Risk management portfolios in New Zealand dairy farming

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Abstract

New Zealand's dairy farming sector has changed dramatically over the last two decades. As a result of growth in global demand, dairy farms have become more intensive in production, more capital-intensive and have more debt. These changes increase the vulnerability of the dairy farmers to risks and uncertainties arising from various sources such as input prices, output prices, climatic conditions, and policy changes. In response to these uncertainties, dairy farmers utilise various sets of risk management strategies, henceforth known as portfolios of risk management strategies.

Previous studies have created a solid foundation for understanding dairy farms' responses to risk. In particular, they found that debt management and planning for capital spending are the two most important risk management strategies for New Zealand dairy farmers. However, little is known about what entails debt management and planning for capital spending from farmers' perspective. Hence, little is known about the diversity of risk management portfolios that New Zealand dairy farmers utilise to manage risks.

By extending the definition of portfolio of risk management strategies into the financial risk management space, this study was one of the first studies that provides a synthesis of farm business risk management and farm financial risk management through the perspective of a risk management portfolio. Six portfolios of risk management strategies were identified, each of which has a different mix of risk management strategies and implications for the overall business strategy. The results also showed that a range of farm and farmers characteristics shape NZ dairy farmers' portfolio of risk management strategies.

The range and complexity of financial management strategies identified in this study suggest that traditional financial management literature can benefit from insights gained from the empirical studies. The results provided the industry people such as rural consultants, policy makers, and banking sector much-needed insights into the risk management portfolios used by dairy farmers.

Keywords: Dairy farming, Risk management, Debt management, Liquidity management, New Zealand.

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Chapter One: Introduction

1.1 Background

The New Zealand dairy sector experienced significant changes over a 16-year period from 2001-2 to 2016-17 season. Increasing demand for dairy products in global markets has provided New Zealand dairy farmers with the opportunity to expand through debt funds while it has exposed farmers to a turbulent global economic and political environment (Bagrie, Williams, & Smith, 2015; Duranovich, 2015; Gray, Walcroft, Shadbolt, & Turner, 2014; Shadbolt & Olubode-Awosola, 2013). Over this period, the average herd size (number of milking cows) and the average milking area (effective hectares) increased by 72% and 61%, respectively. However, the extent and nature of farm expansion varies considerably across different regions of New Zealand (DairyNZ, 2017). While expansion in North Island (N.I) is mostly attributed to the amalgamation of small farm units, expansion in the South Island (S.I) is a result of land use change, normally from sheep and beef and arable to dairy farming, along with the development of irrigation-based pastoral systems in lower rainfall areas (Corong, Hensen, & Journeaux, 2014; Pangborn, Woodford, & Nuthall, 2015; Saunders & Saunders, 2012).

Intensification was another major change in New Zealand dairy farming sector. At the farm level, the stocking rate of dairy farms (milking cows per effective milking hectare) increased by 7.7% across the country. Again, the extent of intensification was different between N.I and S.I. While stocking rate in N.I does not show any trend over the 16-year period, in the S.I the stocking rate shows an upward trend, so that in the 2016-17 season the stocking rate was 12% higher than in the 2001-02 season. This is largely related to the expansion of dairy farming in Canterbury where irrigation and a stronger reliance on grazing young stock and non-lactating dairy cows off the milking platform allowed farmers to run higher stocking rates (Pangborn et al., 2015; Saunders & Saunders, 2012). Hence, the amount of feed (Kg dry matter-per-cow) and the amount of supplementary feed (i.e. non-pasture feed) offered to dairy cows increased by 9% and 219%, respectively (Figure 1-1) (DairyNZ, 2019).

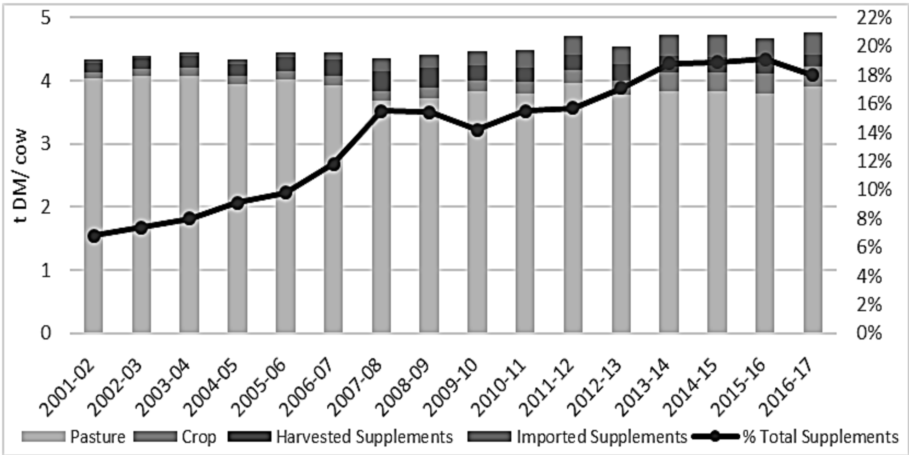

Figure 1-1: Breakdown between pasture and brought-in feed per cow (DairyNZ, 2019).

Although strong global dairy demand was the main driver of dairy expansion and intensification in New Zealand, it exposed farmers to turbulent global dairy markets, exchange rate risk and the global economic and political environment (Dooley, Shadbolt, Khatami, & Tauer, 2017; Gray, Dooley, & Shadbolt, 2008; Shadbolt & Olubode-Awosola, 2016). As a result, dairy farmers have faced increasingly volatile terms of trade[1] over the 16-year period from 2001-2 to 2016-17 (Figure 1-2). The volatility in MS price is a major contributing factor in the output terms of trade volatility. Expenses such as feed, fertiliser, and repair & maintenance (R&M) were other contributing factor in the input terms of trade volatility (DairyNZ, 2018).

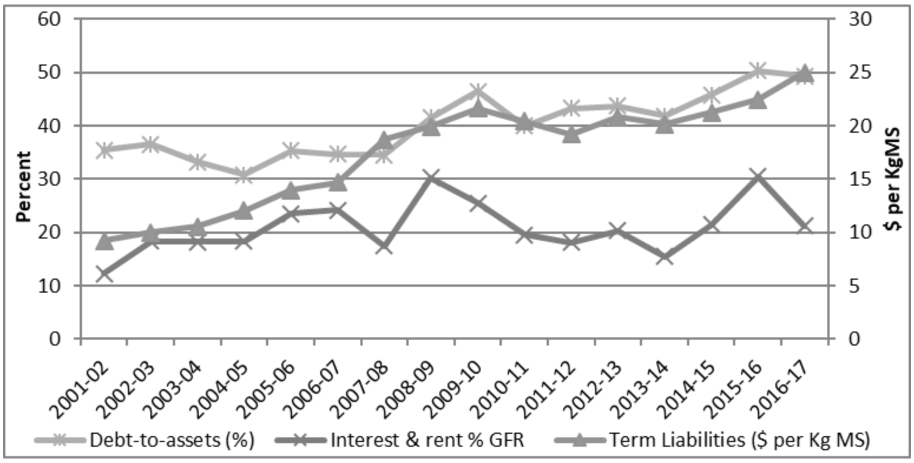

Figure 1-2: Dairy Farm Owner-operator Terms of Trade (2001-02 to 2016-17) (DairyNZ, 2012, 2016, 2018).

The second drawback is related to the financial position of the New Zealand dairy farms. Dairy expansion has largely been funded by debt (Greig, 2010; Greig, Nuthall, & Old, 2018; Ma, Renwick, & Zhou, 2020). The Reserve Bank of New Zealand (RBNZ) reported that the total liabilities of the New Zealand dairy industry almost trebled over the past decade reaching NZ$ 45 billion in 2016. In the

[1] The MS price earned to input price paid ratio. It indicates the real purchasing power of each dollar of revenue at the farm gate relative to the previous years.

2016-17 season, the average debt-to-asset ratio of NEW ZEALAND dairy farmers was 49.4% (RBNZ, 2016). Hence, interest and rent payments were equal to 21 percent of gross farm revenue (GFR) (DairyNZ, 2009, 2019) (Figure 1-3).

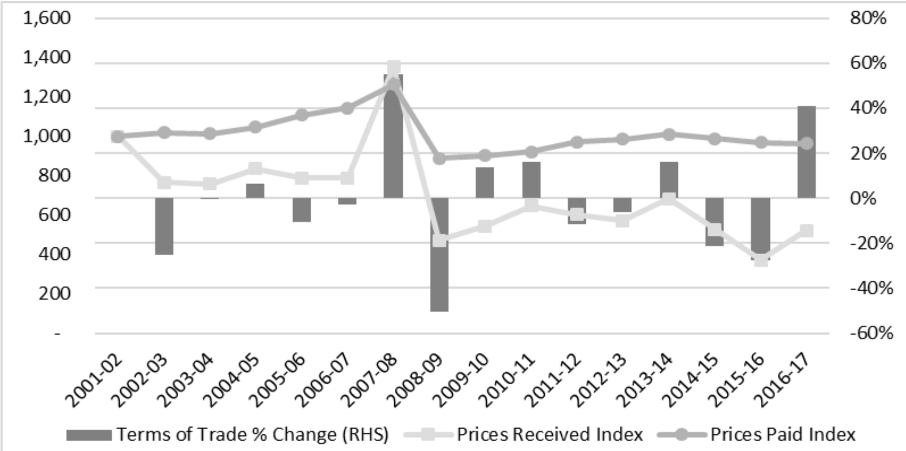

Figure 1-3: Owner-operators' debt and liabilities (DairyNZ, 2009, 2018).

Another drawback of the intensification of NEW ZEALAND dairy farming systems is a higher breakeven milk price. As a result of more reliance on non-pasture feed[2], farm working expense (FWE) per kilogram of milksolids increased by 37% over the 16-year period (Ma, Bicknell, & Renwick, 2019; Ma, Renwick, & Bicknell, 2018; Shadbolt, Siddique, & Hammond, 2017). This increase in FWE combined with an increase in the interest and rent expenses led to a 13 percent increase in the break-even milk price[3] over the 16-year period (Figure 1-4).

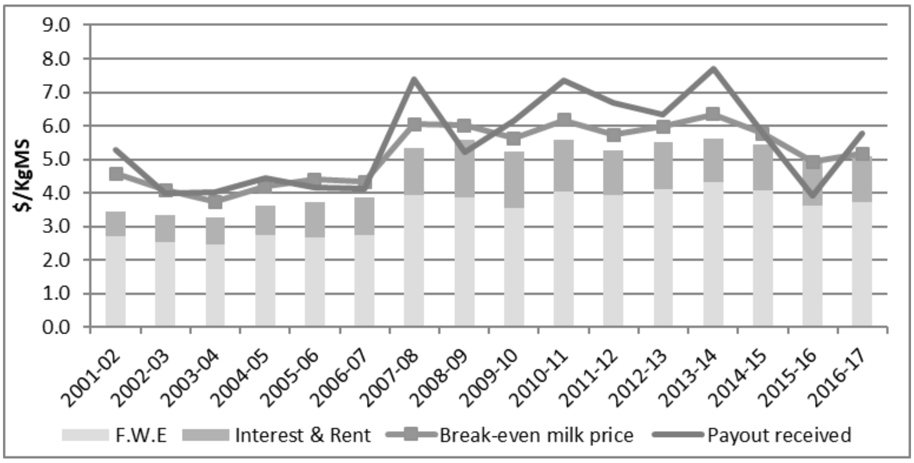

Figure 1-4: Trend in the actual and break-even milk price (DairyNZ, 2009, 2018).

The final drawback from the expansion and intensification of NEW ZEALAND dairy farming systems is related to the environmental impact of the dairy farming sector. Intensification of dairy farming operations contributed to a range of environmental issues including the degradation of freshwater

[2] The impact of intensification on the physical and financial performance is discussed in the section 2.5.1.3.3.
[3] The milk price required to meet the cash costs of a farm prior to any development, off farm income or introduced funds.

ecosystems (Baskaran, Cullen, & Colombo, 2009; Foote, Joy, & Death, 2015). As a result of the growing concern over the degradation of rivers and groundwater, the government has introduced the essential freshwater package (EFP) to minimise the impact of dairy farming on freshwater ecosystems. Expansion and intensification of the dairy farming sector is also closely associated with greater greenhouse gas (GHG) emissions. Between 1990 and 2018, emissions from the dairy farming sector rose by about 130%, accounting for 22.9 percent of total GHG emission in 2018 (2020). While this is largely driven by the dairy sector's expansion (Foote et al., 2015), the intensification of dairy farming systems through the inclusion of supplementary feed is also contributing to an increase in the sector's GHG emission (Ledgard & Falconer, 2015).

To summarise, although New Zealand dairy farmers have successfully expanded and intensified their business operations over the past 16 years, current levels of debt expose farm businesses to financial risk arising from debt. This high debt coupled with highly turbulent terms of trade (Shadbolt et al., 2017) led to a high level of volatility in relation to farm financial performance over this period (Beux Garcia, Shadbolt, & Dooley, 2015; Ma, Bicknell, et al., 2019; Tozer, 2017). Exposure to financial risks and volatility in terms of trade may limit dairy farmers capacity to withstand future price downturns, as well as constrain their ability to invest and adapt to the changes required of the sector over the longer term. This is particularly important in the context of the environmental regulatory and macro-economic risks currently facing the dairy farming sector (Greig, Nuthall, & Old, 2019; Ma et al., 2020).

1.2 Farm risk management

What makes some dairy farmers successful while others are terminated every day? The implicit answer to this question is dairy farmers' managerial ability. Managerial ability enables dairy farmers to manage uncertainties and generate profit (Patrick & Ullerich, 1996). There are many uncertainties within the dairy farm business environment that cause volatility in the dairy farm business, and it is important that dairy farmers obtain the skills to cope with an increasingly turbulent business environment. New Zealand dairy farmers use different risk management strategies to manage these risks (Gray, Dooley, et al., 2008; Shadbolt, 2008; Shadbolt, Olubode-Awasola, Gray, & Dooley, 2010; Shadbolt & Olubode-Awosola, 2013; Shadbolt, Olubode-Awosola, & Rutsito, 2013), and it is important for extension personnel to identify the different risk management strategies that have been utilised by dairy farmers and also to understand what determines their choice of strategies.

This information can enable extension specialists to provide risk management recommendations that best suit a farmer's risk profile and context. Such understanding would also help policy makers to provide targeted information and advice that is aligned with farmers' motives and characteristics. Moreover, it enables insurers to offer customized complementary risk management services, and help farmers to manage risks, which are not manageable with the current set of risk management strategies.

A series of studies have investigated pastoral farmers' risk management strategies in New Zealand. To begin with, Martin's (1996) study of pastoral farmers' risk perceptions and their perceived importance of risk management strategies[4] found that change in product prices, rainfall variability, change in the world economic and political situation, and changes in the New Zealand economic situation were the most important risks faced by dairy farmers at the time of the study. Hence, routine spraying and drenching, maintaining feed reserves followed by financial management strategies (Keeping debt low, and managing capital spending[5]) were the most important risk management strategies utilised by dairy farmers.

Almost a decade later[6], Pinochet-Chateau, Shadbolt, Holmes, and Lopez-Villalobos (2005) repeated the study by Martin (1996) to explore changes in the dairy farmers' risk perception and importance of different risk management strategies. Consistent with the early studies, they found that change in product prices and change in the world economic and political situation are still among top three risks. However, the 'diseases and pests' was a less important risk in 2004. Instead, rainfall variability became a more important source of risk when it compared to 1992 survey (Pinochet-Chateau et al., 2005). In terms of risk management strategies, the results confirmed that routine spraying and drenching and the use of feed reserves were still the main production risk management strategies. However, they reported a shift from a "keeping debt low" strategy in the mid 1990's (Martin, 1996) to "managing debt" in the 21st century (Pinochet-Chateau et al., 2005).

The majority of risk management studies have focused only on 'downside risks' whereas in many risky situations, the potential benefits from upside risk can explain why farm managers accept a certain degree of risk in their businesses (Detre, Briggeman, Boehlje, & Gray, 2006; Hardaker, 2006; Hardaker, Huirne, Anderson, & Lien, 2004; Shadbolt et al., 2010). As such, to fully understand farmers' risk-taking and management behaviour, an unbiased view of risk must be taken where both upside and downside risk are considered (Detre et al., 2006; Hardaker, 2006; Hardaker et al., 2004; Shadbolt et al., 2010).

Almost two decades after the seminal study by Martin (1996), another empirical study by Shadbolt and Olubode-Awosola (2013) investigated farmers' perceptions of both "upside" and "downside" risk. Their results showed that New Zealand dairy farmers perceive "global supply and demand" and "product prices" as the sources of risk (i.e., opportunities) that they benefit from (Shadbolt & Olubode-

[4] The survey was undertaken in 1992.

[5] Capital expenditures include tractors, trucks, cars, machinery, buildings, land improvements, and miscellaneous capital expenditures.

[6] The survey was undertaken in 2004.

Awosola, 2016). In contrast, “Input prices & availability” and “local body laws & regulation” were the most important sources of threat. Finally, congruently with the 2004 survey (Pinochet-Chateau et al., 2005), they found that that “managing debt” and “planning for capital spending” were the farmers’ most important risk management strategies (Shadbolt & Olubode-Awosola, 2013).

An important consideration in understanding farmers’ risk responses is the interconnectedness of risk management strategies. Several studies provide evidence that showed the use of risk management strategies are complementary (Pennings, Isengildina-Massa, Irwin, Garcia, & Good, 2008; Sartwelle, O'Brien, Tierney, & Eggers, 2000) and interrelated (Kuethe & Morehart, 2012; Pennings et al., 2008; Tudor, Spaulding, Roy, & Winter, 2014). In reality, risk management strategies are part of the overall management strategy, and the choice of a particular risk management strategy is a function of what other strategies are used by the farmer (de Mey et al., 2014; Gabriel & Baker, 1980; Gray, Reid, & Horne, 2011; Gray et al., 2014; Gray, Parker, & Kemp, 2009; OECD, 2009; Pennings et al., 2008). Therefore, rather than focusing on a single risk management strategy and assuming that risk management strategies are discrete and independent (van Winsen et al., 2013; van Winsen et al., 2014), farmers’ risk management behaviour should be operationalised in the form of a bundle, a set, or a “portfolio of risk management strategies” (Meraner & Finger, 2017; Tudor et al., 2014; Velandia, Rejesus, Knight, & Sherrick, 2009).

Empirical studies have indicated that New Zealand dairy farmers use different portfolios of risk management strategies (Gray et al., 2014; Martin & McLeay, 1998; OECD, 2009). In an attempt to identify different sets of risk management strategies (i.e., risk management portfolio), Martin and McLeay (1998) proposed that although farmers have access to a wide range of risk management strategies, they only use a limited sub-set of these risk management. Based on the above proposition, a sample of sheep and beef farmers in New Zealand were classified into four groups based on the risk management strategies that they indicated were important in their farm businesses (i.e., a portfolio of risk management strategies).

Martin & McLeay’s study (1998) was one of the few studies that provided empirical evidence about the integrated nature of farmers' risk management activities, and the fact that a high degree of diversity exist between farmers in term of their adopted risk management strategies (Martin & McLeay, 1998). One interesting discussion point raised by Martin and McLeay (1998) was that except for one group of farmers, all other groups placed a reasonably high emphasis on financial risk management strategies including keeping debt low, managing debt and planning for capital spending. Despite the fact that financial management consistently has been identified as important in farmers’ overall portfolio of risk management strategies (see for example Martin (1996), Pinochet-Chateau et al. (2005), and Shadbolt and Olubode-Awosola (2013)), with the exception of Gray et al.'s (2014) research on dairy farmers' financial management, there has been limited research into the financial risk management strategies used by farmers in New Zealand. This problem, partially, lies with the fact that the agricultural finance and farm management literature have largely developed separately (Barry & Stanton, 2003).

Most of the studies in the farm risk management context treat the financial structure of the farm as an external, independent factor that may influence farmers' risk management decisions (Flaten, Lien, Koesling, Valle, & Ebbesvik, 2005; Meuwissen, Huirne, & Hardaker, 2001; Pennings et al., 2008; van Winsen et al., 2014). However, from a farmer's perspective, financial risk management strategies and business risk management strategies are integrated (Gray et al., 2014; OECD, 2009; van Winsen et al., 2013). As such, several studies in the agricultural finance (Collins, 1985; de Mey et al., 2014; Escalante & Barry, 2001, 2003; Wauters et al., 2015) and farm systems areas (Cowan, Kaine, & Wright, 2013; Gray et al., 2014) suggest that farmers are using financial management tools to cope with risk on their farms. Hence, financial management responses have been found to be particularly important strategies for managing the newer risks such political, regulation and legislation risks (also called institutional risks) (Boehlje, Gray, Dobbins, Miller, & Ehmke, 2003; Boehlje & Lins, 1998; Flaten et al., 2005; van Winsen et al., 2014).

Traditional financial management methods such as maintaining a low debt position and keeping cash in hand are the most widely discussed financial risk management strategies in the literature (Barry & Ellinger, 2012; Hardaker, Huirne, Anderson, & Lien, 2015). However, as explained previously, New Zealand dairy farmers moved away from "keeping debt low" and focused on "managing debt" as their main risk management strategy. But it is unclear from the literature what debt management in the New Zealand dairy farming context entails. Therefore, it is important to identify what financial risk management strategies are utilised by dairy farmers. This, in turn, provides a better understanding of New Zealand farmers' portfolio of risk management strategies.

1.3 The determinants of farmers' portfolios of risk management strategies

The field of farm risk management draws heavily on managerial economics (March & Shapira, 1987; Sitkin & Weingart, 1995) and psychology (Kahneman & Tversky, 1979; Pratt, 1964; Tversky & Kahneman, 1974). According to these theories, managerial decisions reflect managers' (i.e., farmers) personal and socio-economic characteristics. In particular, farmers' perceptions and attitude toward risk (i.e., risk preferences) plays a crucial role in describing the decision-making behaviour of farmers in risky situations (Ahsan, 2011; Flaten et al., 2005; Meuwissen, Huirne, et al., 2001; van Winsen et al., 2014). Hence, the risk management behaviour of farmers depends on the biophysical characteristics of the farm (i.e., location, farm size and infrastructure) (Martin & McLeay, 1998; McLeay, Martin, & Zwart, 1996). Figure 1-5 provides a simplified conceptual model that is developed to depict the relationship between risk attitude (as one of the farmer's characteristics), risk perceptions and the economic behaviour (risk management behaviour) of farmers.

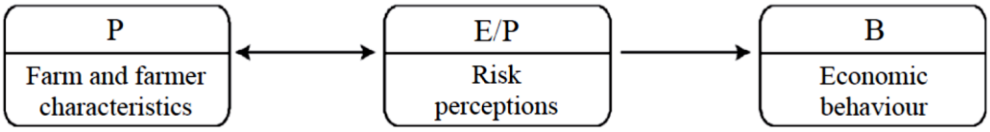

Figure 1-5: Conceptual framework of farmers decision making (adapted from Flaten et al., 2005; van Raaij, 1981).

Integrated models provide evidence of the relationship between farm and farmer characteristics and farmers' risk management behaviour. However, the explanatory power of these models is generally low (Ahsan, 2011; Flaten et al., 2005; Meuwissen, Huirne, et al., 2001; Patrick & Musser, 1997; van Winsen et al., 2014). Several studies argued that the low explanatory power of the models was due the fact that risk perceptions are very personal (i.e., varying from farmer to farmer), (Koesling et al., 2004; Meuwissen, Huirne, et al., 2001; van Winsen et al., 2014). Another possible explanation for the low explanatory power of the models is that important risk management strategies, explaining farmers' risk responses, are not incorporated in the questionnaire (Meuwissen, Huirne, et al., 2001). This particularly applies to newer multi-dimensional risks (such political, regulation and legislation risks) that require multiple management responses (Boehlje & Lins, 1998). In particular, financial management responses (solvency, liquidity, and low-cost production) were found to be highly important strategies to manage these risks (Flaten et al., 2005; van Winsen et al., 2014). However, as discussed in the previous section (section 1.2), the majority of studies that investigated farmers' risk management responses assume that financial risk management is limited to two strategies, keeping debt low and liquidity reserves.

Several studies have proposed that a limited number of factors may not be able to predict farmers' behaviour, and that other factors may be helpful in explaining their risk management behaviour (Wilson, Dahlgran, & Conklin, 1993). Farmers' goals (Fairweather & Keating, 1994; Parminter & Perkins, 1997; Patrick, Blake, & Whitaker, 1983), personality traits (Basarir, 2002; Rawlings, 1999; Willock, Deary, McGregor, et al., 1999; Xu, Alexander, Patrick, & Musser, 2005), knowledge and beliefs (Baquet et al., 2008; Hall, Knight, Coble, Baquet, & Patrick, 2003; Patrick, Peiter, Knight, Coble, & Baquet, 2007; Patrick & Ullerich, 1996), perceived self-efficacy, locus of control , and management styles (Alvarez & Nuthall, 2001; Brodt, Klonsky, & Tourte, 2006; Fairweather & Keating, 1994; Parminter & Perkins, 1997) are some of the characteristics that have been investigated to improve the explanatory power of the models of farmers' risk responses.

Although the above studies create a solid foundation for analysing risk management behaviour, several questions still remain unanswered regarding the impact of risk attitude, risk perception and farm and farmers characteristics on farmers' choice of risk management strategies. Obtaining a more in-depth understanding of the financial risk management strategies used by farmers would provide a more comprehensive picture about farmers' risk responses (i.e., risk management portfolios). This in turn should improve the understanding about the relationship between farm and farmer characteristics, risk attitude and risk perception and farmers' risk responses (operationalised through risk management portfolios).

1.4 Problem statement

New Zealand dairy farmers use a wide range of risk management strategies based on the biophysical farm and farmer characteristics (Gray, Dooley, et al., 2008; Shadbolt, 2008; Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2013; Shadbolt et al., 2013). Previous studies operationalised farmers' risk management behaviour with the view that these strategies are independent from each other and that there are no interaction between these strategies. However, several theoretical (Hardaker et al., 2015; OECD, 2009) and empirical studies (Coffey & Schroeder, 2018; Martin & McLeay, 1998; Meraner & Finger, 2017; Pennings et al., 2008; Tudor et al., 2014) have highlighted that a farmer's choice of risk management strategies are interconnected and interrelated. As such, it is more appropriate to operationalise risk management behaviour as a set of risk management strategies (here after this will be referred to as "a portfolio of risk management strategies").

A limited number of empirical studies that have operationalised farmers' risk responses through the lens of a risk management portfolio tend to focus on a narrow set of risk management strategies (i.e., insurance, forward contracts). However, empirical studies in the agricultural finance literature provide evidence that showed that farmers extensively rely on financial management tools to manage risk in their farm businesses (Collins, 1985; Escalante & Barry, 2001; Gabriel & Baker, 1980). No empirical studies have integrated both financial and business management strategies when investigating farmers' risk management behaviour. By extending the definition of a portfolio of risk management strategies into the financial risk management space, this research offers a synthesis of farm business risk management and farm financial risk management through the perspective of a risk management portfolio. This will be accomplished by incorporating capital structure, debt servicing, and liquidity management strategies into the overall set of risk management strategies and conducting additional analysis to better understand the impact of financial risk management strategies on the portfolio of risk management strategies adopted by New Zealand dairy farmers.

Operationalising farmers' risk responses in the form of a risk management portfolio that entails financial management strategies should provide new insights into farmers' risk responses and provide a more comprehensive understanding of its determinants. The result of this study will help extension personnel to identify the diversity of risk management portfolios that have been chosen by New Zealand dairy farmers and to also understand what determines the structure of these portfolios. This information will help extension specialists to provide risk management recommendations that best suit a farmers' risk profile and context. Such an understanding would also help policy makers to provide targeted information and advice that is aligned with a farmer's motives and characteristics. Moreover, it enables insurers to offer customized complementary risk management services to help farmers to manage risk.

1.5 Research aim

The main aim of this research is to explore the diversity of risk management portfolios that New Zealand dairy farmers use to manage business (production, market, human resources) and financial risks, and to understand the factors that determine the farmers' choice of a risk management portfolio.

1.6 Research questions

1. What are the business (production, market, human resources) and the financial risk management strategies, within the portfolio of risk management strategies, that New Zealand dairy farmers utilise to manage risk in their farm businesses?
2. What is the diversity of risk management portfolios that New Zealand dairy farmers employ to manage risk in their farm businesses?
3. What are the trade-offs and the interrelationships between risk management strategies?
4. What farm-specific and farmer-specific factors shape New Zealand dairy farmers' portfolio of risk management strategies?

1.7 Research objectives

These research questions were answered by addressing the following objectives:

- To describe the business risk management strategies that New Zealand dairy farmers utilise to manage risk in their businesses.
- To describe the financial risk management strategies that New Zealand dairy farmers utilise to manage the risks in their businesses.

- To identify and describe the diversity of risk management portfolios that New Zealand dairy farmers utilise to manage the risks in their farm business environment.
- To identify farmers' current risk perceptions, risk attitudes and other socio-economic variables that shape their portfolio of risk management strategies.

Chapter Two: Literature Review

2.1 Chapter outline

This study set out to answer the following research questions:

1. What risk management portfolios do New Zealand dairy farmers use to manage risk in their farm businesses?
2. What are the business (production, market, human resources) and the financial risk management strategies within the risk management portfolios that New Zealand dairy farmers use to manage risk in their farm businesses?
3. What factors influence New Zealand dairy farmers' choice of risk management portfolio?

The following sections review the literature relevant to these questions. The primary focus of the review is on the farm management literature, but because there is a paucity of literature in New Zealand dairy farm financial management, this chapter also drawn on the empirical studies in agricultural finance from other countries and research in corporate finance and small and medium enterprises (SMEs) field.

Section 2.2 reviews the definitions of risk and uncertainty. Sources of risks and different schemas for classifying sources of risk are presented in the Sections 2.3 and 2.4. Section 2.5 provides an overview of the sources of risk in New Zealand dairy farming. Section 2.6 reviews the literature about farmers' views on sources of risk. Sections 2.7 and 2.8 introduce the definition of risk management and a taxonomy of risk management strategies, respectively. Section 2.9 provides an overview of the impact of strategic-level decisions on shaping farmers' risk management portfolios. Section 2.10 presented an in-depth overview of the different types of business risk management strategies that New Zealand dairy farmers utilise to manage risk in their farm businesses and the potential impact of these strategies on farmers' risk management portfolio choice . Section 2.11 present an overview of the financial structure and policies that New Zealand dairy farmers utilise to manage their farm businesses. Section 2.12 reviews the empirical studies on farmers' views of risk management strategies within the New Zealand dairy farming context. Section 2.13 provides a review of the determinants (i.e., farm and farmers characteristics) of a farmer's risk management behaviour and the different conceptual models that integrate these determinants. In Section 2.13.1, the concept of a risk management portfolio is introduced. The implication of adopting a portfolio of risk management strategies framework for investigating New Zealand dairy farmers' risk management behaviour is also discussed in this section. Finally, a summary of the chapter is presented in the section 2.14.

2.2 The definition of risk and uncertainty in farm management

Several definitions of risk and uncertainty are provided in a management and economics context, including the agricultural and resource economics and farm management literature. These definitions can be divided into two prevailing categories. In the first category, risk and uncertainty are expressed by means of the probability and potential severity of an adverse outcome (probabilistic view), whereas in the second category, risk is expressed through events, consequences, and uncertainties.

From a probabilistic point of view, two dimensions shape the concept of risk: the probability of loss and the expected impact of the loss (Eidman, 1990; Hardaker et al., 2004). The difference between risk and uncertainty is that under conditions of uncertainty, the decision-maker does not know the probability of the expected loss, whilst under conditions of risk, the probability of an unfavourable outcome is known (Hardaker et al., 2015). Although this distinction is widely accepted in statistics and actuarial sciences, the usefulness of this distinction has been criticised for two reasons (Hardaker et al., 2015; OECD, 2009). First, in the vast majority of situations, insufficient numerical observations are available for determining the probability of loss and estimating its impact (Hardaker, 2006; Hardaker et al., 2004). Second, elaboration of probabilities for extremely unlikely events such as wars, global pandemics, and extreme weather conditions (e.g., drought, and flooding) is extremely complex. Yet, these Black Swan events (Taleb, 2007) have a considerable impact on the well-being of the farm mangers. Finally, from a managerial perspective, subjective probabilities (individuals' assessments of relative frequency) (Savage, 1954) are the basis that shape one's judgement (Chavas Jean-Paul, 2004; OECD, 2009). That is, farmers utilize a wide range of available information, from objective probabilities and forecasted data to their best guess, to estimate the likelihood of unfavourable events and what the consequences will be (Boehlje, Roucan-Kane, & Broring, 2011; Chavas Jean-Paul, 2004; OECD, 2009). Therefore, the probabilistic distinction between risk and uncertainty provides little practical insight into risk in the farm management context (Hardaker et al., 2015).

In the second category of definitions, risk is defined as an event where the outcome is uncertain. A distinction between risk and uncertainty in this category is proposed by Hardaker et al. (2015) in which they defined: "uncertainty as imperfect knowledge and risk as uncertain consequences, particularly possible exposure to unfavourable consequences" (p.4). Similarly, Crane, Gantz, and Isaacs (2013) defined risk "as the chance of loss or an unfavourable outcome associated with an action, whereas uncertainty is not knowing what will happen in the future" (p.1). According to this definition, uncertainty is a value-free statement that is concerned with the imperfect knowledge in a situation or an action regardless of its outcome, whereas risk is not a value-free concept and is often associated with adversity and negative consequences of a situation or an action (Crane et al., 2013; Hardaker et al., 2015). For example, uncertainty can refer to a situation where the decision maker is uncertain about what the weather will look like in Fiji over the next month (a value-free statement simply implying imperfect knowledge of the future). However, when a decision maker is planning a holiday to Fiji in the next month, the possibility of a tropical storm over that period places the decision maker's value at stake. Therefore, uncertainty is a state of the world and exists regardless of the decision maker's evaluation, whereas risk does not exist independent of the decision maker because the value at stake needs to be evaluated by somebody (Aven & Renn, 2009; Slovic, 1992). This view of risk is congruent with the psychometric paradigm of risk (Slovic, 1992), which is adopted by Wilson et al. (1993) and became the foundation of risk perception research in the agricultural economics and farm management fields (see section 2.13.3). According to the psychometric paradigm of risk, "*Human beings have invented the concept of risk… there is no such thing as real risk or objective risk*" (Slovic, 1992, p. 119). Therefore, risk perception is equal to risk.

This proposition does not mean that the definition of probability is invalid in the risk context. Probability is a way of expressing risk through the eyes of the beholder (also called subjective probability) (Slovic, 1992; Slovic, 2000). This subjective probability is based on personal beliefs, affects and experiences irrespective of their validity. It also may be based on available statistical data, direct experience, models, and theoretical approximations that may also be plausible to others (van Winsen et al., 2011). In summary, the distinction between risk and uncertainty in the first category of definitions comes down to the knowledge about the probability of an adverse event (epistemology[7]), whereas in the second category of definitions, the distinction refers to the ontological[8] (state of the world) difference between risk and uncertainty (Aven & Renn, 2009).

One of the shortcomings of the risk research studies in the agricultural economics and farm management context is that they focus on downside risk and try to minimize business uncertainty. In reality, uncertainty has upside potential as well as a downside exposure (Detre et al., 2006; Shadbolt et al., 2010). Farming involves taking risk to obtain a higher income (further discussed in the section 2.4) (Hardaker et al., 2015; OECD, 2009).

The farm debt decision can be a good example of upside risk in the New Zealand dairy farming context. While farm expansion through debt financing exposes farmers to financial risk, it allows farmers to create wealth by taking advantage of capital (land) appreciation. Historical data on dairy farmers' equity growth (an indicator for wealth creation) shows that average dairy farm equity (owner's funds or net worth) increased by 8.9% over a 16-year period.

[7] Assumptions about the way of knowing the nature of reality
[8] Assumptions about the nature of reality

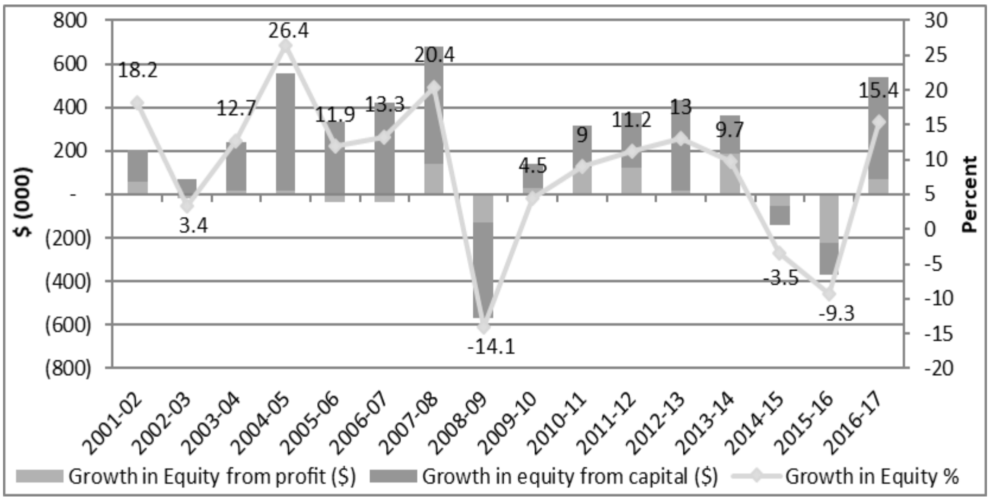

Figure 2-1: Owner-operators' equity growth and components of Equity (DairyNZ, 2010, 2018).

A closer look at the components of equity growth highlighted that, on average, over 90% of the growth is driven by capital appreciation, with profits from the dairy farming operation contributing less than 10% of this equity growth (DairyNZ, 2010, 2019). However, equity growth from capital is fuelled by debt funds. As such, focusing on potential threats, which typically occurs in analysing risk (Boehlje et al., 2011; Hardaker & Lien, 2007; Shadbolt et al., 2010), can produce misleading results about dairy farm debt. As Hardaker and Lien (2007) pointed out, "two risky prospects with similar downside consequences may have very different upside outcomes, so that one would be acceptable and the other not"(p. 83).

Apart from potential upside risk in any uncertain situation, there is ample evidence from empirical studies that suggests farmers may use risk management tools to increase income rather than to reduce volatility (Kuethe & Morehart, 2012; Patrick, Musser, & Eckman, 1998; Pennings, Isengildina, Irwin, & Good, 2004; Shapiro & Brorsen, 1988). Kuethe and Morehart (2012) employed a propensity score matching method to explore the impact of utilising different risk management instruments (three input and six output risk management tools) on increasing farm profitability among a sample of farmers. The risk management strategies include input risk management tools, marketing risk management tools, and utilising both input and marketing risk management tools (Kuethe & Morehart, 2012). Their results highlighted that input risk management tools are associated with significantly higher levels of net farm income. Moreover, their findings suggest that the farmers place greater emphasis on input purchasing tools that have a higher potential to enhance profits rather than reduce risk (Kuethe & Morehart, 2012).

In a recent study, Cao, Weersink, and Ferner (2019) findings suggest that Canadian beef farmers are using insurance as both an investment strategy (upside risks) and as a tool to protect their farm businesses against business risks (downside risk)(Cao et al., 2019). Similarly, Pennings et al. (2004)

survey on the impacts of marketing extension services on the marketing decisions among crop farmers in the Midwest, Great Plains, and South-east of the United State supported the notion that producers may use risk management tools to increase income rather than to reduce risk (Pennings et al., 2004). This point is best described by Hardaker et al. (2015): "It is particularly dangerous to equate risk minimization with minimizing the variability of returns [as a measure of risk] … in many situations the best route to risk efficiency is by finding strategies that improve the expected value of returns" (p. 224).

As such, 'upside risk' as well as 'downside risk' should be considered to better understand why farm managers accept a certain degree of risk in their businesses and why they utilise or do not utilise a particular risk management strategy in their farm business (Cao et al., 2019; Detre et al., 2006; Hardaker, 2006; Shadbolt et al., 2010). Based on the above assertion, Harwood, Heifner, Coble, Perry, and Somwaru (1999) proposed a neutral definition that accommodates both 'upside risk' and 'downside risk': "risk is uncertainty that matters" (p. 2).

One of the important features of Harwood et al.'s (1999) definition is its inclusiveness. Traditionally, the agricultural economics literature has focused on yield and price risk (Chavas, Chambers, & Pope, 2010; Just, 2003; OECD, 2009). However, farmers face a range of risks that matter to them. As such, Harwood et al.'s (1999) definition encompasses the diverse range of risks that farmers face. Even though farmers face several uncertainties in their farm businesses, it is neither possible nor worthwhile to fully explore all the risks that farmers face within their farm businesses. That is, only risks that is likely to have a significant impact on the farm owner's financial and personal position needs to be considered (Hardaker, 2006; Hardaker & Lien, 2010). Again, this latter point is best described by Hardaker and Lien (2010): "It is sensible to set a farmer's risk issues in the context of the overall asset position of the business; on this basis, only risks that threaten [or improve] the asset base need be taken seriously"(p. 347). Accordingly, a more compelling definition of risk and uncertainty, offered by Robison and Barry (1987), is deemed to be suitable. Based on this definition "events are uncertain when their outcome is not known with certainty...uncertain events are important when their outcomes alter a decision maker's well-being[9]" (Robison & Barry, 1987, p. 13). Accordingly, risk

[9] A multidimensional concept that refers to a dynamic process that gives people a sense of how their lives are evolving, and stems from the degree of fit between an individuals' beliefs, their objectives, their needs, aspirations and values (Boncinelli & Casini, 2014; Nimpagaritse & Culver, 2002).

is defined as "uncertain events whose outcomes alter the decision maker's material [economic][10] or social [non-material][11] well-being"(Robison & Barry, 1987, p. 9).

In summary, the definition proposed by Robison and Barry (1987) is deemed suitable for this study because it has four desirable characteristics. First, it offers a useful distinction between risk and uncertainty that fits with the psychometric paradigm of risk and risk perception. Second, it presents a neutral definition of risk that accommodates both 'upside risk' (opportunities) and 'downside risk' (threats). Third, this definition provides an inclusive view of risk that encompasses a diverse range of risks (e.g., human resources, technology etc.). Finally, it only focuses on the important risks that may alter a farmer's well-being. Therefore, it allows the researcher to investigate farm risk in a comprehensive, but non-exhaustive manner. The next section introduces different sources of risk and provides an overview of different risk classification schemas in agriculture.

2.3 Sources of risk in agriculture

Farmers face a wide variety of risks that originate from different sources of uncertainty. Several classification schemas are offered in the literature for sources of risks. These are driven from two prevailing classification schemas. In the first schema, risks are differentiated according to the management field they impact on, namely: "business risks" and "financial risks" (Gabriel & Baker, 1980). In the second risk schema, risks are differentiated according to the level of management they impact on, namely: "operational or tactical risks" and "strategic risks" (Boehlje & Lins, 1998). Each of these classification schemas are reviewed in the following sections.

2.3.1 "Business risk" and "financial risk"

The seminal works of Johnson and Haver (1954) proposed that farm managers need to respond to the price and market conditions for inputs and outputs, production responses, new technologies, the actions and attitudes of other people, and the conditions of the institutional environment (political, economic and social). These five areas combined with financial risk represented Sonka & Patrick's (1984) risk sources schema. Other authors have also adapted this schema to classify sources of risk in agriculture (e.g., Crane et al. (2013), Harwood et al. (1999), Musser and Patrick (2002), and OECD (2009)). For example, Baquet, Hambleton, and Jose (1997) identified five primary sources of risk:

[10] "The evaluation assigned by an individual to the well-being from those goods and services that the individual can buy with money" (Van Praag & Frijters, 1999, p. 444), and it is measured by indicators such as the level of income, wealth, and household consumption in the agricultural economics literature (Katchova, 2008; Mishra, El-Osta, Morehart, Johnson, & Hopkins, 2002).

[11] The evaluation assigned by an individual to factors such as environment, health status, happiness, personal safety and social inclusion. The factors in this group are not traded in the market and the evaluation implies the use of non-monetary measures (Boncinelli & Casini, 2014).

production, marketing, finance, legal, and human resources. A more recent schema classified risk into six sub-categories: production, market, financial, institutional, contractual, and human resources risk (Hardaker et al., 2015).

Each of the above schemas proposed slightly different categories of risk. However, two main categories of risk in agriculture can be identified from all of these classification schemas: business risk and financial risk (Gabriel & Baker, 1980). "Business risk is uncertainty in financial performance independent of financing" (Gabriel & Baker, 1980, p. 560), and it exists regardless of the way the firm is financed (Boehlje & Lins, 1998; Musser & Patrick, 2002). Financial risk is the added uncertainty that arises from obligations associated with debt financing" (Gabriel & Baker, 1980, p. 560).

Production risk in farming involves the unpredictability of output production levels due to weather, pests, and epidemic and non-epidemic animal diseases (Hardaker et al., 2015; Musser & Patrick, 2002). Market risk is the uncertainty inherent in output and input prices along with the availability of inputs (i.e., fertiliser, feed, fuel) (Hardaker et al., 2015; Musser & Patrick, 2002). Institutional risk concerns changes in the rules, regulations, and policies imposed by central and regional governments in relation to farming practices (Musser & Patrick, 2002). Institutional risks also include the risks inherent in tariffs and trade agreements caused by the actions of governments (also called political risks). Risks arising from conflict between trading partners (such as buyers, suppliers, and contractors) is called contractual risk (Hardaker et al., 2015). Human Resource (HR) risk is the uncertainty arising from the people associated with the farm business (owner, owner's family and employed staff) (Musser & Patrick, 2002). Death or serious illness of the farm owner or manager (also called personal risk), the inability to find and retain competent staff, and the failure of the owner or employed staff to perform duties are examples of HR risk (Hardaker et al., 2015). Martin (2005) also asserted that "scale risk", that resulted from a farm being too small, is another type of business risk.

Financial risks are associated with the different methods of financing a farm business (Barry & Ellinger, 2012; Hardaker et al., 2015). The use of borrowed funds to provide capital require that a proportion of the operating income must be allocated to pay the interest charges on the capital before the equity holder (farmer or farm owner) can take a reward. Therefore, the greater the proportion of debt capital to total capital (leverage), the higher the share of operating income which must be paid as debt repayments. This risk, known as leverage risk, is the most significant source of financial risk (Barry & Ellinger, 2012; Hardaker et al., 2015). Volatility of interest rates on borrowed funds, the unanticipated calling-in of a loan by the lender, and the uncertainty of loan finance being available when required are other sources of financial risk (Barry & Ellinger, 2012; Hardaker et al., 2015; OECD, 2009).

2.4 "Operational or tactical risks" and "strategic risks"

Boehlje and Lins (1998) offered an alternative classification schema that classifies risks by the level of management that it impacts on. These are "operational or tactical risks" and "strategic risks". Operational risks are often associated with production, costs, or debt use. These risks are easier to measure or quantify and well-known tools and strategies (e.g., insurance or hedging) are available to manage these risks (Boehlje & Schiek, 1998; Cowan et al., 2013; Gray, Dooley, et al., 2008; Miller, Dobbins, Pritchett, Boehlje, & Ehmke, 2004). In contrast, strategic risks are less predictable and may be less likely to occur, but the consequences of such risks on a business can be severe (Boehlje et al., 2003; Gray, Dooley, et al., 2008). These risks might emanate from: (1) inappropriate strategic positioning, (2) improper strategic adjustment, and (2) ineffective strategy implementation (Boehlje, Dobblins, & Miller, 2001; Boehlje, Gray, & Detre, 2005; Martin, 2005).

While strategic risks may emerge from uncertainties in the business climate[12], as explained above, it can also emerge from strategic choices (Miller et al., 2004). In fact, strategic risks are innate rather than a product of strategic management. Strategic risks are multidimensional in nature and cannot be managed through conventional risk management strategies (e.g., insurance and forward contracts) (Beijeman, Shadbolt, & Gray, 2009; Boehlje et al., 2005; Shadbolt et al., 2010). More importantly, unlike other risk types, there are no tools or techniques for transferring these risks to others. In fact, strategic risks are not inherently undesirable. After all, profit is the reward for taking risk (Hardaker & Lien, 2007), and avoiding risk will cause a firm to miss the opportunities to create value (Shadbolt et al., 2010).

A more recent taxonomy of strategic risks, offered by Boehlje et al. (2011), classified sources of strategic uncertainty that farm businesses face in the 21st century (Table 2-1). As can be seen in Table 2-1, except for financial markets, the first two categories of uncertainty concern strategic management and farm business strategy (internal factors) whereas the remaining categories refer to uncertainties in the business environment (external factors) (Boehlje et al., 2011).

The schemas presented in the section 2.3.1 and 2.4 provide a good basis for understanding and classifying risks in the New Zealand dairy farming context. For this study, a combination of Boehlje et al. (2011) and Hardaker et al. (2015) schemas is deemed to be more instructive to classify sources of risk in the New Zealand dairy farming sector.

[12] Agricultural industrialisation, globalisation of agricultural markets and the risks inherent in trade agreements, environmental concerns, the emergence of new technologies, changes in consumer's demand for food quality, safety, convenience and nutrients are some examples of strategic uncertainties in the business climate (Brester & Penn, 1999; Detre et al., 2006).

Table 2-1: Strategic uncertainties in agribusiness (Source: Boehlje et al., 2011).

Categories of Strategic Uncertainties	Sources of uncertainty
Business/Operational	Operations and business practices, people and human resources, strategic positioning, and flexibility
Financial	Financing and financial structure, financial Markets
Market Conditions	Market prices and farmers' terms of trade, competitors and competition, customer relationships, reputation, and image
Policy & Regulation	Political climate, regulatory and legislative climate
Business Relations	Business partners and partnerships, distribution systems and channels
Technology	Technological change

First, a category called "business strategy risk" is adapted from Boehlje et al.'s (2011) classification that is specifically concerned with the risks related to the overall direction of the business. This category addresses how strategic risks inherent in resource configuration and organisational design (Boehlje et al., 2011) affect owner-operator dairy farm businesses in New Zealand (Parker, Shadbolt, & Gray, 1997; Shadbolt, 2012).

The business/operational category in Boehlje et al.'s (2011) schema does not make a clear distinction between some of the well-known sources of risks such as human resources and production risks. This is particularly important in the scope of this research because empirical studies show that production risk and human resource risk are two important sources of risk for New Zealand owner-operator dairy farms (Gray, Dooley, et al., 2008; Gray et al., 2014; Shadbolt & Olubode-Awosola, 2016). Drawing on Hardaker et al.'s (2015) schema, two separate categories called "human resource risks" and "production risks" are adapted to better scrutinize these sources of risk. Finally, the market conditions and business relationships categories in Boehlje et al.'s (2011) schema are merged together, and a new category called "Market risk" is adapted. The rationale for merging these two categories lies in the fact that, contrary to the majority of agriculture supply chains, New Zealand dairy farmers own and have control over the majority of the dairy supply chain (Conforte, Garnevska, Kilgour, Locke, & Scrimgeour, 2008; Shadbolt, 2012). As such, "business relationships" is better viewed as an integral part of market risk.

2.5 Sources of risk in the New Zealand dairy farming sector

This section highlights the major sources of risk in the New Zealand dairy farming sector. Initially, the context and potential impact of the various sources of risk are reviewed in the section 2.5.1 to 2.5.7. In the last section (2.6), a review of New Zealand dairy farmers' views on the sources of risks that affect them is provided.

2.5.1 Business strategy and risk

Section 2.4 established that strategic risks are innate to strategic management, so it is imperative to provide a brief overview of strategic management and choice of strategy in parallel with strategic risks. Strategic management, as a scholarly domain regularly overlaps with other well-established fields such as economics, sociology, marketing, finance, cognitive psychology, and organizational management (Nag, Hambrick, & Chen, 2007). In agriculture, several studies in relation to strategic management have been conducted in the agribusiness domain (Ng & Siebert, 2009), production economics (Ferguson & Hansson, 2013; Hansson & Ferguson, 2011; Hansson, Ferguson, & Olofsson, 2010), organisational management (Bitsch, Kassa, Harsh, & Mugera, 2006; Mugera & Bitsch, 2005), psychology (Hansson, Ferguson, & Olofsson, 2012) and more recently entrepreneurship (Díaz-Pichardo, Cantú-González, López-Hernández, & McElwee, 2012; McElwee, 2006; McElwee & Bosworth, 2010). Accordingly, different definitions for strategic management are offered in the literature.

Strategic management is the broad process of setting a firm's mission, goals, and objectives; controlling resources to pursue these ends; and monitoring and controlling performance relative to the objectives (Shadbolt & Bywater, 2005). Gunderson, Boehlje, Neves, and Sonka (2014) argued that strategic management emphasized various approaches that firms must adopt to develop a strategic competitive advantage. Cost control and efficiency are the two overarching approaches to achieve competitive advantage at strategic level for farm businesses (Shadbolt, 2012).

Parker et al. (1997) stated that strategic management for pastoral farm businesses essentially means defining or finding a strategic position that creates a long-term sustainable fit between the farm business and its physical, social and financial environment (Parker et al., 1997). Parker et al.'s (1997) definition implies that in addition to steering the farm business to achieve competitive advantage, strategic positioning is also important so that the farm business has the capacity to respond to risks in the business environment (Chapman, Malcolm, Neal, & Cullen, 2007; Miller et al., 2004). In fact, decisions at the strategic level influence the capacity of the farm business to manage risk (Cowan et al., 2013; Miller et al., 2004). In many instances, strategic choices are mutually exclusive and involve trade-offs, and managers must evaluate the trade-offs when planning and implementing farm business strategy (Campbell-Hunt, 2000). Therefore, it is crucial to scrutinise the impact of each strategic decision on the overall capacity of the farm business to respond to business environment risks (Boehlje & Roucan-Kane, 2009; Boehlje et al., 2011; Cowan et al., 2013). Understanding a business' strategic fit, competencies, and opportunities and threats can assist in recognising when strategic adjustments are required and help plan which strategic adjustment may be most effective when facing risks (Boehlje et al., 2005; Martin & Shadbolt, 2005; Miller et al., 2004; Shadbolt, 2008).

Seven key strategic decisions in every farm business include (1) business enterprise focus, (2) marketing and channel linkages, (3) growth strategy, (4) operating structure, (5) financial structure[13], (6) business model (7) managerial style/lifestyle, and (8) social responsibility (Boehlje et al., 2003). In the next sections, a brief overview of the implication of the main strategic decisions, and the strategic risks innate in these strategic decisions is presented[14].

2.5.1.1 *Business enterprise focus*

The first strategic decision called business enterprise focus, is concerned with the manager's decision about the product that will be produced and whether that product will be a commodity or a differentiated product (Boehlje et al., 2003; Cowan et al., 2013). Except for a limited number of organic dairy farms, the generic strategy (Porter, 1980) that is followed by over 95% of New Zealand dairy farms is the cost leadership strategy (Jiang & Sharp, 2014; Shadbolt, 2012; Shadbolt, Olubode-Awosola, & Rutsito, 2013). As such, the dairy farm systems in this study are highly homogenous in terms of business enterprise strategy.

2.5.1.2 *Marketing and channel linkages*

In terms of marketing and channel linkages, the Fonterra Cooperative (the largest dairy company in New Zealand) processes about 85% of New Zealand milk production (Shadbolt & Apparao, 2016). Because the contractual arrangement between Fonterra and its farmers is similar for all farmers, they effectively receive the same milk price in a given period (Ma, Bicknell, et al., 2019; Ma et al., 2018). As such, the dairy farm systems in this study have a high degree of commonality in terms of their marketing and channel linkages strategy.

2.5.1.3 *The growth strategy of New Zealand dairy farm businesses*

In contrast to the previous two strategic decisions, the growth strategy of dairy farmers in New Zealand varies considerably (Shadbolt, 2012). Different routes are available for dairy farmers to pursue a growth strategy (Boehlje et al., 2003). Expansion, replication (also called geographical diversification), intensification, and enterprise diversification are the four major growth strategies that are pursued by New Zealand dairy farmers (Martin & McLeay, 1998; Shadbolt & Olubode-Awosola,

[13] The implication of financial structure will be discussed in the section 2.5.6.
[14] It is beyond the scope of this research to explore the impact of the business model, managerial style/lifestyle, and social responsibility categories on strategic decisions.

2016). The next four sections provide an overview of the implication of pursuing each of these growth strategies, and how this influences the risk management strategies of dairy farms.

2.5.1.3.1 Expansion

New Zealand dairy farms have expanded dramatically over the past 16 years. However, the extent and nature of farm expansion varies considerably across the different regions of New Zealand (DairyNZ, 2017). In the North Island, the number of dairy herds dropped by 34% over the past 16 years whereas dairy herd size has increased from 246 to 340 cows, a 28% increase from 2001-02 season (Figure 2-2).

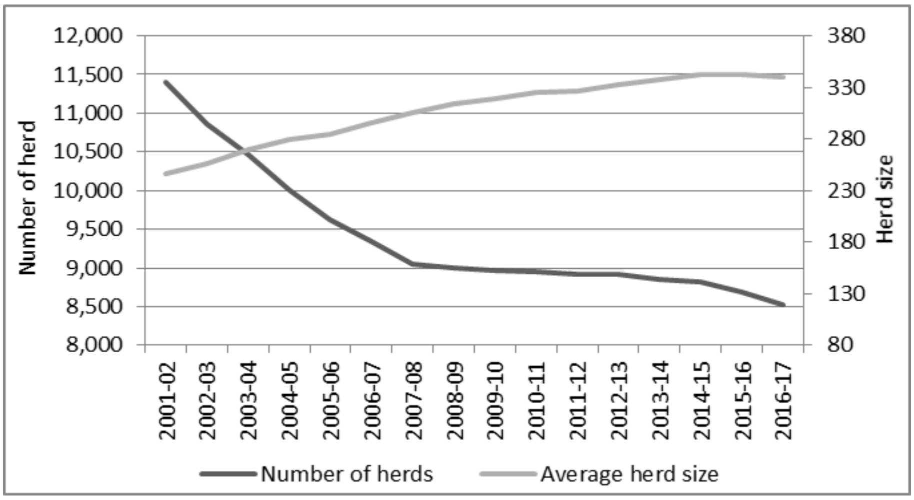

Figure 2-2: Trends in the number of herds and average herd size in the North Island from 2001-02 to 2016-17 (DairyNZ, 2017).

In the South Island, both the average dairy herd size (+36%) and the number of dairy herds have increased (+30%) over the past 16 years (DairyNZ, 2017). Comparing Figure 2-2 with Figure 2-3 highlights that while farm expansion in the North Island can be attributed to the amalgamation of small farm units, dairy farm expansion in the South Island is a result of land use change, generally from sheep and beef and crop to dairy farming (Pangborn et al., 2015).

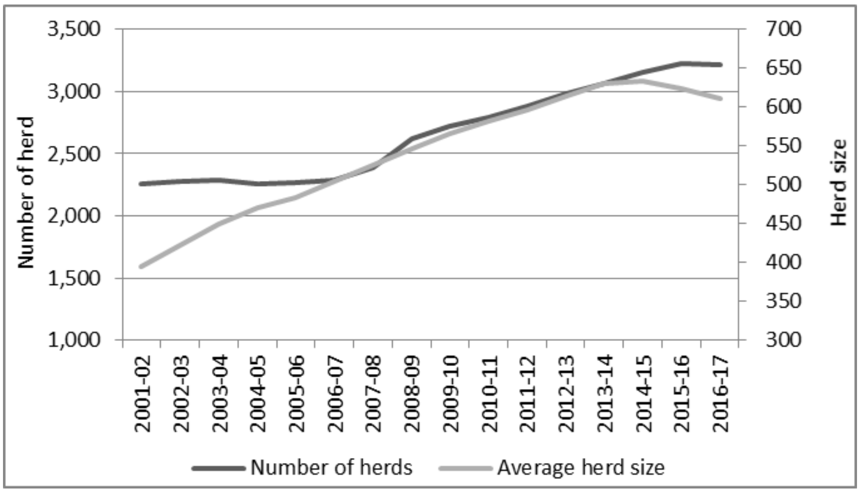

Figure 2-3: Trends in the number of herds and average herd size in the South Island from 2001-02 to 2016-17 (DairyNZ, 2017).

The increase in farm size is closely related to the concept of economies of scale in agricultural economics, which proposes that the average fixed cost per unit of production decreases as the size of the farm increases (Chavas Jean-Paul, 2004; Kislev & Peterson, 1996). Moreover, by buying larger volumes of inputs and selling larger volumes of output, economies of scale also reduce marketing costs (Alem, Lien, Kumbhakar, & Hardaker, 2019). A recent review of literature on economies of scale provides empirical evidence that show that larger farms in developed countries are able to produce at a lower average cost (per unit of output) (Rada & Fuglie, 2019). Rada and Fuglie (2019) identified that a clear productivity disadvantage emerges when farm size falls under a certain limit (Rada & Fuglie, 2019). However, the extent to which an increase in farm size would reduce the average cost per unit of production is not clear (Chavas, 2008).

A series of empirical studies found that economies of scale exist up to a certain level and after that the long-term average cost per unit of production tends to become constant (known as the L-shaped average cost curve) (Chavas, 2008). Another group of studies have identified diseconomies of scale, where the long-term average costs per unit of production starts to increase at a certain level (known as the U-shaped average cost curve). This latter point is more common in dairy farms than other farming systems (Alvarez & Arias, 2003; Melhim & Shumway, 2011). The most commonly cited explanation for the inverse U-shaped cost curve, known as diseconomies of scale, is managerial ability (farm size increases without increasing managerial ability) (Alvarez & Arias, 2003; Chavas, 2008; Løyland & Ringstad, 2001).

No empirical studies have analysed the economies of scale in the New Zealand dairy farming context (shape of the average cost curve). However, some of the factors that contribute to diseconomies of scale are identified in the literature (Allen, 2005). Higher financial risk due to the increase in debt, and reduced ability for monitoring and evaluation in key management areas (e.g. financial management, staff, livestock management, and machinery maintenance) were some of the identified factors contributing to diseconomies of scale in the New Zealand dairy farming sector (Allen, 2005). The next section discusses the extent and implication of implementing a replication strategy among New Zealand dairy farms.

2.5.1.3.2 Replication

Replication is a well-known growth strategy for dairy farmers in New Zealand. Prior to the 1980's, dairy farming in New Zealand was primarily based in the North Island (Pangborn et al., 2015; Reekers, Shadbolt, Dooley, & Bewsell, 2007). Since the early 1980's, dairy farmers who were generally from well-established dairy areas in the North Island started to replicate dairy farm systems in the South Island. Cheap land relative to the prices of established dairy land in the North Island, and the installation of irrigation systems have been the main drivers for dairy farm replication in Canterbury (Pangborn et al., 2015). Since the early 2000's, strong global demand for dairy products and high operating profits accelerated the conversion of sheep and cattle farms to dairy farms in the South Island (Pangborn et al., 2015). North Island dairy farmers and investors outside of the farming sector were two major groups of investors. Most of the converted farms during this period were equity partnerships farms[15] (Pangborn et al., 2015).

Initially, North Island dairy farmers started to replicate all grass wintering, self-contained farm systems in the South Island. However due to the different biophysical characteristics (soil type, climate, topography etc.) of South Island farms, farmers started to adopt a range of different technologies and infrastructures to increase production (Pangborn et al., 2015). The development and adoption of efficient irrigation technology, cowsheds, and machinery were the main factors that increased dairy farm productivity in the South Island (Pangborn et al., 2015). New input suppliers, sheep and cattle farms that dedicated their system to support dairy farms (with the provision of supplementary feed and grazing), improved access to funds from financial institutions, and new business structures that assisted farmers in sourcing capital were other important factors that contributes to the establishment of dairy farms in the South Island (Pangborn et al., 2015). The next section discusses the extent and implications of implementing an intensification strategy on New Zealand dairy farms.

2.5.1.3.3 Intensification

As established in section 2.5.1.1, virtually all dairy farm businesses in New Zealand are operating under the cost leadership competitive strategy. The use of pasture-based farming systems, in which the production system depends on pasture grazed *in-situ*, has been the single most important factor that provides cost leadership competitive advantage to New Zealand dairy farmers (Britt et al., 2018; Conforte et al., 2008; Shadbolt, 2012; Von Keyserlingk et al., 2013). Over the past 16-year period, dairy farm systems in New Zealand have moved away from a purely pasture based production system to a more intensive[16] production system where they utilise bought-in feeds, nitrogen, pasture, hay and silage and other forages produced on support blocks for the purpose of increasing stocking rates, extending lactation length, and grazing cows off the milking area (Foote et al., 2015; Ma, Renwick, & Greig, 2019).

The amount of non-pasture feed offered to New Zealand dairy cows has increased considerably over a 16-year period since 2001-02 (Figure 2-4). This additional feed is mainly utilised to overcome short-

[15] A joint venture between a few (usually non-related) individuals who pool their capital to invest in a business venture.
[16] Intensification can be defined as an increase in output per unit area by increasing inputs (Ho, Newman, Dalley, Little, & Wales, 2013; Shadbolt, 2012).

term pasture deficits, maintain cow body condition and to increase Milksolids production. A comparison between the North Island, and South Island dairy farms shows that the amount of supplement eaten per-cow (t DM) and the percentage of brought-in supplement (tonnes eaten per-cow (t DM)) was higher in the North Island (Figure 2-4).

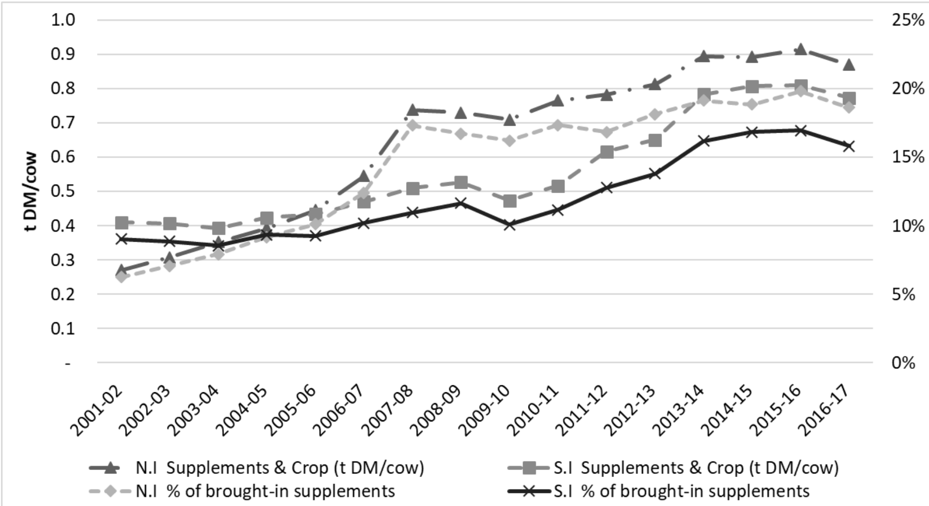

Figure 2-4: Supplementary feed per cow and percentage of supplement from 2001 to 2017 (DairyNZ, 2017).

Three main motivations for dairy farm intensification in New Zealand are identified in the literature. First, intensification may improve the profitability of the dairy farm systems if returns from extra milk production exceed the cost of the extra feed required to produce it (Ma et al., 2018; Shadbolt, 2012; Shadbolt et al., 2017). Second, intensification allows efficient use of resources (land, cows, plant, and labour) (Ma, Bicknell, et al., 2019; Ma, Renwick, et al., 2019; Tozer, 2017). Compared to North Island farms, dairy farms in the South Island tend to be larger and produce more output per unit of input (i.e., MS per hectare and MS per cow) (Figure 2-5). Finally, importing feed reduces the reliance on pasture that in turn reduces milk production variation between seasons (Ho et al., 2013; Ma et al., 2018; Shadbolt et al., 2017).

