to their way of collecting data and how they analyse the empirical evidence. In this sense each strategy has its own advantages and disadvantages, nevertheless all of them can be used for any of the three purposes described in 3.4 (descriptive, exploratory and explanatory). Each research strategy has its own characteristics

however as in the purposes of the studies, there are large overlaps between the strategies. Three conditions determine what kind of strategy has to be used (a) the type of research question posed, (b) the extent of control an investigator has over actual behavioural events, and (c) the degree of focus on contemporary as opposed to historical events (Yin, 2003)(Table 3-2).

Table 3-1. Relevant situations for different research strategies (Yin, 2003)

Strategy	Form of research question	Requires control of behavioural events?	Focuses on Contemporary events
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

3.3 RESEARCH DESIGN

The research design is the logical plan that links the questions to be answered, through the data collection, to the set of conclusions that answer the initial questions of the study within the given constraints (Ghauri et al., 1995; Yin, 2003). This is like a blueprint of research that deals with at least four problems: what questions to study, what data is relevant, what data to collect, and how to analyse the results (Philliber, Schwab, & Samloss cited by Yin, 2003).

3.3.1 The Case Study

Yin (2003) defines the case study as "an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly defined. It copes with the technically distinctive situation in which there will be many more variables of interest than data points, and therefore it relies on multiple sources of evidence, with data needing to converge in a triangulating situation; and it benefits from the prior development of theoretical propositions to guide data collection and analysis" (pp. 14-15). Case studies have been increasingly used as a research tool in many different areas of social sciences and management, as it measures and records behaviour (Chetty, 1996; Eisenhardt, 1989; Ghauri et al., 1995; Yin, 2003). One of the advantages of a case study is that it allows an in-depth insight of the problem studied to be developed, so instead of testing hypotheses the researcher seeks insight through the features and characteristics of the object being studied (Ghauri et al., 1995). It is worth mentioning that despite criticism of the method, Yin (2003) states that case studies, like experiments, are generalizable to theoretical propositions but not to population and universes. Data collection in case studies usually combines methods such as archives, interviews, questionnaires, and observations. Therefore the evidence may be qualitative (e.g. words), quantitative (e.g. numbers) or both (Eisenhardt, 1989; Yin, 2003).

Yin (2003) proposes four types of case study designs based on a 2*2 matrix (Figure 3-1). Every design includes the desire to analyse contextual conditions in relation to the case, reflecting that the boundaries between the case and its context are not likely to be sharp. The four designs are holistic single-case design, embedded single-case designs, holistic multiple-case designs, and embedded multiple-case designs.

	Single-case designs	Multiple-case designs
Holistic (Single unit of analysis)	*Type 1*	*Type 3*
Embedded (Multiple unit of analysis)	*Type 2*	*Type 4*

Figure 3-1. Basic types of designs for case studies (Yin, 2003)

3.4 METHODOLOGY AND METHODS FOR THE RESEARCH

The present research used the first of those four designs proposed by Yin (2003). As a sample of New Zealand dairy farmers was surveyed, a *holistic single-case* design was employed. The underlying principles in using this approach are twofold, firstly it was a *longitudinal* case study (Yin, 2003), as the findings of a survey conducted in 1992 (Martin, 1994) were compared with the same survey undertaken in another sample of dairy farmers during the period July-August 2004 (Survey 2004). As a consequence it also had a combination of both descriptive and exploratory purposes. Secondly the same sample of 1,000 dairy farmers surveyed in 2004 was a *revelatory* case study (Yin, 2003), as the findings of the Survey 2004 were complemented with the analysis of the Profit Watch Database for the seasons 1998 to 2003 provided by Dexcel. This analysis, undertaken for farm owners only, had both descriptive and explanatory power.

3.4.1 Data Collection and Sources

3.4.1.1 Secondary Data

Secondary data is "the information collected by others for purposes which can be different from the current research" (Ghauri et al., 1995) (p. 54). The first and most important advantage of secondary data is the amount of time and money saved, as

well as suggestions that it can give about suitable methods or data to handle a particular research problem (Ghauri et al., 1995). One of the disadvantages of secondary data is it is second-hand material, collected by other researchers for different purposes and therefore may not fit in the current research, having less worth and validity than primary data (Burns, 2000; Ghauri et al., 1995).

For this current research, the secondary data came at two different stages of the research, the survey and the database analysis. As the present research started updating the 1992 survey (Martin, 1994), the first secondary source to be used was the results from that work, in addition to some extra questions from the survey Fetsch et al. (2001) developed in 1997. The next secondary source was Dexcel's database Profit Watch (1998-2003), as this was used to examine the relative importance of factors contributing to risk.

3.4.1.2 Primary Data

The primary data is "the data originally collected by the researcher for the research problem at hand" (Ghauri et al., 1995) (p. 54). The main advantage of this data is it was collected by a witness to the event of study (the researcher) (Burns, 2000). Figure 3-2 is a representation of the sources of primary data collection.

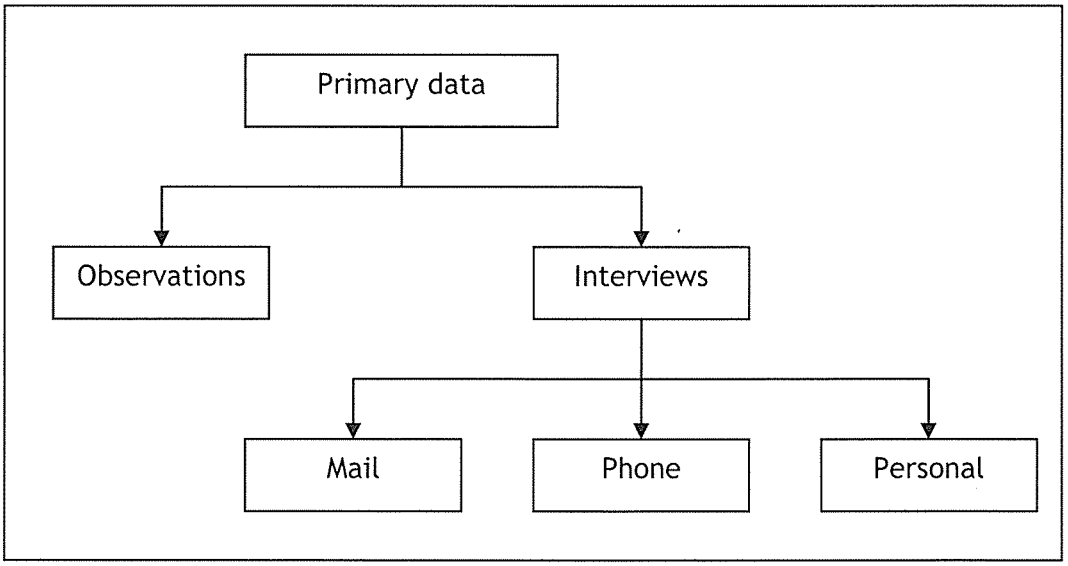

Figure 3-2. Sources of primary data collection (Ghauri et al., 1995)

For the present research the primary data was the survey sent out to 1,000 New Zealand dairy farmers during July-August 2004.

3.4.1.2.1 Interviews and Surveys

Yin (2003) says that interviews are one of the most important sources of case study information. The same author distinguishes three different types of interviews: open-ended nature, the focused interview and surveys. Similarly Ghauri et al..,(1995) mentions three types of interviews, structured (surveys), unstructured and semi-structured interviews. For the present research only the survey conducted in 2004 was used as a source of primary data collection.

The use of surveys is probably the most common method of data collection in business studies and it is the dominant methodology in social science research (Burns, 2000; Philliber, Schwab, & Sloss, 1980). The strength of a survey lies in the fact that the number of respondents is greater than in a case study therefore it has the ability to describe large populations. Surveys are characterized by a structured or systematic set of data (de Vaus, 2002) and they have descriptive and/or analytical power or more commonly a mixture of both, so sample surveys are very adaptable. (Burns, 2000; Casley & Lury, 1985; Ghauri et al., 1995). In an analytical way, surveys can test theories by taking the logic into a field; they will seek to establish cause and effect relationships but without experimental manipulation (Burns, 2000; Ghauri et al., 1995). On the other hand by their descriptive power, surveys aim to estimate as precisely as possible the phenomena whose variance the researcher wishes to describe, either the nature of existing conditions or the attributes of a population (Burns, 2000; Ghauri et al., 1995). Both analytical and descriptive surveys seek to identify the population, which is the object of the study.

One of the disadvantages in using surveys in research is the fact that they are unable to explore intentions and attitudes and the way these work through behaviour and actions (Casley & Lury, 1985).

3.4.2 Sampling

3.4.2.1 Survey

The Livestock Improvement Corporation (LIC) provided a sample of 1,000 dairy farmers. In this way, the sample represented the same distribution pattern as the dairy herds currently operating in New Zealand (LIC, 2003). Therefore in the sample analysed 83% of the farmers were from the North Island and 17% from the South Island, as Appendix 1 shows. There was no ownership structure targeted in the sample, therefore it was expected that the sample would have owner operators, sharemilkers and managers.

3.4.2.2 Database

The database analysed in this study is from the 1998/1999 to 2002/2003 season. The total number of farms in the database, from both North and South Islands, for the five year period was 2,341 which included both Owner-operators and Sharemilkers with a variety of milk supply patterns. The criteria used to determine what farms to include in the latter analysis were:

- Owner operated farms,
- Seasonal milk supply pattern (spring), and
- Return on Equity (ROE)[2] between -40% and 40%

From the total number of farms available in the database only 1,026 were included in the analysis. The analysis was conducted between farms and within each of the five seasons, therefore there was no need to use a price index as only financial ratios and the physical information of the farms were used.

[2] ROE = (Economic Farm Surplus + Runoff adjustments - Other rent - Interests payments)/(Owner's Equity)

3.4.3 Data Analysis

3.4.3.1 Conceptual Framework

The theoretical framework, which is the starting point of the research process, determines under what circumstances the phenomenon of study (risk in the dairy systems) is likely to be found (*a literal replication*) as well as the conditions when it is not likely to be found (*a theoretical replication*) (Yin, 2003). Therefore the theoretical framework will be the vehicle from which to generalize the study to new cases. For the present research, the theoretical framework was developed from published literature related to risk in agriculture, with emphasis on both concepts: the social or practical (survey analysis) and the econometric or technical (database analysis).

3.4.3.2 Survey Analysis

One of the purposes of the survey was to identify if there had been any change in risk perception and risk management strategies of New Zealand dairy farmers over the last twelve years. The survey used in the present research then was based on that developed by Martin (1994). The information collected basically covers the following points:

- Ownership structure
- Overall risk perception
- Perception of risk sources: six groups of risk sources were asked (Market, Financial, Production, Regulatory, Human and Miscellaneous risks) making up a total of nineteen sources listed.
- Risk management strategies most commonly used: four groups of risk management responses were included (Production, Marketing, Financial and Overall management strategies) making a total of twenty one strategies used to control risk. One more group of risk management strategies was included, Strategic Planning, with five responses taken from another survey conducted in the USA (Fetsch, 2004, pers. comm.; Fetsch et al., 2001)
- Property and personal information
- Description of farmers (age, educational level, others)
- Description of farms (both physical and financial)

- Sources of information or education most commonly used by farmers to update themselves
- Areas of further interest in risk management perceived as critical by farmers (Fetsch et al., 2001)

The relative importance attached to the different risk sources and risk management practices used by each farmer was captured using a Likert format 1-5 scale. One thousand surveys were sent out on the 2nd of July 2004. By early August the response rate was 35%, so a follow up was sent out on the 16th of August 2004. The deadline for receiving surveys was set on September the 15th and by that date the total number of surveys returned was 429.

The analysis of the survey was divided in three stages. The first stage aimed to compare the findings of the survey undertaken in June 2004 with those reported by Martin (1994). This comparison was accomplished for the whole sample of both studies for risk perception and risk management strategies. The second stage of the analysis consisted of the stratification of the information gathered according to relevant variables. Since the sample included Owner-operators, Sharemilkers and Managers, from both North and South islands, these two variables (ownership structure and geographic location) were used to categorise the data for comparisons. Sharemilkers and Managers have less capital tied up in the farming business than Owner-operators, therefore their perception of risk was expected to differ from that of Owner-operators, especially considering the effect of greater risk attached to the Sharemilker's investment of cattle (not in land) and the short term of most Sharemilker contracts (e.g. 3 years) (Holmes et al., 2002). Similarly, North and South Islands have shown remarkable differences not only in terms of the capabilities to produce pasture (Holmes et al., 2002) but in other physical variables such as farm and herd size (LIC, 2003). The role of farm size regarding risk perception and risk management strategies have been reported by several studies. Langemeier & Jones (2000) and Purdy et al.(1997) reported the effect of farm size on the variability of return on equity; Bogges, Anaman, & Hanson (1985), Huirne (2002), Nartea & Barry (1994) and Wilson, Luginsland, & Armstrong (1988) reported the differences in perception of risk and risk management strategies utilized by farmers depending on farm size; and the 2003 Commercial Producer Study by the Centre for Food and Agricultural Business at Purdue University cited by Boehlje, Doehring, & Sonka (2004)

where different buying behaviours were found according to farm size. Therefore farm and herd size can lead to the development and use of practices that may be very different in both islands.

The third stage of the survey analysis looked at the interaction between ownership structure and geographic location, therefore four groups were created: Sharemilkers from the North Island, Owner-operators from the North Island, Sharemilkers from the South Island and Owner-operators from the South Island. These four groups were analysed in terms of their perception of risk, their risk management strategies and the areas each group perceived as being more critical to learn about risk management. Each of these three areas was analysed in groups. Analyses of Variance were carried out in each of the three areas analysed (risk sources, risk management strategies and critical areas to learn about risk management), to account for differences in the mean scores of the groups. The grouping of risk sources changed slightly in comparison with their original classification; those sources included under the heading "Miscellaneous" were now relocated in order to give this analysis more discriminatory power. The new classification is presented in table 3-2.

Table 3-2 Classification of the risk sources and risk management strategies used for the third part of the analysis of the survey

A.- GROUPS OF RISK SOURCES

1.- Market Risks	4.- Regulatory Risks
Changes in product prices	Changes in government laws and policies
Changes in world economic and political situation	Changes in local bodies laws and regulations
Change in New Zealand's economic situation	Changes in producer board policies
Changes in inputs costs	
2.- Financial Risks	**5.- Human Risks**
Changes in interest rates	Accidents or health problems
Changes in land prices	Changes in family situation
Being unable to meet contracting obligations[1]	Theft[1]
	Problems with hired labour and contractors[1]
3.- Production Risks	**6.- Technological Risks**
Rainfall variability	Changes in technology and breeding[1]
Other weather factors	
Diseases or pests	
Disasters	

B.- GROUPS OF RISK MANAGEMENT STRATEGIES

1.- Production responses	3.- Marketing responses
Routine spraying and drenching	Market information
Maintaining feed reserves	Spreading sales
Not producing to full capacity	More than one enterprise
Monitoring pests, crops, climate	Forward contracting
Irrigation	Futures markets
2.- Financial responses	**4.- Strategic planning reponses**
Keeping debt low	Using practical planning steps in your business
Managed capital spending	Assessing strengths, weaknesses, threats and opportunities
Arranging overdraft reserves	Using of financial ratios for decision making
Debt management	Having written a shared mission statement for your operation
Financial reserves	Having written a shared vision statement for your operation
Insurance	
Off-farm investment	**5.- Overall reponses**
Main operator working off-farm	Short term flexibility
Family members working off-farm	Long-term flexibility

[1] Originally in the Miscellaneous group of risk sources

In pastoral systems there are not many chances to increase production once the system has been optimally stocked, and therefore supplements have been suggested to overcome this problem. Through increases in carrying capacity (stocking rate) and/or milk production per cow, the amount of milk produced per hectare can be lifted,

which is a measure of production efficiency in pastoral systems. The interaction between production per animal, stocking rate and consequently production per hectare, has been well documented over many years (Jones & Sandland, 1974; McMeekan, 1961; Penno, 1999; Wright & Pringle, 1983). McGrath (1999) found that most profitable farms in New Zealand have three common characteristics: high production per cow, "well above average stocking rates" and therefore high performance per hectare. As production per hectare is the result of the multiplication of stocking rate and milk production per cow, any change in these two last variables will affect in some way the former. The last analysis undertaken for the current survey was the identification of variables included in the survey that explained kilograms of milk solids produced per hectare. As the best set of variables, nineteen risk sources plus twenty six risk management strategies listed in table 3-2, that would explain milk solids produced per hectare was not known, through the use of SAS® Statistical Software a Stepwise Regression Analysis (SRA) was undertaken. SRA allows identification of these variables forming a discriminant function that explains the dependent variable (Sharma, 1996). The inclusion of both risk sources and risk management strategies altogether in the SRA is based on the concepts of risk constraint and risk balancing effect (2.3.2.3.1). The former is the level of risk that the decision-maker can comfortably tolerate, and the latter refers to the adjustments the decision-maker does in order to bring the total risk he/she is facing to the levels at which he/she can feel comfortable; one is the reflection of the other. Using SRA, three different procedures can be used to select the variables: Forward, Backward or Stepwise selection. The latter is a combination of the first two, and it is an "iterative process that adds and deletes one independent variable at the time. The decision to add or delete a variable is made on the basis of whether that variable improves the model" (Keller & Warrack, 2003; p. 718). Therefore as a result of the SRA, a multiple regression equation (or multiple linear regression model) was constructed as 3.1 shows.

(1) $$y = \beta_0 + \beta_1 * x_1 + \beta_2 * x_2 + \beta_3 * x_3 + \ldots\ldots\ldots + \beta_n * x_n + \mu$$

Where y is kilograms of milk solids produced per hectare, β_0 is the intercept of the equation, $\beta_1, \beta_2, \beta_3 \ldots\ldots\ldots \beta_n$ are the coefficient of the variables identified x_1, x_2, $x_3 \ldots\ldots$ x_n through the SRA. Similar to simple regressions, μ is the error term or disturbance.

All those variables significant at 25% were allowed to be included in the equation, however only those that were significant at the 10% level remained as selected variables.

3.4.3.3 Database Analysis

The analysis of the database followed a framework similar to that proposed by Langemeier & Jones (2001) where return on equity (ROE) is recognized as a good indicator of downside risk in agriculture. ROE ranges from negative to positive values. Businesses with negative ROE are not covering at least a portion of their cost, and the more negative the ROE the greater is that portion, therefore at highly negative ROEs the owner's equity (without considering land appreciation) is being eroded at a faster rate than at lower negative values. High positive ratios of ROE are normally associated with profitable farm businesses, however it may also indicate an undercapitalised or highly leveraged farm business; on the other hand a low positive ratio that normally indicates an unprofitable farm business could also indicate a more conservative high equity farm business (Boehlje & Eidman, 1984; FFSC, 1997). To consider all these situations, ROEs for each one of the five seasons included in the database were ranked in ten different categories, where category 1 contained the highest ROEs (less risky operation) and category 10 reflected the more negatives ROEs (the riskiest farms) (Appendix 2). The use of the same range of ROE to determine the intervals for every season is consistent to determine risk and it allows comparisons between seasons as "comparing risk based upon different risk reference points ... is undesirable if not erroneous and misleading" (Watts, Held, & Helmers, 1984, p. 177).

A logistic regression analysis (cumulative logit model), using the software Enterprise Guide® (SAS®), was used to examine the relative importance of factors affecting downside risk measured by the ROE ranking proposed above. The logit model uses odds and odds ratios to quantify the chances that an event will occur. Odds, as with probabilities, have a lower limit of 0, however unlike probabilities odds do not have an upper limit. Because the logit model calculates the logarithm of the odds of one event, the lower limit is also removed, thus using odds is a more sensitive scale for multiplicative comparisons (Allison, 2001). Therefore, for k explanatory variables and i= 1,..., n individuals, the model is:

(2) $$\log [p_i/(1 - p_i)] = \alpha + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_k x_{ik}$$

where p_i is the probability that $y_i=1$ (or the probability that the *y* event occurs), α is the intercept and $\beta_1, \beta_2, ..., \beta_k$ are the coefficients. The expression on the left hand side of the equation (2) is usually referred to as the *logit* or *log-odds* (Allison, 2001). The logistic regression is simply a transformation of a non-linear regression model into a linear regression model, however unlike the usual linear regression there is no normal random disturbance term in the equation for the logit model (Allison, 2001). As has been outlined, there is no linear relation between the coefficient and the probability p_i and, except for the signs, the interpretation of the coefficient of the independent variables tends to be difficult since it must be done with respect to their effects on the log of odds (Allison, 2001; Sharma, 1996). However, as the model provides the Odds Ratio, these offer the easiest way to approach the logit model (Allison, 2001), as they represent the effect of the variable on the odds of being in a higher interval than in a lower one. Allison (2001) states that there are two reasons to prefer logit models that take the ordering into account as (i) they are easier to interpret than those with unordered categories, and (ii) hypothesis tests are more powerful.

Prior to running the model, all the variables to be included were standardized. The variables included in the regression were: Farm Working Expense Ratio, Debt to Asset Ratio, Operating Profit Margin, Asset Turnover Ratio, Debt Servicing Capacity, Effective Area and Economic Farm Surplus (Appendix 3). Some of these factors have been used in previous research to examine financial performance and risk (Langemeier & Jones, 2000, 2001; Purdy et al., 1997). According to the criterion used to classify downside risk in the database a category equal to 1 meant less risk than a category equal to 10, therefore the model was run predicting the probability of being in a higher category, which means a riskier position (using the DESCENDING ORDER option in the statistical software). The specific regression run for each of the five seasons can be stated follows:

(3) $$\log [p_i/(1 - p_i)] = \alpha_0 + \beta_1 FWER_{i1} + \beta_2 DTAR_{i2} + \beta_3 OPM_{i3} + \beta_4 ATR_{i4} + \beta_5 DSC_{i5} + \beta_6 HA_{i6} + \beta_7 EFS_{i7}$$

where p_i is the probability that risk category = 1,...,10; FWER is the Farm Working Expense Ratio, DTAR is the Debt to Asset Ratio, OPM is the Operating Profit Margin,

ATR is the Asset Turnover Ratio, DSC is the Debt Servicing Capacity, HA is the Effective Area, EFS is the Economic Farm Surplus, *i* refers to an individual farm.

The Farm Working Expense Ratio (FWER) reflects the farm's ability to control expenses. This ratio is calculated by dividing the total farm working expenses by the gross farm income. In this sense we expected that FWER would be negatively correlated with the proposed ranking of risk, especially at lower payouts.

As mentioned above (2.3.2.2), the P*rinciple of Increasing Risk* states that the use of non-equity capital within a business has an asymmetric impact on it and the potential losses are far greater than potential gains. Debt to Asset Ratio (DTAR) reflects the basic leverage of the firm, therefore highly leveraged firms will be facing high risk. DTAR measures the risk-bearing ability of the firm as it is the capacity of the business to repay all financial obligations if all the assets were sold (Boehlje, 1994). We therefore expected a positive relationship between DTAR and the proposed ranking of risk.

Operating Profit Margin (OPM) and Asset Turnover Ratio (ATR) are the drivers of Return on Assets as is shown on the DuPont Financial Analysis System (Barnard & Boehlje, 1998-99; Boehlje, 1994). The former measures operating efficiency through revenue generation and cost control, whereas the later is a measure of capital efficiency (Boehlje, 1994), therefore we expected a positive relationship between both of them and the proposed ranking of risk.

The Debt Servicing Capacity (DSC) measures the ability of a firm to service the commitments acquired through the money borrowed. It includes the annual interest payments plus the non-run off lease payments. As debt influences profitability through interest costs (Barnard & Boehlje, 1998-99), it was expected that those businesses with lower risk would have a lower Debt Servicing Capacity.

The effect of farm size was present through the Effective Area (HA). Some researchers have found that as farms get bigger they would face less risk, therefore we expected a negative relation between farm size and downside risk. Purdy et al. (1997) found that mean financial performance (measured as Return On Equity) was "quite responsive to farm size" (p.160). They also found that the variability in financial performance is not affected by farm size, suggesting that there would be large benefits associated with increases in farm size. Similarly, Boehlje (1999) mentions that agriculture is in the midst of major structural changes where, amongst other changes, small scale firms are becoming larger at an increasing rate.

The Economic Farm Surplus (EFS) or Operating Profit is a measure of the profit generated by a farm business, irrespective of both its funding or ownership structure. It is commonly used in New Zealand as a primary indicator of farm profitability, and it allows farmers to make comparisons with other similar farm businesses without giving too much personal information. However, EFS has several limitations as the excluded information can influence farm profitability measurement in different ways (Shadbolt, 1997). For example, if a farm has higher investment in machinery which allows it to save, say, 3 labours unit its EFS will look better (being all the rest equal) than other farms, however in terms of Return on Assets its ranking will not be as high.

CHAPTER FOUR

4 RESULTS

4.1 GENERAL INFORMATION OF THE 2004 SURVEY

Of the 1,000 surveys sent out, 429 surveys were returned and usable responses were obtained from 426. General information of the 2004 Survey is presented in Table 4-1. As the information collected was also stratified according to both geographic location and ownership structure, the percentages of farm in each of these groups are also presented in Table 4-1. Because of the small number of surveys from Managers, this group was not considered for any statistical analysis.

Table 4-1 Summary of the main variables gathered through the 2004 Survey

	2004 Survey		LIC (2003)*
1.- General Information	Average	SD	Average
- Farm Size (Ha)	184	190	111
- Herd Size (Cows)	409	315	285
- Kilograms of Milk Solids Produced per Hectare	134,606	105,662	90,621
3.- Age of operator (years, N= 414))	48.9	11	
2.- Gender of operator (N = 415)			
- Male Operators (%)	84%		
- Female Operators (%)	16%		
4- Geographic Location (N = 426)			
- North Island	81%		83%
- South Island	19%		17%
5.- Ownership Structure (N = 423)			
- Owner-operators	77%		63%
- Sharemilkers	20%		37%
- Managers	3%		N/A

* Information reported in the New Zealand Dairy Statistics, LIC (2003)

4.1.1 The 2004 Survey: General Results

Of the sources of information, "Workshops, Seminars, Meetings and Field Days" was signalled as the main source used by farmers (Figure 4-1). This was followed by "Popular Press" and "Consulting Officer" in third place with 51%. Then at the 40% level were "Fact Sheets", "Television" and "Private Consultants". "Scientific Publications", the "World Wide Web" and "Radio" were all about the 30% level. The least important sources were "Video/Audio Tapes" and "Others" where it was mainly mentioned own experience and industry peers.

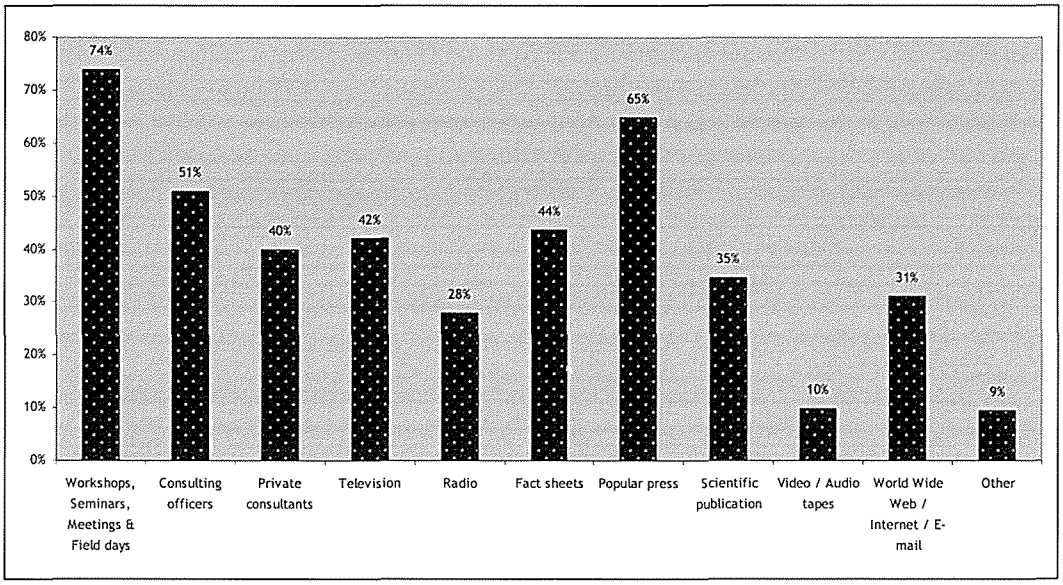

Figure 4-1 Sources of information most commonly used by dairy farmers to be up to date

4.1.1.1 Perception of the Sources of Variation

The perception of risk for the different sources is presented in Figure 4-2. The three most important sources perceived by farmers were in the market side of their business. "Changes in product prices" with a mean score of 4.03 was the most important source followed by "Changes in world economic and political situation" with a mean score of 3.78; the third most important source of variation was "Changes in input costs" with a mean of 3.76. "Accidents or health problems" was also highly ranked in fourth position (3.71) and the fifth place was for "Changes in interest rates" (3.62). Even though all the three regulatory risk sources did not get high mean scores

(3.58, 3.41 and 3.20), they were a clustered at about the same level of importance (8th, 10th and 11th in the overall ranking). Farmers were the least concerned about "Changes in technology and Breeding" and "Being unable to meet contracting obligations" which were in the 18th and 19th position.