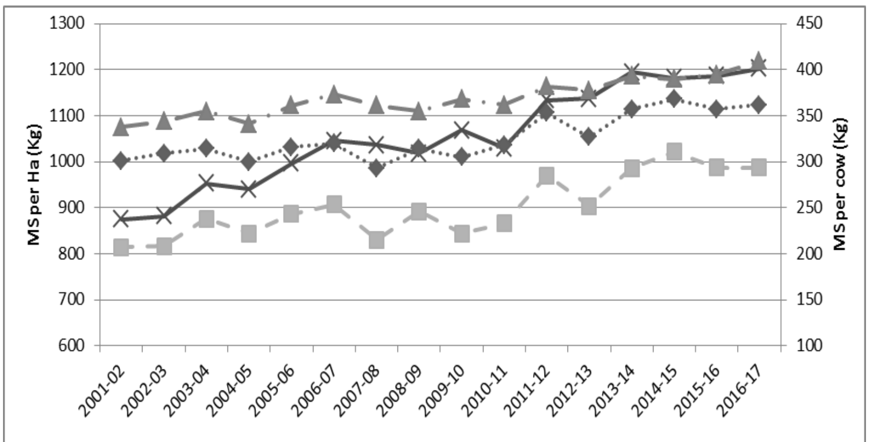

Figure 2-5: Trends in the average production (per Ha & Per SU), in the North Island (N.I) and in the South Island (S.I) from 2001-2 to 2016-17 season (DairyNZ, 2017).

Several studies have compared the physical and financial performance of low input versus high input dairy farm systems in New Zealand using productivity and efficiency as well as profitability measures (see Table 2-2 for a summary). The findings showed that moving to a more intensive farming system improved the physical performance (e.g., milksolids production and technical efficiency) and gross farm revenue of owner-operator dairy farms (see Table 2-2 for references). Despite this, there is no evidence that shows the financial performance (e.g., operating profit and financial efficiency) of more intensive dairy farm systems is higher than that of less intensive systems. This was because increasing supplementary feed levels substantially increased the operating expenses of high input farm systems. Besides, intensive farm systems need more capital investment. As such, the return-on-equity and return-on-assets of "high input" dairy farm systems are not significantly different to "low input" farms (Shadbolt, 2012; Shadbolt et al., 2017; Tozer, 2017).

Table 2-2: An overview of the impact of farm intensification on dairy farm performance

Author	Financial Metrics	Timeframe	Findings
Shadbolt (2012)	Return on equity (RoE)	3-year period (2006-07 to 2008-09)	No significant difference is found between the RoE of low input and high input farms.
Beux Garcia et al. (2015)	Financial efficiency using gross farm revenue (GFR)	5-year period (2006-07 to 2010-11)	1. There is no one single pathway to attain higher financial efficiency. 2. Indicators such as return on dairy assets (RoDA)[17], and operating profit-per-hectare can be used to estimate the financial efficiency.
Shadbolt et al. (2017)	Financial performance measures	9-year period (2006-07 to 2014-15)	1. Milksolids production per-hectare and operating profit per-hectare in the high-input farm systems were higher than the low input systems. However, RoDA was not significantly different between systems over the 9-year period.
Tozer (2017)	Financial efficiency using return on dairy assets (RoDA)	9-year period (2005 to 2014)	1. Systems with higher levels of supplementary feeding were more efficient. 2. Higher efficiency is driven by the value of assets whilst the operating profit between farm systems was not significantly different.
Ma et al. (2018)	Physical and financial performance measures	3-year period (2010-11 to 2012-13)	1. Adopting higher input systems had a positive and significant impact on milksolids production and gross revenue relative to lower input systems. 2. Adopting higher input systems significantly increased operating expenses relative to lower input systems. 3. The operating profit of low input and high input systems were not different. 4. High input systems had significantly lower operating profit margins, but this did not have any significant effect on the RoDA.
Ma, Bicknell, et al. (2019)	Technical efficiency	4-year period (2010 to 2013)	1. Supplementary feed has a positive impact on the technical efficiency of dairy farms. 2. Larger farms (effective milking area) were less technically efficient than smaller farms. 3. The technical efficiency of larger herds was higher than smaller herds.

[17] The profit generated from dairy assets employed. RoDA (%) = (dairy operating profit- rent) ÷ (dairy assets)*100

Shadbolt et al. (2013) investigated the performance of a sample (a balanced panel data) of owner-operator dairy farm businesses to identify the farm systems that best captured upside risk (upswings in milk price from one year to the next) and those systems that best avoided downside risk (when milk prices dropped from one year to the next). Their results indicated that the farm businesses that best captured upside risk had relatively more intensive production systems (more cows-per-hectare and a higher reliance on brought-in feed). In contrast, the farm businesses that best minimised downside risk had relatively less intensive production systems (less cows-per-hectare and a low or no reliance on brought-in feed). This latter finding is congruent with the suggestion that high input dairy farm systems (such as confinement production systems in the United States) are better able to seize the opportunity arising from upswings in the world milk price than the low input farming systems (such as pasture-based farming systems in New Zealand) (Von Keyserlingk et al., 2013). Importantly, Shadbolt et al. (2013) also found that none of the farm systems that best captured upside risk were in the group that best minimised downside risk.

While empirical studies did not find significant differences between the performance of low input and high input farming systems, low input farms face different types of risks when compared to high input systems (Ho et al., 2013; Shadbolt et al., 2017). First, moving to a higher input system reduces the risk associated with climate (production risk), but it does increase exposure to market risk (feed prices, contractual risks, milk payout). Second, intensification increases the need for nutrients such as nitrogen fertiliser to increase pasture production and compensate for nutrients losses (Foote et al., 2015). As such, it may expose farmers to regulatory risks. Third, because the capital investment required in high input farming systems is higher than low input systems, these farm systems are more likely to be exposed to financial risk (more debt per ha) (Ho et al., 2013; Ma et al., 2018; Raedts et al., 2017; Shadbolt et al., 2013; Shadbolt et al., 2017). Finally, managing high input farming systems can be more challenging than less intensive systems because they require a farm manager who is motivated and capable of implementing the new system (Ho et al., 2013; Westbrooke, 2013).

2.5.1.3.4 Diversification

Diversification is defined as the reallocation and recombination of farmland, or non-farm resources (i.e., land, labour or capital) into new agricultural or non-agricultural enterprises (Barbieri & Mahoney, 2009). Three main types of diversification that are pursued by dairy farmers in New Zealand include enterprise diversification (business activities related to farming such as beef and lamb production), geographical diversification, and income diversification or off-farm work (also called pluriactivity by Hansson, Ferguson, Olofsson, and Rantamäki-Lahtinen (2013)). Although management of risk is the prominent motivation for diversification, other motivations were also found to be important in pursuing diversification. The desire to use idle farm resources, increasing family household income, and even non-economic motivations (i.e., social and/or lifestyle) are some other important reasons for pursing a diversification strategy (Barbieri & Mahoney, 2009; Hansson et al., 2013; Just, 2003). This section only focuses on the implications of diversification from a risk management perspective.

2.5.1.3.4.1 Enterprise diversification

Enterprise diversification is a way for farmers to reduce the risk of being too dependent on one product by having several enterprises with imperfectly correlated returns (Purdy, Langemeier, & Featherstone, 1997).

The general belief is that diversified farm businesses will be more viable compared to non-diversified farms (Barnes, Hansson, Manevska-Tasevska, Shrestha, & Thomson, 2015; Purdy et al., 1997). The theory suggests that the impact of diversification on the long-term performance of a farm mostly depends on its economies of scale (Purdy et al., 1997; Sonka & Patrick, 1984). If economies of scale for a particular enterprise are significant (a decrease in the average long-term cost with an increase in size), then diversification into other enterprises may diminish the long-term financial performance of the farm (Sonka & Patrick, 1984). However, because of the potential price volatility of outputs, an increase in specialization is likely to result in relatively more volatility in the financial performance of the specialised farms over the long-term (Purdy et al., 1997).

There is no empirical evidence on whether enterprise diversification can reduce the overall risk (variability of financial performance) of New Zealand dairy farm businesses. However, one of the most comprehensive empirical studies of the impact of diversification on the long-term financial performance of farms was conducted by Purdy et al. (1997) for a sample of Kansas farmers over a nine-year period. Their results indicated that for dairy enterprise diversification diminishes mean financial performance and increased its variability, whereas in the beef sector (mixed crop/beef), enterprise diversification increases mean financial performance and reduced its variability over the long-term. The increase in the mean financial performance of dairy enterprises was attributed to product-specific economies of scale and the profitability of the dairy enterprise (Purdy et al., 1997).

A study by Melhim & Shumway's (2011) specifically examined the impact of diversification on a sample of U.S. dairy farms (22 states) over a 10-year period. They concluded that enterprise diversification is a more effective risk management strategy for smaller dairy farms whereas specialisation is more effective for larger dairy farms (Melhim & Shumway, 2011). That is, by reducing the impact of output price volatility, enterprise diversification improves the competitiveness of smaller dairy farms (bottom 5%).

The inference from empirical studies on enterprise diversification applies to the New Zealand dairy farming context. However, there are substantial differences between pasture-based dairy farming systems in New Zealand and confinement dairy farm systems in the Unites States. New Zealand's pastoral landscape is a dynamic system in which the movement of animals between farms and farm blocks is a common practice and the boundaries between the dairy enterprise and other enterprise such as sheep, beef cattle, and dairy cattle are not as clear as for U.S farming systems (Morris, 2017; Morris & Kenyon, 2014). As such, there is a considerable interplay between different land uses in the pastoral landscape (Morris & Kenyon, 2014). Many dairy farm systems own or lease a block or blocks of land, called "dairy support blocks" or "run-off blocks". While these blocks are mainly used for the winter grazing of the dairy herd, rearing dairy heifer replacements, and growing feed supplements (e.g., silage and forage crops), dairy farmers are using dairy support blocks for raising dairy-bred bulls, in conjunction with other livestock production such as sheep and deer (Morris, 2013). Therefore, inferences from U.S. studies should be made with proper justification.

2.5.1.3.4.2 Geographical diversification

Geographical diversification is another available strategy to dairy farmers in New Zealand (Melyukhina, 2011). Dairy farm profit is highly dependent on the biophysical characteristics of the farm (temperature, rainfall, soils etc.) (Holmes et al., 1987), and the biophysical characteristics of farms vary between regions. Therefore, farmers may limit their profit risk exposure through geographical diversification (Barry & Ellinger, 2012; Nartea & Barry, 1994).

There has been no empirical research on whether geographical diversification can reduce the overall risk of New Zealand dairy farm businesses. Outside of New Zealand, the findings about the influence of geographical diversification on overall farm risk are inconclusive (Larsen, Leatham, & Sukcharoen, 2015; Nartea & Barry, 1994). Several modelling studies concluded that geographical diversification could reduce weather related production risks (lower standard deviation for farm yield) (Davis, Price, Wetzstein, & Rieger, 1997; Larsen et al., 2015; Nartea & Barry, 1994). However, once the models take into account the increase in transportation and monitoring costs, and losses due to poor machinery coordination, geographical diversification does not provide any significant reduction in the total risk of the representative farm businesses (Nartea & Barry, 1994). Based on the above findings , Nartea and Barry (1994) suggested that geographical diversification could be more effective as a risk management strategy when an owner employs a manager to operate the farm on their behalf.

Farmers who are pursuing the replication strategy (owning a dairy farm in the non-traditional dairy areas of New Zealand i.e., South Island) (Section 2.5.1.3.2), inadvertently, are pursuing a geographical diversification strategy. However, due to the unique characteristics of dairy farms in the South Island (larger and more intensive) and the difficulty of commuting between the South and North Islands, replicated dairy farms (in the South Island) do not share any machinery and capital items with the so-called home farms in the North Island. In fact, North Island farmers who partly or fully own replicated dairy farms in South Island normally have no role in the tactical and operation level decisions. As such, losses due to poor coordination and lack of monitoring are not different from non-diversified farms. Finally, it is worth reiterating that although replication can potentially limit risk exposure through geographical diversification, however as discussed in 2.5.1.3.2, motivations other than risk management were found to be the drivers for establishing new dairy farms outside of the home farm region (Pangborn et al., 2015).

2.5.1.3.4.3 Income diversification

Working outside of the farm allows the farm household to diversify their income, secure household expenses, and invest the extra earnings in the farm business (Barnes et al., 2015; Hansson et al., 2010; Hansson et al., 2013). In particular, off-farm earnings seem to be more important during times of economic hardship (Melyukhina, 2011). Historical data shows that - except for low milk payout seasons of 2008-09 and 2015-15 - off-farm income normally made up less than 10 percent of total cash available for living and growth in owner-operator dairy farms over a 16-year period (Figure 2-6) (DairyNZ, 2009, 2018).

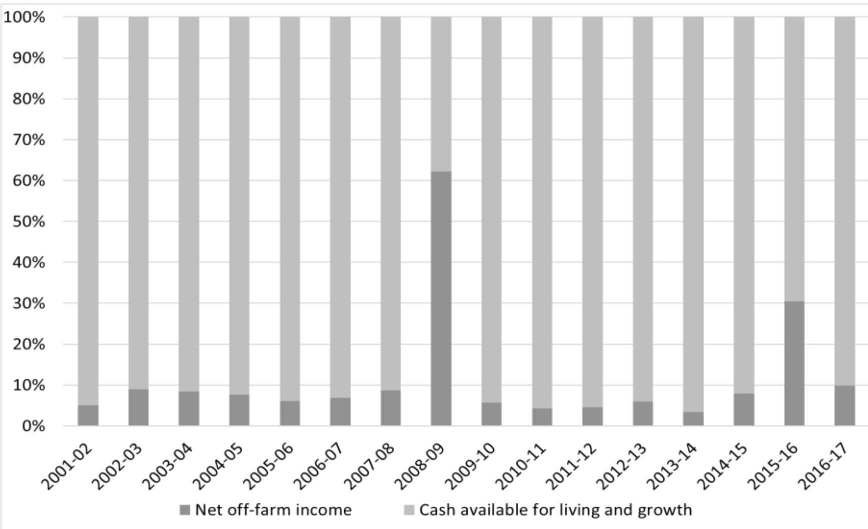

Figure 2-6: Off-farm income as percentage of total cash available for living and growth from 2001-02 to 2016-17 (DairyNZ, 2009, 2018).

Outside New Zealand, the results from empirical studies suggested that although income diversification can provide financial security for farm households, it is not without its potential drawbacks. The most important drawback of income diversification is that the farm owner/operator (or family members who are involved in the farm) need to reallocate time to off-farm activities, which may influence the management and operational practices of the farm business (Goodwin & Mishra, 2004; Sabasi, Shumway, & Astill, 2019). A study by Sabasi et al. (2019) showed that US dairy farm with off-farm employment have lower technical efficiency than those without off-farm jobs.

2.5.1.4 *Operating structure*

Another strategic decision that shapes a dairy farm's businesses strategy is its operating structure (Payne, Shadbolt, Dooley, Smeaton, & Gardner, 2007). The two main operating structures used by New Zealand dairy farms are owner-operator and owner with sharemilker or contract milker (Gardner & Shadbolt, 2005). While these arrangement have been common for decades, the emergence of two other types of operating structures, namely equity partnerships (also known as farm or equity syndicates) and owner with employed manager(s), is attributed to the emergence of large-scale dairy farms in the early 90's [18] (Payne et al., 2007).

The owner-operated business model is the most common form of operating structure. An owner-operator owns both the herd and the land, operates the farm, and receives all the farm income. They may pay wages if labour is employed (Gardner & Shadbolt, 2005). An owner-operator is also responsible for making decisions at every level (strategic, tactical, and operational), and is responsible for the financial and legal consequences of the farm decisions.

Industry statistics identify that in the 2016-17 season, 28% of all dairy herds in New Zealand are under a share-milking arrangement (DairyNZ, 2017). Share-milking is a contractual arrangement that involves a sharemilker operating a farm on behalf of the farm owner for an agreed share of the farm receipts (based on the unit of production (Kg MS) (DairyNZ, 2017; Payne et al., 2007). Two types of share-milking arrangements are the variable order share-milking arrangement (VOSM) (also called lower order share-milking) and the herd owning share-milking arrangement (HOSM) (also called 50/50 share-milking) (Gardner & Shadbolt, 2005; Payne et al., 2007). As the name implies, in a HOSM arrangement, the sharemilker owns the herd, whereas in the VOSM arrangement, the farm owner owns the herd.

In both types of share-milking arrangements, the farm owner owns the land, buildings and heavy machinery while the sharemilker typically provides the labour, and pays for shed costs, electricity, transport and sometimes a share of feed and nitrogen costs (Gardner & Bennett, 2011; Gardner & Shadbolt, 2005). The farm work required by the sharemilker and the owner is determined by the individual agreement (DairyNZ, 2017).

[18] Other business models that could be identified in NZ dairy farming include "family partnerships/companies" and "government owned enterprises".

In both types of arrangements, the owner is solely responsible for the long-term (strategic level) decisions and is not involved in the day-to-day tasks. The owners in the VOSM arrangement are more involved in the medium-term tasks (Butler, 2013). Moreover, by owning the herd, HOSMs own a bigger share of the total dairy asset. As a result of the increase in capital requirement and more responsibilities, HOSMs receive higher profit share than VOSMs (Gardner & Bennett, 2011; Payne et al., 2007).

From a risk management perspective, farms with a share milking arrangement are quite different from owner-operator farms. To begin with, share milking is a risk sharing mechanism where the parties share the costs and revenues for mutual benefit (Gardner & Bennett, 2011). The owner does not need to be involved in the day-to-day tasks, such as milking the animals, herd management, the repair and maintenance of machinery. As such, a proportion of risks from the undertaken tasks are transferred to the sharemilker (Gardner & Bennett, 2011; Shadbolt & Martin, 2005). Second, the HOSM arrangement allows the farm owner to free up the capital that is otherwise held in the herd and machinery. Third, because the owner is not required to comply with the legislations related to employees[19], it is easier for the owner to withdraw from a share-milking arrangement than to terminate an employee contract. Despite all of the advantages of the share-milking arrangement for owners, its exposed owners to other types of risks (Gray et al., 2014). Difficulties in finding, contracting and retaining a skilled sharemilker are the major sources of risk for owners in a share milking arrangement (Gray et al., 2014). Poor performance of the sharemilker and conflict between the owner and sharemilker are other reported sources of risks in a share-milking arrangements (Gray et al., 2014).

In addition to owner operator and owner with sharemilker arrangements, equity partnerships (also known as farm or equity syndicates) are another more recent business model in the New Zealand dairy farm sector (Payne et al., 2007). An equity partnership is defined as a joint venture between a few (usually non-related) individuals who pool their capital to invest in a business venture (Payne et al., 2007; Reekers et al., 2007). An equity partnership provides several advantages for farmers. First, pooling the financial resources of different investors facilitates the creation of a larger farm business (with the associated benefits of a larger scale of production) while minimising the debt and other related costs of larger farms (Payne et al., 2007; Reekers et al., 2007). An equity-partnership also provides an opportunity for owners to hire skilled managers and it enhances the ability to use

[19] The legal relationship between a farm owner and a sharemilker is principal and independent contractor. As such, employer-employee legislations do not apply to it (Gardner & Bennett, 2011).

professional advice for day-to-day activities (e.g., rural advisors, accountants) (Bagrie, Williams, & Croy, 2014).

Agency risk, a category of risk that arise from the relationship between the equity holders and the managers, and the relationships between the equity-holders (Jensen & Meckling, 1976) is the first drawback of the equity partnership. In most cases, the farmer operating the business also owns a share of the equity-partnership (called an equity manager) and receives a salary, dividends as well as capital gains made on the value of the property (Bagrie et al., 2014; Westbrooke, 2013). This arrangement encourages quality managers into equity partnerships and allow the business to minimise the agency risk arising from the conflict between the manager and non-operating equity-holders[20]. However, the agency risk[21] arising from the relationship between equity holders' is as one of the major sources of risk for New Zealand dairy farm equity-partnership business models (Payne et al., 2007; Reekers et al., 2007; Westbrooke, 2013).

2.5.2 Production risks

Climate is the primary source of risk for New Zealand dairy farmers. Dairy farming in New Zealand relies on a seasonal pasture-based production system where pasture is the primary source of feed. Seasonal climatic variability drives pasture growth, and the profitability of dairy farms is dependent on annual pasture production (Gray, Dooley, et al., 2008; Holmes et al., 1987; Melyukhina, 2011). The seasonal supply of pasture has to be matched with the feed requirements of lactating and growing cattle (Gray, Dooley, et al., 2008; Holmes et al., 1987; Shadbolt & Martin, 2005).

Adverse weather conditions such as drought and floods significantly affect farm profitability (Gray, Dooley, et al., 2008; Melyukhina, 2011). For instance, farmers in the Bay of Plenty area experienced two consecutive years of dry conditions (2007-09) which resulted in a seven per cent, and three per cent, drop in milk-solids production per hectare, respectively. According to the Ministry of Agriculture and Forestry (MAF) (2009), this drought cost the dairy sector NZ$155 million incurred to farmers for extra feed and other related costs (DairyNZ, 2009, 2010; MAF, 2009). Dairy farmers also have to cope with the impact of long-term climate change. Clark, Mullan, and Porteous (2011) have forecasted that exposure to drought risk in the coming 50 years is likely to increase by 20% in the eastern regions of the North Island of New Zealand.

[20] Farm with multiple equity holders may take various forms such as: "equity manager on VOSM arrangement", "equity manager on HOSM arrangement", and "syndicates".
[21] A category of risks that arise from the misaligned expectations (in relation to investment) between the equity holders and the managers, as well as misaligned expectations between the equity-holders (Jensen & Meckling, 1976).

The risk associated with animal health is another source of production risk. The annual cost of facial eczema in the dairy sector is estimated at around $30 million (DairyNZ, 2017). The outbreak of 'Mycoplasma Bovis' is another example. In 2017, 91,000 cows were culled and more than $57 million paid to farmers as compensation. In addition to this, the dairy farming sector has to pay approximately $272 million for a ten-year eradication programme (Taunton, 2019).

The risk arising from pasture health is another source of production risk. Argentine stem weevil (ASW) (*Listronotus bonariensis*) is an exotic weevil from South American that can cause severe damage to newly sown and established ryegrass pasture. ASW pest is distributed throughout the country and is considered to be the worst insect pest of pasture in New Zealand. When unsuppressed, this insect was estimated to cause costs to the pastoral sector of NZ$78-251M annually (Prestidge, Barker, & Pottinger, 1991).

2.5.3 Market risks

The New Zealand dairy industry relies heavily on foreign markets. The domestic market is small and there are no government policies to buffer or stabilise prices. In 2016-17 season, almost 95% of the milk produced in New Zealand was exported to global markets (MPI, 2017). The value of New Zealand's annual dairy exports in 2017 was $NZ 14.6 billion, accounting for 38% of New Zealand's annual agriculture exports (MPI, 2017). Increasing demand for dairy products in global markets has provided New Zealand dairy farmers with the opportunity to expand (Melyukhina, 2011).

The OECD-FAO agriculture outlook (2017), forecasted a strong growth in demand from developing countries, in particular from the Middle East and Asia until 2026. Despite these opportunities, relying on global markets exposes New Zealand dairy farmers to volatile milk prices (Figure 2-7). Figure 2-7 illustrates the fluctuations in the milk price received by dairy farmers over a 15-year period from 2001-02 to 2016-17. Milk-solids payout was relatively stable in the first six years of this period, but from 2007 onwards, there has been a noticeable increase in the average milk-solids payout, as well as an increase in the volatility of the milk-solids price paid to farmers.

Figure 2-7 also illustrates the impact of milk price (in the form of payout received), on the financial position of New Zealand dairy farms. The dairy sector experienced a downturn in milk price over the last three years of the 16-year period from 2001-02 to 2016-17. In the 2014-15 season, milk price dropped by 48%. The next season it further declined by 11% and reached NZ$ 3.90 kg/MS. During the 2015-16 season, cash expenses exceeded dairy cash income, resulting in negative profit margins for dairy producers (DairyNZ, 2017). Given the obvious importance of milk price on the viability and profitability of dairy farms, milk price volatility is a key risk for dairy farmers.

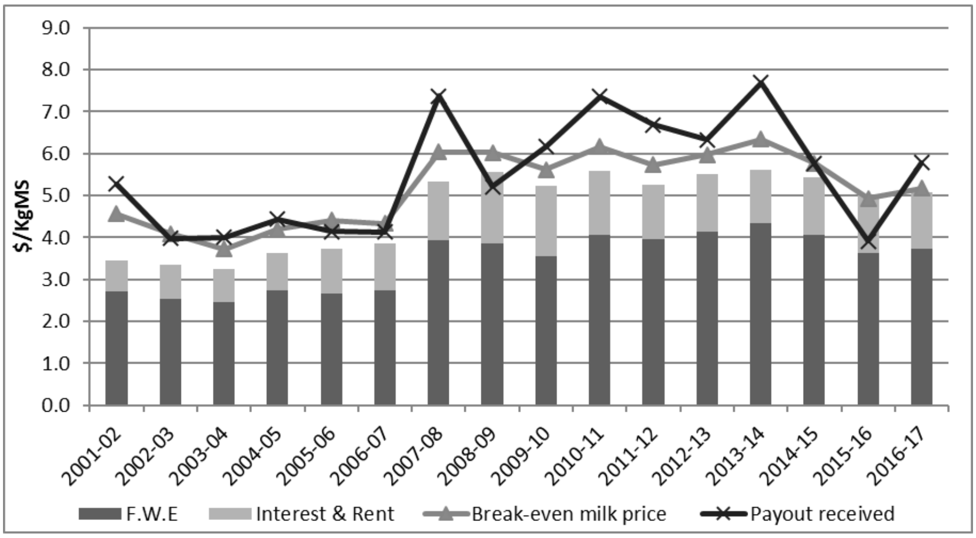

Figure 2-7: Trends in the payout received and beak-even milk price for the last 16 seasons (DairyNZ, 2018).

Shadbolt and Apparao (2016) investigated the main drivers of global dairy volatility. They stated that the global dairy market is characterised as a "thin market" where small changes in supply or demand can disrupt the market and MS price volatility is mostly related to the volatility of supply in the global markets (Shadbolt & Apparao, 2016). The undersupply of milk due to a food safety issue in China in 2008 led to a moderate increase in the milk-solids prices from 2008-09 to 2012-13 (Figure 2-7). The outbreak of an animal disease in China led to another price spike in 2013-14. However, the removal of the dairy produce quota in the EU resulted in an increase in milk supply which led to an oversupply in 2015. This in turn, led to a sudden drop in global dairy prices (Figure 2-7) (Shadbolt & Apparao, 2016).

Exchange rate movements also affect New Zealand dairy farmers' income (Greig, 2010). The exchange rate movement works as a natural hedge and smooths out the effect of milk-solids price volatility on dairy farmers' income (Apergis & Papoulakos, 2013). However, this cannot completely control the effect of exchange rate fluctuations and can lead to risk for dairy farmers (Melyukhina, 2011; Rotherham, 2015; Westpac, 2009).

New Zealand dairy farmers are also exposed to market risk in the form of input price risk, and the price of bought-in feed (Gray et al., 2014). As explained in Section 2.5.1.3.3, exposure to this risk is dependent on the farm system type. Low input dairy farming systems have little exposure to input price risk associated with bought in feed, whereas higher input systems that rely on this are much more exposed (Gray, Dooley, et al., 2008; Holmes et al., 1987; Ma et al., 2018; Melyukhina, 2011; Shadbolt et al., 2017). Although buying in feed can reduce a farmer's exposure to climatic risk, it can increase exposure to both input price and contractual risk related to the feed market (Gray et al., 2014).

2.5.3.1 *Business relationships*

Generally, the food and agribusiness industry is characterized by complex and fragmented supply chains that are not well coordinated (Boehlje et al., 2011). However, New Zealand dairy farmers' strong beliefs towards control and ownership of downstream manufacturing and marketing activities have led to vertical integration[22] through its dairy cooperatives (Conforte et al., 2008; Shadbolt, 2012). This vertical integration allows dairy farmers to receive an increased percentage of the margin from the dairy sector (Boehlje & Schiek, 1998; Shadbolt, 2012). Vertical integration also enables upstream members of the supply chain (e.g., dairy farmers) to receive quality and attribute signals from downstream members of the supply chain (e.g., consumers) (Boehlje & Schiek, 1998; Conforte et al., 2008). This is particularly important in today's marketplace where establishing a competitive advantage within the marketplace depends on recognising and reacting to changing consumer demand in a timely manner (Helmsing & Vellema, 2012; Young & Hobbs, 2002).

Utilisation of palm kernel expeller[23] as a supplementary feed is a good example of how vertical integration enables dairy farmers to respond to customer specification requirements (Foote et al., 2015). The production of palm oil has severe environmental impacts including deforestation, biodiversity loss, and greenhouse gas emissions (GHG) in the country of origin (Indonesia) (Foote et al., 2015). In addition to this, the excessive use of PKE changes milk fat composition in a way that limits the manufacturing of some products (e.g., butter) (O'Callaghan et al., 2019).

In response to criticism from environmental activists, the dairy industry decided to procure PKE from sustainable sources (Taunton, 2018). In addition to this, the industry introduced policy standards that included: a fat evaluation index (FEI) test, a guideline for dairy farmers on how to use palm kernel in their production systems, and the establishment of penalties for excessive use of palm kernel (Baker, 2016). Implementing this policy helped the New Zealand dairy farming sector to maintain its image as a green and environmentally friendly industry, and allowed the dairy processor to produce high quality products from milk (Foote et al., 2015). However, implementation of these new policy standards exposes dairy farmers to two additional risks. First, farmers have to change feeding methods (e.g., replace some palm kernel with other supplements) or adjust their production systems (e.g., reduce stocking rate) that could either increase the cost of production or reduce the level of milk production (Baker, 2016). Second, farmers face risks from ambiguous quality measurements and complex product quality verification systems (Baker, 2016).

[22] Vertical integration in agribusiness refers to an organizational structure that controls every step of a particular commodity from its conception to its end use.
[23] A waste product from palm oil production; New Zealand is the largest global importer of PKE, importing almost a third of the total global trade in 2017 (Taunton, 2018).

A closely related issue to the dairy value-chain is the risk associated with the dairy industry structure (Conforte et al., 2008; Melyukhina, 2011). In a highly integrated agri-food chain such as the New Zealand dairy cooperative value-chain, achieving competitive advantage for dairy farmers is not solely related to farm-level performance (Conforte et al., 2008; Le Cren, Lyons, & Dana, 2009). Rather, it depends on the performance of other members in the value chain, and in particular to the efficient coordination between value-chain members (Junqueira, 2010; Le Cren et al., 2009). This is facilitated through a governance structure that make strategic decisions for the value-chain and effectively controls the implementation of decisions (Gall & Schroder, 2006; Gellynck & Molnár, 2009). As such, dairy industry structure (both governance and the performance of other members) is another source of risk for New Zealand dairy farmers (Conforte et al., 2008; Junqueira, 2010).

2.5.4 Political, regulation, and legislation risks

Environmental regulations are one of the most important sources of risk for dairy farming in New Zealand (Melyukhina, 2011). Rapid growth in the dairy farming sector and a shift to more intensive farming systems have impacted on the environment (Melyukhina, 2011). In particular, studies have shown that natural water quality has declined where intensive dairy farming is dominant (Wilcock et al., 2013). The New Zealand dairy farming sector has been widely criticised because of its environmental impacts and faces political pressure to improve environmental performance. In response to growing societal demands for a clean environment, New Zealand regulations have been strengthened over the past two decades. Moreover, a series of new strategies, policy statements and environmental standards have emerged that addressed a range of environmental concerns such as air quality, waste management, soil conservation, and biodiversity (Melyukhina, 2011).

The uncertainty about the image of the dairy industry is another source of institutional risk (Melyukhina, 2011; Weary & von Keyserlingk, 2017). Although pasture-based farming systems provide an opportunity for New Zealand dairy farming to portray itself as a clean green industry from the perspective of international consumers (MfE, 2001), growing concerns over animal welfare practices may negatively impact on this positive image from the perspective of domestic consumers and New Zealand citizens (Kaefer, 2014).

Access to global markets is the main driver of growth in the dairy farming sector. However, it exacerbates dairy farmers' exposure to risks arising from the global economic and political environment (Bagrie et al., 2015; Conforte et al., 2008). Changes in foreign governments' policies, international trade agreements, import quotas, and tariffs are examples of institutional risks that may affect the dairy farming sector (Melyukhina, 2011). A series of simulations, using a static computable general equilibrium model, showed that eliminating all global dairy tariffs would lead to a $1.3 billion increase in the value of New Zealand's dairy exports (Ballingall & Pambudi, 2017). In contrast, imposing a 28% increase in average global dairy tariffs would result in a 7.4% decrease in dairy export volumes and an overall drop in dairy export revenue of $2.3 billion (Ballingall & Pambudi, 2017). Similarly, Langley, Somwaru, and Normile (2006) found that New Zealand gained the most from global trade liberalization. These findings support the premise that the global economic and political situation is another source of risk for the dairy farming sector.

2.5.5 Human resource risks

The demand for labour in the New Zealand dairy sector has been greater than the supply since 1992 (Tipples, 2017; Wilson & Tipples, 2008). In addition to this, the change from the traditional small family-owned dairy farm to large dairy farms with complex ownership and organisational structures has meant that more farm staff are now employed on wages (Wilson & Tipples, 2008). In such farm business systems, senior farm staff have to be considerably more skilled to deal with the multiple issues in the dairy farm business (Greenhalgh & Tipples, 2013; Stup, Hyde, & Holden, 2006). As such, the shortage of skilled labour is one of the most important sources of human resources risk in dairy farming (Greenhalgh & Tipples, 2013; Melyukhina, 2011).

The problem with retaining employed staff is another important human resource risk. Long working hours, a high rate of work injuries, and social isolation are some of the reasons why staff turnover is high in the dairy farming sector (Tipples, 2017). Staff turnover has both direct and indirect costs to the farm business. The costs of staff turnover arise from recruiting, selecting and training a new employee (Greenhalgh & Tipples, 2013). The effect of staff turnover on dairy business performance is also negative (Billikopf & González, 2012). However, the cost of turnover depends on the labour market. That is, better staff availability (highly skilled, knowledgeable, relative to wage offered) in the job market, reduces the cost of turnover. Likewise, the opposite is true (Durst, Moore, Ritter, & Barkema, 2018). Because the availability of competent staff is a risk in New Zealand dairy farming sector, the cost of turnover is higher (Eastwood, Greer, Schmidt, Muir, & Sargeant, 2018; Tipples, 2017).

A wide group of actors (called 'web of influencers') are involved in the New Zealand dairy farmers' decision-making process (Hilkens, Reid, Klerkx, & Gray, 2018). New Zealand dairy farmers have a reliance on other farmers, scientists, and veterinarians as their most trusted sources of information (Brown & Roper, 2017; Small, Brown, & Montes de Oca Munguia, 2016). Hence, they may seek advice from a range of service providers (e.g., input suppliers, contractors, and bank managers), and experts that are solely responsible for providing advice (e.g., farm consultants and accountants). These advisors provide information and recommendations on a vast range of different topics such as pasture management (Eastwood, Rue, & Gray, 2017), animal health (Lam, Jansen, Van den Borne, Renes, &

Hogeveen, 2011), financial management (Hilkens et al., 2018), and environmental regulations (Small et al., 2016) that help dairy farmers to shape their decisions. The knowledge and skills of these groups can strongly influence the success of dairy farm businesses. As such, the uncertainty about the skills and knowledge of the web of influencers is another source risk for New Zealand dairy farmers.

2.5.6 Financial risks

Financial risks are another form of uncertainty that New Zealand dairy farmers face (Gray, Dooley, et al., 2008; Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2013). Farming businesses often rely on external funding to finance their operations. The use of debt capital to finance a farm's activities suggest that a share of the operating profit must be allocated to cover the debt costs. Therefore, higher debt means more risk for farmers (Barry & Ellinger, 2012). This risk, known as financial leverage risk, is one of the most fundamental financial risks for any business (Barry & Ellinger, 2012; Hardaker et al., 2015). In addition to the financial leverage risk, uncertainty about the availability of funds when it is required is another important financial risk (Barry & Ellinger, 2012; Hardaker et al., 2015). Empirical studies also found that the availability of, and access to, credit significantly impacts the profitability of farms and rural businesses (Briggeman, Towe, & Morehart, 2009; Ciaian & Fałkowski, 2012). Interest rate volatility (Barry & Ellinger, 2012; LaDue & Zook, 1984; Leatham & Baker, 1988), the availability of liquid assets (Barry, Baker, & Sanint, 1981; Hardaker et al., 2015; Mishra & Lence, 2005), and debt amortization (Baker, 1976; Rahman & Barry, 1981; Schnitkey & Novak, 1989) are other important sources of farm financial risk.

In the New Zealand dairy farming context, the result of a study by Pinochet-Chateau, Shadbolt, Holmes, and Lopez-Villalobos's (2005) clearly indicate that if debt is not used efficiently, a high leverage ratio can rapidly lead to bankruptcy. Driven by the expansion of existing dairy farms (DairyNZ, 2017) and the entry of new operators (Melyukhina, 2011), the outstanding debt in the dairy farming sector almost trebled in a 15-year period and reached NZ$45 billion in 2016 (RBNZ, 2016). Hence, the average leverage ratio has increased significantly in the last two decades and reached 49.4% in the 2016-17 seasons (Figure 2.8) (DairyNZ, 2018).

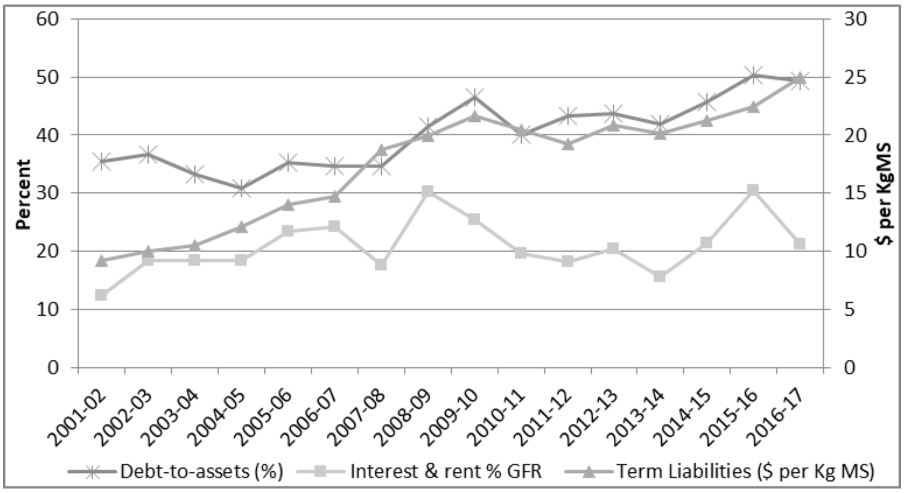

Figure 2-8: Trends in the liabilities of the dairy farming sector (Source: DairyNZ (2011, 2018)).

Another separate, but related topic to financial risk is uncertainty in relation to farmland price. From an economic perspective, the growth in equity (as a measure of wealth creation) for a farmer is the sum of the returns from the dairy farming operation and the capital gain from the property business (Adelaja, Hailu, Tekle, & Seedang, 2010; Shadbolt & Martin, 2005). Therefore, the uncertainty in land price has two major impacts on the well-being of farmers. First, it directly influences the wealth creation of farmers (Gardner & Shadbolt, 2005), and second, it influences the leverage risk of farm businesses (Barry & Ellinger, 2012; Pinochet-Chateau et al., 2005).

In terms of the debt-to-asset ratio (leverage), appreciation of land (as the most significant collateral [24] of a dairy farm business) provides New Zealand dairy farmers with the opportunity to improve their debt-to-assets ratio position whereas a reduction in land prices exposes farmers to a higher degree of leverage risk (Barry & Ellinger, 2012), which in turn diminishes the availability of capital. As such, land value volatility (as an indicator of capital gain from the property business) could expose farm owners' wealth to financial risk[25] (Pinochet-Chateau et al., 2005; Shadbolt & Martin, 2005).

Dairy farmers in New Zealand are also subject to variation in the borrowing cost of their loans (Melyukhina, 2011; Shadbolt & Martin, 2005). Figure 2-9 illustrates the average Official Cash Rate (OCR)[26] and its volatility over a 15-year period (2001-2016). For the first eight years, the OCR was higher than the 15-year average whereas from 2009 onward, the OCR rate was lower than the 15-year average. The relatively low and stable period of the OCR provides New Zealand dairy farmers with the opportunity of borrowing money at lower cost. However, periods of shock in OCR levels, such as the

[24] Property pledges to assure repayment of debt (Barry & Ellinger, 2012).
[25] Although uncertainty in dairy farmland values could have considerable impact on the well-being of dairy farmers, it is beyond the scope of this research to fully explore the effects of this risk on farmers' risk management behaviour.
[26] The Official Cash Rate is the daily benchmark interest rate set by the Reserve Bank of New Zealand that applies to lending and borrowing between the Reserve Bank and commercial banks. It influences all other interest rates and is, in effect, the wholesale price of borrowing or lending money in New Zealand.

global financial crisis (GFC) in 2008, could influence dairy farmers' debt servicing ability and threaten the profitability of dairy farms (Melyukhina, 2011).

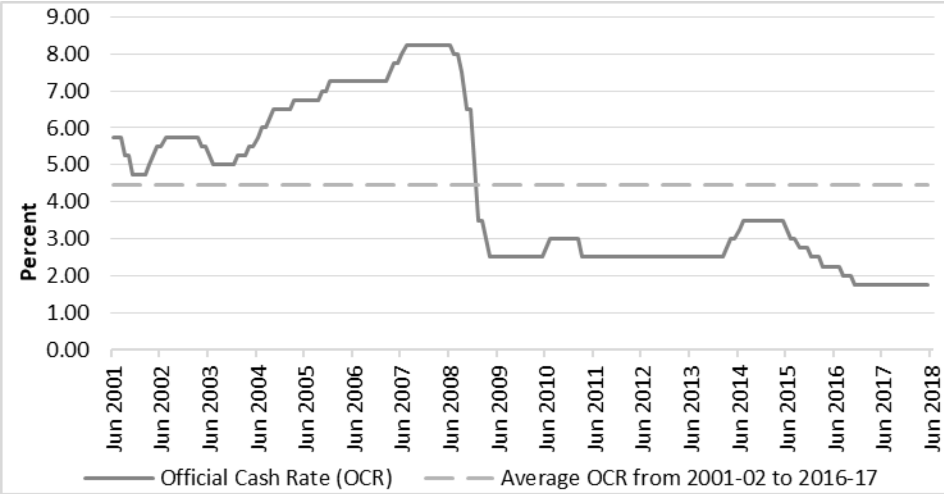

Figure 2-9: Historical Official Cash Rate in New Zealand (Source: RBNZ (2019)).

The availability of credit is also subject to uncertainty (Barry & Ellinger, 2012; Barry & Robison, 2001; Briggeman et al., 2009). The results of the Credit Conditions Survey (CCS) (RBNZ, 2019) on banks' observations and expectations for relative credit availability in the agriculture sector is presented in the Figure 2-10. Response scores ranged from -100 to +100 where a positive score indicates increasing relative credit availability, and a negative score indicates decreasing relative credit availability. The results clearly indicate that agriculture credit is subject to uncertainty (Figure 2-10). For example, the period after the GFC of 2007-8 shows a sharp reduction in the availability of agriculture credit.

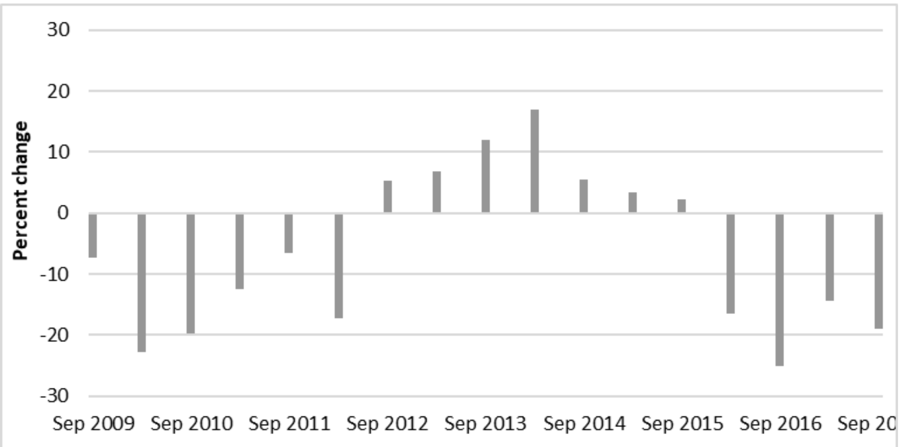

Figure 2-10: Agriculture credit availability relative to the previous three years (Source: RBNZ, 2019).

Hence, the availability of credit decreased between the 2015-17 period. This was mostly due to the low milk prices. Despite this decrease, banks also reported that they were approving more working capital loans to dairy farms outside of their regular lending policy guidelines. This suggests that although banks' lending policies and credit terms were tighter, dairy farms were still able to borrow to get through the downturn over this period.

2.5.7 Technology risks

Technology is another source of risk for dairy farm businesses (Boehlje & Schiek, 1998). Studies in precision technologies provide some useful insights into the impact of technology risks for New Zealand dairy farm systems. Utilising precision dairy farming technologies provide advantages to farmers such as reducing labour requirements, attracting and retaining staff, and improving decision making (Edwards, Rue, & Jago, 2015). Despite these advantages, there are some risks inherent in the adoption of these technologies (Eastwood et al., 2017; Eastwood, Jago, Edwards, & Burke, 2016; Jago, Eastwood, Kerrisk, & Yule, 2013). According to Jago et al. (2013), uncertainties related to utilising new technologies can be classified into three main sub-categories: uncertainty in the investment decision (Bewley et al., 2010), uncertainties around the implementation of the new technology (Eastwood et al., 2016; Jago et al., 2013), and uncertainty arising from the integration of the technology within the farm system (Eastwood & Kenny, 2009).

The decision to purchase precision dairy technology represents a long-term financial commitment for dairy farmers (Borchers & Bewley, 2015). Therefore, uncertainty around the technology's performance could directly diminish the financial position of dairy farms (Bewley et al., 2010; Borchers & Bewley, 2015). Besides, the rapidly evolving nature of technology contributes to a type of a technology risk called obsolescence risk. A new technology may be adopted, but a better or newer technology may make the earlier technology obsolete, which can result in financial loss and a competitive disadvantage that is not expected to occur when a new technology is adopted (Boehlje & Schiek, 1998).

In terms of the implementation of technology within a farming system, Eastwood et al. (2016) reported that adopting new technologies imposed a significant learning load on farm managers. In addition to this, teaching staff that are involved with the new technology is a source of threat because of the higher skill level required to work with new technologies (Eastwood et al., 2016). Finally, several studies reported that using technology, for managerial decisions, could be challenging because it requires significant changes in farmer routines, mind-set and managerial skills (Eastwood et al., 2017; Eastwood et al., 2016; Jago et al., 2013). In particular, uncertainty arises when farmers try to strike a balance between tacit (subjective, cognitive, experiential learning) and explicit (objective, rational, technical) knowledge (Eastwood & Kenny, 2009). The previous sections have reviewed the literature on the sources of risk faced by New Zealand dairy farmers. The next section reviews the literature on New Zealand farmers' perceptions of risk.

2.6 New Zealand dairy farmers' perception of risk

Since the mid-1990s, a series of studies in New Zealand have focussed on exploring the relative importance of various sources of risk from a farmer's perspective (Duranovich, 2015; Martin, 1994; Pinochet-Chateau, Shadbolt, Holmes, & Lopez-Villalobos, 2005; Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2016). The results of these surveys provide insights into dairy farmers' perceptions of the various risks they face and how the farming environment has changed over time. The earlier surveys only focused on the downside risk (threats). The respondents were provided with a list of risks that they could score in terms of importance using a five-point Likert-type scale (see: Martin, 1994; Pinochet-Chateau et al., 2005). A comparison of risk study findings in 1992 (Martin, 1994) and 2004 (Pinochet-Chateau et al., 2005), highlighted changes in farmers' perceptions of risk (Table 2-3).

Table 2-3: Risk perceptions of New Zealand dairy farmers in 1992 (Martin, 1994) and 2004 (Pinochet-Chateau et al., 2005).

	1992		2004	
Sources of perceived risk	**Mean Score***	**Rank**	**Mean Score***	**Rank**
Market Risk	**3.79**		**3.83**	
Product prices	4.03	1	4.20	1
World situation	3.78	2	3.80	3
New Zealand economy	3.58	7	3.70	4
Input costs	3.76	3	3.60	5
Financial Risk	**3.36**		**3.05**	
Interest rate	3.62	5	3.40	8
Land prices	3.09	14	2.70	13
Production Risk	**3.17**		**3.13**	
Rainfall	3.61	6	3.90	2
Other weather	3.02	15	2.90	11
Pest and disease	3.43	9	3.20	10
Disasters	2.63	17	2.50	15
Regulatory Risk	**3.40**		**3.23**	
Government laws and policies	3.58	8	3.40	8
Local laws and policies	3.41	10	2.80	12
Producers board policies	3.20	11	3.50	6
Human Risk	**3.43**		**3.10**	
Accidents or health	3.71	4	3.50	6
Family situation	3.14	12	2.70	13
Miscellaneous Risk	**2.75**		**2.20**	
Theft	2.83	16	2.50	15
Labour and contractors	3.14	13	2.30	17
Change in technology	2.60	18	2.20	18
Bing able to meet contracting obligations	2.42	19	1.80	19

* Scale from 1 to 5 (not important to very important)

The findings from Pinochet-Chateau et al. (2005) indicated that the mean score for market risk increased between 1992 and 2004. However, this category of risk was ranked as the most important source of risk in both 1992 and 2004 (Pinochet-Chateau et al., 2005). In addition to output prices, growing awareness about the risks arising from the global situation and the New Zealand economy are other important market risks Pinochet-Chateau et al. (2005) identified. These findings suggested that the globalisation of the agricultural sector has increased the farm business environment risks (Boehlje & Roucan-Kane, 2009).

The perceived risk score for production risk slightly decreased between 1992 and in 2004 (Pinochet-Chateau et al., 2005). However, there were significant changes in the scores given to the different sources that represented production risk. In 1992, diseases and pests were a relatively important source of risk (rank = 9), whereas in 2004, rainfall shortages became a much more important production risk (rank = 2) than it was in 1992 (Pinochet-Chateau et al., 2005). The perceived risk score of financial risk decreased considerably from 1992 to 2004. In comparison to 1992, interest rates and land values were relatively less important risks in 2004. The results of these two surveys (Pinochet-Chateau et al., 2005) showed that farmers' perceptions of the different sources of risk are likely to change over time due to changing environmental conditions.

A more recent survey of New Zealand dairy farmers by Shadbolt and Olubode-Awosola (2013) acknowledged the importance of upside risk (opportunities) in their decision-making, and it assessed the magnitude of opportunity or threat impact, and the likelihood of the impact occurring over the short and long-term period (Table 2-4). Shadbolt and Olubode-Awosola (2016) found that in the short-term, there were no sources of risk that were perceived to have a strong negative effect or a high likelihood of occurring. That is, in the short-term, dairy farmers' perception of risk is predominantly a "glass half-full' view with more sources perceived to be providing opportunities to benefit the fam business as opposed to sources that would provide threats that would impact negatively on the farm business over the short-term.

Table 2-4: Risk perceptions of New Zealand dairy farmers in 2011 (Shadbolt & Olubode-Awosola, 2013).

	Short-term				**Long-term**			
	Opportunity		**Threat**		**Opportunity**		**Threat**	
Risk Sources	**Mean Score[1]**	**Rank**	**Mean Score**	**Rank**	**Mean Score**	**Rank**	**Mean Score**	**Rank**
Climate variation	12.5	*5*	10.2	*5*	9.8	*14*	9.7	*7*
Pasture/crop/animal health	11.3	*7*	9.0	*10*	9.9	*6*	8.9	*11*
Interest rate	10.3	*11*	9.0	*8*	9.8	*11*	9.9	*5*
Land values	8.2	*15*	5.43	*14*	9.9	*7*	8.9	*12*
Product prices	13.2	*2*	13.3	*3*	14.3	*2*	9.5	*6*
Input prices & availability	10.5	*8*	13.6	*1*	10.0	*13*	14.1	*1*
Availability of labour	9.1	*14*	8.0	*13*	9.2	*15*	8.7	*10*
Skills and knowledge of associate	12.6	*3*	4.9	*15*	13.6	*4*	8.1	*15*
Technological changes	11.2	*6*	5.0	*16*	14.2	*3*	5.4	*16*
Business relationships	10.0	*12*	5.0	*17*	9.4	*10*	8.0	*17*
Dairy industry structure	9.5	*13*	8.3	*11*	10.0	*9*	8.7	*9*
The global economic and political situation	10.8	*9*	13.7	*2*	10.4	*8*	13.9	*3*
Global supply and demand for food	15.5	*1*	9.1	*7*	15.6	*1*	6.1	*14*
Global competitors & competition	10.2	*10*	9.2	*9*	10.0	*12*	9.3	*8*
Reputation and image	12.1	*4*	8.1	*12*	13.7	*5*	8.3	*13*
Government laws and policies	8.5	*16*	9.6	*6*	9.8	*16*	12.0	*4*
Local body laws and regulations	7.8	*17*	13.0	*4*	6.5	*17*	14.0	*2*

1. Score: Impact (from 1=no impact to 5=very high impact) * Likelihood (from 1=very unlikely to 5=highly likely)

Over the long-term, the top four sources of risk that were perceived to provide opportunities included "global supply and demand for food", "product prices", "technological change" and "the skills and knowledge of associates" (Shadbolt & Olubode-Awosola, 2013).The risks that were perceived as providing more threats included, "input prices and availability" followed by "local body laws and regulations", and then "the global economic and political situation" and "government laws & policies" (Shadbolt and Olubode-Awosola (2016). In terms of financial risk, the results showed that interest rates provided an equal degree of opportunity and threat over the long-term. However, land values were perceived to provide more opportunity than threat over the long-term (Shadbolt & Olubode-Awosola, 2013).

Duranovich (2015) characterises farmers' perceptions of risk from three dimensions namely "pace of change", "volatility", and "opportunity/threat judgement[27]" (Table 2-5). The first dimension "pace of change" defined the speed at which farmers perceived a source of risk had been changing over the last ten years. The next dimension "volatility" defined as the variation perceived in the source of risk in the last ten years. The third dimension, opportunity/threat judgement captured farmers' evaluation about whether a source of risk was considered as an opportunity, as a threat or as both an opportunity and a threat for the farm business in the last ten years (Duranovich, 2015).

Table 2-5: New Zealand dairy farmers risk perception in 2011 (Duranovich, 2015).

	Pace of change		Volatility[1]	
Risk Sources	**Mean Score[2]**	**Rank**	**Mean Score[3]**	**Rank**
Climate variation	3.5	12	3.4	3
Pasture/crop/animal health	3.4	13	2.8	9
Interest rates	3.1	17	3.0	6
Land values	4.0	6	3.3	4
Availability of capital	3.3	16	3.0	7
Milk prices	3.6	8	3.9	1
Input prices & availability	4.1	2	3.5	2
Availability of labour	3.1	18	3.1	5
Skills and knowledge of associate	3.5	10	2.9	8
Technological changes	4.0	4	NA	NA
Business relationships	3.3	15	NA	NA
Dairy industry structure	3.5	11	NA	NA
The global economic and political situation	3.9	9	NA	NA
Global supply and demand for food	3.9	7	NA	NA
Global competitors & competition	4.1	3	NA	NA
Reputation and image	3.3	14	NA	NA
Government laws and policies	4.0	5	NA	NA
Local body laws and regulations	4.2	1	NA	NA

1. Only applicable for nine sources of risks
2. Score from 1=decreasing rapidly to 5=Increasing rapidly
3. Score from 1=very low to 5=very high

[27] Duranovich (2015) called the term "risk perception" for this dimension. However, the operationalization of this dimension in the Duranovich's (2015) survey is similar to the risk and return evaluation in the behavioural economics studies (Finucane, Alhakami, Slovic, & Johnson, 2000; Ganzach, 2000; Ganzach, Ellis, Pazy, & Ricci-Siag, 2008; Slovic, Finucane, Peters, & MacGregor, 2004).

Interest rates and the reputation and image of the dairy industry were two sources of risk that were declining either slowly or rapidly. Five risk sources including climate, pasture/crop/animal health, availability of capital, business relationships, and availability of labour were constant over the past decade. Finally, regulatory risks, technological risks, and market risks were three risk sources that were most associated with an increasing rate of change (Table 2-5). Regarding volatility, risk sources such as milk price, and input prices and availability, were considered highly volatile. Whereas sources such as climate, land values, availability of labour, interest rates, availability of capital, skills and knowledge, and pasture/crop/animal health were considered to have a low to moderate volatility (Table 2-5).

Figure 2-11 shows responses in relation to the opportunity/threat judgement for each source of risk. The results showed that technological changes, business relationships, the global supply and demand for food, and the skills and knowledge of those associated with the business were considered an opportunity. In contrast, the most threatening sources of risk were local body laws and regulations, government laws and policies, global competitors and competition, and input prices and availability (Figure 2-11).

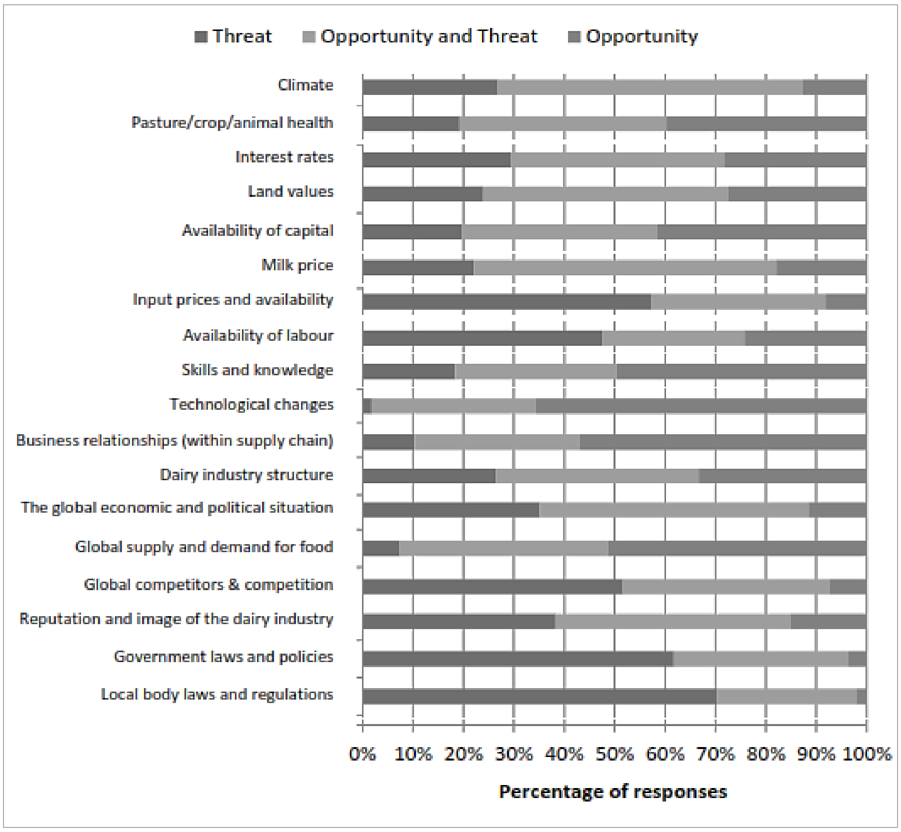

Figure 2-11: Opportunity/threat judgment for each of the sources of risk (Duranovich, 2015).

Risk theory suggests that opportunities and threats tend to be positively correlated (i.e., risks that possess a high threat tend to have provide a greater opportunity than risks that possess a low threat).

However, Figure 2-11 shows that some of the risk sources are negatively correlated in the farmers' minds (i.e., a low threat is associated with a high opportunity, and vice versa).

Duranovich's (2015) findings on the opportunity/threat judgment can be explained using affect theory (Finucane et al., 2000). Affect theory hypothesises that human beings evaluate risky situations with two fundamentally different systems, namely the analytical mechanism (also called deliberative, and verbal), and the intuitive mechanism (also called automatic, natural, and experiential) (Slovic et al., 2004). In the analytical mechanism, a decision maker relies on analytical reasoning, logic, and scientific deliberation. In contrast, in the intuitive mechanism, decision makers rely on their emotions and feelings to evaluate a risky situation (Slovic et al., 2004). One of the main characteristics of the intuitive, experiential system is its affective[28] basis (Finucane et al., 2000). In this mechanism, risky prospects are judged as good (perceived to provide high returns and low risk) or bad (perceived to provide low returns and high risk) by a decision maker, and the probabilistic nature of the risky prospects plays little or no role in its evaluation (Slovic & Peters, 2006). Different explanations are offered as to why decision makers might use the intuitive mechanism rather than the analytical mechanism. In the realm of cognitive psychology, Slovic and Peters (2006) argued that reliance on affect is generally a quicker, easier, and more efficient way to evaluate a complex, uncertain, and sometimes hazardous situation. In finance, Ganzach (2000) found that investors are using intuitive judgement when they want to evaluate unfamiliar stocks. Accordingly, if the unfamiliar stocks were perceived as good, they were judged to have a high return and low risk, and if they were perceived as bad, they were judged to have a low return and high risk. In contrast, for familiar stocks, the perceived risk and return were directly correlated (Ganzach et al., 2008).

Inferring from the affect theory, it can be argued that for sources of risk where little or no statistical information is available or applicable (such as local body laws and regulations, government laws and policies, and technology) intuitive judgement is used. As such, perceived risk and return were negatively correlated (Figure 2-11). In contrast, for sources of risk where enough historical data and analytical information is available (familiar risks such as interest rates, land values, pasture/crop/animal health) analytical judgement is used. As such, perceived risk and return were directly correlated (Figure 2-11).

To summarise, empirical studies on New Zealand dairy farmers have highlighted three main findings in relation to their risk perceptions: first, farmers' perceptions of different sources of risk are likely to change over time. This finding is congruent with the Patrick and Alexander's (2004) findings on U.S

[28] "The specific quality of "goodness" or "badness" experienced as a feeling state with or without conscious" (Slovic et al., 2004, p. 312)

crop producers risk perceptions. Second, farmers' perceptions of risk are likely to be different based on the timeframe within which they choose to evaluate risk (short-term vs. long-term). More importantly, the empirical findings revealed that the risks in the business environment provide both opportunities and threats for the farm business. Therefore, it is critical to enquire about both the positive and the negative implications of each risk when assessing farmers' risk perceptions (Duranovich, 2015; Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2016). The empirical findings also showed that for some type of risks , especially if little or no statistical information about that risk is available, perceived risk and return may be negatively associated. This is contrary to the objective view of risk that assumes opportunities and threats in a particular source of risk (e.g., technology) tend to be positively associated. Finally, this section discussed how this seemingly conflicting finding can be explained by the affect theory in risk (Finucane et al., 2000). An overview of the definition of risk management, a taxonomy of risk management and New Zealand dairy farmers' views on different risk management strategies are provided in the next three sections.

2.7 Definition of risk management

Risk management in agriculture is concerned with the way farmers deal with risk (Meuwissen, Hardaker, Huirne, & Dijkhuizen, 2001; Meuwissen, Huirne, et al., 2001). Patrick (1992) defined risk management as a variety of strategies that may reduce the probability of unfavourable events occurring or reduce the adverse consequences if the event occurs. He also asserts that risk management has two main dimensions. The first dimension refers to the anticipation that an unfavourable event may occur, and the second dimension refers to the act of reducing the probability of its occurrence. One of the most comprehensive definitions of risk management is offered by Hardaker et al. (2004): "the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, treating and monitoring risks" (p. 12).

The majority of the definitions imply that risk management is an independent entity that can be set out from the overall farm management system. However, all the actions that might be taken by a farmer are subject to risk decisions because they are made with imperfect knowledge about outcomes. Therefore, there is no distinction between farm management and what is historically called risk management (Jolly, 1983). The seminal book by Earl Heady "Economics of agricultural production and resource use" (1952) acknowledged that risk management strategies should be considered as an integral part of the overall farm management policy. This view was later rephrased by Just and Pope (2003), in which they stated that in many situations, it is unclear when farmers select to use a risk management strategy, are they doing this primarily to manage risk or is it just part of a broader strategy to increase farm returns (Just & Pope, 2003).

At least, two studies provide empirical evidence that support Just and Pope's (2003) notion. The first study showed that futures markets were perceived by a sample of U.S crop farmers to both reduce risk and increase income (Shapiro & Brorsen, 1988). Similarly, findings from an empirical study on a sample of beef producers in Ontario (Canada) also suggested that farmers were using income protection insurance both as an investment strategy and as a risk management tool (to protect against business risks). Yet, the incentive for risk management was stronger than investment (Cao et al., 2019).

In addition to Just and Pope's notion (2003), Musser and Patrick (2002) argued that the best strategy to protect farmers' equity over the long-term is to improve the physical and financial efficiency of the farm business. That is, "in many situations, improving the expected value of returns (i.e., the financial returns) is the most effective risk management strategy" (Hardaker et al., 2015, p. 224). This statement reinforces the claim that was proposed in the Section 2.3, one can conclude that risk management is incorporated in any fields of farm management (production, finance, human resources, marketing) and more importantly the overall farm business strategy.

2.8 Taxonomies of risk management strategies

In response to the potential impact of uncertain events, farmers utilise various risk management strategies (Hardaker et al., 2004; Melyukhina, 2011; OECD, 2009). The main aim of this section is to demonstrate the approaches that are used to create taxonomies of risk management strategies. An early schema classified risk management strategies based on the procedure to manage risk. Jolly (1983) proposed that procedures to manage risk can be classified into risk exposure control responses and risk impact control responses. The former group of strategies are aimed at reducing the variability in farm income (i.e., enterprise diversification, pest and disease control, and marketing strategies). Risk impact control responses are concerned with the capability of businesses to absorb the unfavourable threats or exploit favourable events (i.e., cash reserves, household consumption smoothing) (McLeay et al., 1996; Melyukhina, 2011). A more recent classification schema was offered by Miller et al. (2004) in which the procedures to respond to risk were classified into four categories: avoidance, reduction, transfer, and assumption/retention. A business can be structured to avoid certain risk types (e.g., drying off the milking cows early to avoid drought in the late summer). Risks can be reduced e.g., diversification to reduce risks associated with a particular enterprise. Risk can also be transferred at a cost (either payment or lost opportunity) through insurance, futures, options and forward contracts. A risk may be retained, particularly when the increased risk is expected to increase overall profitability or maintain control (Gray, Dooley, et al., 2008; Miller et al., 2004).

Another schema that is particularly is useful for classifying tactical (operational) risk management strategies (Gray, Dooley, et al., 2008) separated them into production, marketing, and financial responses (Patrick, 1992; Sonka & Patrick, 1984). Production strategies are designed to reduce variability in production while marketing strategies can also reduce risk by narrowing the range of possible outcomes. They may involve transferring price risks to other individuals or institutions. Financial responses generally emphasize the firm's capacity to bear risk and do not reduce the probability of an unfavourable event. Financial responses may also transfer risks to others and provide a means with which the firm can withstand adverse consequences should they occur (i.e. insurance).

Harwood et al. (1999) offered another risk management strategy classification schema. The first group of risk management strategies reduce risk within the farm's operation (i.e., diversification, irrigation, chemical spraying). Another group of strategies transfer risks outside the farm (i.e., production contracts and insurance). This group of management strategies are also called risk-sharing strategies (Meuwissen, Hardaker, et al., 2001). The final group of risk management strategies reduce the impact of a risky event once it has occurred (i.e., maintaining liquid assets). This latter group of risk management strategies are also called risk-bearing strategies (Patrick, 1992).

A more recent classification schema offered by Crane et al. (2013) adopted a combination of two different taxonomies. Initially, risk management strategies were classified into production, marketing, financial, legal, and human resource strategies. Then, within each of these groups, the risk management strategies were further classified based on the mechanism that controls the effect of risk on-farm. The first covered risk management strategies that were aimed at minimizing the probability or impact of an adverse event occurring within the farm operations (i.e., use of chemicals, irrigations). The second covered risk management strategies that were aimed at diversifying risk (i.e., vertical integration, and diversification). The third risk management strategies are aimed at transferring risk to a third party (i.e., procuring inputs by contracts, insurance)(Crane et al., 2013).