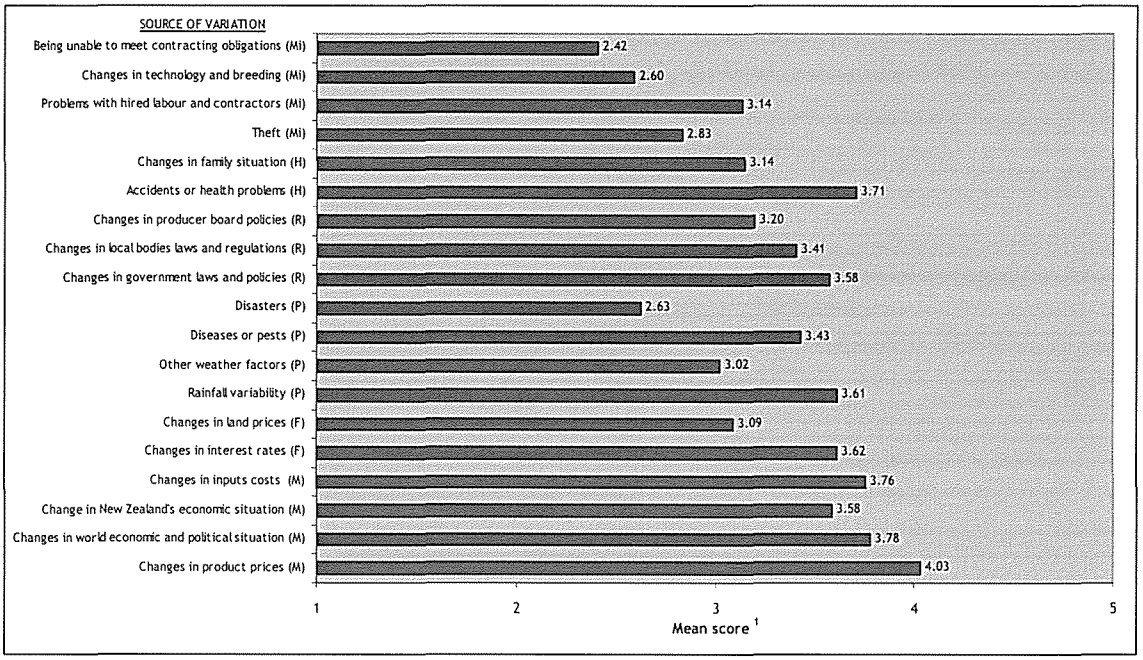

Figure 4-2 Sources of variation asked in the survey and mean scores[1] of each one of them for 2004

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)
(Mi)= Miscellaneous Risk Sources; (H)= Human Risk Sources; (R) Regulatory Risk Sources; (P)= Production Risk Sources; (F)= Financial Risk Sources; (M)= Market Risk Sources

4.1.1.2 Risk Management Strategies

The most important strategy used by dairy farmers was "Routine spray and drenching" with an average score of 3.92 (Figure 4-3). The second most important strategy the farmers used to control risk was also in the production side of the business as "Maintaining feed reserves" had a mean score of 3.90. Within the production area, "Monitoring crops, pests and climate" (3.30) was relatively important however the other two management practices, "Not producing to full capacity" (2.67) and "Irrigation" (2.23), were ranked as relatively unimportant.

"Debt management" was the third most important risk management strategy with a mean score of 3.81. Of the nine risk management strategies included in the financial area, six of them (included "Debt management") had very close mean scores. These strategies were: "Managed capital spending" (3.64), "Insurance" (3.63), "Arranging overdraft reserves" (3.43), and "Financial reserves" and "Keeping debt low" both with mean score of 3.37.

The two overall risk management strategies listed in the survey were ranked fourth and fifth. They were "Short term flexibility" with a mean score of 3.75, and "Long term flexibility" with an average of 3.65.

Finally, farmers did not attach much importance to the marketing area. The highest mean score for the marketing risk management strategies listed was achieved by "Market information" with a mean score of 3.06, followed by "Spreading sales" (2.51). The other three risk management responses had mean scores under 2.50.

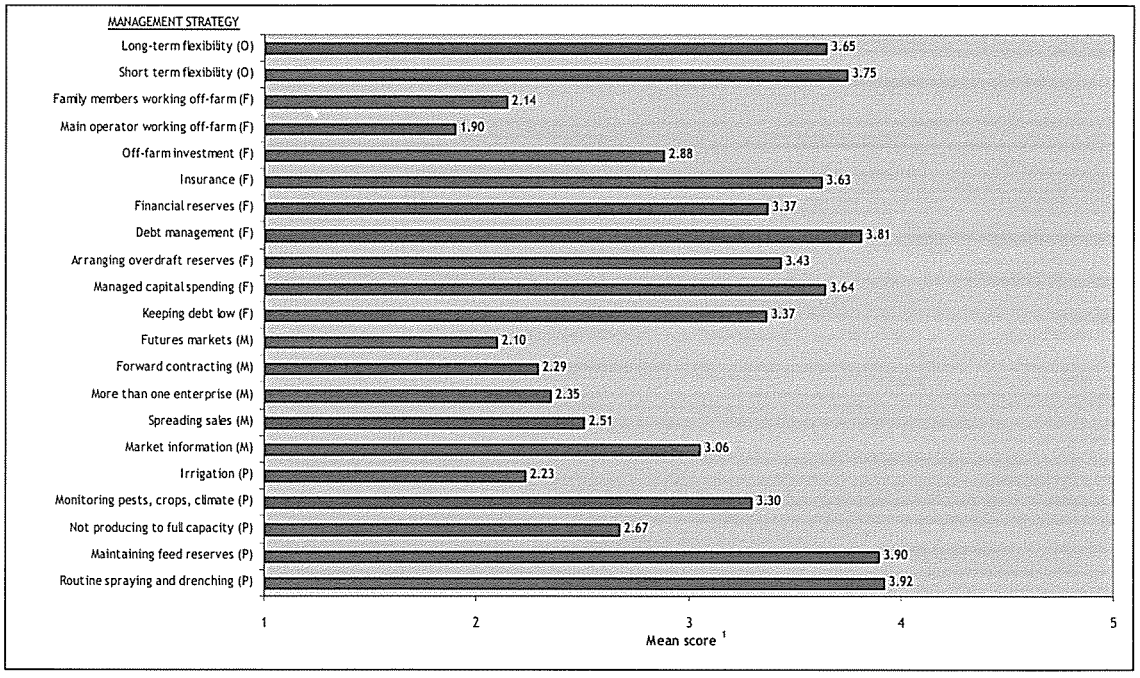

Figure 4-3 Risk management responses included in the survey and their mean scores[1] for 2004

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)
(O)= Overall Risk Management Strategies; (F)= Financial Risk Management Strategies; (M)= Marketing Risk Management Strategies; (P)= Production Risk Management Strategies

Additional risk management strategies, from the field of strategic planning, were also asked. These strategies were taken from the work of Fetsch, Bastian, Kaan, & Koontz (2001) and they are presented in Table 4-2. Of the five strategies listed, "Using practical planning steps in your business" was the strategy most used with a mean score of 3.79, and 90% of the farmers recognized they used it. "Assessing strengths, weaknesses, threats and opportunities" was second (3.65) and 84% of the farmers used it. The use of financial ratios for decision making was the third most important with 3.09 but only 56% of the farmers used it to control risk.

Table 4-2 Mean scores and ranking of the Risk Management Strategies included in the present research from the study of Fetsch et al. (2001)

Risk Management Strategy	N	Mean Score [1]	SD	Rank	% [2]
Using practical planning steps in your business	395	3.79	0.93	1	90%
Assessing strengths, weaknesses, threats and opportunities	397	3.65	1.00	2	84%
Having written a shared mission statement for your operation	342	2.61	1.29	5	27%
Having written a shared vision statement for your operation	335	2.65	1.30	4	28%
Using of financial ratios for decision making	366	3.09	1.19	3	56%

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)
[2] Percentage of farmers using the strategy

The areas in which farmers were more interested to learn about risk management are presented in Figure 4-4. The figure shows that the financial side of the farming business was perceived as the most critical area with a mean score of 3.82. The production area was perceived as the second most important with a mean score of 3.70 and strategic planning (3.52) was in third place. The farmers were least keen to learn about the marketing side of their businesses to control risk, as this area achieved a mean score of 2.67 and occupied the lowest position of the six areas listed.

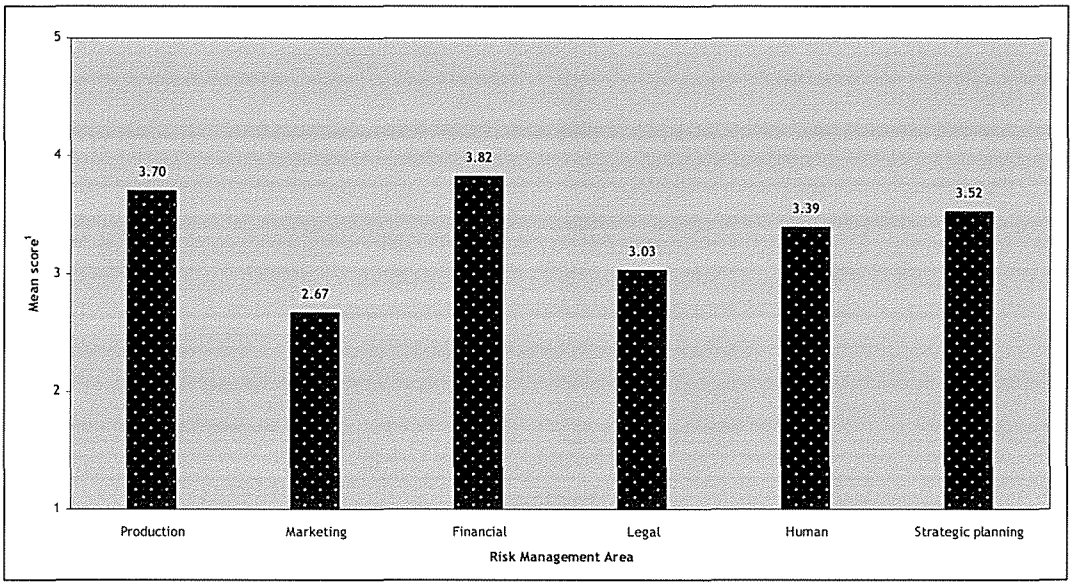

Figure 4-4 Mean scores[1] of the areas perceived as critical to learn more about risk management strategies

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

4.1.2 Comparison between the 2004 Survey and that carried out in 1992

The comparison of the perception of risk regarding current farm size being too small in the future is presented in Figure 4-5. It is important to highlight that the average farm size for 1992 was 169 hectares, whereas for 2003 it was 285 hectares (LIC, 2003). Only the extreme categories of the scale of perception (Very High and Minimal) increased their percentages during the last twelve years. However, fewer farmers in 2004 perceived there is either Some or Moderate risk in their farm sizes than in 1992. Consequently, in 2004 as the scale of risk perception increases from Minimal to Very high, the proportion of farmers reduces to 10% of them now perceiving that their current farm sizes are a very important source of risk.

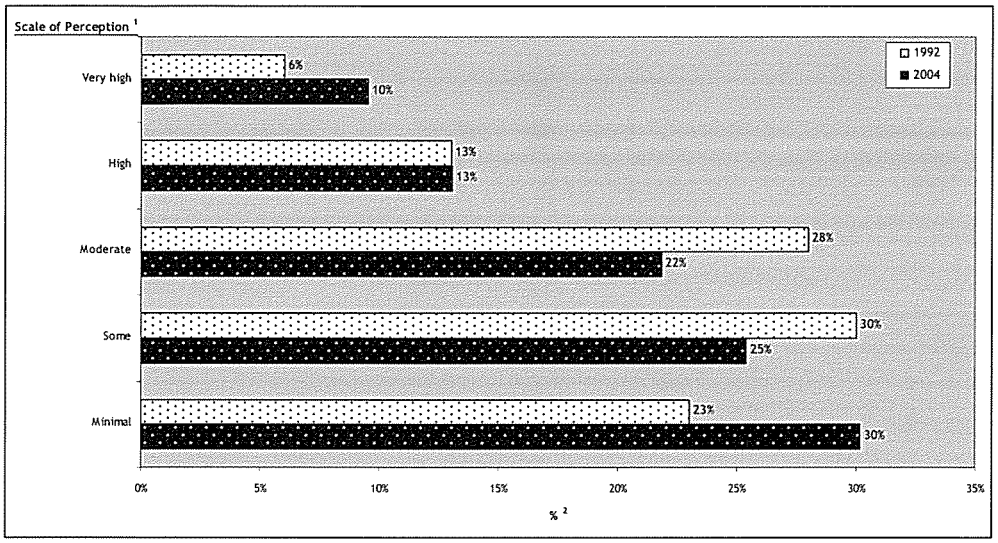

Figure 4-5 Comparison of the perception of risk in farm size being too small in the future (1992 vs. 2004)

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

The perception of risk associated with the level of debt changed radically during the last twelve years (Figure 4-6). The three higher categories of risk perception have currently increased their proportions in comparison with 1992. These increases have been made at the expense of the lower two categories (Some and Minimal) as they have decreased by 6% and 16% respectively during the last twelve years. All these changes have meant that the skewed distribution in the lower categories for the survey in 1992 have evolved to a more normal distribution in 2004 (the highest percentage of responses in the Moderate category).

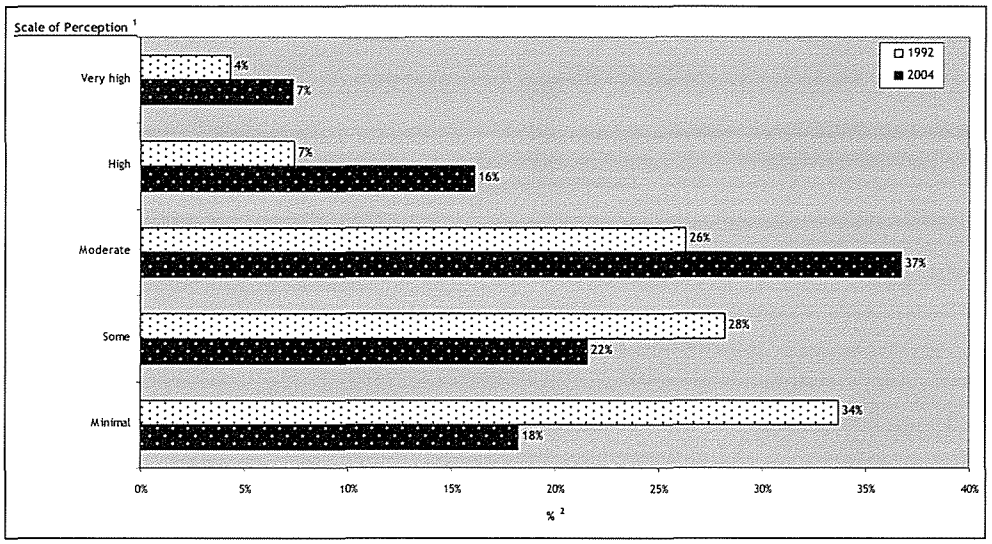

Figure 4-6 Comparison of the perception of risk in the level of debt (1992 vs. 2004)

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

From Figure 4-7 it can be seen that there was a shift in the perception of the production risk associated with the overall variation of yields and prices in the farming business. More farmers currently rated this source of risk to be high. This important change has been made at the expense of all the rest of the risk perception categories in the current survey.

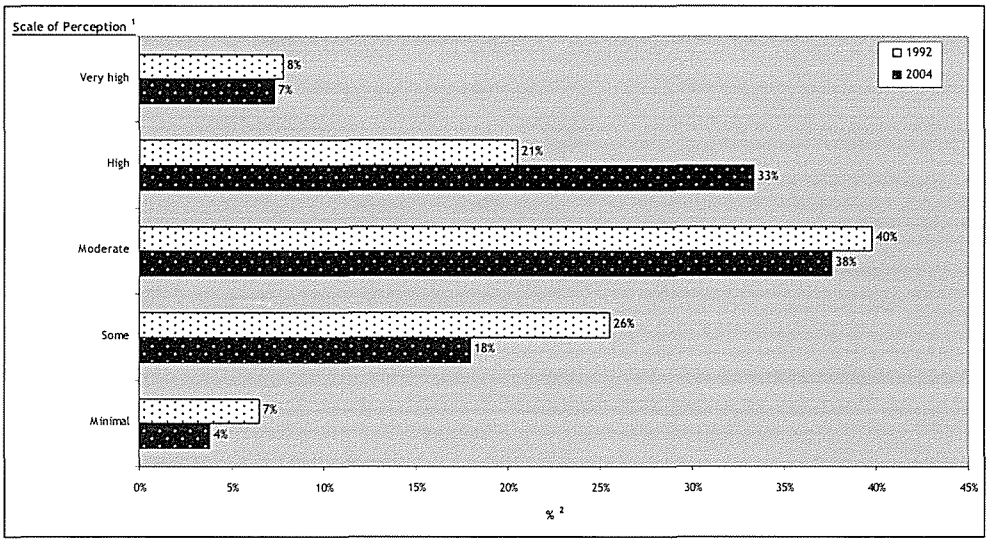

Figure 4-7 Comparison of the perception of risk in the changes in yields and prices (1992 vs. 2004)

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

4.1.2.1 Perception of risk sources

As was mentioned in 3.4.5.2, six groups of risk sources were asked to farmers and these groups added up the nineteen sources of risk listed in the survey. The six groups were: Market, Financial, Production, Regulatory, Human and Miscellaneous risk sources. The mean score values and rankings of the risk sources for both surveys are presented in Figure 4-8. Despite the fact that the Human, Financial, Regulatory and Miscellaneous groups of risk sources had increased their mean scores since 1992, only the Miscellaneous group showed a significant difference between its mean scores for the two surveys.

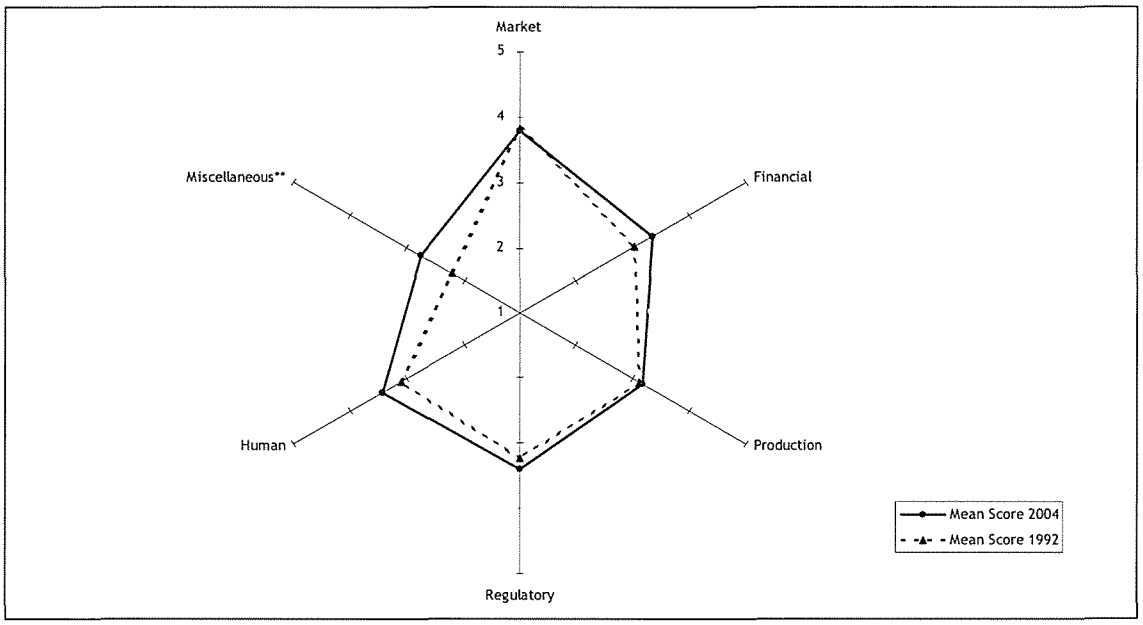

Figure 4-8 Mean score[1] comparison of the six groups of risk sources between the two surveys (2004 vs. 1992)

** Indicates statistical difference between the mean scores (T-Test at the 5% level)
[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

At a more detailed level, the nineteen risk sources were ranked and their mean scores compared (Table 4-3). There were statistical differences between the 1992 and 2004 Surveys in fifteen out of the nineteen sources asked (78.9%). From these fifteen sources, twelve increased their mean scores whereas the other three decreased in their values. There was no statistical difference in the overall ranking for each the nineteen risk sources listed in both surveys ($r= 0.90$, $P < 0.001$).

Table 4-3 Mean scores[1] and ranking of the nineteen risk sources included in the surveys (2004 vs. 1992)

RISK SOURCES	2004				1992		
	N	Mean Score [1]	SD	Ranking	Mean Score [1]	SD	Ranking
Market Risks		**3.79**			**3.83**		
Changes in product prices	420	4.03[a]	0.80	1	4.20[b]	0.90	1
Changes in world economic and political situation	422	3.78	0.87	2	3.80	1.00	3
Change in New Zealand's economic situation	421	3.58	0.87	7	3.70	1.00	4
Changes in inputs costs	422	3.76[a]	0.83	3	3.60[b]	1.00	5
Financial Risks		**3.36**			**3.05**		
Changes in interest rates	421	3.62[a]	1.08	5	3.40[b]	1.30	8=
Changes in land prices	422	3.09[a]	1.15	14	2.70[b]	1.70	13=
Production Risks		**3.17**			**3.13**		
Rainfall variability	422	3.61[a]	1.00	6	3.90[b]	1.10	2
Other weather factors	421	3.02	0.97	15	2.90	1.20	11
Diseases or pests	422	3.43[a]	1.03	9	3.20[b]	1.20	10
Disasters	417	2.63	1.18	17	2.50	1.50	15=
Regulatory Risks		**3.40**			**3.23**		
Changes in government laws and policies	422	3.58[a]	0.92	8	3.40[b]	1.10	8=
Changes in local bodies laws and regulations	423	3.41[a]	0.94	10	2.80[b]	1.10	12
Changes in producer board policies	420	3.20[a]	1.02	11	3.50[b]	1.20	6=
Human Risks		**3.43**			**3.10**		
Accidents or health problems	422	3.71[a]	1.03	4	3.50[b]	1.20	6=
Changes in family situation	421	3.14[a]	1.20	12	2.70[b]	1.30	13=
Miscellaneous Risks		**2.75**			**2.20**		
Theft	421	2.83[a]	1.04	16	2.50[b]	1.20	15=
Problems with hired labour and contractors	422	3.14[a]	1.13	13	2.30[b]	1.10	17
Changes in technology and breeding	421	2.60[a]	0.96	18	2.20[b]	1.20	18
Being unable to meet contracting obligations	419	2.42[a]	1.06	19	1.80[b]	1.00	19

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two surveys (Z-Test at the 5% level)
N is the number of responses received in each question for the 2004 Survey

4.1.2.2 Risk Management Strategies

The risk strategies used to control risk listed in the surveys were also analysed in four groups of risk management: Production, Marketing, Financial and Overall

Strategies. The ranking of the four groups was the same in both surveys, but the scores in all four were significantly higher in 2004 than in 1992 (Figure 4-9).

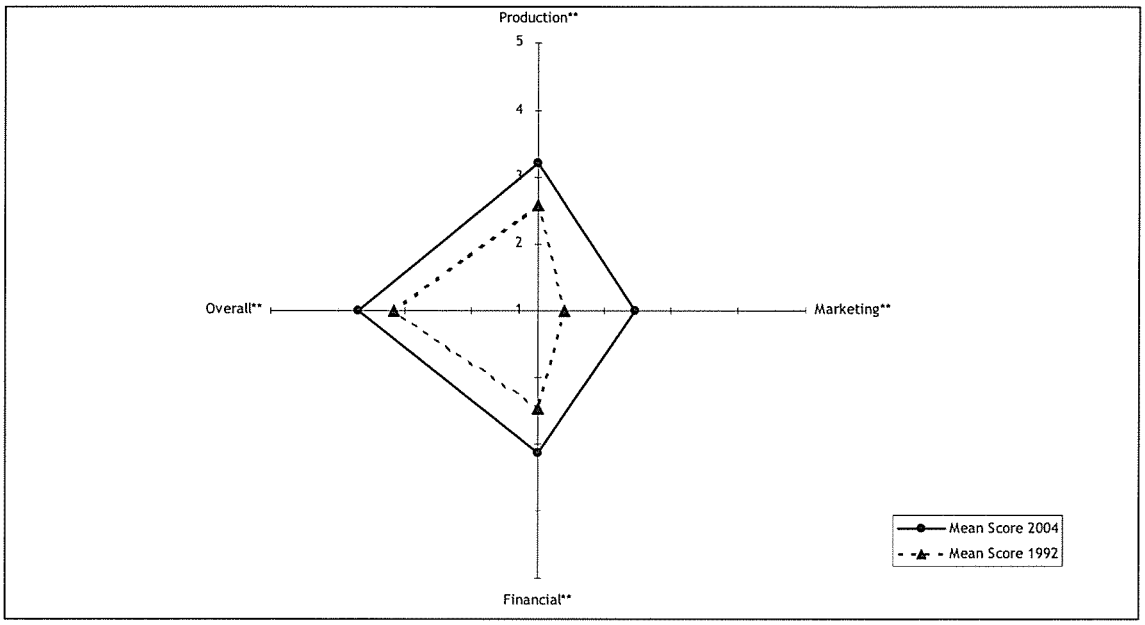

Figure 4-9 Mean score[1] comparison of the four groups of risk management strategies between the two surveys (2004 vs. 1992)

** Indicates statistical difference between the mean scores of the two surveys (T-Test at the 5% level)
[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

Comparing the twenty one Risk Management Strategies (Table 4-4) that were included in both surveys (1992 and 2004) eighteen of them presented statistical differences in their means (Z-Test at the 5% level) between the two surveys. The only risk management strategy that decreased significantly was "Keeping debt Low", in contrast the other seventeen strategies that showed significant differences, increased their mean scores (Table 4-4). In a similar way to the 1992 survey, in 2004 the only strategy used by more than 90% of the farmers surveyed, was "Maintaining feed reserves". The 80% to 90% interval included the strategies "Routine spray and drenching" (88%), "Managed capital spending" (84%), "Debt management" (83%), "Insurance" and "Long-term flexibility" (81% each). However, of these strategies only "Maintaining feed reserves", "Routine spray and drenching" and "Managed capital spending" were used by a greater proportion of farmers in 1992 than in 2004. As for

the overall ranking of the risk sources, the overall ranking of the strategies was not different between the two surveys (r= 0.91, P <0.001).

Table 4-4 Mean scores[1] and ranking of the twenty one risk management strategies listed in both surveys (2004 vs. 1992)

		2004				1992			
RISK MANAGEMENT STRATEGIES	N	Mean Score [1]	SD	Rank	% [2]	Mean Score [1]	SD	Rank	% [2]
Production responses		**3.20**				**2.58**			
Routine spraying and drenching	410	3.92	1.01	1	88%	3.90	1.3	1	92%
Maintaining feed reserves	417	3.90	0.88	2	95%	3.80	1.1	2	96%
Not producing to full capacity	377	2.67[a]	1.10	13	39%	2.20[b]	1.5	12	43%
Monitoring pests, crops, climate	391	3.30[a]	1.05	10	63%	2.30[b]	1.7	11	49%
Irrigation	273	2.23[a]	1.45	17	18%	0.70[b]	1.4	21=	10%
Marketing responses		**2.46**				**1.40**			
Market information	355	3.06[a]	1.16	11	58%	2.00[b]	1.8	13	51%
Spreading sales	327	2.51[a]	1.16	14	27%	1.70[b]	1.9	15=	41%
More than one enterprise	333	2.35[a]	1.20	15	27%	1.70[b]	1.5	15=	34%
Forward contracting	296	2.29[a]	1.20	16	17%	0.90[b]	1.4	19=	15%
Futures markets	289	2.10[a]	1.09	19	7%	0.70[b]	1.3	21=	9%
Financial responses		**3.13**				**2.47**			
Keeping debt low	400	3.37[a]	1.19	9=	63%	3.70[b]	1.3	3	85%
Managed capital spending	393	3.64	0.99	6	84%	3.50	1.4	4	86%
Arranging overdraft reserves	382	3.43[a]	1.12	8	75%	2.70[b]	1.6	10	75%
Debt management	386	3.81[a]	1.07	3	83%	2.80[b]	1.8	9	68%
Financial reserves	392	3.37[a]	1.12	9=	66%	3.10[b]	1.5	6=	72%
Insurance	392	3.63[a]	1.20	7	81%	2.90[b]	1.6	8	77%
Off-farm investment	339	2.88[a]	1.25	12	44%	1.60[b]	1.6	17	36%
Main operator working off-farm	311	1.90[a]	1.08	20	17%	0.90[b]	1.3	19=	13%
Family members working off-farm	310	2.14[a]	1.21	18	27%	1.00[b]	1.3	18	19%
Overall reponses		**3.70**				**3.15**			
Short term flexibility	401	3.75[a]	0.99	4	78%	3.20[b]	1.5	5	80%
Long-term flexibility	389	3.65[a]	0.95	5	81%	3.10[b]	1.6	6=	73%

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two surveys (Z-Test at the 5% level)

[2] Percentage of farmers using the strategy

N is the number of responses received in each question for the 2004 Survey

4.1.3 The 2004 Survey: Results Categorised According to Ownership Structure

The results presented in this section include only Owner-operated farms and Sharemilkers. The third group, Managers, was omitted from the analysis, as already explained, however full detail of their responses can be found in Appendix 9. The summary of the main variables according to ownership structure is presented in Table 4-5. Age of the operator, average farm size and the percentage of heifers grazing off-farm were the only variables which differed significantly between the two groups (z-Test at the 5% level).

Table 4-5 Summary of some variables according to ownership structure[1]

	Owners		Sharemilkers	
	Mean	SD	Mean	SD
Average Age of the operator (years)	48.47[a]	10.40	36.92[b]	8.28
Average farm size (effective hectares)	190[a]	201	139[b]	104
Average herd size	410	330	386	235
Average R1 heifers	86	78	80	53
Average milk solids production (kg)	135,152	105,644	123,598	82,652
Average percentage of heifers grazing off	60[a]	45	82[b]	35
Average percentage of cows wintered	47	45	46	44

[1] Different letters Indicates statistical difference between the means of the two groups (Bonferroni test at the 5% level)

The perception of risk regarding farm size in the future is presented in Figure 4-10. A greater proportion of Sharemilkers perceived high levels of risk in their current farm sizes than Owner operators (19% vs. 11% respectively). Paradoxically, the same trend happened in the lowest category of risk perception, since more Sharemilkers perceived minimal risk in their farm sizes (33% vs. 29% respectively). On the other hand, the owner operators' risk perception on farm size was skewed into the lower categories.

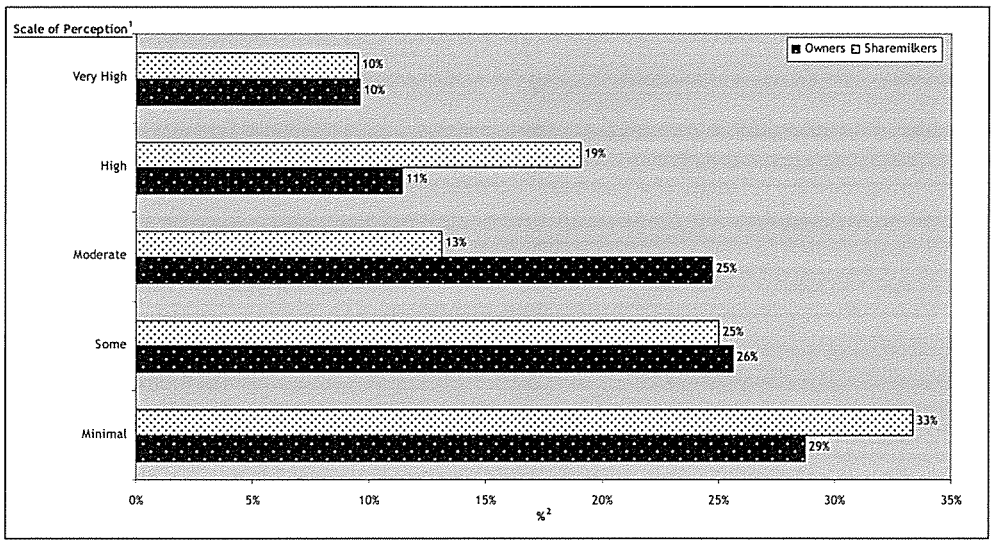

Figure 4-10 Comparison of the perception of risk in farm size being too small in the future according to ownership structure

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

In terms of the financial risk of their operations, Owner Operators and Sharemilkers perceived their levels of debt similarly (Figure 4-11). However a slightly greater percentage of owner operators perceived the level of debt as a very high source of risk (8% vs. 6%).

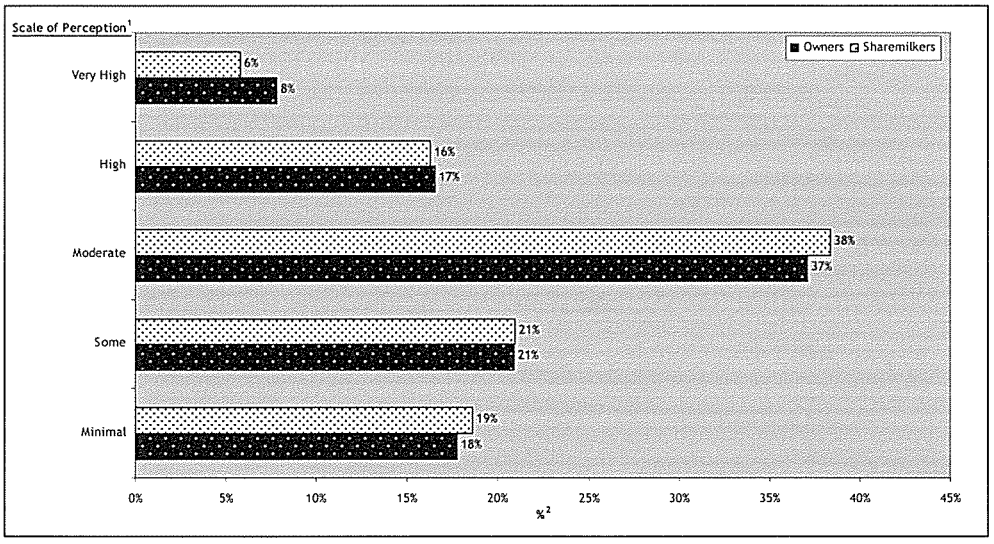

Figure 4-11 Comparison of the perception in the level of debt according to ownership structure

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

The perception of risk on the production side on the farming business is presented in Figure 4-12. Sharemilkers are clearly more concerned about the risk involved in the changes in product prices and yields. The biggest difference is reflected in the fact that 44% of the Sharemilkers perceived there are high levels of risk in the changes in prices and yields, whereas only 31% of the Owner-operators were in the same category. Consequently the figure shows that more Owner-operators perceived the changes in "prices and yields" as being moderate, or even minimal levels of risk.

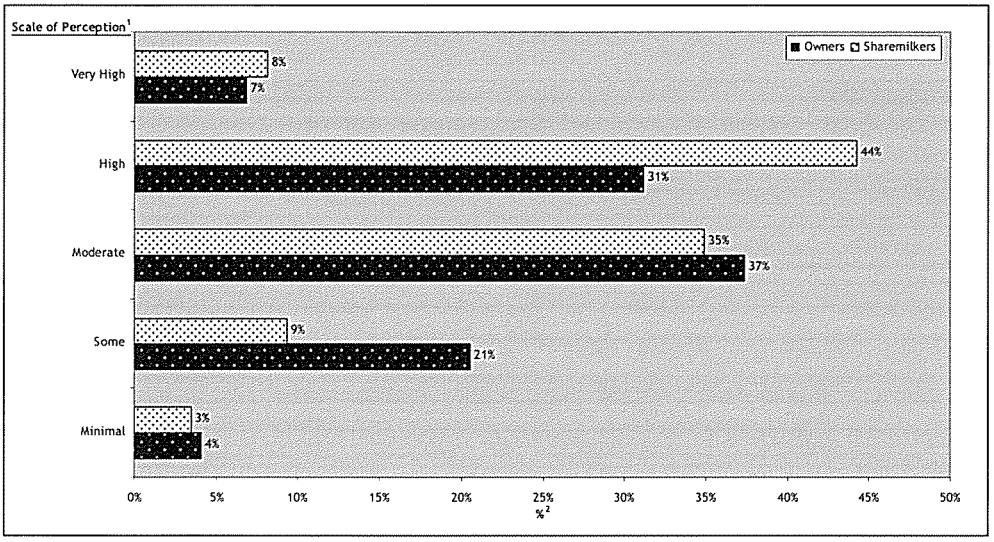

Figure 4-12 Comparison of the perception of risk with the changes in yields and prices according to ownership structure

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

4.1.3.1 Perception of risk sources

The comparison of the mean scores of the six groups of risk sources, Market, Financial, Production, Regulatory, Human and Miscellaneous groups, is presented in Figure 4-13. The Miscellaneous group of risk sources was the only one that showed a statistical difference in mean scores between the two ownership structures (2.67 vs. 2.97 for Owner-operators and Sharemilkers respectively).

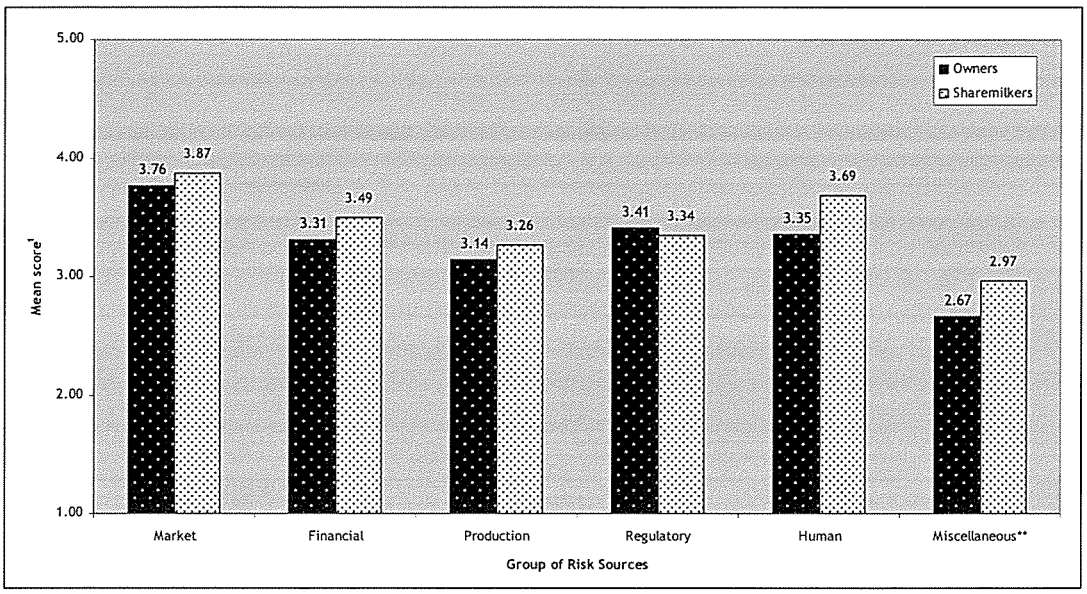

Figure 4-13 Mean score[1] comparison of the six groups of risk sources according to ownership structure

** Indicates statistical difference between the mean scores (T-Test at the 5% level)
[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

At a more detailed level, of the nineteen risk sources listed, ten showed statistical differences in perceptions between Owner-operators and Sharemilkers (Table 4-6). These differences were in five of the six groups of risk sources, with Production the only group where there was no significant difference in the perceptions between Owner-operators and Sharemilkers. For the ten risk sources where the differences in perception were significant, Sharemilkers had higher mean scores than Owner-operators in nine of them; only for "Changes in local bodies laws and regulations" were Owner-operators more concerned than Sharemilkers (mean scores of 3.46 vs. 3.20 respectively). The ranking analysis showed that there was no significant difference in the overall ranking of the nineteen sources of risk listed in the survey between the two ownership structures considered.

Table 4-6 Mean scores[1] and ranking of the nineteen risk sources listed in the survey according to ownership structure

	Owners				Sharemilkers			
RISK SOURCE	N	Mean Score [1]	SD	Rank	N	Mean Score [1]	SD	Rank
Market Risks								
Changes in product prices	319	3.99[a]	0.83	1	85	4.20[b]	0.67	1
Changes in world economic and political situation	320	3.78	0.89	2	86	3.76	0.80	4
Change in New Zealand's economic situation	319	3.58	0.87	7	86	3.60	0.84	7
Changes in inputs costs	320	3.71[a]	0.84	3	86	3.92[b]	0.75	3
Financial Risks								
Changes in interest rates	320	3.63	1.08	5	86	3.56	1.05	8
Changes in land prices	320	3.00[a]	1.12	14	86	3.43[b]	1.19	10
Production Risks								
Rainfall variability	320	3.58	1.02	8	86	3.74	0.94	5
Other weather factors	320	2.99	0.99	15	85	3.12	0.93	15
Diseases or pests	320	3.40	1.06	10	86	3.62	0.90	6
Disasters	317	2.61	1.17	17	84	2.57	1.20	19
Regulatory Risks								
Changes in government laws and policies	320	3.61	0.93	6	86	3.49	0.88	9
Changes in local bodies laws and regulations	321	3.46[a]	0.93	9	86	3.20[b]	0.97	14
Changes in producer board policies	318	3.15	1.02	11	86	3.35	0.96	13
Human Risks								
Accidents or health problems	321	3.66[a]	1.02	4	85	3.95[b]	1.08	2
Changes in family situation	320	3.05[a]	1.17	13	86	3.42[b]	1.25	11
Miscellaneous Risks								
Theft	319	2.75[a]	1.01	16	86	3.06[b]	1.02	16
Problems with hired labour and contractors	320	3.06[a]	1.13	12	86	3.38[b]	1.10	12
Changes in technology and breeding	319	2.52[a]	0.94	18	86	2.78[b]	0.95	17
Being unable to meet contracting obligations	317	2.33[a]	1.02	19	86	2.64[b]	1.08	18

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two groups (Z-Test at the 5% level)

4.1.3.2 Risk Management Strategies

The risk management strategies were also analysed both individually and in the five groups asked. As it was outlined in 3.4.3.2, to the four groups of risk management strategies originally included in the 1992 Survey, an additional group was added in the 2004 survey. This group of strategies was from the field of strategic planning (Fetsch et al., 2001). The mean scores of the four groups of strategies originally considered in the 1992 survey, were not statistically different between the two ownership structures

compared (Figure 4-14). However, there was statistical difference between the mean score of Owner-operators and Sharemilkers in the Strategic Planning group (3.08 vs. 3.42 respectively).

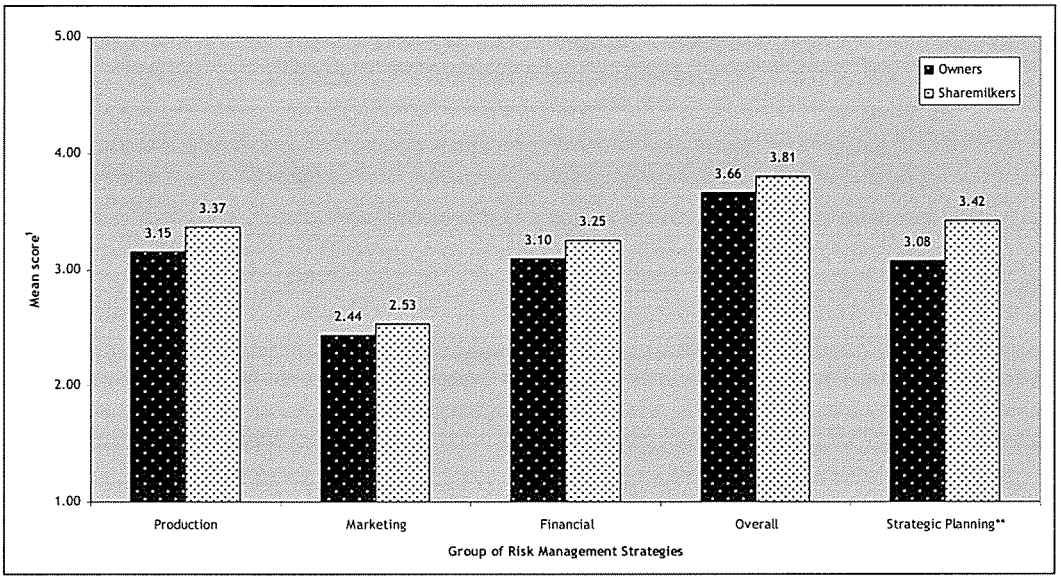

Figure 4-14 Mean score[1] comparison of the five groups of risk management strategies listed in the survey according to ownership structure

** Indicates statistical difference between the mean scores (T-Test at the 5% level)
[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

When comparing the importance of the twenty one management strategies (not including those from the strategic planning area) listed in the survey for both ownership structures analysed, significant differences were found in the mean scores of six of them. These differences were only in the production and financial sides of the business (Table 4-7). There was no significant difference in the overall ranking of the twenty one risk management strategies between the two groups of ownership structure analysed.

Table 4-7 Mean scores and ranking of the twenty one risk management strategies included in the survey according to ownership structure

	Owners					Sharemilkers				
RISK MANAGEMENT STRATEGIES	N	Mean Score [1]	SD	Rank	% [2]	N	Mean Score [1]	SD	Rank	% [2]
Production responses										
Routine spraying and drenching	310	3.83[a]	1.02	2	87%	85	4.27[b]	0.84	1	96%
Maintaining feed reserves	317	3.87	0.89	1	96%	85	3.96	0.87	3	93%
Not producing to full capacity	284	2.75[a]	1.10	14	41%	79	2.46[b]	1.11	16	33%
Monitoring pests, crops, climate	295	3.23[a]	1.02	11	60%	81	3.57[b]	1.02	7	70%
Irrigation	205	2.09[a]	1.38	18	16%	56	2.57[b]	1.50	13	19%
Marketing responses										
Market information	273	3.03	1.12	12	58%	71	3.17	1.24	11	58%
Spreading sales	249	2.50	1.17	15	28%	64	2.56	1.08	14	21%
More than one enterprise	259	2.32	1.21	16	27%	60	2.45	1.13	17	20%
Forward contracting	225	2.31	1.21	17	17%	58	2.26	1.15	18	15%
Futures markets	216	2.05	1.07	19	7%	61	2.21	1.10	19	7%
Financial responses										
Keeping debt low	308	3.38	1.17	9	63%	80	3.30	1.25	10	62%
Managed capital spending	305	3.62	1.00	6	85%	75	3.68	0.99	6=	79%
Arranging overdraft reserves	294	3.48	1.11	8	79%	76	3.34	1.08	8	69%
Debt management	295	3.78	1.07	3	84%	79	4.00	1.03	2	83%
Financial reserves	299	3.36	1.12	10	65%	81	3.31	1.13	9	70%
Insurance	295	3.52[a]	1.26	7	77%	83	3.95[b]	0.94	4	93%
Off-farm investment	257	2.84	1.21	13	44%	69	3.01	1.38	12	40%
Main operator working off-farm	236	1.84	1.05	21	14%	62	2.11	1.13	20	25%
Family members working off-farm	234	2.04[a]	1.14	20	26%	63	2.54[b]	1.33	15	30%
Overall reponses										
Short term flexibility	306	3.69	1.01	4	76%	81	3.94	0.94	5	82%
Long-term flexibility	299	3.63	0.94	5	81%	77	3.68	0.98	6=	81%

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two groups (Z-Test at the 5% level)
[2] Percentage of farmers using the response

The risk management responses in the field of strategic planning were ranked identically by both groups of ownership structures. However of the five strategies listed, there were significant differences between the two groups for three of them. Those strategies were "Using practical planning steps in your business", "Having written a shared mission statement for your operation" and "Having written a shared vision statement for your operation", and in all of them Sharemilkers had higher mean scores than Owner-operators (Table 4-8).

Table 4-8 Mean score and ranking for the strategic planning risk management strategies[3] according to ownership structure

	Owners					Sharemilkers				
	N	Mean Score [1]	SD	Rank	% [2]	N	Mean Score [1]	SD	Rank	% [2]
Strategic Management reponses [3]										
Using practical planning steps in your business	302	3.74[a]	0.93	1	89%	80	4.00[b]	0.93	1	91%
Assessing strengths, weaknesses, threats and opportunities	300	3.61	1.00	2	82%	83	3.78	1.00	2	88%
Having written a shared mission statement for your operation	255	2.45[a]	1.22	5	22%	72	3.06[b]	1.38	5	41%
Having written a shared vision statement for your operation	249	2.52[a]	1.24	4	24%	72	3.07[b]	1.37	4	42%
Using of financial ratios for decision making	276	3.06	1.17	3	57%	76	3.20	1.24	3	49%

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two groups (Z-Test at the 5% level)
[2] Percentage of farmers using the response
[3] Taken from Fetsch et al. (2001)

4.1.3.3 Sources of Information used and Areas of further interest

The data collected regarding the sources of information the farmers use to be updated is presented in Figure 4-15. The figure shows that both Owner-operators and Sharemilkers had similar preferences of the sources of information. However when comparing the two ownership structures it can be seen that in seven of the eleven sources of information proposed to farmers, a greater proportion of Sharemilkers used those sources. Only "Scientific Publication", "Video/Audio tapes" and "Other" sources were used more by Owner-operators than by Sharemilkers.

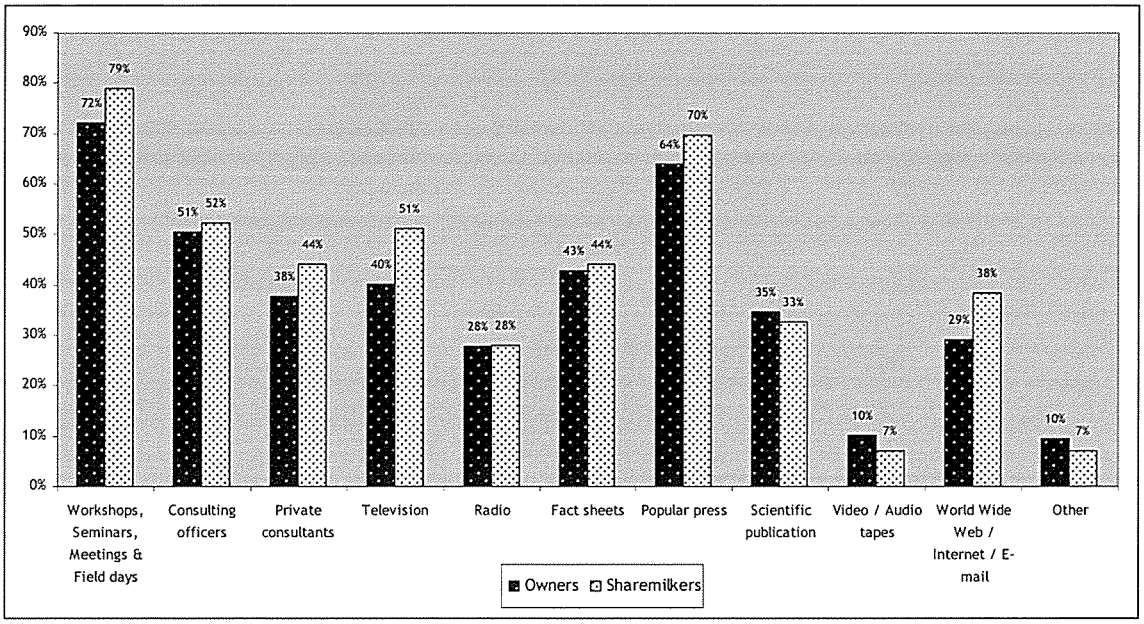

Figure 4-15 Sources of information most commonly used by farmers to be up to date according to ownership structure

Finally, of the six areas listed as the ones farmers would like to learn more about risk management strategies, Owner-operators were more interested than Sharemilkers in the Production and Marketing areas, however Sharemilkers had higher mean scores in the other four areas. Despite these differences, there were no differences between Owner-operators and Sharemilkers in their rankings for the six areas, with Financial first followed by Production. The two least important areas for farmers were Legal and Marketing (Figure 4-16). Statistical difference in mean scores was found only in the Financial area, where Sharemilkers were more concerned than Owner-operators (4.00 vs. 3.76).

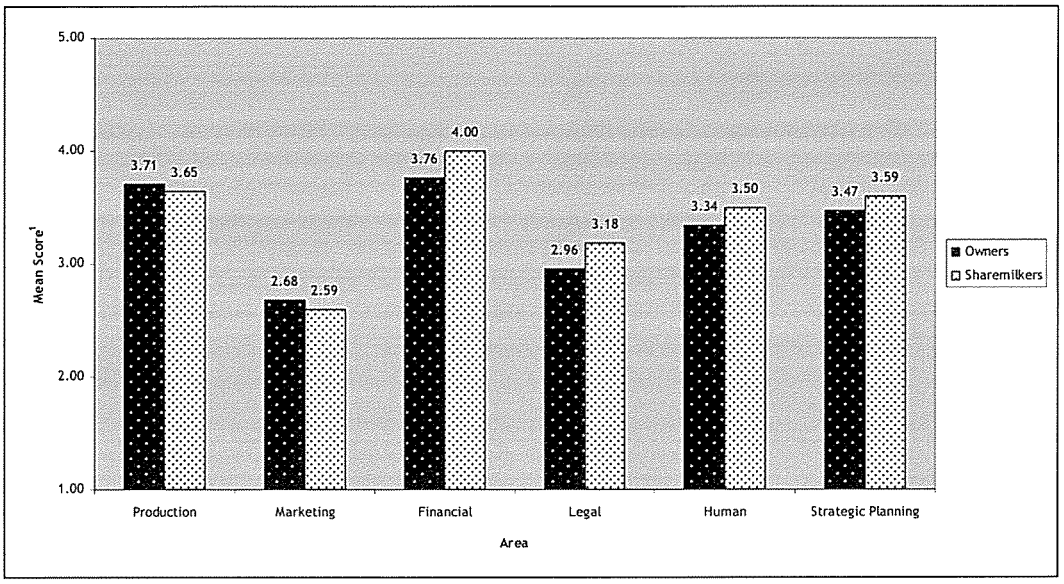

Figure 4-16 Mean score of the areas perceived as critical to learn about risk management strategies according to ownership structure

**Indicates statistical difference between the mean scores at the 5% level (T-Test).
[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

4.1.4 The 2004 Survey: Results Categorised According to Geographic Location

A summary of the information collected for the survey according to geographic location is presented in Table 4-9. Differences between the North and South Islands were significant in average farm size, average herd size, average R1 heifers and kilograms of milk solids produced per farm. For each parameter, South Island's means were always higher than North Island.

Table 4-9 Summary of the main variables according to geographic location[1]

	North Island		South Island	
	Mean	SD	Mean	SD
Average Age of the operator (years)	46.51	11.03	43.74	10.40
Average farm size (effective hectares)	162[a]	160	283[b]	268
Average herd size	367[a]	293	589[b]	347
Average R1 heifers	76[a]	63	138[b]	107
Average milk solids production (kg)	117,371[a]	94,111	207,964[b]	104,722
Average percentage of heifers grazing off	66	44	57	46
Average percentage of cows wintered	45	45	55	43

[1] Different letters Indicates statistical difference between the means of the two groups (Bonferroni test at the 5% level)

The perception of risk regarding farm size for the future is presented in Figure 4-17. An outlook of the figure shows that the perception of farmers from the South Island is highly skewed into the low risk categories, in fact almost 75% of the farmers from the South Island believed there is Some or Minimal risk in their current farm size being too small in the coming years. On the contrary the perception of farmers from the North Island is more evenly distributed, as 26% of farmers from the North Island perceived Large or Very large risk in their farm sizes for the future compared with only 6% of the farmers from the South Island.

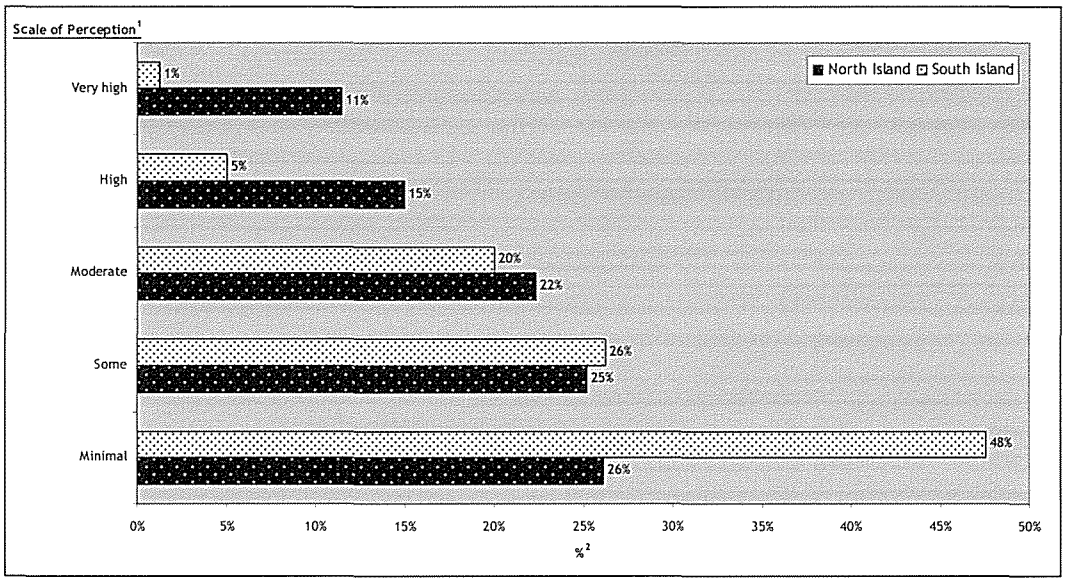

Figure 4-17 Comparison of the perception of risk in farm size being too small in the future according to geographic location

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

The perception of risk in the level of debt is presented in Figure 4-18. A similar proportion of farmers from both Islands perceive minimal or some risk from this issue. Nevertheless, a greater share of farmers from the South Island perceived this risk as High or Very high (31% vs. 22% for South and North Island respectively).