2.9 Managing risk at the strategic level

As highlighted in the section 2.5.1, risks at the strategic level are incorporated in the overall farm business strategy, and it is not possible to simply draw a one-to-one connection between strategic risks and risk management strategies. More importantly, there are no tools or techniques for transferring these risks to others. This is because the strategic risks are not inherently desirable. In fact, an important aspect of strategic decisions is the ability of the farm business to take advantage of strategic risks (Boehlje et al., 2001; Boehlje et al., 2003; Kaplan & Mikes, 2012). As such, managing risks at the strategic level require a fundamentally different approach (Boehlje et al., 2003; Kaplan & Mikes, 2012).

Strategic risk management would not stop a farm business from undertaking risks. Instead, it would allow the farm business to retain risk while enabling them to respond to potential risks (Boehlje et al., 2005; Boehlje et al., 2003; Shadbolt et al., 2010). That is, "farms must evaluate and manage strategic uncertainty through approaches that enable them to capture the potential benefits of the uncertainty and mitigate exposure if they fail to act" (Hardaker et al., 2015, p. 224).

Primarily managing risk at the strategic level is concerned with choosing the appropriate amounts of different types of risks while taking measures to avoid or alleviate those risks perceived too great to be borne to generate a return[29] (Hardaker et al., 2015). Obviously, an extreme uncontrolled approach to strategic risk management, without the proper use of risk management strategies would lead to gambling behaviour (Shadbolt & Olubode-Awosola, 2016; Willebrands, Lammers, & Hartog, 2012). In contrast, implementing a wide range of strategies to eliminate all strategic risks will ultimately lead to a situation which is called "safe loss" because, after all, return is the reward for taking risk (Hardaker et al., 2015; Willebrands et al., 2012). In short, managing risk at the strategic level comes down to finding the optimal balance between risk-taking, planning to control the undesirable outcome of the risk, and avoiding the risk (Hardaker et al., 2015).

Farmers must evaluate the risk-return and risk trade-offs when they plan and implement a farm business strategy (Boehlje et al., 2001; Boehlje et al., 2005; Boehlje et al., 2011). For example, in a region with unreliable rainfall through the season, a dairy farmer may decide to dry the milking herd off early in the summer to avoid the possibility of drought risk (positioning to avoid). However, the potential profit opportunity from extending the lactation period also will be missed (risk-return trade off). To capture the opportunity of extending lactation, the farmer may choose to install an irrigation system. Although irrigation enables the farmer to mitigate the risk from the variability of pasture production (production risk), the capital cost associated with irrigation may expose the farmer to financial risk. Therefore, by positioning the business in a way that reduces exposure to production risk, the farmer will expose his business to financial risk (Gray et al., 2014).

The above examples showed that farmers can define the extent and types of strategic risks that they are willing to take by positioning the businesses in the desired direction. In addition to positioning to avoid risk, three main approach to manage strategic risks include positioning to absorb, positioning for flexibility, and positioning for adaptation (Boehlje et al., 2003; Miller, Boehlje, & Dobbins, 1998). Positioning to absorb can be defined as the extent to which a farm business can continue to behave

[29] This definition is analogous to the definition of "Risk appetite" offered in the Enterprise Risk Management (ERM) framework (Moeller, 2007). According to this framework, risk appetite is the aggregate amount and types of risks that a business is prepared to tolerate or to retain to achieve its strategic objectives (Kaplan & Mikes, 2016).

within limits and produce acceptable outcomes without requiring any significant change in its structure (Holling, 2001). That is, absorption is the capacity of a farm business to cope with risks while preserving its structure (Kaine & Cowan, 2011; Kaine & Tozer, 2005). Having feed reserves for unexpected climatic events (such as floods, storms and droughts) is a classic example of this approach (Gray, Kemp, et al., 2008).

Positioning for flexibility (i.e. long-term flexibility) is another key approaches to cope with strategic risks (Darnhofer, Bellon, Dedieu, & Milestad, 2010; Gray, Dooley, et al., 2008). Flexibility is defined as the ability of a system to respond, at a reasonable cost and at an appropriate speed, to planned and unanticipated changes in external and internal environments (Slack, 1987). Flexibility can be divided into tactical and strategic flexibility (Darnhofer, Bellon, et al., 2010). Tactical flexibility refers to the ability of a farm business to implement changes in the short term when facing anticipated risks (such as seasonal drought) whereas strategic flexibility refers to the capacity to change the structures and the resources of the business when a dramatic change in the environment is anticipated or a sudden unanticipated risk calls for a fundamental change in business structure and processes (Darnhofer, Bellon, et al., 2010).

Carrying spare capacity, is one of the well-known strategic decisions that allows a pasture-based farm system maintain flexibility[30] and adapt a range of contingency plans to accommodate variabilities in the business environment such as floods, droughts, and volatility in terms of trade (low output prices and/or high input prices) (Díaz-Solís, Grant, Kothmann, Teague, & Díaz-García, 2009; Gray et al., 2009; Ingrand et al., 2007; Nozieres et al., 2011). The choice of stocking rate is primarily driven by the biophysical characteristics of the farm such as soil fertility, land topography, and annual rainfall (Holmes et al., 1987) and farmer managerial skills (Gray & Lockhart, 1996). However, risk considerations such as uncertainties in the business environment as well as the farmer's personal preferences influence the choice of intensity in a dairy farm business (Díaz-Solís et al., 2009; Ho et al., 2013; Ingrand et al., 2007; Macdonald et al., 2017).

Maintaining a stocking rate lower than the full carrying capacity of the land allows farmers to respond to adverse climatic events such as drought and flooding. Availability of spare capacity also can compensate the initial drop in productivity, which generally happens when a farm system adopts a

[30] Flexibility is a complex and multidimensional concept. In a pasture-based farm system flexibility can be built on different aspects of the farm business such as technical, economic, and marketing (Ingrand et al., 2007). However, it is beyond the scope of this research to fully explore different dimensions of flexibility in the pasture-based farm systems. As such, this research is focusing on maintaining a stocking rate lower than maximum capacity of land, which is the most common type of flexibility in the pasture-based farm systems (Nozieres, Moulin, & Dedieu, 2011).

new technology (Boehlje & Roucan-Kane, 2009; Jago et al., 2013). As such, spare capacity can facilitate adoption of new technologies (seed, machinery etc).

Empirical evidence showed that farms with a large amount of spare capacity can afford to adopt production operations and technologies that may not fit with their respective business environments because the excess capacity acts to buffer them from the consequences of the misalignment (Díaz-Solís et al., 2009; Nozieres et al., 2011). Finally, carrying spare capacity may simplify the production operation because it requires less control. As such, the demand for highly skilled labour is lower (Bitsch et al., 2006; Ullah & Zheng). This is particularly important In the New Zealand dairy farming because finding highly skilled labour and contractors has become a challenge over the past decade (Greenhalgh & Tipples, 2013).

One of the key challenges in achieving flexibility is finding the right balance between efficiency or productivity and flexibility. That is, strategies that enable farmers to achieve flexibility may lead to inefficiencies in the production system[31] (Astigarraga & Ingrand, 2011; Cowan et al., 2013; Hirsch, Mishra, Möhring, & Finger, 2019; Ingrand et al., 2017; Renner, Glauben, & Hockmann, 2014). When the terms of trade across the sector is low, it is more likely that farms are penalised more heavily for having overly large spare capacity than necessary. Therefore, decisions about the size of a farm's spare capacity that both allows for flexibility while not limiting to overall performance is of great importance.

Adaptability is another key approach for managing strategic risks (Cowan et al., 2013; Miller et al., 1998; Miller et al., 2004). Adaptability refers to the ability of farm businesses to cope with constant, but dynamic (ever-changing) changes in the business environment (Darnhofer, Bellon, et al., 2010; Milestad, Dedieu, Darnhofer, & Bellon, 2012; Schiere, Darnhofer, & Duru, 2012).

Climate change risk is a classic example of a risk that can be managed by the adaptability approach (Kalaugher, Beukes, Bornman, Clark, & Campbell, 2017; Nettier, Dobremez, Lavorel, & Brunschwig, 2017). The three adaptation strategies to increase the capacity of the pasture-based dairy farming systems to cope with climate change include increasing the resources available to the farm system (in this case water through irrigation); more efficient use of soil water through a change to a deeper rooting pasture species; and reducing the pressure on the available resources by reducing stocking rates (Kalaugher et al., 2017). The adaptive approach is not exclusively focused on external dynamic changes in the farm environment, but also considers the dynamic nature of the farm business and farm family, including their objectives, perceptions, values, and intentions. Improvement in the

[31] Spare capacity closely resembles the built-in redundancy concept in the farm system's resilience literature (see for example (Meuwissen et al., 2019)).

working conditions, the farmer's view of farming, the farmer's lifestyle, and inclusion of family into the farm workforce are some examples of internal dynamic changes that may be managed by the adaptive approach (Dedieu, 2009; Ingrand et al., 2007; Milestad et al., 2012).

Despite some similarities, flexibility and adaptability are two distinct strategic risk management approaches (Bhamra, Dani, & Burnard, 2011; Darnhofer, Bellon, et al., 2010; Schiere et al., 2012). In the absence of risk, a farm manager plans a series of strategies and implements repeated patterns of behaviour to produce output and achieve acceptable profit. This point is called the equilibrium point. Risks (as disruptive forces) prevent farm systems from running near the to the equilibrium point. However, a farm system may be robust enough to withstand disruption and attain the equilibrium point (positioning to absorb (Boehlje et al., 2001)).

The farm system moves away from equilibrium point when it cannot absorb the risk (Kaine & Tozer, 2005), and the flexibility approach allows the farm system to bounce back to the original equilibrium point after the system is disrupted by a risk (Figure 2-12). The adaptation approach allows a farm system to respond to the disruptions by continuous, but steady changes in the equilibrium point. Therefore, rather than returning to the original equilibrium point (flexibility), positioning for adaptation involves moving from the original equilibrium point to a new one in order to minimize the impact of the disruption and maintain an acceptable level of profit (Bhamra et al., 2011; Kaine & Cowan, 2011; Kaine & Tozer, 2005).

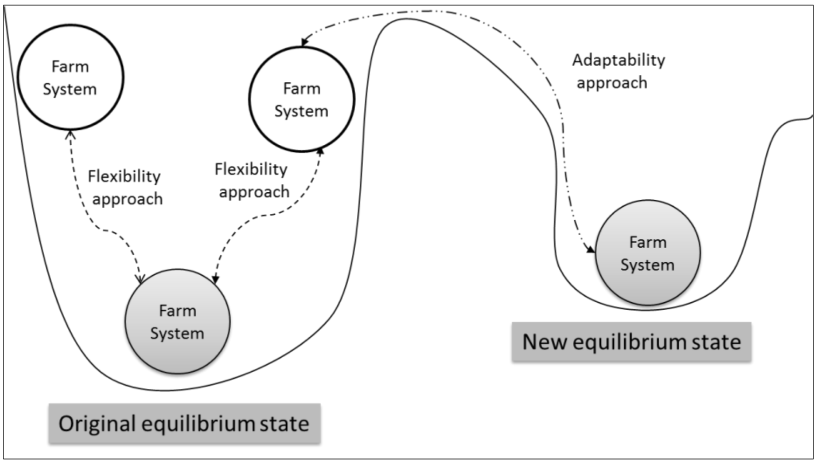

Figure 2-12: Risk management at the strategic level: A schema of the flexibility and adaptability approaches (Adapted from Fiksel, 2003).

Diversification (see section 2.5.1.3.4), gradual implementation of on-farm changes, controlling risks through monitoring, benchmarking and detecting strategic shortfalls between reality and what has been planned (Martin & Shadbolt, 2005; Parker et al., 1997; Shadbolt, 2008), and finally, identifying possible exit strategies (also called transformation (Darnhofer, 2014; Darnhofer, Fairweather, &

Moller, 2010)) in case the risks become impossible to manage are some other risk management approaches at the strategic level (Boehlje et al., 2005; Gray, Dooley, et al., 2008; Gray et al., 2014).

This section highlighted how the choice of overall business strategy (also called meta-strategies (Gray, Dooley, et al., 2008)) dictate lower level strategies, and the way it allows dairy farmers to manage uncertainties. Similarly, this section illustrate that farmers may also respond to a risk by adjusting the overall positioning of the business and as such, the response to a particular type of risk could be “multi-faceted”. The next sections describe the main risk management strategies utilised by New Zealand dairy farmers and how these strategies enable dairy farmers to manger risks in their farm business.

2.10 Risk management strategies in New Zealand dairy farming

This section discusses the most widely used risk management strategies used by New Zealand dairy farmers. Following Patrick's (1992) schema, management strategies are classified into business (production, marketing, human resource), and financial risk management strategies. Sections 2.10.1, 2.10.2, and 2.10.3 cover the main business risk management strategies (production, market, and human resource risk management strategies, respectively). Section 2.11 reviews the financial risk management strategies used by New Zealand dairy farmers. Given the importance of debt management for New Zealand dairy farmers (Martin, 1996; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2013), section 2.11.1 reviews different aspects of debt management including farm capital structure, access to capital, interest rate risk management and debt amortisation. Sections 2.11.1.3 and 2.11.3 review other aspects of financial management namely, liquidity management and financial monitoring. Section 2.12 presents farmers’ view on risk management strategies and finally section 2.13 provides an overview of determinants of risk management behaviour and the conceptual models that have been employed to explain farmers’ risk management behaviour.

2.10.1 Production risk management strategies

This section reviews the main production risk management strategies utilised by New Zealand dairy farmers and how these strategies enable farmers to manage production risks. Given the importance of wintering strategies on the production risk management, Section 2.10.1.3 provides a more detailed view on the available wintering management strategies and the strengths and weaknesses of those strategies.

2.10.1.1 *Having feed reserves for unexpected events*

Success in a pasture-based dairy system relies on balancing pasture supply and herd demand throughout the season (Holmes et al., 1987; Neal & Roche, 2020). Balancing between feed supply and feed demand ensures that capital stock live-weight is protected, and adequate pasture cover is available over the calving period. Farmers use different strategies at different times of the year to maintain the balance between pasture supply and feed demand[32]. The period from calving date to balance date (early spring) is of great importance because grazing during this period determines production to Christmas (Figure 2-13).

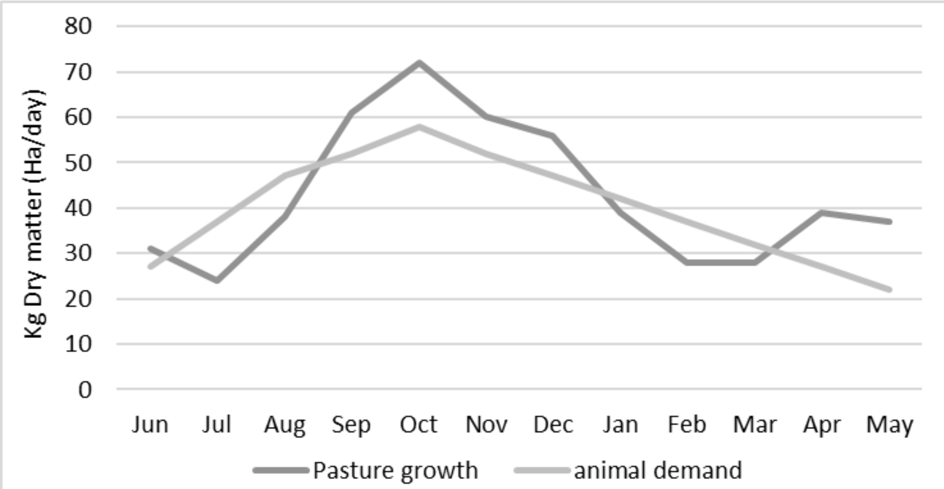

Figure 2-13: Typical pasture growth and animal feed demand in New Zealand ((Holmes et al., 1987).

Feed deficits during the mating period, due to prolonged adverse weather and poor pasture management, also can be detrimental to the reproductive performance of the herd (Holmes et al., 1987). As such, options to reduce herd demand are limited and farmers normally focus on strategies to meet feed demand (Neal & Roche, 2020). Maintaining feed reserves is one of the most widely used strategies to meet a milking herd's feed demand. Depending on the farm structure, different types of feed (e.g., maize silage, grass silage, baleage, hay, grain, PKE) may be used to respond to adverse climatic events in the early spring period.

In contrast to the early spring period, farmers have a greater range of strategies to balance feed supply and feed demand in the late lactation period (mid-summer to dry off date). The decision to increase feed supply or reduce feed demand in the late lactation period depends on several factors including milk price and the marginal cost of the extra milk produced from the feed supply (Ramsbottom, Horan, Berry, & Roche, 2015; Roche et al., 2016). In addition to the use of feed reserves, culling policy, milking frequency (once or twice daily), adjusting lactation length (the decision on dry-off dates) are some examples of other available strategies to balance feed supply and feed demand during the lactation period (Gray & Lockhart, 1996; Gray et al., 2014).

[32] The choice of the farm stocking rate, calving date, and farm system's intensity is a strategic decision that is influenced by several factors (e.g., climate, soil, land topography, staff availability, managerial skills). However, this section discusses the strategies farmers use to cope with unexpected feed shortages, after the decision about farm intensity is made by the farmer.

2.10.1.2 *Irrigation*

In many parts of New Zealand (especially the East coast), evapotranspiration during the summer months exceeds rainfall, which eventually leads to soil moisture deficits (Corong et al., 2014). Soil moisture deficits are the major factor limiting pasture growth rates over the period from late spring until mid-autumn (Corong et al., 2014; Saunders & Saunders, 2012). There is a general consensus that irrigation water increases pasture yields, reduces the variability in pasture yields, and hence the variability of income in the New Zealand dairy farms (Corong et al., 2014; Saunders & Saunders, 2012). Irrigation also triggers additional benefits because it enables land use change to products with higher income such as dairy (Saunders & Saunders, 2012). Corong et al. (2014) investigated the direct impacts on the dairy sector of removing irrigation from different regions of New Zealand. Based on these findings, three distinct dairy farming regions can be identified in relation to irrigation (Table 2-6).

First, dairy farming regions where rainfall is generally reliable during the pasture growth season (spring, summer and autumn). For these farming regions, there is limited incentive to invest in the irrigation technology because soil moisture deficits are not a limiting factor (e.g., most of Waikato, Taranaki, West Coast, and Southland). Second, regions where without irrigation a large number of dairy farms would most probably not be established because the initial risk would be quite high (e.g., Auckland, Marlborough-Canterbury, central Otago) (KC et al., 2018; Saunders & Saunders, 2012) (Table 2-6). Third, regions where climate varies, and soil moisture deficits during the pasture growing season (spring to autumn) become a limiting factor from season to season (KC et al., 2018; Saunders & Saunders, 2012).

Table 2-6: The impact of irrigation on dairy regions of New Zealand (Adapted from Corong et al. (2014)).

Region	**Impact if irrigation had never occurred**
Northland and Auckland	A lower average production and more vulnerable to dry summers. Impossible to continue dairy farming in the Auckland region.
Waikato	A decrease (20-25%) in the level of production, and higher variability between years.
Bay of Plenty and Gisborne	A decrease (15%) in the level of production for the Bay of Plenty. Impossible to continue dairy farming in the Gisborne region.
Taranaki	A lower level of production with higher variability.
Lower North Island and Napier	A decrease in performance including a 20% reduction on heavier soils, and a 40% reduction on lighter soils. Also, might have to develop different systems (e.g., early calving split calving, winter milk production). For Hawke's Bay, farms on heavier soils would remain in dairying, but those on lighter soils would have to revert to sheep and beef.
West Coast-Tasman	Farming systems (beef, dairy) would still be as is, but at a less intensive level. In some areas (e.g., Waimea plains) dairy farming without irrigation is not possible.
Marlborough-Canterbury	Impossible to continue dairy farming in the Marlborough region. It would only be possible on the heavier soils or in the foothills with a higher rainfall pattern in Canterbury.
Otago- Southland	Very unlikely to continue dairy farming without irrigation in the drier areas of Otago such as the Central Otago and the Ranfurly regions.

Investment in irrigation technology depends on the several factors including the extent of exposure to drought risk (due to low rainfall or low soil water holding capacity) farmers' managerial capability, and the biophysical characteristics and the organisational structure of the farm. While the impact of irrigation on yield performance (higher MS per ha and/or higher MS per cow), performance variability (less volatility in pasture production and MS production) and intensity of dairy farming (more cows per ha) is evident, estimating the financial impact of irrigation is not straightforward (Howes, Horne, & Shadbolt, 2014; KC et al., 2018). Specifically, the financial performance of an irrigated farm system depends on how the extra feed produced by irrigation is utilised. For example, the financial impact of utilising extra feed through increasing farm intensity is different from the financial impact of increasing per cow feed intake while the intensity of the farm system is held constant (Howes et al., 2014; KC et al., 2018). Moreover, irrigation technology requires considerable capital investment, and this may offset the financial gain from increases in yield (Barham, Robinson, Richardson, & Rister, 2011; Foudi & Erdlenbruch, 2011).

2.10.1.3 *Wintering strategies*

In a temperate pasture-based system, such as New Zealand dairy farming, limited pasture growth occurs during winter and early spring. In this system, cows are managed to minimize their requirements for fresh pasture during winter through: ensuring they are dry over this period, the provision of conserved forages, with or without housing, during the winter months, or moving them to an alternative property for feeding before calving (Ramsbottom et al., 2015). Because of the relationship between cow condition at calving and production (Holmes et al., 1987), one of the key strategic decisions in the New Zealand dairy farm systems is managing dry dairy cows over the winter period (called wintering) (Dalley, 2010; Dalley, 2011; Edwards, Mashlan, Dalley, & Pinxterhuis, 2017; Gray et al., 2014).

In addition to issues of pasture availability over winter, soils are prone to compaction or pugging - an undesirable occurrence on grazed pastures during these wetter months of the year (Bennett, Pangborn, & Bywater, 2012; Holmes et al., 1987). Finally, grazing wet soils increases the risk of nitrogen loss into waterways and soil erosion (Beukes et al., 2013; Dalley, 2010). As a result of these risks, wintering solely on pasture (based on autumn saved pasture) supplemented with conserved feed is not a viable strategy for many dairy farm businesses.

Wintering based on forage crops that provide large quantities of high-quality standing feed on a relatively small area (e.g. kale, swedes, and fodder beet) or the use of hay and silage to supplement pasture are the traditional wintering strategy in New Zealand (Dalley, 2011). To manage soil compaction risk, farmers may choose to keep the herd on blocks with shallow, stony soils or use blocks on river gravels (Beukes et al., 2013). Where stony blocks are not prevalent, some farmers may choose to change the herd rotation so the blocks with heavy soils would be grazed earlier in the season (when the soil is not too wet) (Edwards et al., 2017). Finally, some farmers may choose to accommodate the herd in a few blocks (called sacrifice paddocks) to minimise soil compaction risk on the remaining blocks (Kaine, 2015).

Wintering using forage crops and conserved feed is relatively simple and low-cost strategy (Dalley, 2010). The low cost of feed, low labour requirements, and no requirement for additional structures are some of the advantages of this strategy (Chrystal, Monaghan, Hedley, & Horne, 2016). However, crop grazing at high stocking densities during winter, combined with high winter rainfall, free-draining soils, and sloping land can result in high nutrient losses, which expose farmers to regulatory risks (Dalley, 2011). Forage crops are generally considered to be a good option in terms of profitability and meeting herd demand. However, the profitability of this strategy depends on the crop yield, which can vary greatly depending on the crop type and biophysical conditions (rainfall, temperature, soil etc) (Chrystal et al., 2016).

In addition to wintering based on the conserved feed (either as a standing crop or hay and silage), farmers may choose other alternative wintering strategies. Wintering on the milking platform using a wet soils management facility, wintering on support blocks (either owned or leased support blocks), and wintering at a graziers (Edwards et al., 2017) are three widely used wintering strategies. The next three sections briefly discuss these three alternatives for forage wintering and pasture-only strategies.

2.10.1.3.1 Having infrastructure for wet soil management (e.g., barns, pads)

Accommodating or feeding milking herds off pasture on the milking platform is an alternative wintering strategy. Effective implementation of this strategy required wet soil management Infrastructures (e.g. stand-off pads, barns, etc) (Chrystal et al., 2016; Dalley, 2011). The Survey of Rural Decision Makers (SRDM) conducted by Landcare Research- Manaaki Whenua, reported that approximately 27% of New Zealand dairy farmers who winter their milking herds on the milking platform had a diverse range of wintering facilities or infrastructure including feed pads [33]

[33] A feed pad is a hard surface area (usually concrete) normally sited adjacent to the farm dairy where stock can be held for some time (1-2 hours), either prior to, or after milking, and provided with supplementary feed.

(predominantly in the Manawatu and Waikato regions), standoff pads[34] (predominantly in the West Coast region), wintering barns and concrete lanes[35] (Samarasinghe & Brown).

Compared to other wintering-on strategies, having wet soil management infrastructure provides different opportunities and threats. Reducing soil damage, providing better pasture quality in the early spring season, improving animal welfare, and reducing the environmental footprint (N-leaching) are some of the potential advantages of the wet soil management infrastructure (Chrystal et al., 2016). In terms of disadvantages, this infrastructure requires considerable capital investment, maintenance costs (machinery, depreciations etc), supplementary feed costs, and higher animal health management skills (Beukes et al., 2013; Newman & Journeaux, 2015). In order to justify the investment cost, farmers usually intensify their production systems and this may neutralise the potential environmental benefits of wet soil management facilities (Newman & Journeaux, 2015).

Newman and Journeaux (2015) conducted a multiple case-study to evaluate the costs and benefits of wet soil management facilities on six New Zealand dairy farms. They concluded that there is a trade-off between increasing the profitability of the farm and reducing the environmental footprint, and It is difficult to achieve both objectives (Newman & Journeaux, 2015). Interestingly, none of these objectives were the main reasons for farmers to invest in the wet soil management infrastructure. In fact, the decision to invest in a wet soil management facility was related to management reasons and control of feed supply. That is, trading climate risk for financial risk (Newman & Journeaux, 2015).

2.10.1.3.2 Grazing dairy stock off-farm (with a grazier)

Another common strategy for dairy farmers is to graze their cows over winter at a grazier's property. The Survey of Rural Decision Makers (SRDM) asked a sample of New Zealand dairy farmers (n=481) to indicate their wintering policy. Approximately, 27% of the dairy farmers that participated in the survey indicated that they graze their dairy cows off the milking platform over the winter months (Wintering-off strategy). The use of this strategy was more prevalent in the Southland, South Canterbury and the Hawkes Bay regions (Samarasinghe & Brown).

The wintering-off strategy is intended to protect the soils and pastures on the milking platform from damage, maintain cows condition and ensure an adequate supply of feed for the start of lactation and a productive milking season (Bennett et al., 2012; Postiglione, 2013). However, the choice of this

[34] A wintering stand-off or loafing pad is a specially built area where stock can be withheld from grazing during the wet season for an extended period (20 hours/day) to minimise damage to pasture. These pads are typically constructed of free-draining materials such as sawdust, bark, wood chips, lime, or a soft metal (rock) mix. There is no provision for stock feeding while the animals are on the pad.

[35] A wintering barns or wintering pad or animal shelter is a specially built area where animals are withheld from pasture for extended periods and supplementary feeds are brought to them.

strategy is associated with contractual risk. Lack of effective communication between the dairy farmer and grazier (Bennett et al., 2012), the grazier's lack of skill to feed dairy cows, an incorrect assessment of feed availability, cows being lighter at the start of winter, and a lack of a suitable monitoring system are some of the identified underlying reasons for contractual risk (Postiglione, 2013). Moreover, not using written contracts, settling the price too late in the season, and a lack of a clear and fair system to set the price were identified as some other reasons that contractual risk may occur (Postiglione, 2013). As a result, some farmers may choose to acquire a dairy support block to mitigate the risks associated with contracting a grazier.

2.10.1.3.3 Owning support block (run-off)

Because of the contractual risk associated with grazing stock off over the winter period, many farmers choose to winter the milking herd on a support block (Bennett et al., 2012; Gray et al., 2014). Wintering on a support block provides dairy farmers with the ability to avoid both the market risk associated with the cost of grazing off and the production risk associated with cow condition over winter (Bennett et al., 2012; Dalley, Wilson, Edwards, & Judson, 2008). It also allows farmers to protect pasture from damage on the milking platform over the winter and early spring period (Bennett et al., 2012; Dalley et al., 2008). Extending lactation in late summer and autumn, rearing young stock, producing supplements, and diversifying into other enterprises such as cash cropping or dairy beef are some of the other reported advantages of support blocks (Bennett et al., 2012; Gray et al., 2014). The size of a support block (relative to the main milking platform) and proximity to the main milking platform determine the range and scale of other activities that can be undertaken (Bennett et al., 2012). Finally for farmers who purchase a support block, profit from capital gain (land appreciation) can be another advantage (Bennett et al., 2012; Dalley, 2011).

Despite all these advantages, the profitability of dairy support blocks is questionable. That is, in many instances, dairy support blocks generate a cash loss to the dairy operation (Bennett et al., 2012; Dalley et al., 2008). However, achieving self-sufficiency and avoiding contractual risk are more important than profitability (Bennett et al., 2012; Dalley et al., 2008). As such, the choice comes down to managing production risk (by acquiring a support block), or contractual and market risk (by developing relationships with graziers and other outside parties) (Bennett et al., 2012).

2.10.2 Market risk management strategies

As explained in Section 2.5.1.2, approximately 85% of New Zealand milk production is processed by the Fonterra Cooperative (the largest dairy company in New Zealand) (Shadbolt & Apparao, 2016). Fonterra uses a price pooling system whereby all producers supplying milk receive a similar price. As such, farmers are effectively exposed to similar degree of market risk (Ma, Bicknell, et al., 2019; Ma et al., 2018).

Fonterra's price pooling system is a mechanism that manages foreign exchange risk, and funding and interest rate hedging (Conforte et al., 2008; Shadbolt & Apparao, 2016). The strategies of exchange rate hedging for the dairy industry typically takes a 12-15 months rolling cover which reflects both the gradual supply of milk year-round and its marketing in various forms offshore. A forecasted price is announced before the start of the season that signals the market price movement and enable farmers to make short-term adjustments in their variable costs (Koeman & Bialkowski, 2015; Mirza, Reddy, Hasnaoui, & Yates, 2020).

2.10.2.1 *Using futures markets to sell milk*

Although strong and extensive reliance on cooperative marketing helps New Zealand dairy farmers to manage marketing risk (e.g. exchange rate), milk price volatility is still a major source of risk for farmers (Gray, Dooley, et al., 2008). Viability of dairy farm businesses depends on the ability to receive milk payouts that are above the break-even milk price whereas payout levels below the breakeven point indicate that the farmer is operating at a loss (Beux Garcia et al., 2015; Ma et al., 2018; Shadbolt et al., 2017).

Dairy futures is a milk price risk management tool. The New Zealand's Exchange (NZX) established Whole Milk Powder (WMP) futures in 2010. This was then followed by Skim Milk Powder (SMP) futures, Anhydrous Milk Fat (AMF) futures, butter futures and WMP options in 2014 (Fernandez-Perez, Frijns, Gafiatullina, & Tourani-Rad, 2019; Koeman & Bialkowski, 2015; Mirza et al., 2020). in 2016, the milk price futures and options contracts were developed by NZX (Fernandez-Perez et al., 2019). Despite the potential benefits of dairy futures, less than 10% of New Zealand dairy farmers utilise these strategies (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2013).

Four reason were identified for low adoption of dairy futures among New Zealand dairy farmers. First, due to a low level of trading volume in the NZX dairy futures, the cost of futures is high (Koeman & Bialkowski, 2015; Mirza et al., 2020). Second, due to the sub-optimal hedge ratios produced, the basis risk is too high (Koeman & Bialkowski, 2015; Mirza et al., 2020). Three, because none of the derivatives offer a hedge proxy for farmgate milk price, farmers need to use more sophisticated techniques (such as Cross-Hedging) to be able to mitigate farmgate milk price risk. Learning these techniques is time consuming and requires a high level of financial and numerical literacy (Fernandez-Perez et al., 2019; Koeman & Bialkowski, 2015; Mirza et al., 2020). Finally, membership in the milk marketing cooperatives helps farmers to manage a considerable amount of milk price risk, so the incentive for using another price risk management strategy is limited (Melyukhina, 2011). These findings were consistent with the findings from empirical studies that investigated the barriers to adopting dairy futures in other countries (Wolf, 2012; Wolf & Widmar, 2014).

2.10.2.2 *Using contracts to procure feed in advance at a fixed price*

Dairy farmers have two options to procure supplementary feed: purchasing with a forward contract or purchasing on the spot market. In the forward contract option, the farmer agrees to buy the input at a set price and set tonnage for an estimated delivery date (Fausett, Rowarth, & Scrimgeour, 2015). Forward contracts allow the farmer to have a secure supply of inputs that minimises the risk of input availability and price changes. However, locking in at a set price also means that the farmer might pay a higher price if the input price decreases in the future (Fausett et al., 2015). In the spot market option, farmers buy the input for immediate delivery in which price changes reflect supply and demand in the market. Flexibility for input choice, pricing and volume are among the main advantages of the spot market option (Fausett et al., 2015).

Farm system type is the main factor in deciding between the two feed purchasing options. In a highly intensive farm system, when bought-in feed is necessary for meeting feed demand, farmers need to make sure that feed is available. Therefore, the forward contract is a more suitable option for these farms (Gray et al., 2011; Gray et al., 2014; Hirst, Donaghy, Gray, Wood, & McCarthy, 2014). However, when bought-in feed is a used as a back-up to support pasture, the farmers' decision depends on several factors. The milk payout, input costs and the weather conditions are the main factors that influence a farmer's decision about their feed input procurement strategy (Fausett et al., 2015). To take the advantage of both options, some farmers may choose to use them both. This option strikes a balance between the certainty of the contract option and the flexibility of the spot market option (Gray et al., 2014).

2.10.2.3 *Spreading sales (reducing seasonality in milk production)*

Milk production in New Zealand follows a distinct seasonal pattern with the shape of the milk production curve reflecting pasture seasonality (Holmes et al., 1987; Macdonald, Beca, Penno, Lancaster, & Roche, 2011; Ramsbottom et al., 2015). Matching seasonal pasture growth to cow demand has been the key to New Zealand's ability to produce milk competitively (Ramsbottom et al., 2015). The dairy processing sector has adapted processing facilities that meet the needs of a seasonal milk production system (Shadbolt & Apparao, 2016). However, the profitability of milk processing companies is negatively affected by a seasonal supply profile (Geary, Lopez-Villalobos, Garrick, & Shalloo, 2014). Therefore, milk processing companies introduce winter milk premiums to encourage farmers to produce milk during the winter months (Chikazhe et al., 2017; Spaans et al., 2019). Accordingly, some farmers moved away from spring calving to split calving and autumn calving options in order to take advantage of winter milk premium (Chikazhe et al., 2017).

Moving from a seasonal milk supply to a less seasonal milk supply would result in the use of a lower proportion of grazed pasture with out-of-season feed requirements met through forage crops and, or bought-in feed (Geary et al., 2014). The results of modelling studies (Chikazhe et al., 2017; Geary et al., 2014) and a farmlet experiment (Spaans et al., 2019) showed that the profitability of winter milk production is highly dependent on the pasture growth profile of the region. That is, farms in regions that grow more pasture in winter than summer and have free draining soils are more likely to be profitable (Chikazhe et al., 2017; Geary et al., 2014; Spaans et al., 2019). The profitability of farms with split calving and autumn calving options is closely associated with the premium milk price offered by milk processing companies (Chikazhe et al., 2017). Farmers' ability to source cheap supplements, the capital cost and transitional cost required to shift to an autumn calving system are other important factors that influence the profitability of winter milking systems (Chikazhe et al., 2017; Geary et al., 2014; Spaans et al., 2019).

2.10.3 Human resource risk management strategies

The increase in size of the dairy farms in New Zealand and accordingly greater number of employed staff required to manage farms indicates that human resource management is another important aspect of New Zealand dairy farm's risk management (Eastwood et al., 2018; Wilson & Tipples, 2008). Empirical studies showed that achieving quality (Rodrigues, Caraviello, & Ruegg, 2005; Schewe et al., 2015; Stup et al., 2006), production, and financial (e.g. profitability and return on assets and return on equity) objectives (Stup et al., 2006). depends on human resource management (Durst et al., 2018).

At strategic level, the choice of farm operating structure is the most crucial decision on the overall farm human resource management strategy. Farmers that decide to utilise any type of contract milking arrangement (e.g. contract milking, variable order sharemilking, and herd-owning share milking) virtually transfer the human resources management risks to the contractors (Payne et al., 2007; Reekers et al., 2007). However, for other type of operating structure particularly as owner-operated, farmers is responsible for human resource management and its associated risks (see section 2.5.1.4). Utilising technology to reduce labour requirement is a strategic decision that have considerable impact on the choice of human resource management strategy in two ways. First, adopting some technologies reduces the need for staff whereas some other technologies reduces responsibilities of the staff and provide better working condition for staff (Eastwood et al., 2018; Eastwood et al., 2016) (see section 2.5.7).

Howard and McEwan (1989) proposed that human resource management in agriculture is a process that include strategies in relation to recruitment, reward systems, employee turnover, job satisfaction, motivation, and management style. Recruitment is the first step in human resource management. Recruitment in a dairy farm is more than just having an employee for each position. Ideal staff recruitment entails having competent, high-performing staff (Durst et al., 2018). Farm owners have two overarching choice when recruiting staff. Employing experienced, high performing staff or providing training for staff with low experience and improving their skills (Gray et al., 2014). There is a shortage of experienced staff in the New Zealand dairy labour market (see section 2.5.5), and the majority of the labours are migrants who have limited knowledge and relevant training useful for New Zealand dairy farm systems (Eastwood et al., 2018; Tipples, 2017). As such, many farm owners need to provide training in the beginning of recruitment to make sure that the staff can undertake the tasks (Greenhalgh & Tipples, 2013).

'Providing good working conditions for staff' is another important risk management strategy to increase labour satisfaction and reduce the risk of staff turnover (Gray et al., 2014; Greenhalgh & Tipples, 2013). Dairy farming, globally, has a reputation for unattractive working conditions, longer average working hours than most other industries with which it must compete (Durst et al., 2018; Tipples, 2017). Empirical studies found that lower staff turnover and job satisfaction depends on factors such as management style and good working conditions, the hours of work, and lifestyle (Eastwood et al., 2018; Greenhalgh & Tipples, 2013). As such, 'providing good working conditions for staff' is an important risk management strategy to increase labour satisfaction and reduce the risk of staff turnover (Gray et al., 2014; Greenhalgh & Tipples, 2013). The next section provides an overview of the financial risk management strategies and impact of financial management on overall farm performance.

2.11 Financial risk management strategies

Financial management is defined as "the acquisition and use of financial resources by economics units and the protection of the units' equity capital from business and financial risk" (Barry & Ellinger, 2012, p. 9). This definition emphasizes the importance of capital acquisition and the use of financial resources i.e. debt financing and related topics on financial management (Barry & Ellinger, 2012). Although financial management traditionally focuses on the acquisition and use of financial resources Barry and Ellinger (2012) argued that it is related to both business risk (the inherent risk of a farm operation regardless of the way it is financed) and financial risk (the risk related to financing a business). As such, financial management is a requirement whether the farm has any debt or not

(Barry & Ellinger, 2012). The following sub-sections review the different financial risk management strategies.

2.11.1 Debt management

Empirical studies on New Zealand dairy farm risk management strategies showed a shift from a "keeping debt low" strategy in the early 1990's (Martin, 1996) to "debt management" and the "planning of capital expenditure" strategies in the 21st century (Duranovich, 2015; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2016). Despite this work, with the exception of Gray *et al's* (2014) research on dairy farm financial management, no empirical research has been undertaken to understand New Zealand dairy farmers' debt management strategies, and there is little research available for industry and policy makers on dairy farmers' debt management strategies. Therefore, the following sections draw heavily from agricultural finance literature. In addition to this, the relevant theories outside agricultural finance field such as corporate finance and small and medium enterprises (SMEs) finance are also reviewed to explain different aspect of New Zealand dairy farm financial management strategies.

2.11.1.1 *Farm capital structure and leverage ratio*

The effect of leverage in magnifying risk raises the question of the optimal financial structure for a farm business. Several theories have been developed to explain the choice of capital structure. The majority of these theories are designed to explain this for large publicly traded corporations (Barry & Ellinger, 2012). However, because the majority of dairy farm businesses are comprised primarily of small, privately held firms, which are sole proprietorships, these theories are not directly applicable to the agriculture context. As such, the first part of this section extensively describes and discusses the most prevalent theory in agriculture called the expected utility model of Collins (1985) and its extensions that are specifically developed to explain farmers' financial behaviour. This is then followed by the prominent theories in corporate financing and their specifications that directly apply to the farming context. In particular, the theory of business finance starts with Modigliani and Miller (1958) equilibrium or trade-off theory, and pecking order theory (Myers, 1984) and these are discussed in this section. Following on from this, a theoretical argument that explains the financial behaviour of Small and Medium Enterprises (SMEs) from a business life-cycle perspective is presented (Berger & Udell, 1998). Finally, a recent hypothesis in corporate finance called flexibility theory (DeAngelo, DeAngelo, & Whited, 2011) and its application to agriculture is discussed.

Gabriel and Baker (1980) proposed the concept of risk balancing in farm capital structure. According to this behavioural framework, a firm will balance financial and business risk in order to maintain an approximate level of overall risk (Featherstone, Ibendahl, Randy Winter, & Spaulding, 2005). Building on the risk-balancing concept, Collins (1985) and Barry et al. (1981) proposed an expected utility (EU) model for analysing the optimal capital structure of farm businesses that assumes that farmers are risk-averse decision-makers who are trying to maximise their expected return on equity when deciding about their leverage ratio (Equation 1). This model, hereafter the Collins-Barry model, also assumes that the cost of external capital is exogenous, constant, and independent of capital structure.

$$A^* = \frac{(\mu_A - r_D)}{\gamma(\sigma_A^2)} \qquad \textit{(Equation 1)}$$

A^*= targeted leverage; μ_A = expected return on assets; r_D= cost of debt capital (interest payment); γ= risk aversion; σ_A^2= variance of the return on assets.

The optimal leverage ratio in the Collins-Barry model is negatively associated with expected income volatility, cost of debt (interest rate), and the level of risk aversion, while the expected rate of return on assets has a positive effect on leverage (Collins, 1985). Following the Collins-Barry model, other studies extended the theory by incorporating other factors into the original model. A theoretical extension of the Collins-Barry model is suggested by Ahrendsen, Collender, and Dixon (1994). They suggested an extension of the original model of farm capital structure that includes depreciation, investment tax, and credit constraints on optimal financial leverage (Ahrendsen et al., 1994) (Equation 2). Ahrendsen et al.'s (1994) model posits that the optimal leverage ratio is negatively associated with the expected income volatility, cost of debt (interest rate), and the level of risk aversion; while asset depreciation, the expected return on capital assets and return on assets due to operating income are positively associated with leverage. Finally, the association between tax (Ψ_τ and τ) and leverage is assumed to be ambiguous (Ahrendsen et al., 1994).

$$A^* = \frac{\mu_G\,(1-\Psi\tau)+(\mu_o - r_D)\,(1-\tau)+\tau\rho+\rho_{ITC}}{\gamma(\sigma_A^2)} \qquad \textit{(Equation 2)}$$

A^*= targeted leverage; μ_G= gain on capital assets; $\Psi\tau$= capital gains subject to tax; μ_o= gain due to operating income; r_D= cost of debt capital (interest payment); τ= tax rate; $\tau\rho$= assets depreciation rate; ρ_{ITC}= investment tax credit; γ= risk aversion; σ_A^2= variance of the return on assets after tax.

Using data from North Carolina dairy farms, results of the (Ahrendsen et al., 1994) study revealed that policies that increases farmers' profit or reduced their business risk will result in an increase in financial risk through additional debt. However, they found no significant relationship between the variance of return on assets (business risk) and leverage (financial risk). In their conclusions, they argued that endogenous factors such as farm credit constraints and farmers' preferences over sources of funds might be influential on farm capital structure (Ahrendsen et al., 1994). Jensen and Langemeier

(1996) offered another extension of the Ahrendsen et al's (1994) model that includes operator's unpaid management and unpaid labour in the regression model (Equation 3).

$$A^* = f[\overline{\mu_o}, \overline{\mu_G}, L, \theta, \rho, \sigma_o^2, \sigma_g^2, \sigma_{og}, \tau, \rho_{ITC}, \Psi, \tau\rho, F, r_D] \qquad \textit{(Equation 3)}$$

A^*= targeted leverage; μ_o= mean of gain due to operating income; μ_G= mean of gain on capital assets; L= value of owned land; θ=value of other non-land assets; σ_o^2= variance of gain due to operating income; σ_g^2= variance of gain on capital assets; σ_{og}= covariance of σ_o^2 and σ_g^2; τ= tax rate; ρ_{ITC}= investment tax credit; $\Psi\tau$= capital gains subject to tax; $\tau\rho$= assets depreciation rate; F= returns to unpaid farm labour and management*; r_D= cost of debt capital (interest).*

Using a sample of Kansas farmers, the results from the Jensen and Langemeier's (1996) model provided empirical evidence that generally supported the original EU model. However, their results found a direct association between leverage ratio and interest rate ratio (an increase in leverage when interest rates increased) which is not consistent with the theory. More importantly, elasticity estimation (an indication of the responsiveness of optimal leverage to the different variables in the model) highlighted that marginal income tax rates, variance of operating income, and the proportion of long-term capital gains subject to income taxes have the highest elasticity. As such, the results reinforce the importance of operating profit and tax policy on leverage decisions (Jensen & Langemeier, 1996).

Wu, Guan, and Myers (2014) claimed that the assumption in the Collins-Barry model in relation to homogeneity of external capital costs does not hold true in real world situations. Accordingly, Wu et al. (2014) proposed that borrowers are heterogeneous in terms of degree of credit access, interest rates and stage of the financial life cycle. As such, they offered an extension of the original Collins-Barry model that incorporates both endogenous and exogenous factors into the original model (Wu et al., 2014). In particular, factors such as macroeconomic conditions (national GDP), farmers' education level, availability of collateral, farm size, business life cycle, and ownership structure were incorporated into the model (Wu et al., 2014). They also divided farmers into different groups using the criteria of leverage range and explored the influence of different factors on farm capital structure (Wu et al., 2014).

The results of the extended model by Wu et al. (2014) confirmed that firstly, the cost of external capital is heterogeneous between farms. Secondly, there was no significant relationship between the variance of profitability (business risk) and leverage (financial risk). Finally, the impacts of other endogenous and exogenous factors on capital structure differed considerably in sign, magnitude, and significance levels on farms at different levels of leverage. For example, profitability had a negative and significant effect at different levels of leverage, but the magnitude of the negative effect changed with an increase in the leverage ratio.

Another line of research examined the applicability of corporate finance theory in agriculture research. Modigliani and Miller (1958, 1963) established the foundation of capital structure theory by introducing the equilibrium theory. This theory assumes that in a perfect capital market, capital is readily available to firms, and managers do not have any preferences over different sources of funds (Modigliani & Miller, 1958). As such, different sources of funds, e.g. retained earnings; debt and equity, are a substitute for one another. In such a perfect capital market, firms have a targeted leverage ratio. When a manager discovers that the net benefit of an investment is positive, he decides to finance the investment based on the trade-offs that occur between the costs and benefits of using external sources of funds. Modigliani and Miller (1963) argued that the main benefit of debt is the tax deductibility of interest, while the primary cost of debt is a greater likelihood of bankruptcy. Bankruptcy costs are incurred when the perceived probability that the firm will default on financing is greater than zero. Therefore, a manager may choose to increase the leverage ratio or conversely, pass up on an investment opportunity because the cost of using external finance exceeds its benefits or the targeted leverage ratio is already met (Modigliani & Miller, 1963).

The pecking order theory of Myers and Majluf (1984) which have roots in previous descriptive findings propose that in real world situations, sources of funds are not perfect substitutes for each other (Frank & Goyal, 2003, 2007; Frank & Goyal, 2009). When an investment opportunity arises, firm insiders have better information than other potential lenders in the capital market (i.e. banks) on the value of the firm and investment opportunities. Therefore, the risk premium of internal funds is lower than other types of financing, and firm insiders prefer to use internal funds. When internal funds are exhausted, firms prefer to fund their investments by debt followed by equity because the risk premium on equity is higher than the risk premium on debt (Myers, 1984; Myers & Majluf, 1984). Although, the pecking order theory can also be framed in terms of tax and behavioural considerations (Frank & Goyal, 2003, 2007; Frank & Goyal, 2009), the asymmetry of information between borrowers and investors as well as agency costs between debt-holders and equity-holders are the major factors that determine the cost of different sources of funds (Barry & Ellinger, 2012; Frank & Goyal, 2003, 2007). In a more complex version of the pecking order theory, Myers (1984) stated that firms are concerned with both current and future financing costs. Firms that anticipate large future investments will maintain low-risk debt capacity to avoid foregoing future investments or financing them with high risk securities. Thus, controlling for other effects, firms with larger expected investment opportunities may maintain a lower leverage ratio (Zhao, Barry, & Katchova, 2008).

Ross (1977) also attempted to provide a more compelling view of firms' financial structure using signalling theory. Originally developed to explain information asymmetry in labour markets, signalling theory in finance integrates the borrower's side of the financing transaction with the credit cost and capacity issues on the lender's side. That is, signalling theory reinforces the bilateral credit relationship between borrowers and lenders (Zhao, Barry, & Schnitkey, 2008). According to signalling theory, the problem of asymmetric information between a borrower and a potential lender can prevent the flow of funds to borrowers. Therefore, sending credible signals that demonstrate firm quality enables borrowers to raise funds through external sources. Lenders, in turn, could adopt an adjusted credit scoring policy and offer a justified interest rate policy based on the credible signals of the potential borrowers. Signalling is a general term that is applicable to broad types of relationships (Connelly, Certo, Ireland, & Reutzel, 2010). Nevertheless, the signalling instruments for financial relationships rely on measures that are used to resolve the information asymmetry and to strengthen risk ratings made by financial institutions (Barry & Robison, 2001; Zhao, Barry, & Katchova, 2008). Similar to the managers of publicly traded companies, farm owners send signals to all potential lenders to influence the cost and availability of debt capital. An early simulation study by Sonka, Dixon, and Jones (1980) confirmed that rural lenders are responsive to the farm's financial situation. That is, the amount of available loans is determined by the financial situation of dairy farms. This includes the borrower's net wealth and the income generating capacity of the farm business (Sonka et al., 1980). Similarly, Zhao, Barry, and Schnitkey (2008) recommended signalling tactics and effective communication should be utilised to improve lender-borrower relationships in the agricultural context.

Information asymmetry is a particularly important issue in a farming business because these firms are small in size, capital intensive, and heterogeneous in terms of managerial context (Zhao, Barry, & Katchova, 2008). In general, the farmer possesses superior information in terms of the project(s) he/she plans to undertake. This information imbalance potentially results in adverse selection (lack of complete prior information on the lender's side) (Barry, Bierlen, & Sotomayor, 2000; Barry & Robison, 2001). Therefore, asymmetric information prevents rural lenders from fully recognising the financial situation of different farm borrowers (Gustafson, Pederson, & Gloy, 2005; Zhao, Barry, & Schnitkey, 2008). Also, since the lender does not typically monitor the farmer's use of the loan, there is no guarantee that the loan is used according to the loan contract agreement. This results in a moral hazard problem (inability of the lender to control the farmer's behaviour after the deal) (Sabasi & Kompaniyets, 2015).

The literature on lender-borrower relationships classified information into soft and hard information (Gustafson et al., 2005). Hard information is quantifiable information that can be collected via an accounting information system. Farm income, profitability, the historical good performance record (return on assets), farm leverage, risk management documentation and operating profit are the most widely used “hard” information (Gustafson et al., 2005; Zhao, Barry, & Katchova, 2008; Zhao, Barry, & Schnitkey, 2008). Soft information is not easily quantifiable and consists of information gathered over time through contact with the farmer. Implementing an adequate risk management plan, using marketing strategies, and educational programs for managers and staff are some examples of soft credible signals (Gustafson et al., 2005; Miller, Ellinger, Barry, & Lajili, 1993). From a prescriptive point of view, a good farmer must convey their advantageous credit risk information to lenders through credible signals (Zhao, Barry, & Katchova, 2008). In particular, key performance indicators such as profitability, debt servicing capacity, solvency and liquidity are the most important credible signals that would help lenders to better evaluate a farmer’s creditworthiness. In addition to this, the quality, completeness, and extent of the documentation they provide affect the costs of raising funds (Barry & Robison, 2001).

Two main conflicting points arise when prominent theories of corporate finance are compared. First, the presence of a targeted financial structure, and second, the relationship between debt level and profitability. According to the trade-off theory, a firm sets a target financial structure and then gradually moves towards the target. This target is not directly observable, but it may be imputed from evidence (Frank & Goyal, 2007). In contrast, the pecking order theory proposes that firms have no desired or target financial structure (Frank & Goyal, 2007). Another conflict between these two theories arises due to the relationship between debt level and profitability (Wu et al., 2014). According to the pecking order theory, firms that are more profitable tend to have less debt as they have access to higher amount of retained earnings, and therefore they would have less debt. Conversely, in the trade-off theory, a negative correlation between profitability and leverage is expected because the potential cost of leverage (financial distress and insolvency) decreases when profitability increases. Moreover, the tax deductibility of interest payments (potential benefit) implies that more profitable firms tend to increase their financial leverage (Frank & Goyal, 2007). Based on the signalling theory, farmers with high debt levels and subsequent debt servicing, need to send signals that show their farms are efficient and profitable to lenders, which motivate managers to become more efficient (Mugera & Nyambane, 2015).

Different studies tested the pecking order theory against the competing trade-off theory in order to integrate a variety of observations in a coherent manner and provide a unifying model (Frank & Goyal, 2007). Jalilvand and Harris (1984) stated that market imperfections and the high cost of adjusting to a changing target prevent firms from fully adjusting their capital structure. As such, a partial adjustment model is more appropriate to explain a firms’ capital structure (Jalilvand & Harris, 1984). An extension of Jalilvand and Harris (1984) argument is offered by Vogt (1994) who conducted an empirical study on manufacturing firms to test the joint effects of partial adjustment and pecking order theory. His findings provide evidence that supports a partial adjustment model for firms' capital structure where the pecking order theory explains deviations from the target or within the targeted range (Vogt, 1994).

Barry et al. (2000) conducted an empirical study among a sample of Illinois farm businesses to test the applicability of the partial adjustment and pecking order theory. Their findings confirmed that in the long-term, farms follow the partial adjustment model to achieve the leverage target, but in the short-term, their decision in relation to sources of fund, is consistent with pecking order theory (Barry et al., 2000). The empirical evidence also provided stronger support in favour of the pecking order theory of farm financial structure relative to the partial adjustment approach (Barry et al., 2000). In particular, Barry et al. (2000) concluded that strong cash flows lead crop farmers to expand through leasing land (a substitute for debt) and other investment expenditures, while paying down debt or refraining from borrowing. Hence, the cash flow and debt relationships appear stronger, although more complicated, for more financially constrained farms (Barry et al., 2000).

A series of empirical and simulation studies in agriculture provide a unifying model to test the joint effects of trade-off, pecking order, and signalling theories in agriculture. Zhao, Barry, and Schnitkey (2008) employed a stochastic multi-period simulation model with eight simulated capital structure scenarios to examine the implications of the signalling, pecking order, and partial adjustment theories on the capital structure of representative large cash crop farms in Illinois over a 10-year period. The findings highlighted that the average net wealth of signalling farms is higher than non-signalling farms. Hence, signalling farms achieved better ratings from lending institutions and lower loan rates. Meanwhile, lower default rates from signalling farms benefit lending institutions (Zhao, Barry, & Schnitkey, 2008). The simulation results also confirmed that pecking order financing is an efficient strategy for liquidity management, and improves the short-term financial performance of the farm (Zhao, Barry, & Schnitkey, 2008). Finally, the results demonstrated that following a trade-off strategy through an aggressive investment strategy will lead to the highest net equity. However, utilisation of this strategy will increase the default rate and diminish the credit rating of the farmer (Zhao, Barry, & Schnitkey, 2008).

Zhao, Barry, and Katchova (2008) conducted an empirical study among a sample of Illinois crop farmers to investigate whether signalling, the pecking order, and trade-off theories jointly apply to farm businesses. Their findings provide strong evidence that confirm signalling theory presents another important dimension in farm capital structure. That is, lenders respond to changes in the financial conditions of the borrowers. Furthermore, their findings provide support for the pecking order theory. That is, a farm that generates more cash flow would borrow less, because using debt is more costly than employing internal equity as a source of financing. Hence, short-term debt is slightly preferred to long-term debt due to its lower borrowing costs (Zhao, Barry, & Katchova, 2008).

One of the limitations in corporate financing theory is that they ignore the dynamics of the capital requirements over the business life cycle (Berger & Udell, 1998; Castro, Fernández, & Tapia, 2014; La Rocca, La Rocca, & Cariola, 2011). Ignoring the effect of a firm's life cycle also results in inconclusive findings in terms of the relationship between cash flow and capital structure. This is a particularly important issue in a Small and Medium Enterprises (SMEs) context. On the one hand, retained earnings in the early stages of the business life cycle is not enough to finance operational and investment activities. On the other hand, SMEs are often constrained by the lack of access to external finance due to the information asymmetry between external lenders and firm insiders (Berger & Udell, 1998; Castro et al., 2014; La Rocca et al., 2011; Mac an Bhaird, 2010).

The result of the empirical studies in agriculture that investigated the impact of debt on the farm performance are inconclusive. In one of the most recent empirical studies, Ma et al. (2020) investigated the impact of debt ratio on the technical efficiency and financial performance (ROA) of a panel of 250 New Zealand dairy farms over a 10-year period. The analysis showed that debt does not significantly affect dairy productivity and profitability. This finding suggests that the presence of farm-specific attributes (e.g. life cycle stage of the business and managerial ability) may influence the debt ratio and farm performance (Ma et al., 2020).

When a farmer increases his or her long-term debt, risk is shifted from the farmer to the lender as the lender assumes the default risk at an increasing rate as debt increases (Mugera & Nyambane, 2015). Even if the farmer's risk preferences do not change, the shift in risk share cause the farmer to consider investment decisions differently because more of the investment risk now lies with the lender. Based on this premise, Mugera and Nyambane (2015) investigated the impact of long-term debt, short-term debt and tax liability on farm performance (technical efficiency and return on assets) among a 10-year unbalanced panel of Broadacre farms in Western Australia. Their findings indicated that there is a positive relationship between a farms' short-term debt and both technical and scale efficiencies, but a negative relationship with ROA. That is, the use of short-term debt to purchase necessary farm inputs and maintain farm operations can improve the technical efficiency of farms. However, long-term debt has an insignificant effect on farm efficiency and ROA (Mugera & Nyambane, 2015). The findings imply that long-term debt does not affect the day-to-day managerial operation activities. However, lenders will provide short-term credit to farmers who send credible signals (efficient and with high ROAs), presumably because of their low risk of default (Mugera & Nyambane, 2015).

In contrast to the above conclusion, Lambert and Bayda (2005) created a set of debt-to-asset ratios based on the length of debt term and the asset life and examined their impact on technical and scale efficiency among a sample of North Dakota grain producers. They found that the intermediate-term debt-to-asset ratio had a positive correlation with technical efficiency whereas the short-term debt-to-asset ratio had a negative correlation with farm technical efficiency (Lambert & Bayda, 2005). They stated two reasons may explain these findings. First, adverse climatic event may end up with higher short-term loans to cover possible cashflow deficit. Second, higher agency cost may result in higher misallocation of resources (Lambert & Bayda, 2005).

Berger and Udell (1998) argued that managerial skills, the firm's demand for financial resources and the degree of information opacity are the main factors that determines the financial structure of the small and medium enterprises (SMEs). Based on these propositions, Berger and Udell (1998) developed a financial growth life cycle to show where firms might lie on a size/age/information continuum. This model suggests that SMEs only have access to private equity and debt markets. In particular, it reemphasize the importance of information opacity on a firm's capital structure and follows Myers' (1984) pecking order theory. That is, SMEs largely rely on retained earnings, the owner's personal savings, and finance from friends and family members at earlier stages of the business life cycle. Moreover, owners may use their personal assets as collateral to secure business debt (Mac an Bhaird, 2010). As SMEs advance along the continuum, and become less informationally opaque, they gain access to increased sources of external debt and equity capital (Berger & Udell, 1998; Mac an Bhaird, 2010). Berger and Udell (1998) also argued that SMEs are usually owner-managed and often have strong incentives to issue external debt rather than external equity as managers want to retain ownership and control of their firms. Therefore, in addition to information asymmetry, maintaining control over the business is another important parameter that shapes SMEs' financial structure. This latter statement is partially supported by the empirical findings of (Frank & Goyal, 2003) in which they concluded that farm size is a critical factor in the choice of capital structure. That is, the pecking order theory provides better prediction for larger firms.

La Rocca et al. (2011) examined SMEs' capital structure from a business life-cycle perspective and showed that firms financing strategies are different over the business life cycle. They found that in the early stages of the business life cycle, firms increased the amount of debt, and after consolidation of the business they gradually rebalanced their capital structure by substituting debt for internal capital (La Rocca et al., 2011). Therefore, an inverted-U-shaped curve indicates the relationship between age of the firm and leverage (La Rocca et al., 2011) (Figure 2-14).

Figure 2-14: General effect of age on leverage (La Rocca et al., 2011, p. 121).

In light of these findings, La Rocca et al. (2011) concluded that higher profitability allows SME managers to reduce their leverage ratio over time. As such, the capital structure of SMEs follows the pecking order theory only after entering the maturity period. Consistent with these findings, Mac an Bhaird (2010) and Mac an Bhaird and Lucey (2010) also reported that Irish SMEs use of internal funds becomes the most important source of financing over time. In contrast to the above statement, Barry et al. (2000) showed that older farmers should be less financially constrained than younger farmers because they may have longer relationships with lenders, a greater accumulation of equity, and generally stronger financial measures. As such, younger farmers adhere more strongly to the pecking order theory than do older farmers. This latter statement is also confirmed by the empirical findings of Zhao, Barry, and Katchova (2008) who concluded that younger farmers follow the pecking order theory more closely than older farmers. Within the New Zealand agriculture context, Wright and Brown (2019) found that congruent with the asset fixity theory (Johnson, 1950), older farmers' planning horizons are shorter, leading them to invest less and have relatively lower debt. In contrast, for younger farmers and farmers that have successors, the planning horizon becomes longer. The longer planning horizon increases the expected returns from additional investment. As such, farmers with succession plan invest more and have higher levels of debt (Wright & Brown, 2019).

Finally, Barry and Baker (1971) proposed that farmers do not, in general, utilize their credit in borrowing to the point where external credit rationing becomes an effective constraint. Self-imposed limitations on credit use provide liquidity in the form of a credit reserve and thus limit exposure of the borrower's equity (Robison, Barry, & Burghardt, 1987). While maintaining credit reserves (short-term debt) has its roots in the early literature of agricultural finance as a liquidity management strategy, corporate finance researchers started to pay attention to this concept in relation to long-term debt and investment strategy.

The seminal paper of Graham and Harvey (2001) on corporate finance was the first study that clearly showed untapped borrowing capacity (called financial flexibility) as an important factor in financial management decisions. Following on from this research, DeAngelo and DeAngelo (2007) proposed that financial flexibility represents the ability of a firm to access and restructure its financing at a low cost. Hence, they proposed that financially flexible firms are able to avoid financial distress in the face of negative shocks, and to readily fund investment when profitable opportunities arise (DeAngelo & DeAngelo, 2007; DeAngelo et al., 2011). While a firm's financial flexibility depends on external financing costs that may reflect firm characteristics such as size, it is also a result of strategic decisions made by the firm related to capital structure, liquidity, and investment (DeAngelo & DeAngelo, 2007; DeAngelo et al., 2011; Mittoo, Bancel, & Mittoo, 2011). Finally, these studies suggested that maintaining low leverage levels preserve the ability to borrow when faced with unanticipated capital needs (DeAngelo & DeAngelo, 2007; DeAngelo et al., 2011; Mittoo et al., 2011). Thus, a firm facing a cash deficit might borrow funds to avoid cutting dividends and investment. A dynamic model developed by DeAngelo et al. (2011) showed that financial flexibility allows firms to undertake unexpected investment opportunities, while subsequent financing surpluses are used to reduce debt.

Another different but related topic to leverage ratio is access to capital. Investment in the farming business is generally large and cannot be carried out solely by internal funds. As such, it is critical for farmers to make sure that they have access to funds when it is needed (Barry & Ellinger, 2012). However, farmers access to risk is subject to risk through both macroeconomic (e.g. economic recession, financial crisis, rising interest rates) and farm-specific risks (e.g. low profitability, low debt-to-asset ratio).

Several studies have specifically tested for the presence of financial constraints on U.S. farms by adding variables such as macroeconomic conditions, cash flow and net worth to traditional investment models. Hubbard and Kashyap (1992) found that the sensitivity of investments (banks loans, self-funds) to changes in net worth is greater during financial stress periods such as the Great Depression and the 1980s farm financial crisis. Barry and Stanton (2003) found that farms become more credit constrained during periods of rising short-term interest rates. Hence, exposure to interest rate risk also likely varies a great deal across firms during periods of rising short-term interest rates (Barry & Stanton, 2003).

Sonka et al. (1980) carried out a simulation experiment and examined the correlation between the financial situation of a potential borrower and the amount of credit offered by a bank. From the results of the experiment, they determined that farms that had nearly reached their maximum debt limit, jeopardized their access to bank credit and, thus, their credit reserves (Sonka et al., 1980). Robison et al. (1987) stated that agricultural bankers consider the debt equity ratio and, therefore, the farm's risk-bearing capacity, as an important and decisive factor for lending.

Briggeman et al. (2009) and Ciaian, Fałkowski, and Kancs (2012) found that the profitability of farms and rural businesses significantly impacts on the availability of, and access to, credit. Hence, Bierlen and Featherstone (1998) found that during the 1980s farm crisis, credit constraints were more important for farms with weaker internal financial positions. Finally, the empirical study of Zhao, Barry, and Katchova (2008) found that because high credit risk farms generate less cash income in the short run and experience greater financial burdens from the repayment of long-term debt, they tend to use internal funds, when available.

2.11.1.2 *Debt amortization and debt repayment*

Another important decision in relation to debt management is the choice of debt amortization strategy (also called loan payment type by RBNZ). The term “amortization” comes from the Latin “mors,” meaning “death” (Merriam-Webster, n.d.). So, amortization means to “kill off,” or pay down a loan, and it refers to the size of the principal payments over the life of a loan (Coulibaly & Li, 2009; LaCour-Little & Yang, 2010; Larsen, Munk, Sejer Nielsen, & Rangvid, 2018). Dairy farmers in New Zealand can choose between two main loan payment types: principal-and-interest loans (also called conventional or table loans) and interest-only loans (also called non-conventional or flexible loans). Principal-and-interest (P&I) loans are loans that require periodic payments consisting of an interest payment and a principal payment in that the principal payment can be increasing, reducing, or constant (Shadbolt & Martin, 2005). Interest-only (IO) loans are loans where the borrower pays the interest accruing on the loan on a monthly basis, but principal repayment is at the borrower’s discretion and the borrower is obliged to repay all remaining principal at the end of the loan’s term (RBNZ, 2016). However, amortization payments can potentially be deferred by rolling over into a new mortgage contract after a certain period (e.g., five years), subject to qualification for a new mortgage at each re-financing . Since mortgages constitute a substantial liability on the farmer’s balance sheet, a better understanding of the factors that shape their amortisation decision is critical.

None of the studies in an agricultural context directly explored the effect of IO loans on the financial situation of farm businesses. However, a series of simulation and mathematical programming studies investigated the possible effect of non-conventional loans (with a flexible amortization plan) on the financial situation of representative farms (Baker, 1976; Rahman & Barry, 1981; Schnitkey & Novak, 1989). Some inferences on the advantages and disadvantages of non-conventional loans can be made from these studies. Obviously, the first advantage of a variable amortization plan is reducing the probability of loan delinquency (Khoju, Nelson, & Barry, 1993). The second advantage of non-conventional loans is that they can accommodate uncertainty in farmers' cash flows (Barry & Robison, 2001). That is, farmers can match their debt repayments with the farm's returns. This is particularly important in the early stages of an investment because the probability of cash-flow deficits then is higher (Barry & Robison, 2001; Shadbolt & Martin, 2005). Non-conventional loans also allow farmers to free up funds for other investment activities (Ellinger, Barry, & Lins, 1983; Stone, 1976). Non-conventional loans also have some disadvantages when compared to conventional loans. First and foremost, IO loans entail a larger equity-driven default risk since no principal repayments are made (LaCour-Little & Yang, 2010). Second, the total interest paid on non-conventional loans might be higher (REFS). Finally, withdrawal from a debt-financed investment in a non-conventional loan might be slower (Schnitkey & Novak, 1989).

Outside the agriculture context, the literature on IO mortgages is only starting to emerge. The household finance literature found that low-income and borrowing constrained households that expect their future income to be higher, and they tended to choose products with deferred amortization such as IO loans (Campbell & Cocco, 2003; Cocco, 2013; LaCour-Little & Yang, 2010). LaCour-Little and Yang's (2010) findings showed that households with a larger tolerance for risk tended to choose IO loans. They also reported that speculators and aggressive borrowers are attracted to IO loans to reap the benefits of the capital appreciation of land holdings (LaCour-Little & Yang, 2010). Finally, Larsen et al. (2018) stated that the tax deductibility of interest payments is another advantage of non-conventional loans. According to New Zealand law, the interest portion of the loan payments can be claimed against taxable income. However, it is unclear what are the main motivation for using IO loans. Given the importance of the debt amortization policy on overall farm risk management it is imperative to investigate the factors that determine the choice between P&I loans versus IO loans. The next section will review the changes in the New Zealand farmers' perceptions of risk management strategies. In particular, different aspect of the business risk management strategies, financial risk management strategies, and some aspects of the risk management at the strategic level will be reviewed.

2.11.1.3 *Interest rate risk management*

In addition to the risk arising from the use of debt financing, farmers are also subject to variation in the borrowing cost of their loans. The two debt-financing options available to farmers are fixed-rate and floating-rate loans. For floating-rate loans, farmers take the risk arising from variation in the borrowing costs, whereas in fixed-rate loans, farmers transfer the borrowing cost risks to the lending institution, but pay an interest rate premium charge (Leatham & Baker, 1988). The breakdown of the figures shows that currently only 30 per cent of the dairy farm debt in New Zealand is on fixed rates, with $ 27,787 million on floating (RBNZ, 2016). These figures also raise the question of which factors determines the choice between floating and fixed rate loans.

Empirical studies in corporate finance primarily focused on hedging and market-timing theories to explain debt-servicing policy (Faulkender, 2005). Under the premise that cash flow volatility is costly for firms, hedging theories propose that a firm with a direct correlation between its operating cash flows before interest expenses and interest rates should maintain a higher floating-rate debt to avoid the costs associated with low cash flow states. The market-timing view posits that firms borrow floating-rate debt when they perceived that the cost of borrowing on floating-rate loans are lower than the fixed-rate loans and vice versa (Vickery, 2008). Thus, when yield spread (i.e., the difference between long-term and short-term borrowing rate) is higher, firms are more likely to use floating-rate loans. Faulkender and Petersen (2006) studied the floating and fixed-rate loans structure of a sample of 133 chemical firms and found support for the market-timing hypothesis.

Vickery's (2008) multiple-case study of SMEs showed firms with a higher debt-to-asset ratio and low cash flows, and a smaller size and in the early stage of the business lifecycle are more likely to use fixed-rate loans because they are more vulnerable to rising interest rates. Similarly, Campbell and Cocco (2003) found that in the housing industry, households with volatile income streams were more likely to default on their loans if their income declined and/or their loan repayments increased. Therefore, they concluded that homeowners with volatile income streams would be more inclined to choose fixed-rate loans because it minimizes the likelihood of a loan default (Campbell & Cocco, 2003).

In the agriculture context, the results from a study by Leatham and Baker's (1988) using a stochastic programming model for a representative corn-soybean-hog farm in the Midwest highlighted that there is no correlation between the return on farm assets and interest rates changes. Therefore, an increase in interest rates potentially can diminish a farms' financial position. As such, strategies to manage interest rates are another important financial management decision (Barry & Ellinger, 2012; Leatham & Baker, 1988). Leatham and Baker's (1988) findings also indicated that farms might be interested to pay an interest premium charge to mitigate the risk arising from variation in the borrowing cost. However, demand for fixed-rate loans is sensitive to the size of the interest rate premium (Leatham & Baker, 1988).

LaDue and Zook (1984) investigated the influence of interest rates changes on the financial position of a sample of dairy farms in California. Their results showed that when interest rates trend up, floating-rate loans reduce the capacity of farms to service the debt whereas in a declining interest rate environment, floating-rate loans provide an advantage over fixed-rates loans and increase the capacity of farms to service the debt. Finally, an interest rate environment with no particular trend produces similar results with either type of loan (LaDue & Zook, 1984).

In summary, studies in agriculture indicated that interest rate variation can potentially increase the variability of cash-flow and may reduce the capacity of farms to service debt (Pederson, Duffy, Boehlje, & Craven, 1991). These studies also indicated that the advantage of fixed-rate versus floating-rate loans depends upon the interest rate environment (LaDue & Leatham, 1984) and the interest rate premium charged (Leatham & Baker, 1988). No empirical study in New Zealand has explored the factors that influence dairy farmers' choice between fixed-rate and floating-rate loans. Therefore, it is useful to investigate the factors that influence the choice between fixed-rate and floating-rate loans in the New Zealand dairy industry.

2.11.2 Liquidity reserves

According to Barry and Ellinger (2012) "Liquidity refers to the structure or form of the firm's assets, which are characterized by cash balances and unused borrowing power." (p. 528), and "Cash-insolvency" is the situation when a cash-flow deficit reaches the point that it hampers normal farm operations, reduces the owner's equity, and ultimately leads to bankruptcy. Because New Zealand dairy farms do not have a guaranteed cash inflow, there must always be some risk that a cash-flow deficit could occur. Several empirical and simulation studies show the importance of liquidity management on the risk faced by a farm (See Barry and Ellinger (2012)).

Maintaining cash reserves is a short-term financial strategy that allows a farm business respond to financial stress and take advantage of opportunities. It provides a buffer to financial downturns that might diminish the farm's ability to purchase inputs and service debt obligations (Barry & Ellinger, 2012; Hardaker et al., 2015). It also provides the financial resources to quickly take advantage of opportunities that might develop (e.g., purchase land) (Barry et al., 1981; Barry & Robison, 2001). It should be emphasized that although debt necessarily increases the chances of cash insolvency, this risk exists whether the firm has any debt or not, so that the choice of debt level is not between liquidity risk and no liquidity risk, but between more and less liquidity risk (Barry & Ellinger, 2012; Hardaker et al., 2004). Therefore, regardless of debt levels, one objective of a farm business is to assure that cash can be generated quickly and efficiently to meet cash demands. As such, liquidity management is of great importance to dairy farmers (Hardaker et al., 2004).

The size of the liquidity reserve depends on both on size of the farm, and the volatility of the business climate. In a volatile business environment when a farm's gross revenue is highly variable, more liquid assets are needed (Barry & Ellinger, 2012; Langemeier, 2018; Langemeier & Featherstone, 2018).

Larger farms also tend to have more liquidity, so it is best to determine the amount of liquid assets relative to either gross farm revenue or total farm expenses (Langemeier, 2018; Langemeier & Featherstone, 2018; Russell, Langemeier, & Briggeman, 2013).

Another different, but related topic to liquidity reserves is credit reserves. Liquidity in the form of reserved credit is valuable to a business manager because it is available to counter uncertain expectations (Bierlen & Featherstone, 1998; Mishra & Lence, 2005). In the New Zealand dairy farming context, credit reserves in the form of an open line of credit, such as an overdraft, is a commonly utilised financial management tool (Gray, Dooley, et al., 2008; Shadbolt & Olubode-Awosola, 2013). Under a credit line agreement, the bank provides the farm with funds when the firm faces a liquidity shortfall. In exchange, the bank collects interest payments and commitment fees. Using a line of credit does not disturb a farm's asset structure or production structure, its transaction costs are relatively low, and it is readily available in rural financial markets (Lins, Servaes, & Tufano, 2010; Sufi, 2009). Several studies in the agricultural finance literature proposed that a line of credit is a suitable tool to cope with risk. Holding a credit reserve is an efficient way to provide liquidity to sustain the business through hard times. While the direct costs of holding liquidity reserves is usually low, the opportunity cost, in terms of the return on the forgone investment, may be considerable (Hardaker et al., 2015). For example, when the return on cash holdings is low (interest paid on the cash reserves is low) rather than keeping cash reserves, a manager may choose to repay debt (Acharya, Almeida, & Campello, 2013). So, when interest rates are favourable, farmers may choose lines of credit over cash holdings.

The drawback of credit lines, however, is that banks may not always be able to provide liquidity insurance for all farms. That is, in contrast to the cash reserves, credit reserves are subject to risk. When credit becomes too volatile, it loses value as a source of liquidity, thereby forcing farmers to seek other more costly sources of liquidity. In an empirical study, Barry et al. (1981) asked agricultural bankers to decide about several hypothetical credit inquiries where the farm's financial situation varied. The results highlighted that credit costs (credit interest rate and the opportunity cost of reduced credit reserves) negatively correlated with the farm's income situation. That is, when the farm's maximum debt limit decreases due to negative income, the remaining credit reserve diminishes, and the resulting opportunity costs increases (Barry et al., 1981). Therefore, credit access risk must also be accounted for in farmers' total risk portfolio, and in the analysis of liquidity management decisions (Acharya et al., 2013; Barry & Robison, 2001).

2.11.3 Financial monitoring tools

The use of business management tools, such as planning, controlling, and monitoring through effective budgeting, accounting help farmers to improve farm performance (Boehlje et al., 2001; Kay, Edwards, & Duffy, 1994; Miller, Dobbins, Boehlje, Barnard, & Olynk, 2000; Ryde & Nuthall, 1984; Shadbolt & Martin, 2005). While some farmers only keep the records necessary to file taxes, this information can be used to analyse and improve the overall profitability of the farm business (Wolf, Lupi, & Harsh, 2011). Empirical studies provide evidences that showed farms with record keeping and budgeting perform better financially (Nuthall, 2009; Nuthall, 2006; Rahman, Nielsen, Khan, & Ankamah-Yeboah, 2020) (Gloy & LaDue, 2003).

Monitoring records and maintaining physical information related with the performance of the herd and the production of the land is the steppingstone of the business analysis . Most record keeping systems take the information that is collected on a day-to-day basis and put it into a spread sheet that later can be used for business analysis (Julian & Seavert, 2011; Rahman et al., 2020). Following to Gloy and LaDue (2003), financial monitoring practices can be divided into three categories: business analysis and control practices, investment analysis and decision making, and capital acquisition.

Business analysis and control practices can be done through three main practices: comparing farm's annual farm profitability and financial performance [36] to other farms (benchmarking), track profitability and efficiency measures over time to help understand financial performance of the farm (trend analysis), and conduct a formal business analysis review or meeting Gloy and LaDue (2003); (Wolf, 2012). The main objective of benchmarking is to identify, learn from and adapt better practices from other farmers to help improve farm performance (Kahan, 2013). Benchmarking also can uncover problems of production, management practices and other factors that affect productivity, cost of production and profitability, which can be used to improve farm performance. Benchmarking also allows farmers to learn from the experience of other farmers and generate new ideas (Kahan, 2013).

Assessment of the past farm performance (trend analysis) is another way that help farmers to improve farm performance. Trend analysis allow farmers to compare performance over time, identify weaknesses and opportunities, and make evidence-based decisions to improve farm performance (Kahan, 2013). Finally, formal business analysis meeting is another practice that help farmers to review and assess financial performance and make appropriate changes to farming operations and financial management decisions. The difference between this practice with the others (benchmarking and trend analysis), is that it considers current limitation and uncertainties of the farm business and allow farmers to set up some expectation based on those limitations (Gloy & LaDue, 2003; Kahan, 2013).

[36] It is beyond the scope of this research to explore the financial metrics (e.g. liquidity, solvency, operating profit, ROA, ROE etc) that farmers utilise to benchmark their farms.

Farmers utilising a range of metrics and information to evaluate long-term investments (such as capital asset purchases). Extension services and reports provided by industry good bodies and conversions with other dairy farmers are some of the informal practices that farmers are utilising when evaluating long-term investment decision (Gray et al., 2014; Hilkens et al., 2018). Farmers also perform some form of capital budget or investment analysis to determine the value of each opportunity, justify expenditures and decide whether they present an acceptable risk-return trade-off. These investment analysis metrics enable farmers to assess the profitability and cash-flow feasibility before they start securing funds for the investment (Julian & Seavert, 2011; Sinnett, Ho, & Malcolm, 2017).

A range of techniques are available to evaluate farm investment decisions. This includes payback period, projected cash flow (ability to make loan payments), and discounted cash flow technique such as net present value (NPV), internal rate of return (IRR). While 'the ability to make loan payments' provides crucial information when evaluating any investment regardless of its size, more sophisticated techniques such as NPV would be less critical for the analysis of small investments (such as equipment replacement) (Gloy & LaDue, 2003).

2.12 New Zealand farmers' views on risk management strategies

Martin's (1994) study was the first empirical research into New Zealand pastoral farmers risk management strategies. In particular, she examined the importance given by farmers to each risk management strategy to cope with the associated risk. A decade later, Pinochet-Chateau et al. (2005), used Martin's (1994) list of risk management strategies and examined how farmers' views on these risk management strategies had changed over the twelve years between 1992 and 2004. Drawing on the work of Fetsch, Bastian, Kaan, and Koontz (2001), they introduced strategic planning as another set of risk management strategies into their study. Eight year later, Shadbolt and Olubode-Awosola (2013) used the same set of risk management strategies and investigated the importance of risk management strategies in 2012. The comparison between the main risk management strategies used by dairy farmers in 1994, 2004 and 2011 are presented in Table 2-7.

Routine spraying and drenching and maintaining feed reserves consistently ranked number one and two for the first two years under analysis. Interestingly, the third ranked option, keeping debt low lost its importance during this period and shifted to ninth ranked. Instead managing debt, planning of capital expenditure and a range of business planning strategies joined the higher ranking group of risk management strategies used in 2011 (Shadbolt & Olubode-Awosola, 2013).

These findings suggest that although farmers were focused on the production risk management through the study period, they moved away from a low debt strategy and turned their attention to other financial management decisions (e.g. investment and debt management) and strategic risk management strategies (Gray, Dooley, et al., 2008; Shadbolt & Olubode-Awosola, 2013). This conclusion can also be corroborated by the evidence presented in section 2.5.6 and the RBNZ data that showed farmers' debt-to-asset ratio increased from 30% in 2004 to 50% in 2017. Other risk management strategies that were also found to be important in the Shadbolt and Olubode-Awosola's (2013) study were using monitoring programmes, having long-term flexibility, and using financial ratios for decision making (Table 2-7).

Table 2-7: Risk perception of New Zealand dairy farmers in 1992, 2004, and in 2011.

	1992		2004		2011	
Risk management strategy	**Mean score**	**Rank**	**Mean score**	**Rank**	**Mean score**	**Rank**
Production responses						
Routine spraying	3.90	1	3.92	1	3.63	11
Maintaining feed reserves	3.80	2	3.90	2	3.94	5
Not producing at full capacity	2.20	12	2.67	13	2.38	20
Monitoring pests, crops climate	2.30	11	3.30	10	3.84	8
Irrigation	0.70	21	2.23	17	2.66	18
Marketing responses						
Market information	2.00	13	3.06	11	3.27	16
Spreading sales	1.70	15	2.51	14	2.44	19
More than one enterprise	1.70	15	2.35	15	2.19	22
Forward contracting	0.90	19	2.29	16	2.61	17
Futures market	0.70	21	2.10	19	1.84	24
Financial responses						
Keeping debt low	3.70	3	3.37	9	3.42	15
Managed capital spending	3.50	4	3.64	6	4.07	2
Arranging overdraft reserves	2.70	10	3.43	8	3.45	14
Debt management	2.80	9	3.81	3	4.27	1
Financial reserves	3.10	6	3.37	9	3.48	13
Insurance	2.90	8	3.63	7	3.80	9
Off-farm investment	1.60	17	2.88	12	-	-
Main operator working off-farm	0.90	19	1.90	20	2.20	23
Family member working off -farm	1.00	18	2.14	18	2.20	23
Overall responses						
Short-term flexibility	3.20	5	3.75	4	3.92	6
Long-term flexibility	3.10	6	3.65	5	3.87	7
Strategic management responses						
practical planning steps	-	-	3.74	4	4.00	3
SWOT analysis	-	-	3.61	8	3.73	10
Strategic purpose	-	-	2.48	20	3.97	4
financial ratios for decision making	-	-	3.06	14	3.49	12

Except for the collecting market information none of the marketing risk management strategies were ranked highly by farmers. Membership of the milk marketing cooperatives helps farmers to cope with a considerable amount of market risk, so the incentive for using other market risk management strategies is limited (see sections 2.5.3 and 2.10.2). Finally, despite the increased price volatility in recent years, strategies such as not producing to full capacity and diversification (enterprise diversification and income diversification) were consistently scored low in terms of importance.

The above empirical studies highlighted the fact that dairy farmers have moved away from a low debt strategy and focused on debt management and planning for capital spending as their main financial management strategies. However, it is unclear what debt management and planning for capital spending entails in the New Zealand dairy farming context. Hence, it is unclear as to what extent farmers are utilising financial overdraft and financial reserves to cope with financial risks. Similarly, little empirical evidence is available on the extent and the type of financial ratios that farmers are using for decision making and debt management.

2.13 Determinants of farmers' risk responses

Understanding the determinants of farmer's risk responses (i.e., risk management strategies) has been the focus of agricultural economics research (Hardaker, 2006; Just, 2003; Just & Pope, 2003). Farmers' risk responses depend on farm business characteristics such as their available finance, the biophysical characteristics of the farm (i.e., location, farm size and infrastructure), their human capital and more importantly, the available time to make a decision (Martin & McLeay, 1998; McLeay et al., 1996). Drawing on behavioural decision theory (March & Shapira, 1987; Sitkin & Weingart, 1995) and behavioural economics (Kahneman & Tversky, 1979; Pratt, 1964; Tversky & Kahneman, 1974), risk-taking has been a central concept in understanding and explaining farmers' risk responses (Hardaker, 2006; Just, 2003; Just & Pope, 2003).

Personal, socio-economic, and cognitive factors including goals (Fairweather & Keating, 1994; Parminter & Perkins, 1997; Patrick et al., 1983), personality traits (Basarir, 2002; Rawlings, 1999; Willock, Deary, McGregor, et al., 1999; Xu et al., 2005), risk perception (Meuwissen, Huirne, & Hardaker, 1999; van Winsen et al., 2014; Wilson et al., 1993), knowledge and beliefs (Baquet et al., 2008; Hall et al., 2003; Patrick et al., 2007; Patrick & Ullerich, 1996), attitudes (Bard & Barry, 2000; de Brauw & Eozenou, 2014; Iyer, Bozzola, Hirsch, Meraner, & Finger, 2020; Meraner & Finger, 2017; Pennings & Garcia, 2001; Robison, Barry, Kliebenstein, & Patrick, 1984; Shadbolt & Olubode-Awosola, 2013; van Winsen et al., 2014), perceived self-efficacy and locus of control, and management styles (Alvarez & Nuthall, 2001; Brodt et al., 2006; Fairweather & Keating, 1994; Parminter & Perkins, 1997)) are some of the determinants that empirical studies in farm management and agricultural economics have investigated to better understand farmers' risk management behaviour. The next section (Section 2.13.1) introduces the concept of a risk management portfolio as the main approach for operationalising farmers' risk responses. Sections 2.13.2 and 2.13.3 then discuss the two main determinant of farmers' risk responses namely, risk attitude and risk perception. Section 2.13.5

presents a review of the conceptual frameworks that is used to illustrate farmers' behaviour under risk. Finally, section 2.13.6, provides a review of the empirical studies that explicitly or implicitly investigated farmers' behaviour under risk through the lens of a portfolio of risk management strategies.

2.13.1 Farmers' risk responses: a risk management portfolio perspective

An inherent characteristic of dairy farming in New Zealand is the high level of production, market, human resource, and financial risks confronted by farmers. The presence of different risks means that farmers need to choose a set of risk management strategies that fit their needs (Harwood et al., 1999; OECD, 2009). Hence, some risk management strategies have multiple impacts on different risk sources or they may have influence on the overall survivability of the farm business (Hardaker et al., 2015; Patrick & Musser, 1997). In fact, these strategies together reduce the impact of the risks on the farm system (i.e., stabilising farm income and allow farmers to continue farming activity) (Flaten et al., 2005; OECD, 2009; Patrick & Musser, 1997; van Winsen et al., 2014). As such, it is difficult to find a one-to-one association between the sources of risk and farmer's responses. Instead of viewing farmers' risk responses as a set of discrete decisions regarding the utilisation of every single risk management strategy, it is suggested that risk management should be operationalized as a set of interrelated choices that creates a farmer's risk management portfolio[37] (Meraner & Finger, 2017; Nastis, Mattas, & Baourakis, 2019; Pennings et al., 2008; Tudor et al., 2014; van Winsen et al., 2014; Velandia et al., 2009).

The presence of interrelationships between risk management strategies has been recognised for a long time, and different theoretical and empirical frameworks have highlighted the challenges of understanding and explaining farmers' behaviour (Hardaker et al., 2004; Just, 2003; Just & Pope, 2003). At a high level, the risk-balancing hypothesis in the agricultural finance sphere proposed the presence of interactions between business risk and financial risk (Gabriel & Baker, 1980) (See section 2.10.3 for more details).

A series of empirical studies that examined the interaction between insurance (e.g. crop, weather, and yield) and marketing risk management strategies (e.g. hedging, forward contracts and spreading sales)(Coble, Zuniga, & Heifner, 2003; Mishra & El-Osta, 2002; Shapiro & Brorsen, 1988; Velandia et al., 2009; Zuniga, Coble, & Heifner, 2001), insurance and diversification (Hellerstein, Higgins, &

[37] According to the Oxford English Dictionary (OED), the word "portfolio" could be defined as "A range of products, services, assets, or qualities offered or possessed". Likewise, a portfolio of risk management strategies is an artificial construct, that consists of a set of risk management strategies that is chosen by a decision-maker, i.e. a dairy farm manager, to respond to the risks that he/she is facing.

Horowitz, 2013; Knapp, Wuepper, Dalhaus, & Finger, 2021), and insurance and irrigation (Foudi & Erdlenbruch, 2011) provided a some insights into the interrelationships between risk management strategies. Initially, the question about choosing a marketing risk management strategy was viewed as how farmers' adopt new marketing tools such as futures and options (Goodwin & Schroeder, 1994). However, the impact of other risk management strategies and the interactions between risk management strategies became evident in these studies (Coble et al., 2003; Coffey & Schroeder, 2018; Sartwelle et al., 2000; Zuniga et al., 2001). For example, Sartwelle et al. (2000) surveyed a sample of crop farmers in the midwestern United States to identify factors that influenced grain-marketing decisions. These decisions included cash sales, forward contracts, and hedging with futures or options. The results of their study show a positive association between the extent of using futures or options and the use of crop insurance (Sartwelle et al., 2000). A simulation study by Coble et al. (2003) evaluated the optimal risk management behaviour of U.S crop enterprises when they have access to yield, price, and revenue risk management tools. Their findings highlighted that the use of insurance tools influenced the choice of an optimal hedge ratio (Coble et al., 2003).

In a more recent study, Coffey and Schroeder (2018) examined the relationships between utilising different marketing risk management strategies namely, forward pricing (defined as options, futures or forward contracting) and revenue protection crop insurance among a sample of U.S corn and soybean farmers. Their findings show that forward pricing tools and revenue protection insurance have a complementary effect (Coffey & Schroeder, 2018). These findings reinforce the point that analysing farmers' risk responses regarding one tool while ignoring their other risk management strategies could result in a misleading or counter intuitive conclusion because, the decision to adopt a particular risk management tool can depend on the other risk managements strategies within the farmer's risk management portfolio (Coffey & Schroeder, 2018; Pennings et al., 2008; Tudor et al., 2014; Velandia et al., 2009).

An important consideration in the operationalisation of farmers' risk responses through risk management portfolio perspective is the diversity of risk management portfolios. The diversity of portfolios of risk management strategies directly depends on a number of factors including the number of strategies available to farmers (Martin & McLeay, 1998; Pennings et al., 2008; Vigani & Kathage, 2019). In some countries and agriculture sectors, such as the U.S. crop farming sector, a wide range of marketing and production strategies are available to farmers. For example, Pennings et al. (2008) illustrated that with six price risk management instruments and six crop insurance products, U.S. crop farmers are facing 2^6 X 2^6 combinations of instruments. In contrast, in some countries and agriculture sectors, such as the dairy farming sector in New Zealand, production and marketing possibilities are more restricted (Martin & McLeay, 1998; McLeay et al., 1996; Shadbolt & Olubode-Awosola, 2016). Regardless of the number of strategies available to farmers, the actual portfolio of risk management strategies that farmers are using is much more limited (Martin & McLeay, 1998; McLeay et al., 1996; Patrick & Alexander, 2004; Pennings et al., 2008). For example, only 14 alternatives (out of the total 4,096 combinations) was utilised by U.S crop producers in the Pennings et al's (2008) study.

The biophysical characteristics of a farm can determine the number of risk management portfolios that are utilised by a farmer. Some strategies may be seen as inappropriate because of the structure of the farming system or its geographical location (Flaten et al., 2005; Meuwissen, Huirne, et al., 2001; Shadbolt & Olubode-Awosola, 2016). Another reason for excluding some of the risk management strategies is cost. Risk management often comes with a cost to farmers, increasing production costs and reducing productivity (Di Falco & Chavas, 2006; Vigani & Kathage, 2019). In particular, relatively complex risk management portfolios tend to have larger negative productivity impacts due to higher costs and the larger amount of farm resources that are required to utilise risk management strategies within the portfolio (Knapp et al., 2021; Vigani & Kathage, 2019)

From a cognitive psychology perspective, bounded rationality (Simon, 1959) is the first factor that limits the choice of risk management strategies. That is, it is difficult for farmers to achieve full information and make choices among all possible risk management alternatives (Pennings et al., 2008). In particular, the interrelationship and resulting complexity of choices between risk management tools limits the number of strategies that potentially can be utilised by farmers (Coffey & Schroeder, 2018; Pennings et al., 2008; Tudor et al., 2014; Velandia et al., 2009). Limitations in terms of competency (Patrick & Ullerich, 1996), personality traits (Xu et al., 2005), risk preferences (Knapp et al., 2021; Meraner & Finger, 2017), and farmers' objectives are other influential factors that limits the choice of risk management strategies (Coble et al., 2003; Katchova & Miranda, 2004; McLeay et al., 1996; Paulson, Katchova, & Lence, 2010; Zuniga et al., 2001). The next section provides a brief overview of the empirical studies that employed risk management portfolios as a framework for operationalising farmers' risk responses.

2.13.2 Risk attitude

The idea of assuming risk attitude[38] as the main antecedent of risk responses emerged in the first few decades of the twentieth century when social psychologists simply assumed that there was no difference between attitude and behaviour (Kraus, 1995). Accordingly, early studies in the economics and managerial decision-making field implicitly assumed that attitude toward risk was a stable personality trait that can explain an individual's risk responses (Binswanger, 1980; de Brauw & Eozenou, 2014; Pennings & Garcia, 2001) and some studies assumed that attitude could be elicited from observed behaviour (Bard & Barry, 2000; Lagerkvist, 2005).

A risk attitude scale usually lies on a continuous scale between risk seeking and risk aversion (Iyer et al., 2020; Mongin, 1997). An extreme risk seeker is willing to accept any risk even for a marginal increase in return, while a risk averse person will not accept whatever risk no matter what the increase in return (Mongin, 1997). From a farm management perspective, a risk-averse farmer, ceteris paribus, is reluctant to accept risk and tries to reduce, transfer or even completely avoid as many risks as possible (Hardaker, 2006; Hardaker et al., 2004; Just, 2003; Just & Pope, 2003). In contrast, a risk-seeking farmer, deliberately accepts a major share of the risks facing the farm and will largely refrain from actively implementing strategies aimed at reducing, avoiding, or transferring these (Chavas Jean-Paul, 2004; Chavas, 2008; Just, 2003; Just & Pope, 2003).

Several methods are developed to elicit individual risk preferences. Broadly speaking these methods originate from cognitive psychology or economics (Iyer et al., 2020; Just & Pope, 2003). The "Expected Utility Model" (EUT) (Von Neumann & Morgenstern, 1944) and its derivatives such as "Rank Dependent Expected Utility Model" (RDEUT) (Quiggin, 1993) were the dominant frameworks for eliciting farmers' risk preferences since the 1970s (Iyer et al., 2020; Just, 2003; Just & Pope, 2003). In all these frameworks, risk preferences are conceptualised by the curvature of the utility function (Hardaker et al., 2015; Iyer et al., 2020; Just & Peterson, 2003; Just, 2003; Just & Pope, 2003).

Even though EUT is a normative theory, it has been widely used to explain an individual's behaviour under risk (Thaler, 2000). Numerous studies have, however, criticised the expected utility hypothesis on descriptive grounds because it fails to describe observed behaviour (Gilovich, Griffin, & Kahneman,

[38] The general assumption in psychology research holds that attitudes affect preferences, which in turn affect behaviour (Liebe, Mariel, Beyer, & Meyerhoff, 2018). However, the multidisciplinary nature of risk research and the fact that risk attitude and risk preferences are theoretical, latent constructs that cannot be directly observed by researchers led to a confusion about the distinction between risk preference and risk attitude (Ajzen & Fishbein, 2005; Weber, 2010). A distinction provided by Weber (2010) can be useful to clarify the difference between these two latent variables. Risk attitude is an underlying personality trait that is independent of situation and domain, whereas risk preference (risk-taking) depends on the domain or context.

2002; Moschini & Hennessy, 2001; Rabin & Thaler, 2001; Robison, Shupp, & Myers, 2010). In order to improve the descriptive power of the EUT, the insights derived from cognitive psychology (e.g., heuristics and bias) were added into the original EUT, and a newly introduced theory called "Prospect Theory" (PT) became the foundation of behavioural economics (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981). Three main inferences derived from research into an individual's risk behaviour in the cognitive psychology and economics literature include loss aversion, risk aversion, and ambiguity aversion. Loss aversion (Tversky & Kahneman, 1992) refers to an individual's tendency to prefer avoiding losses to acquiring gains (Kahneman & Tversky, 1979). Risk aversion is an individual's tendency to prefer more certain. but possibly lower expected return to a bargain with a potentially higher expected return, but a relatively more uncertain return (Fishburn, 1988). A later refinement proposed that individuals are risk averse when they expect gain and are risk seeker when they expect loss (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). Finally, ambiguity aversion refers to a preference for known risks over unknown risks (Gilovich et al., 2002).

In summary, the original EUT was able to predict how individuals should behave under risk (i.e., normative perspective). PT, another derivate of EUT, highlighted some of the heuristics and biases underlying the psychological nature of an individual's decision making and improved the descriptive power of the original EUT (Gilovich et al., 2002). However, both of these theories were criticised because they impose an absurd degree of risk aversion and, mostly, are sensitive to the wealth of the individuals (Rabin, 2000; Rabin & Thaler, 2001). Just and Peterson (2010) and Just (2011) were among the few empirical studies that tested the accuracy of the EUT in the agriculture context. Their findings confirm that EUT is only accurate when expected returns of alternatives are similar, or when more than half of the individual's wealth is at risk. Otherwise, behavioural predictions drawn from EUT may be misleading (Just & Peterson, 2010; Just, 2011).

Another framework (called econometric method (Iyer et al., 2020)) assumes that risk preferences can be elicited from observed the behaviour of farmers. As such, by employing econometric and mathematical methods, the observed behaviour of farmers (with respect to input and output choices) is compared with the behaviour predicted by theoretical models incorporating risk and risk preferences (Bar-Shira, Just, & Zilberman, 1997; Chavas & Holt, 1996; Lien, 2002). The ability to elicit farmers' preferences through panel data (both cross sectional and time-series) is the main strength of this method. However, the main limitation of this method is that without controlling for unobserved variables (e.g. biophysical characteristics, policy, technology, and a farmer's personal characteristics), the entire difference between farmer's behaviour (with respect to input and output choices) and predicted behaviour, derived from econometric or mathematical models will be attributed to the farmer’s risk preferences (Just & Pope, 2003; Reynaud & Couture, 2012). Another criticism of the econometric elicitation framework is that this method mostly focuses on production risk, while as highlighted in the Section 2.3, farmers are facing different sources of risk (such as market risks) and ignoring these risks may lead to a biased estimation of risk preferences (Iyer et al., 2020).

Finally, the literature also has methods based on the psychometric paradigm of risk (Slovic, 1992) that were designed to elicit risk preferences by scale-based (multi-item) questions. These methods are straightforward to execute and are relatively cheap (Menapace & Colson, 2012). However, They cannot be linked to any economic theory or utility function (Iyer et al., 2020). Hence, the simplicity of these methods may increase the possibility of ill-considered responses (Hardaker et al., 2004). Given the above criticisms, particularly the one in relation to the EUT, several studies started to examine the extent of convergence between different risk preference elicitation methods.

One central question in relation to the validity of the elicitation methods is to what extent are the risk preference stable across different domains. Anecdotal evidence in the managerial decision-making showed that decision makers’ risk attitude and, accordingly, their responses to risk is different in different domains (Maccrimmon & Wehrung, 1990; March & Shapira, 1987). A series of experiments in the field of cognitive psychology showed that decision makers often have different risk preferences in different decision domains (e.g., financial, career, health and safety, ethical, recreational, and social)(Weber, 2010; Weber, Blais, & Betz, 2002; Weber & Milliman, 1997).

Dohmen et al. (2011) investigated the stability of risk preference measures among a sample (n=12,000) of German households across different domains (holding stocks, smoking, self-employment, and participation in active sports). Their result pointed out that although using context specific measures can provide a more accurate measure of preferences to the corresponding context, general risk attitude measures can be as useful as context-specific measure of risk preference (Dohmen et al., 2011).

Empirical studies in farm management also investigated the stability of risk attitude across different fields of management (e.g., production, marketing, and HR) (Flaten et al., 2005; Hansson & Lagerkvist, 2012; Lagerkvist, 2005; Meuwissen, Huirne, et al., 2001; Slijper, de Mey, Poortvliet, & Meuwissen, 2020; van Winsen et al., 2014). Congruent with the findings in cognitive psychology, the result highlighted that farmers’ risk attitude is relatively stable across different management fields. However, domain-specific risk preference measures may provide a more accurate insight about farmers’ risk preferences across different domains (Hansson & Lagerkvist, 2012). Given the theoretical and practical importance of financial risks, empirical studies designed specific measurement methods to evaluate farmers' financial risk preferences (Bard & Barry, 2000; Cao et al., 2019; Reynaud & Couture, 2012; Robison et al., 1987; Slijper et al., 2020; Ye, Liu, Wang, Wang, & Shi, 2015).

In a later study, Meraner and Finger (2017) employed the self-assessment method, developed by Dohmen et al. (2011), with two other widely used methods in the faming context (Business statement (Meuwissen, Huirne, et al., 2001) and multiple price list (MPL) (called choice-based) to determine the consistency of farmers' risk preference across different domains. Their results confirmed that once elicitation methods are defined in a way that reflects farming context, all elicitation methods are highly correlated (Meraner & Finger, 2017).

Apart from the criticism in relation to the validity of risk preference elicitation methods, a more fundamental criticism was related to the extent to which the observed risk responses are attributed to risk preferences[39] (also called risk aversion and risk attitude) (Hardaker, 2006; Just, 2003; Just & Pope, 2003). That is, it is unclear whether risk responses are due to preferences (risk aversion) or other factors such as technology, physical constraints (e.g., fixed allocable inputs), or financial constraints (caused by imperfect capital markets) (Just, 2003; Just & Pope, 2003; Pannell, Malcolm, & Kingwell, 2000). As Hardaker (2006) pointed out: "*there is growing recognition that risk aversion [risk preferences or risk attitude], but not risk itself, is less important than is commonly believed… For many decision problems with a few discrete options, the best choice often is not sensitive to differences in the degree of risk aversion [risk preferences or risk attitude] over a plausible range* (p. 598).

Influenced by the models suggested in other disciplines particularly cognitive psychology (Ajzen, 1985; Bandura, 1986; van Raaij, 1981) and managerial decision-making (March & Shapira, 1987; Sitkin & Weingart, 1995; Sitkin & Pablo, 1992), other determinants of risk responses such as risk perception and the importance of risk management strategies were introduced to improve the explanatory power of the farm risk management models (Ahsan, 2011; Bergfjord, 2009; Boggess, Anaman, & Hanson, 1985; Hall et al., 2003; Martin, 1994; Patrick, Wilson, Barry, Boggess, & Young, 1985; Pinochet-Chateau et al., 2005; Wilson et al., 1993; Wilson, Luginsland, & Armstrong, 1988). These variables were assumed to be the most relevant psychological variables for describing farmers' risk management behaviour and they have been the focus of numerous studies over the last three decades (Flaten et al., 2005; Gray, Dooley, et al., 2008; Gray et al., 2014; Koesling et al., 2004; Meuwissen, Huirne, et al.,

[39] In the psychology sphere, the view that attitude is the main determinant of behaviour was criticized in the 70's and 80's because many studies in cognitive psychology found that models that only included attitude as the latent variable to explain behaviour have limited explanatory power (Ajzen, 2012; Armitage & Conner, 2001). Eventually, the definition of attitude changed from a stable personality trait that is almost equal to behaviour to "a psychological tendency that evaluates a particular entity with some degree of favour and disfavour" (Eagly & Chaiken, 1993, p. 1). In farm management literature Willock, Deary, Edwards-Jones, et al. (1999) pointed out that: "attitudes on their own are poor predictors of behaviour" (p. 287).

2001; Shadbolt & Olubode-Awosola, 2013; van Winsen et al., 2014; van Winsen et al., 2011; Wilson et al., 1993).

Empirical research also examined the association between farmers' risk responses and other variables such as personality traits (Austin, Deary, & Willock, 2001; Willock, Deary, McGregor, et al., 1999), managerial ability (Cowan et al., 2013; Gray et al., 2009; McCown, 2005), and goals (Gray et al., 2014; Gray et al., 2009; Nuthall, 2010; Patrick et al., 1983). Hence, farm characteristics such as the farm infrastructure, available resources, and the biophysical environment of the farm have also been studied as factors that influence farmers' risk responses (Gray, Dooley, et al., 2008; Gray et al., 2014; Hardaker, 2006; Hardaker et al., 2004; Just, 2003; Just & Pope, 2003; Meuwissen, Huirne, et al., 2001; Shadbolt & Olubode-Awosola, 2013; van Winsen et al., 2014). The next section provides a review of risk perception as another important antecedent of farmers' risk management behaviour.

2.13.3 Risk perception

Risk perception is another main suggested antecedent of individuals' risk responses (Nosic & Weber, 2010; Sitkin & Pablo, 1992; Sjöberg, 2000; Weber & Milliman, 1997). In cognitive psychology, risk perception is defined "subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences" (Sjöberg, Moen, & Rundmo, 2004, p. 4). In managerial decision-making sphere, risk perception can be defined as the manager's evaluation of the level of risk inherent in a situation, associated with its uncertainty and the control that individuals perceive they have over such uncertainty (Sitkin & Weingart, 1995).

Risk perception is a highly complex and individualistic (i.e. specific) entity that can be influenced by a plethora of personal and social factors (Kortenkamp & Moore, 2010). Four distinct levels of context influencing an individual's risk perception (Renn & Rohrmann, 2000). The first level includes the heuristics that individuals apply during the process of decision-making (Mousavi & Gigerenzer, 2014; Sitkin & Pablo, 1992). The second level refers to the cognitive and affect, influencing an individual's risk perception. A series of recent empirical studies in cognitive psychology provided evidence of the role of emotions in individuals' decision-making (Slovic et al., 2004). The third level introduces the cultural backgrounds (e.g. underlying values) that influence an individual's decision-making processes (Sjöberg, 2000; Sjöberg et al., 2004). Finally, risk perception is influenced by communication about risks from external sources (Renn, 1998; Sjöberg, 2000; Sjöberg et al., 2004).

Drawing on the psychometric paradigm of risk perception (Slovic, 1992), the basic premise for the inclusion of risk perception in farmers' risk responses is that selected perceived risks are of such importance that they would directly influence the decision to utilise a particular or a set of risk management strategies (van Winsen et al., 2013; van Winsen et al., 2014; Wilson et al., 1993). Accordingly, several empirical studies in agriculture investigated farmers' perceptions of risk and the impact of perceived risk on the choice of risk management strategies (Ahsan, 2011; Bergfjord, 2009; Hall et al., 2003; Koesling et al., 2004; Martin, 1994; Meraner & Finger, 2017; Meuwissen, Huirne, et al., 2001; Nicol, Ortmann, & Ferrer, 2007; Patrick et al., 1985; Shadbolt & Olubode-Awosola, 2016; Slijper et al., 2020; van Winsen et al., 2014; Wilson et al., 1993). While empirical findings in the cognitive psychology and managerial economics fields generally support the relationship between risk perception and risk responses (van Winsen et al., 2014), lack of significant relationship between risk perception and the adoption of risk management activities led to confusion about the association between risk perception and farmers' risk management behaviour (Ahsan, 2011; Flaten et al., 2005; Meuwissen, Huirne, et al., 2001; Shadbolt & Olubode-Awosola, 2016; van Winsen et al., 2014; Wilson et al., 1993). Different explanations were provided for the lack of relationship between risk perception and the decision to engage in risk management activities. An early explanation for this discrepancy was that important sources of risk and risk management strategies explaining farmers' risk responses may not have been included in the survey (Flaten et al., 2005; Meuwissen, Huirne, et al., 2001). However, the most widely accepted explanation for this discrepancy is that farmers' perceptions are very personal (i.e., varying from farmer to farmer). Therefore, it is not possible to identify the relationship between risk perception and risk management behaviour at the aggregate level (Ahsan, 2011; Flaten et al., 2005; Koesling et al., 2004; van Winsen et al., 2014).

The lack of association between risk perception and risk management behaviour also lies in the fact that in most cases, perceived risks do not directly correspond to any specific risk management strategy. That is, perceived risk sources are not specific enough to trigger the utilisation of any particular risk management strategy (Flaten et al., 2005; Patrick & Musser, 1997; van Winsen et al., 2014). Hence, some risk management strategies appear to have multiple effects on the whole farm business. These strategies (e.g. diversification, and off-farm income) reduce the overall impact of risks on the farm business and allow it to withstand different kind of the risks (van Winsen et al., 2014).

In a more recent study, van Winsen et al. (2014) argued that the lack of relationship between risk perception and risk management behaviour might be due to the differences in the way that risk responses in agriculture and other fields are defined. In managerial economics (March & Shapira, 1987; Sitkin & Pablo, 1992) and cognitive psychology (Slovic, 1992; Slovic, 2000) risk responses comes down to a simple decision "whether or not a manager engages in a risky activity (e.g. investment or gambling)". However, in agricultural economics and farm management, risk responses definition goes beyond the simple question of engaging in a risk activity and concerns with other aspects such as the decision to utilise risk management strategies, or the importance utilising risk management strategies (van Winsen et al., 2014).

2.13.4 Self-efficacy and risk perception

Self-efficacy is one of factor that indirectly, through risk perception, influences individuals' risk-taking behaviour (Bandura, 2012; Krueger Jr & Dickson, 1993; Krueger & Dickson, 1994). Self-efficacy, which has its roots in the social cognitive theory [40], is defined as "an individual's belief in his/her own capability to organize and execute the future courses of action required to produce given attainments" (Bandura, 1997, p. 7). A series of experimental studies showed that an individual's self-efficacy is directly related to risk perception where Individuals with higher self-efficacy are more likely to perceive a source of risk as an opportunity rather than a threat and vice-versa (Krueger Jr & Dickson, 1993; Krueger & Dickson, 1994). Because risk perception is one of the determinants of an individual's risk behaviour, the effect of self-efficacy on risk perception ultimately influences the risk-taking behaviour of individuals (i.e., the higher the belief that one can manage risk, the greater the willingness to take on risk) (Meertens & Lion, 2008; Sjöberg et al., 2004).

The importance of self-efficacy in risk management has roots in the entrepreneurship domain (Just, Khantachavana, & Just, 2010). The seminal work of Schumpeter (1928) on entrepreneurship hypothesized that risk preferences is the primary driver of entrepreneurial ventures. However, empirical studies failed to find any difference between entrepreneurs and non-entrepreneurs with respect to their risk attitude (see Stewart Jr and Roth (2001)). Rather than being less risk averse, entrepreneurs were found to be more confident of their ability to manage risk (Chen, Greene, & Crick, 1998; Gibbs, 2009; Poon, Ainuddin, & Junit, 2006; Zhao, Seibert, & Hills, 2005), an attribute that closely resembles the concepts of perceived behavioural control in the theory of planned behaviour (Ajzen, 1985, 1991) and perceived self-efficacy in the social cognitive theory (Bandura, 1986). Accordingly, some researchers in the entrepreneurship literature has turned away from risk attitude (also called risk-propensity) toward efforts to understand the role of self-efficacy in individuals' decisions to start businesses (Chen et al., 1998; Cho & Lee, 2006; Densberger, 2014; Macko & Tyszka, 2009; Zhao et al., 2005).

The results from empirical studies found that entrepreneurs have a higher self-efficacy than other individuals, which distinguishes entrepreneurs from others (Densberger, 2014; Macko & Tyszka, 2009) In particular, entrepreneurs see themselves as capable of processing, analysing, and making optimal

[40] Social cognition theory proposed that human functioning is a result of the interplay between personal, behavioural, and environmental influences (Bandura, 1997, p. 7).

choices from limited information (Densberger, 2014; Mitchell & Dacin, 1996). Therefore, they may choose to undertake actions that others consider too risky (Macko & Tyszka, 2009).

In the management field, Cho and Lee (2006) found that when individuals believed they had the ability to make investment decisions, they made behavioural choices that would lower their feelings of vulnerability to the potentially negative outcomes. Individuals' self-efficacy can positively influence their choice of risk mitigation strategies as they feel more certain about their ability to face a given risky situation. Research has consistently demonstrated that risk mitigation is likely to be undertaken when individuals are confident in their ability to protect themselves and their property (Martin, Martin, & Kent, 2009).

An important aspect of self-efficacy is its level of specificity. At the broadest level, self-efficacy can be completely general referring to an individual's confidence about all tasks (Judge, Erez, Bono, & Thoresen, 2003). Yet, empirical findings suggest that self-efficacy should not be defined as a general trait, and that it is best assessed with regard to specific decisions or domains (Bandura, 2012). Regarding risk management behaviour, Meertens and Lion's (2008) results suggest that self-efficacy only influences risk-taking for risks that offer the possibility of control over the outcome. Therefore, it is not possible to assume that general self-efficacy could reflect risk management self-efficacy and vice-versa.

The concept of task specific self-efficacy provides a more accurate view on an individual's behaviour. However, as highlighted in the previous sections, farm managers are normally facing a series of interrelated risks in their farm businesses. Therefore, it is difficult to determine the impact of a single risk on the farm business (OECD, 2009; van Winsen et al., 2013). Besides, in many instances, a single tool or strategy does not reduce the impact of a specific risk, rather a portfolio of risk management strategies enable farmers to cope with the overall effect of risk (OECD, 2009; Vigani & Kathage, 2019). Therefore, developing a measure of self-efficacy for every single type of risk and connecting it to a particular risk management strategy (task) does not provide useful insights into farmers' risk management self-efficacy. To overcome this limitation, Bandura (2012) suggest that it is more appropriate to measure self-efficacy as a series of related behaviours within a domain (called domain-specific self-efficacy).

Within the domain of farm risk management, it is possible to further distinguish risk management self-efficacy from a time-horizon perspective (Shadbolt & Olubode-Awosola, 2016). Recent empirical studies showed that farmers' perceptions toward different risks depends on the time-horizon (Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2013). Moreover, the associated decisions about a farmer's response to the risks are different with respect to the time-horizon. For example, the perceived risk from climate change, as a long-term risk, and the associated decisions to address climate change risks are different from climate variations that might happened within a year. Similarly, the nature of product price risk over the long-term (i.e., change in milk price) is entirely different from the variation in product prices that happen in the short-term (due to changes in the supply and demand). Accordingly, the appropriate decisions to address risks in the short-term and long-term are different (Kimura, Antón, & LeThi, 2010; OECD, 2009). Therefore, measuring farmers' risk management self-efficacy in both the short-term and the long-term may provide a better insight about farmers' risk management behaviour. The next section provides an overview of the proposed conceptual frameworks to explore the impact of different factors that shape farmers' risk responses.

2.13.5 Conceptual frameworks to study farmers' risk responses

Numerous studies in agricultural economics and farm management have investigated farmers' risk responses from a descriptive point of view (Gray, Dooley, et al., 2008; Hansson & Lagerkvist, 2012; Just, 2003; Meuwissen, Huirne, et al., 2001; Patrick et al., 1985; Shadbolt & Olubode-Awosola, 2013). Similar to cognitive psychology, the general idea is that a person's risk attitude in some way shapes, influences or guides behaviour (Fishbein & Ajzen, 2011). The incorporation of other variables into the subsequent models provided the opportunity to obtain further insights into the drivers of farmers' risk responses and improve the descriptive power of these models. However, the absence of a robust theoretical framework has created confusion about the relationship between the predictors of risk response behaviour, such as risk attitude, risk perception and other socio/economic variables (e.g., Fausti & Gillespie, 2006; Goodwin & Mishra, 2004; Goodwin & Schroeder, 1994; Hellerstein et al., 2013; Pennings & Garcia, 2001). This confusion was initially related to the exploratory nature of the risk management studies. Most of the risk management studies investigated risk perception, risk attitude and risk responses separately, but did not seek to understand the relationship between these three variables. As such, the relationship between these variables and risk responses remains unclear (e.g., Ahsan, 2011; Bergfjord, 2009; Martin, 1994, 1996; Musser, Patrick, & Eckman, 1996; Patrick & Ullerich, 1996; Pinochet-Chateau et al., 2005).

In one of the early studies, Wilson et al. (1993) employed a framework based on the model suggested by van Raaij (1981) (Figure 2-15) to study large dairy farmers' risk perceptions and decision-making behaviour and its relationship with other farm and farmer characteristics. They stated that "economic choices are revealed in human behaviour (B), but have their foundation in a multidimensional and recursive environment of internal and external conditions" (p. 91). However, they concluded that a limited number of factors were not able to predict choices, and more specific factors may be helpful in explaining risk management behaviour (Wilson et al., 1993).

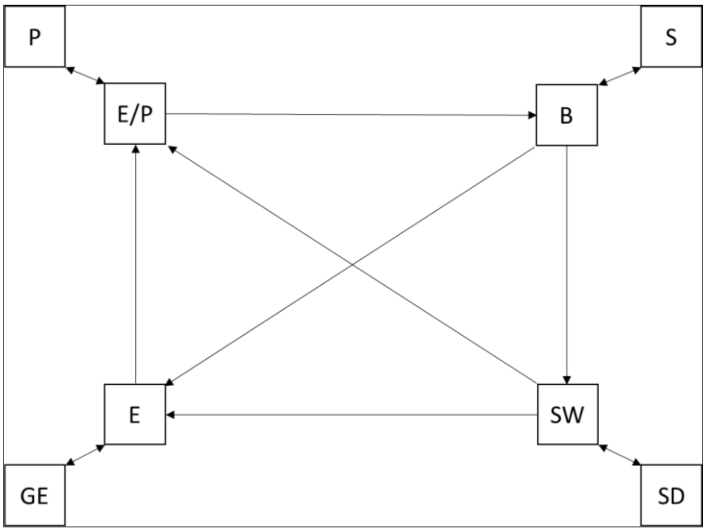

Figure 2-15: Van raaij (1981) model of decision making for the firm[41]

Flaten et al. (2005) argued that the assessments of farmers' perceptions and attitudes toward risk are very important because these could describe the decision-making behaviour of farmers when faced with risky situations. The results from their study revealed that several socio-economic variables had a significant effect on farmers' risk perceptions and management responses.

Flaten et al. (2005) adapted a simplified model that was initially developed by Wilson et al. (1993) (Figure 2-16) to investigate risk attitude, risk perception and perceptions toward risk management strategies among dairy farmers in Norway (risk attitude was considered as a characteristic (P) of farmers). However, their findings failed to find any association between risk perception and risk management behaviour and they concluded that "the low explanatory power in the regression models may imply a high degree of farm-specific risk perceptions" (p. 23). That is, more detailed risk statements may be able to increase the explanatory power of the model.

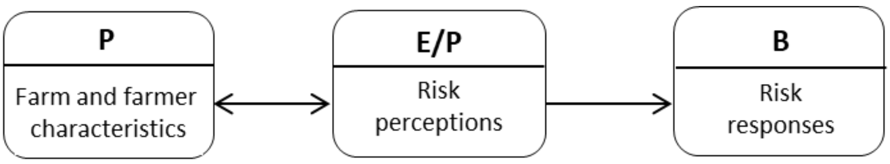

Figure 2-16: Conceptual framework of farmers decision making (Flaten et al., 2005).

Meuwissen et al. (1999) developed a model to draw a more complete picture of risk behaviour and its determinants. In particular, their model was designed to find the relationship between socioeconomic characteristics and (1) attitude toward risk, (2) perceptions of the sources of risk and (3) perceptions of risk management strategies. In contrast to the Wilson et al.'s (1993) model, risk attitude was a

[41] G/E= general macroeconomic environment; E/P= perception toward economic environment; P= personal factors, socio-demographic variables; S= anticipated and unanticipated situation; SW= subject wellbeing; SD= societal discontent; E= objective economic condition and opportunity for the firm; B= economic behaviour

separate predictor (not a mediating variable) along with the socioeconomic variables. Hence, all the determinants were directly associated with risk management strategies (Figure 2-17). They concluded that although some independent variables had significant relationships with the dependent variables, because of the low degree of coefficient of determination, it may be useful to include other farmer specific features like personality traits as determinants of risk management strategies (Meuwissen et al., 1999).

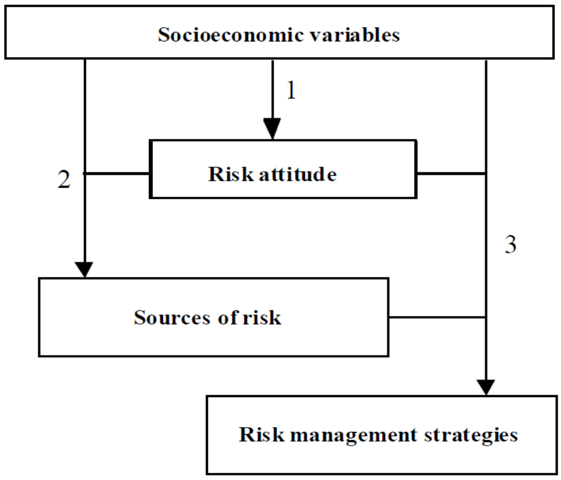

Figure 2-17: Schematic overview of the relationship between socio economic variables, risk perception and risk management strategies (Source: Meuwissen et al., 1999).

In a later study, van Winsen et al. (2014) argued that while risk perception and risk attitude were investigated separately in farm management studies, few studies have focused on the interaction between these two variables. In addition, they pointed out that the very fragmented nature of the findings about the relative contribution of risk perception and risk attitude as well as the direct and (or) mediated role of these variables in risk behaviour produced conflicting results. As such, they presented an integrated conceptual model (Figure 2-18) based on a framework developed by Sitkin and Pablo (1992) in order to examine the relationships between indirect determinants of risk responses including socio-demographic variables (e.g. age and level of education) and farm structural variables (e.g. farm size), as well as direct determinants of (intended) behaviour like risk perception and risk attitude among a sample of farmers in Belgium.

The results of the research undertaken by van Winsen et al. (2014) showed that risk management strategies are mostly influenced by risk attitude. In fact, while farmers' risk attitude had a significant impact on farmers' intended risk management behaviour; risk perception did not have an effect on the intended risk management behaviour of the farmers. Furthermore, they did not find any clear relationship between farmers' characteristics and their risk management strategies. That is, only two indirect variables namely, “age” and “farm size” had a significant correlation with some of the risk management strategies (van Winsen et al., 2014).

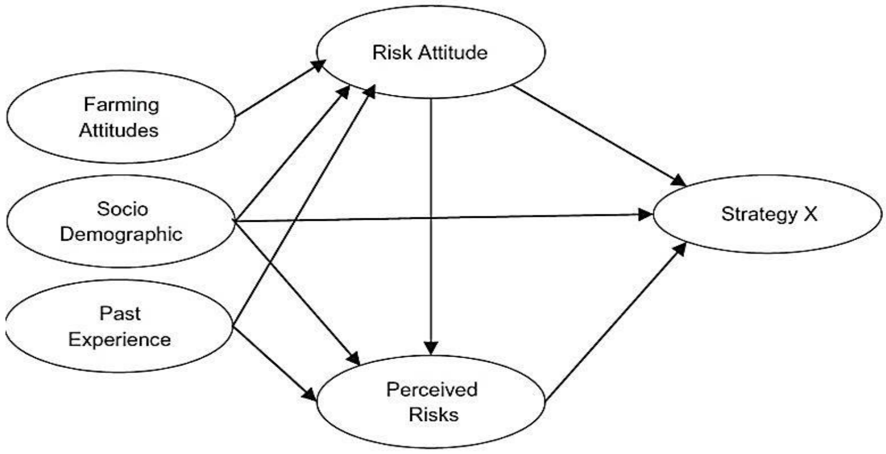

Figure 2-18: integrative model of risk perception, risk attitude and risk management strategies (van Winsen et al., 2014).

To summarise, a farmer’s risk responses are determined by the interaction between the biophysical characteristics of the farm business (Cowan et al., 2013), risk preferences (Bocquého, Jacquet, & Reynaud, 2014; Just, 2003; Robison et al., 1984), farmer’s risk perception (Patrick et al., 1985; Shadbolt & Olubode-Awosola, 2013), as well as the belief in farmer’s ability to successfully implement the risk management strategies (Duranovich, 2015; Monsen & Urbig, 2009). Hence, two major conceptual frameworks from behavioural economics (Wilson et al., 1993), and managerial economics (Sitkin & Pablo, 1992) were adopted to explain farmers’ risk responses. However, empirical studies failed to identify a consistent pattern on the relationship between the determinants of risk management behaviour (e.g., risk attitude, risk perception, and socio-economic characteristics) (van Winsen et al., 2014).

The highly complex nature of farmers’ risk responses (i.e. no one-on-one relationship between risk and risk management strategies) (Flaten et al., 2005; van Winsen et al., 2014), the highly specific nature of risk management strategies (i.e. the choice of risk management strategies depends on the farm and farmer characteristics)(Flaten et al., 2005; Meuwissen et al., 1999), the different methods for eliciting farmers’ risk attitude (e.g. self-assessment versus lottery) (Meraner & Finger, 2017), the different methods for eliciting farmers’ risk perceptions (e.g. focusing on downside risks only) (Shadbolt & Olubode-Awosola, 2016), and the different approaches to define farmers’ risk responses (i.e. different methods for creating risk management portfolios) (Meraner & Finger, 2017; van Winsen et al., 2014) are some of the explanations proposed by researchers to address the puzzling relationship between farmer’s risk management strategies and their determinants.

2.13.6 Empirical studies on risk management portfolios

Section 2.13.1 highlighted that the majority of empirical studies were focused on the complementary nature of marketing risk management strategies (e.g., forward contracts, futures hedging) and insurance (e.g. weather, income, and yield) (see for example Coble et al. (2003); Coffey and Schroeder (2018); Pennings et al. (2008); Velandia et al. (2009)). However, these studies recognised the fact that other risk management strategies may have impacted on the choice of a particular risk management strategy and accordingly the content of a farmer's risk management portfolio (Meraner & Finger, 2017; Pennings et al., 2008; Velandia et al., 2009; Zuniga et al., 2001). To overcome this shortcoming, a number of empirical studies began adding other relevant (marketing, financial and human resource) risk management strategies (Flaten et al., 2005; Martin & McLeay, 1998; Meraner & Finger, 2017; Meuwissen, Huirne, et al., 2001; Patrick & Musser, 1997; Shadbolt & Olubode-Awosola, 2013; Tudor et al., 2014; van Winsen et al., 2014).

The study of Patrick and Musser (1997) was one of the first empirical studies that provided a more holistic view of farmers' risk management portfolios. Farmers were asked to indicate the usage and importance of different risk management strategies. They employed an exploratory factor analyses (EFA) to summarise risk management responses into five main dimensions namely: 'marketing', 'production, security', 'off-farm', and 'financial'. The high cross-loading effect of individual risk management strategies on the groups indicated that each strategy had multiple roles in the overall set of risk management (Patrick & Musser, 1997). For example, crop insurance had cross loading on 'marketing', 'security' and 'off-farm' factors. The above findings support the notion that there is no one-to-one correspondence between the sources of and responses to risk (Patrick & Musser, 1997).

Martin and McLeay (1998) undertook a nation-wide survey to investigate the diversity of risk management strategies among New Zealand sheep and beef farmers. They collected farm and farmer characteristics along with information about the farmers' perceptions of risk sources and their preferences for various risk management strategies. Four groups of risk management responses were included in the analysis include production, marketing, financial, as well as strategic decisions. A cluster analysis followed by factor analyses were employed to address the simultaneity of choosing different risk management instruments among a sample of sheep and beef producers in New Zealand. From the analysis, five distinct groups (with different risk management portfolios) were identified: 'income spreaders', 'capital managers', 'part-timers', 'debt and market risk managers', and 'production managers' (Martin & McLeay, 1998). Farmers' perceptions of economic, political, human and technological risk were not significantly different across different groups. This finding was not surprising because all sheep and beef farmers were facing a similar economic (Market risk), political (regulatory risk), human (labour) and technological risk environment. In contrast, farmers perception were different in areas such as perceived debt and profitability risk (financial risk), perceived climate risk (production risk) and perceived personal risk (accidents and health problems, family situation, changes in land prices) (Martin & McLeay, 1998). Finally, financial characteristics (e.g. income and indebtedness), physical attributes (e.g. lambing percentage and beef cattle numbers), attitudes towards the future, farm size, farmers' age and geographical location were different across different risk management portfolios (Martin & McLeay, 1998).

Meuwissen, Huirne, et al. (2001) asked a sample of Dutch livestock farmers to indicate the importance of different risk management strategies. A Principal Component Analysis (PCA) method was then employed to summarise their risk management strategies into four main dimensions namely: price risk reduction, insurance, diversification, and income certainty. Their findings highlighted that farmers that believed price risk reduction strategies are important were more likely to believe that certain income risk management strategies were important. In contrast, farmers that perceived diversification as an important risk management strategy were less likely to perceive price reduction strategies as important (Meuwissen, Huirne, et al., 2001).

Flaten et al. (2005) asked a sample of Norwegian organic and conventional dairy farmers to indicate the importance of different risk management strategies. A common factor analysis technique was employed to summarise the information in a reduced number of dimensions, namely: consultancy, disease prevention, flexibility, insurance, diversification, and financial and fixed cost sharing. Hence, a series of linear regressions were conducted to explore the relationship between perceived risks and risk management strategies. Their results indicated that institutional risks are highly related to financial management strategies (solvency, liquidity, and low-cost production). They also found that production risks are highly associated with multiple management strategies such as consultancy, disease prevention, flexibility, and financial strategies. These findings support Patrick and Musser (1997) notion that there is no one-to-one correspondence between multidimensional risk sources (such as institutional risks) and any particular risk management strategy (Flaten et al., 2005).

Tudor et al. (2014) explored the diversity of risk management strategies that were utilized by a sample of Illinois farmers. The farmers were asked to indicate the use and effectiveness of a set of risk management strategies. Their findings highlighted that farmers who perceived risk management strategies to be more effective were more likely to utilise those strategies. Hence, a cluster analysis technique was employed to group farmers based on the utilization of risk management strategies. Four identified clusters were labelled as: moderately high tool use (MHTU), high tool use (HTU), moderately low tool use and low tool use (LTU) (MLTU) (Tudor et al., 2014). Their results showed that, except for the government support programmes, farmers in the HTU are more likely to use all the risk management strategies in the set provided.

Shadbolt and Olubode-Awosola (2013) applied a different approach to that of other authors to study New Zealand dairy farmers' risk management behaviour and its determinants. They investigated the relationship between the long-term performance of the farm and variables such as risk attitude, risk perception, and the perceived importance of risk management strategies. Instead of classifying farmers based on their risk management strategies, they classified farmers according to their risk profiles[42]. Then farmers with similar risk profiles (farm groups) were compared to other farm groups in terms of their perceptions of the sources of risk[43], their use of risk management strategies and farm business performance (both physical and financial KPIs) (Shadbolt & Olubode-Awosola, 2013).

The relationship between risk attitude and only two (out of the 17) risk management strategies were significant: not producing to full capacity and keeping debt low (Shadbolt & Olubode-Awosola, 2013). In terms of the relationship between risk attitude and risk perception, the only significant relationship that was found between risk attitude and risk perception was for a group of respondents who had an extremely negative risk perception (Shadbolt & Olubode-Awosola, 2013). In terms of the relationship between long-term performance and the predictors of risk management behaviour, risk attitude had a significant relationship with financial performance measures such as debt to asset ratio, liabilities, interest and rent as a percentage of gross farm revenue, off-farm investment and discretionary cash (Shadbolt & Olubode-Awosola, 2013). They also reported a significant relationship between risk perception and some of the physical performance measures such as effective area (size), and the value of dairy land and buildings (Shadbolt & Olubode-Awosola, 2013). Finally, the evidence for an association between perception and production and financial performance indicators were ambiguous. That is, farmers that have a negative perception (perceive more threats than opportunities from uncertainty) were smaller (effective ha) but had a higher total asset value.

van Winsen et al. (2014) examined the relationship between indirect determinants of risk management behaviour, such as socio-demographic variables and farm structural variables, as well as mediated variables, such as risk perception and risk attitude, on the risk management of a sample of dairy farmers in Belgium. van Winsen et al. (2014) survey found that the influence of risk attitude on risk perception was significant. However, only risk attitude had a significant relationship with intended

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[42] A typology of respondents is based on a combination of their ability to manage risk within a season, manage risk over the long term, plan for an uncertain future, make choices, and their propensity for 'playing it safe' (Shadbolt & Olubode-Awosola, 2013).

[43] Risk perception was elicited using an aggregated method called the risk importance index. In this method, farmers' responses for all sources of risk were aggregated into a continuous index between -1 (signifies having negative perception) and +1 (signifies having positive perception) (Shadbolt & Olubode-Awosola, 2013).

risk management behaviour whilst risk perceptions sources did not have any significant relationship with intended risk management behaviour. In terms of indirect variables, "age" and "farm size" showed a significant correlation with some of the intended risk management strategies (van Winsen et al., 2014). In the discussion section van Winsen et al. (2014) argued that the limited descriptive power of these variables (risk attitude and risk perception) did not allow researchers to draw clear a conclusion about farmers' risk responses.

Meraner and Finger (2017) acknowledged the existence of portfolios of risk management strategies in farm businesses. However, instead of using the ad-hoc summarisation techniques (such as factor analysis or latent class analysis) to identify risk management portfolios, farmers were classified based on three predefined risk management portfolios namely, on-farm agriculture, on-farm non-agriculture, and off-farm. The main rationale for utilising predefined risk management portfolios was difficulties in comparing results with other empirical studies (Meraner & Finger, 2017). While their findings provide evidence of the factors that impact on the adoption of risk management portfolios, they have not specifically scrutinised the interaction between risk management strategies.

2.14 Summary

This chapter provided a review of the literature on risk and risk management strategies in the New Zealand dairy farming context and incorporates other relevant literature and studies. The complex nature of risk and risk management at strategic level and how strategic choices shapes the overall structure of the farm business are also discussed in this chapter. This chapter also underlined how strategic choices expose farmers to different types of risks and provide them with different opportunities. Different approaches to cope with strategic risks including positioning to avoid, positioning to transfer, positioning to retain, and positioning for flexibility and adaptability are also reviewed in this chapter.