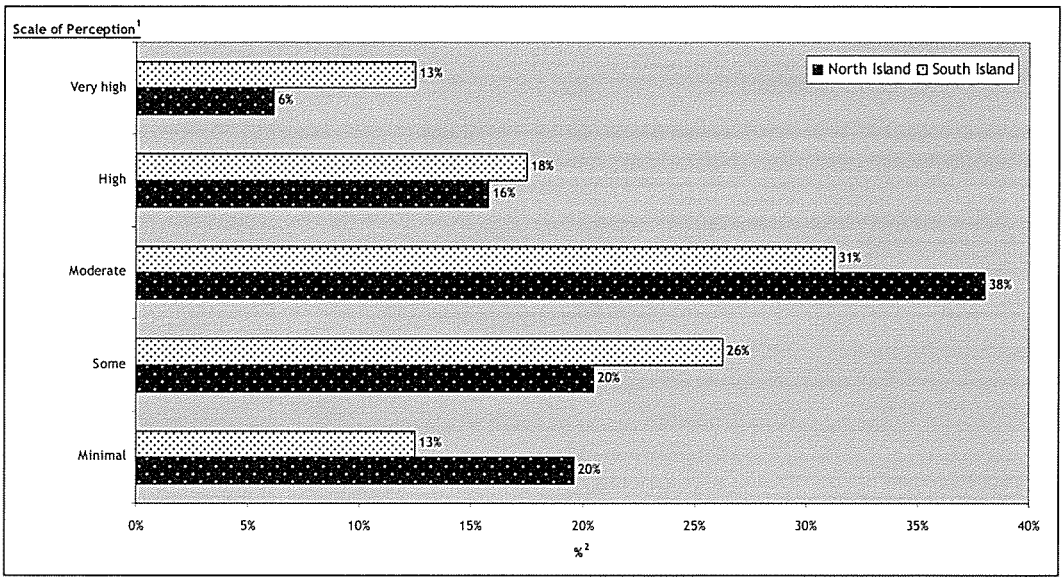

Figure 4-18 Comparison of the perception of risk perceived in the level of debt according to geographic location

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

Figure 4-19 shows that despite the fact that a greater proportion of farmers from the South Island perceived that variability of yields and prices is a very high source of risk, a similar proportion of farmers from both Islands perceived this source in the higher two categories of perception (41% for the North Island and 43% for the South Island farmers). No major differences were found in the three lower categories of risk perception.

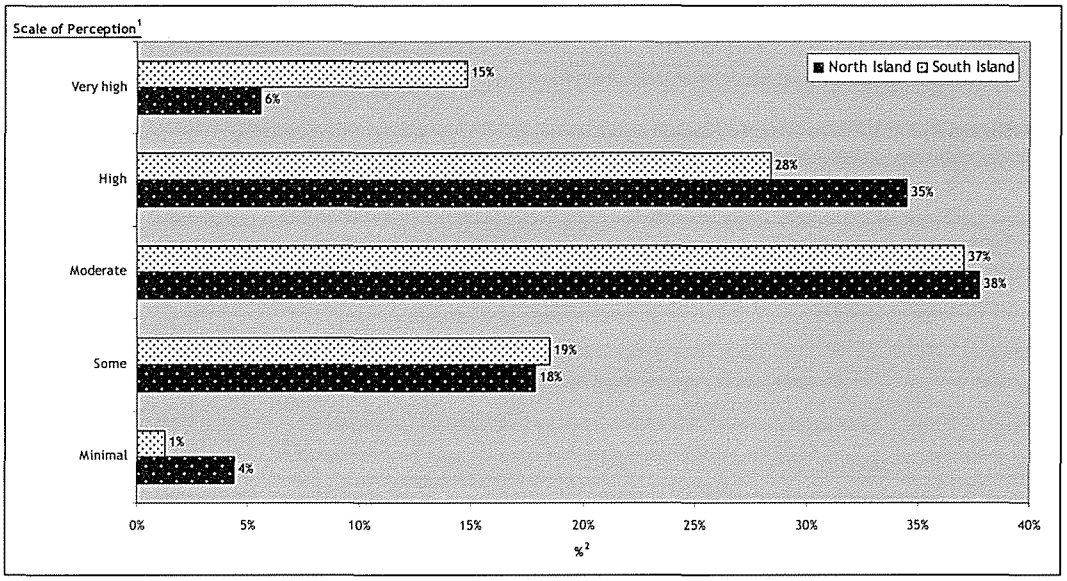

Figure 4-19 Comparison of the perception of risk in the changes of yields and prices according to geographic location

[1] Scale of perception 1= minimal, 5= Very high
[2] Percentage of farmers

4.1.4.1 Perception of risk sources

There were no statistical differences between the two islands in their mean scores of the six groups of risk sources (Figure 4-20). Nevertheless, farmers from both North and South Islands perceived the groups of risk sources in the same order of importance: Market Risks were the most important followed by Human Risks; in third and fourth places were Regulatory and Financial risks and the least important sources were Production and Miscellaneous risks.

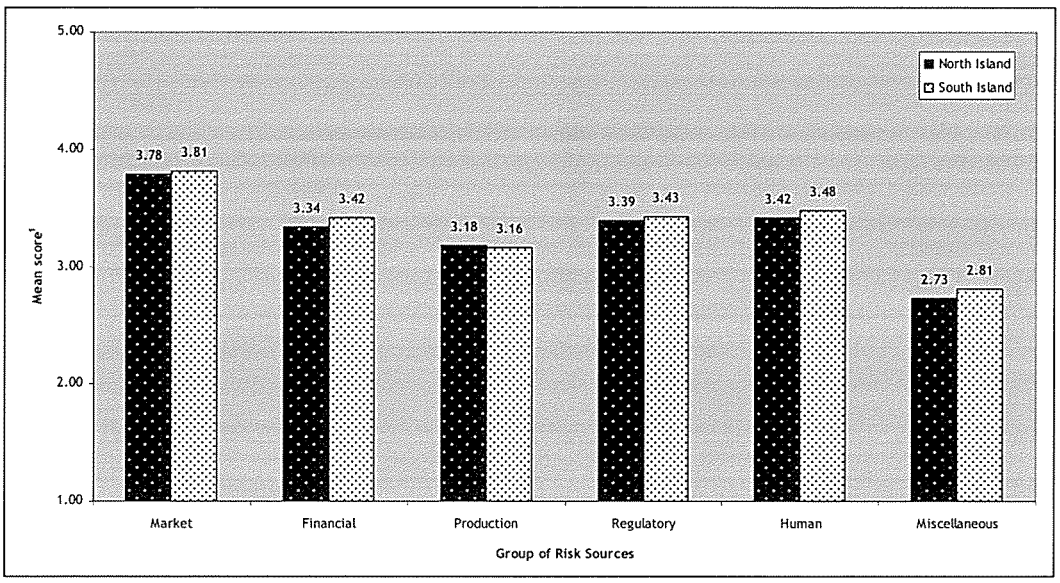

Figure 4-20 Mean comparison of the six groups of risk sources listed in the survey according to geographic location

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

The comparison of the mean scores and ranking of the nineteen risk sources listed in the survey for both islands is presented in Table 4-10. No difference was found between both Islands in the overall ranking of the nineteen sources ($r= 0.92$, $P <0.001$). However the perception of risk between both Islands was different for four of the nineteen risk sources listed. The farmers from the North Island perceived "Rainfall variability" and "Diseases or pests" as more important sources of risk than their counterparts from the South Island (3.67 vs. 3.40 and 3.49 vs. 3.20 respectively). On the contrary, farmers from the South Island were more concerned about "Disasters" and "Problems with hired labour and contractors" than those from the North Island (2.95 vs. 2.55 and 3.48 vs. 3.06 for South and North Island farmers.

Table 4-10 Mean scores[1] and ranking of the nineteen sources of risk included in the survey according to geographic location

	North Island				South Island			
	345				81			
RISK SOURCE	N	Mean Score [1]	SD	Rank	N	Mean Score [1]	SD	Rank
Market Risks								
Changes in product prices	339	4.02	0.78	1	81	4.07	0.88	1
Changes in world economic and political situation	341	3.79	0.87	2	81	3.75	0.84	3
Change in New Zealand's economic situation	341	3.57	0.88	7	80	3.65	0.80	7
Changes in inputs costs	341	3.76	0.83	3	81	3.77	0.84	2
Financial Risks								
Changes in interest rates	340	3.60	1.09	6	81	3.67	1.00	6
Changes in land prices	341	3.07	1.17	13	81	3.17	1.05	13
Production Risks								
Rainfall variability	341	3.67[a]	0.99	5	81	3.40[b]	1.03	10
Other weather factors	341	3.01	1.00	15	80	3.10	0.85	15
Diseases or pests	341	3.49[a]	1.02	9	81	3.20[b]	1.05	12
Disasters	337	2.55[a]	1.16	18	80	2.95[b]	1.21	16
Regulatory Risks								
Changes in government laws and policies	341	3.55	0.93	8	81	3.68	0.86	5
Changes in local bodies laws and regulations	342	3.39	0.96	10	81	3.49	0.85	8
Changes in producer board policies	339	3.22	1.03	11	81	3.11	0.99	14
Human Risks								
Accidents or health problems	342	3.71	1.05	4	80	3.73	0.98	4
Changes in family situation	340	3.12	1.22	12	81	3.23	1.14	11
Miscellaneous Risks								
Theft	340	2.86	1.03	16	81	2.72	1.05	17
Problems with hired labour and contractors	341	3.06[a]	1.15	14	81	3.48[b]	1.00	9
Changes in technology and breeding	341	2.60	0.97	17	80	2.59	0.88	18
Being unable to meet contracting obligations	339	2.41	1.06	19	80	2.45	1.03	19

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two groups (Z-Test at the 5% level)

4.1.4.2 Risk Management Strategies

The mean scores of the four groups of risk management strategies are presented in Figure 4-21. No statistical differences were found between the mean scores of both islands for each group of risk management strategies, however farmers from the South Island were more focused on the use of production responses than farmers from the North Island. For the other three categories, the latter group had higher mean scores

than the former. Despite these differences, farmers from both Islands attached the same level of importance to the four groups: Overall group of strategies, which includes short and long term flexibility, occupied the first place; Production group of strategies were second, Financial was third and finally the Marketing group.

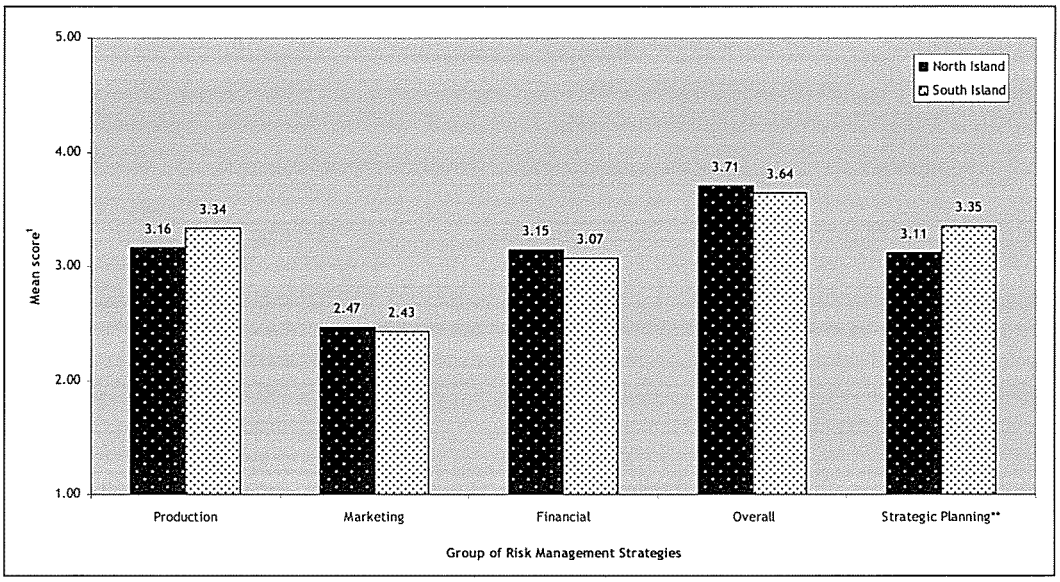

Figure 4-21 Mean scores[1] of the five groups of risk management responses included in the survey according to geographic location

**Indicates statistical difference between the mean scores at the 5% level (T-Test).
[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

Statistical differences between the mean scores of the two groups of farmers were found in five of the twenty one risk management strategies listed in the four groups outlined above (Table 4-11). Differences were found in the use of production and financial risk management strategies. Among the former group, "Routine spray and drenching" was rated higher by farmers from the North Island than those from the South Island (4.00 vs. 3.59 respectively), however the use of irrigation was by far more important for the farmers in the South Island (1.92 vs. 3.33 for North and South Island farmers). These two strategies also differed in the percentages of farmers that used them: 90% of the farmers from the North Island used "Routine spray and drenching" compared with 81% in the South Island; on the contrary 52% of farmers from the South Island mentioned they use "Irrigation" to reduce the risk in their operations compared with only 9% in the North Island.

Within the financial responses, farmers from the South Island put more emphasis on the strategy "Arranging overdraft reserves" than their peers from the North Island (3.67 vs. 3.38 respectively), however a similar proportion of farmers from both islands mentioned they use this strategy (74% and 78% for North and South Islands). On the contrary, the group of farmers from the North Island was more focused on getting income from outside the operation, as the strategies "Main operator working off-farm" and "Family members working off-farm" had higher mean scores in the North than in the South Island (1.98 vs. 1.57 and 2.23 vs. 1.81 respectively). In spite of these differences, there was no significant difference between the islands in their overall ranking of the twenty one risk management strategies (r= 0.82, P <0.001).

Table 4-11 Mean scores[1] and ranking of the twenty one risk management strategies included in the survey according to geographic location

	North Island					South Island				
RISK MANAGEMENT STRATEGIES	N	Mean Score [1]	SD	Rank	% [2]	N	Mean Score [1]	SD	Rank	% [2]
Production responses										
Routine spraying and drenching	334	4.00[a]	0.96	1	90%	76	3.59[b]	1.16	7	81%
Maintaining feed reserves	340	3.93	0.87	2	96%	77	3.77	0.93	3	91%
Not producing to full capacity	303	2.64	1.10	14	37%	74	2.80	1.13	15	49%
Monitoring pests, crops, climate	316	3.32	1.06	11	61%	75	3.19	1.05	12	70%
Irrigation	213	1.92[a]	1.15	21	9%	60	3.33[b]	1.84	9	52%
Marketing responses										
Market information	286	3.05	1.14	12	57%	69	3.10	1.21	13	61%
Spreading sales	265	2.54	1.14	15	28%	62	2.37	1.24	17	23%
More than one enterprise	269	2.35	1.22	16	26%	64	2.38	1.12	16	31%
Forward contracting	236	2.28	1.19	17	15%	60	2.35	1.23	18	24%
Futures markets	233	2.13	1.06	19	7%	56	1.95	1.17	19	11%
Financial responses										
Keeping debt low	324	3.40	1.18	8	64%	76	3.21	1.21	11	57%
Managed capital spending	317	3.67	0.97	5	84%	76	3.53	1.05	8	86%
Arranging overdraft reserves	310	3.38[a]	1.13	10	74%	72	3.67[b]	1.03	5	78%
Debt management	313	3.79	1.10	3	83%	73	3.92	0.97	1	82%
Financial reserves	318	3.40	1.11	9	69%	74	3.26	1.15	10	54%
Insurance	316	3.58	1.23	7	80%	76	3.84	1.10	2	86%
Off-farm investment	272	2.90	1.25	13	43%	67	2.82	1.25	14	47%
Main operator working off-farm	251	1.98[a]	1.13	20	18%	60	1.57[b]	0.74	21	9%
Family members working off-farm	248	2.23[a]	1.25	18	28%	62	1.81[b]	0.99	20	25%
Overall reponses										
Short term flexibility	327	3.78	0.97	4	79%	74	3.61	1.07	6	75%
Long-term flexibility	316	3.64	0.99	6	80%	73	3.67	0.76	4	85%

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two groups (Z-Test at the 5% level)

[2] Percentage of farmers using the response

The group of strategic planning strategies was ranked equally by both North and South Island dairy farmers (Table 4-12). Farmers from the South Island had higher mean scores than their counterparts from the North for each strategy, these differences were significant for statements of mission and vision. Similarly, a greater proportion of farmers from the South Island used each strategy than those from the North Island.

Table 4-12 Mean score and ranking for the strategic planning risk management strategies[3] according to geographic location

	North Island					South Island				
	N	Mean Score [1]	SD	Rank	% [2]	N	Mean Score [1]	SD	Rank	% [2]
Strategic Planning responses [(1)]										
Using practical planning steps in your business	321	3.78	0.95	1	89%	74	3.85	0.86	1	93%
Assessing strengths, weaknesses, threats and opportunities	320	3.62	1.02	2	82%	77	3.79	0.89	2	88%
Having written a shared mission statement for your operation	277	2.53[a]	1.31	5	25%	65	2.91[b]	1.16	5	33%
Having written a shared vision statement for your operation	271	2.57[a]	1.32	4	27%	64	3.02[b]	1.15	4	35%
Using of financial ratios for decision making	295	3.07	1.20	3	55%	71	3.18	1.14	3	59%

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate statistical difference between the mean scores of the two groups (Z-Test at the 5% level)
[2] Percentage of farmers using the response
[3] Taken from Fetsch et al. (2001)

4.1.4.3 Sources of Information used and Areas of further interest

The sources of information most commonly used by the dairy farmers from both islands are presented in Figure 4-22. There were no big differences between the two islands for most of the sources, although the differences were bigger for "Workshops, Seminars, Meetings and Field days" and "Television" presented the greater differences between both Islands. The former source is used by a larger proportion of farmers from the South Island than their counterparts from the North Island (80% vs. 72% respectively). The use of "Television" as a source of information was much more important for farmers from the North Island (46%) than for the farmers of the South Island (26%).

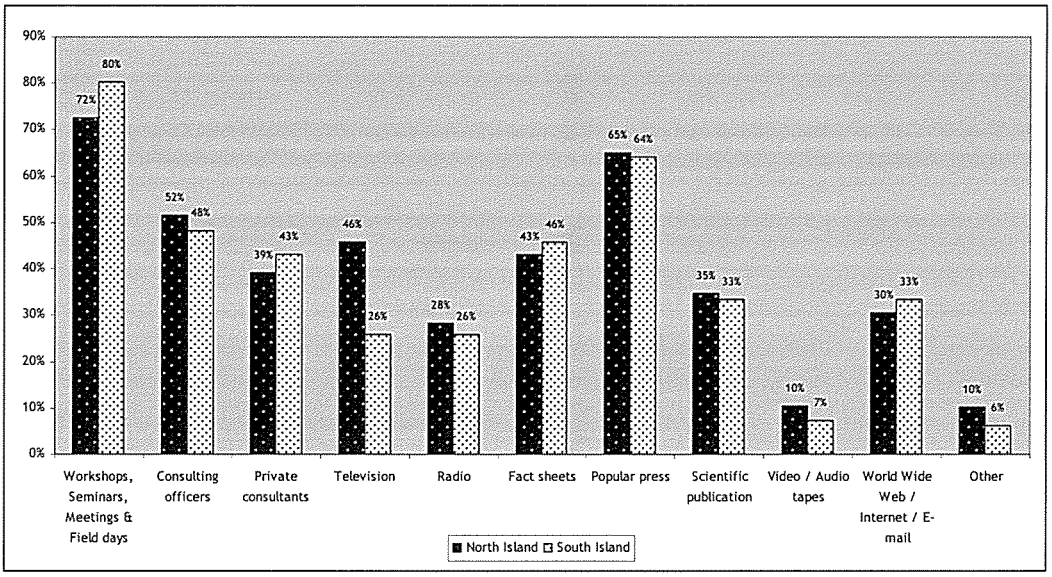

Figure 4-22 Sources of information most commonly used by farmers from North and South islands to be up to date

Finally, the areas farmers perceived as critical to learn about risk management are presented in Figure 4-23. For farmers from both Islands, the financial area was the most important to learn about risk management. Second and third places for farmers from the North Island were the production and strategic planning areas, whereas farmers from the South Island were more concerned about the strategic planning issue (2^{nd}) followed by the production area (3^{rd}). The least important area for both groups was the marketing one, where farmers from the South Island had a slightly higher mean score than farmers from the North Island (2.74 vs. 2.65). In spite of these differences in rankings, only in the human and strategic planning areas were there significant differences between the mean scores of farmers from both islands.

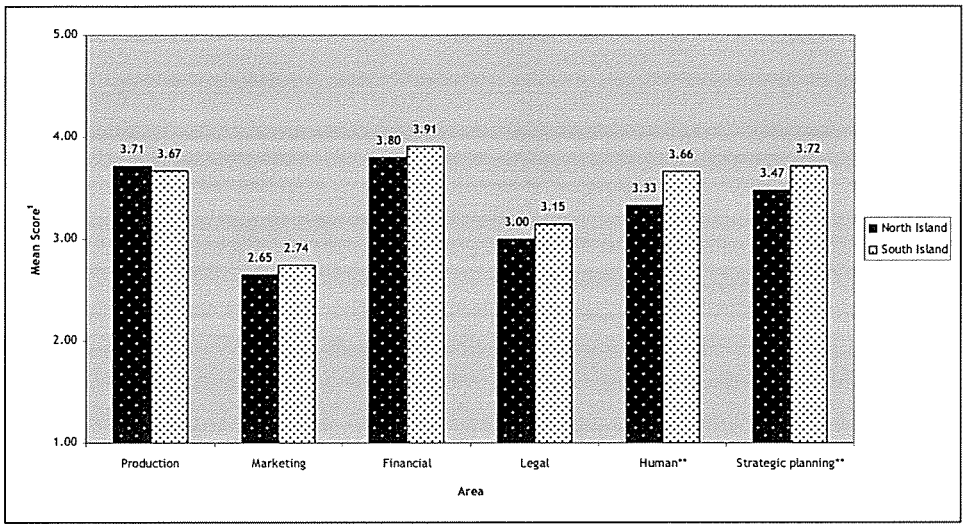

Figure 4-23 Mean scores[1] of the areas perceived as critical to learn more about risk management strategies according to geographic location

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

4.1.5 Additional information according to the interaction between Ownership Structure and Geographic Location

As the criteria analysed in the 2004 survey were ownership structure and geographic location, the interaction between these two was also included. Therefore four groups were created: Owner-operators from the North Island, Owner-operators from the South Island, Sharemilkers from the North Island and Sharemilkers from the South Island. Averages of Effective Area, Total Kilograms of Milk Solid produced and Herd Size for each of the four groups analyzed are presented in Table 4-13.

Table 4-13 Summary of some of the physical variables analyzed for Owner-operators and Sharemilkers from both North and South Island

Variable**	Sharemilkers North Island	Owner-operators North Island	Sharemilkers South Island	Owner-operators South Island
Average effective area (Ha)	127[a]	168[a]	192[ab]	301[b]
Average total Kg of MS produced	104,608[a]	119,781[a]	196,206[b]	195,610[b]
Average Herd Size	341[a]	373[ab]	555[bc]	570[c]

** Letters indicates significant differences at the 5% level (Bonferroni test)

This section analysed three aspects of the survey: groups of risk sources, groups of risk management strategies and areas of educational interest for the farmers. As explained in 3.4.5.2, in order to make this analysis more sensitive to identify the potential differences between the groups created from the interaction between ownership structure and geographic location, the risk sources listed originally under the Miscellaneous heading were now relocated into other groups of risk sources. The change in the classification of the risk sources in presented in Table 4-14, however a detailed description of the groups can be found in Chapter Three (Table 3-2).

Table 4-14 Groups of risk sources used in the analysis of the interaction between ownership structure and geographic location, Stepwise Regression and Linear Mixed Models

1.- Market Risks	4.- Regulatory Risks
Changes in product prices	Changes in government laws and policies
Changes in world economic and political situation	Changes in local bodies laws and regulations
Change in New Zealand's economic situation	Changes in producer board policies
Changes in inputs costs	
2.- Financial Risks	**5.- Human Risks**
Changes in interest rates	Accidents or health problems
Changes in land prices	Changes in family situation
Being unable to meet contracting obligations[1]	Theft[1]
	Problems with hired labour and contractors[1]
3.- Production Risks	**6.- Technological Risks**
Rainfall variability	Changes in technology and breeding[1]
Other weather factors	
Diseases or pests	
Disasters	

[1] Originally in the Miscellaneous group of risk sources

Sharemilkers from the North Island were the most concerned about both the Market and Production groups of risk sources (Table 4-15). The other three groups perceived the same group of risk at a similar level to one another. The financial area was perceived to be more important by Sharemilkers than Owner-operators from both islands. Owner-operators from both islands gave high importance to the Regulatory group of risk, with those from the South Island the most concerned group about this issue. At the Sharemilkers' level, those from the North Island were more concerned about the Regulatory issue than their counterparts from the South. Although the Human group of risk sources was considered more important by Sharemilkers than by

Owner-operators, this difference was significant only in the North Island; there were no differences between the two islands in their mean scores for either group of farmers. Finally, despite the fact that Sharemilkers from the North Island and Owner-operators from the South Island were the groups that attached the highest importance to Technological risk, this source of variation presented the same pattern of mean scores as the Human group of risk sources.

Table 4-15 Risk perception according to ownership structure and geographic location of the 6 groups of risk sources

	North Island						South Island					
	Sharemilkers			Owner-operators			Sharemilkers			Owner-operators		
Risk Source Group	N	Mean Score[1]	Std Dev	N	Mean Score[1]	Std Dev	N	Mean Score[1]	Std Dev	N	Mean Score[1]	Std Dev
Marketing	67	3.89	0.57	260	3.75	0.68	18	3.78	0.53	55	3.78	0.70
Financial	68	3.21	0.84	259	2.98	0.83	18	3.22	0.73	55	3.04	0.72
Production	67	3.30	0.60	258	3.14	0.79	16	3.08	0.67	56	3.17	0.74
Regulatory	68	3.42	0.78	258	3.39	0.82	18	3.06	0.80	56	3.54	0.63
Human	68	3.42^{a}	0.75	260	3.11^{b}	0.75	17	3.57^{ab}	0.63	56	3.22^{ab}	0.70
Technological	68	2.88^{a}	0.94	261	2.51^{b}	0.96	18	2.39^{ab}	0.92	55	2.62^{ab}	0.83

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important); different letters indicate significant differences between mean scores (Bonferroni Tests at the 5% level)

Both Sharemilkers and Owner-operators from the South Island were equally focused on the use of production risk management strategies, however Sharemilkers from the North Island were keener to use this group of risk management strategies than Owner-operators (Table 4-16). The situation was the opposite when considering the Marketing group of strategies, where the Owner-operators from the South Island was the group that had the highest mean score. In the financial area, Sharemilkers were more focused on using these strategies than Owner-operators, as the mean scores were higher in both islands for Sharemilkers. As with the financial group of risk management strategies, Sharemilkers from both Islands attached more importance to the use of the responses listed in the Overall group of strategies than Owner-operators, however both ownership structures from the North Island had higher mean scores than their counterparts from the South Island. The group of strategic planning strategies was also more important for Sharemilkers than for Owner-operators, however those farmers from the South Island were keener to use these strategies than their counterparts from the North Island.

Table 4-16 Risk perception according to ownership structure and geographic location of the 5 groups of risk management strategies

	North Island						South Island					
	Sharemilkers			Owner-operators			Sharemilkers			Owner-operators		
Risk Management Strategies Group	N	Mean Score[1]	Std Dev	N	Mean Score[1]	Std Dev	N	Mean Score[1]	Std Dev	N	Mean Score[1]	Std Dev
Production	65	3.00	0.69	241	2.78	0.64	17	3.04	0.59	47	3.05	0.65
Marketing	62	1.93	1.17	234	1.97	0.94	17	1.86	0.84	45	2.06	1.01
Financial	60	2.91	0.84	231	2.88	0.72	18	2.98	0.61	48	2.78	0.63
Overall	66	3.62	1.11	254	3.56	0.97	18	3.33	0.94	52	3.45	1.08
Strategic	65	3.14	1.26	235	2.77	1.04	17	3.27	1.14	47	2.96	0.86

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

Finally from Table 4-16 it is important to highlight that farmers from both Islands were very focused on maintaining short and long term flexibility in their operation (group of Overall risk management strategies), and equally for all of them, the marketing group of strategies was the least important. Despite these similarities, only Sharemilkers from both islands attached the same ranking for the five groups of risk management strategies: Overall (1), Strategic (2), Production (3), Financial (4) and Marketing (5); whereas the ranking of the same five groups of risk management strategies for Owner-operators from both Islands was different (Table 4-16).