A detailed overview of the sources of risks and the risk management strategies that are utilised by farmers in the production, marketing, human resource management, and financial fields are presented in this chapter. In addition, empirical evidence was provided to explain how each of these risk management strategies enables farmers to manage risk. The concept of "risk management portfolio" was also introduced in this chapter. Although a large amount of work has been done to advance the understanding of farmers' risk responses, the empirical research that brings financial management and business management strategies together are scarce. This is despite the wide recognition that farmers' financial management strategies have considerable impact on the overall risk management strategy of farmers. Interestingly, many important aspects of financial management decisions have not been explored in previous studies. Liquidity management, capital structure, and debt servicing management are an especially significant part of a farm's risk management strategy that typically is not addressed in previous empirical studies. As such, the main purpose of this study is to define farmers' risk responses in a way that allows the incorporation of both financial risk management strategies and business risk management strategies into the portfolio of risk management strategies.

This chapter also provides an overview of the major factors that determines farmers' risk responses including farmer's risk preferences, risk perception, biophysical characteristics of the farm, and socio-economic characteristics of the farmer. While several theoretical and conceptual models claim that the aforementioned factors are important in farmers' risk responses, the empirical evidence is conflicting, and several questions remain unanswered such as: how farmers choose their risk management portfolios, and what factors determine a farmer's choice of the risk management strategies that make up their risk management portfolios. The next chapter outlines the research method used in this study.

Chapter Three: Method

3.1 Chapter outline

The literature review section established current knowledge in the field of farmers' choices under risk and uncertainty, and the factors that influence the choice of risk management strategies within a farmer's risk management portfolio. It has also highlighted that little is known about the nature of the risk management portfolios used by New Zealand dairy farmers.

As such, this study seeks to answer the following research questions:

1. What are the business (production, market, human resources) and the financial risk management strategies, within the portfolio of risk management strategies, that New Zealand dairy farmers utilise to manage risk in their farm businesses?
2. What is the diversity of risk management portfolios that New Zealand dairy farmers employ to manage risk in their farm businesses?
3. What are the trade-offs and the interrelationships between risk management strategies?
4. What farm-specific and farmer-specific factors shape New Zealand dairy farmers' portfolio of risk management strategies?

A research method is defined as the tools, techniques, or processes that enable the researcher to answer the questions that exist within the boundaries of the study (Cameron, 2009; Johnson & Onwuegbuzie, 2004; Leech & Onwuegbuzie, 2009; Tashakkori & Teddlie, 2010). This section will map out how the research questions shape the research process used in this study. For this study, a mixed method approach was used to address the research questions. The primary focus of mixed method is exploring and providing better insights into the research problem and phenomena of study (Creswell, 2014; Creswell & Plano Clark, 2011; Molina-Azorín, 2010; Tashakkori & Teddlie, 2010). The use of mixed method is recommended in the management research context because it is a field where many disciplines meet (Cameron, 2009; Mingers & Brocklesby, 1997). That is, management sciences include disciplines such as human resources, economics, social psychology, public policy, finance, and marketing just to name a few (Cameron, 2009; Mingers & Brocklesby, 1997).

An overview of the design and the rationale for choosing an exploratory sequential mixed method research design is discussed in the next section. Following on from this, the design of the qualitative phase, which includes a description of the sampling method (section 3.6), data collection protocol (section 3.7), and data analysis procedures is discussed (section 3.8). After this section, the quantitative phase is described. In this section, how the results from the qualitative stage are used to inform the design of the quantitative phase (survey approach) is described (section 3.9). The survey design description includes the design and testing of the survey instrument (section 3.10), the sampling strategy (section 3.11), the data collection protocol (section 3.13), and a description of the statistical methods that is used to analyse the data is described in the last section of this chapter (section 3.14).

3.2 An overview of the mixed research approach

Although there is no consensus over the definition of a mixed research approach, central to a mixed study is the idea of combining, integrating, linking, and employing both qualitative and quantitative data in a study (Creswell, 2014; Creswell & Plano Clark, 2011; Creswell, Plano Clark, Gutmann, & Hanson, 2003; Fetters, Curry, & Creswell, 2013). However, the use of both qualitative and quantitative data collection methods in a single study is not enough to categorize a study as mixed. It is in the integration or linking of the two types of data that defines a mixed research strategy. There are several approaches to integrate qualitative and quantitative research procedures and data (Creswell & Plano Clark, 2011).

To begin with, Mertens (2014) introduced parallel and sequential data collection forms in mixed studies (time dimension). The parallel (or concurrent) form is a mixed research in which two types of data are collected and analysed in parallel. In contrast, in the sequential form one type of data provides a basis for collection of another type of data (Mertens, 2014). In sequential design, the main objective is to have one phase of the mixed methods study that informs the data collection approach of the other procedure, the latter building on the former. In the convergent designs, the main intention is to merge the phases in such way that the quantitative and qualitative results can be compared (Mertens, 2014). Creswell and Plano Clark (2011) classified mixed research designs based on the weighting of the qualitative and quantitative research procedures and data.

Tashakkori and Teddlie (2010) made a distinction between two types of mixed research by assigning specific definitions to the concepts of “mixed method” and “mixed model”. Based on this terminology, mixed method designs involve the mixing of the quantitative and qualitative approaches only in the methods stage of a study whereas mixed model designs involve the mixing of the quantitative and qualitative approaches over several stages of a study.

Fetters et al. (2013) extended the idea of mixed method research and propose that integration in a mixed method design can happen at the design-level, the methods-level, or the interpretation-level. At design level, Creswell and Plano Clark (2011) proposed that integration can also happen in a variety of different ways which they termed: connecting, building, merging, or embedding (Table 3-1).

Table 3-1: Integration through design (adapted from Creswell and Plano Clark (2011))

Approach	Description
Connecting	One database links to the other through sampling
Building	One database informs the data collection approach of the other
Merging	The two databases are brought together for analysis
Embedding	Data collection and analysis link at multiple points

Creswell and Plano Clark (2011) defined connecting as an approach in which one type of data links with the other through sampling e.g., when the interview participants are selected from the population of participants of the survey. “Building” was defined as an approach in which the results from one data collection procedure (either qualitative or quantitative) informs the data collection approach of the other procedure, one builds upon the other (e.g., Items for inclusion in a survey are built upon previously collected qualitative data that generate hypotheses or identify constructs or language used by research participants). “Merging” of data occurs when researchers bring the two databases together for analysis and for comparison. Preferably, researchers design a plan for collecting both forms of data in a way that will be conducive to merging the databases. Finally, “embedding” occurs when data collection and analysis are being linked at multiple stages. This involves any combination of connecting, building, or merging, but the most important feature of this method is the recurring linkage between qualitative data to quantitative data. Embedding may occur in the initial stage of the research, when qualitative (or even a combination of qualitative and quantitative) data can be used in various ways such as clarifying outcome measures, understanding contextual factors, or for developing measurement tools to be utilized during the trial.

Combining the above dimensions, Creswell and Plano Clark (2011) offered a comprehensive classification system using categories associated with variants, design type, weighting and mix (Table 3-2). The four designs are called triangulation, embedded, explanatory, and exploratory.

Table 3-2: Major mixed design types (Source: Creswell and Plano Clark, (2011))

Design type	Timing	Mix	Weighting/Notation
Triangulation	Concurrent: quantitative and qualitative at the same time	Merge the data during interpretation or analysis	QUAN + QUAL
Embedded	Concurrent and sequential	Embed one type of data within a larger design using the other type of data	QUAN (qual) Or QUAL (quan)
Explanatory	Sequential: Quantitative followed by qualitative	Connect the data between two phases	quan → QUAL
Exploratory	Sequential: Qualitative followed by quantitative	Connect the data between two phases	qual → QUANT

In triangulation, researchers might seek convergence and corroboration of findings from different methods that study the same phenomenon (Creswell & Plano Clark, 2011). It also may be used to elaborate, illustrate, and clarified the results from one method with results from the other method. Finally, triangulation might be used to extrapolate the breadth and range of the investigation by using different methods for different inquiry components (Onwuegbuzie & Leech, 2006).

In an exploratory sequential design, the researcher first collects and analyses qualitative data, and these findings inform subsequent quantitative data collection (Creswell & Plano Clark, 2011; Leech & Onwuegbuzie, 2009). In an explanatory sequential design, the researcher first collects and analyses quantitative data, and then the findings inform qualitative data collection and analysis (Leech & Onwuegbuzie, 2009). In an embedded design, the qualitative and quantitative data are collected and analysed during a similar timeframe. During this timeframe, an interactive approach may be used where iteratively data collection and analysis drives changes in the data collection procedures (Creswell & Plano Clark, 2011; Creswell et al., 2003; Harrison & Reilly, 2011).

Creswell and Plano Clark (2011) argue that when an investigator has insufficient information about the questions that need to be asked in a survey, the variables that need to be measured, and the theories that may guide the study, it is best to first explore the phenomena qualitatively to learn what questions, variables, and theories can answer the research questions. Because little is known about the nature of the risk management portfolios used by New Zealand dairy farmers and the reason behind their choice of risk management strategies within these portfolios, it is difficult to design a suitable survey instrument to explore this area effectively. Thus, a qualitative data collection phase is used initially to collect information about dairy farmers' portfolios of risk management strategies. This information will then be used to design a suitable survey instrument to identify the portfolios of risk management strategies that New Zealand dairy farmers use. That is, the aim of this research is to generalize the findings of qualitative phase of research, and classify farmers based on their portfolio of risk management strategies. Therefore, it is imperative to collect quantitative data through a survey. As such, an exploratory sequential mixed method design is selected as an appropriate research design (Figure 3-1).

An exploratory sequential mixed method, uses a qualitative case study approach to explain the phenomenon of interest, followed by a survey to test the theory and its generalizability to the broader population under investigation (Creswell et al., 2003; Fetters et al., 2013). Analysis of the survey data will help to identify the archetypes of risk management portfolios used by New Zealand dairy farmers (to address the first research question). Moreover, the generalisability of the qualitative findings about the extent of using risk management strategies within a particular portfolio of risk management strategies will be tested using the survey data (to address the second research question).

The point of connection between qualitative phase and quantitative phase in an exploratory sequential mixed method design is at the method level. However, a series of inference can be made by comparing qualitative and quantitative findings. As such, points of contention and areas of convergence between the qualitative and quantitative phases were dissected in the conclusion phase to form meta-interferences, or an overall understanding developed through integration of data strands. Hence, the connected data was interpreted within the scope of the study's purpose: to understand dairy risk management portfolios, and the factors that contribute to the construct of risk management portfolio. A description of the qualitative and quantitative phases of the mixed method are described in the following sections

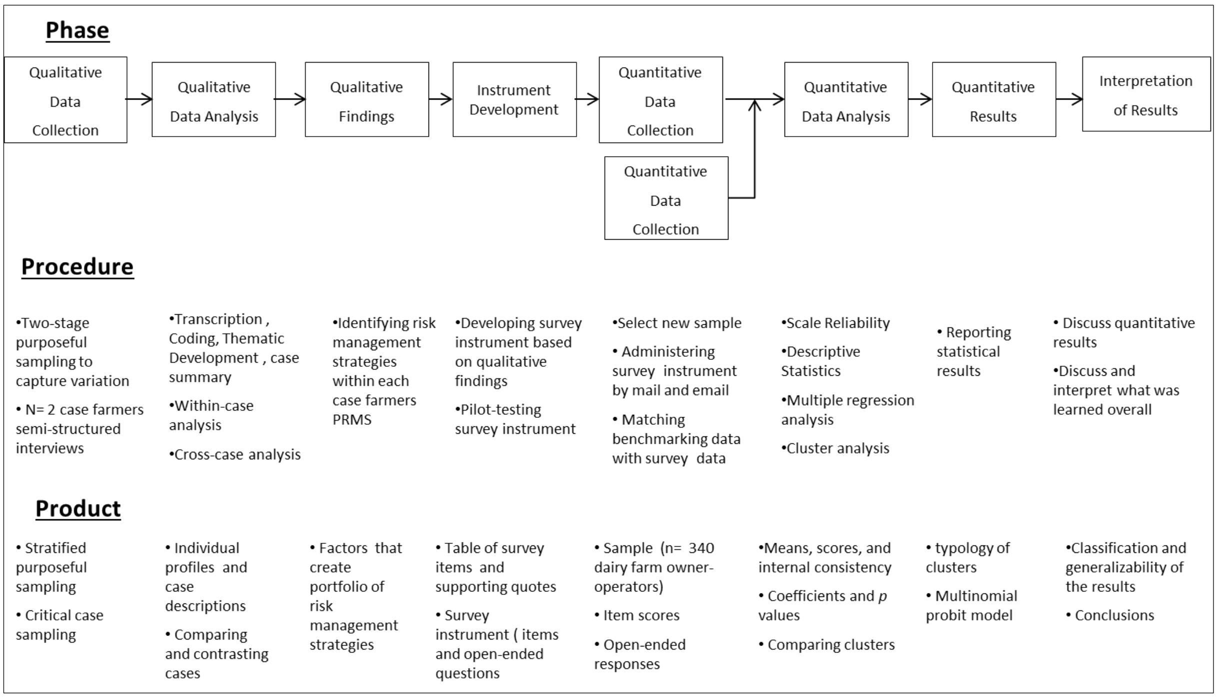

Figure 3-1: Visual diagram of the research design

3.3 Qualitative phase

The primary aim of the qualitative phase is to describe a range of risk management portfolios New Zealand dairy farmers use to manage risk and to understand the factors that shape the mix of risk management strategies the farmers have within their portfolios. During this phase, insight into the trade-offs between risk management strategies within the identified portfolios will also be obtained.

The specific objectives of the research during the qualitative phase in relation to each case farmer are:

1. To describe the key characteristics of the dairy farmer, and the farming systems.
2. To describe the case-farmers' risk perception, and perceptions of different risk management strategies.

3. To describe the risk management strategies that comprises the farmers' risk management portfolio.
4. To understand the farmers' reasons for developing the risk management portfolio they operate, including why they do not use other risk management strategies.
5. To describe the trade-offs between risk management strategies that the farmer considers when developing his/her risk management portfolio.

Considering the specific research objectives for this phase of the study, two theoretical lenses can be identified. The first focuses on describing the risk management decisions (why farmers choose a specific portfolio), and the second lens focuses on exploring the risk management strategies that comprises the farmers' risk management portfolio. The following section explains the choice of the research strategy.

3.4 Choice of research strategy in qualitative phase

For the objectives set forth in this phase of the study, an embedded multiple-case study design (Creswell, 2013; Eisenhardt, 1989) offered the opportunity to explore the nature of the portfolio of risk management strategies that dairy farmers use, and the factors that influence their choice through an inductive, constructivist lens (Eisenhardt, 1989; Shakir, 2002). A case study is deemed a suitable research strategy when (a) the proposed research addresses a contemporary phenomenon, (b) the researcher does not require control over those involved in the study, (c) it addresses "how" and "why" questions; and, (d) the contextual conditions are pertinent to the phenomenon of the inquiry (Creswell, 2013; Yin, 2013). As such, dairy farmers' portfolios of risk management strategies (a) is a contemporary phenomenon, (b) the researcher does not require control over the farmers' risk management decisions, (c) the researcher seek to understand why the farmers have chosen the portfolio of risk management strategies, and (d) the farmers' risk management must be understood within the overall context of the farm business and the operating environment. Therefore, a case study approach is well suited to this phase of the study.

The logic behind choosing a multiple-case study instead of a single-case study was because the study seeks to understand the range of risk management portfolios dairy farmers use. As such, the research wants to investigate a range of cases (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). Thus, a multiple-case design was selected in this study to investigate dairy farmers who are using a range of risk management portfolios. In addition to this, by Including multiple cases the findings and interpretations about the reason behind choosing risk management portfolios became more compelling (Creswell, 2013, 2014). That is, studying multiple cases of the same phenomenon validate, qualify, or extend the findings that might occur were there to be only a single case (Dey, 2003; Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Yin, 2011).

Another decision in relation to a multiple-case study design relates to how cases should be analysed. According to Perry (1998), two variants of case study design can be identified, namely holistic and embedded case studies. To make a choice between these two variants, the purpose of the research and the research questions needs to be considered (Yin, 2013). Holistic case studies examine the case as one unit. They might, focus on the broad issues of a dairy farm as a whole. Embedded designs identify a number of sub-units (e.g., risk management strategies) each of which is explored individually. Results from these units are drawn together to yield an overall picture of the risk management strategies used by the case farmers. A carefully established rationale guided the selection of embedded multiple-case study design (Figure 3-2).

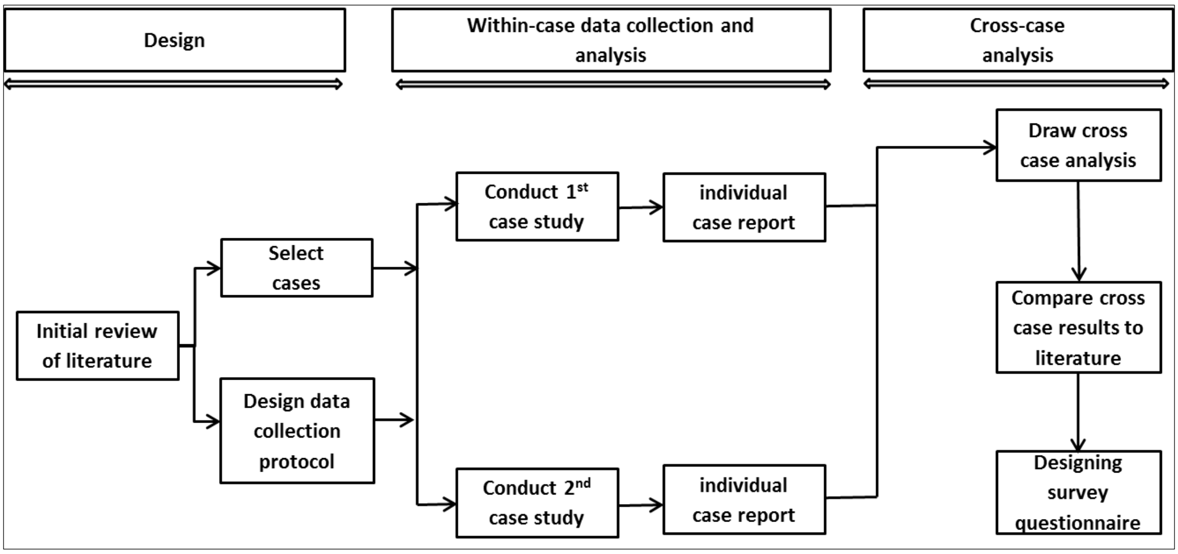

Figure 3-2: Multiple-case study method diagram (Adapted from Yin, 2013)

3.5 Study population

Dairy farm owners were chosen as the population for the study. Owner operators are farmers who either own and operate their own farms, or who employ a manager to operate the farm for a fixed wage. Owner receive all the farm income, although they may pay wages (DairyNZ, 2014). Previous empirical study of (Pinochet-Chateau et al., 2005) shows that owners and sharemilkers have different risks perception, and accordingly utilise different risk management strategies. As such, it is not possible to accommodate portfolios of risk management strategies of these two types of farmers in one research. Dairy owners found as the suitable population to answer the research questions in this study. The rationale for choosing owner overs sharemilkers lies in the fact that sharemilkers do not have full control over risk management decisions. That is, sharemilkers have limited or no control on the risk management decisions at strategic level whereas farm owners have full control and autonomy over farm risk management decisions at different levels. Therefore, farm owners were selected as the suitable population to investigate PRMS.

3.6 Sampling strategy

The sampling logic for qualitative research is quite different from that used in quantitative research (Patton, 1990). The most widely used sampling method in qualitative research is purposeful sampling (Onwuegbuzie & Leech, 2007; Palinkas et al., 2013; Patton, 1990) which can involve one or more than one stage (multiple-stage sampling). Palinkas et al. (2013) developed a classification schema embedded in the ability of each sampling technique to compare and contrast, and to identify similarities and differences in the phenomenon of interest (Table 3-3).

Table 3-3: Purposeful sampling methods with emphasis on variation (Source: Palinkas et al., 2013)

Sampling technique	Objective	Considerations
Intensity	Sampling intense examples of the phenomenon of interest	Requires the researcher to do some exploratory work to determine the nature of the variation of the situation under study, then sampling intense examples of the phenomenon of interest
Maximum variation	Important shared patterns that cut across cases and derived their significance from having emerged out of heterogeneity	Can be used to document unique or diverse variations that have emerged in adapting to different conditions
Critical case	To permit logical generalization and maximum application of information because if it is true in this one case, it's likely to be true of all other case	Depends on recognition of key dimensions that make for a critical case
Theory-based	To find manifestations of a theoretical construct so as to elaborate and examine the construct	Sample based on potential manifestation or representation of important theoretical constructs.
Confirming-disconfirming Cases	To confirm the importance and meaning of possible patterns and checking out the viability of emergent findings	Usually employed in later phases of data collection. Confirmatory cases are additional examples that fit already emergent patterns to add richness, depth, and credibility
Stratified purposeful	To capture major variations rather than to identify a common core, although the latter may emerge in the analysis	This represents less than the full maximum variation sample, but more than simple typical case sampling
Purposeful random	To increase the credibility of results	Not as representative of the population as a probability random sample

Considering the research questions, a two-stage purposeful sampling technique was justified as a suitable sampling strategy (Onwuegbuzie & Leech, 2007) to capture the insights from a range of dairy farm owners. A stratified purposeful sampling technique was used in the first stage to divide the population into homogeneous strata (Palinkas et al., 2013; Patton, 1990). Following on from the first stage, a critical case sampling strategy was used as the appropriate method of sampling to choose a suitable case within each strata (Onwuegbuzie & Leech, 2007; Patton, 1990). The process of sampling and the criteria used to choose cases is explained in the following sections.

According to Onwuegbuzie and Leech (2007) the stratified sampling strategy is a useful technique when the population of study is heterogeneous, and a researcher desire to divide the population of study into homogenous groups to capture the diversity that occurs in relation to the phenomena of interest (Palinkas et al., 2013). In this study, the population (dairy farm owners) is heterogeneous, and the researcher seeks to capture some of the diversity in the risk management portfolios they use. Thus, this technique was adjusted for the first stage to divide the population of study into homogenous strata. The first step was to determine one or more distinguishing features (criteria) from which to create the stratum needed for the study (Patton, 1990).

According to Eisenhardt (1989) distinguishing features (criteria) for sampling should be identified from the literature. The first criteria to build stratum was geographic location. The rationale behind choosing geographic location is grounded in the fact that the dairy farm environment in different regions of New Zealand is different, and farmers in different regions face different sources of uncertainty (Pinochet-Chateau et al., 2005). Evidence of this diversity is likely to be reflected in the dairy famers' perceptions. That is, New Zealand dairy farmers have different risk perceptions, and different risk management strategies according to geographical location (Pinochet-Chateau et al., 2005). Initially, three regions was considered appropriate to cover the diversity in the New Zealand dairy farming system that let the researcher design survey questions and statements (Birks & Mills, 2011). However, a major earthquake in the South Island prevented the researcher to interview cases in that region. Therefore, two different regions in the North Island (Taranaki, Manawatu) were selected to create the stratum. Characteristics and specification of each region is briefly described in the following.

Taranaki was the first region selected for this study. This region has the advantage of reliable rainfall (Clark et al., 2011; MAF, 2009) and fertile soils. As a result, the milksolids production per cow in Taranaki is higher than North Island average (DairyNZ, 2012, 2013, 2014, 2016, 2016). In addition, farm-working expenses (FWE) per kilogram milksolids in this region are lower than the North Island average (DairyNZ, 2012, 2014, 2015, 2016). However, the average size of dairy farms (effective area) in Taranaki is smaller than other dairying regions in the North Island (DairyNZ, 2012, 2013, 2014, 2015, 2016), As such, compared to other dairying regions in the North Island, the Taranaki dairy bio-physical environment can be characterised as a benign and stable environment.

The average farm size in Manawatu region, the second selected region in the North Island, is larger than other dairying regions in the North Island (DairyNZ, 2012, 2013, 2014, 2015, 2016). In contrast to the Taranaki region, farm businesses in this region face uncertain climatic condition (Clark et al., 2011; MAF, 2009) which means dairy farms in this region have to deal with much greater pasture production variability, and fluctuations in milksolids production per cow. As can be seen, these two regions have diverse physical and biological characteristics, as well as production systems. The remaining of this section outlines the considerations for choosing cases within each region.

Several selection criteria are proposed in the literature for case study research. Among them, Eisenhardt and Graebner (2007) and Jack and Raturi (2002) suggested that the construction of strata on the basis of cases that enables the researcher to learn more about the phenomenon. That is, the case study in this research was designed to capture variation in terms of the PRMS used by dairy farmers. The results of the case studies were then used to design the questionnaire in the next phase of the study. Therefore, the researcher needed to ensure that adequate information was obtained to develop questionnaire statements. The second criterion was that the case farmers needed to have enough experience in dairy farming, so that they had a sound understanding about their decision making in relation to their risk management portfolios. Thus, information-rich farmers with at least 15 years of ownership and managerial experience in each strata were targeted for the study.

While achieving variation according to the above design is desirable it would be very difficult to ensure that the selected cases can adequately cover a broad range of portfolios of risk management strategies within each stratum. In order to solve this problem, Guest, Bunce, and Johnson (2006) suggest that flexibility in choosing cases is necessary to ensure that selected cases are adequate to capture information about the topic of interest. The cases in each region were identified with the help of experienced farm management consultants who were given the criteria and asked to identify suitable case farmers.

3.7 Qualitative data design and collection

Although the term qualitative research and case study are used interchangeably, case study research can involve both qualitative and quantitative data collection methods (Tashakkori & Teddlie, 2010; Yin, 2013). Central to collecting data in a multiple-case study method is the interview (Eisenhardt & Graebner, 2007). However, contextual data will be gathered beforehand to help the researcher to design the interview protocol and triangulate responses from the interview (Creswell, 2013). In this research, a semi-structured interview (Creswell & Plano Clark, 2011) is the main tool to collect data about the farmers' portfolio of risk management strategies, and the trade-offs farmers take into account when choosing their risk management portfolio. The case farmers were selected based on the suggestions from local farm management consultants. After choosing the cases, they were invited to be involved in the research. First, each case farmer was contacted and briefed about the purpose of the study. After obtaining verbal consent, the information sheet and the consent form (Appendix I), and the written questionnaire were sent to the case farmer via electronic mail (email) (Appendix II). The case farmers were asked to read the information sheet, sign the consent form, and answer the questions in the written questionnaire. After receiving and interpreting the questionnaire data, a semi-structured interview was organised to collect information about the case farmer's PRMS. This information was used to help focus of the semi-structured interview (Creswell & Zhang, 2009; Yin, 2013). Before starting the interview, the case farmer was asked to return the signed consent form. The structure of the written questionnaire and the interview protocol is explained in the next two sections.

3.7.1.1 *Written Questionnaire*

A structured questionnaire was sent to the case farmers to collect data about their socio-demographic characteristics, the farm's physical characteristics, the farmer's goals and management style, strategic thinking skills, perceived environmental uncertainty, and the importance of different risk management strategies to their business (Appendix II). The first section of the written questionnaire was designed to capture the case farmer's characteristics and related farm business characteristics. The second section of the questionnaire was designed to capture the case farmers' goals and management style. This construct was adapted from previous studies of farmers' goals (Brodt et al., 2006; Fairweather & Keating, 1994; Nuthall, 2010; Willock, Deary, Edwards-Jones, et al., 1999) and family businesses' goals (Tagiuri & Davis, 1992). The case farmers were asked to respond on a five-point Likert scale (strongly disagree - strongly agree).

The strategic thinking construct was developed to measure the case farmers' cognitive capacity to think strategically. The first five items were based on Duranovich (2015) and Pinochet-Chateau et al. (2005) studies. The remaining items were adapted from Pang and Pisapia's (2012) strategic thinking questionnaire. The case farmers were asked to respond on a five-point Likert scale (strongly disagree - strongly agree).

Three constructs developed in the previous studies were used to measure case farmers' risk attitude. Following Shadbolt and Olubode-Awosola (2016), a construct called risk profile was used to create case farmers' risk typologies based on farmers' responses about their ability to manage risk, plan for the future and make choices when there are multiple options, and their appetite for risk. The second measure, relative risk aversion (Hardaker et al., 2004), were asked farmers to indicate their willingness to take risk relative to other farmers (Ahsan, 2011; Flaten et al., 2005; Koesling et al., 2004; Meuwissen, Huirne, et al., 2001). Finally, financial risk attitude construct was specifically used to capture farmers' attitude toward financial risks (van Winsen et al., 2014).

In terms of perception to sources of risk, a five-point scale (rare - almost certain) was used to measure the perceived likelihood of the uncertainty, and a five-point scale (very low - very high) was used to measure the perceived impact for each source of uncertainty (Shadbolt & Olubode-Awosola, 2013). Perceived uncertainty scores of each uncertainty for both opportunities and threats were calculated by multiplying the scores for the perceived likelihood and the scores for the perceived impact of the different risk sources (Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2016). In addition to that, the case farmers were asked if they knew how to respond to the different uncertainties by selecting "yes", "no" or "sometimes" for each of the sources of risks. This construct, known as response uncertainty, was adapted from Ondersteijn, Giesen, and Huirne (2006).

To gain a detailed view about the research topic, a pool of risk management strategies was generated from prior surveys (Gray, Dooley, et al., 2008; Martin & McLeay, 1998; Ondersteijn et al., 2006; Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2013), and the findings of exploratory research (Bitsch et al., 2006; Gray et al., 2011; Gray et al., 2014; Greenhalgh & Tipples, 2013; Hirst et al., 2014). Two questions were asked of the case farmers in relation to the newly developed list of risk management strategies. The first question asked if the farmers used the risk management strategy and they could answer "yes", "no" or "not applicable" for each strategy. Then, the second question asked them about the importance of each strategy for managing risk in their farm business. The case farmers were asked to answer this using a five-point Likert scale (very low - very high).

Generally, time-consuming questionnaires obtain lower response rates (DeVellis, 2017). Consequently, care was taken to create a "non-exhaustive" questionnaire. However, because of the vast number of available risk management strategies, the written questionnaire was longer than previous survey questionnaires and consisted of 55 statements in relation to risk management strategies. Care was also taken to avoid redundancy, lengthy statements and jargon among the statements (DeVellis, 2017).

3.7.1.2 *Interviews*

Semi-structured interviews (Eisenhardt & Graebner, 2007) were used as the main data collection technique for the qualitative phase of the study. This techniques is particularly useful because it enables the researcher to choose the sequence and way in which questions will be asked (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). The Information from the written questionnaire that the case farmer filled out prior to the interview provided an overview of their socio demographic variables, goals, perceptions toward sources of risk, and perceptions toward risk management strategies, and the strategies that they use to manage risk. This information was used to help focus of the semi-structured interview (Creswell & Zhang, 2009; Yin, 2013).

Upon arrival, the researcher again explained the purpose of the research and spent time building rapport so that the farmer was relaxed before beginning the interview process (Seidman, 2013). The case farmer was also asked permission to tape the interview before it was initiated (Seidman, 2013). At the start of the interview, simple, non-threatening questions about the case farmer's career trajectory, family characteristics and farm business were asked to relax the farmer. This is then followed by a series of questions about the sources of risk that were perceived as important by case farmer. Availability of data in the written questionnaire, allowed the researcher to make decisions about which risks were more important from the case farmer perspective, and these were investigated in-depth during the interviews (Dooley, 2002; Sandelowski, 2000). Follow up questions were more focused on the reason for choosing a particular strategy to manage risk (Dooley, 2002; Sandelowski, 2000). Probing and follow up questions as well as other techniques such as clarifying questions were used to obtain more information on each of the important areas (Appendix III) (Drever, 2003; Gray et al., 2011; Sandelowski, 2000). As such, case farmers were also asked to explain the reasons behind choosing the strategies they used to manage risk, why they did not use other available alternatives, and the interrelationship between the strategies. After completion of the interview, it was transcribed verbatim (Patton, 1990). Some secondary data, including case farmer's cash-flow budget and financial KPIs for the previous financial year were observed during the interview. Both case farmers were agreed to provide a copy of their benchmarking data. A summary of the interviews was made and sent to the case farmer for verification.

3.7.1.3 *Ethical Requirements*

The qualitative phase of the project was evaluated to be low risk according to the Massey University Human Ethics Committee. Informed and voluntary consent to participate were obtained from the participants prior to any data being collected (Seidman, 2013). The information sheet, consent form (Appendix I), and interview questions (Appendix II) were provided to the case farmers invited to participate in the project. Interviews were taped (with participant consent) and transcribed by the researcher. Confidentiality of the information was always ensured. The participants were not be referred to by their real names in any publications (Seidman, 2013). Any personal information was securely stored at the university.

3.8 Qualitative data analysis

Generally, in a qualitative study, multiple sources of evidence and different types of data are available for the analyses. Although availability of different sources of information helps to improve the validity of the study, it makes the analysis of the data more complex task. Therefore, implementation of a comprehensive analytic procedure is of great importance in qualitative studies (Eisenhardt, 1989).

There is no agreement about the systematic procedures for analysing qualitative data (Houghton, Murphy, Shaw, & Casey, 2015). To begin with, it is necessary to clarify two types of analysis in multiple case study research, namely 'within-case' and 'cross-case' (Creswell, 2013; Eisenhardt, 1989; Yin, 2013). 'Within-case' analysis was carried out to a build a detailed description of each case farms' portfolio of risk management strategies Once the 'within-case' analysis was undertaken, 'cross-case' analysis was carried out to identify similarities and differences between the case farms' portfolio(s) of risk management strategies (Figure 3-2).

3.8.1 Within-case analysis

Within-case analysis is a process of pulling the data apart and putting them back together in more meaning full way (Creswell, 2013; Houghton et al., 2015; Patton, 1990). The main aims of the 'within-case' analysis are to become familiar with each case, and to identify the individual patterns within each case (Eisenhardt, 1989). The procedure used for the within-case analysis in this study was based on the Dey's (2003) qualitative data analysis technique. This involves a three steps iterative process of describing, connecting and classifying (Dey, 2003). The following section will describe 'within-case' analysis process.

Description is the first step in the qualitative data analysis process (Patton, 1990; Stake, 1995), and is the foundation upon which qualitative research is built. The purpose of this stage is to provide a detailed description of what is observed and why that observation is important (Schutt, 2011). That is, description is the act of making a detailed account of the setting, and the facts of the case (Stake, 1995). The description is especially useful to explain the case within its setting or context (Creswell & Plano Clark, 2011). According to Schutt (2011), presenting a rich description of a case study without identifying the context of the case can be problematic because the context helps explain the results from a specific case. The description will also help the researcher to understand the case from a theoretical perspective (Dey, 2003; Stake, 1995). The description should also contain other important outputs such as, the intentions of the subject, important concepts, cause and effect relationships, and processes (Creswell, 2014; Stake, 1995). As mentioned earlier, within-case analysis is an iterative process of pulling the data apart and putting it back together. As such, the description will enable the researcher to provide a holistic view of the case and its context (Schutt, 2011; Stake, 1995).

The next step in Dey's (2003) process, classifying, is similar to open coding in the grounded theory approach advanced by Corbin and Strauss (1990). Again, this is an iterative process, where data with similar characteristics are placed into the same group or category. According to Dey (2003, p. 9), a category is "an idea (a word or phrase) that stands for a set of objects or events with similar characteristics". The availability of related theory and research questions provides a guideline to build and revise categories (Baptiste, 2001). In addition to these factors, the researcher's identity will guide the iterative process of revising tagged data and deciding whether to discard, discount, narrow, expand, split, join, refine, and re-define previously constructed categories (Baptiste, 2001). That is, categories must relate to the wider theoretical context of the study, and the empirical data (Dey, 2003; Rubin & Rubin, 2005). Subcategories were developed where theoretically important distinctions were identified between the data within a category (Corbin & Strauss, 1990; Dey, 2003). Similarly, categories were combined into a supra-category if it provides a useful theoretical concept (Dey, 2003). Data analysis in this section was conducted manually using word. Excel also was used to create tables that had the category name, definition, and evidence along with the location in the logical hierarchy.

The third and final step in the Dey's (2003) data analysis process is connection (Dey, 2003) or axial coding (Corbin & Strauss, 1990). According to Corbin and Strauss (1990, p. 13) axial coding is "a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories". During the connection step, explanatory, causal relationships between categories as well as chronological relationships that depict a process were identified and defined (Dey, 2003).

3.8.2 Cross-case analysis

Cross- case analysis is the task of going beyond single case analysis, and seeking patterns through a structured framework (Eisenhardt, 1989). According to Eisenhardt and Graebner (2007), in a multiple-case study each case is a distinct and discrete analytical unit which is serve as replications, contrasts, and extensions to the existing theory or other cases. Paired-case comparison (Eisenhardt, 1989) was adapted to identify similarities and differences between the cases, and to develop new categories and concepts.

3.8.3 Comparison to the literature

The final step in the process is to compare the cross-case results to the literature to identify similarities and differences (Eisenhardt, 1989; Perry, 1998). In particular, the qualitative results revealed the influence of the less explored dimensions of risk management on the case-farmers PRMS (i.e., debt management and utilisation of different financial management strategies on shaping the case farmers' PRMS). Case study finding is corroborates the findings from previous empirical studies of Shadbolt and Olubode-Awosola (2016), and Gray et al's (2014). Findings from qualitative phase was particularly important because similar research in other farming sectors and countries are focusing on the risk management tools that have limited utilisation rate in New Zealand (i.e., forward pricing instruments and income insurance products) (see for example: (Pennings & Garcia, 2004; Tudor et al., 2014; Velandia et al., 2009)).

Different theoretical and empirical literature was compared with the findings from case study (Gebreegziabher & Tadesse, 2013). Theoretical and empirical studies in farm management and agricultural economics are employed to highlight the importance of different factors on the choice of risk management strategies. Available literature in farm management, agribusiness, agricultural finance, corporate finance, financial management in SMEs, also are employed to address some of the less explored aspects of case farmers' risk management behaviour (i.e., debt amortization policy).

The findings from the qualitative research phase was formed the basis for the development of the second research phase. Some of the less explored dimensions of financial management are covered in the revised version of the survey (i.e., debt structure and determinants of debt structure, debt servicing and determinants of debt servicing structure, liquidity management and determinants of liquidity management). The qualitative phase also revealed the role of other stakeholders that contribute to PRMS (i.e., bank managers). Accordingly, a sub section of the survey was dedicated to exploring some aspects of the lender-borrower relationship. The aforementioned topics has not been covered in the previous surveys (Duranovich, 2015; Martin & McLeay, 1998; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2016).

One of the drawbacks of mixed method research is that it takes much more time and resources to plan and implement this type of research (Creswell, 2014). In this study, the available time from qualitative data analysis and distributing survey questionnaires was limited. This shortage of time place constrains to the time available for the qualitative data analysis. As such, some insights did not emerge until after the survey had been sent out.

Using Jack and Raturi's (2002) approach, a protocol for conducting case studies in two farms were developed. Data were obtained using the written questionnaires and the semi-structured interviews with farmers to identify portfolios of risk management strategies. Table 3-4 summarise the case study method by addressing the seven steps of the case study process.

Table 3-4: Summary of qualitative phase methodology (Adapted from Jack & Raturi, 2002)

Steps	Comments
Research question	What risk management portfolios do New Zealand dairy farmers apply to manage risk in their farm businesses?
Objectives	Two specific objectives of the multiple-case study are: To describe the risk management strategies that comprises the case farmers' PRMS. To describe the relationships between risk management strategies that the farmer considers when developing the risk management portfolio
Designing instruments and protocols	Data was collected using two sources: (1) questionnaire and (2) interviews. An 11-pages questionnaire was designed to identify farmers' goals, risk profile, perceived uncertainty, and risk management strategies. Then, a pilot tested semi-structured interview protocol was designed to address the portfolio of risk management strategies that New Zealand dairy farmers apply.
Sampling strategy	A two-stage purposeful sampling technique was adapted to choose the case farmers. In the first stage, a purposive stratified sampling method was adapted, and two regions were selected. Then, within each region, a typical and information rich case farmer was selected as the case.
Collecting data	Multiple case farmers were interviewed to gain a rich insight about the portfolio of risk management strategies. Each farmer was contacted and briefed about the project. First, oral consent was obtained. Then, a questionnaire was sent to the case farmers. Following that, the interview was organised.
Data analysis	By applying Dey's (2003) approach, the different portfolios the case farmers utilise to manage risks were identified and compared. Cross-case analysis were also undertaken to compare cases in terms of the utilised risk management portfolios.
Comparison to the literature	Comparisons and contrasts were conducted with the literature to develop survey statements and questions.

3.9 Quantitative phase

In phase two, the results from the findings in the first phase and the information from the literature review were used to develop a survey instrument to collect the data required to answer the research questions. Aspects of the literature review were drawn on to inform the development of the survey instrument for this phase are summarised in section 3.13. The qualitative phase provided a detailed context for the study and identified a number of risk management strategies that had not been covered in previous risk management surveys of farmers. New themes identified include farm capital structure and policy, debt serving structure and policy, and liquidity management structure and policy. Questions and statements were constructed to address these themes in the survey. The method used in the quantitative phase of the project, including the sampling strategy, the survey tool, data collection in the interview, and the statistical methods that are used to analyse the data are described below.

3.10 Choice of research strategy in quantitative phase

One of the objectives of this study was to generalise the findings about dairy farmers' portfolios of risk management strategies. Another objective of this study was to investigate the relationship between farm and farmer characteristics and the different portfolios of risk management strategies used by New Zealand dairy farmers. According to Creswell (2013), a survey is the most appropriate research design for studying the distribution of a particular phenomenon in a population. However, the use of a survey instrument is not without potential drawbacks. First, there is the risk that the respondents are not representative of the population. Second, the survey analysis faces the risk that the survey questions can be misunderstood (Creswell, 2013). Finally, surveys measure beliefs and intended actions and not necessarily the actions. The remedial measures for the first and second drawbacks are explained in the next sections. Nevertheless, a survey questionnaire design was ultimately considered to be the most appropriate research strategy because first, the data collected should effectively represent the population that is the focus of the study, and any correlational relationships between research variables in the survey can be explored.

3.11 Sampling strategy

Generally, the aim of sampling in quantitative studies is to reflect the characteristics of the population of interest (Hair, Money, Samouel, & Page, 2007). As mentioned in the qualitative phase of the study, dairy farm owners in New Zealand are the population for the study. A random sampling procedure was adapted for this phase of the research (Hair et al., 2007). A representative sample of farmers was selected from one of the New Zealand dairy industry databases in New Zealand (AsureQuality).

Sample size was estimated based on the below equation**,** assuming a response rates similar to those observed in previous surveys on risk management by New Zealand dairy farmers (Duranovich, 2015; Martin, 1994; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2013). As suggested by Hair et al. (2007), a confidence level of 5% was chosen for sampling. Thus, a sample size of 400 responses was required at a 5% confidence level. On this basis, a list with email and postal addresses of more than 2,000 farm-owners was sent out to ensure that a sample of at least 400 farmers would be obtained.

$$n = \left(\frac{1}{(confidence\ level)}\right)^2$$

3.12 Survey administration

The details about the randomly selected respondents' email and postal addresses were obtained from AsureQuality Limited [1]. The database effectively represents the New Zealand dairy farm population. The questionnaire was distributed as either a postal or an online survey (if email address were provided) to 2000 dairy farm owners. Each postal survey included a cover letter, an information sheet, a postal survey, and a return-paid envelope. An incentive (i.e., a gift card) was also offered to encourage survey responses. A reminder was sent to the potential participants (both email and postal) three weeks after the initial distribution, as the survey spanned between June 2017 and September 2017. The following sections set out the design process and structure of the survey instrument.

3.13 Survey design and measures

The questionnaire was 12 pages long and included eight sections: farm and farmer characteristics, risk preferences and risk profile, farm capital structure, debt management and debt servicing policy, liquidity management, financial management metrics and practices, perceived business environment uncertainty over the long-term, and the use and importance of risk management strategies. A mix of Likert scale agree/disagree questions, dichotomous choice questions (yes/no), single-best response items and free-response items were used in the survey (DeVellis, 2017).

A combination of methods was used to ensure that the proposed measures and the employed frameworks are true representation of reality (construct validity) (DeVellis, 2017). First, a literature review identified previous attempts at construct development, the strengths, and the weaknesses of various approaches, and whether good measures of constructs already existed were carefully evaluated. These constructs were used as a starting point and adjusted as required to ensure a better fit with the New Zealand dairy industry context. To ensure that the survey questions and response categories were clear and unambiguous, a pilot survey (DeVellis, 2017) was conducted with six New Zealand dairy farm owners before the start of data collection. The objective of the pilot study was to check farmers understanding of the questions, identify the time required to complete the survey, and ensure that the survey layout is logical (DeVellis, 2017; Hair et al., 2007). The results of the pilot study were used to finalise the survey questionnaire. The final version of the survey questionnaire is presented in the (Appendix IV).

[1] AsureQuality is a commercial company owned by the New Zealand government and provides a wide range of services for the agricultural industry all over New Zealand.

3.13.1 Socio-Demographics

A number of questions was asked to identify the socio-demographic characteristics of the respondents. This included years of experience in dairy farming, age, managerial experience, level of education, current role in the farm, and stage of the business.

In terms of farm characteristics, attributes such as number of dairy farms, type of dairy farm system, location, farm size (hectare of milking platform and number of milked cows), milksolids produced, and number of employed staff in the 2016-17 season were requested.

Farm physical performance indicators provided a holistic view of the business indicating how a farm manager decided to allocate resources. As such, indicators such as stocking rate (cows/ha), production ratios (Kg Milksolids/cow, Kg Milksolids/ha); and labour input ratio (cows/FTE, kg Milksolids/FTE) were also used in the first section of the survey.

3.13.2 Risk preferences and self-efficacy to manage risks

A series of statement were developed to measure the farmers' risk preferences. This construct consists of six items measured using five-point Likert scales. A Likert item is a statement where the respondent is asked to evaluate by using a scale, which in the case of this survey ranged from "Strongly disagree" to "Strongly agree".

The first three items were drawn from the van Winsen et al. (2014) survey and measured respondents level of agreement on statements related to financial risk-taking behaviour. The next three items were developed from the Shadbolt and Olubode-Awosola (2016) survey to capture a respondent's risk profile in terms of plan for the future, making choices when there are multiple options, and a general statement about risk-taking. Finally, two statement were adapted from (Shadbolt & Olubode-Awosola, 2016) survey to measure farmers' self-efficacy to manage risks both within the season and over the long-term (see section 2.13.4)

3.13.3 Capital structure and policy

A construct developed for measuring the respondents' debt-to-assets ratio (leverage ratio) and the factors that determine the choice of leverage ratio (Table 3-5). First, farmers were asked to indicate the debt-to-asset ratio. The actual leverage ratios of farms vary through time (Barry & Ellinger, 2012). Such variability might occur because of strategic adjustment (risk balancing) in the financial position of a farm (Escalante & Barry, 2001), short-term fluctuations in farm asset (land) value, or as a result of debt increasing due to adverse weather conditions and low output prices for two-three consecutive seasons (Gray et al., 2014; Shadbolt et al., 2013). As such, the respondents were also asked to indicate where their debt-to-asset ratio should be over the next 5-7 years.

Table 3-5: Leverage ratio policy statements

Survey statement	Relevant theory	Original context	Original reference	Agriculture reference
Interest rates	EU	Agriculture finance	Collins (1985)	-
Income volatility	EU	Agriculture finance	Collins (1985)	-
Tax deductibility of interest	Equilibrium (trade-off)	Agriculture finance	Modigliani and Miller (1958, 1963)	Ahrendsen et al. (1994)
The likelihood of insolvency or bankruptcy	Equilibrium (trade-off)	Corporate finance	Modigliani and Miller (1958, 1963)	Zhao, Barry, and Katchova (2008)
Availability of own funds	Pecking order	Corporate finance	Myers (1984)	Barry et al. (2000)
Farm creditworthiness (as assigned by banks)	Signalling	Corporate finance	Ross (1977)	Zhao, Barry, and Katchova (2008)
The ability to borrow further funds when unexpected opportunities and/or threats occur	Flexibility	Corporate finance	DeAngelo et al. (2011)	Anastassiadis, Liebe, and Mußhoff (2015)

3.13.4 Access to capital

A series of questions were asked to identify capital-constrained respondents (Briggeman et al., 2009; Simtowe, Diagne, & Zeller, 2008). Figure 3-3 provides a summary of the steps that were implemented to identify "capital-constrained" respondents. First, the respondents were asked whether they applied for a term-loan in the last three years. Then, the respondents who applied for a term-loan were asked to indicate whether any of their applications were rejected. The respondents who indicated that their application was rejected classified as "capital-constrained".

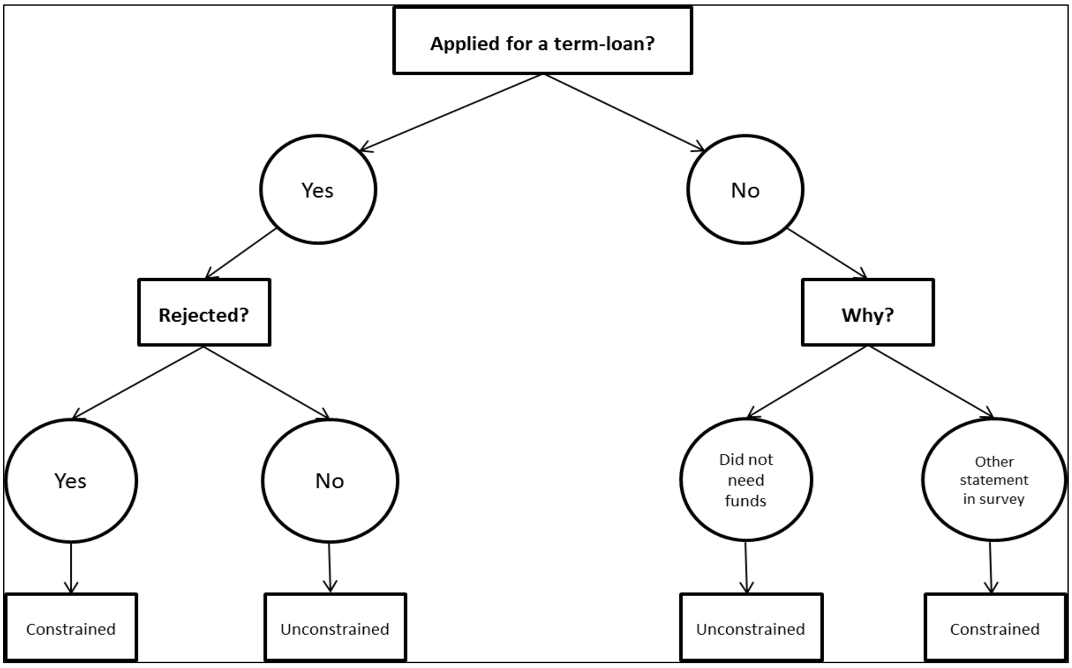

Figure 3-3: Flowchart showing identification of capital constrained farmers

The respondents who had not applied for a term-loan were asked to indicate the main reasons for not applying for funds. The respondents who indicated that "they did not need funds" were classified as unconstrained respondents. The respondents who chose the other statements including “Not sure if the loan would be approved”, “The size or the maturity of the loan was insufficient for what I was considering funding”, “Interest rates were unfavourable”, and “Not sure whether I could service the debt” were classified as capital-constrained respondents.

3.13.5 Debt servicing structure and policy

The debt servicing structure and policy of the respondents was explored from two perspectives: the interest rate payment and debt amortization. The respondents were asked to indicate the percentage of their debt that was fixed and the percentage of debt that was set up as a principal and interest (P&I) loan. A series of questions also were asked to capture the importance (using Likert items from very low to very high) of different factors on the choice of fixed-rate loans versus floating-rate loans (statements 1 to 6 in Table 3-6), and the choice of P&I loans versus interest only (IO) loans (statements 7 to 11 in Table 3-6).

Table 3-6: interest rates risk management and debt repayment policy statements

Survey statement	Original context	Original Reference(s)
Forecasted interest rates at the time of borrowing	Agriculture finance	LaDue and Zook (1984)
Income volatility	SMEs	Vickery (2008)
The difference between fixed rate and floating rates loans at the time of borrowing	Agriculture finance	Leatham and Baker (1988)
The flexibility of making additional repayments on floating loans	Agriculture finance	Gray et al. (2014)
The flexibility of restructuring or exiting a floating loan	Agriculture finance	Gray et al. (2014)
Certainty over interest rates on fixed-rate loans	Agriculture finance	Leatham and Baker (1988)
The difference between the initial amount paid on table-mortgages and the initial amount paid on interest only-mortgages	Agriculture finance	Barry and Robison (2001)
The difference between the overall amount paid on table-mortgages and the overall amount paid on interest-only mortgages	Agriculture finance	Schnitkey and Novak (1989)
The higher tax deductibility potential for interest-only mortgages	Housing and real estate	Larsen et al. (2018)
Flexibility in the repayments for interest-only mortgages	Agriculture finance	Barry and Robison (2001)
The potential to borrow more on interest-only mortgages	Agriculture finance	Ellinger et al. (1983)

3.13.6 Liquidity reserves

The liquidity management structure and policy section of the survey was divided into two sub-sections: cash reserves and overdraft line of credit. First, the respondents were asked to indicate the statement that best described their cash reserve situation. The respondents then were asked to indicate the importance (very low to very high) of different factors in influencing the size of the cash reserves that they maintained (Table 3-7).

Table 3-7: Liquidity management policy statement

Survey statement	Original context	Original reference	Agriculture reference
The difference between the Interest rate received on cash reserves and the interest rate paid on debt	Corporate finance	Lins et al. (2010)	-
Having funds available when they are needed	Agriculture finance	Barry et al. (1981)	Barry and Robison (2001)
The time it takes to raise money when funds are needed	Agriculture finance	Barry et al. (1981)	Barry and Robison (2001)
The amount of undrawn financial overdraft available	Corporate finance	Lins et al. (2010)	Barry et al. (1981)
The size of the expected cash-flow deficit	Corporate finance	Lins et al. (2010)	Barry, Baker, and Sanint (1981)
A preference to self-fund	Corporate finance	Lins et al. (2010)	-

In terms of a credit line of overdraft, the respondents were asked to indicate the statement that best described the size of the overdraft that farmers had arranged. The respondents then were asked to indicate the importance (very low to very high) of different factors in influencing their choice of the size of the cash reserves they maintained (Table 3-8). The farmers were also asked to indicate the frequency with which they used their overdraft facility and the frequency with which they reached their financial overdraft limit. In order to gain greater insight into their overdraft line of credit, the respondents were asked to indicate whether they had applied for an extension to the size of their arranged financial overdraft facility over the past three years and whether over the past three years the respondents carried over their financial overdraft to the next year.

Table 3-8: Overdraft line of credit use policy statement

Item in the survey	Agriculture reference	Non-agriculture reference
The interest rates on the financial overdraft facility	Barry et al. (1981)	Lins et al. (2010)
The time it takes to raise funds through other sources of funds	Barry and Robison (2001)	Lins et al. (2010)
The amount of cash reserves that I hold	Barry et al. (1981)	Lins et al. (2010)

3.13.7 Financial management metrics and practices

This section asked the participants to respond to a variety of questions regarding financial record keeping and performance analysis practices and metrics, investment analysis/decision making, and capital acquisition metrics (see section 2.11.3). Statements in this section were adapted from previous questionnaire developed by Gloy and LaDue (2003) and Jackson-Smith, Trechter, and Splett (2004).

3.13.8 Perceived business environment uncertainty

This construct was developed to assess a farmers' perception toward the potential to gain or lose from a range of uncertainties, and the likelihood that they will gain or lose from this opportunity or threat (Shadbolt & Olubode-Awosola, 2016). A five-point scale (rare - almost certain) was used to measure the perceived likelihood of the uncertainty, and a five-point scale (very low - very high) was used to measure the perceived impact for each source of uncertainty (Shadbolt & Olubode-Awosola, 2013). The risk sources included in the questionnaire were based on recent surveys on dairy farm risk management (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2016), as well as Gray et al.'s (2008) review of literature. Perceived uncertainty scores for each uncertainty, for both opportunities and threats, was calculated by multiplying the scores for the perceived likelihood and the scores for the perceived impact for the different risk sources (Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2016).

3.13.9 Risk management strategies and practices

Farmers' opinions on a number of risk management strategies were asked in the qualitative phase of the study (see Appendix II). Taking the findings from this phase into consideration, the suitable questions to evaluate portfolios of risk management strategies are (see Table 3-10).

3.14 Survey data analysis

Data were entered into a database as the surveys were received. Responses were checked, and care was taken to avoid any mistakes in entering data and identifying inconsistencies while entering the data. Moreover, the results were examined to check the suitability of the gathered data, and questionnaires with insufficient data were excluded from the analysis. The data analysis process includes the five steps described in Table 3-9. Each step is explained in the following sections.

Table 3-9: A summary of the statistical analysis methods

Step(s)	Description	Analytical method
Step 1: Descriptive Data Analysis	Exploratory data analysis, cleaning and preparing data	Mean, standard deviation, boxplot, scatter plot, etc.
Step 2: Summarizing the Data	Identifying the underlying dimensions of the risk management strategies	Multiple Correspondence Analysis (MCA)
Step 3: Identifying portfolios of risk management strategies (PRMS)	Identifying clusters of farm businesses that apply similar portfolios of risk management strategies	Two-step Cluster Analysis (CA)
Step 4: Profiling portfolios of risk management strategies PRMS	Comparing the cognitive dimensions and socio-demographic characteristics of the clusters	ANOVA and χ^2 test for quantitative and qualitative supplementary variables, respectively
Step 5: Estimating the determinants of the choice of PRMS	The choice of one of the PRMS (dependent variable with six clusters); farm's biophysical characteristics, farmer's socioeconomics characteristics, risk preferences, risk profile perception to sources of uncertainty (independent variables)	Multinomial logit model

3.14.1 Descriptive data analysis

In the first step, the data was examined to evaluate the impact of missing data, identify outliers, and to test the underlying assumptions, including normality, linearity and multicollinearity (Hair et al., 2007). Methods such as multivariate profiling techniques were carried out to characterise the distribution of the variables and groups of variables (Hair, 2010). Following this, the extent of missing data was evaluated and a suitable imputation method, if needed, was applied to handle the missing data (Hair et al., 2007). Outliers were deleted from the collected data. Finally, the data was examined to check the normality, linearity, correlated error, and heteroscedasticity assumptions (Hair, 2010). After cleaning and preparing the dataset, exploratory descriptive statistical analysis was carried out on all variables to identify the nature of the data and to explore some of the relationships between the variables. All analyses were carried out in R-Studio version 1.1.4.3

3.14.2 Summarizing the data

A list of 22 potential risk management strategies were identified from the interviews and the literature: 17 of these variables were business risk management strategies (variable 1 to 17 in Table 3-10) and five variables were financial risk management strategies (variable 18 to 22 in Table 3-10).

Multiple correspondence analysis (MCA) is employed to summarise the risk management strategies and to explore the association between different risk management strategies. MCA is one of the members of the dimensional multivariate analysis family (e.g., factor analysis, and principal component analysis) that can be employed to reveal patterning in datasets when there is limited information about the nature of those patterns (Franco, 2016). As a generalization of correspondence analysis[1], MCA is specifically designed to provide a representation of the relationships between a set of categorical (i.e., nominal and ordinal) variables into a low-dimensional space (Friendly & Meyer, 2015; Greenacre, 2017; Husson, Le, & Pagès, 2017). The outputs of an MCA are inertias[2] (or eigenvalues) and percentage of inertia (or explained variance) for each relevant combination of variables and modalities, called dimensions.

There are two main data transformation methods for conducting MCA analysis. These are correspondence analysis on the indicator matrix[3] and correspondence analysis on the Burt matrix[4] (Franco, 2016; Greenacre, 2017). The outputs of MCA using these methods are almost equivalent. However, the transformation schemes create artificially inflated solutions and the inertias in these methods are underestimated. A correction is suggested by Greenacre (2017) that provides a sub-optimal estimation for the inertias (known as adjusted MCA method). Accordingly, in this study the inertia estimation is calculated using the adjusted MCA method (Greenacre, 2017).

[1] CA is an exploratory method designed to account for association (Pearson χ^2) between a set of categorical variables in a small number of dimensions.

[2] A relative measure of variance (χ^2 statistics) that indicates how much of the categorical information is accounted for by each dimension

[3] A matrix in which all categorical variables transforms into dummy columns for each category within the variables

[4] The set of all two-way cross-tabulations of the variables

Table 3-10: Risk management strategies that used to create risk management portfolios

	Description	Type	Code
Business risk management strategies	Feed reserves	**Nominal** (Y[1],N[2])	Y-Feed reserves; N-Feed reserves
	Not producing to full capacity	**Nominal** (Y,N)	Y-Buffer; N-No Buffer
	Grazing dairy stock off-farm	**Nominal** (Y,N)	Y-Graze off; N-Graze off
	Irrigation	**Nominal** (Y,N)	Y-Irrigation; N-Irrigation
	Owning a run-off	**Nominal** (Y,N)	Y-Runoff; N-Runoff
	Infrastructure for wet soil	**Nominal** (Y,N)	Y-Wet soil mgt; N-Wet soil mgt
	Futures markets to sell milk	**Nominal** (Y,N)	Y-Future mkt; N-Future mkt
	Contracts to procure inputs	**Nominal** (Y,N)	Y-Input contract; N-Input contract
	Spreading sales	**Nominal** (Y,N)	Y-Spread sale; N-Spread sale
	Use of contract and/or sharemilkers	**Nominal** (Y,N)	Y-SM/CM; N-SM/CM
	Employing experienced staff	**Nominal** (Y,N)	Y-Experienced staff; N-Experienced staff
	Providing training for staff	**Nominal** (Y,N)	Y-Train staff; N-Train staff
	Technology to reduce labour	**Nominal** (Y,N)	Y-Technology; N-Technology
	Good working conditions for staff	**Nominal** (Y,N)	Y-Work conditions; N-Work conditions
	Other enterprises on your property	**Nominal** (Y,N)	Y-Enterprise divers; N- Enterprise divers
	Geographical diversification	**Nominal** (Y,N)	Y-Geo diversity; N-Geo diversity
	Off-farm sources of income	**Nominal** (Y,N)	Y-Income diversity; N- Income diversity
Financial risk management strategies	Intended debt-to-assets ratio in the coming 5-7 years	**Nominal with 2 levels:** maintaining low debt (<30%) Not maintaining low debt	Intended debt level (low debt, high debt)
	Percentage of loans set up as fixed or floating	**Ordinal with 3 levels:** Predominantly floating rate loans (>70% of debt): floating Floating rate and fixed rate combined: floating & fixed Predominantly fixed rate (>70% of debt): fixed	Loan type: (floating, floating & fixed, fixed)
	Debt Amortization policy	**Ordinal with 3 levels:** Predominantly IO (>70% of debt): IO IO and P&I (31% to 69% of debt): IO and P&I Predominantly P&I (>70% of debt): P&I	Interest type: (IO, IO and P&I, P&I)
	Cash reserve size	**Ordinal with 4 levels:** No cash-reserve: no cash Covers short-term cash-flow deficits: short-term cash Covers cash-flow deficit over the year: a year cash Cover cash-flow deficit for more than one year: >1y cash	Cash reserve size: (no cash, short-term cash, a year cash, >1y cash)
	Overdraft line of credit facility size	**Ordinal with 4 levels:** No overdraft: No OD Covers short-term cash-flow deficits: short-term OD Covers cash-flow deficits over the year: a year OD Covers cash-flow deficits over more than one year: >1y OD	Overdraft size: (No OD, short-term OD, a year OD, >1y OD)

One of the main decisions in the MCA is the choice of the optimal number of dimensions to retain. Although, there is no clear rule for determining how many dimensions should be retained in MCA, different methods are suggested to define this (Lorenzo-Seva, 2011). The most widely used method is to retain and interpret two or three dimensions with the highest eigenvalues (Hair, 2010; Husson et al., 2017). The main rationale for selecting two or three dimensions is that graphical representation needs a single bi-dimensional or tri-dimensional map (Friendly & Meyer, 2015; Greenacre, 2017; Husson et al., 2017).

Lorenzo-Seva (2011) argued that a two- (or three-) dimensional solution is not a systematically optimal solution in MCA. Different rules have been recommended for identifying the optimal number of dimensions to retain. The first rule, adapted from PCA, is the scree plot test where dimensions are plotted in order of the decreasing amount of explained inertia. The point at which the scree plot shows a sudden decrease (called "elbow") can be considered as an optimal point (Husson et al., 2017). Another rule of thumb, suggested by Hair (2010), is to retain factors with inertias greater than 0.2. A third rule of thumb, known as the average rule, considered all the dimensions with eigenvalues that explain more than the average percentage of inertia (average = 100/(number of dimensions-1)) (Bendixen, 1995; Lorenzo-Seva, 2011). Finally, many researchers suggested that all the dimensions that have a coherent substantive interpretation should be retained regardless of the chosen rules and objective measures, because any findings would not be useful unless the solution makes sense (Hair, 2010; Lorenzo-Seva, 2011). For this study, a combination of the average rule and the interpretability of the dimension was used to determine the suitable number of dimensions to retain.

One of the strengths of the correspondence is its ability to turn large association tables (two-way cross-tabulations of the variables) into an easy-to-read low-dimensional map (i.e., two or three dimensions) (see Figure 3-4). The x- and y-axes are extracted dimensions from MCA analysis and the relative amount of variance explained by each dimension are mentioned next to the axes. The default map (called biplot[1]), depicts both rows' points[2] (observations) and columns' points[3] (variables) together (similar to a scatterplot). However, it is possible to select only rows' (observations) or columns' (categories of variables) points in low-dimensional maps. Because the main objective of this stage is to explore the association between risk management strategies, the maps in this part of the analysis only depict columns' points (risk management strategies in Table 3-10).

The interpretation of MCA is often based upon the position of the points in a bi-dimensional plot (Biplot). In a biplot, the vectors represent columns (categories of variables), when lengths of the

[1] "bi" in the term "biplot" refers to the fact that both rows and columns are displayed in a map (Greenacre, 2017)
[2] Called profile in a low dimension map
[3] Called vertex in a low dimension map

vectors from the origin of the biplot represent their contributions to the bi-dimensional plot (Vector B represents the x-axis dimension in Figure 3-4). The end point of each vector has the property that the high frequency categories are closer to the origin (in the Figure 3-4 vector B has the highest frequency). The proximity between levels of different categorical variables indicates that these levels tend to appear together in the observations (Abdi & Valentin, 2007; Friendly & Meyer, 2015; Nenadic & Greenacre, 2007). For example, vector A and vector B (representing variables A and B) are more likely to appear together. Moreover, the proximity between different levels of one categorical variable indicates that these two levels tend to be similar to each other.

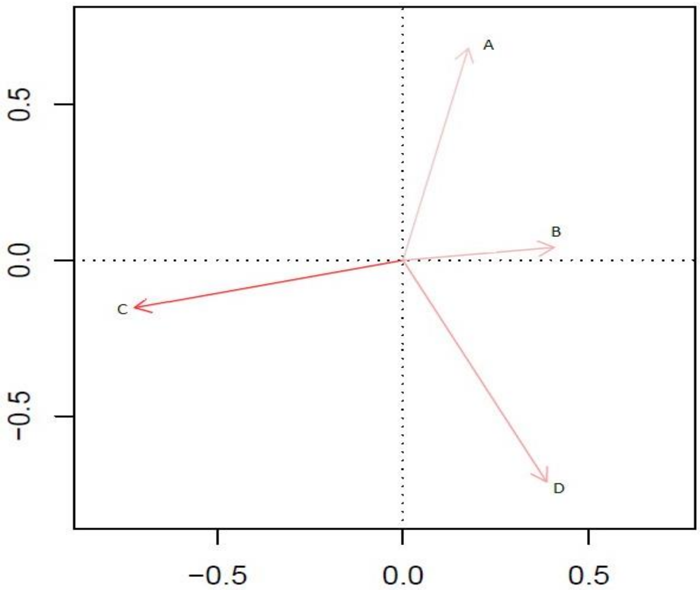

Figure 3-4: An example of MCA biplot

Initially, the relative positions of one set of columns' points (variables) on the first principal axis were used to give a conceptual name to the dimensions. This process was separately repeated for the other set of points for the second dimension. Then, the association between each variable was investigated using MCA maps.

A number of key characteristics help to interpret the maps provided by MCA. First, points near the origin[1] are less likely to contribute to the information contained in a particular dimension or in a map. That is, points near the origin are less likely to be discriminating attributes. Second, for a particular variable, the contribution of a category decreases as the marginal frequency in that category increases. Therefore, high frequency points appear close to the origin and are less likely to contribute to the information contained in a particular dimension or in a map. Third, vectors represent the column points from the origin. The use of vector enables the reader to easily compare the contribution of each category point when the length of the vector represents its contribution to the dimensions of the plot

[1] The origin is where the x- and y-axes are both at zero (The intersection of two axes lines).

(longer vectors implies higher discriminating power of the variable). Fourth, the inner products (as projections of the points onto the vectors) let the reader easily compare the proximity between two points in an MCA map. That is, the angle between vectors can be interpreted as correlation coefficients. The proximity between categories of different variables suggest that these levels tend to appear together in the observations (Abdi & Valentin, 2007; Friendly & Meyer, 2015; Nenadic & Greenacre, 2007). The proximity between different levels of a single categorical variable suggest that these two levels tend to be similar to each other. The MCA was carried out using "FactoMineR 1.41" (Lê, Josse, & Husson, 2008) and "factoextra 1.0.5" packages (Husson et al., 2017) to extract and visualize the output of MCA analyses, respectively.

3.14.3 Identifying portfolios of risk management strategies

This step of the analysis aimed to classify farm businesses based on the portfolios or risk management strategies that they apply to manage risks. Cluster analysis method is used to identify farms with similar portfolio of risk management strategies. The rationale for choosing this method is that it enables to create and considers the real-world simultaneity of farmer choice among risk management alternatives (Martin, 1996).

A tandem approach (Markos, D'Enza, & van de Velden, 2018) where the MCA output (in the form of a reduced dataset based on the retained MCA dimensions) is subjected to cluster analysis (CA) was employed for classifying the respondents based on their PRMS. A two-step approach is employed to create the cluster (Hair, 2010; Husson et al., 2017). First, a hierarchical agglomerative clustering algorithm using Euclidean distance and Ward's linkage method was employed to define the initial partition for k-means clustering (Hair, 2010; Husson, Josse, & Pages, 2010). Then, the cluster centres obtained from the hierarchical clustering was employed as the initial partition for k-means clustering. This method known as the "consolidation approach" (Markos et al., 2018) allows the researcher to balance the advantages and disadvantages of hierarchical and partitioning clustering methods (Hair, 2010; Husson et al., 2010).

Determining the number of clusters is one of the most critical issues in CA (Hair, 2010). Objectively speaking, the ultimate aim of clustering is to maximize intra-cluster homogeneity and inter-cluster heterogeneity (Hair, 2010; Husson et al., 2017). However, there is a trade-off between the number of clusters and the level of dissimilarity between clusters (Cichosz, 2014; Husson et al., 2017). As such, several statistical measures of heterogeneity are introduced and developed to evaluate the degree of heterogeneity in CA. Two of the most widely used method include: the percentage of change in heterogeneity, which is defined as "between cluster variance" (Hair, 2010; Husson et al., 2017), and the mean root square of the standard deviation (RMSSTD). RMSSTD is a measure of homogeneity within clusters (Hair, 2010). Regardless of the objective criteria used to determine the quality of clustering, choosing the number of clusters is a function of interpretability (Hair, 2010). A balance between the objective values of intra-cluster homogeneity and inter-cluster heterogeneity and the interpretability of clusters is required (Hair, 2010; Husson et al., 2017). For this study, a hybrid approach that considered both objective cluster indicators and the interpretability of clusters was used to decide upon the optimal number of clusters. The CA analyses in this section were carried out in R-Studio using “FactoMineR” package (version 1.41) (Husson et al., 2010; Husson et al., 2017; Lê et al., 2008).

Empirical studies employed different criteria to scrutinize the interpretability of clusters of risk management strategies. Meraner and Finger (2017) choose a prescriptive approach and adopted a theoretical framework offered by Van der Ploeg and Roep , to cluster and investigate the difference between farmers. According to this framework farmers were clustered into three groups of on-farm agricultural, on-farm non-agricultural, and off-farm strategies (Meraner & Finger, 2017). This perspective also was adopted by Nastis et al. (2019) to study Greek farmers’ management behaviour. Although using this approach proved to be useful in the aforementioned studies, it was not possible to adopt this approach for this study because there is significant structural difference between New Zealand dairy farming sector and farming in Europe (i.e., farm size, market structure, climatic differences etc.). Tudor et al. (2014) selected the number of risk management strategies that was used in each cluster as the criteria to label and analyse the difference between clusters (e.g., high tool use, moderately high tool use, moderately low tool use, and low tool use). The obvious criticism to this approach is that it is not possible to distinguish two clusters that have similar overall usage percentage rate but use different type of risk management strategies. Finally, Martin and McLeay (1998) examined the content of risk management strategies that is ranked important among the members of each cluster and labelled clusters accordingly (e.g., income spreaders, capital managers, part-timers, debt and market risk managers, and production managers). For this study, a combination of Tudor et al.’s (2014) and Martin and McLeay’s (1998) approach is adopted to choose and scrutinize the cluster solutions.

The chi-square test (Friendly & Meyer, 2015) was used to identify risk management strategies that significantly differed across clusters (i.e. portfolios of risk management strategies (PRMS)) . Given the fact that the chi-square test is omnibus[1] in nature (Agresti, 2002; Sharpe, 2015), a series of pairwise comparisons using Fisher’s two sided exact test with the Benjamini and Hochberg correction

[1] An omnibus test is used to test for the significance of several model parameters at once. If we reject the null hypothesis of an omnibus test, we know that at least one model parameter is significant. In this research, rejecting the null hypothesis means than there is significant differences between at least two of the PRMS.

procedure (Carlson, Heckerman, & Shani, 2009) was conducted to identify which PRMS differed from the others in terms of risk management strategies (Sharpe, 2015). All analyses were carried out in R-Studio, version 1.1.4.

3.14.4 Profiling portfolios of risk management strategies

A set of farm and farmer characteristics (based on the model provided in the 2.13) also were used to provide better inferences about the nature of farmers in each PRMS. This procedure, which is called profiling (Hair, 2010) was carried out by different bivariate techniques. First, cross-tabulation were made between each of the categorical variables (Table 3-11) and PRMS. This is then followed Pearson's chi-square tests to identify farm and farmer characteristics that were significantly differed across PRMS (Friendly & Meyer, 2015). A series of pairwise comparisons using Fisher's two sided exact test with the Benjamini and Hochberg (BH) correction (Carlson et al., 2009) also were conducted for post-hoc analyses (Sharpe, 2015). For continuous farm and farmer characteristics, One-way ANOVA test followed by Hochberg's Benjamini and Hochberg (BH) correction were used to identify differences across PRMS (Friendly & Meyer, 2015).

Table 3-11: Farm and farmer characteristics used for profiling PRMS

Type	variable
Continuous variables:	**Production (MS produced in 2016-17):** as a proxy for gross farm income
	Kg MS per ha: as a proxy for physical productivity
	Farm Stocking rate (cow per ha)
	Farm support block area size (ha)
	Farmers' financial risk attitude score (out of 15)
	Farmers' risk profile score (out of 25)
	Farmers' risk outlook score index (-1 to +1)
Categorical variables:	**Farmers' age:** 20-30 years; 31-40 years; 41-50 years; 51-60 years; 61-70 years; 71 years or more
	Farmers' education level: High school; Diplomas; University Degree
	Farmers' risk perception cluster membership (five clusters): Highly uncertain and balanced; Certain but pessimist; Slightly uncertain but optimist; Moderately uncertain and optimist; Certain and balanced
	Lifecycle stage of the farm business: Entry; Growth; Consolidation; Entry of next generation; Exit
	Farm Geographical location: Northland; Waikato; Bay of Plenty; Taranaki; Lower North Island; West Coast; Marlborough-Canterbury; Otago-Southland
	Farm business structure: Owner operator; with HOSMs; with manager; with VOSM; manging partner in an equity partnership
	Farm Input system: Low input (system 1&2); Moderate input (system 3); High input (system 4&5)

Bivariate techniques are useful for identifying the differences between PRMS in terms of farm and farmer characteristics. However, these techniques cannot be used when the aim of the research is prediction[1]. Therefore, in the next step a multivariate technique was employed to determine which variables could be used to predict membership in PRMS. Specifically, a multinomial logit model (MLM) was carried out to study the relationship between the membership in the PRMS and potential farm/farmers characteristics that are associated with membership in each of the PRMS (predictor variables) in a multivariate setup. All analyses were carried out in R-Studio, version 1.1.4.

3.14.5 Multivariate analysis

A multinomial logit model (MLM) was employed to explore potential association between membership in the PRMS as determined by the cluster analysis, and selected farm and farmer characteristics (Equation 1). A generalization of the binary logit model, MLM is a statistical model for estimating polytomous (i.e., multi-category) responses (Gujarati, 2015; Wulff, 2015).

$$y_{ij}^{*} = \beta_{ij} X_j + \varepsilon_{ij} \; and \; j = (1{:}\,n) \qquad Equation\ 1$$

$with\ y_i = vector\ of\ the\ individual\ i\ \ assgined\ to\ the\ specific\ portoflio\ of\ risk\ management\ strategies$

$X_j = vector\ of\ selected\ farm\ and\ farmer\ characteristics;$

$B_{ij} = vector\ of\ parameteres\ specific\ to\ the\ j_{th} alternative;$

ε_{ij} = *the error terms conditional on the predictor values*

The MLM estimation was implemented in two steps: In the first step, several models with different sets of predictors (independent variables) were compared to find the model with the best estimation fit. In the second step, the selected model in the first step was used for coefficient estimation (Moral-Benito, 2015).

Akaike Information Criterion (AIC) and Schwarz's Bayesian Information Criterion (BIC) are two indexes that are extensively used to obtain the 'best' model in the regression analyses (Burnham & Anderson, 2004; Gujarati, 2015). Both AIC and BIC provide comparison between models and their absolute values have no particular meanings, *per se* (Burnham & Anderson, 2004). The 'best' model would be obtained from the smallest values for AIC and BIC (Equation 2).

*AIC = -2*ln (likelihood) + 2*k,* $\quad Equation\ 2$

*BIC = -2*ln (likelihood) + ln (N)*k,*

where: k = model degrees of freedom; N = number of observations

Although these two indicators are very similar, they are based on different sets of assumptions and answer different questions. AIC tries to select the model that most adequately describes an unknown, high dimensional reality taking into consideration the sample size. The basic assumption in the AIC is

[1] Bivariate techniques are also useful for identifying the confounding effect of predictors in the model (see section 5.11.4.1)

that the real model for estimation is never in the set of candidate models being considered i.e., all models are an approximation of reality. The weakness of the AIC is that it frequently selects complex models over simpler models (Vrieze, 2012). In contrast, BIC tries to find the simplest model among the set of candidates that describes reality (the most parsimonious model) and heavily penalizes more complex models (Gujarati, 2015). There is no agreement on the choice between AIC versus BIC (Moral-Benito, 2015). Several studies show that the suitability of AIC or BIC depends on the design of the study, sample size, the research question, and the notion of a "true model" in the research context (Burnham & Anderson, 2004; Vrieze, 2012). Vrieze (2012) Monte Carlo simulations showed that when the true model is among the candidate models sets the BIC is a better indicator for suitable model. In contrast, the AIC is a more efficient index for finding the best model when the true model is not among the set of candidate models. For this research, the AIC is deemed most suitable because it was highly unlikely that the true model was among the set of candidate models.

After selecting models with the best estimation fit, the model described in the Equation 1 was used to test for the relationship between membership in the different PRMS and selected farm and farmer characteristics. Like the binary logit model, the coefficient returned by a multinomial regression is the logs[1] of the odds[2] ratio (which can take any value and has an approximately normal distribution). In a binary logit model (when the outcome variable has two levels A and B) the odds ratio (OR) describes the odds of being assigned to level A over the odds of being assigned to level B. Therefore, the interpretation of the OR is in relation to one of the level when the coefficients in that level is set to zero (called the base level or category) (Gujarati, 2015). In the Equation 3, the denominator (level B) represents the base level or category.

$$Odds\ Ratio\ (OR) = \frac{Odds_{level\ A}}{Odds_{level\ B}} \qquad Equation\ 3$$

The range of the OR is from 0 to infinity. An OR equal to 1.0 suggest that the chance of an event occurring or not is even. When the value of the OR moves away from 1.0 toward infinity, the chance of an event occurring increases. In contrast, when the value of the OR moves away from 1.0 toward zero the chance of an event occurring decreases (Gujarati, 2015). In other words, "whether an odds ratio is greater or less than 1.0 can be thought of as its sign" (Morgan & Teachman, 1988, p. 930). An important feature of the OR is that except for its "sign", it is invariant with respect to the ordering of

[1] Because it is difficult to interpret the results in the log form, the coefficients returned by a logit model are usually converted to an odds ratio.
[2] The odds are the probability that the event of interest occurs relative to the probability that it does not.

the variables. Therefore, in pairwise comparisons such as binary logit models , it does not matter which of the categories are chosen as the base category (Gujarati, 2015).

The interpretations of the odds ratio are different for categorical and continuous predictors in the logit models. Returning to the above example, for a continuous predictor (such as milksolids production), an odds ratio less than one suggests that a unit increase (one kilogram of milksolids) in the continuous predictor decreases the odds of being assigned to level A, *ceteris paribus.* In contrast, an odds ratio greater than one suggest that a one unit increase in the continuous predictor increases the odds of being assigned to level A, *ceteris paribus*. Finally, an odds ratio equals or close to one suggests that a one unit increase in the continuous predictor does not change the odds of being assigned to level A, *ceteris paribus*.

Categorical predictors have a slightly different interpretation because it does not make sense to use the rate of change for describing the odds ratio. For categorical predictors, a category of the categorical predictor needs to be chosen as the reference category and then the odds ratios is compared with reference to that category (Gujarati, 2015; Morgan & Teachman, 1988). Again, using the above example, for a categorical variable (such as gender when female is the reference category), an odds ratio less than one suggests that the odds of being assigned to cluster A for males is lower than the odds of a being assigned to cluster A for females, *ceteris paribus*. In contrast, an odds ratio greater than one suggest that the odds of being assigned to cluster A for males is higher than the odds of being assigned to cluster A for females, *ceteris paribus*. Finally, an odds ratio equals or close to one suggests that the odds of being assigned to cluster A is not different for males and females, *ceteris paribus* (Source: IDRE Statistical Consulting Group).

Although using odds ratios is a straightforward method for describing the coefficients in the binary logit models, it restricts the comparison to one selected base category in the multinomial logit models (Wulff, 2015). For example, in a MLM in which the outcome variable has four categories (e.g., Cluster A, Cluster B, Cluster C and Cluster D), the standard odds ratio method, as implemented in the binary logit model, would only provide three comparisons (any rows of Table 3-12) out of 6 possible comparisons[1] (Table 3-12).

This is a particularly important issue in this research for two reasons: first, there is no natural base category (Wulff, 2015) among the PRMS, and second, the main aim of MLM is to identify the statistically significant differences between all PRMS in terms of farm and farmer characteristics

1 As explained earlier, except for its sign, the odds ratios are invariant with respect to the ordering of the variables (i.e. OR1 = OR4, OR2 = OR7 and so on). Therefore, for this example, a thorough comparison between all categories only needs all the comparisons either above or below of the diagonal line.

considering all predictor variables. Therefore, a thorough understanding of the association between all of the categories was provided by varying the base category (Wulff, 2015). The MLM analyses were carried out using the "nnet" (Ripley & Venables, 2016) and "mlogit" package (Croissant, 2012) in R-Studio.

Table 3-12: Schematic Table of possible comparisons in MLM

Outcome variable(s)	Cluster A	Cluster B	Cluster C	Cluster D
Cluster A		$\mathrm{OR}_1 = \frac{\mathrm{Odds}_{\text{cluster B}}}{\mathrm{Odds}_{\text{cluster A}}}$	$\mathrm{OR}_2 = \frac{\mathrm{Odds}_{\text{cluster C}}}{\mathrm{Odds}_{\text{cluster A}}}$	$\mathrm{OR}_3 = \frac{\mathrm{Odds}_{\text{cluster D}}}{\mathrm{Odds}_{\text{cluster A}}}$
Cluster B	$\mathrm{OR}_4 = \frac{\mathrm{Odds}_{\text{cluster A}}}{\mathrm{Odds}_{\text{cluster B}}}$		$\mathrm{OR}_5 = \frac{\mathrm{Odds}_{\text{cluster C}}}{\mathrm{Odds}_{\text{cluster B}}}$	$\mathrm{OR}_6 = \frac{\mathrm{Odds}_{\text{cluster D}}}{\mathrm{Odds}_{\text{cluster B}}}$
Cluster C	$\mathrm{OR}_7 = \frac{\mathrm{Odds}_{\text{cluster A}}}{\mathrm{Odds}_{\text{cluster C}}}$	$\mathrm{OR}_8 = \frac{\mathrm{Odds}_{\text{cluster A}}}{\mathrm{Odds}_{\text{cluster C}}}$		$\mathrm{OR}_9 = \frac{\mathrm{Odds}_{\text{cluster A}}}{\mathrm{Odds}_{\text{cluster C}}}$
Cluster D	$\mathrm{OR}_{10} = \frac{\mathrm{Odds}_{\text{cluster A}}}{\mathrm{Odds}_{\text{cluster D}}}$	$\mathrm{OR}_{11} = \frac{\mathrm{Odds}_{\text{cluster B}}}{\mathrm{Odds}_{\text{cluster D}}}$	$\mathrm{OR}_{12} = \frac{\mathrm{Odds}_{\text{cluster C}}}{\mathrm{Odds}_{\text{cluster D}}}$	

Another issue in relation to using the odds ratios in MLM is that the odds ratio may be nonlinear and thus vary across the distribution of a single predictor variable. This could lead to invalid inferences about the findings from the MLM when the aim of the regression analysis is to determine the association between the predictor variables and the outcome variable. To overcome this issue, rather than using the odds ratios, the probabilities of being assigned to each category of outcome variable (membership in PRMS) at the mean values of the predictor variables can be computed (Gujarati, 2015). The probability plots, as suggested by Fox and Weisberg (2018), provide an intuitive way for presenting the probability of membership in each PRMS across the distribution of each predictor variable (Fox & Weisberg, 2018; Leeper, 2018; Wulff, 2015). The "margins" package (Leeper, 2018) in R-Studio was used to illustrate the probability plot of predictors (Leeper, 2018).

A critical assumption of the multinomial logit model is the Independence of Irrelevant Alternatives (IIA) assumption (Gujarati, 2015). IIA implies that the odds ratio of two alternatives is not influenced by the characteristics of any other alternative. If the IIA is violated, the MLM model is mis specified and its estimation results should not be used (Gujarati, 2015). The Hausman and McFadden (1984) test is used to test the IIA of the model. For this test, one (or more) of the clusters is excluded from the results and the model parameters are estimated for the remaining clusters. Then, by applying the chi square test, the results of the restricted MLM models are compared to the full MLM model (when the MLM is the true model). A significant test statistic rejects the assumption of IIA (Wulff, 2015).

Another important consideration in the categorical models, such as MLM, is the "perfect prediction". The perfect prediction happens when only one value of a predictor variables associated with only one value of the response variable. (Agresti, 2002). Apart from the fact that the inclusion of such predictors diminishes the model fit, it is quite possible that the MLM analysis produces implausible estimates of parameters (Cook, Hays, & Franzese, 2018; Cook, Niehaus, & Zuhlke, 2018). Surprisingly, the statistical packages that are used to implement MLM (mlogit and nnet) in this study, did not warn the user about the possibility of perfect prediction. Perfect prediction is extensively explained and well documented in the binary logit models (Agresti, 2002), and the remedy suggested for perfect prediction is exclusion of problematic variables from the model. However, if the problematic variables are excluded in the model, the interpretation of the model estimation should be done with caution (Cook, Hays, et al., 2018; Cook, Niehaus, et al., 2018).

Chapter Four: Qualitative Results and Discussion

The results from the qualitative phase of the research are presented in this chapter. The first section provides a brief background about the farming environment at the time that interviews were conducted. Section 4.2 to section 4.4 compares key characteristics of the farms and farming systems This include the farmers' socio-economic characteristics, as well as their personality characteristics such as risk attitude, perceptions of sources of risk along with the risk management strategies the farmers utilise to manage risk on their farms. In section 4.5, the new insights from the case study findings which informed the design of the survey for the quantitative phase of the study are explained.

4.1 The research setting

The 2015-16 seasonal conditions were moderate, beginning with a winter which was mild yet unpredictable at times for most of the country. Many areas experienced a dry spring due to El Niño spring conditions. Challenging spring conditions coupled with low milk prices and prospects of an El Niño summer meant that farmers culled cows early. The dry El Niño conditions did not persist throughout summer, and instead favourable seasonal conditions were experienced during the latter half of the season for most regions. Warm air from the tropics contributed to a warmer than average summer for most of the country which was accompanied by numerous rain events and humidity in some regions. However, the average rainfall in Lower North Island and South Taranaki remained relatively dry, influencing production. That is, the average rainfall for Taranaki and the Lower North Island were 53% and 25% lower than ten-year average, respectively (DairyNZ, 2017).

Fonterra's forecasted milk price at the beginning of the 2015-16 season was $5.25/kg MS (excluding dividend). However, during the season Fonterra revised this forecast which reflected an oversupply in global dairy markets throughout the season. The milk payout received by owner-operators was $4.30/kg MS. This figure shows an 11% decrease comparing to the previous (2014-15) season and was well below 10-year average of $ 6.16/Kg MS (DairyNZ, 2016).

Apart from the 2008-9 season (- 9.8%), the trend for land prices was generally upward since the 2001-02 season. However, in the 2015-16 season, land values dropped by almost 7.6 per cent. During the season, the Official Cash Rate (OCR), an indicator of interest rates, was reduced by 75 percentage points and reached 2.5 per cent, well below the long-term (from 2001-02 to 2015-16 season) average of 4.46 per cent (DairyNZ, 2017).

4.2 Farm and farmer characteristics

A cross-case comparison of farmer characteristics is presented in Table 4-1. Both farms are owned by married couples[58]. The couple on Farm A are in their forties and the couple on Farm B are in their sixties. Both couples have two children. Farmers A's children still live with their parents and are financially dependent on them, whereas Farmers B's children are mature and financially independent. The male partner on Farm A (hereafter Farmer A) and the male partner on Farm B (hereafter Farmer B) have been involved in the dairy farming business for over 30 years.

Table 4-1.A cross-case comparison of farmer characteristics (2015-16 season)

Parameter	Farm A	Farm B
Age		
Male	Late 40's	60's
Female	40's	60's
Children		
Number	2	2
Age range	15 - 17	Adult
Farming background	Yes	Yes
Year's dairy farming	31	36
Years as a dairy farm owner	16	26
Career trajectory	Dairy assistant Lower order sharemilker 50/50 sharemilker Farm ownership	Farm advisor in Thailand 50/50 sharemilker with parents Farm ownership Farm consultant in New Zealand
Stage of the farm family life cycle	Consolidation with a view to expansion	Entry of next generation with a view to expansion
Education	NCEA level 1 and Farm cadetship	Tertiary (Agriculture)

Both farmers bought their farms from their parents. Farmer A has 16 years of ownership experience and is at the growth stage of the business life cycle whereas Farmer B has 26 years of ownership experience and is at the entry of next generation stage of the farm business life cycle. Both cases recently expanded their businesses and are interested in further expansion within the next five years. In terms of education, Farmer A has school certificate and a certification in agriculture (farm cadetship) whereas Farmer B has a degree in agriculture.

For Farmers A, income from the farm business is the only source of income. The male partner works full time on the farm whereas the female partner is involved in the financial management of the farm (0.2 FTE). Farmer B has been working as a farm consultant for over 30 years. The female partner on Farm B is not officially involved in any of the farm business activities. Farmer B states that his personal interest is the main motivation for why he undertakes his consultancy job. However, in the earlier stage of the farm/business lifecycle income from his consultancy job was crucial to cover the family's

[58] On both farms, the male partners were interviewed. Therefore, information provided in this chapter largely reflects the male partners' point of view. The role of the female partners in each farm is explained during this section.

expenses in low milk payout seasons. Over the past 10-15 years, the consultancy position has been undertaken because it is a personal interest, and it has lost its importance as a means of covering family expenses because their children have become financially independent. As such, family living expenses are significantly lower. The dairy farm businesses has also been in a better financial situation making a higher operating profit and debt repayments have been reduced.

A cross-case comparison of farm business characteristics is presented in Table 4-2. Milking area in Farm A (226 hectare) is slightly larger than Farm B (220 hectares). For Farm A, the entire milking area is in a single block of land, whereas the milking area for Farm B is divided into two separate blocks of land about 10 minutes travelling distance apart. Farm A has a large support area (225 hectares owned, and 45 hectares leased). Some 140 hectares of support area (mostly hill country) is attached to the milking area whereas Farm B does not have a support block.

Both farms have a temperate climate with few frosts in winter, and an average annual rainfall of 1200 mm. However due to an uneven rainfall dispersion and free draining soils, Farm A is prone to drought in summer. In contrast, Farm B benefits from good rainfall dispersion along with a low frequency of droughts in the summer period and benign climatic conditions over the year (Table 4-2).

Topography and soil characteristics are quite different between the two farms. Farm A is spread over three terraces: the first terrace is 60 hectares (100 meters above sea-level), the second terrace is 136 hectares (around 110 meters above the sea-level), and the third terrace is 30 hectares (around 120 meters above sea-level). There are eight kilometres of river frontage, and up to 50 ha (22 %) of the milking area are prone to flood risk during spring, but also at other times of the year. In contrast, Farm B is mostly flat (50 to 60 meters above the sea) and has no risk from flooding (Table 4-2).

The soil types on Farm A are free draining Manawatu silt-loams that have high structural vulnerability and are prone to soil compaction and pugging damage. The soil type on Farm B is a well-drained Egmont brown-loam (volcanic ash-loam). In contrast to Farm A, Farm B can be grazed intensively with little decline in soil quality over the winter due to soil wetness. Olsen P levels on Farm A range from 40 to 45 (mg/kg) on the milking platform whereas on Farm B the Olsen P ranges from 50 to 60 (mg/kg) (Table 4-2)[59]. Pasture quality is estimated to be good on both farms. Farmer A stated that after each flood, he renews damaged paddocks with species that are able to establish quickly (*Italian ryegrass*). In contrast, Farmer B does not have any plans for pasture renewal as he believes the performance of his existing pasture species is as good as any of the new varieties.

[59] Optimum levels of Olson P range 30-35.

Farmer A runs a 701 cow predominantly Friesian milking herd while Farmer B runs 790 crossbred cow herd split across two farms (Table 4-2). The stocking rate on Farm A (3.0 cow/ha) is lower than Farm B (3.6 cow/ha)[60]. However, both case-farmers are running a relatively high stocking rate when it is compared to their regional average (2.7 and 3.0 cow/ha respectively). Farmer A are running a system four dairy farm regardless of the milksolids price. In contrast, Farmer B may adjust his system based on milksolids price. For example, in 2012-13 season, with a high milk price, he decided to change from a system two to a system three. However due to the significant drop in the milk price in the following year, he reversed his decision and returned to a system two.

Table 4-2. A cross case comparison of farming systems (2015-16 season)

Parameters	Farm A	Farm B
Number of milking platforms	One	Two
Milking platforms (eff. ha)	226	220
Runoff (ha)	270	0
(% Milking area)	119%	-
Irrigated area (ha)	136	0
(% Milking area)	%60	-
Rainfall (mm)	1200 mm	1200 mm
Altitude (m)	100-120	50-60
Soil Characteristics		
Soil type	Manawatu silt-loam	Egmont brown-loam
Olson p level	40-45	50-60
Herd size	701	790
Breed(s)	Predominantly Friesian	Friesian * Jersey
Stocking rate (cow/ha)	3.04	3.6
System type	3-4	2
Calving date	1st of July	15th June
Use of Once-a-Day milking	Late Summer	Late April
Planned drying off date	May to June	10th of May
Grazing		
Cows	No	Yes
Calves	No	Yes
R1yr heifers	No	No (grazier)
Milking herd wintered on milking platform (%)	10%	100%
Supplement made/brought in		
Maize silage (dry tonnes)	~ 125t	No
Grass Silage	100 t	Yes / Not Determined
Hay	400 bales	45 bales
Supplements bought in		
Palm kernel (tonnes)	250-350 t	20t
Proliq	-	200 t
Imported	20%-25%	10%-15%

Both case-farms are running a predominantly twice-a-day (TAD) milking system. Farmer A is milking the herd TAD until the late January. From late January, the bottom 25% of the herd goes onto once-a-

[60] Excluding calves and R1yr heifers.

day (OAD) milking and the top 75% of the milking herd goes onto a 16-hour milking. Normally, Farmer B is milking the herd TAD until drying-off. However, for 2015-16 season they have decided to change to OAD milking from mid-January because of a drought and a low milksolids price. Farmer A rears his replacement heifers on a 60-hectare runoff block whereas Farmer B rears his heifer calves on the milking platform and then contract a grazier to rear the R1yr heifers until they re-join the herd as R2yr heifers the following May (Table 4-2).

The winter grazing strategy is quite different between two case farms. Farmer A sends his milking herd off the milking platform mainly because the milking platform is susceptible to flooding and the soils are prone to compaction and pugging over winter. As such, some 90% of the milking herd on Farm A is wintered on the adjacent support area for six weeks. The scale of the runoff allows Farmer A to keep the majority of the milking herd on the support area adjacent to the milking platform during the winter period. In contrast, well-drained soils and temperate climatic condition allows Farmer B to retain the milking herd on the milking platform over winter without major soil damage (Table 4-2).

Both case-farmers grow feed supplements to balance feed supply and demand. However, the amount, type and the way the supplements are used are quite different (Table 4-2). Farmer A is importing approximately 20% to 25% of his total feed onto the milking platform whereas Farmer B is importing approximately 10% of his total feed. Again, availability of a large support area (270 ha) allows Farmer A to grow supplements on the support area. Farmer A grows approximately 125 tonnes (dry) of maize silage (60 ha runoff block), 100 tonnes of grass silage and baleage and 400 bales hay to supply the milking area (25 ha runoff block). Farmer B does not have a support block. As such, the only supplementary is feed harvested from surplus spring pasture on the milking platform.

In terms of purchased feed, Farmers A buy in approximately 250-350 tonnes of palm kernel per annum. The palm kernel is used to extend the lactation period over the autumn period. Farmer B buys in 200 tonnes of proliq[61] to balance feed supply and demand during the lactation period. Farmer B also buys in 20 tonnes of palm kernel to feed his replacements (Table 4-2).

The relatively large runoff owned by Farmer A also provides him with the opportunity to operate a beef finishing enterprise on the hillier country adjacent to the milking platform area. The decision to run a beef cattle enterprise was one of the consequences of the strategic decision to buy a support block for the milking herd. That is, part of the support block has a steep area that is unsuitable for dairy stock and forage cropping. As such, Farmer A decided to set up a breeding cow herd to utilise this land and he finishes surplus progeny which are then sold on the beef market.

[61] A by-product of the dairy processing industries which contains 38% dry matter (DM) and significant quantities of protein, minerals, vitamins and about 18% lactose.

A cross-case comparison of the dairy farms' physical performance is presented in Table 4-3. Both farms produced around 300,000 kilograms milksolids in 2015-16 season. On a per cow basis, both farms produce more milksolids compared to the regional average (13% and 4% respectively). However, milksolids production per cow (Kg Ms/cow) on Farm A was 11% higher than Farm B (432 and 387, respectively). In contrast, because of the higher stocking rate on Farm B (3.1 vs 3.6 cows/ha), milksolids production per hectare (Kg Ms/ha) on Farm B was slightly higher than Farm A (1340 Kg Ms/ha and 1390 Kg Ms/ha, respectively).

Table 4-3. Cross-case comparison of physical performance (2015-16)

Parameters	Farm A	Farm B
Effective area (ha)	226	220
Herd size	701	790
Total milksolids (2015-16)	303,000	306,000
Kg MS/Cow (2015-16)	432	387
Kg MS/ha (2015-16)	1,340	1,390
Stocking rate	3.1	3.6
6 weeks in calf (%)		70%
3 weeks submission rate (%)		90%
Empty rate (%)	11	9

To maintain pasture production over the summer period[62], some 136 hectares of the milking area on Farm A is irrigated (Table 4-4). Farmer A also has built a concrete stand-off area to feed up to 600 cows during flood events while Farmer B uses plastic tanks to store feed supplements (proliq). Both farms have herringbone milking sheds. Farm B has a herringbone shed on one of the milking platforms. Two years ago, the milking shed on the second property was upgraded to rotary shed with automatic cup removers (Table 4-4). Farm A has a dual oxidation pond system to manage dairy effluents. The effluent in the second pond (the storage pond) is used to irrigate 136 hectares of the milking area through a sprinkler system (8mm equivalent). Farm B also uses an oxidation pond for the storage of the dairy effluent, and this is discharged through spray irrigators onto 40 hectares of the milking area.

Table 4-4. Cross-case comparison of farm infrastructure

Parameter	Farm A	Farm B
Milking shed(s)	44 aside herringbone	1. 36 aside herringbone; 2. 44 Rotary shed
Irrigation	136 ha	No
Feed pad	Yes	No
Pastures	Good	Good

A cross-case comparison of staffing and the roles and responsibilities are presented in Table 4-5. All strategic decisions at the business level such as growth and acquisition are undertaken jointly (male

[62] The entire system (pond and 136 hectares of irrigation system) was installed when Farmer A bought the farm.

and female) on both farms. In terms of production decisions, the male partner on Farm A undertakes strategic and tactical decisions. Similarly, on Farm B, the male partner undertakes the strategic decisions. The sharemilker and Farmer B undertake tactical decisions, jointly.

The male and female partner on both farms undertakes financial management decisions jointly. The female partner on Farm A is responsible for the financial management of the farm (0.2 FTE) whereas on Farm B, the male partner takes the leading role in this. In terms of human resource management, the male partners take the lead role on both farms. On Farm A, the male partner recruits and manages the staff, whereas on Farm B, the male partner is responsible for finding a suitable sharemilker and arranging contracts (Table 4-5).

Table 4-5- A cross-comparison of staffing, roles, and responsibilities (2015-16)

Parameters	Farm A	Farm B
Roles		
Strategic Management	Joint	Joint
Human Resource	Joint	Farmer B
Finance	Joint	Joint
Accountancy and financial management	Female partner	ND
Production		
Pasture management	Farmer A	Sharemilkers (contract milkers)
Mating and herd management	Farmer A/Dairy assistant (1)	Sharemilkers (contract milkers)
Replacement rearing		
Calves and R1yr heifers	Dairy assistant (2)/relief milker	Sharemilkers (contract milkers)
R2yr heifers	Dairy assistant (2)/relief milker	Grazier
Winter grazing	Dry-stock manager	Sharemilker (contract milkers)
Staff	Herd manager (full-time) Dairy assistant (full-time) Dairy assistant (full-time) Dry-stock manager (full-time) Relief milker (part-time) Accountant (0.2 FTE)	Two sharemilkers (contract-milkers)
Cows/labour unit	167	N/A

The staffing situation is quite different between the farms, and this in part reflects differences in the farmers' goals and the farms' production systems. Farmer A employs a herd manager, two dairy assistants, and a relief-milker to milk the herd during the mating period. Farmer A also employs a dry-stock manager who is responsible for managing the runoff blocks (Table 4-5). Since Farmer B is interested in working outside the farm, variable order sharemilkers [63] were contracted to undertake the tactical decisions including pasture management, repairs and maintenance and milking tasks.

[63] Refers to any sharemilking situation where the sharemilker does not provide the herd. They provide the labour and receive an agreed percentage of the income, and cover some of the costs. They may provide a small amount of equipment such as bikes or tractors.

However, due to the low milk price in the 2015-16 season, instead of contracting variable order sharemilkers, Farmers B had decided to shift to a contract milking arrangement(s)[64].

For the 2015-16 season, the total value of assets and the debt to assets ratio of Farmer A were lower than Farmer B. Hence, the total liabilities of Farm A and Farm B are estimated at $21.54 /Kg MS and $24.68/Kg MS, respectively (Table 4-6). Farmer A stated that he recently bought a neighbouring block, which increased his debt ratio by 10%, whereas Farmer B stated that he is preparing to buy another piece of land soon.

Table 4-6: A cross-case comparison of assets and liabilities (2015-16 season)

Parameters	Farm A	Farm B
Assets	13,590,223	14,820,000
Liabilities		
Term Loan	6,540,827	8,000,000
Overdraft facility size	Not arranged	200,000
Debt-to-assets	48.1%	54.6%
Debt-to-equity	92.8%	114%
Total liabilities ($/Kg MS)	21.57 $	24.68 $

The cost structure and financial performance of the farms are presented in the Table 4-7. Due to the different operating structure (Owner operator vs contract milking), it is difficult to compare the profitability of the case farms. For Farmer A, income from farming constitutes more than 90 per cent of the total income whereas for Farmer B, off-farm income constitutes about 20 per cent of the total revenue.

Table 4-7: A cross-case comparison of farm income and expenses (2015-16 season)

Parameters	Farm A	Farm B
Revenue ($/ Kg MS)		
Milk sales	3.94 $	4.20 $*
Livestock Sales	0.30 $	0.03 $
Off-farm income	0.13 $	0.95 $
Expenditure ($/ Kg MS)		
Farm Working Expenses (FWE	3.41 $	4.35 $**
Debt servicing	0.78 $	1.56 $
Drawings	0.34 $	1.05 $
Cash surplus/deficit (excluding tax)	(0.16) $	(1.81) $

*Including Fonterra support payment (0.30 $)
** Including contract-milking expenses

Farmer A had relatively lower cost structure when it compared to Farmer B, which mostly reflects the costs associated with contract milkers. In the middle of the 2015-16 season, Farmer B decided to change the variable order sharemilker arrangement to contract milking arrangement (see previous

[64] A contractual arrangement where the contractor managing the property is paid on a set price per kg MS produced. A contract milker (CM) typically provides the labour, and pays for shed costs, electricity, transport and sometimes a share of the feed and nitrogen costs.

section). The main motivation for this decision was to provide financial support for the VOSM during the downturn. Farmer B did not work out the exact farm working expenses and the numbers provided in Table 4-7 is an estimate. As such, care must be taken when comparing the farm working expenses.

Debt serving expenses ($/ Kg MS) for Farmer B was twice that of Farmer A. Similarly, the drawing taken by Farmer B were about three times that of Farmer A on a per kilogramme milksolids basis. This is despite the fact that Farmer A had two young adult children that were financially dependent. The relatively higher drawings reflect the lifestyle and family lifecycle stage of Farmer B. Farmer B stated that at this stage of his family lifecycle, he was not willing to constrain his lifestyle and enjoyment. Therefore, one thing that he would do when preparing budget is to make sure that he and his partner would be able to have a good holiday.

Both case-farmers stated that they do not save cash reserves in their accounts for unexpected events, but rather arrange an overdraft credit facility to cover potential cash deficits. Farmer A has not used this facility for a long period of time and could not remember the size of their overdraft facility. In contrast, Farmer B relies on his overdraft facility. In 2015-16, Farmers B reached their overdraft limit and converted the overdrawn money into a term-loan.

4.2.1 Risk preferences

Before the interviews, the case-farmers were asked to respond to a series of questions in relation to risk attitude and during the interview the case-farmers were asked to elaborate on their responses (see section 3.7.1.1). In terms of risk profile, Farmer A fits the “competent conservative” risk profile whereas Farmer B closely resembles the “experienced but cautious” risk profile (Table 4-8).

Table 4-8: The Case farmers’ risk profile

	Farmer A	Farmer B
Within a season, I am able to manage almost all uncertainty that occurs.	Able[65]	Neutral
Over the long term, I am able to manage almost all uncertainty that occurs.	Able	Able
I find planning difficult because the future is so uncertain.	Don't	Neutral
When there are a number of solutions to a problem, I find it difficult to make a choice.	Don't	Neutral
When it comes to business, I like to play it safe.	Neutral	Do

According to Shadbolt and Olubode-Awosola (2016) the “competent conservative” and “experienced but cautious” categories are not alerted to opportunities to maximise their profit. However, the case-farmers showed degrees of alertness to opportunities. Farmer A seeks out opportunities to maximize his profit even in risky situations. His decision to buy land (investment decision) is an example of his ability to seek out opportunities. He stated that he postpones farm expansion to periods of downturn

[65] Based on the Shadbolt and Olubode-Awosola (2016) terminology.

in the dairy sector. Although servicing debt in these periods is challenging, it is more likely that Farmer A can purchase land at a low price.

An example of Farmer B's alertness to opportunities at the strategic level is his milking strategy. Farmer B stated that he is quite interested in changing from TAD milking to OAD milking for the entire season, and he believes it would be a more profitable system in the long-term. However, he would only do this if the sharemilkers accepted a share of the risk related to possible losses during the transition period.

A cross-case comparison of the case farmers' relative risk aversion scores are presented in (Table 4-9). The overall scores showed that Farmer A believes he is willing to take more risks in comparison to other dairy farmers while Farmer B believes he is neutral in relation to his willingness to take risks (Table 4-9).

Table 4-9: A cross-comparison of case-farmers' relative risk aversion

	Farmer A	**Farmer B**
I am willing to take more risks than my colleagues with respect to production issues.	Agree (4)	Neutral (3)
I am willing to take more risks than my colleagues with respect to market issues.	Neutral (3)	Neutral (3)
I am willing to take more risks than my colleagues with respect to HR issues.	Neutral (3)	Neutral (3)
I am willing to take more risks than my colleagues with respect to financial issues.	Agree (3)	Neutral (3)
Overall score- Relative risk aversion (out of 20)	**14**	**12**

The choice of a high stocking rate is an example of a risky decision in relation to production. When Farmer A bought the original block of land from his parents, he decided to increase the stocking rate because he wanted to achieve higher production per hectare. This is a risky decision because Farm A is naturally exposed to climatic risks such as drought and flooding. Farm B is running a stocking rate of 3.6 cow/ha. He stated that a considerable number of dairy farmers with a similar bio-physical environment run a lower stocking rate system. However, he also believes that there are other dairy farmers with a similar bio-physical environment who have chosen to run a higher stocking rate system and take on more production risk to increase their profit. As such, he ranked his business as "neutral" in relation to his willingness to take production risks.

The strategy to purchase inputs was an example that was used to elaborate farmers' responses in relation to the market risk attitude statement. Farmer A is using a combination of contract and spot purchasing strategies. The majority (70%) of the bought-in feed is purchased by contract. The remaining 30% of the bought-in feed is purchased through the spot-market. Farmer A stated that 70% of the palm kernel is typically is required within a season. As such, by buying it on contract, he ensures that the feed will be available. Farmer B also procures his bought-in feed through a contract as the feed supplement he normally buys (Proliq) is not available on the spot market and must be purchased on contract.

Both case-farmers believe they are neutral in relation to their willingness to take on risk with respect to the human resource management field (Table 4-9). However, they achieve this through different strategies. Farmer A carefully chooses his staff and delegates responsibility according to the employees' capabilities. He also closely monitors his employees' activities. However, he is not comfortable delegating responsibility. For example, he stated that although one of his employees is more capable than him in mating management, he still closely controls the mating tasks. In addition to this, Famer A stated he would never delegate grazing rotation decisions. Farmer B contracts two variable order sharemilkers to perform production and HR tasks. As such, his main influence is in relation to the recruitment and retention of his sharemilkers. The sharemilkers are responsible for tasks such as milking the cows, running the farm, and the day-to-day allocation of feed. The variable order sharemilkers are also responsible for the recruitment and retention of the other staff on the Farmer B's dairy farms.

The above results revealed that using numerical risk attitude measures cannot adequately address the nature and the extent of famers' risk-taking in different fields. That is, although the case-farmers' human resource risk attitude scores were similar, they chose a completely different human resource management strategy (see Table 4-5) and accordingly were facing different types of risks and utilised different set of risk management strategies.

A cross-case comparison of the financial risk-taking attitude is presented in Table 4-10. The overall financial risk attitude score for Farmer A is higher than Farmer B. That is, he believes he is willing to take more risk in terms of financial decisions. However, the debt-to-asset ratio and debt/Kg milksolids (as proxies for financial risk-taking) of Farmer A is lower than Farmer B. In fact, the debt-to- asset ratio and the debt servicing costs of Farm B are slightly higher than the North-Island average (50%).

Table 4-10: A cross-comparison of case-farmers' financial risks taking

	Farmer A	Farmer B
I am more concerned about a large loss in my farm operation than missing a substantial gain.	Neutral	Agree
I do not like to take risky decisions concerning my farm.	Disagree	Agree
I take challenges more often than other dairy farmers do.	Strongly Agree	Neutral
I postpone investments until they really need to be done.	Disagree	Disagree
I am not afraid to borrow money to undertake investments that can enhance profitability.	Strongly Agree	Strongly Agree
Overall score- Financial risk-taking attitude (out of 25)	**21**	**16**

During the interview, Farmer A stated he would not delay an investment decision if the analysis showed that he can increase the profitability of his farm and service the debt. However, at the time of the interview, he believed that he has limited scope to further improve on-farm profitability and he has decided to focus on expansion options. Similarly, Farmer B is looking to expand the business for two main reasons. First, he believes he has a reasonable amount of equity which will allow him to borrow more money. The second reason is that his son has decided to start dairy farming within the family business and as such he needs to expand the operation.

Comparing financial risk-taking scores with the responses during the interview revealed an interesting point. While Farmer A has lower debt and a higher debt coverage ratio, his financial risk-taking score was higher than Farmer B. When asked to elaborate on the financial decisions and the associated financial risk-taking scores, both case-farmers indicated that their responses were referring to milk solids production, and accordingly income volatility between the seasons. That is, Farm A is located in a relatively difficult biophysical environment (e.g., drought in summer, flood in winter, heavy soils prone to pugging and relatively difficult contour to farm). As such, milksolids production can vary from one year to another. Given this variability in milksolids production, Farmer A believes the current level of debt (48%) is a risky level. Likewise, Farmer B stated that he is aware that the current level of farm debt (54%) is higher than the sector's average. However, he believes that this level of debt is not too high because the biophysical characteristics of the farm (e.g., flat land, fertile soil, low probability of drought and flood) allow him to run a profitable business with the current level of debt and even increase debt by approximately 10 per cent. The next section provides an overview of the case farmers risk perceptions.

4.2.2 Risk perception

Before the interview, the case-farmers were asked to answer a series of questions in relation to their perceptions of the different sources of uncertainty enabling a risk choice matrix for each case farmer to be created. The responses in the written questionnaire were probed in the interview and the case-farmers were asked to elaborate on their responses.

The source of risk inside the arrow of attention for both cases is presented in Figure 4-1. The overall results of the risk choice matrix and risk perception section reflect the fact that Farm A is located in a summer dry area and bounded by a river that regularly floods whereas Farm B is situated in a benign climate where production is relatively stable across years. Farmer A perceived milk price as an important source of risk that creates both opportunities and threats for his business, whereas for Farm B none of the uncertainties were perceived as a threat. Instead, many sources of uncertainty were perceived as an opportunity for his business (see β in Figure 4-1).

During the interview, the case-farmers also discussed other sources of risk that are perceived as important in their businesses. Farm A is bounded by a river which regularly floods. As such, Farmer A stated flooding as the single most important threat to his farm. In particular, flooding during early lactation would have a severe adverse effect on farm production. Drought is another important threat to his farm business. Farmer A expects to confront both risks within a season and has a rough estimation on the likelihood and the potential impact of these threats on his business. He also implemented a range of risk management strategies to mitigate the impact of these uncertainties. In contrast, Farmer B mentioned that the favourable biophysical environment of his farm is a factor that enables him to build a competitive farming system. For Farmer B, the eruption of a nearby active volcano is the most important threat. Farmer B stated that because this is an extremely unlikely event, he has not done anything about it[66].

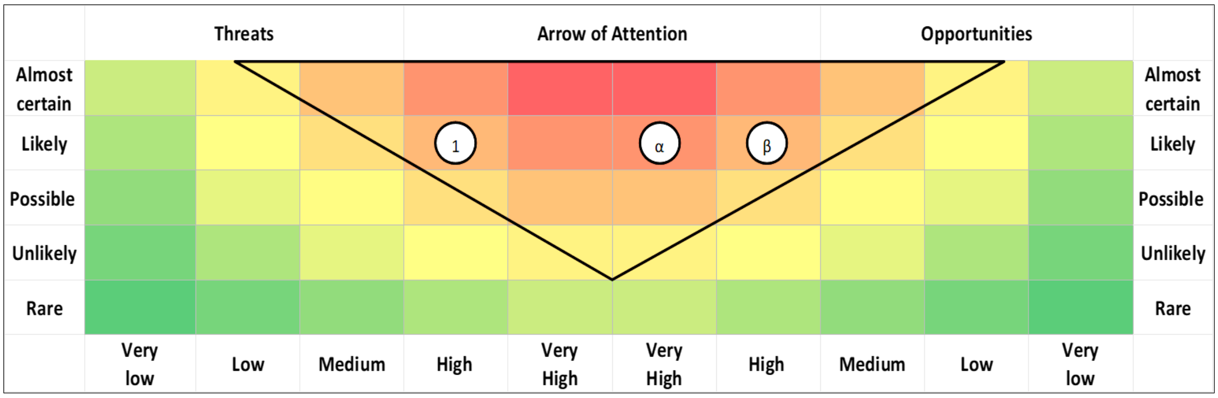

Figure 4-1: Case-farmers' Risk Choice Matrix

Farmer A's threats:
1 Milk prices.
Farmer A's opportunities:
α Milk prices.
Farmer B opportunities:
β Pasture/crop/ animal health; interest rate; Availability of capital; skill and knowledge of those associated with the business; Technological changes; Business relationship with input providers; Dairy industry structure; The global economics and political situation; Global supply and demand; Global competitors and competition; Reputation and image of dairy industry; Government laws and policies; local body laws and regulation;

Farmer A stated that the dairy market is cyclical. As such, he is expecting low milksolids prices in 2-out-of-5 years. He also added that there are a range of uncertainties that he puts into the basket to do with milk price uncertainty. These include global competition, global supply and demand, and the political and economic situation in the world. Specifically, Farmer A believes that although global demand will increase in the coming 3-5 years, the removal of EU milk quotas will increase the supply of dairy products. However, he believes the cooperative nature of the dairy industry partially mitigates the risk of milk price volatility.

Farmer B acknowledges that in the short-term, milk price volatility can be a moderate source of uncertainty. However, he believes that the structure of the dairy industry and the favourable biophysical environment of his farm will help his business to maintain its competitive advantage over the long-term. As such, other sources of uncertainty such as the global economics and the political

[66] Farmer B admits that after a recent major earthquake in another part of the country he is increasingly worrying about this risk.

situation, global supply and demand, global competitors and competition, and the reputation and image of the dairy industry are perceived as opportunities.

Both case-farmers acknowledge that interest rates at the time of the interview were at a record low. As such, they perceived it as an opportunity for their business growth plans. However, Farmer A also perceived interest rate volatility as a moderate threat because he recent bought another piece of land and increased his debt ratio by 10% to approximately 47%. In contrast, Farmer B believes that even at a 54% debt ratio, the interest rates are still favourable for his business. Again, this reflects the fact that Farm B's production is relatively stable between years.

The image of dairy farming is another threat for Farmer A. Although he believes the actions taken by Fonterra to mitigate this threat have been effective, he stated that these actions are not enough, and he is expecting to see more actions from other dairy processing companies to improve the image of the dairy farming industry. Finally, local body regulations are another threat for Farmer A. He has been confronted with this threat for several years particularly because the farm is in a sensitive catchment area and beside a river. Local body regulations and laws are perceived as an opportunity for Farmer B. He has been a member of the regional council for over a decade and believes participation in the process of decision making on environmental issues helps him and other dairy farm businesses to raise their concerns over the regulations and effectively negotiate with the local regulatory and legislation body. The next section compares case farmers' main risk management strategies across different management fields.

4.3 Overview of risk management strategies

This section outlines the case-farms' business strategy and major factors and associated strategic decision that are shaping it. An overview of the risk management strategies across the different fields of management including production, marketing, human resource and financial management will then be presented (section 4.3.2 to 4.3.4). Before the interview, the case-farmers were asked to answer a series of questions in relation to their risk management strategies. The responses in the written questionnaire were probed during the interview and the case-farmers were asked to elaborate on their responses in the written questionnaire. The decisions covered in each of these sections aligned with the decisions discussed in the literature review chapter (sections 2.10 and 2.11, respectively).

4.3.1 The case farmers' business strategy and associated risks

The biophysical characteristics of the case farms and the personal goals and preferences of the case farmers are two major factors that shaped the case farms' business strategy (See Table 4-2). Farm A is located in a relatively unfavourable biophysical environment and exposed to different risks including flooding risk during the winter and spring period, and drought risk during the late-summer and early autumn period. The physical characteristics of the soil and land topography (contour) expose Farm A to soil compaction and pugging damage risks. In contrast, Farm B benefits from relatively favourable biophysical environment. Good rainfall dispersion combined with a low risk of droughts in summer and flat land with naturally fertile and free-draining soils allow Farmer B to retain the milking herd on the milking platform during the winter period with minimum soil compaction and pugging risk.

Both case farmers have a number of personal goals and preferences. Farmer A's focus has been on farm business expansion. However, after the recent land acquisition (finalised less than three months before the interview), Farmer A's attention turned to the consolidation of the business. Farmer A stated that due to increase in the size of the operation and his age, he won't be able to undertake day-to-day tasks anymore. As such, he is planning to focus on the managerial aspects of the farm operation and delegate the day-to-day tasks to employed staff.

Farmer A: *"I love being in the shed, but I can't do every milking anymore because I've got to be doing other stuff. So, maybe to spend more time running the business rather than working on it. With staff, I can deal with that".*

Farmer B is a full-time farm consultant and utilises contract milkers to undertake the day-to-day tasks in the farm business. Personal interest is the main motivation as to why Farmer B undertakes this consultancy job. Farmer B is in the entry of next generation phase of the business lifecycle, and the main priority is supporting the next generation during the transition period. He is also focusing on lifestyle for himself and his wife. As such, at the beginning of each season, he makes sure that there is enough money for a decent holiday during the Christmas and winter periods for himself and his wife.

One of the most important factors that shapes the overall business strategy of Farm A is wintering decisions. The poor quality of winter grazing in the region and a high probability of pugging on the milking platform means that Farmer A was not able to maintain the majority of milking herd on the milking platform throughout the winter (see section 4.2). Farmer A stated that rather than using a grazier for wintering his herd, he chose to buy support blocks and maintain the milking herd there during the winter period. This decision eliminates Farmer's A reliance on a grazier and its associated market and contractual risks (see section 2.10.1.3.2):

Farmer A: *"I have 100% control over my destiny without having cows going out for grazing and coming home thin or our grazier letting me down or anything like that. When you have got full control, you got flexibility as well".*

The decision to buy support blocks provides other advantages for Farm A including the ability to grow supplementary feed for the milking herd. However, purchasing a support block increases the financial risk associated with the servicing the debt for the purchased support block. To mitigate this recently created financial risk, Farmer A decided to set-up a beef finishing enterprise on the support block and hired a dry-stock manager to run his support blocks.

Setting up a beef finishing enterprise mitigates the financial risk associated with debt servicing of purchased support block. However, it exposes Farm A to new risks in the form of human resource risk associated with hiring a dry stock manager, and the financial risks associated with the dry stock manager's salary and the cost of setting up a beef finishing enterprise. Considering all risks and benefits, Farmer A believes acquiring support blocks provides profit for the business at the aggregate level[67].

Flooding during the spring periods is another risk on Farm A. The milking platform on Farm A has 7 km of riverbank, and in the case of extreme flooding, up to 50 hectares of the milking platform can be flooded. Farmer A implements a range of strategies to manage this risk. First, he has built a concrete stand-off area that can accommodate and feed up to 600 cows during flood events. The stored feed - 500 tonnes of fresh maize silage[68] - is large enough to feed the milking herd for up to 15 days. Farmer A stated that this is the amount of time that is required for fixing possible damages (access ways, fences, pasture) after a moderate to excessive flood event.

Drought during the summer and early autumn period is another important production risk on Farm A. Drought management strategies can be classified into two categories: strategies that increase feed supply, and strategies that reduces feed demand (Gray et al., 2014). For Farmer A, the most important strategic decision is to increase feed supply by installing and utilising an irrigation system. Approximately 60% of the milking platform on Farm A is irrigated. The irrigation system was present when Farmer A bought the farm. So, he had no control on the type of the irrigation system or the irrigated area, initially.

The use of irrigation normally starts mid-summer to maintain pasture quality. The availability of irrigation water becomes critical for pasture growth during the late summer and early autumn period. Farmer A stated that without irrigation, it is probably impossible to set up a dairy farming enterprise on his land. However, he had no plans to expand the irrigated area because the water holding capacity of the soil on the remaining 40% of the milking platform is higher than the current irrigated area. As such, there is no need irrigate the rest of the farm.

Farmer A bought in between 250 to 350 tonnes of feed supplements - PKE in particular- to increase feed supply during the late summer and autumn period (Table 4-2). The decision to utilise PKE depends

[67] Farmer A did not undertake a full investment analysis for each of the support blocks as an independent business unit. However, he believes even as an independent business unit, each support block yields a good return on investment.

[68] Approximately equal to 120 tonnes of dry maize silage.

on the milk price and the marginal profit from producing extra kilograms of milk solids (see section 4.3.5). Hence, Farmer A utilised a range of tactics including adjusting milking intensity and lactation length to mitigate the late-summer drought risk with the choice of tactics dependent upon milk price (see section 4.3.2).

4.3.1.1 *Operating structure*

The operating structure of the farm was another major factor that shaped the case farms' business strategy. Farmer A works full-time on the farm and is responsible for all the decisions at every level (i.e. operational, tactical, strategic) across the different fields of management. In contrast, Farmer B's personal interest in working outside of the farm, as an agribusiness consultant, means that he needs to bring a contract milker to undertake tasks such as herd, pasture, and staff management.

Contracting a sharemilker transfers the risk associated with undertaking these tasks to the contract milker (Shadbolt & Martin, 2005). However, it exposes Farmer B to new types of risks. First and foremost is the risk associated with finding, contracting, and retaining a skilled contract milker.

Farmer B: *"Employing sharemilkers is easier for me because they are independent contractors, and I am off the farm a lot. I am employing a contractor to take care of the business like milking the cows, running the farm, the day to day allocation of feed and staff management".*

Farmer B stated that perhaps the most significant risk is the failure of the contractors to fulfil his or her obligations. As such, finding a suitable contractor is critical for the survival of the business. The risk has been increased over the recent years because the number of good contractors is declining and the competition for attracting high quality contractors is high. Farmer B utilises a range of strategies to attract and contract suitable contractors. Building a reputation as a good farm owner is the first step to attract quality contractors:

Farmer B: *"You are trying to build good name as good farmer who looks after them [contract milkers]. I mean the first thing is if you advertise, you want people to think 'that farmer is good, and I am happy to go and share milk for that farmer".*

Farmer B stated that the decision to replace the old dairy shed with a new rotary shed with automatic cup removers is an example of a strategy that he utilised to attract better contractors. That is, the new shed makes the business more attractive for contractors because it requires less staff and allows contractors to take more time off during the early morning milking shifts.

To make sure that he can attract capable contract milkers, Farmer B starts the process of finding a contract milker early in the season so that he gets first pick of the best candidates. The selected candidates will be invited for an interview and a farm tour will be arranged by Farmer B to help them understand the biophysical characteristics of the farm and its infrastructure. The contractor's referees are normally contacted to verify the applicant's suitability in terms of herd management (animal health and welfare) and their maintenance of farm assets. Attitude to other people in the dairy farming sector and evidence that they are passionate about the dairy industry are other criteria for selecting applicants.

The selected applicant will be asked to read the contract and understand the duties and obligations specified in the contract. Farmer B meet with the selected applicant and clarifies the clauses in the contract. He stated that during the first year of the contract, he monitors the activities and performance of his contract milkers and supports contractors in the tasks such as grazing management and animal health management. However, he never gets involved in tasks such as staff management and milking:

Farmer B: ***"****When anybody first comes on the farm, it's very much my way. I believe we have a good system and I want them to farm how I believe is the best way to farm and I make that really clear it is my way. But after the first couple of seasons, I am happy to let them try other ideas as long as they are not too radical. We are talking about more fine-tuning. So, they do have the opportunity to have influence over how things go".*

Farmer B also implemented a range of strategies to retain contractors. Supporting contractors in low milk price years through changing the contracts arrangement is an example of a strategy he uses to retain his contractors. Farmer B believes that maintaining a long-term relationship with his contractors is more important than short-term profit. During the 2015-16 season, Farmer B agreed to change from a sharemilking to contract-milking arrangement to support his contractors when faced with a low milk price.

Farmer B: *Because the payout was so low and so uncertain, we believed that we had to offer him [contractor] a contract to take out the variability of the dollar amount and the payout ... If we identify good people that are able to maintain our business going forward, then we will do what we think we need to, to retain them in the business.*

sharemilking is a risk-sharing arrangement that reduces the farm owner's exposure to milk price risk (see section 2.5.1.4). However, the above statement highlighted that for Farmer B, reducing milk price risk is not a motivation for utilising a contract milking arrangement. Instead, Farmer B decided to accept the low milk price risk and support the contract milkers to maintain long-term relationship with them. This latter strategy mitigates the contractual risk associated with finding and retaining suitable contractors.

4.3.1.2 *Farm production capacity*

The operating structure of case farmers has direct impact on the case farms' utilised production capacity[69]. In the written questionnaire, Farmer B indicated that 'not producing to full capacity' is a risk management strategy. However, during the interview, he stated that this response was not referring to the current production system and infrastructures. That is, it may be possible to adjust the production system and increase the farm profit and return on assets.

Farmer A believes that the current production system is highly profitable, and that he already pushes the production system to its limits. As such, increasing production (more milksolids) by investing in infrastructure and changing the production system may diminish the marginal profit and decrease farm returns (a lower return on assets). In contrast, Farmer B believes that given the biophysical characteristics of his farm, he would be able to increase production while maintaining the current marginal profit and improve total farm return (a higher return on assets). However, he stated that he prefers a production system that requires less control because it aligns with his personal preferences and lifestyle:

Farmer B: *"I want a system that is more resilient in terms of bringing in independent contractors and me being off the farm if I want to go overseas for three months. I mean, having say, a feed pad makes a system more demanding, more intensive, and animal health is a little bit more challenging in that system. I think we have got a system that is sustainable, and I am happy with that".*

Again, the farmers personal goals and preferences can explain the difference in a farmer's view about farm production capacity and the spare capacity in the production system. Farmer A closely controls all the operations on the farm and tries to minimise any errors as soon as he notices them. In contrast, Farmer B's willingness to work off-farm means that he has less control over the farm operations and needs to contract someone to undertake the tactical and day-to-day operations such as pasture and herd management. He stated that finding a contract milker or lower order sharemilker that can manage an intensive production system is extremely difficult. Therefore, running a simpler, less intensive production system allows him to reduce the risk of not being able to find a suitable contract milker, and mitigate the risks associated with inability of a contract milker to fulfil their obligations.

4.3.2 Production risks and risk management strategies

As explained in the previous section, owning support block enabled Farmer A to retain the milking herd on the support block over winter and avoid the risk associated with soil pugging damage. His support blocks also allow Farmer A to grow supplements to feed the dairy herd during the early spring

[69] Total carrying capacity = Utilised capacity + Spare capacity

and late summer period when feed demand exceeds pasture supply. Besides, the cost of winter grazing and growing supplements on support block(s) is lower than contracting a grazier or purchasing feed supplements. Therefore, Farmer A reduces the financial risk associate with higher farm working expenses.

Farmer A buys in between 250 to 350 tonnes of supplementary feed - PKE in particular- to increase feed supply during the late summer and autumn period (Table 4-2). He also implements a range of strategies to reduce feed demand during a drought. The first strategy is culling cows early in the season. The decision in relation to milking intensity is another important strategy to reduce feed demand during a drought. Normally, Farmer A utilises a TAD milking interval from calving until the end of January (late summer). From February, the milking interval for the bottom 25% of the milking herd (low producing cows) is shifted to OAD. For the remaining 75% of the milking herd, Farmer A normally utilises a 16-hour milking interval regime until the end of February. Farmer A stated that every week he decides about the numbers of cows that need to be dried off. The available pasture on the farm, the remaining amount of stored feed, and the forecasted weather during the week are three factors that determine the milking interval regime. The last mobs of milking cows are normally dried off in June. The availability of the adjacent support block provides flexibility for Farmer A to gradually dry-off the milking herd and send the herd to the support block.

For Farm B, drought is a low probability risk. As such, Farmer B normally keeps milking the herd TAD until the drying-off date. The decision on the numbers of cows that need be dried off is mostly driven by the cows' condition. However, for 2015-16, he decided to change to OAD milking from mid-January because he experienced dry condition over summer in combination with historically low milk prices (see section 4.3.5).

4.3.3 Market risks and risk management strategies

Both case farmers had contracts with the Fonterra milk processing company and the contractual arrangement and milk price received by both case farmers were similar (See section 2.5.1.2). However, there were differences between the case farmers' inputs, marketing management strategy and its associated risks. Primarily, the case-farmers' market risks reflected the case farms' production system and its intensity (see section 2.10.2.2). Although Farmer A grows a significant proportion of supplements on his support blocks, due to his relatively high stocking rate (relative to the carrying capacity of the land), he still has to buy in almost 10% of his total feed as palm kernel from the market. Buying supplements expose Farm A to market risk in the form of input availability and price risk. To mitigate these market risks, Farmer A decided to procure a large proportion of palm kernel (almost 70% of the total purchased supplement) on contract. The main rationale for contracting 70% of the purchased supplements lies in the fact that this amount would normally be utilised within a season and the remaining 30% of the purchased supplements would be used to cater for possible feed deficits throughout the season, in other words the downside risk (see section 4.3.3).

Farmer A: "*Normally we bought about 70% on contract and 30% on the spot market… If in Waikato and Taranaki is a big drought, they will suck up the entire palm kernel in the North Island. So, this is critical for us.*

Farmer B is facing the contractual risk related to raising replacement dairy stocks. The replacements on farm B are maintained on the milking platform until about six to eight months after weaning. After this period, a grazier would be contracted to rear the R1yr heifers for about six months. Farmer B stated that contract grazing the younger aged heifers is too risky because normally graziers are not skilled enough to meet the liveweight targets he has set. As such, he prefers to maintain the heifers on the farm for at least eight months after weaning to make sure that the heifers' rumen is developed, and they have reached a suitable size.

Farmer B: "*It is very difficult to find good grazing for the very young animals. We used to do that and about every two years I have to find someone else because, they let me down or something happens, or something goes wrong. So, I just decided that we keep them here".*

To manage the contractual risk arising from contracting heifers grazing, Farmer B is trying to select good graziers and build a long-term relationship with them. He also stated that he normally visits the heifer mobs twice during the contract to make sure that the heifers are meeting target liveweights. In terms of feed supplements, Farmer B also purchases supplements (Proliq) to make sure enough feed is available in the early spring period. However, the purchased supplement is not available on the spot market and must be purchased on contract.

4.3.4 Human resource management risks and risk management strategies

The human resource management strategies reflect the case farmers' personal goals and the farms' production systems. Farmer A is running a highly efficient production system that produces close to the full carrying capacity of the land (see section 4.3.1). Although this production system maximises farm returns, it is not without its drawbacks. To maintain farm efficiency, Farm A requires close control and constant supervision at tactical and operational levels, which exposes Farm A to managerial risk. That is, the farm business is heavily reliant on Farmer A's managerial capability and finding a replacement to run and control the operation is a risk if he becomes incapacitated.