Figure 4-24 shows the mean scores of the areas where farmers believe they need to learn more about risk management strategies. Sharemilkers in the South Island and Owner-operators from the North Island are the groups most interested in learning strategies to manage risk in the production area. However, on the marketing side, Owner-operators from the South Island were the group most interested to learn to control risk using this kind of strategies; they were followed by the Sharemilkers from the North Island. The least concerned group about learning marketing strategies were Sharemilkers from the South Island. The financial and legal areas had the same distribution pattern: in both islands Sharemilkers had higher mean scores than owner operators, who in turn had similar mean scores; Sharemilkers from the South Island were the group most concerned about both issues as they got the highest mean scores (4.11 and 3.39 for financial and legal areas respectively). For human and strategic planning areas, both ownership structures from the South Island were more concerned than their counterparts from the North Island, and once again Sharemilkers from the South Island was the group with the highest mean score for both areas (3.78 and 3.72 for human and strategic planning respectively).

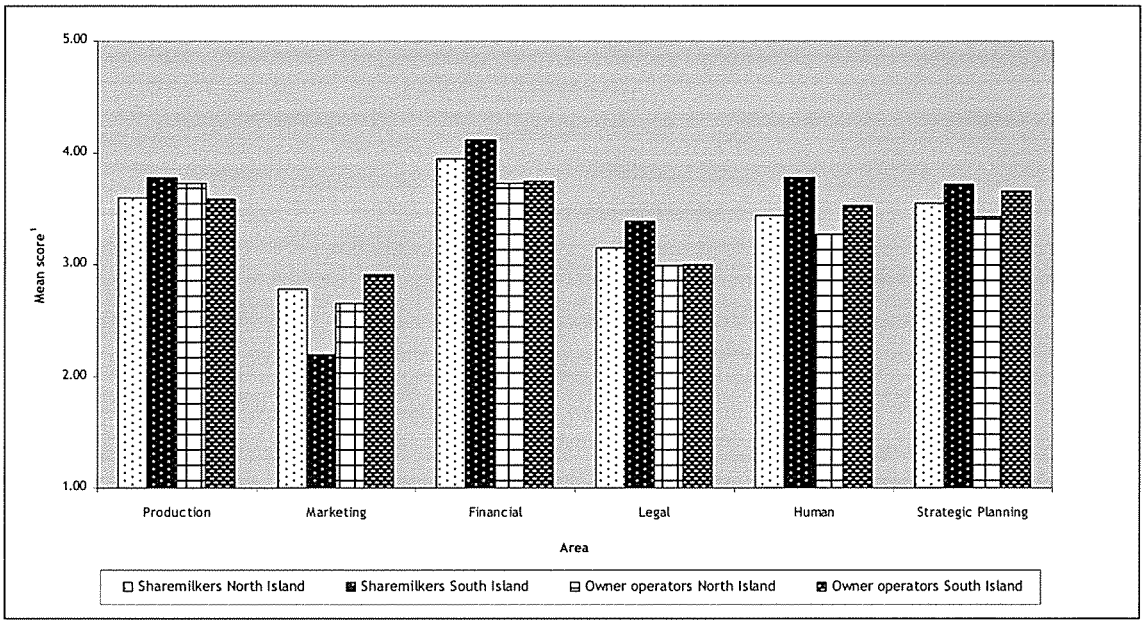

Figure 4-24 Mean scores[1] of the areas perceived as critical to learn about risk management according to geographic location and ownership structure

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

4.1.6 The 2004 Survey: Stepwise Regression Analysis

As explained in 3.4.5.2, Kilograms of Milk Solids produced per Hectare (kg MS/Ha) was selected as the independent variable to develop a model where some of the information gathered through the 2004 Survey might explain this physical parameter. All the sources of risk (19) and the risk management strategies (26) (See Table 3-2) were included in the Stepwise Regression Analysis. Through the stepwise process those variables significant at the 10% level in explaining the production of Kilograms Milk Solids per Hectare were identified, and a multiple linear regression model was constructed.

The total number of variables included at the beginning of the Stepwise process was forty five, however only nine of them were found to be significant for the model at the 10% level or less (Table 4-17). Four of these were risk sources, while the other five were risk management strategies. The impact of each variable, considering the other eight included in the model, is shown in its Estimate, e.g. for an increase of one unit in the risk perceived in "Changes in body local laws and regulation" there is a

change of 117.51 kg MS/Ha produced, when all the other independent variables are held constant (*ceteris paribus*). When the estimate has a positive sign, it means that as the importance in risk perception increases so does milk production per hectare. For example, each 1-unit increase in the risk perceived in "Changes in land prices" there is an increase in milk production per hectare of 55.52 kilograms, *ceteris paribus*. For strategies the explanation is very much the same, but instead of the risk perceived in the source now it is the importance of the risk management strategy that is associated with milk produced per hectare. For instance, a 1-unit increase in the importance of the use of the strategy "Having more than one type of animal or enterprise..." means a reduction of 46.27 kilograms of milk solids produced per hectare, *ceteris paribus*. Table 4-17 also shows the percent of variation explained by each variable out of the total variation explained by the model. As can be observed, "Changes in local body laws and regulations" was the variable with the higher percentage (11.07%), followed by the "Use of financial ratios for decision making" (8.89%). Those variables that had the lowest influence in explaining the model were "Planning of capital spending: pacing investments and expansion to reduce risk" (2.82%) and "Change in the world economical and political situation" (2.07%).

Table 4-17 Summary of Stepwise Regression for Sources of Risks and Risk Management Strategies

Variable	Group	Estimate	Standard Error	Percent of Total Variation
Intercept***		961.33	156.52	
Changes in the world economical and political situation+	Market Source	-62.18	32.49	2.07%
Changes in New Zealand's economic situation**	Market Source	95.28	33.74	4.50%
Changes in local body laws and regulations***	Regulatory Source	-117.51	26.53	11.07%
Changes in land prices*	Financial Source	55.52	21.97	3.60%
Having more than one type of animal or other enterprises on your property*	Marketing Strategy	-46.27	20.90	2.76%
Keeping the debt low: reducing debt or maintaining a low level of debt to reduce risk**	Financial Strategy	53.67	20.10	4.02%
Planning of capital spending: pacing investments and expansion to reduce risk*	Financial Strategy	-54.33	24.29	2.82%
Having written a shared vission statement for your operation**	Strategic Planning Strategy	-53.05	20.00	3.97%
Use of financial ratios for decision making***	Strategic Planning Strategy	82.02	20.66	8.89%

+ Significant at 10% level
* Significant at 5% level
** Significant at the 1% level
*** Significant at the 0.1% level

Within the risk sources that were significantly associated with milk solids produced per hectare, two of them belong to the Market group of risk sources, one to the Financial and one to the Regulatory. Of these four risk sources, the one with the highest influence on milk production per hectare was the Regulatory one (-117.51). Similarly, of the 5 risk management strategies identified as relevant, one was a Marketing risk management strategy, two were Financial and two from the Strategic Planning field. The most relevant of these, holding the other variables fixed, was the "Use of financial ratios for decision making" with an estimate of 82.02.

Therefore the multiple regression equation identified through the Stepwise Regression analysis is:

$$Kg\ MS/Ha = 961.33 - 62.18x_1 + 95.28x_2 - 117.51x_3 + 55.52x_4 - 46.27x_5 + 53.67x_6 - 54.33x_7 - 53.05x_8 + 82.02x_9$$

where,

X_1 = risk perceived in the changes in the world economical and political situation

X_2 = risk perceived in the changes in New Zealand's economic situation

X_3 = risk perceived in the changes in local body laws and regulations

X_4 = risk perceived in the changes in land prices

X_5 = the importance of having more than one type of animal or other enterprises on the property to reduce risk

X_6 = the importance of keeping the debt low: reducing debt or maintaining a low level of debt to reduce risk

X_7 = the importance of planning capital spending: pacing investments and expansion to reduce risk

X_8 = the importance of having written a shared vision statement of the operation

X_9 = the importance in the use of financial ratios for decision making

The coefficient of determination (R^2) of the regression shown above is 0.2949 ($p< 0.0001$). The coefficient of determination measures how well the independent variables explain variations in the dependent variable and can be interpreted as the percentage of the sample variation in the Kilograms of Milk Solids produced per Hectare that is explained by the variables x_1, x_2,..., x_9.

4.2 ANALYSIS OF THE DEXCEL PROFITWATCH DATABASE FOR THE SEASONS 1998-2003

The analysis of the database was undertaken within each of the five seasons and across owner-operated farms with seasonal milk supply patterns. Therefore of the total number of dairy farms available on the database (2,341) only 1,026 were included in the following analysis. The number of dairy farms analysed per season, some of their physical and financial characteristics and the comparison with information available from the Economic Survey published Dexcel (2003) are presented in Appendix 4.

As was mentioned in 3.4.4.2, the logistic analysis was undertaken for each of the five seasons included in the database. The farms were classified into ten categories of ROE (Appendix 2), from the least risky category (farms with highest level of ROE) to the most risky ones (farms with the lowest ROEs). The logistic model was built using the category of ROE estimated for each season as the indicator of downside risk (dependent variable) and seven independent variables to explain ROE (3.4.3.3).

4.2.1 Econometric Results of the Database Analysis

The Likelihood Ratio test statistic was highly significant (Chi-square < 0.0001) for each season, indicating that the variables as a group were a good indicator of risk measured through the categories of ROE proposed (Appendix 5). The Odds Ratios, the Standard Deviations and the signs of the variables included in the logistic regression for each season are presented in Table 4-18; the Generalized R-square for each season analysed is also presented in the same table. The Odds Ratio represents the effect of the independent variable on the odds of the dependent one. For example, in Table 4-18, the Odd Ratio of Asset Turnover Ratio (ATR) of 0.526 means that each increase of one Standard Deviation (4.22%), is associated with a 0.526 times decrease in the predicted odds of being in a more risky category. The Generalized R-square measures the predictive power of the logistic model; finally the signs of the coefficients included in the model indicate the way the independent variables are correlated with the dependant one. For instance, if the variable has a positive sign, this means that an increase in the variable is associated with an increase in the level of risk; if it is negative, then an increase in the variable will mean a reduction in the level of risk. More details of the model, the coefficients of the independent variables and the interval of confidence, are presented in Appendix 5.

Table 4-18 Odds ratios, signs and standard deviations of the seven variables included in the logistic model used to assess analyse the database

Season	1998/1999			1999/2000			2000/2001			2001/2002			2002/2003		
Payout[1]	3.58			3.78			5.01			5.35			3.66		
Variable	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation
Farm Working Expense Ratio	+	1.412	12.04%	+	2.551*	26.82%	+	1.085	12.47%	+	1.298	9.34%	+	1.229	12.83%
Debt to Asset Ratio	–	0.625**	25.51%	–	0.338*	20.88%	–	0.217*	20.38%	–	0.065*	18.70%	–	0.107*	23.42%
Operating Profit Margin	–	0.088*	13.37%	–	0,012*	14.67%	–	0.009*	16.54%	–	0.004*	9.51%	–	0.008*	14.23%
Asset Turnover Ratio	–	0.526*	4.22%	–	0.189*	5.64%	–	0.089*	9.96%	–	0.023*	5.36%	–	0.258*	5.60%
Debt Servicing Capacity	+	13.285*	10.81%	+	91.762*	22.47%	+	41.512*	10.48%	+	46.203*	6.89%	+	87.087*	9.86%
Effective Area	+	1.525**	51.65 ha	+	1.085	54.41 ha	+	1.482	67.97 ha	–	0.969	57.80 ha	+	1.206	78.73 ha
Economic Farm Surplus	–	0.628	$36,391	–	0.427**	$65,473	–	0.284	$112,923	–	0.870	$107,134	–	0.534**	$66,306
Generalized R-square	75.42%			89.59%			71.29%			82.26%			87.95%		

[1] Seasonal payout in nominal NZ$ per kilogram of milk solid
* Significant at the 1% level
** Significant at the 5% level

For every season analysed, the Debt to Asset ratio (DTAR), Operating Profit Margin (OPM), Asset Turnover Ratio (ATR) and Economic Farm Surplus (EFS) were negatively correlated to risk measured as the categories of ROE. From these four variables DTAR, OPM and ATR were significant in the logistic model for the five seasons included in the analysis. The Farm Working Expense Ratio (FWER) and Debt Servicing Capacity (DSC) were positively correlated to downside risk, but only for the latter were there significant correlations for all five years. Effective Area did not have a consistent correlation with downside risk, neither with its sign nor with its level of significance. The results to be presented are only for those variables that were found significant (DTAR, OPM, ATR and DSC).

Of those four variables found to be significant for the logistic model, the most important was DSC. As it can be seen in Table 4-17, DSC had the highest Odds Ratio for every season analysed. During the first four years of the database, DTAR was the second most important variable affecting downside risk followed by ATR. However for the Season 2002/2003 ATR occupied the second place in explaining downside risk and DTAR was third. OPM was the least important variable affecting downside risk for all the five years.

4.2.2 Creation of Downside Risk Categories and their distribution in the period analysed (1998-2003)

For all the five seasons analysed, three downside risk categories were created: High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG). The ROEs for each farm of the database were grouped into 10 categories (see 3.4.3.3); the average of the ROE's categories was then calculated for each season analysed. [The HRG was created by adding one standard deviation to the average of the ROE's category estimated for each season of the database. Similarly, the LRG was created by subtracting one standard deviation to the average of ROE's category estimated for each season from the database]. As expected the percentage of farms in the LRG was higher in the two years with the higher payout (2000/2001 and 2001/2002). The opposite happened with the HRG, as Figure 4-25 shows.

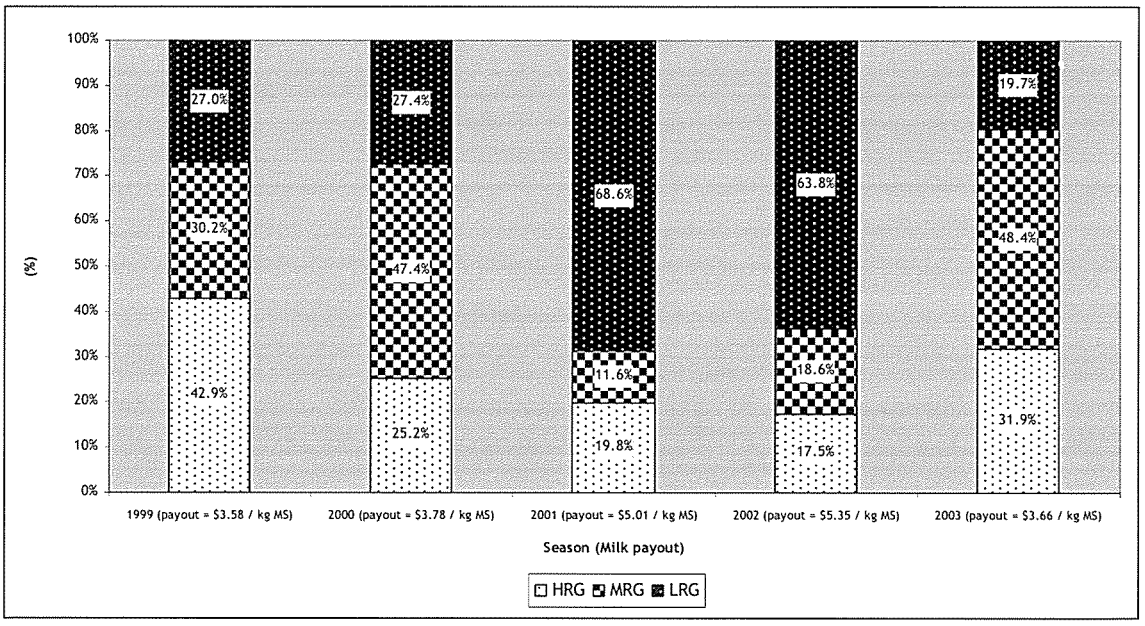

Figure 4-25 Percentage of farms in the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season analyzed

4.2.2.1 Description of the three risk category groups

The three risk category groups created (HRG, MRG and LRG) were described according to the variables included in the logistic model proposed in 3.4.3.3.

Additionally, other variables were also included in the analysis of the three risk category groups. These were: Cost of Milk, Owner's Equity, Stocking Rate, Kilograms of Live Weight per Hectare, Kilograms of Milk Solid produced per Cow and Kilograms of Milk Solid produced per Hectare (Appendix 6). The inclusion of the analysis of these variables is because of the changes they have had during the last 20 years in New Zealand (see 2.1.1).

4.2.2.1.1 Variables included in the logistic model

For each season, analysis of variance (One-way ANOVA) and Bonferroni tests were carried out to assess the differences in the means of the variables included. This section presents the statistical differences found at the 5% level. The results of this section are listed in full in Appendix 7. The figures used to present the results in this section utilized bubble graphs. Different bubble sizes proportionally indicate the differences in actual data. For example, in Figure 4-26, the HRG had a DTAR of 46%, whereas the LRG had a 35%; therefore the bubble sizes reflect those numbers. It is worth pointing out that a farm can be in a different risk group in different seasons.

The Farm Working Expense Ratio (FWER) and Economic Farm Surplus (EFS) were different between the three groups in the three seasons with the lower payouts (1998/1999, 1999/2000 and 2002/2003). The farms in the LRG always had both the lowest values of FWER for every season analysed (all values under 50%) and the highest EFS.

The HRG had the highest Debt to Asset Ratio (DTAR) for the first two seasons (46% and 44% for 1998/1999 and 1999/2000 respectively) (Figure 4-26). For the same two seasons, the levels of debt were no different between the LRG and MRG farms. However, when payout increased in the season 2000/2001 the only group that increased their DTAR was the LRG (from 36% to 40%). The LRG stayed at about 40% in the level of debt and these were the highest values of DTAR during the next three years.

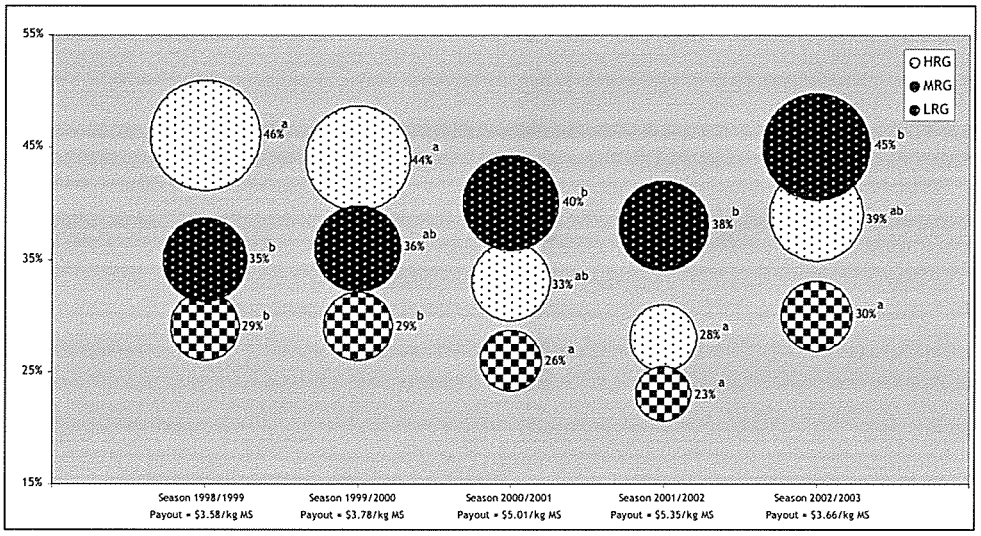

Figure 4-26 Debt to Asset Ratio (DTAR) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

The Debt Servicing Capacity (DSC) presented its lowest values in the LRG for each of the five seasons (Figure 4-27). Conversely, the HRG had always the highest value of DSC with average values around 20%. Despite the differences found in the DTAR between the three groups, the DSC was similar for LRG and MRG farms during the whole period analysed, and these two groups differed of the HRG during the five years.

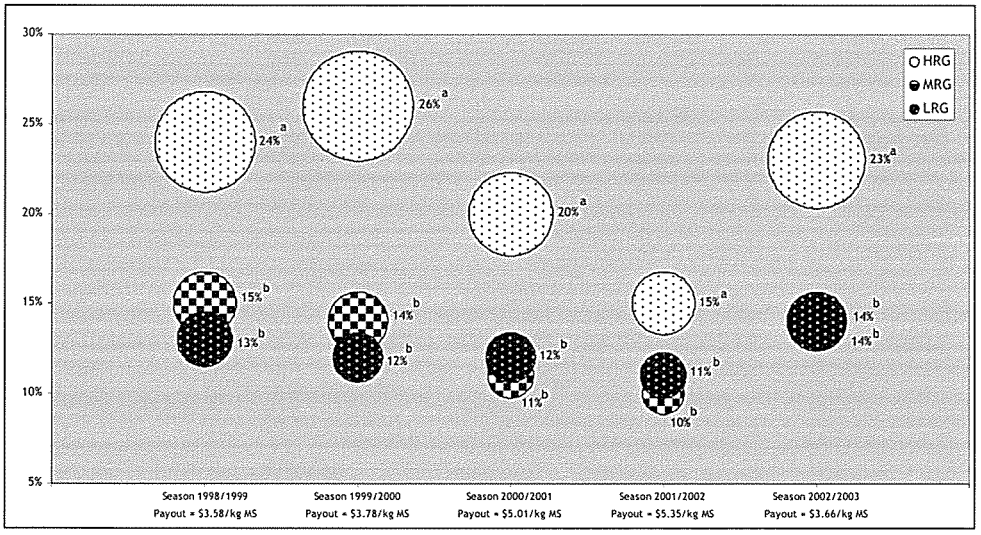

Figure 4-27 Debt Servicing Capacity (DSC) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

The Operating Profit Margin (OPM) was consistently different for the three groups during the time span analysed (Figure 4-28). The highest values of OPM were present in the LRG for every season, and each time those values were higher than 30%. As payout increased from the season 1999/2000 to 2000/2001 so did it OPMs' values for every group. However when milk payout dropped again in the season 2002/2003 OPMs went downward.

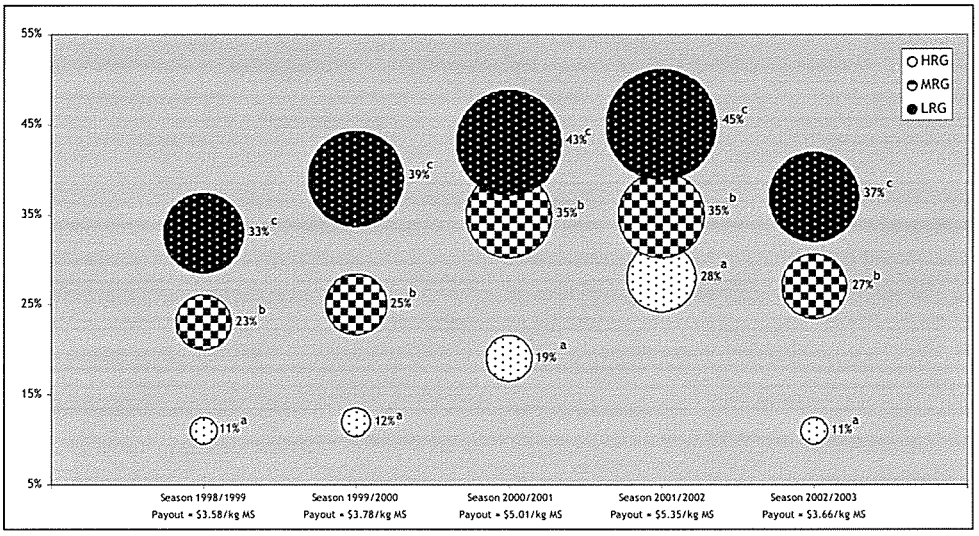

Figure 4-28 Operating Profit Margin (OPM) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

The Asset Turnover Ratio (ATR) was always higher in the LRG farms (Figure 4-29). Despite the fact that OPM was different between the three risk groups in each of the five seasons analysed, the HRG and MRG farms did not differ in their ATR values for any of the years. Nevertheless, the LRG farms were different from the other two groups in four of the five seasons included in the analysis.

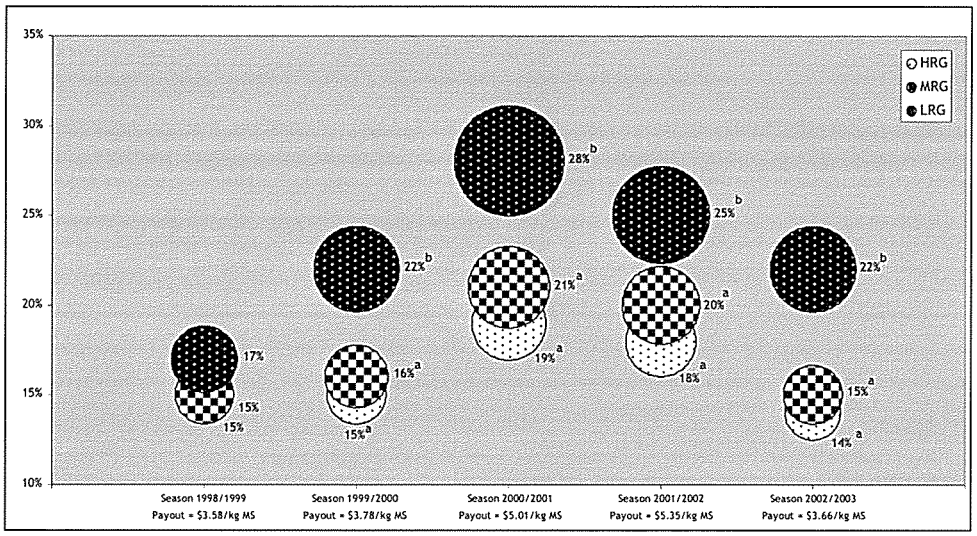

Figure 4-29 Asset Turnover Ratio (ATR) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

The Return on Equity (ROE) was significantly different between the three groups within each of the five season analysed (Figure 4-30). As payout increased, ROE also increased and, as expected, the LRG farms had the highest values of ROE for every season. The only season HRG farms could get a positive ROE was at the highest payout (season 2001/2002, $3.78/kg MS), nevertheless the difference between the average ROE of LRG and HRG was always greater than 10%.

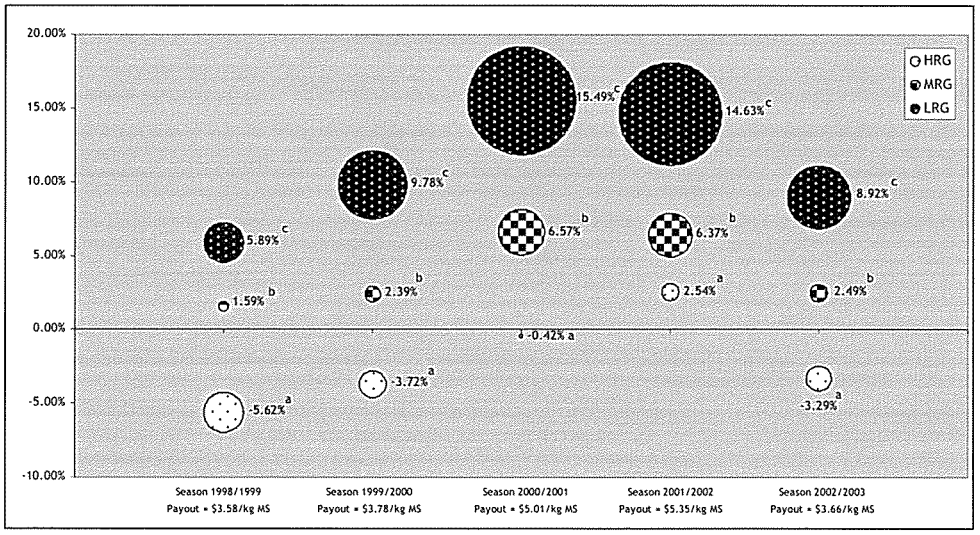

Figure 4-30 Return on Equity (ROE) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

4.2.2.1.2 Additional variables analysed for the three risk groups

As in the previous section, analysis of variance (One-way ANOVA) and Bonferroni tests were carried out to assess the differences amongst the averages of the variables considered relevant for the analysis. The variables included were: Cost of Milk (CoM), Owner's Equity (OE), Stocking Rate (SR), kilograms of Live Weight Total per Hectare (kg LWT/Ha), Kilograms of Milk Solids produced per Cow (kg MS/Cow) and Kilograms of Milk Solids produced per Hectare (kg MS/Ha). These variables were calculated from the information available in the database (Appendix 6). This section presents the statistical differences found to be significant at the 5% level. A full list of the results can be found in Appendix 8.

Of the six variables included in this analysis, only two of them, kg MS/Cow and kg MS/Ha, showed significant differences between the groups. Differences between the three risk groups were present in the first four seasons of the database analysed, and for every season the LRG had the highest values for production per cow and per hectare (Figure 4-31). The differences were not significant in 2002/2003.

Both production per cow and per hectare had the same pattern for the 1998/1999, 2000/2001 and 2001/2002 seasons. During these three years, the MRG was not statistically different from either the LRG or the HRG. In the 1999/2000 season, there were significant differences in the milk produced per cow between all three risk groups, whereas for milk solid produced per hectare the LRG was significantly higher than the other two groups.