The decision to produce to full capacity exposes Farmer A to other human resource management risks. The most important risk is related to the recruitment and retention of competent staff. Farmer A carefully selects farm staff and delegates responsibility according to the employees' capabilities. He also closely monitors his employees' activities. However, he is not comfortable delegating responsibility. For example, he stated that although one of his employees is more capable than him at mating management, he still closely controls the mating tasks. In addition to this, Famer A stated he would never delegate grazing rotation decisions.

Farmer B transfers the human resource management risk to another by bringing in contractors to undertake the tasks related to human resource management. This includes evaluating staff requirements, staff recruitment, competency and motivation, health and safety, and discipline and grievances:

Farmer B: *"Contractors are responsible for task management, relief time, H&S [Health and safety], and policies. I am employing a contractor to take care of the business. So, I don't want to be dealing with relief staff and organising time. As opposed to if I employ a manager, I am responsible to employ staff and taking care of that. I am employing a contractor and I ask him to do that".*

The above statement shows that Farmer B uses independent contractors (whether a contract milker or a sharemilker) so that he does not have to undertake operational management or manage staff. As such sharing the milk price risk is not a motivation for Farmer B to employ contract milkers.

4.3.5 Financial risks and risk management strategies

Both case farmers are using a range of financial management strategies to ensure the survival and profitability of their farm businesses. These strategies can be divided into two categories: managing expenditure, and debt management strategies.

4.3.5.1 *Managing expenditure*

There are two main categories of expenditure in a dairy farm business: operating expenditure and capital expenditure. Achieving marginal profit through adjusting the lactation duration and milking intensity regime was the first operating expenditure related strategy. Both case farmers stated that normally the lactation period and milking intensity is a function of pasture availability and cow condition. However, the case farmers had a different view on the impact of milk prices that reflects the case farms' production systems and operating structures.

Farm A is a low-cost, to a large extent self-sufficient system where about 60% of the milking platform is irrigated. Approximately 90% of the available feed is produced inside the farm (either on the milking platform or the support block), and PKE is the only purchased feed supplement (Table 4-2). In high milk price seasons, Farmer A would utilise the purchased supplement (PKE) to extend the lactation period. However, in the 2015-16 season he decided to stop using the previously purchased supplement

(PKE) to ensure that marginal expenses of the feed did not exceed the marginal revenue obtained from its use. Farmer A also decided to dry off low producing milking cows a month earlier than normal (early-January), to reduce feed demand[70]:

***Farmer A:** "If you control your cost year on year regardless of payout, you will know that in really bad years you make a small loss... In the good years, you probably exploit increase in the milk price by not changing your cost structure because straight away you are making 100% profit on every extra dollar that they give you and you make really good profit".*

Similarly, Farmer B reduced farm operating expenditure through adjusting milking intensity and lactation period to ensure his marginal costs did not exceed his marginal revenue. During the summer of 2015-16, even though he was anticipating that the pasture would be available to feed the milking herd, Farmer B decided to shift to OAD milking earlier than usual because he had to pay contractors a fixed amount per kilograms of milk solids while the milk price was quite low:

Farmer B: "*If things are normal, we continue milking cows twice-a-day until around 10th of May. But last summer [due to] low milk price and costs, the profit was still marginal. We just felt that for our system and for our contractors it was a good strategy to go OAD milking early".*

The above statement also highlights another aspect of this decision that is supporting contract milkers (see section 4.3.1.1).

Deferring other expenditures such as fertiliser and repairs and maintenance (R&M) expenses (e.g. fences and machinery) is another strategy to reduce farm operating expenses (Langemeier & Featherstone, 2018). Nevertheless, the case farmers' view on utilising this strategy was different. Farmer A believes that it is not a viable strategy because delaying R&M expenses would cost more over the long run:

***Farmer A:** "I always keep up with the maintenance. If you keep up with your maintenance in the poor years, you are spending 10 dollars now, but you save 100 dollars later. I could reduce them [R&M] for one year or may be two, but [over the] long term you are still going to spend the money. So, it's smart to keep up with that".*

In contrast, Farmer B stated that he would postpone these expenses until he had a high profit year:

Farmer B: "*In good years, I am quite happy to put extra phosphate on knowing that in these soils that it is going to sit there for a long time and then in the bad payout years, we can withhold phosphate*

[70] Farmer A stated that if he takes non-cash operating expenses (unpaid labour and depreciation) into account the business would not be profitable (negative operating profit).

and know that we built up the level of phosphate and we can mine it to an extent…It is like putting money in the bank, I suppose".

Another group of strategies was related to deferring capital expenditure (machinery, fencing, pasture renewal, land improvement etc.). Farmer A believes that, regardless of the farm's financial situation in a particular season, it is important to replace machinery right after the end of its useful life. As such, Farmer A spent a considerable amount of money on capital items to replace farm machinery in the 2015-16 season. Due to the operating structure of the farm business (owner with contract milker), Farmer B does not own any machinery. However, he stated that he would normally postpone capital expenditures (such as fencing) until a high profit season.

Finally, both farmers stated that the decision to acquire land is different from other capital expenses for two reasons. First, the opportunity to acquire a property may happen once or twice in lifetime. Second, buying land is a lifetime investment that requires a significant amount of debt funds. Therefore, both case farmers stated that dealing with land acquisition requires a different set of financial management strategies that will be discussed in section 4.3.5.3.

4.3.5.2 *Liquidity management*

Maintaining liquid assets is another widely cited financial management strategy to manage short-term cashflow deficits for a farm business (see section 2.11.1.3). Neither of the case farmers were maintaining cash reserves to cope with possible cashflow deficits. During the interview, the case farmers stated that debt repayment is the reasons why they do not maintain cash reserves:

Farmer A: "*We sort out cash reserve in a sense that we are paying off debt. I normally have a two-year cash flow in front of me. If we don't need the money in the cash-flow, that's taken off debt".*

Farmer B stated that from a financial point of view, it is better not to maintain cash in the bank account while having debt because the interest rate on savings (cash reserves) is lower than the interest rate on loans:

Farmer B*: "At the time [of cash surplus] what we did was we weight everything up and then we paid off our debt ... if you do the sums if you have cash reserves, you may get 2% interest, if you are lucky, while you have to pay 5% on debt. So, we are better to pay off debt".*

Both case farmers arranged an overdraft line of credit for possible cashflow deficits. However, the extent to which this facility was utilised was different between farmers. Farmer A could not remember the last time he utilised an overdraft line of credit. Hence, he did not know the exact limit of his overdraft. In contrast, Farmer B had relied on overdraft in the earlier stages of his farming career and knew the size of his overdraft limit. The difference in the extent of use and the size of overdraft line of credit reflect the case farmers' cashflow position. Farmer A has close control over the costs and is less likely to have cashflow deficit within a season. In contrast, Farm B is more likely to face cashflow deficit within the season. As such, Farmer B reliance on overdraft line of credit is higher than Farmer A.

Farmer B: "*In our younger days, we were quite heavily reliant on overdraft. At that date, credit was harder to get. Nowadays we would rather [be] using overdraft for up to 50,000 dollars. We have got a limit of 200,000 dollars. But we purposely are trying to keep the capacity".*

The above statement also highlights that Farmer B is exclusively using overdraft line of credit to cover cashflow deficit. However, due to credit unavailability, he used to rely on overdraft line of credit for both medium-term investments and managing cashflow deficits within the season. Relatively higher interest rates is the main reason why Farmer B is not using overdraft line of credit for medium-term investment. So, for the medium to long-term projects he prefers to use term-loans:

Farmer B: "*We don't have money in the bank, but we are financially strong enough to borrow money. If we know there are some medium or long-term projects, we will go to the bank to borrow money at a lower interest rate. But for short-term variability we are happy to use our overdraft because there are not a lot of difference between these two in terms of the overall costs and opportunity costs".*

The above statement highlights that the overdraft line of credit is a substitute for cash reserves to cater for cashflow deficits in the short-term. Having financial flexibility (in the form of untapped borrowing capacity) was the main reason that let Farmer B had access to funds for medium to long-term projects. Financial flexibility is closely associated with the farmers' decision on debt levels and their debt management strategies, which is covered in the next section.

4.3.5.3 *Debt management*

The results from the written questionnaire highlighted that debt management is a very important risk management strategy for both case farmers. During the interview it became evident that debt management entails different dimensions including the choice of debt ratio (debt-to-assets ratio), the debt repayment strategy, and interest rate management strategies. These are discussed in the following sections.

4.3.5.3.1 Farm capital structures and the drivers of farm debt level

The decision about debt level (leverage ratio) was the first and most important dimension of the case farmers' debt management strategies. Risk preference scores in the written questionnaire indicated that Farmer A tends to take on more financial risk when it compared to Farmer B (Table 4-10). However, comparing the case farmers' debt ratio and debt servicing expenditure showed that Farmer

B had more debt (Table 4-6) and higher debt servicing expenditure (Table 4-7). During the interview, it became evident that several factors, other than risk preference, are important in relation to a farmer's choice of debt levels.

Both case farmers stated that the ability to service debt over the long-term was the first important factors in the choice of debt level. Breakeven milk price was the main index that the farmers constantly referred to during the interview to determine the maximum debt servicing capacity of their farm businesses. That is, the case farmers calculated the total cash expenditure per kg milk solids (farm working expenses, interest, tax, and drawings) to work out whether they were able to service the debt. Farmer A recently bought a neighbouring block of land and projected a 22 cents/kg MS increase in his debt servicing costs for the next season (approximately \$1.00 / Kg MS), and stated that he was not willing to increase his debt beyond this point. In contrast, Farmer B believed that he would be able to service a greater amount of debt than he currently held (\$1.56 / Kg MS) by about 35-40 cents/kg MS (approximately \$2.00 / Kg MS). This might be explained by the fact that Farm A is located in a relatively hostile biophysical environment where milksolids production and cashflow can be highly variable from one season to another. In contrast, Farm B is located in a relatively benign biophysical environment where the milk production and the associated cashflow is less volatile between seasons. As a result of differences in cashflow volatility, the case farmers' view on their ability to service debt are different.

Financial flexibility, in the form of untapped borrowing capacity, was the second important consideration in terms of farm debt levels. Farmer B stated that untapped borrowing capacity enabled them to survive when milk price dropped below the farm's breakeven point in 2015-16 season:

Farmer B: "*Because we are sitting on 54 percent [debt ratio], we could go to the bank and they would lend us money to make us stay viable for maybe a couple of years. We have done it over the past from time to time particularly when there was a downturn".*

More importantly, Farmer B stated that the untapped borrowing capacity enables him to seize new investment opportunities as they come along. This is because the opportunity to acquire a property may happens once or twice in a lifetime, and maintaining financial flexibility is crucial to being able to capture this opportunity when it arises:

Farmer B: "*If I go beyond 60 percent [debt ratio], I know that would make me more vulnerable in terms of not having the flexibility to go to the bank and get finance for short-term projects".*

The ultimate goal of financial flexibility is to makes sure that farmers have access to funds at a low cost in a timely manner. The case farmers stated that maintaining a strong relationship with their bank manager[71] is another crucial part of the farm's financial flexibility:

Farmer A: "*The first one [before debt ratio] is to keep a really really strong business connection with the bank manager. They are a critical part of the business, so I have to keep a really good communication flow with them".*

Farmer B provided some examples of developing and maintaining relationship with bank manager:

Farmer B: "*It means being upfront with them… doing the figures, doing the budgets rather than relying on them to do the budgets. Sitting down with them and making sure that everything is correctly calculated".*

While both case farmers had a similar view about the importance of financial flexibility and credit availability, their view on debt repayment over the long term (i.e., debt loading) was different. The availability of a range of mortgage products allow the case farmers to control the extent and pace of debt repayment (see section 4.3.5.3.2). Farmer A is trying to pay down debt as soon as possible, whereas debt repayment is not a priority for Farmer B. This difference can be partly explained by the case farmers' beliefs about their maximum borrowing capacity. That is, Farmer A believes that he is operating at near his maximum borrowing capacity and he is willing to repay debt whereas Farmer B believes that he can increase his debt level by up to 10 percent if any investment opportunity arises.

The case farmers' personal goals and lifecycle stage of the farm business were other reasons why they had different views on debt repayment. Before the last land acquisition, Farmer A was in a growth stage and his philosophy was to be prepared to buy neighbouring blocks when they become available. As such, he was focused on paying down debt. In contrast, Farmer B is at the entry of next generation stage of the business lifecycle and his personal goals (e.g., purchasing a holiday house, travel etc.) are more important than capturing long-term investment opportunities. As such, he is not aggressively focused on debt repayment.

Farmer B: "*I guess my security is not so much aggressive debt repayment. It is more thinking, let us enjoy life. We have got family that may want to come into the business over time and the debt will be there for them. That might be a little bit harsh, but if we pay debt more aggressively all we do is set the business up better for our family. I mean we constrain our living and our enjoyment while we are paying debt".*

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[71] Bank manager, accountants, and lawyers are important actors in the web of influencers that shape farmers' financial management decisions. However, it is beyond the scope of this research to look at the relationship between farmers and other actors including bank managers.

Tax considerations are another reason why Farmer B is not aggressively trying to repay debt:

Farmer B: "*I have a bit of a philosophy where I would rather pay interest than tax. If I am paying interest, that interest bill helps me to grow my asset. But if I am just sitting still and paying off lots of debt, I am going to pay lots of tax. That is part of the role around debt loading. It is one of the reasons and it certainly does have some impact. If interest rates were at a different level, that might change things. So, interest rates are having quite a bit of impact".*

As highlighted in the above statement, the interest rate is another consideration that influences the farmers' choice about the` debt loading of the farm business. That is, at higher interest rate levels farmers tend to borrow less and repay the principal as fast as possible.

4.3.5.3.2 Debt repayment and debt amortisation strategy

The previous section highlighted the case farmers' views on the targeted debt ratio over the long-term. A range of different debt amortisation products are available to achieve this target ratio (see section 2.11.1.2). Both case farmers were using interest-only (IO) loans as the main strategy to manage debt loading. The flexibility of the principal repayments was the main reason why the case farmers preferred interest-only loans. That is, interest-only loans enabled the case farmers to match principal repayments with the cash flow position of the farm business:

Farmer A: "*If we end up with a cash surplus at different times of the year and we can see it is a genuine surplus we just go and pay off chunks of debt ... We have had periods where we paid no principal, and periods where we chewed up a massive amount of debt".*

Farmer B also stated that using interest-only loans also let them seize investment opportunities when they arise.

Farmer B: "*We don't believe that we need a fixed discipline of paying principal every month. We are happy with the flexibility of our repayments. As soon as we have some extra money, we will pay off debt. Unless we have some new project … We are looking at the prospect of paying off debt against any of investment that we might make".*

As highlighted in the previous section, tax considerations are another important factor in the debt ratio decision. Again, the availability of interest-only loans enabled Farmer B to implement the intended debt ratio strategy. The next section addresses another dimension of farm debt management, interest rates risk management.

4.3.5.3.3 Interest rate risk management

Another important dimension of debt management was the decision in relation to interest rate risk management. Both case farmers stated that they are constantly monitoring the official cash rate (as a proxy for interest rate) and make decisions based on the yield curve (as an indicator of future interest rates). Because the Interest rates were at the record low and expected to either drop or remain stable, both cases were only using floating-rate loans at the time of the interview. However, Farmer A has extensively utilised fixed-rate loans in the past when interest rates were relatively high:

Farmer A: "*All the debt is floating***.** *I started off way back in the 90's with floating and we were up at 17% at one stage. Been there and felt the pain, so we went for fixed. We started using fixed interest rates from probably around 2003-04 to about 2011-12. But we keep monitoring it. If its look like we are heading to a period where interest rates look like again skyrocketing, we will fix them".*

The cashflow position of the business is another factor that impacts on the choice of their interest rate risk management strategy. Farmer A stated that he completely stopped utilising fixed-rates loans when he felt that the business cashflow was strong enough that could withstand minor interest rate volatilities.

Similarly, Farmer B switched between fixed rate loans and floating rate loans based on the macro-economic signals:

Farmer B: "*It is completely floating. Well, we went fixed many years ago and that was fine because the interest rate was climbing. We may fix some in the future, but a lot of indication has been shown that we are in a fairly low interest rate environment at the moment, and we have been for sometimes".*

Finally, the case farmers stated that interest rates can have a considerable impact on a farmer's decision to engage in an investment activity. The case farmers stated that when evaluating investment opportunities, it is prudent to consider the average and the volatility of the interest rates over the long-term (approximately 10-years). Hence, they consider the outcomes of interest rate volatility on debt repayment ability. That is, both farmers used a simplified version of sensitivity analysis to determine the impact of interest rates volatility on the cashflow situation of the farm and decide about the percentage of their loans that needed to be arranged as a fixed-rate loan.

4.3.6 The association between perceived risk and farmers' risk responses

One of the challenges in interpreting the results of the written questionnaire was the mismatch between farmers' risk perceptions and the implemented risk management strategies. In the written questionnaire, Farmer A indicated that climatic risks (such as drought and flooding) are relatively less important risks for the farm business. However, the during the interview it became clear that farmers are utilising a wide range of risk management strategies at both the strategic (e.g., buying support block, building feed pad area etc.) and tactical (e.g., feed reserves) levels to manage climatic risks. When asked to clarify, Farmer A stated that climatic risks can potentially have severe negative impact on the overall survivability of the farm business. However, he employed a range of strategies to manage the impact of climatic risk on the farm business. These strategies enabled Farmer A to successfully manage climatic risks. As such, Farmer A responses in the written questionnaire reflected his beliefs about the residual climate risk (the remaining risk after implementing his existing risk management strategies). Farmer A managed climatic risks by trading them off for the debt risk associated with building a feed pad area and acquiring a support block (financial risks). As such, responses in the written questionnaire reflected Farmer A's risk perception after the risk-risk trade-offs that happened as a result of implementing those strategies.

4.4 Summary of qualitative phase of the study

The findings presented in this chapter provided an in-depth view of the case farmers' risk management portfolios. Initially, the qualitative findings highlighted how the biophysical characteristics of the farm and the case farmers' goals and preferences shaped the strategic direction of the farm business (Boehlje et al., 2003; Boehlje & Roucan-Kane, 2009). The strategic direction of the farm business, in turn, defined the key risks that the case farmers chose to take as well as the risks that farmers decided to avoid (Martin & Shadbolt, 2005).

The case study provided insights that helped to clarify why farmers might use some risk management strategies and not others. For example, Farmer B's decision to work off-farm (personal preferences) required him to bring in a contractor or sharemilker to undertake the day-to-day tasks on the farm (e.g., herd and pasture management and staff management). During the interview, it became evident that the main motivation for choosing the contracting arrangement was to avoid staff management risks (Gardner & Bennett, 2011; Payne et al., 2007). As a result of this decision, Farmer B deliberately chose to avoid (risk avoidance (Miller et al., 2004)) human resource management risk, but this decision exposed the farm business to the contractual risk associated with finding and retaining contract milker(s). As such, rather than utilising strategies to manage human resource management risk (e.g. recruiting and retaining staff), a range of risk management strategies were implemented to mitigate the risk associated with attracting, contracting, and retaining a suitable contractor (Gray et al., 2014; Greenhalgh & Tipples, 2013). This supports the notion proposed by Harwood et al. (1999) and Miller et al. (2004) that farmers at strategic level may make trade-offs between risks.

Not producing to full capacity is a well-known strategy for managing risk within the farming system (Díaz-Solís et al., 2009; Gray et al., 2009; Ingrand et al., 2007; Nozieres et al., 2011). In the written questionnaire, one of the case farmers (Farmer B) indicated that they were utilising this strategy. However, during the interview, it became evident that in their responses they were not referring to the current farm system. The case farmer stated that by changing the infrastructure (such as irrigation, feed pad etc.), he could extend the farm's production capacity and accordingly increase farm profit and return. In contrast, the other case farmer (Farmer A) stated that even with changing the farm infrastructure he would not be able to improve farm profitability and return (return on assets). However, within the boundaries of the current production system, both farmers were producing to full capacity. The potential misinterpretation of the statement by respondents is likely to result in misleading conclusions being drawn from the survey results. As such, the statement in the survey was adjusted to alleviate the risk of misinterpretation.

Financial management emerged as an important theme with substantial impact on the overall risk management portfolios of the case farmers. Managing operating expenditure (through managing marginal profit) (Barry & Ellinger, 2012; McBride & Johnson, 2006) and managing capital expenditure (Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2013) were two liquidity management strategies identified in the case study.

Rather than utilising cash reserves to cover potential cash flow deficits, the case farmers arranged an overdraft line of credit. This finding supports the conclusion in the corporate finance field that argued an overdraft line of credit is a substitute for cash reserves (Lins et al., 2010; Sufi, 2009). Because the interest received on cash holdings was lower than interest, the case farmers preferred not to maintain cash reserves and covered their possible liquidity needs with an overdraft line of credit. This supports the theoretical notion (Acharya et al., 2013) and empirical findings (Lins et al., 2010) in the corporate finance domain that stated the difference between the interest paid on overdraft line of credit versus that received on cash is an important factor on the choice of liquidity reserves product. Maintaining cash reserves may not make the best use of their financial assets if interest received on these cash reserves is lower than the interest paid on their overdraft line of credit. Finally, the results from the case study supports the notion in corporate finance that the stated overdraft line of credit facility is normally used by firms as an investment facility. That is, the case farmer utilised an overdraft line of credit to cover a short-term cashflow deficit.

Debt management emerged as an essential part of the case farmers' overall risk management portfolios. While this is congruent with the findings from previous empirical studies in the New Zealand dairy farming context (Duranovich, 2015; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2013), the qualitive phase highlighted that debt management encompasses a range of strategies including the decision on debt-to-asset ratio, debt repayment strategy, and interest rates risk management strategy. The interviews also highlighted the factors that drive the choice of debt management strategies. Cashflow volatility (Ahrendsen et al., 1994; Collins, 1985; Zhao, Barry, & Schnitkey, 2008), interest rate (Ahrendsen et al., 1994; Collins, 1985), financial flexibility (in the form of untapped borrowing capacity) (Anastassiadis et al., 2015; Anastassiadis & Mußhoff, 2013; Barry et al., 1981), and tax considerations (Ahrendsen et al., 1994; Collins, 1985) are some of the factors that impact on the choice of debt ratio. Congruent with the findings in the SME literature, the lifecycle stage of the farm business also had a substantial impact on the case farmers' views on debt and debt loading (Berger & Udell, 1998; La Rocca et al., 2011; Mac an Bhaird, 2010; Mac an Bhaird & Lucey, 2010).

While both case farmers stated that they were planning to reduce debt in the future, the extent and the pace of debt repayment was different. The availability of interest-only loans allow dairy farmers to control the extent and pace of their debt repayment. Both case farmers utilised interest-only loans as the main option for debt amortisation. The ability to match principal repayment with income volatility was the main reason why the case farmers utilised this option. Simulation studies in agricultural finance showed that cash-flow considerations are the most important advantage of non-conventional loans over conventional loans (Barry & Robison, 2001). The ability to borrow more was another stated reason for choosing interest-only loans. This is generally consistent with the simulation modelling that suggests non-conventional loans, such as interest-only loans, may help farmers to acquire more assets with less equity (Ellinger et al., 1983; Rahman & Barry, 1981). Finally, the tax deductibility of interest was found to be another important factor in the choice of interest-only loans. This latter finding is generally consistent with the findings in real-estate sector studies (Cocco, 2013; Larsen et al., 2018). Interest rate risk management was another aspect of debt management. Both case farmers were using floating rate loans at the time of the interviews. The choice of a floating rate loan was mainly attributed to the relatively low forecasted interest rates levels over the long-term (yield curve), which was congruent with other empirical findings (LaDue & Zook, 1984; Leatham & Baker, 1988).

The interviews also highlighted some of the challenges in interpreting written questionnaire results. The results in the written questionnaire assumes that risk management is the main motivation for choosing a particular risk management strategy. Consistent with conclusion in other studies (Basarir, 2002; Fairweather & Keating, 1994; Willock, Deary, McGregor, et al., 1999), the results highlighted that achieving goals other than risk management may be the main motivation for adopting a strategy. For example, the use of sharemilking arrangement implies that Farmer B is willing to share a part of the milk price risk with the sharemilker (Gardner & Bennett, 2011). For Farmer B, not undertaking day-to-day operations including staff management was the single most important motivation for utilising sharemilkers (Shadbolt & Martin, 2005). Surprisingly, Farmer B decided to change the contractual arrangement (from variable order sharemilking to contract milking) and fully accepted the financial loss associated with a low milk price to support the contractor (Allen & Kloeten, 2016).

The qualitative phase also highlighted the feedback loops in relation to the relationship between risk perception and farmers' risk responses. Implementing risk management strategies can have impacts on farmers' risk perception in two ways. Reducing the impact or probability of the risk source that is intended to be managed, and an indirect impact that happens as a result of risk-risk and risk-return trade-offs (Hardaker et al., 2004; Harwood et al., 1999). For example, installing irrigation enables a farmer to manage drought risk, but it exposes a farmer to the financial risk associated with investing in irrigation. Accordingly, the farmer's risk perception after installing an irrigation system reflects their view about residual drought risk (the remaining drought risk after installing the irrigation system, if any), and their perception about the recently created financial risk. As Slovic (1987) stated "humans have an additional capability that allows them to alter their environment as well as respond to it. This capacity both creates and reduces risk" (p. 280).

The conceptual models in the previous studies normally ignored the feedback effect of farm risk responses on farm characteristics and accordingly on farmer's perception (Flaten et al., 2005; Meuwissen et al., 1999; van Winsen et al., 2014). This feedback effect (long dash arrow in Figure 4-2) may explain why empirical studies reported a mismatch between farmers' risk perceptions and utilised risk management strategies.

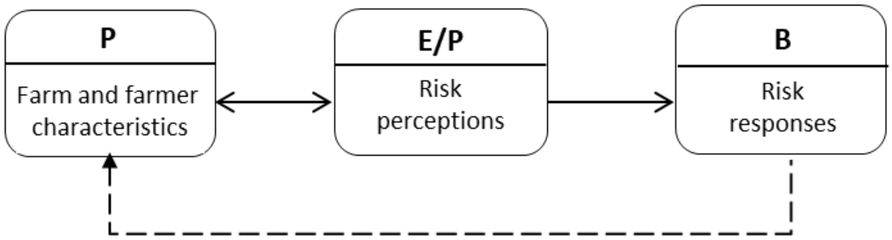


Figure 4-2: Revised Conceptual framework of farmers decision making (adapted from Flaten et al. (2005)).

Because the agriculture production cycle is a long process, the usefulness and effectiveness of some of the risk management strategies, and accordingly changes in farmer's risk perception, may only be realised after two or more seasons. Therefore, rather than cross sectional survey studies, such as this study, a longitudinal (multi-year) case study research design (Creswell, 2013; Yin, 2011) may be able to provide empirical evidence of the feedback effect of risk responses on farm and farmer characteristics and accordingly on farmers' risk perceptions.

4.5 The implications from the case study for the quantitative phase of the study

The interviews with the case-farmers highlighted that financial risk management is an important component of New Zealand dairy farmers' risk management portfolio. In particular, the qualitative phase revealed what is entailed in relation to debt management in the dairy farming context. Hence, it showed that debt repayment strategy and interest rate risk management are other important dimensions of debt management. The findings from the interviews also underlined some of the factors that influence the choice of a debt management strategy. However, to gain a more accurate understanding about the different aspects of financial management and the factors that impact on the decision to utilise those strategies, further research was required.

The themes that emerged from the qualitative phase, particularly those in relation to debt management, informed the development of the survey that is used in the quantitative phase of the study. The quantitative analyses were employed to identify the diversity of risk management portfolios and what factors determines the choice of risk management portfolios. The findings in the qualitative phase also helped with the interpretation of the farmer segmentations identified through multivariate analysis. The results of the statistical analyses undertaken in the second phase of the research are presented and discussed in the following chapter.

Chapter Five: Quantitative Results and Discussion

5.1 Survey response rate

From the 1939 contacts that could potentially respond to the survey questionnaire, 373 responses (19.23%) were received of which 340 (17.53%) were usable. The majority of past surveys on New Zealand dairy farming have reported higher response rates than this survey; Pinochet-Chateau et al. (2005), Shadbolt and Olubode-Awosola (2013), and Duranovich (2015) reported usable response rates of 43%, 18%, and 23.3% respectively. Despite the observed differences between the usable response rates obtained in this survey and these three surveys reported above, the absolute number of usable responses was similar, since these authors reported 325, 257, and 364 responses respectively.

5.2 Descriptive results

The following sections outline the descriptive statistics for farmer characteristics, farm business characteristics, farmers' risk profiles, farmers' perception towards environmental uncertainty, and farmers' risk management strategies. These results are also discussed in relation to existing literature and in particular with two recent studies: Duranovich (2015) and Shadbolt and Olubode-Awosola (2013). It is important to note that this study only obtained information from dairy farm owner operators while the aforementioned studies obtained information on both owner-operators and sharemilkers. Selection criteria for participating farms (owners only), and voluntary participation made this a non-random sample; therefore, results might have been different if farms were chosen from a random sample.

5.3 Farmers' socio-economic characteristics

The distribution of the respondents' age is presented in Figure 5-1. About 14% of respondents were younger than 40 years old whereas 66% of respondents were 51 years and older. Two of the more recent surveys of dairy farmers in New Zealand undertaken by Duranovich (2015) and Shadbolt and Olubode-Awosola (2016) reported that 65% and 71% of their sample were aged between 41 and 60 years old, respectively. The fact that more 66% of respondents were above 51 years of age indicated that the average age in the sample was similar to the ages reported by Shadbolt and Olubode-Awosola (2013) as well as Duranovich (2015). The relatively higher age when compared to the national census (Fairweather & Mulet-Marquis, 2009) may be explained by the fact that survey used in this study was addressed to farm business owners, who may have well have been older than the farmers defined in the National Census. This may be explained by the fact that the National Census, covers the entirety of the dairy farming population, had a mix of sharemilkers and farm owners, where sharemilkers tend to be younger than farm owners.

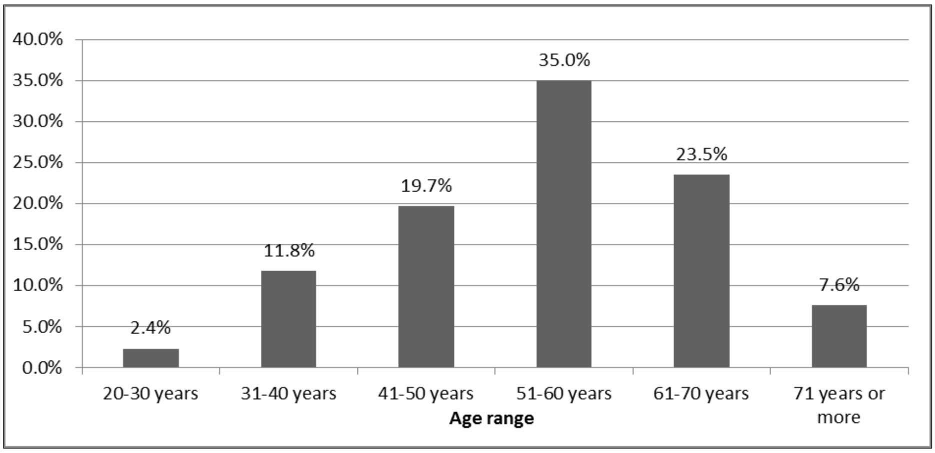


Figure 5-1: Age of respondents.

The respondents' highest level of formal education achieved is presented in Figure 5-2. The highest qualification achieved for over a third of respondents (37.1%) was high school level degrees (NCEA level 1 or School Certificate or University Entrance, Bursary, or NCEA level 2 or 3) whereas 42.6% of respondents had some university qualifications (diploma, degree, or post graduate degrees). Finally, about 26% of respondents had technical training or other qualifications.

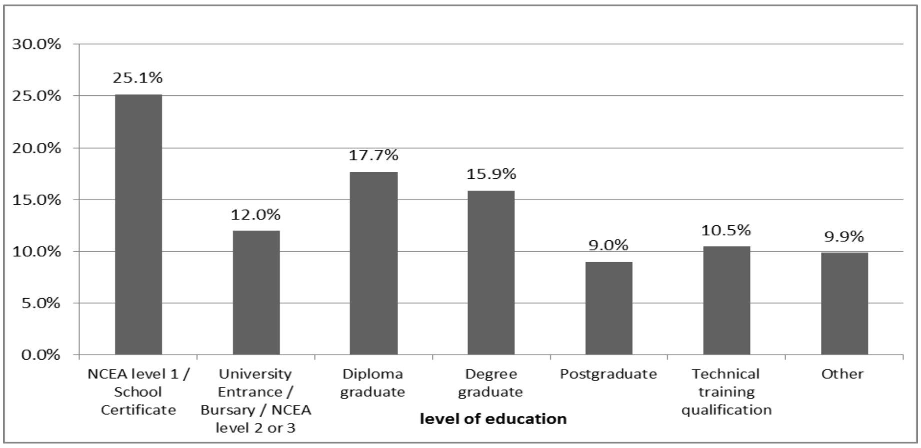


Figure 5-2: Highest level of education achieved by respondents.

The education categories used in this survey were slightly different from those used in Duranovich (2015). However, the level of farmer education in this survey was similar to those reported by Duranovich (2015), i.e. 25% of respondents had achieved NCEA level 1 or School Certificate, 18% had achieved University Entrance, Bursary, or NCEA level 2 or 3, and 13% had a graduate degree.

The ownership situation of respondents in the survey is presented in Figure 5-3. This study only obtained information from dairy farm owner operators. Therefore, it is not possible to compare the ownership structures of respondents in this survey with responses obtained in the other studies.

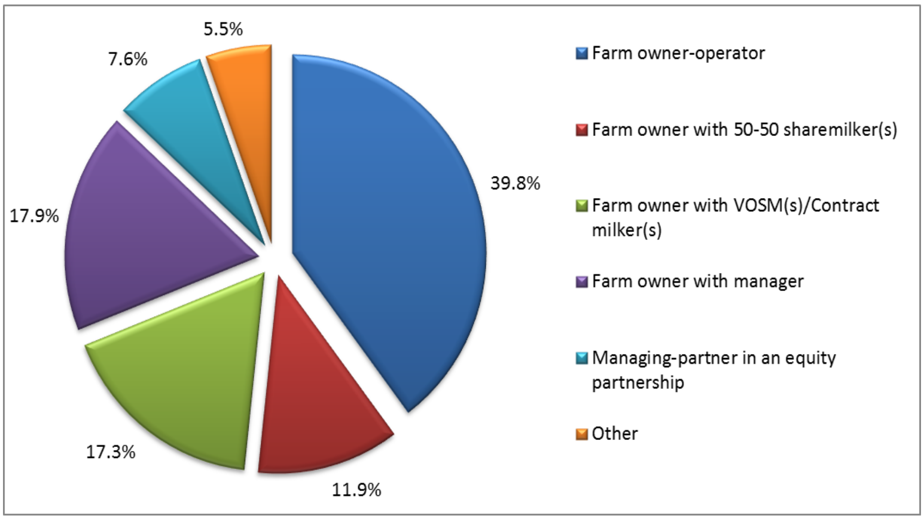


Figure 5-3: Current role of respondents in farm business.

About 40% of respondents in this survey considered themselves to be owner-operators (Figure 5-3). More than 29% of the respondents indicated that they were owners with 50-50 or variable order sharemilkers (VOSM). Farm owners with managers constituted 18% of the respondents, and 7.6% of the respondents were managing partners in an equity partnership. Finally, 5.5% (n=18) of the farm owners indicated that their current situation was "other". Two of these respondents described themselves as CEOs of the company, and two described themselves as directors of the dairy farm. One of the respondents described himself as a manager who leases the farm from his family.

5.4 Farm business characteristics

Table 5-1 shows the regional distribution of farm businesses and the percentage of cows by region obtained from responses in the sample, compared to the national dairy statistics survey reported by DairyNZ (2016). More than 60% of farms in the sample were in the North Island, whereas 39.4% of the farms were in the South Island. The farm businesses located in the North Island and in the South Island accounted for 58.2% and 41.8% of total cow numbers, respectively. The distribution of cows by region was similar to that observed in the national dairy statistics, at 59.7% and 40.2% for the North Island and the South Island, respectively (DairyNZ, 2016). Although most differences were small, there were differences between the percentage of dairy cows in Northland, Waikato, West Coast, and North Canterbury regions in the sample and the national statistics (Table 5-1).

Table 5-1: Regional distribution of respondents.

		Survey		National (DairyNZ, 2016)
Location	**Number of farms**	**Farm businesses (%)**	**Cows (%)**	**Cows (%)**
Northland	10	3.0%	**2.4%**	**5.6%**
Auckland	2	.6%	.4%	2.2%
Waikato	104	31.5%	**28.5%**	**23.1%**
Bay of Plenty	13	3.9%	3.4%	4.0%
Central Plateau	5	1.5%	6.9%	5.4%
Western Uplands	0	.0%	.0%	.9%
East Coast	0	.0%	.0%	.1%
Hawkes Bay	2	.6%	.2%	1.0%
Taranaki	34	10.3%	7.5%	9.7%
Manawatu	24	7.3%	7.4%	4.4%
Wairarapa	6	1.8%	1.7%	3.3%
North Island	**200**	**60.6%**	**58.2%**	**59.7%**
Nelson/Marlborough	5	1.5%	1.0%	1.7%
West Coast	51	15.5%	**10.7%**	**3.2%**
North Canterbury	18	5.5%	**8.0%**	**13.8%**
South Canterbury	15	4.5%	7.6%	4.8%
Otago	14	4.2%	4.5%	5.2%
Southland	27	8.2%	10.0%	11.5%
South Island	**130**	**39.4%**	**41.8%**	**40.2%**
Total	**330**			

The descriptive statistics for farm business characteristics such as effective milking area, herd size, milksolids production, stocking rate, production per cow, production per hectare, and people involved in the farm business are shown in Table 5-2. The results from the most recent survey (Duranovich, 2015) and national statistics are shown for comparative purposes DairyNZ (2018).

Table 5-2: Descriptive characteristics of dairy farm businesses.

	Survey					Duranovich (2015)	National
	N	**Mean**	**Max**	**Min**	**Std. Dev**	**Mean***	**Mean****
Effective milking area (ha)	335	219	3324	20	266	229	147
Milksolids produced (Kg) per farm business	332	233,567	3,125,000	20,000	302,900	274,285	160,302
Cows milked at peak	332	605	10675	64	860	692	414
Stocking rate (cow/ha)	329	2.72	4.73	1.00	.65	2.9	2.81
Production per cow (kg MS/cow)	328	389	1094	165	86	389	387
Production per hectare (kg MS/ha)	330	1065	2270	293	353	1153	1085
Family members involved in farm duties (FTE)	340	1.1	4.5	.0	1.0	1.9	N/A
Total No of staff (FTE)	340	3.1	55.0	.0	5.1	3.9	2.9

* reported for 2013-14 season.
** DairyNZ (2018)

The average effective milking area, number of cows milked at peak, and stocking rates, for the farm businesses in the survey was smaller than averages reported by Duranovich (2015) (Table 5-2). However, production per cow was consistent across studies. Moreover, the average number of non-family staff employed by farm businesses and the average number of family members involved in farm duties in this survey was lower than the one reported by Duranovich (2015).

Table 5-3 shows the distribution of respondents in terms of the number of milking property they own/manage. The majority (81%) of the respondents own/manage one milking property, and about 19% of the respondent owned/manage more than one milking properties. The percentage of respondents who own multiple milking properties was 8% less than those in Shadbolt and Olubode-Awosola (2013) survey (Table 5-3).

Table 5-3: The distribution of number of milking properties.

	Survey		**Shadbolt and Olubode-Awosola (2013) (n=253)**
Number of milking properties	**Count**	**%**	**Count (%)**
Single properties	274	81%	73%
Two properties	39	11%	n/a
More than two properties	27	8%	n/a
Multiple properties	66	19%	27%
Total	340	100%	100%

The distribution of respondents with respect to lifecycle stage of the farm business is presented in Table 5-4. The percentage of farmers in the entry stage was higher than previous studies whereas the percentage of farmers in the growth stage (20.8%) was similar to those reported by Duranovich (2015), but lower than that reported by Shadbolt and Olubode-Awosola (2013).

Table 5-4: Lifecycle stage of the farm business.

	Survey	**Duranovich (2015)**	**Shadbolt and Olubode-Awosola (2013)**
Stage of the business	**% farm (n=340)**	**% farm (n=426)**	**% farm (n=256)**
Entry	3.9	1.4	0.4
Growth	20.8	19.2	30.9
Consolidation	46.6	50.4	52.0
Entry of next generation	22.0	6.2	2.7
Exit	6.8	22.8	14.1
Total	100	100	100

As with the previous studies by Shadbolt and Olubode-Awosola (2013) and Duranovich (2015), the majority of respondents (46.6%) were at the “Consolidation” stage of the business. The percentage of the businesses in the “Entry of next generation” phase was considerably higher than those reported in the previous studies (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2013). Finally, the percentage of businesses that indicated they were at the "Exit" stage of the business cycle is considerably lower than previous studies (Table 5-4).

5.5 Farmers' self-efficacy to manage risks

Two statements were used in this survey to capture dairy farmers' self-efficacy to manage risks (Table 5-5). The statements were used to capture respondents' self-efficacy to manage risks both within the seasons and over the long-term. In addition, results from the studies by Duranovich (2015) and Shadbolt and Olubode-Awosola (2013) are also reported[72]. As shown in Table 5-5, 78% of respondents strongly agreed or agreed that they had the ability to manage almost all uncertainties that occur within a season and over the long term.

Table 5-5: Distribution of respondents by self-efficacy to manage risks.

	Survey			Duranovich (2015)	Shadbolt and Olubode-Awosola (2013)
	N	Count	%	%	%
Within a season, I am able to manage almost all uncertainty that occurs.	339				
Strongly Agree		42	12%	15%	11%
Agree		220	65%	69%	64%
Neutral		42	12%	12%	11%
Disagree		30	9%	5%	12%
Strongly Disagree		5	1%	0%	2%
Over the long term, I am able to manage almost all uncertainty that occurs.	339				
Strongly Agree		42	12%	16%	10%
Agree		221	65%	68%	61%
Neutral		50	15%	13%	15%
Disagree		24	7%	3%	12%
Strongly Disagree		2	1%	0%	1%

5.6 Farmers' risk preferences

Three statements were used to extract farmers' risk preferences: ability to plan for the future, making choices when there are multiple options, and playing it safe (Table 5-6). Nearly 60% of the respondents did not find it difficult to plan despite the future being uncertain. The majority of respondents (73%) indicated that they had no difficulty in making a choice where multiple solutions were available. Approximately half of the respondents strongly agreed or agreed that when it came to business, they liked to play it safe, whereas 21% strongly disagreed or disagreed with this statement, showing a more risk-taking attitude. The results observed in the survey were similar to both previous empirical studies

[72] It is important to note that this study only obtained the information from dairy farm owner operators while the studies by Duranovich (2015) and Shadbolt and Olubode-Awosola (2013) obtained information about both owner-operators and share-milkers.

of Duranovich (2015) and Shadbolt and Olubode-Awosola (2013) but with some areas of difference (Table 5-6).

Table 5-6: Distribution of respondents by risk preferences.

	Survey			Duranovich (2015)	Shadbolt and Olubode-Awosola (2013)
	N	Count	%	%	%
I find planning difficult because the future is so uncertain.	337				
Strongly Agree		12	4%	3%	1%
Agree		60	18%	13%	16%
Neutral		60	17%	16%	21%
Disagree		159	47%	43%	49%
Strongly Disagree		46	13%	26%	13%
When there are a number of solutions to a problem, I find it difficult to make a choice.	339				
Strongly Agree		2	1%	1%	1%
Agree		25	7%	8%	8%
Neutral		64	19%	10%	15%
Disagree		193	57%	51%	57%
Strongly Disagree		55	16%	30%	19%
When it comes to business, I like to play it safe.	339				
Strongly Agree		16	5%	7%	7%
Agree		148	44%	47%	36%
Neutral		104	31%	30%	35%
Disagree		63	19%	15%	22%
Strongly Disagree		8	2%	1%	1%

5.6.1 Farmers' financial risk-taking

Three statements were used to evaluate the respondents' financial risk-taking attitude. The distributions of respondent answers to the three statements used to assess financial risk-taking behaviour are shown in Table 5-7. More than 75% of respondents indicated they are not afraid to borrow money in order to undertake investments that can enhance profitability. In addition to this, almost half of the respondents indicated that they do not postpone investments until they really need to be done. Finally, 35% of respondents believed that compared to other dairy farmers they take more risk whereas 34% of respondents believed that they take less risk in comparison with other dairy farmers (Table 5-7).

Table 5-7: Distribution of respondents by financial risk-taking attitude.

	N	Mean	Std. Dev	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am not afraid to borrow money in order to undertake investments that can enhance profitability.	338	3.8	.9	2.1%	8.6%	12.4%	56.2%	20.7%
I postpone investments until they really need to be done.	339	3.2	1.1	8.0%	41.6%	20.6%	24.8%	5.0%
I take risks more often than other dairy farmers do.	339	3.0	1.0	7.7%	23.6%	33.9%	27.7%	7.1%

5.7 Farmers' perceived environmental risk

In terms of perceived opportunities to benefit from, milk prices, global supply and demand for food, technological changes, Pasture/crop/ animal health, and to a less extent, as the likelihood of benefit happening is less, skills and knowledge of those associated with the business were the most important sources of risk that create potential opportunity for respondents (Figure 5-4).

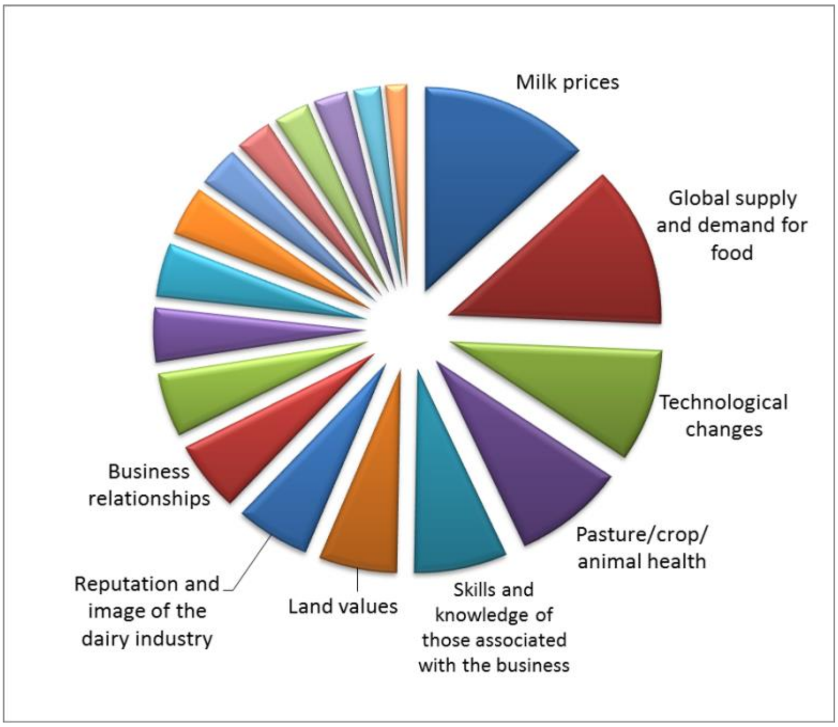


Figure 5-4: Risk (opportunity) importance indices ranked in order.

In terms of perceived threats to lose from local body regulations and laws, government laws and policies, milk prices, input prices and availability, and to a lesser extent the global economic and political situation, and reputation and image of the dairy industry were the most important sources of risk that create potential threats for respondents (Figure 5-5).

A series of studies with New Zealand dairy farmers assessed their perceptions of sources of risk in 1992 (Martin, 1994), 2004 (Pinochet-Chateau et al., 2005) (only the negative impacts), and 2011 (Shadbolt & Olubode-Awosola, 2013). With respect to farmers' perceptions of potential opportunities (positive impact), the top three sources of opportunity in the 2011 study of Shadbolt and Olubode-Awosola (2013) were similar to the findings in this survey. That is, global supply and demand for milk, product (milk) prices, and technological changes were the top three risk sources that potentially could create opportunities for respondents.

With respect to risk sources that were perceived negatively by the farmers, input prices and availability were the most important source of risk in 2011 (Shadbolt & Olubode-Awosola, 2013) whereas in both 1992 and 2004 changes in product (milk) prices was the most important sources of risk. Interestingly, local body laws and regulations and government laws and policies that were ranked 13th and 14th in 2004 overtook most of the risks to become the second and the fourth most important sources of risks in 2011 survey of Shadbolt and Olubode-Awosola (2013), and eventually became the most important source of risk in this survey. These findings revealed a growing concern over central government and local body regulations as farming practices are under greater scrutiny and control.

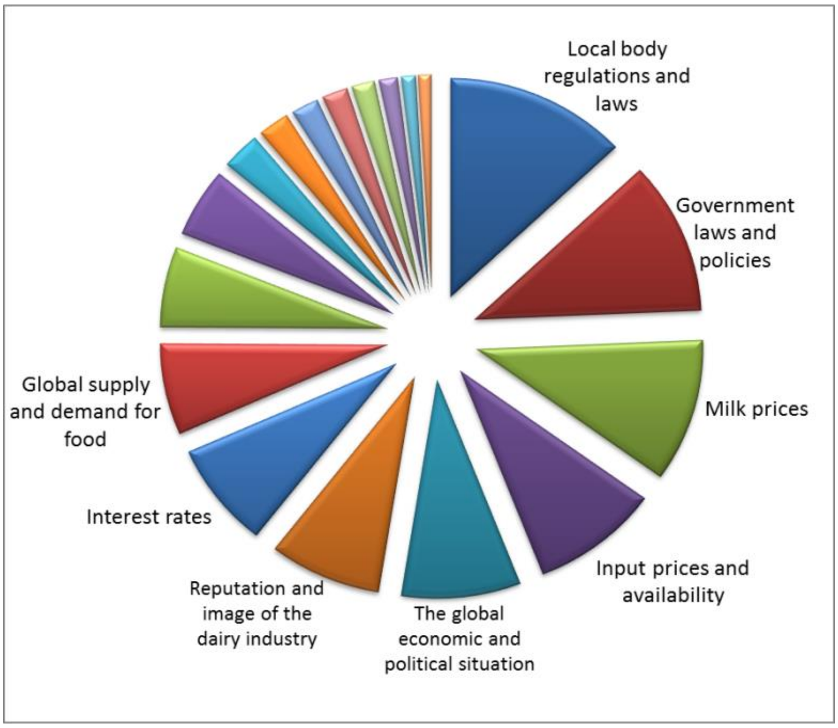


Figure 5-5: Risk (threat) importance indices ranked in order.

Another important finding is the change in the respondents overall risk score over time. Pinochet-Chateau et al. (2005) compared the risk perceptions of New Zealand dairy farmers in 1992 from the study by Martin (1994) with those in 2004 and found that farmers' perceptions of risk (the negative impacts) changed over time and that the mean scores for the majority of risk sources increased. Similarly, Shadbolt and Olubode-Awosola (2013) reported the mean score for risk increased over time. The findings from this study are also consistent with the previous studies. That is, compared to Shadbolt and Olubode-Awosola's study (2013), the mean scores for the majority of risk sources (both threats and opportunities) have increased. In particular, in the Shadbolt and Olubode-Awosola's (2013) study, six of the positive perception scores (opportunities) over the long-term were above 10 whereas in this study, perception scores for 13 of the positive perception scores (opportunities) are above 10 (Appendix Table 1). Similarly, only four of the negative perception scores (threats) in the Shadbolt and Olubode-Awosola's study (2013) study were above 10 whereas in this study perception scores for 10 of the negative perception scores (threats) are above 10 (Appendix Table 3).

The "risk choice matrix", suggests that respondents' perception to risk is 'glass half-full' with more risk perceived to be providing opportunities (a positive impact), than loss (negative impact) (Figure 5-6). Results of a Fisher's exact test confirms that similar to Shadbolt and Olubode-Awosola's (2013) and Duranovic's (2015) respondents were not significantly different in terms of upside risk versus downside risks, and found to be 'glass half-full'.

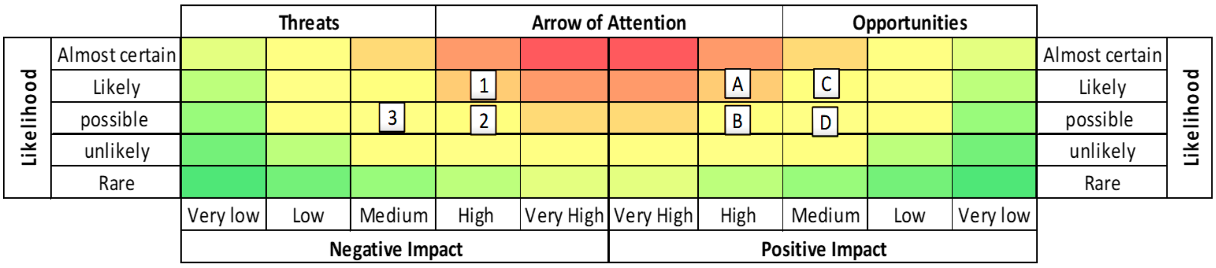


Figure 5-6: Risk choice matrix over the long-term.

Opportunity to benefit from:
A = Milk prices; Global supply and demand for food; Technological changes; Pasture/crop/ animal health
B = Skills and knowledge of those associated with the business
C: Land values
D: Reputation and image of the dairy industry; Business relationships; The global economic and political situation; Availability of capital; Availability of quality labour (employees and contractors); Input prices and availability; Interest rates; Government laws and policies; Local body regulations and laws; Dairy industry structure; Climate variation; Staff turnover
Threat to lose from:
1 = Local body regulations and laws; Government laws and policies; Milk prices; Input prices and availability
2 = The global economic and political situation; Reputation and image of the dairy industry
3 = Interest rates; Global supply and demand for food; Availability of quality labour (employees and contractors); Climate variation; Staff turnover; Pasture/crop/animal health
Dairy industry structure: Skills and knowledge of those associated with the business; Land values; Availability of capital; Technological changes; Business relationships.

5.8 Business risk management strategies

This section presents the findings about the respondents' view on the business risk management strategies including production, marketing, and human resource risk management strategies. The full comparison of risk management strategies- across different fields are presented in the appendix (Appendix VI). Each section discusses about the risk management strategies in different fields of management and provide possible explanation why these strategies perceived to be important risk management strategies.

The risk literature in agriculture can be classified into three bodies, the sources of risk literature, the agricultural and production economics literature, farming systems literature, and management process literature (Gray, Dooley, et al., 2008). The sources of risk literature is the most relevant body of literature to this study that can be used to discuss the findings of this study. This body of literature is also been useful in showing how contextual factors influence a farmer's choice of risk management strategies and the importance they place on them. However, because the consistency of risk management strategies between studies- particularly international studies- is poor, the scope for a useful comparison is limited. As such, the comparison with the agricultural and production economics literature, and farming systems literature are also used to discuss the results in this chapter.

5.8.1 Production risk management strategies

Having feed reserves for unexpected climatic events (e.g., floods and droughts) was ranked as the most important production risk management strategy (mean = 3.91) (Table 5-8). Consistent with the findings of previous studies in New Zealand (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2013) over 90 percent of respondents utilised this strategy to increase feed supply within the season and reduce production risks (Gray et al., 2014; Neal & Roche, 2020). This finding is not surprising. Pasture-based systems - such as New Zealand dairy farms- are heavily reliant on *in-situ* grazing as the main source of feed. Because pasture growth rates can be highly variable, the majority of farmers maintain feed reserves for unexpected climatic events such as prolonged droughts and floods during the lactation period (Fausett, Rowarth, & Scrimgeour, 2015; Nozieres et al., 2011; Rigolot, Roturier, Dedieu, & Ingrand, 2014; Webby, Johnstone, & Sherlock, 2001).

Table 5-8: The distribution of respondents in relation to their use and importance of production risk management strategies.

	N	Usage rate (%)	Importance score	Importance index	Rank
Having feed reserves on farm for unexpected events	329	91%	3.91	97	1
Not producing to full capacity within the current farming system	323	41%	3.06	21	6
Grazing dairy stock off-farm	326	73%	3.60	68	3
Having irrigation	327	22%	2.69	53	5
Owning a run-off	324	48%	3.37	62	4
Having infrastructure for wet soil management (e.g., barns, pads)	329	57%	3.62	94	2

Having infrastructure for wet soil was the second most important production risk management strategy (Table 5-8). Except for the Gray et al's (2014) case-study research, none of the previous studies on dairy farm risk management measured the importance of having wet soil management infrastructure on dairy farm systems in New Zealand. Result of the cross tabulation between farm geographical location and utilising this strategy confirmed that, farms in the bottom of South Island (Southland, West coast, and Otago), and Lower North Island (Wairarapa and Manawatu) have a relatively higher utilisation rate of wet soil management infrastructures. In contrast, farms in Canterbury and Central plateau region had a relatively low utilisation rate of these infrastructures. This reflects the proportion of heavy and poorly drained soils in these regions.

Wintering management strategies including grazing dairy stock off the farm and owning run-off (support block) were the next two important production management strategies (Table 5-8). Again, previous empirical studies on the dairy farm risk management did not investigate the importance of these strategies in New Zealand dairy farm businesses. So, it is not possible to compare the results with previous studies.

Utilising irrigation was the fifth important risk management strategy (Table 5-8). The percentage of dairy farmers using irrigation found in this survey (22%) was lower than that reported by Shadbolt and Olubode-Awosola (2013) (28%) and Duranovich (2015) (29%)[73] but higher than that reported by Pinochet-Chateau et al. (2005) (18%) and Martin (1994) (10%). The trend indicates that there has been an increase in adoption of irrigation and the intensification of dairying in New Zealand. Cross tabulation between farm geographical location and use of irrigation shows that approximately 42% of the irrigated farms were in the Canterbury, and 13% of the irrigated farms were in the Manawatu region. According to Corong et al. (2014), having irrigation is a crucial strategy for establishing dairy fam businesses in Canterbury. That is, without irrigation majority of dairy farms in Canterbury region cannot be established. In contrast, Manawatu is classified as the regions that have unreliable rainfall and soil water deficits may become a limiting factor from season to season (Corong et al., 2014). Finally, congruent with the previous studies (Duranovich, 2015; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2013), not producing to full capacity was found to be one of the least utilised (<40%) production management strategies (Table 5-8).

5.8.2 Market risk management strategies

The importance score of the three marketing risk management strategies that proposed to the respondents (Table 5-9) were generally lower than other than business management strategies, which is found to be consistent with previous studies in New Zealand (Duranovich, 2015; Melyukhina, 2011; Shadbolt & Olubode-Awosola, 2013).

Using contract to procure input is found to be the most important marketing management strategy (mean= 3.31) (Table 5-9). Pasture is the primary feeding system for dairy cows, however relatively intensive farming systems in New Zealand (system 4 and 5) started to introduce other feed sources to supplement pasture to maximize production (Ma, Bicknell, et al., 2019; Ma et al., 2018; Macdonald et al., 2017). With the reduction in the pasture intake of dairy cows and an increase in other feed supplements, dairy farms are exposed to market risk arising from volatility in the input market (Melyukhina, 2011). Accordingly, the exposure to input market risks depends on the farming system. In some of the high input farming systems (system 4 and 5), bought-in feed is crucial to meet herd demand whereas in some of the low input farming system (system 1 and 2), bought-in feed is a

[73] The farms in the Canterbury and Manawatu regions – two important irrigated regions are under-represented in this study (see Table 5-1).

substitute for short-term pasture feed deficit when unexpected climatic events, such as drought and flooding, happen (Gray et al., 2011; Gray et al., 2014; Hirst et al., 2014).

Gray et al. (2014) reported that farmers extensively use contract to secure the proportion of feed that is crucial for balancing feed supply and feed demand and use spot-market purchasing strategy to procure feed reserves (for unexpected climatic events). Climatic conditions during the milking season, feed price and milk price are three main factors that influence a farmer's decision about their feed input procurement strategy (Fausett et al., 2015).

Table 5-9: Distribution of respondents by utilising marketing management strategies

	N	Usage rate (%)	Importance score	Importance index	Rank
Using futures markets to sell milk	323	12%	2.28	9	2
Using contracts to procure inputs in advance at a fixed price	327	65%	3.31	51	1
Spreading sales (reducing seasonality in milk production)	324	27%	2.63	7	3

Congruent with the previous studies in New Zealand (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2013) and United States (Wolf, 2012; Wolf & Widmar, 2014) a small percentage (approximately 10%) of farmers utilised dairy futures to manage milk price risk (Table 5-9). Membership of milk cooperatives that manage market and exchange rate risk help farmers to mitigate considerable amount of risk associated with milk price (Melyukhina, 2011). Moreover, util recently, the futures market products were only available for dairy product categories such as WMP, AMP, butter etc, and farmers needed to more sophisticated techniques (such as Cross-Hedging) to be able to mitigate farmgate milk price risk (Fernandez-Perez et al., 2019). Finally, complexity of dairy futures that requires a high level of financial and numerical literacy (Fernandez-Perez et al., 2019; Koeman & Bialkowski, 2015; Mirza et al., 2020) were three barriers identified in utilising dairy futures.

Consistent with previous studies in New Zealand (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2013), spreading sales through milking the dairy herd out of the season was utilised by less than a third of the respondents. Similar to other seasonal pasture-based system, New Zealand dairy farming focus is on matching feed supply and demand through management of stocking rate, spring calving date, and the levels of supplementary feeds offered (French, Driscoll, Horan, & Shalloo, 2015; Geary et al., 2014; Ramsbottom et al., 2015). While the premium offered by milk processing companies may help farmer to increase profitability of their system (Chikazhe et al., 2017), the high production risk associated with production out-of-season- through forage crops and bought-in feed (Geary et al., 2014)- capital cost required to build winter grazing infrastructures, and transition cost required to shift to alternative calving system are important factors that may explain why utilising rate is not high (Chikazhe et al., 2017; Geary et al., 2014; Spaans et al., 2019).

5.8.3 Human resource risk management strategies

About a third of respondents (Table 5-10) indicated that they are utilising contractual arrangement and virtually transferring all the risk related to human resource (e.g. recruitment, retention, health and safety, roster etc) to a contractor (Gardner & Bennett, 2011; Shadbolt & Martin, 2005).

Dairy farming sector has a reputation for unattractive working conditions and shortage of skilled labour has been one of the important challenges in New Zealand dairy farming (Durst et al., 2018; Tipples, 2017). So, it is not surprising that providing good working conditions for staff is found to be the most widely utilised strategy (88% usage rate). High utilisation rate combined with high importance index (Table 5-10) shows that dairy farmers in New Zealand turned their attention to improving staff work-life balance and offering attractive remuneration package to be able to compete with other sectors for low skilled labour market (i.e. general farm hand), and recruit quality staff for the positions that requires skilled labour (such as assistant farm manager, 2IC etc) (Gray et al., 2014; Greenhalgh & Tipples, 2013).

Table 5-10: Distribution of respondents by utilising human resource management strategies.

	N	Usage rate (%)	Importance score	Importance index	Rank
Use of contract milkers and/or sharemilkers	323	30%	3.16	59	4
Employing experienced staff	326	77%	3.95	117	2
Providing training and/or career development opportunities for staff	322	69%	3.69	82	3
Using technology to reduce labour	324	66%	3.37	36	5
Providing good working conditions for staff	324	88%	4.22	158	1

Employing experienced staff was the second most important human resource risk management strategy (Table 5-10). The general belief is that experienced staff are typically more skilled due to their longer service, and require lower level of supervision and less training (Greenhalgh & Tipples, 2013). In addition to this, because less experienced staff are younger, they have a greater tendency to resign faster in order to pursue a career that have better pay and better access to good training opportunities (Taylor, 2011). As such, utilising this strategy helps farmers to improve labour efficiency and attract farmers that have lower tendency to resign and reduce staff turnover risk.

Retaining staff in the farm is another important objective of human resource management. Due to the heterogeneity in the biophysical characteristics of the farming systems, even experienced staff that are employed to undertake mid-level tasks (such as assistant farm management) require a minimum of three year to fully understand the farm system (Taylor, 2011). Providing training and career development opportunity is an important strategy to mitigate the risk associate with staff turnover and help farmers to retain staff in the farm business for longer period (Greenhalgh & Tipples, 2013; Tipples, 2017; Wenlu, 2014).

Finally, use of technology was the least important human resources management strategy (Table 5-10). Technology can reduce labour requirements, and help farmers to attract and retaining staff (Edwards et al., 2015). However, uncertainty around the technology performance (Bewley et al., 2010; Borchers & Bewley, 2015) and learning load imposed to staff and farm managers (Eastwood et al., 2016) are some of the reasons that may explain why this strategy was ranked as the least important human resource risk management strategy (Table 5-10).

5.9 Diversification

Consistent with the findings in previous studies, diversification strategies were found to be a less important risk management strategy among New Zealand dairy farmer (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2013). Having off-farm income was the first important diversification strategy that was proposed to the farmers (Table 5-11). Historical data shows that off-farm income comprised less than 10% of total cash available for living and growth (DairyNZ, 2009, 2018). However, off-farm earnings seem to be an important risk management strategy to cover their living expenses during low milk price seasons (Melyukhina, 2011) (see Figure 2-6). Apart from farm household consumption, off-farm income has implications for overall farm risk management. During low farm income periods, off-farm earning reduces the need to withdraw funds from the farm business and hence acts as a financial buffer (Dries, Pascucci, & Gardebroek, 2012; Melyukhina, 2011; Wauters et al., 2015). Particularly in the earlier stage of the farm business, off-farm income provides more flexibility in decisions concerning farm investment and its timing (Dries et al., 2012; Melyukhina, 2011; Wauters et al., 2015).

Table 5-11: Distribution of respondents by utilising diversification strategies.

	N	Usage rate (%)	Importance score	Importance index	Rank
Having other enterprises on your property	326	31%	2.81	28	2
Geographical diversification through having properties in different areas	324	19%	2.34	7	3
Having off-farm sources of income	324	46%	3.24	48	1

Enterprise diversification was the second important risk management strategies (Table 5-11). Dairy farming in New Zealand is regarded as a highly specialised enterprise that consistently outperformed other pastoral sectors (e.g. sheep and beef, deer, wool) (Melyukhina, 2011). Yet, some degree of interplay between different pastoral land uses and particularly in the dairy support blocks can be found in the dairy farm businesses (Morris & Kenyon, 2014). The trends in the dairy sector also clearly shows that, rather than diversification, dairy farmers in the New Zealand are focusing on increasing farm size and specialisation to cope with risks (see section 2.5.1.3.1). The above notion is generally supports Purdy et al's (1997) and Melhim & Shumway's (2011) conclusion in the U.S dairy farming that found enterprise diversification generally diminishes mean financial performance and increases variability of dairy enterprise (Purdy et al., 1997). Hence, enterprise diversification is a less effective risk management strategy for large dairy farms (Melhim & Shumway, 2011).

Finally, geographical diversification was the least utilised diversification strategy (Table 5-11). Section 2.5.1.3.2 highlighted that some of the dairy farmers who own a dairy farm in the non-traditional dairy areas of New Zealand (i.e., South Island) inadvertently, are pursuing a geographical diversification strategy. However, the above findings supports Pangborn et al's (2015) notion that motivations other than geographical diversification are the main drive for establishing new dairy farms outside of the home farm region (Pangborn et al., 2015).

5.10 Financial risk management strategies

This section presents the findings about the farmers' financial risk management strategies. The first section focused on the respondents' liquidity structure and policy including the size and extent of utilising different liquid assets to manage risks within the dairy farm business. Section 5.10.2 discusses the findings in relation to debt management and farmers' debt-to-asset ratio policy. Given the importance of access to capital on farmers' risk management and overall survivability of dairy farm businesses in New Zealand, section 5.10.2.1 reports the findings on the extent of capital constraints among the surveyed farmers. Finally, sections 5.10.3 and 5.10.4 discuss two dimensions of debt management namely, interest rate risk management structure and policy, and debt amortisation structure and debt repayment policy.