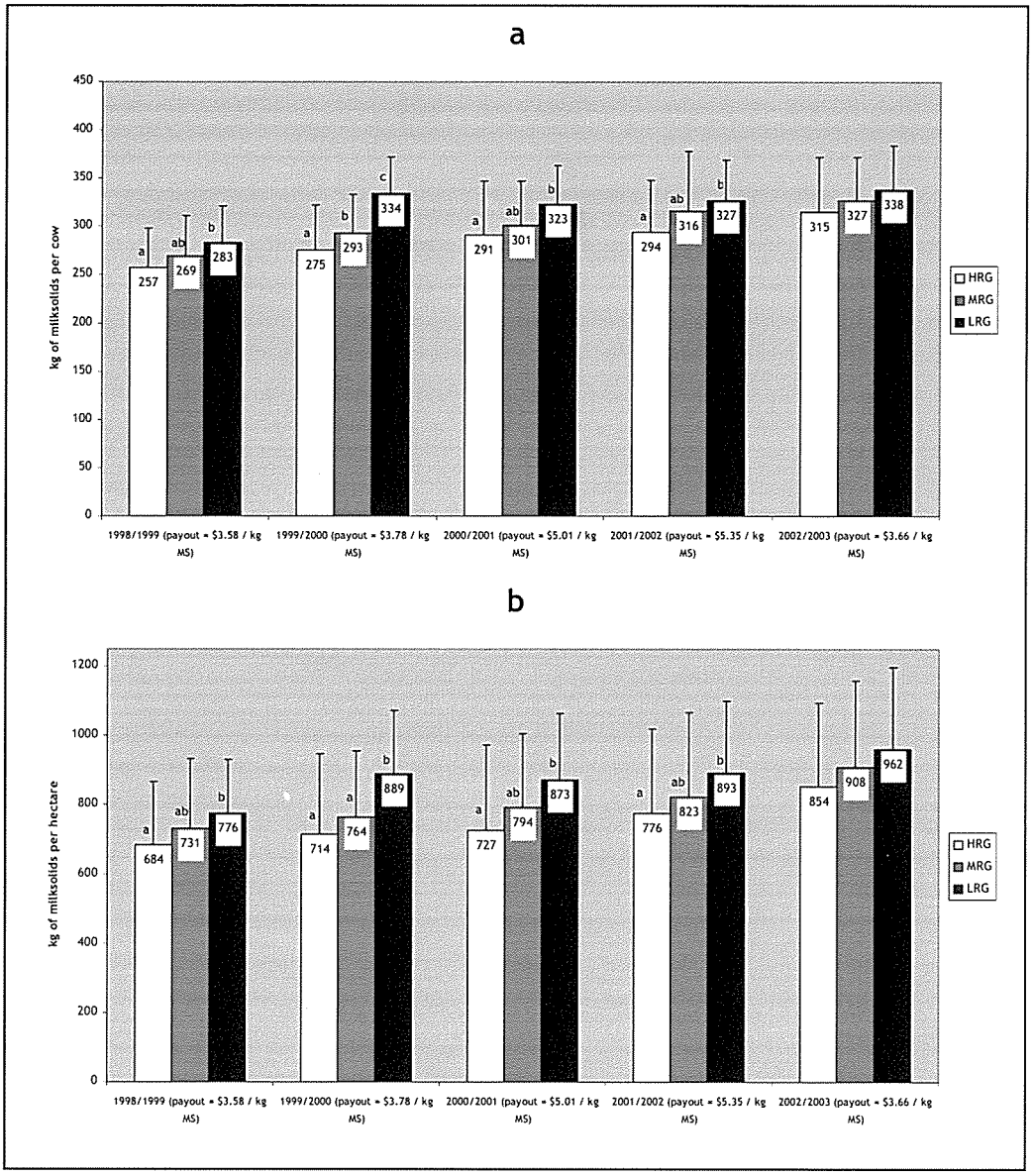

Figure 4-31 The kilograms of milk solids produced per cow (a) and per hectare (b) for the three risk groups created for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

CHAPTER FIVE

5 DISCUSSION

This section discusses the main findings presented in Chapter Four, and is divided into two main sub-sections. Firstly, the main results of the Surveys are addressed. The second sub-section deals with the key findings of the ProfitWatch Database analysis.

5.1 SURVEY

5.1.1 2004 Survey

The response rate of the current survey was 42.9% and usable responses were obtained from 426 responses (42.6%). Other surveys conducted in the agricultural field have reported rates of usable responses at about 20% (Nartea & Barry, 1994), 30% (Hall et al., 2003; Meuwissen et al., 2001), and near 50% and over (Fetsch et al., 2001; Lien et al., 2003; Martin, 1994; Wilson et al., 1988).

Of the total surveys included in the analysis 81% were from the North Island and 19% from the South island. This sample had a similar distribution pattern to that reported by LIC (2003) for the season 2002/2003 (Appendix 1), 83% of the New Zealand herds being located in the North island whereas 17% were in the South island. The same report mentions that 62.5% of the total number of New Zealand's dairy farms were run under an Owner-operator structure, 37% under a Sharemilking agreement and 0.5% is reported as "unknown". This distribution differed from the findings of the current survey as 76.6% of the farms were operated by owners, 20.3% were operated by Sharemilkers and those farms run by Managers were 3.1% of the sample. This last group was not included for analysis in the current research and nor was identified in the LIC (2003) report.

5.1.1.1 Sources of Information most commonly used

The top three sources of information used by the respondents, to update their knowledge, were no- or low-cost sources (see section 4.1.1). The most common source of information used by farmers was "Workshops, seminars, meetings & Field days". This source must be continued to communicate knowledge to farmers. Unfortunately, this category was too broad since it included both private and industry activities, thus more specific information would be desirable in order to identify the relative importance of each sector. Fetsch et al. (2001) found that for Colorado farmers this source was ranked among the top three, however for those farmers from Wyoming this source was less important. For the latter two groups of farmers, the most common source of information used was Radio, however for the sample of New Zealand dairy farmers Radio was only ranked in 9th position. Because of the low cost of using radio, and the ease with which this source can be accessed, it is a point to re-consider in the future for extension programs. The second most important source of information used by New Zealand dairy farmers was the Popular Press which was only ranked in 6th position in the study conducted by Fetsch et al. (2001). Consulting Officers (Dexcel) were the third most important source, being only slightly above Private Consultants. This situation was expected since "Knowledge is not perfectly transferable and must be extracted from information through processes of local adaptation" (Just et al., 2003; p.203), therefore farmers from different areas have to go through the adaptation process in order to get the information in usable forms. This process is associated with the use of external service providers (private consultants) that will help farmers to extract the knowledge required for their business from the more generalized information available. These external service providers will add more value to the external information (Cohen & Levinthal cited by Just et al., 2003) and thus create new knowledge. Knowledge is thus needed to create or access new knowledge, and this explains in part why most of the more progressive firms choose the services of better-quality consultants (Barry & Fraser, 1976; Just et al., 2003).

Despite the fact that the use of the Internet was ranked similarly to the use of Scientific Publications in the present survey, it will be interesting to monitor the use of the former source of information into the future, as access to this service is becoming easier. In addition the increase in Internet use may allow the use of other

sources of information, however the current technical barriers are the key to determine its low level of Internet use by farmers.

5.1.1.2 Perception of risk sources

The three sources of risk perceived by farmers to be most important in 2004 were within the market group of risk sources (Changes in products prices, Changes in world economic and political situation and Changes in input costs). This is consistent with the research findings of Peiter et al. (2004), Patrick & Alexander (2004), Hall et al. (2003), Lien et al. (2003), Meuwissen et al. (2001), Wilson et al. (1988), Bogges et al. (1985) and Patrick et al. (1985), in all of which at least one market source of risk was ranked within the top three. The most common market risk source mentioned in these latter studies was related to the changes in the agricultural prices of the goods being produced. All of these studies were conducted in countries where government support systems to agriculture are, or were, in place, but New Zealand does not have any of those. As the changes in product prices have a big impact on the gross farm income, then the importance of this risk source for farmers becomes clear.

Accidents or health problems were also ranked highly by New Zealand dairy farmers (4^{th} place). In this sense it is important to mention that the sole-operator nature of most New Zealand dairy systems is still the most common structure used by both Sharemilkers and Owner-operators, however equity-sharing structures are becoming increasingly more common (Holmes, 2003). This may reduce the perception of risk from this source and transfer it to a greater perception of risk from human resource management. Most of the previous studies about risk perception also found that accidents or health ranked among the top eight risk sources. Only the work done by Wilson et al. (1988) found that safety and health issues ranked quite low (16^{th} of the 18 sources included) by a sample of Arizona dairy farmers.

As for health and accidents, variation in interest rates has also been considered in some of the published studies (Bogges et al., 1985; Meuwissen et al., 2001; Patrick & Alexander, 2004; Patrick et al., 1985; Wilson et al., 1988). In the present survey, New Zealand dairy farmers ranked this source of risk in 5^{th} place whereas the other studies have found that farmers were less concerned about this issue. Again, one probable explanation is the fact that New Zealand has an open economy, the

combination of both the interest rates at which the farmers borrow money and the high proportion of liabilities over equity (IFCN, 2003) can have a big impact on the overall performance of the farm and is therefore an important source of risk.

Within the production risks, rainfall variability was ranked as the most important source of risk for New Zealand dairy farmers, followed by diseases or pests. Since New Zealand dairy systems are underpinned by grass production, for most of them rainfall is the only source of water that allows the systems to work. Despite this importance for New Zealand dairy farmers, those studies conducted in the United States by Hall et al. (2003) with beef producers and Bogges et al. (1985) with crop farmers and livestock producers, have found that rainfall variability was ranked much more higher (at first or second) by them than in the present study. Similarly, Wilson et al. (1988), working with dairy farmers in Arizona, reported that weather variability was ranked in third position.

Despite the fact that regulatory sources of risk were not ranked highly by New Zealand dairy farmers, all the three sources included in the present survey that were related to government laws, local body regulations and board policies, were given similar rankings (see section 4.1.1.1). A comparable cluster is found in those reports from Hall et al. (2003), Lien et al. (2003), Meuwissen et al. (2001), Wilson et al. (1988) and Patrick et al. (1985). The difference between these five works is, while for the sample surveyed by Lien et al. (2003) the importance farmers attached to regulatory risk was high, whereas the samples of Meuwissen et al. (2001) and Patrick et al. (1985) were less concerned about the same issue; finally the samples surveyed by Hall et al. (2003) and Wilson et al. (1988) lay between the two extremes. On the other hand, the surveys conducted by Patrick & Alexander (2004), Peiter et al. (2004) and Bogges et al.(1985) do not show this cluster pattern, because these alter surveys found that Government programs were perceived as being more important by crop farmers than by livestock and hog producers. These in turn perceived the changes in both environmental regulations and federal laws as a greater source of variation than crop farmers did. This is mainly explained by the Government agricultural programs operating in the United States.

5.1.1.3 Risk management strategies

The two most important strategies used to cope with the sources of variation were production responses. These two strategies point toward minimizing variation in physical performance (kilograms of milk solids produced) through a reduction of the climatic effect by the use of feed reserves, and by the reduction of diseases and pest by spraying and drenching the cows. In this way, the reduction of production risk may allow the farmers to take advantage of financial risk, as explained by Gloy & Baker (2002). Although these top two strategies were within the production responses listed in the survey, the remainders of these strategies were poorly ranked, reflecting therefore the common *modus operandi* shared by farmers to control physical performance by using these two strategies.

In the present survey, it is clear that the use of debt management as a strategy to cope with risk is also highly important (it was ranked 3rd in the overall ranking), however the remainder of the financial strategies were not considered equally important and some of them are even used by less than 50% of the farmers. The low use of activities off-farm to reduce risk indicates that farming in New Zealand is still a full time job. On the other hand, as New Zealand dairy industry's structure is based on cooperatives, where Fonterra processes and markets 95% of New Zealand's milk, is consistent with the finding that the marketing group of risk management strategies was ranked lowest. In fact Barry & Fraser (1976) mention that one of the benefits of marketing goods through cooperatives is the stability of farmers' price expectation. It is important to highlight that despite the low ranking of the marketing strategies, within this group of risk responses, Market Information was the most important.

New Zealand dairy farmers showed that both long and short term flexibility is an important strategy for managing risk. The changes that agriculture is facing all over the world, the changes that have taken place in the New Zealand Dairy Industry during the last ten years plus the economic liberalization started in the mid 1980s, have all combined to make farmers realize how these changes may affect their business, not only in the short term but also in the long term.

Those strategies to manage risk that related to strategic planning, showed that farmers are mostly concerned about the development of their business through the use of practical tools to assess their situation. Less important were those strategies related to the written visions or missions for the operations, however this may not

reflect the true situation as many farmers may have visions or missions which are not necessarily in the written form.

5.1.1.4 Areas of further interest in risk management

The two most important areas in which New Zealand dairy farmers perceived that they have the greatest need to learn more, financial and production, were the same as those found by Fetsch et al. (2001). Despite the fact that Fetsch et al. (2001) worked with a sample of both farmers and ranchers and the current research was limited only to dairy farmers, the similarities in the educational needs for risk management confirm that, worldwide, agriculture is facing massive changes, becoming more industrialized and, therefore, requiring more knowledge to run the business. Particularly in New Zealand, the dynamics of the dairy sector during the last 10 years have been huge. This fact has certainly affected the importance of strategic planning within farm businesses. In the same way, the increases in farm size and the relative lack of labor is putting more pressure on farmers in human resource management, which was identified as the fourth area of importance that farmers would like to learn in order to control risk. The low importance farmers attached to learning in the legal area is probably explained by the fact the Resource Management Act was established in 1992, therefore most farmers know the rules with which they have to comply. On the other hand, as already mentioned, Fonterra deals with all the marketing process of dairy products in New Zealand and thus the farmers are not keen to learn those strategies that they have entrusted into the cooperative.

5.1.2 Comparisons between the 1992 and 2004 Surveys

5.1.2.1 Perception of risk sources

In spite of the increases in the average farm size reported by LIC (2003) and the proportion of farmers perceiving low levels of risk in their current farm sizes was found to be greater in 2004 than 1992, 10% of farmers perceived very high levels of risk in this source, an increased from 6% in 1992. The growth of the dairy industry in New Zealand during the last ten years has been concentrated in the South Island, where bigger farms and bigger herds than in North Island have been established. The

average herd and farm size reported by LIC (2003) for the North Island is 256 cows and 100 hectares, whereas for the South Island those numbers are 422 cows and 164 hectare. Given this situation, it was not surprising to find that those farmers more concerned about their current farm sizes as a source of risk in the future, were mainly farmers from the North Island (see 5.1.3).

The perception of risk in the levels of debt in 2004s has tended to a more normal distribution than in 1992, however it is clear that debt levels as a source of risk has been increasingly perceived as important for the business. After the economic deregulation in New Zealand, interest rates increased sharply, thus it is highly probable that farmers aimed to reduce their debt levels to a minimum and this is what Martin (1994) captured in 1992. Since then, the New Zealand economy has been performed with relative stability and some of this stability has transferred into interest rates (lower rates and more stable over time) which in turn attracted farmers to become more indebted.

In contrast, the perception of business risk both in physical performance and market prices did not change greatly between 1992 and 2004 which may well be partly explained by the openness of the New Zealand economy. As prices in New Zealand are determined by international markets, it is reasonable to expect that a greater proportion of farmers currently perceive more risk in changes in prices. This perception is despite the fact that Fonterra markets most of the New Zealand milk itself and also now forecasts prices fifteen months ahead, giving stability to farmers. In summary, despite the fact that during the last twelve years the risk perceived in the changes in the production and marketing environment has not changed, there has been a significant increase in the risk perceived by farmers in their levels of debt. This situation reflects the dramatic changes faced by farmers during the period analysed, as Martin (1994) reported that the greater concern about business rather than financial risk "...suggests that most pastoral farmers believe that they have made the necessary adjustments to bring financial risk under control and to a level appropriate for a deregulated environment" (p. 364). In contrast, the findings of the present research suggest that currently farmers realize, consciously or unconsciously, the benefits of leverage, or maybe the expansion of dairy farming is currently far more aggressive than twelve years ago.

At a glance, the changes in farmers' perception of risk sources since 1992 shows that the financial, human, regulatory and miscellaneous groups of risk sources

have increased their average mean scores. Of these increases, only the miscellaneous group showed a significant rise between the two studies, however as this group was a combination of different risk sources, its increase may be confusing. It would be desirable to allocate the sources included in this group to more specific and more relevant groups. Considering this situation, and despite the fact that the increases in the risk perceived in the financial and human resource groups were not significant, they are relevant as they clearly identify some of the farmers' concerns. The remarkable point of this brief outlook of farmers' risk perception is that five of the six groups of risk sources have increased their mean scores between the two surveys, reflecting the fact that farmers are now more aware of their current situation, probably because of a greater availability of high-quality information.

At a more detailed level, of those nineteen sources of risk listed in both surveys, there were significant changes in fifteen of them. Farmers still perceived the changes in product prices as their most important source of risk, which is not unexpected because of the low chances that dairy farmers have for diversifying their business, and their big reliance on milk payout. Similarly, cost control was also seen as important and reflects the focus New Zealand dairy farmers have had on low cost dairy systems, which is widely recognized. Despite the fact that the previous survey was conducted in 1992, just eight years after radical economic deregulation, interest rates are considered far more important by farmers now than twelve years ago. The greater awareness by farmers about interest rates, and the increased use of debt management to control risk, both indicate a greater use of debt in the present farming businesses. This fact may indicate that the dynamics of the dairy sector during the last twelve years, the expansion of the dairy industry in the South Island and the growth of highly leveraged farm as reported by IFCN (2003), have made farmers consider this source of risk to be highly important for their survival.

The overall risk perceived in the production group of risk sources had not change very much during the twelve years. However there was a compensatory effect, since the reduction in the risk perceived in "Rainfall variability" was balanced by an equivalent level of increase in the risk perceived in "Diseases and pests". The greater use of irrigation as a management strategy to control production risk explains the reduction in the risk perceived in "Rainfall variability". Although there was an increase in the use of "Spray and drenching" to manage risk, there was also an increase in the risk perceived in "Diseases and pest", reflecting that farmers now feel

more vulnerable to some threats (e.g. Foot and Mouth disease). Thus, despite the fact that the effect of rainfall variability "...can be more quickly identified by dairy farmers through lower milk production" (Martin, 1994; p. 366), the current relevance of this source of risk is overlooked by farmers who perceived a greater risk in the animal health issue.

The merging of the New Zealand Dairy Board and the cooperatives Kiwi Dairies and New Zealand Dairy Group into the Fonterra Cooperative Group in October 2001 has brought more stability to farmers in terms of the policies operated by the cooperative. Farmers however, now feel that their business is threatened by changes in policies at a national level, but more importantly at the local level (City, District and Regional Councils), probably because of the ramifications of the Resource Management Act (1991) and the power that it confers to these local government bodies.

Holmes et al. (2002) reported that the average number of people working per farm is two persons, so it is not surprising that the health issue is a significant source of risk for farmers and the farm staff. The fact that the source "Changes in family situation" has increased its mean score significantly, gives the opportunity to investigate this source of risk in more depth in the future, to assess it and estimate its implications for New Zealand dairy farmers.

The most radical change in the perception of risk sources for New Zealand dairy farmers is related to the availability and management of human resources. The increase in average farm size has put more pressure on farmers in areas such as quality and reliability of labour. This situation is coupled with the increase in the risk perceived in changes in technologies, which can bring further changes to dairy systems in order to cope with these two sources of risk.

5.1.2.2 Risk management strategies

As with the risk perceived in the five groups of risk sources, all the four groups of risk management strategies increased their mean scores over the last twelve years. Although the four groups of risk management strategies increased their mean scores significantly during the last twelve years, these increases have not been symmetrical. In this sense the production, financial and overall groups of responses increased their mean scores by similar magnitudes, whereas the marketing group of responses had a

greater increase in its average mean score. Farmers are still very much focused on controlling risk through the use of production responses, mainly by spraying and drenching the cows, plus using feed reserves to cope with bad seasons. Although the remainder of the production responses were not ranked highly, the increase in both the importance and the proportion of farmers using irrigation to control risk is of note, in contrary to what Martin (1994) found. The development of the dairy industry in the South Island has included irrigation to a greater extent than in the North Island, which explains in part the high levels of production achieved in the South Island East Coast and Southland (Holmes et al., 2002).

Farmers also still perceive as "Very important" the "ease and economy with which their farming business can adjust to changed circumstances" (Hardaker, Huirne, Anderson, & Lien, 2004; p. 274). This flexibility is crucial, especially in systems where the environment is not regulated but is highly variable. Within the financial responses it is worth mentioning the decrease in the perceived importance attached to low levels of debt as a way of controlling risk, which in turn fits in with the significant increase in the perception of the changes in interest rates as a source of risk for New Zealand dairy farmers. It is reasonable that at high levels of debt, any change in interest rates would be perceived as an important source of risk. Under this scenario, it is expected both that debt management has increased in its importance, and that the proportion of farmers who use it to control risk has also increased. Similarly, the use of personal or business insurances has become a tool more commonly used by farmers now than in 1992.

Although the strategies to reduce risk related to off-farm activities were ranked poorly, all three of them increased their mean scores significantly for the period analysed. Fulton (1995) in his study about the future of Canadian agricultural cooperatives, states that for an increasing number of families farming is no longer a full time activity. He concludes the research saying: "With increasing levels of off-farm employment as well as increased on- and off-farm diversification, farmers are likely to perceive increasing opportunity costs to cooperative involvement. The ramifications of this opportunity cost may include less commitment, poorer quality of elected leadership, and less cooperative development." (p.1151). Even though this is not very relevant now, this situation should not be overlooked when considering the cooperative structure of dairy farming in New Zealand.

Although all the marketing strategies to manage risk listed in the surveys increased their importance significantly during the 12-years analysed, they were also poorly ranked, and the proportion of farmers using them tended to be less than in 1992. Gathering market information about prices and trends, was by far the most important strategy in both preference (ranking) and the proportion of farmers that used it. The subtle changes in the use of and the preferences for marketing strategies, reflect that the structural changes within the dairy industry, in particular the marketing role of the New Zealand Dairy Board, now undertaken by Fonterra, has not changed very much during the last twelve years. Even though the reduction of seasonality in New Zealand dairy systems has become more common during recent years, it is not widely used as a strategy to cope with risk. Similarly, despite the increase in the importance of diversification as a risk management tool to control risk, the high levels of specialization required in dairy farming meant that this strategy is used less by farmers in 2004 than it was twelve years ago.

5.1.3 Comparison between Owner-operators and Sharemilkers

In the present survey average farm size for Owner-operators was significantly bigger than for Sharemilkers. Since the overall risk perceived in the current farm size did not show a clear difference between the two groups, it is difficult to link the perception of this source of risk with the physical information gathered. Owner-operators had bigger herds but lower stocking rates than Sharemilkers, but these differences were not significant. LIC (2003) also reported lower stocking rates for Owner-operators, however in that report both farm and herd sizes were greater for Sharemilkers than Owner-operators.

5.1.3.1 Perception of risk sources

As dairy farming is highly specialized, so that most of the gross farm income comes from the total kilograms of milk solid produced, the nature of the sharemilking contracts make Sharemilkers even more sensitive to changes in yields and prices. Therefore it was not surprising to find that Sharemilkers ranked these types of risk more highly Owner-operators. It is important to note that, of the six groups of risk sources, Sharemilkers perceived more risk than Owner-operators in five of them. The

only group in which there were significant differences in perception between the two ownership structures was the Miscellaneous group, which includes many sources of risk of different kinds. Only the Regulatory group of risk sources was perceived to be slightly more important by Owner-operators than Sharemilkers. This suggests that in general terms farm owners themselves have to deal with this issue, as the only identified source of risk that Owner-operators perceived to be significantly more important than Sharemilkers was "Changes in local bodies' laws and regulations".

A closer look at the perception of risk in the sources of variation asked of farmers showed that in most cases where differences between Owner-operators and Sharemilkers are significant, the latter group attached higher mean scores to these sources. This fact reflects the fact that Sharemilkers face a more risky situation than Owner-operators. The changes in prices and costs were extremely important for Sharemilkers, as the profitability of their business is more driven by these two factors than for Owner-operators, since they have invested low levels of capital in the business and capital appreciation does not have any relevance for them. As sharemilking has been considered to be a stepping stone in the New Zealand Dairy Industry in order to achieve ownership over land, it was logical to find that land prices were perceived more importantly by Sharemilkers. This group feels that their chances of owning land are threatened if land price continues its sharp trend upward. The greater risk perceived in those human risks ("Accidents and health problems" and "Changes in family situation") reflect the high reliance of Sharemilkers not only on themselves but on their family members as well. On this point it is of interest that Sharemilkers also attached a higher mean score to problems with hired labour and contractors. While sharemilkers might be expected to do most of the job themselves, human resource management is equally important for Sharemilkers and Owner-operators.

5.1.3.2 Risk management strategies

An overview of the groups of risk management strategies included in this survey, showed that Sharemilkers had higher mean scores than Owner-operators in every category. It does not mean they used them more than farm owners, but that they recognize the importance of reducing risk to a minimum level in order to strengthen

their position as sharefarmers. Of these five groups of strategies, only with the strategic planning was there significant difference between Owner-operators and Sharemilkers. As sharemilking is a step-to-step process to, generally, achieve land ownership the plans for the development of the business become highly important if it is to succeed. The assessment of the use of management strategies to control risk, showed that Sharemilkers are more focused on the production side of the business than Owner-operators. The former group put more emphasis on reducing physical performance variation through practices like spraying and drenching, producing to full capacity, monitoring pest, crops and climate, and using irrigation. As most of these practices have associated costs, this explains in part why they perceived the changes in product prices and input costs as being so important. Although the Sharemilkers seemed to be more focused on the production side of the farming business, they were also concerned with some of the financial side as well, particularly with the management of debt. Again, this agrees with the fact previously explained, that sharemilking is a path toward land ownership, therefore it is a very dynamic business where debt plays a key role in order to achieve business growth. Activities off-farm are an increasingly important way to ensure business viability and to reduce risk world wide. In this sense it is a common expectation that some of the Sharemilkers' family members work off-farm in order to stabilize income. Control of the threat of accidents and health problems is attempted through the greater use of personal insurance. The differences between the two groups within the strategic planning area, suggested that long-term goals set by Sharemilkers motivate them to be very clear about their next steps in order to succeed.

5.1.3.3 Sources of information most commonly used and areas of further interest in risk management

It is interesting to point out that of the eleven sources of information farmers were asked about, the top seven were used more by Sharemilkers than by Owner-operators. This situation may be important in two. Firstly, since it can be assumed that people avoid risk except when they feel their situation is threatened (Nicholson, 1998), the greater use of information can lead to the perception of greater levels of threat to the current situation, in other words a greater perception of risk. Secondly,

as risk taking and creativity have been found to be strongly linked (Eisenman, 2001), the perception of a threatened situation can lead to "new, useful ways of thinking or doing things" (Eisenman, 2001; p.189). In the present research, both points could be present in the comparison of sources of information used by farmers in the two ownership structures, hence the differences in risk perception and management strategies in each group.

Finally, and despite the production emphasis that Sharemilkers have to manage risk, this group was less interested in learning risk management strategies in the Marketing and Production fields than Owner-operators. Marketing strategies can be highly relevant for farm owners, since increases in their marketing knowledge could involve their desiring to sell their products themselves, amongst other things. The remaining areas (Financial, Legal, Human and Strategic planning) were perceived more important by Sharemilkers than Owner-operators in learning to manage risk, however only those strategies that related to the financial side of the business were significantly more important for Sharemilkers than Owner-operators. This could reflect their relative inexperience in these areas, as the average Sharemilkers were eleven years younger than Owner-operators.

5.1.4 Comparisons between North and South Islands

The physical data collected through the survey, showed that farms in the South and North Islands were significantly different in average farm size, average herd size, average number of one-year old replacement heifers and average kilograms of milk solids produced per farm. The average farm size, herd size and milk solids produced per farm in South Island dairy farms were larger by 43%, 38% and 43% respectively than their counterparts from the North Island. LIC (2003) also reported differences of 39% for both farm and herd size and 45% for the average of kilograms of milk solids produced per farm. Although no differences were found in the percentage of heifers grazing off-farm nor the percentage of cows wintered on farm, both values were lower for farmers from South Island who, in turn, raised almost 3% more heifers than farmers from the North Island.

5.1.4.1 Perception of risk sources

The greater average size of the South Island farm influences farmers' perception that size is not an important source of risk. The opposite is true for farmers from the North Island, since the perception of risk from their current farm size is more widespread among the 1-5 Likert scale used. It seems also that farmers from the South Island were slightly more concerned about their levels of debt than their peers from the North Island, however there are no large differences between farmers in the two islands in their perception of risk from the changes of yields and prices.

The perception of risk sources showed that there were no significant differences between North and South Islands in the overall perception of the six groups included in the survey. This may indicate that, on average, farmers from both islands are facing the same type of problems, and that they also perceive the sources of risk in a similar way. At a deeper level, for the individual nineteen risk sources asked, it can be seen that the differences in perception between the two groups were mainly within the production sources of risks. Disaster was the only production source of risk that was more important for farmers from the South Island than those from the North Island; the latter being more concerned about rainfall variability and diseases and pests, two risk sources that have a very direct impact on physical performance. Based on the fact that the magnitude of the risk can be can be classified depending on their frequency and the potential impact (see 2.3.2.2), it can be appreciated that farmers from North Island are more concerned about ordinary sources of risk (e.g. Rainfall variability) whereas farmers from the South Island are more concerned about extraordinary sources of risk (e.g. Disasters). One more effect of farm size in risk perception is the one related to human resources. Farmers from the South Island were considerably more concerned about problems with hired labour and contractors, reflecting the effect of scale of the operations, the increased reliance on hired staff and the lack of high skilled labour to work with.

5.1.4.2 Risk management strategies

The farmers from South Island put significantly more importance on the use of strategic planning responses to control risk than their peers from the North Island (see 4.1.4.2). Confirming the finding that farmers from North Island perceive more risk in

diseases and pests than those from the South Island, the former group of farmers consider routine spray and drenching as the top strategy to manage risk, whereas this strategy was ranked 7th by farmers in the South island. Another major difference in the importance and use of specific risk management strategies was the use of irrigation. In the South Island 52% of the farmers use it (it was ranked 9th), compared with only 9% of the farmers from the North Island (it was ranked nineteenth). Although a similar proportion of farmers from both Islands arrange overdraft reserves as a way of managing risk, this strategy was far more important for farmers from the South Island (ranked 10 vs. 5 in the North and South Islands, respectively). This fact may indicate the greater dynamism and more rapid expansion of dairy farming businesses in the South Island, whereas in the North Island the business might be considered more stable. It was also evident from the present survey, that off-farm work, either by the farmer him/herself or some of his/her family members, was more important for farmers from the North Island. This situation could be linked to size of farm and herd, as smaller operations may be forced to have additional sources of income to stabilize the overall family income. Within the strategic planning responses, for every strategy listed, a greater proportion of farmers from the South Island used them than those from the North Island. Significant differences, however, were found only for both the written mission and vision of the business, which could be linked to the developmental stage of the dairy industry in the South Island.

5.1.4.3 Sources of information most commonly used and areas of further interest in risk management

There are similarities and differences in the importance of the sources of information used by farmers. The use of "Workshops, Seminars, Meetings and Field days" was the most important source for both groups, however it was more important for farmers from the South Island. "Television" was much more important as a source of information for North Island dairy farmers than those from the South Island; and there was an inverse relationship between the use of "Consulting Officers" and "Private Consultants" as sources of information. "Consulting Officers" are used more widely than "Private Consultants" by both groups of farmers, however North Island dairy farmers use more "Consulting Officers" than their peers from the South Island,

whereas for "Private Consultants", the situation is exactly the opposite. Once again, characteristics such as farm size, herd size, use of different strategies and other reasons not clear in this research, make the farmers from the South Island use more "Private Consultants", with all the associated additional costs.

It is interesting to note that of the six areas farmers of learning to control risk, only the Production area was more important for farmers from the North Island. Of the remaining areas, farmers from the South Island were significantly keener to learn about the Human and Strategic planning areas to control risk than their counterparts from the North Island. Once again, the interest in these two areas may reflect the dynamic and expansion mode of the dairy farms in the South Island, and all the issues related to managing labour on their bigger farms.

5.1.5 Relationship between Ownership Structure and Geographic Location

Despite all the differences found in the analysis of the current survey between the two ownership structures and the two geographic locations, no significant differences were found with the interaction between ownership structure and geographic location (see 4.1.5). In other words, the present research found that the way farmers perceived risk, whether they are Sharemilkers or Owner-operators from the North or the South Island, is not significantly different. Although the Human and Technological groups of risk sources were perceived differently by Owner-operators and Sharemilkers in the North Island, a generalization cannot be made and the relevance may not be significant since both groups of farmers from the South Island did not have any differences between them or with their counterparts from the North Island (Table 4-15).

Absolutely no differences were found between the four groups of farmers in the analysis of the groups of risk management strategies as well as in the areas perceived to be critical for further learning about risk management. This situation would indicate that despite the differences in resources, tenure and geographic location, the farmers tend to show similar behaviours in the way they attempt to control risk and therefore one or more common patterns can potentially be defined.

So, in spite of the significant differences found in variables such as average farm size, average total kilograms of milk solids produced per farm and herd size for the four groups of farmers analysed, there must be some factors, or the interaction

between them, that not only affect the way farmers perceive risk, but also the way they cope with those perceived sources and the educational needs they believe are required for the future.

5.1.6 Identification of the variables associated with yield of Milk Solids produced per Hectare: Stepwise Regression

The best set of variables associated with milk solid produced per hectare included risk sources and risk management strategies that either have or have not changed over the last twelve years (see Table 4-17). The two market sources identified as relevant for the model, "Changes in the world economical and political situation" and "Changes in New Zealand's economic situation", had opposite signs. These two sources did not change in their mean scores over the last twelve years, but their presence in the final set of variables highlights their importance, especially considering the open economy in which the dairy farmers are immersed. It is also important to mention that the relative importance of changes at the local level in explaining the total variation of the model was slightly more important than the changes at a global level. Despite this situation, it seems that farmers perceive that the changes at the global level have a longer-term effect than the changes at the local level; thus the reaction of farmers to changes at the global level is a reduction of the Kg MS/Ha produced, whereas for changes within New Zealand levels of production will be increased in an attempt to cope with this situation. "Changes in land prices" was also included in the set of variables and its importance increased during the last twelve years as the comparison of the surveys showed (see Table 4-3). This financial source of risk is a reflection of the economic changes at the local level, therefore it is not surprising that this source of risk also had a positive value, as had "Changes in New Zealand's economic situation". Additionally, as dairy farming has become more intensive during the last twenty years, it is reasonable to find that as the risk perceived in "Changes in land prices" increases so too does the yield of milk solids produced per hectare, as dairy land is commonly valued as dollar per Kg MS/Ha.

The most important variable associated with Kg MS/Ha was "Changes in local body laws and regulations". The risk perceived in this variable has increased significantly over the last twelve years. Part of this situation can be explained through the publication of the Resource Management Act whose effect was probably not fully

captured in the survey conducted in 1992 since it had come into force only ten months before the survey was undertaken, in October 1991. The high levels of specialization required in dairy farming are clearly manifested in the fact that greater diversification of the system as a way of controlling risk is associated with a reduction of 46.27 kilograms of milk solids produced per hectare. This agrees with the fact that, even though the importance of this strategy increased during the last twelve years, the proportion of farmers that truly use it has reduced.

The strategy "Keeping the debt low: reducing debt ..." was positively correlated with milk produced per hectare. This strategy showed a reduction in both its importance and the proportion of farmers using it over the last twelve years. When considering the *risk balancing effect* (2.3.2.3.1) the identification of this variable for the model suggests that a reduction in financial risks allows an increase in production risk to be accepted, regarding the maximum level of risk an individual can comfortably tolerate. It must be remembered that milk solids production from a pastoral system relies on, and is limited by the availability of pasture, and increases in production levels can be perceived as increases in production risk if they are made only at the expense of pasture production. On the contrary, it is interesting to note that the other financial risk management strategy identified as significant through the Stepwise Regression Analysis, "Planning of capital spending: pacing investments and expansion to reduce risk", was negatively correlated with Kilograms of Milk Solids produced per Hectare and much less important than "Keeping the debt low...". This strategy did not change in the importance of its use since 1992, yet its presence in the model reflects the fact that some farmers use cash as a tool to expand or invest in their businesses rather than use debt to do the same. So, as the reliance to achieve business growth through cash generated in the business increases, then milk production is reduced. This situation could also indicate that no tight financial plans should be made in order to control risk, as cash dominates the decision-making process; nonetheless, the inclusion in the model of the strategy "Use of financial ratio in decision making" contradicts what has already been outlined as will be explained shortly.

Both strategic planning strategies identified in the model had opposite sign values. "Having written a shared vision statement for your operation" was negatively correlated with Milk Solids production per Hectare, suggesting that those who used this strategy more reduced their performance per hectare. It is worth mentioning that Sharemilkers were found to use this strategy more than Owner-operators, thus one

could suppose that the low levels of production associated with a higher use of this strategy can be related to the stage of the business cycle in which the farmers are situated. On the contrary the other strategic planning response identified as significant for the model, "Use of financial ratios for decision making", was positively correlated to kg of MS/Ha and it was the second most important variable in explaining the total variation of the model. The fact that the use of financial ratios for decision making was positively included in the model is more logical, and it reflects the importance of both the financial awareness that currently is required by farmers, as well as the planning ability needed to cope with risk in dairy farming in New Zealand.

5.2 DATABASE

5.2.1 General Discussion

Despite all the work done worldwide recognizing and reporting the effect of economies of scale such as those of Boehlje (1999), Gabriel & Baker (1980), Langemeier & Jones (2000, 2001), Purdy et al. (1997), plus the information at a more local level such as those from Rauniyar & Parker (1999) and the LIC (2003) indicating that during the last ten years in New Zealand farm size has increased by 50%, herd number has decreased by 9.1% and average herd size has increased by 58%, no economies of scale effect was consistently found in the database analysis. It is important to highlight that the period of analysis in the database is within the time span reported by LIC (2003), but the percentages of increase for both farm and herd sizes during that five year period were 28% and 30% respectively (LIC, 2003).

Much of the literature in New Zealand regarding dairy farm profitability has put a lot of emphasis on the Economic Farm Surplus (EFS) (Deane, 1999; Leslie, 2001; McGrath, 1997; McGrath, 1999; McGrath, 1999; Roche & Reid, 2002) and the measurement of cost control through the farm working expense ratio (FWER) (Clearwater & Wright, 2003; Hamilton, 2002; McGrath, 1997; McGrath, 1999). The current analysis however has found that although EFS is negatively correlated with increases in risk levels, it was not significant for the whole period analysed. Barry, Ellinger, Hopkin, & Baker (2000) define profit as "the difference between the value of goods and services produced by the firm and the costs of resources used in their production" (p. 23). In consequence the use of EFS to evaluate both farm profitability

and viability may be confusing and misleading as it does not include the leverage structure of the farm. The leverage structure reflects the use of non-equity capital in the production process. Similarly, and despite the fact that FWER was positively correlated with profitability, it was not consistently significant in determining risk in the operations under New Zealand's conditions. The reasons for that could be that the New Zealand dairy systems are by their own nature low cost systems and as the average farm working expense ratio for the database analyse in the present research was too low, so FWER did not have an effect on risk. Langemeier & Jones (2001) found that for a sample of 926 farms from Kansas, the total expense ratio (TER)[3] had a significant effect in determining downside risk, however the average TER for the sample was 83.6 (SD= 20.05) compared with the average of the current research of 50.1% (SD= 12.77). For New Zealand conditions the Farm Working Expense Ratio has little, if not nil, effect on the risk faced by a farm business. Despite the low cost nature of New Zealand dairy systems, several papers that have reported increased spending on supplements and fertilisers, have also mentioned that those increases have not invalidated the concept of low cost system but have allowed the benefits of greater levels of production to be captured (Clearwater & Wright, 2003; Deane, 1999; Leslie, 2001; Roche & Reid, 2002).

The most powerful variable associated with risk for the current research was the Debt Servicing Capacity (DSC). As DSC in the current database included mainly interest payments (90%), this indicates that those farmers with a higher proportion of their GFI being used to service debt (high interest payments and low levels of GFI) are more likely to face high risk levels than those whose proportion of GFI to paid debt is less (with low interest payments and high GFI). However there is an interesting interaction to consider on this point, as the Debt to Asset ratio (DTAR) was found to be negatively correlated to risk during the whole period analysed. Although Langemeier & Jones (2001) found in their analysis that DTAR was positively correlated with downside risk, and thus higher levels of debt would mean more risk for the farmers, Purdy et al. (1997) also found that DTAR was negatively correlated to the mean of ROE but positively correlated to its variation. The average DTAR for the present research and for that of Purdy et al. (1997) were slightly higher than the average for Langemeier and Jones's (2001) (35.69%, 32.82% and 30.56% respectively) and all of them had a

[3] TER = (Total Expenses) ÷ (Gross Farm Income)

standard deviation of about 22%, thus the difference in the results between the studies could be explained by a low level of debt for the sample of Kansas farmers analysed by Langemeier & Jones (2001). In other words the present research, and that conducted by Purdy et al. (1997), have confirmed that when non-equity capital is used efficiently and return on assets is greater than the interest rate, highly leveraged farms would increase their ROEs sharply and therefore they would be facing less risk than those with lower levels of debts as they would be able to increase their rates of business growth . Under the *Principle of Increasing Risk* described by Boehlje & Eidman (1984) and Boehlje (2004) this situation is absolutely consistent with that shown in table 2-3. The use of leverage is also explained by Gloy & Baker (2002) as they state that the use of different levels of leverage influences the strategies to be adopted: "...financial leverage can be used to increase the mean return of strategies that contain a relatively small amount of business risk" (p. 1142). Therefore the efficient use of non-equity capital is one of the best ways to increase the financial performance of the business, however it is also one of the easiest routes to bankruptcy.

The fact that Operating Profit Margin (OPM) and Asset turnover ratio (ATR) were negatively correlated to risk was not surprising as the DuPont Financial Analysis System described by Boehlje (1994) and Barnard & Boehlje (1998-99) show that both OPM and ATR are the drivers of return on assets (ROA) which in turn is one of the drivers of return on equity (ROE). Similarly, Purdy et al. (1997) found that financial efficiency was negatively related to financial performance (ROE). Therefore the profitability of the systems, measured as the return per dollar of gross farm income (OPM), and the efficient use of farm assets to generate revenue (ATR) are also highly important to ensure long term viability of the farm business.

5.2.2 Differences between the three groups of farms facing different levels of risk

In general terms dairy farms have little or no chance to diversify the business, therefore milk payout is one of the main drivers of gross farm income which in turn has a big effect on farm profitability. During the first four seasons analysed in this study, the increases in payout were 5.6% (1998/1999 - 1999/2000), 32.5% (1999/2000 - 2000/2001) and 6.8% (2000/2001 - 2001/2002) (in real terms). Therefore, the proportion of HRG farms decreased steadily (42.9%, 25.2%, 19.8% and 17.5%

respectively), on the contrary the proportion of farms facing low levels of risk increased sharply (from 27.4% to 68.5%) when payout had its largest increase (32.5%). Finally it is important to notice that when the milk price dropped to $3.66/kg of MS (2002/2003 Season), the proportions of farms in each group returned to a distribution that was similar to the distribution that had existed before milk prices increased.

The analysis of the variables included in the logistic model that explained risk through the categories of Return on Equity, showed that Debt to Asset Ratio (DTAR) for the HRG farms was very changeable during the five seasons analysed. When payout was over $5/kg MS this group decreased its DTAR, probably because with higher gross farm incomes they were able to repay some of their financial commitments. However by the time payout dropped to $3.66, the average level of debt in this group was again at similar levels as those presented by the LRG. On the contrary, as milk price increased, the LRG increased its average levels of debt, reaching even greater levels of debt than the HRG. This situation can be explained by the fact that the farmers of the LRG took strategies with less production risk, such as the use of supplements or others, so allowing them to take more financial risk, as described by Gloy & Baker (2002). Instead of undermining their chances to be more profitable through a reduction in their levels of debt, these farmers increased DTAR in order to capture the benefits of high payouts through the use of non-equity capital. The MRG had the lowest values of DTAR through out the whole period analysed, which probably reflects farmers who are very conservative in their financial management.

Although the HRG had the highest DTAR in the first two seasons and LRG had the highest values of DTAR in the last three seasons, the Debt Servicing Capacity (DSC), which is the proportion of the GFI used for interest payments, was always statistically higher for the HRG than both the LRG and the MRG. The increases in DSC can be explained in three ways: (1) an increase in gross farm income either by an increase in volume produced or in milk price or, (2) a decrease in the annual interest payments (interest rates and levels of debts) or, (3) a combination of both. The reduction of DSC for the HRG during the two seasons with the highest payouts can be explained mainly by the increase in gross farm income (GFI) due to higher milk payout; nevertheless, as greater GFI means more money available to repay debt, it is very likely that there was a carry over effect from season 2000/2001 to 2001/2002 that allowed farmers to repay some of their financial commitments. Finally, as already explained, a combination of both of these reasons may have been used to reduce DSC. Both LRG and MRG had

significantly lower levels of DSC than HRG during the whole period analysed, which was expected since MRG had lower levels of debt than the HRG. However as the LRG had even greater DTAR than HRG, the difference in DSC is explained by a greater GFI generated by the LRG than the HRG, which was clearer when Asset Turnover Ratio (ATR) was analysed. This situation reflects the differences in financial management and the relation between level of debt and profitability of the HRG and LRG.

Those variables that belong to the DuPont financial analysis system, Operating Profit Margin (OPM) and Asset Turnover Ratio (ATR), had similar patterns. As expected, the higher the payout the more profitable all the groups were, as a bigger proportion of the gross farm income was captured as operating profit or economic farm surplus (EFS). The OPM indicated that although MRG were more efficient in revenue generation and cost control than HRG farms, LRG farms were much more efficient than both MRG and HRG farms for every season analysed. Despite the fact that the increases in OPM for the HRG during the seasons 1999/2000 to 2000/2001 and from this to 2001/2002 were greater than the increases of LRG for the same seasons (+7% and +9% for HRG and +4% and +2% for LRG), the OPM of the HRG in the last season dropped by -17% when payout went back to $3.66/kg MS, whereas the LRG dropped only 8%. This situation highlights the stability of the operating efficiency of the farmers in the LRG. On the other hand, the capital efficiency of the farms measured through the ATR showed that, although for the first season analysed there were no differences between the three risk groups, during the last four seasons of the analysis there were significant differences between HRG and MRG compared with LRG. No differences were found in ATR between the LRG and MRG, but they did differ in their OPM, reflecting that although both groups can be equally efficient in using farm's assets to generate revenue, differences exist between them in terms of their returns per dollar of gross farm income. High management skills are highlighted in the LRG, since they are not only able to be profitable but they achieve this by trying to optimise the combination of resources used in the production process.

The ability to manage debt according to milk payout (DTAR), the lower proportion of interest payment over gross farm income (DSC), the high efficiency achieved by the system measured as the proportion of operating profit over the gross farm income (OPM) and the high efficiency in generating income from the farm's assets (ATR), resulted in the LRG having the highest return on equity of all the three groups.

Of the physical variables included to characterize the risk groups, only kilograms of milk solids produced per hectare and kilograms of milk solids produced per cow were different among the three risk groups of farm in four of the five seasons analysed, with higher levels for the LRG (Figure 4-31). No significant differences were found either in the cost of milk or in stocking rate of the three risk groups, indicating that it was not possible to identify a specific dairy system based on the level of intensification (high or low input system). However the LRG always had the highest averages for milk production per cow and per hectare, suggesting some differences on skills levels between groups. Higher production per cow can mean (1) more productive or high genetic merit cows, or (2) better fed cows, or (3) both. As there were no differences in stocking rates between the three groups, this greater production per cow is manifested in greater production per hectare.

5.3 GENERAL DISCUSSION OF THE 2004 STUDY: LINKING THE SURVEYS AND THE DATABASE ANALYSES

The comparison undertaken between the 1992 and 2004 Surveys found there were clear changes in the risk perceived in the following areas: Market, Regulatory, Financial and Miscellaneous. At a more detailed level, the top three risk sources perceived to be the most important were from the Market group: "Changes in input prices", "Changes in world economical and political situation" and "Changes in input costs". Although farmers are still focused on production and finances to manage risk, there was a huge change in this last area (Financial). This situation is explained by the decrease in importance of using low levels of debt as a risk management strategy, and the significant increase in importance of the strategy "Debt management". This suggests that farmers are not afraid of becoming indebted, and also that they are aware that proper management of debt- achieving good returns on the borrowed money- can be beneficial. The database analysis supported this finding, as it was found that the two most important factors affecting risk (measured as Return on Equity) were directly related to debt levels (Debt Servicing Capacity and Debt to Asset Ratio). Increases in debt levels were found to be negatively correlated with risk. This is not a cause-effect phenomenon, since those high levels of debt have to be used

efficiently to achieve high returns. The low risk group of farms, that had highest levels of ROE, was found to have high levels of debt, even higher than the high risk group of farms, indicating the efficient use of leverage to achieve high returns.

CHAPTER SIX

6 CONCLUSIONS

The current research has confirmed that the use of both approaches for risk analyses, qualitative and quantitative, is suitable and that the complementarity between these two approaches is very important to develop accurate identification of problems regarding risk.

The qualitative analysis, the survey conducted in 2004, showed that there are significant differences in both the risk perceived and the risk management strategies used by farmers in 1992 and in 2004. This probably reflects all the changes undergone by the New Zealand dairy sector during the last years. These changes have altered not only the dairy systems but, as a consequence, the dairy farmers as well. One of the main changes in the sources of risk was that related to human resources, which is likely to become even more important as farm size continues to increase in New Zealand with more employed staff needed on larger farms. It is also interesting to see that despite the openness of the New Zealand economy, farmers were more concerned about issues other than those specifically related to economic regulations. This fact suggests that the free economy has been assumed by farmers as one more factor to be considered in their analysis but is not perceived as the most important risk source affecting their farming business.

Farmers still use production strategies as the main way to control risk, however during the last twelve years there has been an increasing importance in the use of financial strategies to cope with risk. The increase in importance of those strategies related to off-farm activities over the last twelve years must be noted; this situation may have an impact in the long-term, such as less commitment with the dairy sector or poor quality of elected leaders, considering the cooperative structure of the New Zealand dairy industry. Finally, it is noted that keeping debt low is no longer considered a "strategy" to reduce risk; instead, currently farmers are not afraid of accruing and managing high levels of debt. This change in debt management implies that farmers themselves acknowledge that financial risk is one more component of

total risk, and that controlling financial risk is part of an overall strategy of reducing the total risk of the business. In summary, the changes found in the use of different risk management strategies, confirms the fact that there are several methods of farming being used in New Zealand. Risk control is now not achieved only from a production perspective but also from a financial point of view.

The analysis of the database, the quantitative analysis of risk, showed that in the sample of dairy farms used, risk was closely related to the relationship between the interest payments and the gross farm income of the business (Debt Servicing Capacity). As this ratio increased, the risk faced by a farm increased as well; this also explains the fact that why rural lenders in New Zealand put a lot of emphasis on this measure. Another association between debt levels and risk was shown by the relationship between the farm's liabilities and assets (Debt to Asset Ratio). Contrary to expectations, increased debt was negatively related to risk, which can be explained by the *Principle of Risk Increasing* (see Table 2-3). Therefore through the combination of efficient use of non-equity capital and levels of Return on Assets greater than the interest rates at which the money is being borrowed, highly leveraged farms can increase their ROEs sharply; as a consequence, they would reduce their levels of risk in terms of their long-term survival. The results also showed that as both capital efficiency (Asset Turnover Ratio) and operating efficiency (Operating Profit Margin) increased, there was a reduction in risk, as measured by the Return on Equity. This was expected as both of these ratios are drivers in the Dupont model.

There were no differences between the three risk groups of farms (Low Risk Group, Medium Risk Group and High Risk Group) in their production characteristics. Differences between them in their debt management, their operating and capital efficiencies were the most distinguishing features between the groups. The efficient use of non-equity capital (debt levels) and the ability to capture the benefits of external factors (e.g. increases in payout) through increases in both operating and revenue generation efficiencies are the determinants of risk (measured as Return on Equity). Against expectations and what other researchers have found, there was no effect of farm size on ROE in the database analysis. This finding may indicate that increases in farm size are not necessarily associated with reduction in risk under current conditions in New Zealand, and that long-term viability of the dairy systems would not be limited by scale of the operations. Finally, the analysis of the database has also highlighted the limitations in using EFS as the only measurement of

profitability in dairy systems, as well as identifying the fact that the Operating Profit Margin is a better indicator of cost control than Farm Working Expense Ratio.

Farmers tended to use mainly free sources of information to update themselves, but the use of those sources listed in the 2004 Survey varied according to ownership structure and geographic location. Similarly differences were also found in the risk perceived and the risk management strategies used by these different groups of farmers. The differences according to geographic location are explained not only because of climate but because of differences in farm sizes, as average farm size in the South Island was significantly larger than in the North Island. These differences in risk perception make farmers control risk in different ways, thus different ways of farming are found in the North and South Islands. In the same way, differences were found in risk perception and risk management strategies between Sharemilkers and Owner-operators. The biggest threat for Sharemilkers was the changes in land prices, whereas for Owner-operators the main concern was related to changes in laws at the local level. For almost every risk management strategy listed in the 2004 Survey, Sharemilkers put much more importance on each one than did Owner-operators. The reliance on production level as the main determinant of a Sharemilker's income put a lot of pressure on Sharemilkers to maximise milk production.

Of the information gathered through the 2004 Survey, the changes in local laws and regulations were found to be the most important variable associated with kilograms of milk solids produced per hectare. Higher levels of risk perceived in this source were closely associated with lower levels of milk yield per hectare. The most important risk source that was associated with higher milk solid production per hectare was the changes in the New Zealand's economic situation. Of those risk management strategies listed, the use of financial ratios for decision making was the most important variable for increases in milk solid production per hectare, followed by keeping low levels of debt.

From an overall perspective this research has provided a clear overview of what are the main concerns for dairy farmers, in terms of risk sources for their businesses as well as the main strategies they use to manage those sources. These useful insights can be very valuable for dairy agencies, universities and the dairy community in general, to develop and improve extension programs to make them more efficient and useful to dairy farmers.

6.1 OPPORTUNITIES FOR FURTHER RESEARCH

As limitations of the current research were found during its course of development, further opportunities to be investigated were also identified. One of them, and probably the most obvious and relevant, was the limitation of the length of time between both surveys (1992 and 2004). As the two surveys are two snapshots at different times, some of the explanations to different situations may well be not clear enough. The analysis and study of changes as they occur can lead to more reliable information; thus more frequent surveys are highly desirable to maintain an up-to-date sense of the general picture of risk perception and its management in the New Zealand dairy sector. This greater frequency of studies will also allow analysis of data for different categories of groups, such as those used in the present study (ownership structure and geographic location) and also others such as age of the operator, educational level of the farmers or other social variables that can provide powerful insights for extension programs.

The inclusion of the new questions in the 2004 Survey is also important to bear in mind in future research. Issues such as the sources of information used by farmers and their need to learn risk management in different areas were an improvement in this research, yet no direct comparison could be made with the 1992 Survey since it did not include these questions. Therefore further exploration of these and other equally important issues will be very helpful to understand farmers' needs and behaviour. Risk and its management should be considered as a long-term project as two main effects can have high impacts on farmers: (i) the changes in the current world are happening at a very rapid rate, (ii) farmers are gaining access to more and more sources of information. Both of these situations can not be changed, they are part of our environment, thus more frequent updates will benefit everyone in the dairy business.

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8 APPENDICES

8.1 APPENDIX 1. Comparison of the distribution of the sample of farmers surveyed in 2004 with the herds currently operating in New Zealand

NORTH ISLAND		No. of surveys	2004 Sample	National*
Northland	Far North	39	3.90%	2.79%
	Kaipara	47	4.70%	3.79%
	Whangarei	35	3.50%	0.48%
Central Auckland	Rodney	17	1.70%	0.08%
	Manukau City	4	0.40%	2.32%
	Papakura	3	0.30%	3.30%
	Franklin	26	2.60%	2.94%
South Auckland	Waikato	81	8.10%	0.94%
	Waipa	60	6.00%	0.08%
	Otorohanga	35	3.50%	4.18%
	Thames-Coromandel	7	0.70%	2.81%
	Hauraki	21	2.10%	3.81%
	Matamata-Piako	94	9.40%	0.17%
	South Waikato	32	3.20%	0.14%
Bay of Plenty	Western Bay of Plenty	21	2.10%	5.22%
	Kawerau/Whakatane	22	2.20%	0.07%
	Opotiki	3	0.30%	0.18%
Central Plateau	Taupo	14	1.40%	2.51%
	Rotorua	18	1.80%	0.68%
Western Uplands	Waitomo	4	0.40%	0.07%
	Ruapehu	3	0.30%	1.86%
East Coast	Gisborne	1	0.10%	0.05%
	Wairoa	1	0.10%	0.81%
Hawkes Bay	Napier/Hastings	1	0.10%	0.09%
	Central Hawkes Bay	1	0.10%	0.30%
Taranaki	New Plymouth	52	5.20%	9.22%
	Stratford	31	3.10%	3.18%
	South Taranaki	95	9.50%	2.73%
Wellington	Wanganui	1	0.10%	6.21%
	Rangitikei	7	0.70%	0.30%
	Manawatu	16	1.60%	2.74%
	Palmerston North City	4	0.40%	0.74%
	Horowhenua	9	0.90%	1.18%
	Kapiti Coast	2	0.20%	0.22%
Wairarapa	Tararua	20	2.00%	0.81%
	Masterton	1	0.10%	0.20%
	Carterton	1	0.10%	0.62%
	South Wairarapa	2	0.20%	9.69%
		831	83.10%	82.69%

* Reported by LIC, 2003

SOUTH ISLAND		No. of surveys	Sample	National*
Nelson/Malborough	Marlborough	3	0.30%	0.23%
	Kaikoura	2	0.20%	0.36%
	Tasman/Nelson	17	1.70%	1.51%
West Coast	Buller	11	1.10%	1.02%
	Grey	4	0.40%	0.59%
	Westland	12	1.20%	1.24%
North Canterbury	Hurunui	3	0.30%	0.37%
	Waimakariri	6	0.60%	0.57%
	Christchurch City	1	0.10%	0.08%
	Banks Peninsula	1	0.10%	0.09%
	Selwyn	14	1.40%	1.19%
	Ashburton	18	1.80%	1.38%
South Canterbury	Timaru/MacKenzie	9	0.90%	0.73%
	Waimate	5	0.50%	0.35%
Otago	Waitaki/Central	11	1.10%	0.69%
	Dunedin City	7	0.70%	0.65%
	Clutha	10	1.00%	1.20%
Southland	Gore	2	0.20%	0.77%
	Southland	33	3.30%	3.68%
		169	16.90%	17.31%
	TOTAL	**1,000**	**100.00%**	**100.00%**

* Reported by LIC, 2003

8.2 APPENDIX 2. Intervals of ROE for the risk categories created

Risk Categories	Interval of Return on Equity (ROE)
1	ROE Greater than or equal to 8%
2	ROE Greater than or equal to 6%, and ROE less than 8%
3	ROE Greater than or equal to 5%, and ROE less than 6%
4	ROE Greater than or equal to 4%, and ROE less than 5%
5	ROE Greater than or equal to 3%, and ROE less than 4%
6	ROE Greater than or equal to 2%, and ROE less than 3%
7	ROE Greater than or equal to 1%, and ROE less than 2%
8	ROE Greater than or equal to 0, and ROE less than 1%
9	ROE Greater than or equal to -10%, and ROE less than 0
10	ROE Less than or equal to -10%

8.3 APPENDIX 3. Formulae for the variables used in the logistic analysis

- Gross Farm Income (GFI):
  - GFI = (Cash Income - Stock Purchases ± Changes in Stock Inventory)

- Farm Working Expenses (FWE):

  Wages
  Animal Health
  Herd Improvement
  Farm Dairy Expenses
  Electricity
  Freights
  Supplements Purchased
  Grazing-off
  Crop and Regrassing
  Fertilizer (incl. N)
  Weed and Pest
  Repair and Maintenance
  Vehicles
  Administration
  Standing Charges
  Run-off Lease
  Other Expenses

- Economic Farm Surplus (EFS)
  - EFS = (Gross Farm Income) - (Farm Working Expenses)

- Owner's Equity (OE)
  - OE = (Total Assets) - (Total Liabilities)

- Return on Equity (ROE)
  - ROE = (EFS + Runoff Adjustments - Other Rent - Interests Payments) ÷ (Owner's Equity)

- Farm Working Expense Ratio (FWER)
  - FWER = (Farm Working Expenses) ÷ (Gross Farm Income)

- Debt to Asset Ratio (DTAR)
    - DTAR = (Total Farm Liabilities) ÷ (Total Farm Assets)

- Debt Servicing Capacity (DSC)
    - DSC = (Interest Payments + Other Rent) ÷ (Gross Farm Income)

- Operating Profit Margin (OPM)
    - OPM = (Economic Farm Surplus) ÷ (Gross Farm Income)

- Asset Turnover Ratio (ATR)
    - ATR= (Gross Farm Income) ÷ (Total Farm Assets)

8.4 APPENDIX 4. Variables of the Profit Watch database included in the logistic analysis and their the Economic Survey*

	1998/1999			1999/2000			20
	Current Research		Dexcel*	Current Research		Dexcel*	Current Res
N =	189		271	230		263	242
	Mean	SD	Mean	Mean	SD	Mean	Mean
Effective area	95	52	87	101	54	90	114
Total milk solids (Kgs)	56,595	30,656	61,792	66,035	33,865	69,789	76,874
Gross Farm Income	$ 221,736	$ 113,724	$ 238,485	$ 267,417	$ 137,117	$ 280,306	$ 423,078
Farm Working Expense Ratio	56%	12%	58%	53%	11%	55%	45%
Economic Farm Surplus	$ 44,217	$ 36,391	$ 46,902	$ 71,028	$ 64,795	$ 78,648	$ 161,966
Debt to Asset Ratio	38%	26%	39%	35%	21%	37%	37%
Debt Servicing Capacity	19%	11%	19%	17%	11%	15%	13%
Owners Equity	$ 890,936	$ 538,555	$ 902,941	$ 1,003,667	$ 528,351	$ 1,013,670	$ 1,057,046
Operating Profit Margin	21%	13%	20%	26%	15%	28%	37%
Asset Turnover Ratio	16%	4%	16%	17%	5%	17%	25%
Kg of milk solids per cow	267	42	277	300	47	307	314
Kg of milk solids per hectare	723	185	710	786	211	775	835

	2001/2002			2002/2003			1
	Current Research		Dexcel*	Current Research		Dexcel*	Curren
N =	177		219	188		208	
	Mean	SD	Mean	Mean	SD	Mean	Mean
Effective area	105	58	92	123	79	101	108
Total milk solids (Kgs)	73,164	38,389	77,370	86,610	48,653	89,674	71,852
Gross Farm Income	$ 434,431	$ 227,149	$ 447,305	$ 379,418	$ 205,294	$ 392,804	$ 345,052
Farm Working Expense Ratio	43%	9%	48%	54%	13%	58%	50%
Economic Farm Surplus	$ 172,718	$ 107,134	$ 179,028	$ 84,762	$ 66,306	$ 87,961	$ 107,598
Debt to Asset Ratio	33%	19%	39%	35%	23%	38%	36%
Debt Servicing Capacity	11%	7%	11%	17%	10%	17%	15%
Owners Equity	$ 1,207,897	$ 566,204	$ 1,120,807	$ 1,554,087	$ 893,461	$ 1,551,684	$ 1,131,58
Operating Profit Margin	40%	10%	40%	24%	14%	22%	30%
Asset Turnover Ratio	23%	5%	24%	16%	6%	16%	20%
Kg of milk solids per cow	319	50	321	325	50	330	305
Kg of milk solids per hectare	860	224	841	902	246	888	820

* Information reported in the Economic Survey of New Zealand Dairy Farmers 2002-2003, Dexcel

8.5 APPENDIX 5. Detailed results of the logistic regression

8.5.1 1998/1999 Season

Score Test for the Proportional Odds Assumption		
Chi-Square	DF	Pr > ChiSq
612.12	56	<.0001

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	773.18	521.94
SC	802.36	573.81
-2 Log L	755.18	489.94

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	265.24	7	<.0001
Score	134.12	7	<.0001
Wald	139.65	7	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Farm Working Expense Ratio	1	0.3453	0.2704	1.6308	0.2016
Debt to Asset Ratio	1	-0.4698	0.2382	3.8901	0.0486
Operating Profit Margin	1	-2.4335	0.4119	34.9081	<.0001
Asset Turnover Ratio	1	-0.6428	0.1871	11.7973	0.0006
Debt Servicing Capacity	1	0.422	0.2098	4.0444	0.0443
Effective Area	1	-0.4655	0.2923	2.537	0.1112
Economic Farm Surplus	1	2.5866	0.2934	77.7425	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Farm Working Expense Ratio	1.412	0.831	2.399
Debt to Asset Ratio	0.625	0.392	0.997
Operating Profit Margin	0.088	0.039	0.197
Asset Turnover Ratio	0.526	0.364	0.759
Debt Servicing Capacity	1.525	1.011	2.301
Effective Area	0.628	0.354	1.113
Economic Farm Surplus	13.285	7.475	23.608

8.5.2 1999/2000 Season

Score Test for the Proportional Odds Assumption		
Chi-Square	DF	Pr > ChiSq
2108.44	56	<.0001

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	1011.09	504.68
SC	1042.03	559.69
-2 Log L	993.09	472.68

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	520.41	7	<.0001
Score	180.03	7	<.0001
Wald	180.52	7	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Farm Working Expense Ratio	1	0.9366	0.2673	12.2762	0.0005
Debt to Asset Ratio	1	-1.0841	0.2195	24.385	<.0001
Operating Profit Margin	1	-4.459	0.5211	73.2113	<.0001
Asset Turnover Ratio	1	-1.6684	0.2306	52.3477	<.0001
Debt Servicing Capacity	1	0.082	0.2476	0.1096	0.7406
Effective Area	1	-0.8516	0.3953	4.6408	0.0312
Economic Farm Surplus	1	4.5192	0.3894	134.6715	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Farm Working Expense Ratio	2.551	1.511	4.308
Debt to Asset Ratio	0.338	0.22	0.52
Operating Profit Margin	0.012	0.004	0.032
Asset Turnover Ratio	0.189	0.12	0.296
Debt Servicing Capacity	1.085	0.668	1.763
Effective Area	0.427	0.197	0.926
Economic Farm Surplus	91.762	42.774	196.852

8.5.3 2000/2001 Season

Score Test for the Proportional Odds Assumption		
Chi-Square	DF	Pr > ChiSq
2426589.01	49	<.0001

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	612.88	324.89
SC	640.79	377.23
-2 Log L	596.88	294.89

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	301.99	7	<.0001
Score	120.32	7	<.0001
Wald	96.82	7	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Farm Working Expense Ratio	1	0.0815	0.39	0.0437	0.8345
Debt to Asset Ratio	1	-1.5288	0.325	22.1227	<.0001
Operating Profit Margin	1	-4.7667	0.7908	36.3364	<.0001
Asset Turnover Ratio	1	-2.416	0.4241	32.448	<.0001
Debt Servicing Capacity	1	3.726	0.5273	49.9286	<.0001
Effective Area	1	0.3933	0.3409	1.3312	0.2486
Economic Farm Surplus	1	-1.2596	0.6526	3.725	0.0536

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Farm Working Expense Ratio	1.085	0.505	2.33
Debt to Asset Ratio	0.217	0.115	0.41
Operating Profit Margin	0.009	0.002	0.04
Asset Turnover Ratio	0.089	0.039	0.205
Debt Servicing Capacity	41.512	14.768	116.686
Effective Area	1.482	0.76	2.891
Economic Farm Surplus	0.284	0.079	1.02

8.5.4 2001/2002 Season

Score Test for the Proportional Odds Assumption		
Chi-Square	DF	Pr > ChiSq
319017.75	49	<.0001

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	484.85	192.74
SC	510.26	240.38
-2 Log L	468.85	162.74

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	306.11	7	<.0001
Score	136.29	7	<.0001
Wald	71.65	7	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Farm Working Expense Ratio	1	0.2612	0.3884	0.4523	0.5012
Debt to Asset Ratio	1	-2.73	0.5065	29.0533	<.0001
Operating Profit Margin	1	-5.4355	0.8023	45.8976	<.0001
Asset Turnover Ratio	1	-3.7597	0.5624	44.6944	<.0001
Debt Servicing Capacity	1	3.8331	0.5311	52.092	<.0001
Effective Area	1	-0.0311	0.347	0.008	0.9287
Economic Farm Surplus	1	-0.1392	0.6292	0.0489	0.8249

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Farm Working Expense Ratio	1.298	0.607	2.78
Debt to Asset Ratio	0.065	0.024	0.176
Operating Profit Margin	0.004	<0.001	0.021
Asset Turnover Ratio	0.023	0.008	0.07
Debt Servicing Capacity	46.203	16.316	130.837
Effective Area	0.969	0.491	1.914
Economic Farm Surplus	0.87	0.253	2.986

8.5.5 2002/2003 Season

Score Test for the Proportional Odds Assumption		
Chi-Square	DF	Pr > ChiSq
636.80	56	<.0001

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	799.25	415.49
SC	828.38	467.27
-2 Log L	781.25	383.49

Testing Global Null Hypothesis: BETA=0			
Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	397.76	7	<.0001
Score	153.38	7	<.0001
Wald	142.05	7	<.0001

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Farm Working Expense Ratio	1	0.2066	0.3272	0.3988	0.5277
Debt to Asset Ratio	1	-2.2347	0.2888	59.864	<.0001
Operating Profit Margin	1	-4.873	0.6144	62.9126	<.0001
Asset Turnover Ratio	1	-1.3561	0.2196	38.1482	<.0001
Debt Servicing Capacity	1	4.4669	0.4401	102.9957	<.0001
Effective Area	1	0.187	0.232	0.6498	0.4202
Economic Farm Surplus	1	-0.6269	0.3107	4.0708	0.0436

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Farm Working Expense Ratio	1.229	0.648	2.335
Debt to Asset Ratio	0.107	0.061	0.189
Operating Profit Margin	0.008	0.002	0.026
Asset Turnover Ratio	0.258	0.168	0.396
Debt Servicing Capacity	87.087	36.754	206.352
Effective Area	1.206	0.765	1.900
Economic Farm Surplus	0.534	0.291	0.982

8.6 APPENDIX 6. Formulae for the additional variables analysed from the ProfitWatch database

- Cost of Milk (CoM)
  - CoM = ((Operating Expenses) - (Stock Income) + (Opportunity Cost)) ÷ (Total Kilograms of Milk Solids Produced per Farm)
  - Opportunity Cost = (Total Farm Assets x 4.5%)

- Owner's Equity (OE)
  - OE = (Total Assets - Total Liabilities)

- Stocking Rate (SR)
  - SR = (Cows) ÷ Hectare

- Kilograms of milk solids produced per cow (kg MS/Cow)
  - Kg MS/Cow = (Total Kilograms of Milk Solids Produced per Farm) ÷ (Number of Maximum Cows Milked)

- Kilograms of milk solids produced per hectare (kg MS/Ha)
  - Kg MS/Ha = (Total Kilograms of Milk Solids Produced per Farm) ÷ (Total Farm Effective Area)

8.7 APPENDIX 7. Comparison of the eight variables included in the logistic model for the three risk groups created (High Risk Group, Medium Risk Group and Low Risk Group) for each season analysed

Season	1998/1999 (payout = $3.58 / kg MS)			1999/2000 (payout = $3.78 / kg MS)			2000/2001 (payout = $5.01 / kg MS)		
Risk Group*	HRG	MRG	LRG	HRG	MRG	LRG	HRG	MRG	LRG
N	81	57	51	58	109	63	48	28	166
Variable	Average	Average	Average	Average	Average	Average	Average	Average	Average
Total Effective Area	105 [a]	91 [ab]	82 [b]	98	95	115	101	107	119
Farm Working Expense Ratio	63% [a]	54% [b]	49% [c]	60% [a]	53% [b]	44% [c]	56% [a]	45% [b]	42% [b]
Economic Farm Surplus	$27,196 [a]	$46,447 [b]	$68,759 [c]	$29,600 [a]	$57,633 [b]	$132,344 [c]	$ 65,886 [a]	$ 109,876 [a]	$ 198,534 [b]
Debt to Asset Ratio	46% [a]	29% [b]	35% [b]	44% [a]	29% [b]	36% [ab]	33% [ab]	26% [a]	40% [b]
Debt Servicing Capacity	24% [a]	15% [b]	13% [b]	26% [a]	14% [b]	12% [b]	20% [a]	11% [b]	12% [b]
Operating Profit Margin	11% [a]	23% [b]	33% [c]	12% [a]	25% [b]	39% [c]	19% [a]	35% [b]	43% [c]
Asset Turnover Ratio	15%	15%	17%	15% [a]	16% [a]	22% [b]	19% [a]	21% [a]	28% [b]
Return on Equity	-5.62% [a]	1.59% [b]	5.89% [c]	-3.72% [a]	2.39% [b]	9.78% [c]	-0.42% [a]	6.57% [b]	15.49% [c]

* HRG = High Risk Group; MRG= Medium Risk Group; LRG = Low Risk Group
Different letters indicate differences at the 5% level (Bonferroni Test) within season

Season	2001/2002 (payout = $5.35 / kg MS)			2002/2003 (payout = $3.66 / kg MS)		
Risk Group*	HRG	MRG	LRG	HRG	MRG	LRG
N	31	33	113	60	91	37
Variable	Average	Average	Average	Average	Average	Average
Total Effective Area	88	102	110	137	119	110
Farm Working Expense Ratio	50% [a]	46% [a]	40% [b]	64% [a]	52% [b]	44% [c]
Economic Farm Surplus	$ 85,177 [a]	$ 127,330 [a]	$ 209,988 [b]	$ 39,124 [a]	$ 92,532 [b]	$ 139,659 [c]
Debt to Asset Ratio	28% [a]	23% [a]	38% [b]	39% [ab]	30% [a]	45% [b]
Debt Servicing Capacity	15% [a]	10% [b]	11% [b]	23% [a]	14% [b]	14% [b]
Operating Profit Margin	28% [a]	35% [b]	45% [c]	11% [a]	27% [b]	37% [c]
Asset Turnover Ratio	18% [a]	20% [a]	25% [b]	14% [a]	15% [a]	22% [b]
Return on Equity	2.54% [a]	6.37% [b]	14.63% [c]	-3.29% [a]	2.49% [b]	8.92% [c]

* HRG = High Risk Group; MRG= Medium Risk Group; LRG = Low Risk Group
Different letters indicate differences at the 5% level (Bonferroni Test) within season

8.8 APPENDIX 8. Comparison of the six additional variables analysed from the ProfitWatch database for the three risk groups created (High Risk Group, Medium Risk Group and Low Risk Group) for each season analysed

Season	1998/1999 (payout = $3.58 / kg MS)			1999/2000 (payout = $3.78 / kg MS)			2000/2001 (payout = $5.01 / kg MS)		
Risk Group*	HRG	MRG	LRG	HRG	MRG	LRG	HRG	MRG	LRG
N	81	57	51	58	109	63	48	28	166
	Average	Average	Average	Average	Average	Average	Average	Average	Average
Cost of milk ($/kg MS)	$3.99	$4.01	$4.04	$3.68	$3.86	$3.95	$3.93	$3.81	$3.99
Owners Equity	$829,478	$1,008,713	$856,912	$ 853,191 [a]	$ 1,065,986 [b]	$ 1,034,377 [ab]	$1,105,772	$1,153,979	$1,026,607
Stocking Rate	2.7	2.7	2.8	2.6	2.6	2.7	2.5 [a]	2.7 [ab]	2.8 [b]
Kilograms of Live Weight Total per Hectare	1177	1182	1211	1134	1131	1204	1122 [a]	1194 [ab]	1222 [b]
Kilograms of Milk Solids per Cow	257 [a]	269 [ab]	283 [b]	275 [a]	293 [b]	334 [c]	291 [a]	301 [ab]	323 [b]
Kilograms of Milk Solids per Hectare	684 [a]	731 [ab]	776 [b]	714 [a]	764 [a]	889 [b]	727 [a]	794 [ab]	873 [b]

* HRG = High Risk Group; MRG= Medium Risk Group; LRG = Low Risk Group
Different letters indicate differences at the 5% level (Bonferroni Test) within season

Season	2001/2002 (payout = $5.35 / kg MS)			2002/2003 (payout = $3.66 / kg MS)		
Risk Group*	HRG	MRG	LRG	HRG	MRG	LRG
N	31	33	113	60	91	37
	Average	Average	Average	Average	Average	Average
Cost of milk ($/kg MS)	$ 4.49 [a]	$ 4.00 [b]	$ 4.12 [b]	$ 4.12 [a]	$ 4.38 [ab]	$ 4.71 [b]
Owners Equity	$ 1,264,185 [ab]	$ 1,456,846 [a]	$ 1,119,753 [b]	$ 1,652,176 [a]	$ 1,703,304 [a]	$ 1,028,033 [b]
Stocking Rate	2.7	2.6	2.8	2.7	2.8	2.9
Kilograms of Live Weight Total per Hectare	1195	1196	1241	1257	1274	1300
Kilograms of Milk Solids per Cow	294 [a]	316 [ab]	327 [b]	315	327	338
Kilograms of Milk Solids per Hectare	776 [a]	823 [ab]	893 [b]	854	908	962

* HRG = High Risk Group; MRG= Medium Risk Group; LRG = Low Risk Group
Different letters indicate differences at the 5% level (Bonferroni Test) within season

8.9 APPENDIX 9. Complete results of the 2004 Survey according to Ownership Structure

	Owners		Sharemilkers		Managers	
	Mean	SD	Mean	SD	Mean	SD
Average Age of the operator (years)	48.47	10.40	36.92	8.28	39.58	13.01
Average farm size (effective hectares)	190	201	139	104	298	245
Average herd size	410	330	386	235	612	393
Average R1 heifers	86	78	80	53	183	131
Average milk solids production (kg)	135,152	105,644	123,598	82,652	201,739	130,443
Average percentage of heifers grazing off	60	45	82	35	54	50
Average percentage of cows wintered	47	45	46	44	53	47

	Owners		Sharemilkers		Managers	
Risk that the property will be too small	N	%	N	%	N	%
Minimal	93	29%	28	33%	6	43%
Some	83	26%	21	25%	3	21%
Moderate	80	25%	11	13%	2	14%
High	37	11%	16	19%	2	14%
Very High	31	10%	8	10%	1	7%
	324	100%	84	100%	14	100%

	Owners		Sharemilkers		Managers	
Risk in the level of debt	N	%	N	%	N	%
Minimal	57	18%	16	19%	3	23%
Some	67	21%	18	21%	5	38%
Moderate	119	37%	33	38%	2	15%
High	53	17%	14	16%	2	15%
Very High	25	8%	5	6%	1	8%
	321	100%	86	100%	13	100%

	Owners		Sharemilkers		Managers	
Risk with changing yields and prices	N	%	N	%	N	%
Minimal	13	4%	3	3%	0	0%
Some	66	21%	8	9%	2	14%
Moderate	120	37%	30	35%	8	57%
High	100	31%	38	44%	2	14%
Very High	22	7%	7	8%	2	14%
	321	100%	86	100%	14	100%

	Owners	Sharemilkers	Managers
SOURCE OF INFORMATION	%	%	%
Workshops, Seminars, Meetings & Field days	72%	79%	85%
Consulting officers	51%	52%	62%
Private consultants	38%	44%	62%
Television	40%	51%	38%
Radio	28%	28%	38%
Fact sheets	43%	44%	69%
Popular press	64%	70%	62%
Scientific publication	35%	33%	38%
Video / Audio tapes	10%	7%	15%
World Wide Web / Internet / E-mail	29%	38%	38%
Other	10%	7%	15%

	Owners		Sharemilkers		Managers	
AREAS OF FURTHER INTEREST	Mean Score [1]	SD	Mean Score [1]	SD	Mean Score [1]	SD
Production	3.71	0.92	3.65	1.11	4.09	0.83
Marketing	2.68	1.13	2.59	1.18	3.00	1.26
Financial	3.76	0.95	4.00	0.89	4.08	1.19
Legal	2.96	1.06	3.18	1.13	3.73	1.42
Human	3.34	1.08	3.50	1.03	4.08	0.79
Strategic Planning	3.47	1.04	3.59	1.01	4.00	1.08

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

	Owners				Sharemilkers				Managers			
RISK SOURCE	N	Mean Score [1]	SD	Rank	N	Mean Score [1]	SD	Rank	N	Mean Score [1]	SD	Rank
Market Risks												
Changes in product prices	319	3.99	0.83	1	85	4.20	0.67	1	14	4.14	0.77	1
Changes in world economic and political situation	320	3.78	0.89	2	86	3.76	0.80	4	14	3.93	0.73	3
Change in New Zealand's economic situation	319	3.58	0.87	7	86	3.60	0.84	7	14	3.64	0.93	5=
Changes in inputs costs	320	3.71	0.84	3	86	3.92	0.75	3	14	4.00	0.96	2
Financial Risks												
Changes in interest rates	320	3.63	1.08	5	86	3.56	1.05	8	13	3.77	1.17	4
Changes in land prices	320	3.00	1.12	14	86	3.43	1.19	10	14	2.93	1.38	18
Production Risks												
Rainfall variability	320	3.58	1.02	8	86	3.74	0.94	5	14	3.57	0.85	7=
Other weather factors	320	2.99	0.99	15	85	3.12	0.93	15	14	3.14	0.77	15=
Diseases or pests	320	3.40	1.06	10	86	3.62	0.90	6	14	3.29	1.14	13=
Disasters	317	2.61	1.17	17	84	2.57	1.20	19	14	3.14	1.10	15=
Regulatory Risks												
Changes in government laws and policies	320	3.61	0.93	6	86	3.49	0.88	9	14	3.43	1.02	10=
Changes in local bodies laws and regulations	321	3.46	0.93	9	86	3.20	0.97	14	14	3.64	1.08	5=
Changes in producer board policies	318	3.15	1.02	11	86	3.35	0.96	13	14	3.29	1.27	13=
Human Risks												
Accidents or health problems	321	3.66	1.02	4	85	3.95	1.08	2	14	3.57	1.02	7=
Changes in family situation	320	3.05	1.17	13	86	3.42	1.25	11	13	3.54	1.51	9
Miscellaneous Risks												
Theft	319	2.75	1.01	16	86	3.06	1.02	16	14	3.36	1.28	12
Problems with hired labour and contractors	320	3.06	1.13	12	86	3.38	1.10	12	14	3.43	1.22	10=
Changes in technology and breeding	319	2.52	0.94	18	86	2.78	0.95	17	14	3.00	1.18	17
Being unable to meet contracting obligations	317	2.33	1.02	19	86	2.64	1.08	18	14	2.79	1.42	19

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)
N is the number of responses received in each question for the 2004 Survey

RISK MANAGEMENT STRATEGIES	Owners					Sharemilkers					Managers				
	N	Mean Score [1]	SD	Rank	% [2]	N	Mean Score [1]	SD	Rank	% [2]	N	Mean Score [1]	SD	Rank	% [2]
Production responses															
Routine spraying and drenching	310	3.83	1.02	2	87%	85	4.27	0.84	1	96%	13	3.92	1.32	6	73%
Maintaining feed reserves	317	3.87	0.89	1	96%	85	3.96	0.87	3	93%	13	4.08	0.64	4	100%
Not producing to full capacity	284	2.75	1.10	14	41%	79	2.46	1.11	16	33%	11	2.36	1.21	16=	38%
Monitoring pests, crops, climate	295	3.23	1.02	11	60%	81	3.57	1.02	7	70%	13	3.00	1.63	13=	58%
Irrigation	205	2.09	1.38	18	16%	56	2.57	1.50	13	19%	11	3.00	1.95	13=	50%
Marketing responses															
Market information	273	3.03	1.12	12	58%	71	3.17	1.24	11	58%	9	3.33	1.50	10	55%
Spreading sales	249	2.50	1.17	15	28%	64	2.56	1.08	14	21%	12	2.25	1.48	17	23%
More than one enterprise	259	2.32	1.21	16	27%	60	2.45	1.13	17	20%	12	2.67	1.23	15	67%
Forward contracting	225	2.31	1.21	17	17%	58	2.26	1.15	18	15%	11	2.36	1.29	16=	31%
Futures markets	216	2.05	1.07	19	7%	61	2.21	1.10	19	7%	10	2.70	1.25	14	25%
Financial responses															
Keeping debt low	308	3.38	1.17	9	63%	80	3.30	1.25	10	62%	10	3.50	1.35	9	50%
Managed capital spending	305	3.62	1.00	6	85%	75	3.68	0.99	6=	79%	11	4.09	0.70	3	100%
Arranging overdraft reserves	294	3.48	1.11	8	79%	76	3.34	1.08	8	69%	10	3.30	1.49	11	50%
Debt management	295	3.78	1.07	3	84%	79	4.00	1.03	2	83%	10	3.80	1.23	8	73%
Financial reserves	299	3.36	1.12	10	65%	81	3.31	1.13	9	70%	10	4.20	0.79	2	83%
Insurance	295	3.52	1.26	7	77%	83	3.95	0.94	4	93%	12	4.25	0.87	1	100%
Off-farm investment	257	2.84	1.21	13	44%	69	3.01	1.38	12	40%	11	3.09	1.30	12	64%
Main operator working off-farm	236	1.84	1.05	21	14%	62	2.11	1.13	20	25%	11	2.00	1.26	19	23%
Family members working off-farm	234	2.04	1.14	20	26%	63	2.54	1.33	15	30%	11	2.09	1.70	18	33%
Overall reponses															
Short term flexibility	306	3.69	1.01	4	76%	81	3.94	0.94	5	82%	12	3.83	0.94	7	100%
Long-term flexibility	299	3.63	0.94	5	81%	77	3.68	0.98	6=	81%	10	4.00	1.25	5	78%
Strategic Management reponses [3]															
Using practical planning steps in your business	302	3.74	0.93	1	89%	80	4.00	0.93	1	91%	11	3.91	0.70	2	100%
Assessing strengths, weaknesses, threats and opportunities	300	3.61	1.00	2	82%	83	3.78	1.00	2	88%	12	3.92	0.90	1	91%
Having written a shared mission statement for your operation	255	2.45	1.22	5	22%	72	3.06	1.38	5	41%	13	3.15	1.57	4	58%
Having written a shared vision statement for your operation	249	2.52	1.24	4	24%	72	3.07	1.37	4	42%	12	3.00	1.60	5	55%
Using of financial ratios for decision making	276	3.06	1.17	3	57%	76	3.20	1.24	3	49%	12	3.08	1.38	3	55%

[1] Mean Score from 1 to 5 (1 = not important, 5 = extremely important)

[2] Percentage of farmers using the strategy

[3] Taken from Fetsch et al. (2001)

N is the number of responses received in each question for the 2004 Survey