5.10.1 Liquidity management structure and policy

This section discusses about the structure and extent of liquid assets that farmers utilise to cope with different types of risks (liquidity reserves). Cash reserves and overdraft line of credit were two main types of liquid assets that were identified in the first phase of the study (see section 4.3.5.2). Hence, a series of statements were also asked to identify what factors drive the choice of liquid assets. No empirical study in agricultural economics and farm management investigated the policy and structure of liquid assets of the farm businesses. So, this section only compares the findings with the literature available in corporate finance field.

5.10.1.1 *Cash reserves*

The distribution of respondents by cash reserves position is presented in Table 5-12. Some 36% of respondents did not hold any cash reserves whereas 64% respondents had different amounts of cash reserves for unexpected events (Table 5-12). The milk payment schedule in the New Zeeland dairy farming is organised in a way that the farmers continuously receive income from milk (even in the winter period when the dairy herd is dried off) (Melyukhina, 2011). As such, comparing to arable and sheep and beef sector, when farmers earning is not continuous (one-off payment), the need for liquidity reserves is lower.

Table 5-12: Distribution of respondents by cash reserves position.

	Frequency (%)
I do not maintain cash reserves in order to cover unexpected cash-flow deficits.	36.1%
Cash reserves cover unexpected short-term cash-flow deficits.	27.8%
Cash reserves cover unexpected cash-flow deficits over the year.	23.1%
Cash reserves cover unexpected cash-flow deficit for more than one year.	13.0%

The survey also seeks to identify the importance of different factors on the choice of cash reserve size (Table 5-13). Availability of funds was the most important factor determining the amounts of cash reserves that respondents hold, which is similar to the results reported in the corporate finance literature (Campello, Giambona, Graham, & Harvey, 2011; Lins et al., 2010). Results of the cross tabulation showed that the importance of this factor was significantly higher among the farmers that decided to maintain cash reserves (64.1%). Expectedly, the size of the expected cash-flow deficit was the second important determinant of cash reserves policy. This latter confirms the findings in the corporate finance that showed firms with higher cashflow volatility tend to maintain higher levels of liquidity reserves (Campello et al., 2011; Sufi, 2009).

Table 5-13: Distribution of respondents by cash reserves policy.

	N	Mean	Std. Dev	Very Low	Low	Moderate	High	Very High
Having funds available when they are needed.	311	3.50	1.00	5.8%	9.6%	23.5%	50.5%	10.6%
The size of the expected cash-flow deficit.	308	3.40	1.05	5.2%	14.6%	28.2%	39.3%	12.7%
The amount of undrawn financial overdraft available.	308	3.32	1.08	6.8%	14.9%	29.2%	37.0%	12.0%
A preference to self-fund.	310	3.15	1.19	10.3%	20.6%	26.1%	30.0%	12.9%
The difference between the Interest rate received on cash reserves and the interest rate paid on debt.	309	3.03	1.20	12.9%	20.1%	30.4%	24.6%	12.0%
The time it takes to raise money when funds are needed.	309	2.82	1.03	11.0%	27.2%	34.6%	23.6%	3.6%

Undrawn financial overdraft was the third most important determinant of cash holding policy. The importance of financial overdraft highlights that the overdraft line of credit and the decision for cash holding are interconnected (Denis, 2011; Lins et al., 2010; Opler, Pinkowitz, Stulz, & Williamson, 1999). Similar to the empirical findings in the corporate finance literature (Lins et al., 2010), the difference between interest received on cash and interest paid on debt is another important factor on the decision to maintain cash reserves. This finding also confirms Acharya's (2013) theoretical notion in corporate finance the difference between cost of holding cash and interest on overdraft is an important factor on the liquidity structure of big firms.

5.10.1.2 *Overdraft line of credit*

The distribution of respondents by the size of overdraft line of credit is presented in Table 5-14. Only 9.5% of respondents did not arrange overdraft line of credit whereas over 40% of respondents indicated the arranged overdraft line of credit covers cash-flow deficit over a year (Table 5-14).

Table 5-14: Distribution of respondents by the size of overdraft line of credit facility.

	Frequency (%)
I have not arranged a financial overdraft.	9.5%
My financial overdraft facility covers short-term cash-flow deficits.	29.6%
My financial overdraft facility covers cash-flow deficits over a year.	41.1%
My financial overdraft facility covers cash-flow deficits over more than one year.	19.8%

The respondents who arranged the overdraft line of credit (n=308) were asked to indicate the frequency and the extent of using overdraft line of credit over the past three years (Table 5-15). The respondents who arranged the overdraft line of credit (n=308) were asked to indicate first, whether they applied for an extension over the past three years and second, whether they carried their overdraft to the next year over the past three years. More than half of the respondents in this group always or almost always use their overdraft line of credit whereas only 9% of the respondents reach the overdraft limit over the past three years (Table 5-15). Moreover, 39.5% and 53.6% of respondents applied for an extension and carried over their overdraft to the next year, respectively.

Table 5-15: Frequency and the extent of using overdraft line of credit facility.

	N	**Never**	**Rarely**	**Some-times**	**Almost Always**	**Always**
Frequency of using financial overdraft facility	304	4.3%	22.0%	23.0%	31.9%	18.8%
Frequency of reaching to financial overdraft facility limit	299	33.8%	33.8%	23.4%	7.7%	1.3%

The respondents who arranged overdraft line of credit were also asked to identify the importance of different factors on whether to use financial overdraft facility (Table 5-16). Expectedly, the interest rates on financial overdraft and the amount of cash reserves were the most important factors on the use of overdraft reserves. While the first statement refers to the general cost of short-term credit (Acharya et al., 2013; Campello, Graham, & Harvey, 2010), the latter statement reemphasized that overdraft line of credit and the size of cash holdings are complement each other or are a substitute for each other (Denis, 2011; Lins et al., 2010; Opler et al., 1999).

Table 5-16: Distribution of respondents by overdraft use policy.

	N	Mean	Std. Dev	Very Low	Low	Moderate	High	Very High
The interest rates on the financial overdraft facility	302	3.23	1.14	7.6%	19.5%	28.8%	30.8%	13.2%
The amount of cash reserves that I hold	298	3.19	1.17	11.1%	13.8%	32.9%	29.2%	13.1%
The time it takes to raise funds through other sources of funds	296	2.75	1.13	15.2%	27.7%	29.4%	22.3%	5.4%

A small number of respondents (n=16) indicated that "other" factors were also important on whether to use financial overdraft line of credit. The majority of comment in this group were referred to the nature of cash-flow shortage. That is, the farmers stated if they expect the shortfall in cash-flow continues longer than a season they prefer to use term-loans. Finally, two respondents stated instead of overdraft[74] they arranged on-going Committed Cash Advance Facility (CCAF)[75].

5.10.2 Debt management and policy

The distribution of debt-to-assets ratio (leverage ratio) is presented in Figure 5-7. The result shows almost five per cent of respondents did not have any debt. Most of the respondents (35.6%) had leverage ratio of 31 to 50%. Twenty-four per cent of respondents had leverage ratios less than 21%, and 73% of respondents had leverage ratio less than 51%. Only six per cent of respondents had a leverage ratio of 71% or higher.

[74] Regular overdraft line of credit is an uncommitted facility in which the providing bank is not obliged to lend money to the borrower. As such, it can be withdrawn immediately by the providing bank. Moreover, it is on demand, which means that it must be repaid whenever the providing bank demands repayment, even if the borrower is not in default of the terms of the overdraft.

[75] CCAF is a working capital facility, in which the providing bank is obliged to lend funds to the borrower.

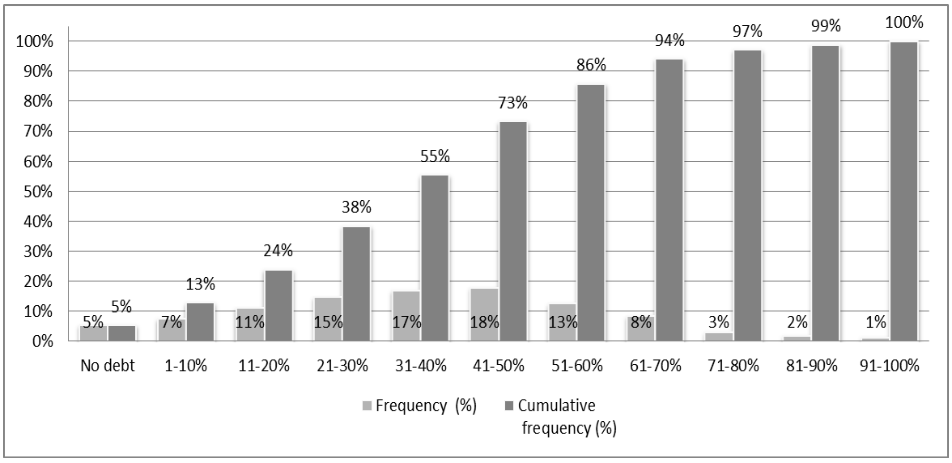


Figure 5-7: Distribution of respondents' debt-to-assets ratio.

Actual leverage ratios of farms vary through time (Barry & Ellinger, 2012). Such variability might occur because of strategic adjustment (risk balancing) in the financial position of a farm (Escalante & Barry, 2001), short-term fluctuations in farm assets (land) value, or as a result of debt increasing due to adverse weather conditions and low output price for two -three consecutive seasons (Gray et al., 2014; Shadbolt et al., 2013). As such, the respondents were asked to indicate where their debt-to-assets ratios should be over the next 5-7 years (Figure 5-8).

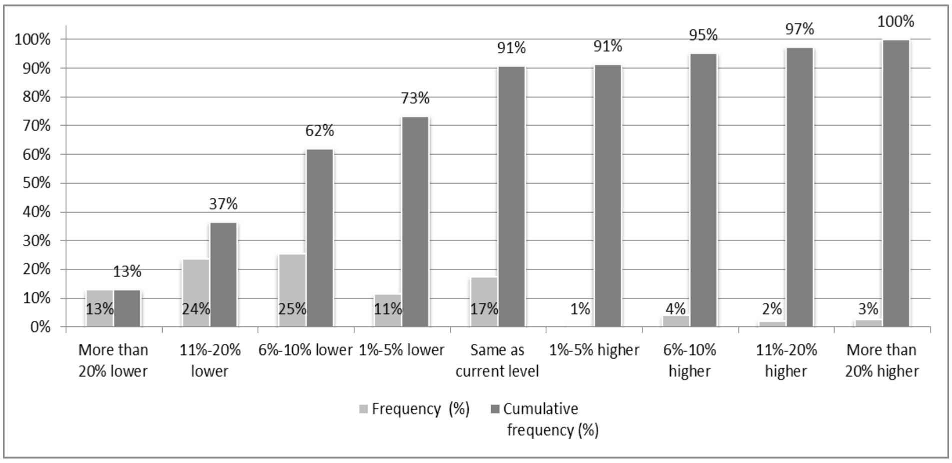


Figure 5-8: Targeted debt-to-asset ratio distribution.

The majority (73.4%) of the respondents believe that they should decrease their leverage ratio in the coming 5-7 years. Some 17% of respondents believed their leverage ratio should remain at their current level. Only 9% of respondents believed they should increase their leverage ratio in the coming 5-7 years (Figure 5-8). This can be partly explained by the fact that dairy farmers experienced two consecutive seasons of downturn (2014-15 & 2015-16) that reduced farm incomes and forced some to borrow to meet operating costs (RBNZ, 2018). When dairy prices recovered in 2016-17 season, farmers started to repay their debt and increase their equity ratio (DairyNZ, 2018). More recently the RBNZ has asked rural lenders to closely monitor vulnerable dairy debt so farmers are being asked to improve their equity buffers and increase their profitability (Stringleman, 2017).

The respondents were asked to indicate the importance of some factors on the choice of leverage ratio (Table 5-17). Income volatility had the most important determinant of leverage ratio. The importance of income volatility in leverage ratio is congruent with Collins-Barry (1985) equilibrium model. Following to this, financial flexibility (The ability to borrow further funds when unexpected opportunities and-or threats occur) was the second most important determinant of leverage ratio. This finding is inconsistent with Collins- Barry (1985) model and confirms the importance of flexibility on the leverage ratio. Congruent with Anastassiadis's et al (2015) conclusion, this finding confirms that dairy farmers intentionally create an equity buffer that can be used when unexpected investment opportunity or threat occurs. Industry level data also confirms the findings from the survey. During the global financial crisis of 2008 and 2016-17 season, as milk solids and land prices fell, dairy farms continued to draw on bank credit to meet their working capital needs (DairyNZ, 2018; Melyukhina, 2011). Although the cash position of farmers has improved after both low milk price periods, the dairy farming sector remained highly leveraged (Melyukhina, 2011; RBNZ, 2018).

Interest rates level scored as the third most important determinant of leverage ratio (mean=3.49). Shadbolt and Martin (2005) argue that interest rate is an indicator of the minimum expected rate of return from an investment (hurdle rate). Therefore, it is plausible that any increase in debt should be decided based on interest rate expectations. This is also confirmed the Barry-Collins hypothesis that proposed interest rates are influential on the optimal leverage ratio of the farms (Barry & Ellinger, 2012). The next factor 'credit worthiness' confirms the singling hypothesis proposed by (Jensen & Meckling, 1976) and hence confirms empirical (Zhao, Barry, & Katchova, 2008) and simulation (Wu et al., 2014; Zhao, Barry, & Schnitkey, 2008) results in agriculture that found in order to obtain funds farm business should send credible signals to lenders.

Table 5-17: Distribution of respondents by debt-to-asset ratio policy factors.

Variable	**N**	**Mean**	**Std. Dev**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
Income volatility	335	3.74	.88	1%	6%	**28%**	**45%**	19%
The ability to borrow further funds when unexpected opportunities and/or threats occur	337	3.71	.93	4%	4%	**26%**	**49%**	17%
Interest rates	336	3.49	.96	3%	9%	**38%**	**35%**	15%
Farm creditworthiness (as assigned by banks)	334	3.49	.98	4%	8%	**34%**	**40%**	13%
Availability of own funds	334	3.11	1.03	7%	18%	**42%**	**24%**	9%
Tax deductibility of interest	331	2.87	1.14	11%	**28%**	**33%**	17%	10%
The likelihood of insolvency or bankruptcy	334	2.68	1.40	**25%**	**27%**	18%	13%	16%

The next factor, availability of own funds, refers to the pecking order theory of Myers (1984). However, it is important to note that due to the nature of faming businesses, it is not possible for farmers to fund their investment plans by their own funds (Barry & Ellinger, 2012). Tax deductibility of interest was the next important factor on the choice debt ratio (Table 5-17). The relatively low score of this factor can be explained by the fact that New Zealand dairy farming are operating in a tax system that is different from other countries (such as United States) (see OECD, 2020) where Collins-Barry (1985) and its subsequent developments such as Ahrendsen's (1994) model were introduced.

Finally, "the likelihood of insolvency influences their debt decisions" was the least important of leverage drivers considered in the survey (Table 5-17). This might be explained by the fact that 73% have leverage of 50% or less (Figure 5-7) and that land appreciation over the past 20 years has helped farmers to keep their businesses solvent. As such, they are not concerned about insolvency.

5.10.2.1 *Access to capital*

The process of identifying capital constrained farmers is explained in the section 3.13.4. Nearly 60% of respondents stated they applied for a new loan over the past three years (Table 5-18). Among those who applied for funds, nearly five per cent of respondents indicated that their applications for term-loans were rejected (Table 5-18); therefore, classified as capital constrained respondents.

Table 5-18: Distribution of respondents applied for term-loans, the outcome of the application and the main reasons for not applying for term loan.

	Count	Count (%)
Whether the respondents applied for term loans:		
Yes	204	59.7%
No	136	40.3%
Total	**340**	**100%**
Term loan applications results:		
Rejected	10	4.4%
Not rejected	194	95.6%
Total	**204**	**100%**
The main reason for not applying for funds:		
I did not need funds.	117	92.1%
I was not sure if the loan would be approved.	1	0.8%
I was not sure whether I could service the debt.	6	4.7%
Interest rates were unfavourable.	2	1.6%
The size or the maturity of the loan was insufficient for what I was considering funding.	1	0.8%
Total	**127**	**100%**

The respondents who did not apply for a term-loan in the past three years were asked to identify the main reason for not applying for funds. More than 90% of total respondents indicated they did not need any funds. As such, the remaining 7.9% of respondents were classified as capital constrained respondents (Table 5-18). In total 19 respondents (5.6%) of total responses were identified as capital constrained. The distribution of capital constrained respondents by the main evidence is reported in

Table 5-19. The cross tabulation between capital constrained farms and several other variables (such as debt-to-assets ratio, location, farm size, risk attitude) failed to identify any relationship between these attributes.

Table 5-19: Distribution of respondents by the main evidence for being identified as capital constrained.

	Count	Count (%)
One of the term loans was rejected.	9	2.6%
I was not sure if the loan would be approved.	1	0.3%
I was not sure whether I could service the debt.	6	1.8%
Interest rates were unfavourable.	2	0.6%
The size or the maturity of the loan was insufficient for what I was considering funding.	1	0.3%
Total	**19**	**5.6%**

Next two sections cover two dimensions of the debt servicing: interest rate and debt amortisation. Briefly, interest rates risk management comes down to the choice between fixed-rate and floating-rate loans, and the debt amortisation comes down to the choice between interest-only loans (IO loans) and principal and interest loans (P&I loans).

5.10.3 Interest rate

The distribution of respondents by interest rate risk management policy (the choice of fixed versus floating interest rate) is presented in Figure 5-9. Around 32% of respondents had completely floating debt, and 26% had up to 50% of their debts to be fixed. Some 31% of respondents had between 51% to 90% of their debts fixed, and finally 11% of respondents had more 90% of their debt fixed.

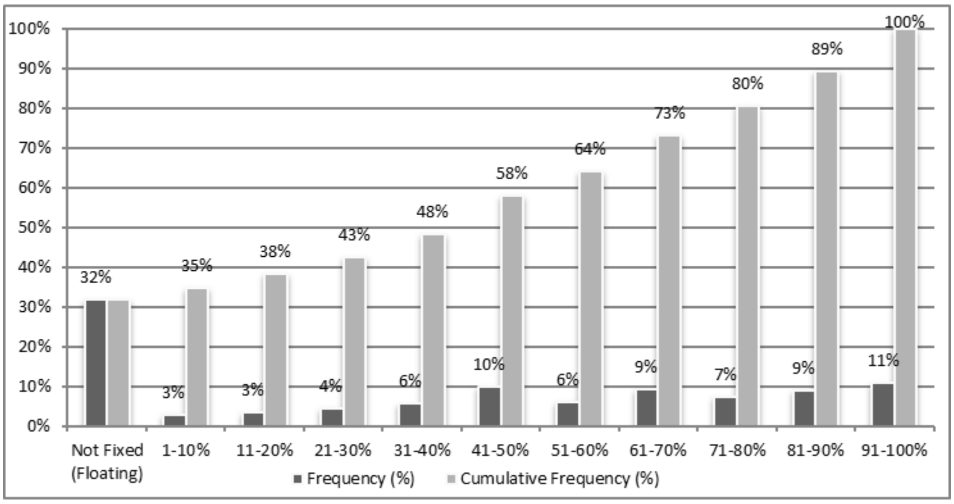


Figure 5-9: Distribution of respondents by the choice of fixed interest rate loans.

The rationale behind choosing fixed versus floating rate loans among New Zealand dairy farmers can be justified from empirical findings of LaDue and Zook (1984). At the time the survey was held the expectations were that the floating rate would remain low in the foreseeable future (RBNZ, 2019).

Therefore, floating-rate loans have advantage over fixed-rates loans and increase the capacity of farms to service debt.

The respondents were also asked to indicate the importance of a series of factors on the choice between fixed-rate versus floating-rate loans (Table 5-20). Consistent with Gray et al. (2014), these results show that "forecast interest rates at the time of borrowing" is an important determinant of the fixed-rate to floating-rate ratio policy.

The historical data in New Zealand dairy farming also corroborates the findings in this research (Figure 5-10). According to RBNZ (2016), the share of fixed-rate loans in total dairy loans was around 70% in 2003, peaked at over 80% in 2008 and then dropped dramatically to slightly over 30% in 2018. These figures again attest that New Zealand dairy farmers switch between fixed and floating loans depending on the expectations about interest rates (Shadbolt & Martin, 2005).

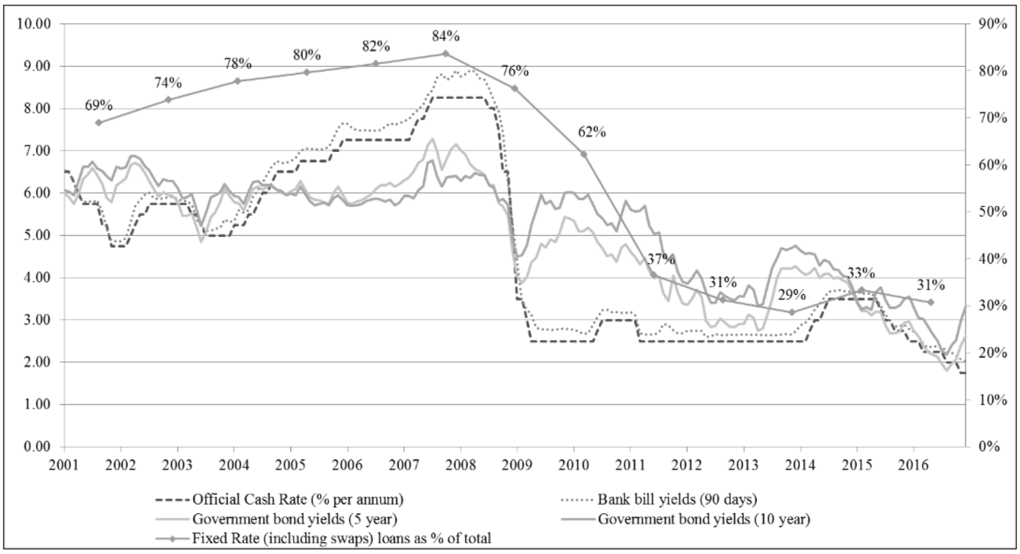


Figure 5-10: Historical interest rates and share of fixed- rate loans in dairy (Source: RBNZ).

The difference between fixed and floating rates at time of borrowing is the next important statement (Table 5-20). The importance of this factor supports Leatham and Baker's (1988) simulation modelling that shows demand for fixed-rate loans is sensitive to the size of the interest rate premium.

Table 5-20: Distribution of respondents by the choice of interest rate risk management policy.

	N	Mean	Std. Dev	Very Low	Low	Moderate	High	Very High
Forecast interest rates at the time of borrowing	316	3.72	.88	2.4%	6.1%	25.6%	50.3%	15.5%
The difference between fixed and floating rates at time of borrowing	314	3.70	.89	2.8%	4.3%	29.7%	47.1%	16.2%
The flexibility of making additional repayment on floating loans	318	3.55	1.02	3.6%	10.6%	29.3%	38.7%	17.8%
Certainty over interest rates on fixed-rate loans	315	3.52	1.03	4.6%	10.7%	27.1%	42.1%	15.5%
The flexibility of restructuring or exiting a floating loan	317	3.46	1.00	3.1%	13.5%	33%	35.8%	14.7%
Expected income volatility	316	3.39	.88	2.1%	10.6%	44.7%	32.5%	10%

The next three statements "the flexibility of making additional repayment on floating loans", "certainty over interest rates on fixed-rate loans", and "the flexibility of restructuring or exiting on floating loans" reflect some trade-offs that farmers are facing when they want to make the decision about fixed and floating rate loans. Although fixed-rate interest provides certainty over interest expenses, it leaves farmers with limited scope for making adjustments in the interest payments structure because lenders apply early repayment fees on fixed-rate loans. Therefore, using floating-rate loans let farmers adjust their debt servicing structure and pay off additional debt without paying any early repayment fees.

A small number of respondents (n=24) indicated "other" factors were also important in the choice of fixed-to-floating ratio policy. More than 40% of the comments in this latter group reemphasize the importance of the market timing factors (such as yield curve and forecasted interest rate). In addition to this, around 30% of comments were related to the macroeconomic conditions (e.g. political volatility, treasury policy, and global economy). Three respondents stated they prefer "Fixed loans with different maturity dates" rather than floating loans. One respondent stated he prefers to fix interest rates on new investment projects as new investments are riskier. Finally, less than 25% of respondents commented that they choose their policy based on advisors, accountant or bank manager recommendation.

5.10.4 Debt amortization and debt repayment

The distribution of respondents by debt amortization policy is presented in Figure 5-11. Only 8% of respondents had more 90% of their loans as principal and interest (P&I) loans. Some 68% of respondents indicated that their debt was fully structured as interest-only loans (IO loans) (Figure 5-11).

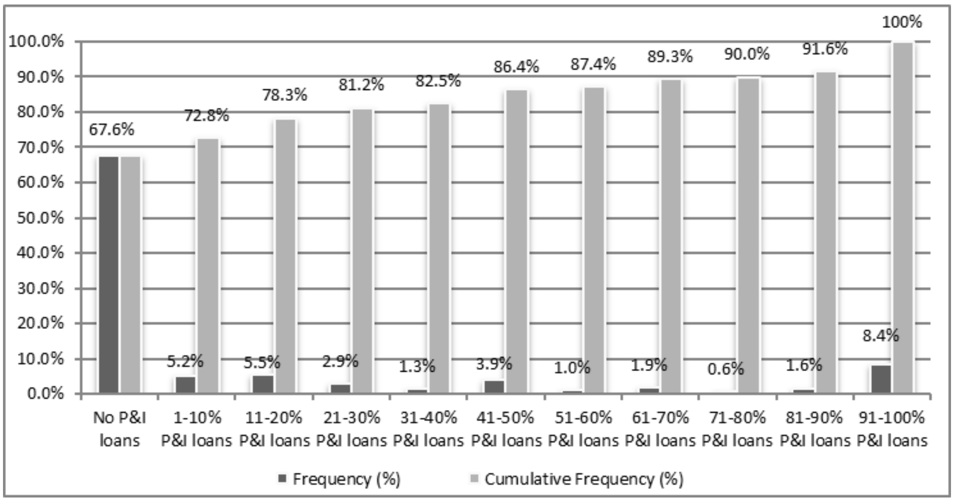


Figure 5-11: Distribution of respondents by the choice of debt amortization.

The survey also seeks to identify the importance of different factors on the choice of debt amortization policy (Table 5-21). None of the studies in agriculture context directly explored the effect of IO loans. However, a series of simulation and mathematical programming studies investigated the possible effect of non-conventional loans (with flexible principal payment structure) on the financial situation of representative farms (Baker, 1976; Rahman & Barry, 1981; Schnitkey & Novak, 1989).

Results show “flexibility in the repayments” by far is the most important reason for choosing interest-only loans. Simulation studies on the impact of non-conventional loans also confirms that cash-flow considerations are the most important advantage of non- conventional loans over conventional loans (Barry & Robison, 2001). In contrast, “tax deductibility on interest” was the least important factor on debt amortization decisions. These two finding collectively may be explained by the fact that farmers do not follow the typical repayment plan of conventional loans. Instead, as also observed by Gray et al. (2014) dairy farmers are using interest-only loans to match their debt repayment with their cash-flow and repay principal as conditions allow.

Table 5-21: Distribution of respondents by the choice of amortization policy.

	N	Mean	Std. Dev	Very Low	Low	Moderate	High	Very High
Flexibility in the repayments for interest-only mortgages	278	3.68	0.99	2.4%	9.4%	25.8%	40.8%	21.6%
Potential to borrow more on interest-only mortgages	272	3.08	1.04	6.8%	19.2%	38.8%	25.6%	9.6%
The difference between the initial amount paid on table-mortgages and the initial amount paid on interest only-mortgages	273	2.92	1.05	10.3%	19.5%	44.0%	18.4%	7.8%
The difference between the overall amount paid on table-mortgages and the overall amount paid on interest-only mortgages	271	2.92	1.02	8.9%	21.8%	43.2%	19.3%	6.8%
Higher tax deductibility potential for interest-only mortgages	273	2.86	1.09	11.7%	23.4%	36.9%	20.6%	7.4%

Potential to borrow more funds” is scored as the second most important factor in choice of debt amortization policy. This is generally consistent with the simulation modelling that suggest non-conventional loans may help farmers to acquire more assets with less equity (Ellinger et al., 1983; Rahman & Barry, 1981). The moderately high importance of the next factor “the difference between the initial amount paid on table-mortgages and the initial amount paid on interest only-mortgages” reinforces higher desirability of interest-only loans in terms of cash-flow flexibility. It also verifies the crucial impact of cash-flow availability in the early stages of a farming investment (Barry & Robison, 2001).

5.11 New Zealand dairy farmers' portfolios of risk management strategies

A list of 22 potential risk management strategies are selected from the interviews and the literature: 17 variables are employed to address business risk management strategies and five variables are employed to address financial risk management strategies (Appendix VII).The results are presented and discussed in two parts. First, risk management dimensions are identified and described. Next, farmers with similar risk management portfolios are clustered and the characteristics of farmers following different risk management portfolio are outlined and discussed.

5.11.1 Risk management dimensions

The adjusted MCA method is used to extract the dimensions of risk management strategies. The eigenvalues and percentages of variance explained by each dimension is presented in Figure 5-12. The inertia explained by each dimension using indicator matrix also is illustrated for comparison purposes (Figure 5-12). The rather low eigenvalues in each dimension indicated that the 22 variables in the survey data are heterogeneous, and all carry unique information to some extent. As such, reducing any of the variables is likely to result in information loss.

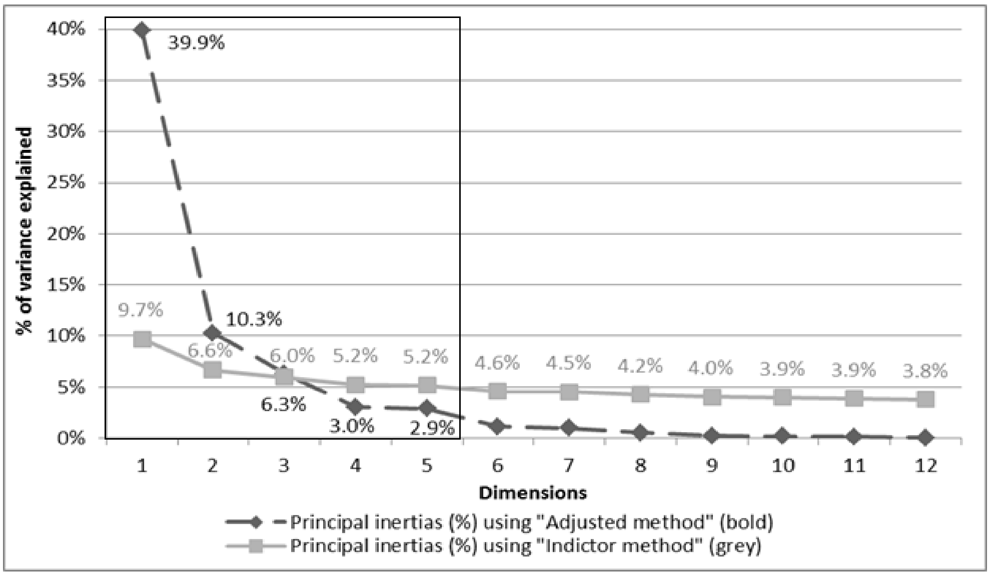


Figure 5-12: Percentage of variance explained by each dimension in MCA.

A combination the average rule and interpretability of dimensions were used to decide on the number of dimensions to retain between different methods (Hair, 2010; Lorenzo-Seva, 2011). Based on these criteria, a solution with five dimensions explaining 62% of the variability in the dataset (using adjusted method) was chosen for further analysis.

5.11.2 Interrelationships between risk management strategies

One of the objectives in this study was to explore the association between risk management strategies. It is possible to explore the association between risk management strategies in a multidimensional space with several low-dimensional maps (i.e., two or three dimensions). Ideally, a five-dimensional plot could show all the associations between variables. Since such 5-D plot does not exist, a series of biplots were created to explore the association between risk management strategies. Figure 5-13 is the MCA biplot for the first two dimensions which accounts for 50.2% of the total association. Figure 5-13 also represents pairwise interactions among nine risk management strategies that create dimensions one and two.

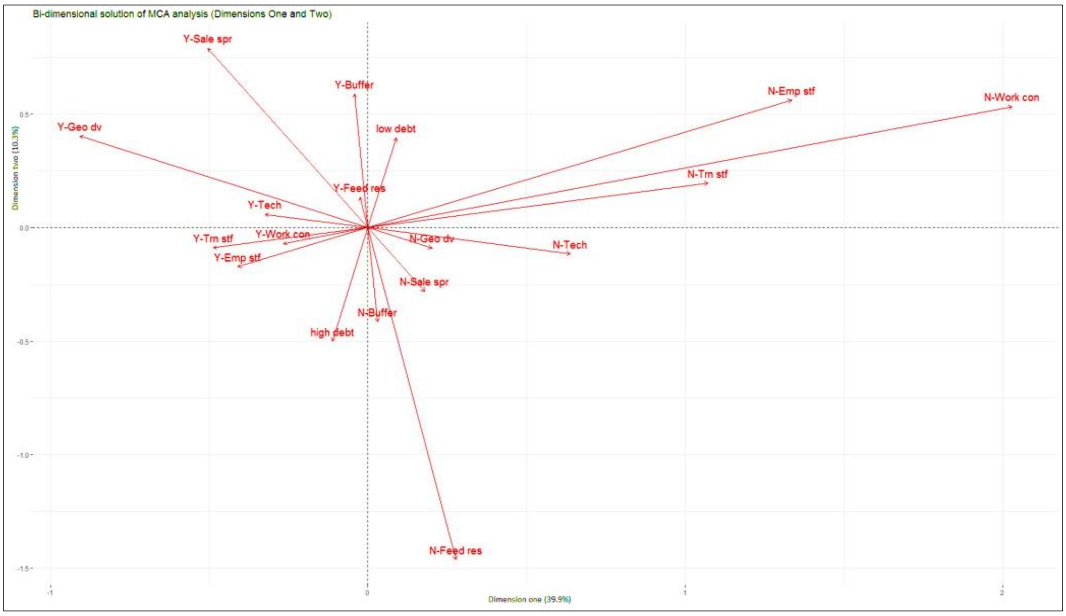


Figure 5-13: Bi-dimensional solution of MCA analysis (Dimensions One and Two).

The first dimension (horizontal axis) pertains mainly to HR risk management strategies including "Employing experienced staff" (Y-Empl staff, N-Empl staff), "Providing training and/or career development opportunities for staff" (Y-Trn staff, N-Trn staff) and "Providing good working conditions for staff" (Y-Work con, N-Work con) effects. The second dimension pertains mainly production management strategies including "Having feed reserves on farm for unexpected events" (Y-Feed res, N-Feed res), and "Not producing to full capacity within the current farming system" (Y-Buffer, N-Buffer) effects. This dimension also was less closely related to "intended debt ratio in the coming 5-7 years" variable (low debt-high debt) (Figure 5-13).

The points for each strategy have the property that the high frequency categories are closer to the origin. In Figure 5-13, "maintaining feed reserves for unexpected events" (Y-Feed res) are close to the origin, which suggest that high percentage of respondents using this strategy. The proximity between levels of different categorical variables suggest that these levels tend to appear together in the observations. Accordingly, the proximity between HR management strategies (Y-Empl staff, Y-Work con, Y-Trn staff,) suggest that the respondents who employ experienced staff (Y-Empl staff) are more likely to provide good working condition (Y-Work con) and training and development opportunities for staff (Y-Trn staff). Figure 5-13 also reveals a close association between "Having feed reserves on farm for unexpected events" (Y-Feed res), and "Not producing to full capacity within the current farming system" (Y-Buffer) strategies. Moreover, respondents who apply the two latter strategies are more likely to intend for a low debt ratio in the coming 5-7 years.

The position of the category points for the selected risk management strategies for dimensions one and three from the MCA accounts for 46.2% of the total association and represents the selected pairwise interactions among the factors (Figure 5-14).

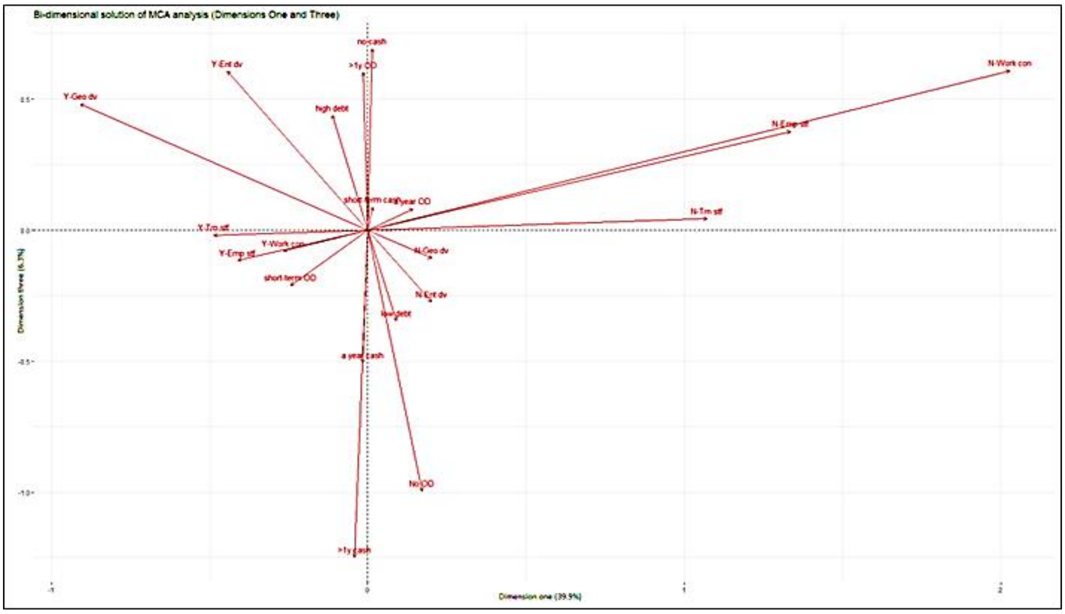


Figure 5-14: Bi-dimensional solution of MCA analysis (Dimensions One and Three).

The first dimension (horizontal axis) pertains mainly to human resources (HR) risk management strategies including "Employing experienced staff" (Y-Empl staff, N-Empl staff), "Providing training and/or career development opportunities for staff" (Y-Trn staff, N-Trn staff) and "Providing good working conditions for staff" (Y-Work con, N-Work con) effects. The vertical axis (dimension three) pertains mainly to liquidity management strategies including "the size of the cash reserves" and "overdraft line of credit facility size" effects. "Dimension three" also is less closely related to the Intended debt-to-assets ratio in the coming 5-7 years. As expected, the proximity between "the size of the overdraft line of credit facility" variable and "the amount of cash reserves for unexpected events" variable shows that these two variables are more likely to be similar to each other. However, there is a negative association between the levels of these variables. That is, respondents with overdraft line of credit that covers more than one year of cash-flow deficit (>1 y OD) are more likely to keep no cash reserves (no cash). Similarly, farmers who did not arrange overdraft facility (No OD) is more likely to keep more than one-year cash for unexpected cash-flow deficits (>1y cash). This association implies that overdraft line of credit and cash reserves are substitute liquidity management tools. This finding is congruent with findings in the corporate finance literature (Lins et al., 2010; Sufi, 2009).

Figure 5-14 also reveals a close association between two different liquidity management tools and intention for debt to asset ratio in the coming 5-years. That is, respondents who intended for a low debt ratio in the coming 5-7 years are more likely to have not arranged overdraft line of credit (No OD) whereas farmers who intended for a high debt in the coming 5-7 years are more likely to arrange overdraft line of credit that covers more than one year cash-flow deficit. Another important association can be found between the diversification strategies (enterprise diversification (Y-Geo dv) and geographical diversification (Y-Geo dv)) and intention for debt ratio in the coming 5-7 years. This indicate that, farmers with high debt intention are more likely to use diversification strategies whereas farmers who intend for a low debt ratio are more likely not to use diversification strategies (Figure 5-14).

The positions of the category points for the selected risk management strategies for dimension one and four from the MCA accounts for 42.9% of the total association and represents selected pairwise interactions among the factors (Figure 5-15). Again, the first dimension (horizontal axis) pertains mainly to human resources (HR) risk management strategies effects while the other dimension (dimension four) mainly pertains to production management (having infrastructure for wet soil management (Y-Wet soil, N-Wet soil)) and marketing management strategies (Spreading sales (Y-Sale spr, N-Sale spr) and using contracts to procure inputs (Y-inpcon, N-inpcon)) effects (Figure 5-15).

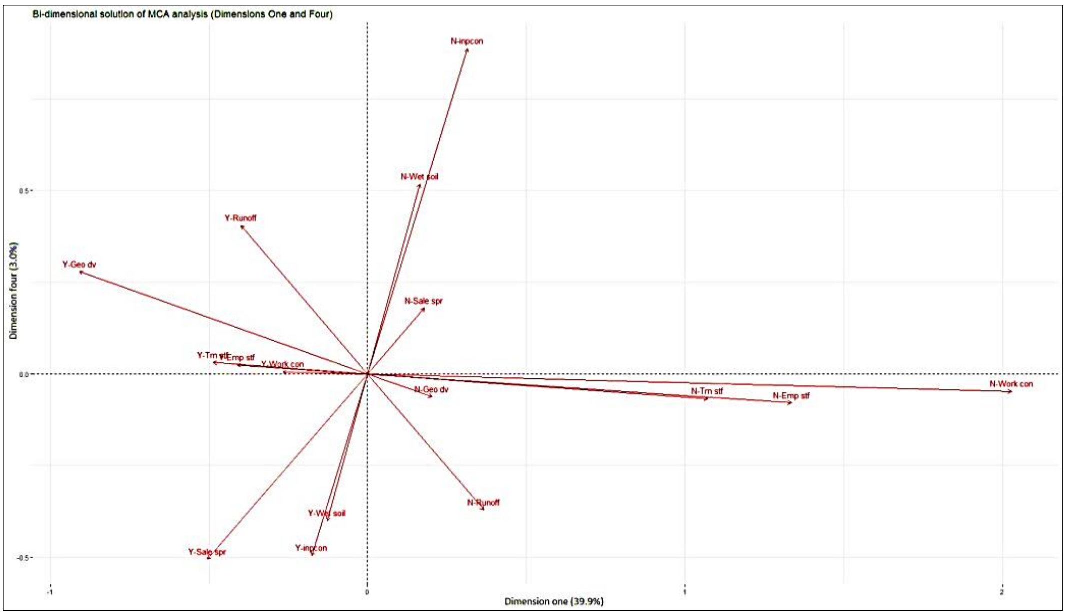


Figure 5-15: Bi-dimensional solution of MCA analysis (Dimensions One and Four).

The proximity between using input contracts and having infrastructure for wet soil management facility reflect the effect of climate on pasture production in New Zealand dairy farming system. Farms located in the regions with excessive winter or spring rainfall and heavier soil utilise wet soil management facilities that let them keep the milking herd in those regions and mitigate the risk of soil compaction. Besides, they utilise contracts to secure availability of feed supply for this period of the year (when the milking herd are wintering in the wet soil management facility). Farms that utilise these two facilities are more likely to spread sales and reduce seasonality in milk production.

The positions of the category points for the selected risk management strategies for dimension one and five (Figure 5-16) from the MCA accounts for 42.8% of the total association and represents selected pairwise interactions among the factors. Again, the first dimension (horizontal axis) pertains mainly to human resources (HR) risk management strategies effects. The other dimension (dimension five) mainly pertains to liquidity management strategies including “the size of the cash reserves” and “overdraft line of credit facility size” effects. While this is similar to dimension three, there is an important difference between dimension five and dimension three. Dimension five also pertains to debt-servicing strategies including the interest rate volatility management strategies (fix, floating, floating & fix) and debt amortization strategies (IO, P&I, IO and P&I) effects. The proximity between two liquidity management strategies reflect the fact that these two strategies are substitutes for each other. However, the direction of the relationship between liquidity management strategies are different from dimension one and three biplot (Figure 5-14). That is, farms that keep cash that covers more than one year of cash-flow deficit (>1y cash) are more likely to arrange an overdraft line of credit facility that covers more than one year of cash-flow deficit (> 1y OD). This can be explained by the mediating impact of debt servicing strategies (fix vs float and P&I vs IO). While liquidity management strategies have impact on farmers’ debt servicing strategies, it is also influenced by farmers’ debt servicing strategies.

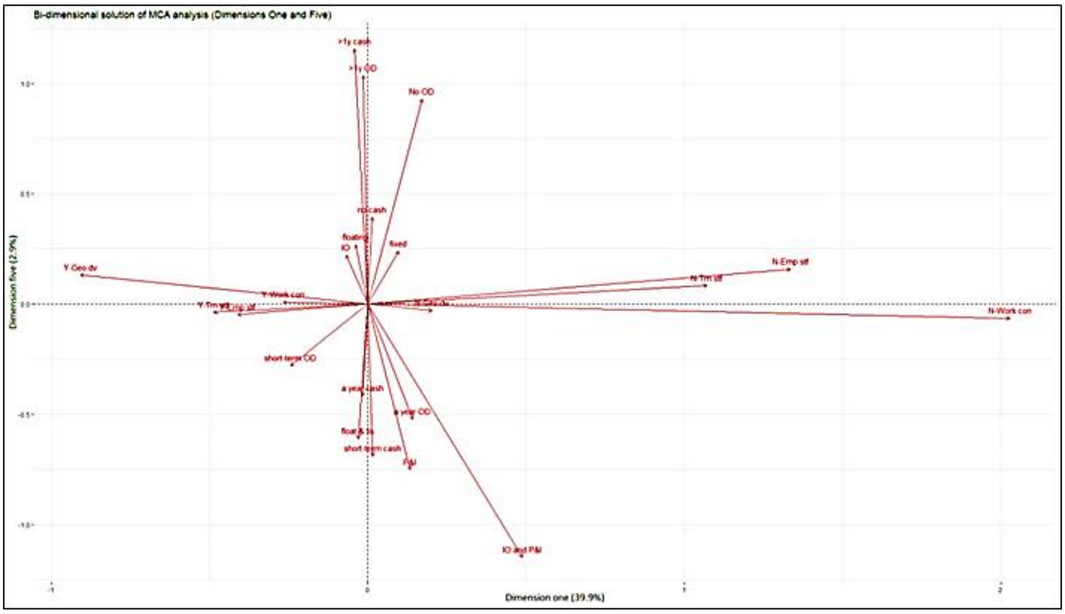


Figure 5-16: Bi-dimensional solution of MCA analysis (Dimensions One and Five).

Farms without any cash reserves (no cash) or overdraft line of credit facility (no OD) are more likely to utilise fixed-rate (fixed) loans to manage interest rate volatility, and more likely to utilise interest-only loans as the debt amortisation strategy. These farmers might use IO loans to borrow to full capacity. However, they have to use fixed-rate loans because they cannot tolerate any increase in interest rates (or afford any increase in debt-servicing expenses).

Farms who have arranged an overdraft line of credit that covers more than one year of cash-flow deficit (> 1y OD) or have cash reserves that cover more than one year's cash-flow deficit (>1y cash) are more likely to utilise floating-rate loans (float) to manage interest rate volatility and utilise interest only (IO) loans as the debt amortization strategy. Farms who arranged an overdraft line of credit that covers a year of cash-flow deficit (a year OD), or have cash reserves that covers a year (a year cash) or short cash-flow (short-term cash) deficits are more likely to use a combination of fixed-rate and floating-rate loans (fixed and floating) for interest rate volatility management. For these farms, they are also more likely to use principal and interest (P&I loans) or a combination of both (P&I and IO loans) loans as the debt amortisation strategy.

The positions of the category points for the selected risk management strategies in dimension two and three from the MCA accounts for 16.3% of the total association and represents selected pairwise interactions among the factors (Figure 5-17). The second dimension is perfectly aligned with the "maintaining a buffer in the production systems" (Y-Buffer, N- Buffer) strategy, and also strongly aligned with "spreading sales" (Y-Sale spr, N-Sale spr) and "maintaining feed reserves for unexpected events" (Y-Feed res, N-Feed res) strategies. The other dimension (dimension three) pertains mainly to liquidity management strategies including "the size of the cash reserves" and "overdraft line overdraft line of credit facility size" effects.

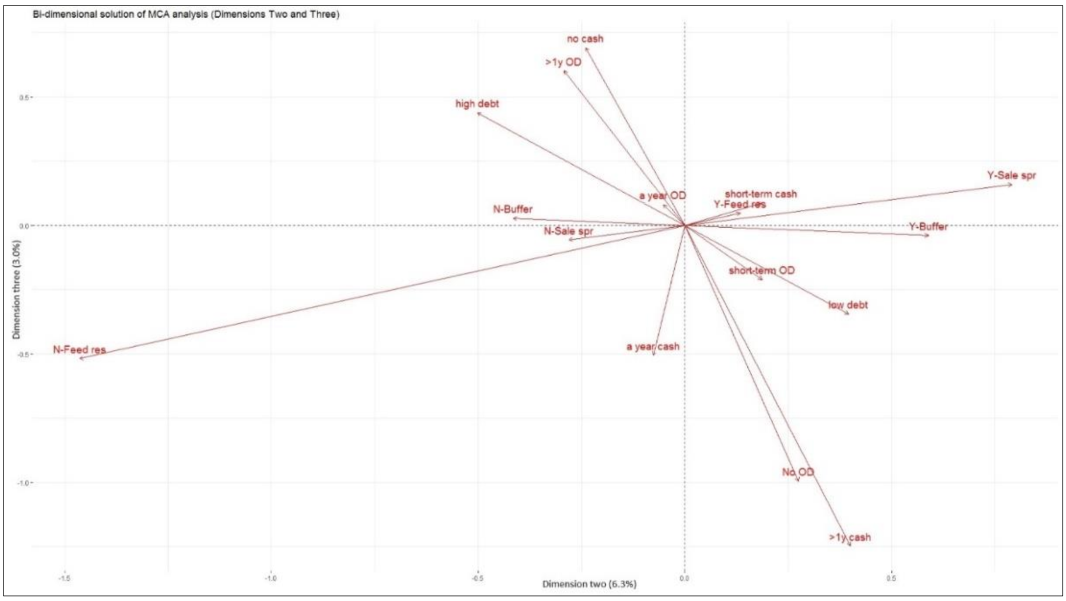


Figure 5-17: Bi-dimensional solution of MCA analysis (dimensions two and three).

The positions of the category points for the selected six risk management strategies in the dimension two and four from the MCA accounts for 13.6% of the total association and represents selected pairwise interactions among the factors (Figure 5-18). Dimension two (horizontal axis) pertains a production strategy ("having feed reserves on farm for unexpected events") effect. Moreover, this dimension pertains an enterprise diversification strategy (N-Ent dv, Y-Ent dv) effect. Finally, this dimension is less closely associated with intended debt ratio strategy (high debt, low debt). Dimension four (Vertical axis) is perfectly aligned with the "Using contracts to procure inputs in advance at a fixed price" (Y-inpcon, N- inpcon) strategy, and also less closely resembles production management strategies such as "owning a run-off" (Y-Runoff,N-Runoff), and "having irrigation" (Y-Irrig ,N-Irrig) strategies.

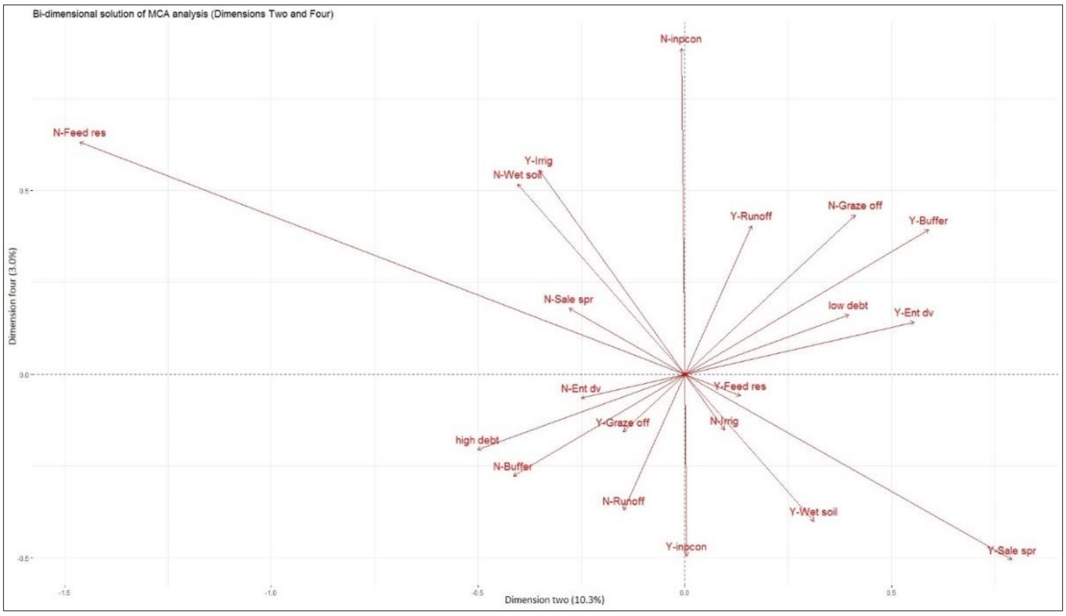


Figure 5-18. Bi-dimensional solution of MCA analysis (dimensions two and four).

5.11.3 Portfolios of risk management strategies

After several comparisons of different cluster solutions, six clusters were identified as providing a useful grouping of dairy farmers around the set of management strategies that they used to manage risks. The following sections scrutinised the characteristics and contents of each portfolio of risk management strategy (PRMS). Initially, an overview of farm and farmer characteristics including farmers' personal characteristics, farms' biophysical and business characteristics, farmers' attitudes (risk attitude, borrowing attitude, and attitude to investment), farmers' self-efficacy to manage risk (both within a season and over the long-term), and farmers' perception to sources of risks over the long-term (upside risk, downside risks, and risk index) is presented to draw a thorough insight into the nature of the PRMS. Next, an overview and the extent of using each of the risk management strategies across the surveyed farmers is presented (section 5.11.3.7). This section also highlighted notable differences between usage rates of different risk management strategies across PRMS (section 5.11.3.7). The focus of the next six sections are on the content of each PRMS. In particular, the potential interrelationship (complementary effect or trade-off effect) between risk management strategies were closely examined. Moreover, using farm and farmer characteristics, the rationale behind the choice of risk management strategies within each PRMS is justified in these sections.

5.11.3.1 *Farmer characteristics across PRMS clusters*

Result of the Pearson's chi-squared test (χ^2) showed that farmers' age is significantly different between, at least two, PRMS (p=0.1). However, pairwise comparisons failed to identify any significant difference between farmers' age across PRMS clusters. As such, the term "trend" is used to explain the difference between farmers' age across PRMS clusters (see section 3.14.4). Therefore, regarding age, there was a trend for PRMS 6 to possess younger farmers. Farmers' managerial experience and level of education were not significantly different across PRMS clusters.

5.11.3.2 *Farm characteristics across PRMS clusters*

Farmers in PRMS 4 and 6 clusters were more likely than other PRMS clusters to own a single farm property. With regard to the geographical location, PRMS 2 farms were more likely than other PRMS clusters to be in Marlborough-Canterbury region whereas PRMS 3 farms were more likely than other PRMS clusters to be in Otago-Southland region. In terms of the business structure, PRMS 6 farms were more likely to be owner-operator farms. From a business life-cycle perspective, PRMS 6 farm businesses were more likely than PRMS 1, 3 and 5 clusters to be at either the entry or exit stage. Moreover, PRMS 4's farmers were more likely than farms in PRMS 3 and PRMS 5 clusters to be at the consolidation stage of the business.

Farms in PRMS 6 produced significantly lower milksolids than farms in other PRMS clusters whereas, farms in PRMS 2 cluster produced significantly more milksolids than farms in other PRMS clusters (except for PRMS 3). In terms of milk solids production per hectare, farms in PRMS 2 and 3 clusters had significantly higher production per ha than PRMS 1 and 6. Finally, PRMS 6 had significantly lower number of employed staff (FTE) than other PRMS clusters, and PRMS 1 farms had significantly lower number of employed staff (FTE) than PRMS 2 and PRMS 3 clusters.

Table 5-22: Selected farm biophysical characteristics across the PRMS clusters.

Farm characteristics [12]	PRMS 1	PRMS 2	PRMS 3	PRMS 4	PRMS 5	PRMS 6	Sample average	F Ratio[3]
Farm size (effective hectare)	156[a] (94)	208[b] (121)	169[a] (91)	136[a] (77)	155[a] (80)	96[c] (48)	156 (92)	11.95***
MS produced in 2016-17 (tonnes)[4]	144[a] (95)	244[b] (171)	219[b] (157)	136[a] (84)	161[a] (78)	81[c] (40)	167 (125)	21.34***
MS per ha (hundred kg)[5]	953[a] (322)	1184[bc] (370)	1243[c] (370)	1007[a] (327)	1064[ab] (316)	904[a] (319)	1065 (355)	7.46***
Stocking rate (Cow per ha)[6]	2.52[a] (.68)	2.95[b] (.70)	2.93[b] (.58)	2.65[a] (.65)	2.75[ab] (.58)	2.49[a] (.59)	2.72 (.65)	4.99***
No of employed staff (FTE)	1.9[a] (1.4)	3.1[b] (2.3)	2.6[b] (1.5)	2.4[ab] (4.3)	2.1[a] (1.3)	0.4[c] (0.7)	2.1 (2.3)	37.21***

1. Standard deviation in bracket.
2. PRMS clusters with common superscripts are not different at the 0.1 level.
3. * p < 0.1; ** p < 0.05; *** p < 0.01
4. As a proxy for gross farm income
5. As a proxy for physical productivity
6. As a proxy for farm production intensity

Farm input system (low vs. medium vs. high) also was significantly different across PRMS. Farms in PRMS 6 were more likely to be low input system than farms in PRMS 2, 3, and 5 clusters. Conversely, farms in PRMS 2 were less likely to be low input system than farms in PRMS 1, 4 and 6 clusters (see appendix table and for full comparisons). Farmers' financial risk-attitude are compared across PRMS clusters in the next section.

5.11.3.3 *Farmers' attitude to risk across PRMS clusters*

Examining the differences between each individual statement highlighted the difference across PRMS clusters. With regard to attitude to risk, PRMS 4 farmers were significantly more risk averse than PRMS 1, 2, and 3 clusters. With regard to attitude to investment, pairwise comparisons showed a trend for PRMS 6 farmers to be more likely to postpone investments until they are really needed than PRMS 1 and PRMS 3 clusters. With regard to attitude to borrowing, there was a trend for PRMS 2 and PRMS 6 clusters to be more afraid of borrowing money than other PRMS clusters. Finally, the overall financial risk-taking attitude also was significant different across PRMS clusters (Table 5-23). Pairwise comparisons showed a trend in PRMS 1 and 3 cluster to be more financial risk-taker than farmers in PRMS 4 and 6 clusters (Table 5-23).

Table 5-23: Attitude to risk, investment, and borrowing across PRMS clusters.

Attitude statements [123]	**PRMS 1**	**PRMS 2**	**PRMS 3**	**PRMS 4**	**PRMS 5**	**PRMS 6**	**Sample**	**One-way ANOVA**[4]
General risk attitude[5] (score out of 5)	3.2[a] (1.1)	3.2[a] (1.1)	3.1[a] (1.0)	2.6[b] (1.0)	3.0[ab] (1.0)	3.0[ab] (1.0)	3.0 (1.0)	2.271*
Investment[6] (score out of 5)	3.4 (0.9)	3.2 (1.2)	3.4 (0.9)	3.2 (1.1)	3.1 (1.0)	2.9 (1.1)	3.2 (1.1)	1.936*
Borrowing[7] (score out of 5)	3.9[ab] (0.9)	3.7[b] (0.9)	4.0[a] (0.9)	3.8[ab] (0.9)	4.0[a] (0.8)	3.6[b] (0.9)	3.9 (0.9)	2.102*
Overall financial risk attitude (score out of 15)[8]	10.53 (1.87)	10.08 (2.11)	10.59 (1.79)	9.71 (2.11)	10.17 (1.79)	9.52 (2.09)	10.12 (1.95)	10.18*

1. Standard deviation in bracket.
2. PRMS clusters with common superscripts are not different at the 0.1 level.
3. If no superscripts is reported then post-hoc test failed to identify any significant difference between PRMS.
4. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
5. Result of a self-reported statement "I take risk more often than other dairy farmers do" is used to measure farmers' risk-taking.
6. Result of a self-reported statement "I postpone investments until they really need to be done".
7. Result of a self-reported statement "I am not afraid to borrow money in order to undertake investments that can enhance profitability".
8. Sum of the three statement: general risk attitude, attitude to investment and attitude to borrowing.

5.11.3.4 *Farmers' Self-efficacy across PRMS clusters*

The total scores of the five statements that constitute risk profile construct (Shadbolt & Olubode-Awosola, 2016) was not significant across PRMS clusters (see Table 5-24). However, further examination of each individual statement highlighted some difference across PRMS clusters. In particular, two statements that were referring to the farmers' risk management self-efficacy were significantly different across PRMS clusters (Table 5-24). Farmers in PRMS 2 and PRMS 3 clusters had significantly lower within a season" self-efficacy than farmers in PRMS 1 and PRMS 4 clusters. Regarding long-term self-efficacy, farmers in PRMS 2 cluster had significantly lower self-efficacy than farmers in PRMS 1 and PRMS 4 clusters (Table 5-24).

Table 5-24: Risk management self-efficacy scores across PRMS clusters.

Self-efficacy [12]	**PRMS 1**	**PRMS 2**	**PRMS 3**	**PRMS 4**	**PRMS 5**	**PRMS 6**	**Sample**	**One-way ANOVA**[3]
Within a season (out of 5)	4.1[a] (0.8)	3.6[b] (0.8)	3.5[b] (1.0)	3.9[a] (0.6)	3.9[ab] (0.7)	3.9[ab] (0.8)	3.8 (0.8)	3.385***
Long term (out of 5)	3.9[a] (0.7)	3.6[b] (0.8)	3.8[ab] (0.9)	4.0[a] (0.7)	3.9[ab] (0.7)	3.8[ab] (0.8)	3.8 (0.8)	2.067*

1. Standard deviation in bracket
2. PRMS clusters with common superscripts are not different at the 0.1 level.
3. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

5.11.3.5 *Farmers' risk perception across PRMS clusters*

This section scrutinised PRMS clusters' perception to risk in two stages. First, the overall perceived opportunity (mean of the upside scores for 22 sources of risk), overall perceived threat (mean of the downside scores for 22 sources of risk), and risk index (overall perceived opportunity/ overall perceived threat) were compared across PRMS clusters. In the second stage, PRMS's perceived opportunity, PRMS's perceived threat, PRMS's risk index (perceived opportunity score/ perceived threat score) for each individual risk sources were compared to identify further differences between PRMS's perception. The overall perceived scores for each PRMS are present in Figure 5-19.

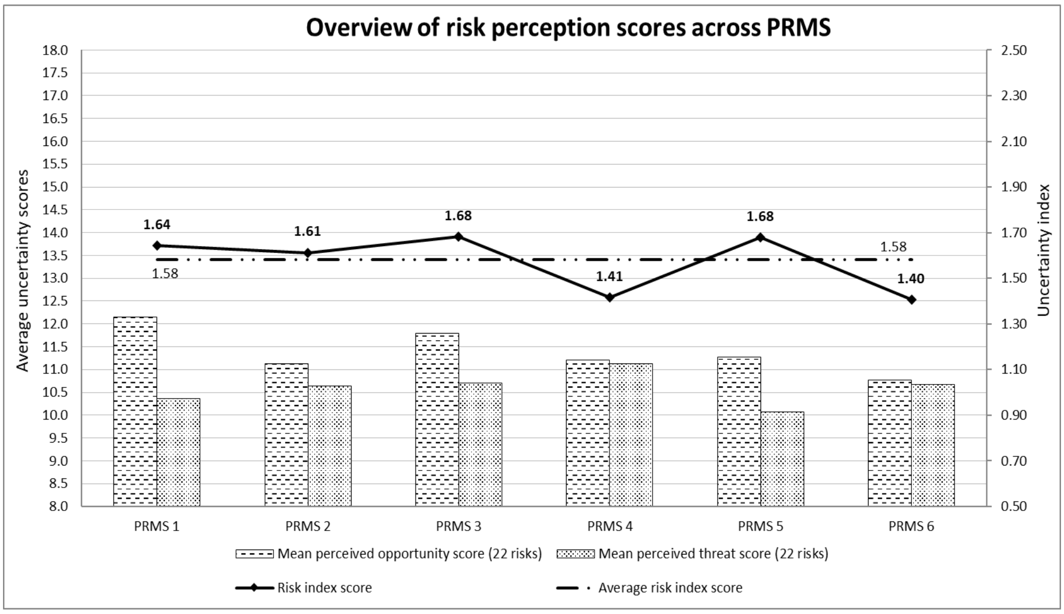


Figure 5-19: Overview of risk perception scores across PRMS.

Figure 5-19 shows that in general, farmers in this study are relatively optimistic about the long-term risk (aggregate risk index= 1.58). This is similar to the findings from the previous studies (Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2016). Comparing risk index scores of the six PRMS clusters, it appeared that farmers in PRMS 1, 3 and 5 clusters tend to be "glass half-full" whereas farmers in PRMS 2, 4, and 6 clusters had a relatively balanced view about the perceived opportunities and threats (see Figure 5-19). Nevertheless, the overall perceived opportunity scores, overall perceived threat scores, and the overall risk index scores were not significantly different across PRMS clusters.

Because there was no statistically significant difference between the overall perception scores, the individual source of risk was examined to identify any possible significant differences between PRMS clusters' risk perception. The perceived opportunity scores for six sources of risks were significantly different across PRMS clusters. The perceived threat scores were only different for two sources of risks across PRMS (Table 5-25). Comparing these two perspectives together shows that farmers' perception to opportunities were more heterogeneous than farmers' perception to threat. This is an interesting finding because, except for a handful of studies (Detre et al., 2006; Shadbolt et al., 2010; Shadbolt & Olubode-Awosola, 2016), empirical studies on farmers' risk perception were biased toward farmers' perceived threat and ignored the fact that the farmers' perceived opportunity also could be different.

Table 5-25: Importance scores for the selected sources of risks across PRMS clusters.

Sources of risk [1,2,3]	PRMS 1	PRMS 2	PRMS 3	PRMS 4	PRMS 5	PRMS 6	Sample	One-way ANOVA[4]
Perceived opportunity:								
Availability of capital	13.0^{a} (5.5)	9.8^{b} (4.9)	12.3^{a} (5.4)	9.8^{b} (5.3)	10.2^{b} (4.7)	12.3^{a} (5.9)	11.2 (5.4)	3.707***
Milk prices	15.6 (5.8)	13.5 (4.9)	15.8 (5.2)	14.8 (5.3)	16.3 (5.3)	15.5 (5.7)	15.2 (5.4)	1.898*
Availability of labour	11.3^{a} (5.3)	11.4^{a} (6.0)	10.8^{a} (5.0)	10.9^{a} (6.3)	11.7^{a} (4.9)	8.0^{b} (5.6)	10.8 (5.6)	2.296**
Staff turnover	7.7^{a} (3.9)	7.5^{ab} (4.5)	8.8^{a} (4.6)	8.7^{a} (6.1)	8.6^{a} (5.8)	5.4^{b} (4.2)	8.0 (5.0)	3.032**
Business relationships	12.4^{a} (5.6)	11.6^{ab} (4.8)	12.9^{a} (4.2)	9.8^{b} (4.7)	11.9^{ab} (4.9)	10.4^{ab} (4.1)	11.6 (4.9)	3.465***
Global supply	16.8^{a} (5.1)	14.2^{b} (5.6)	15.7^{ab} (5.0)	14.1^{b} (5.2)	14.8^{ab} (5.7)	14.2^{ab} (5.8)	15.0 (5.4)	2.332***
Perceived threat:								
Government laws	12.6^{a} (5.1)	13.0^{ab} (5.4)	13.8^{ab} (5.7)	15.5^{b} (5.8)	12.3^{a} (5.7)	14.8^{ab} (5.6)	13.6 (5.7)	2.382**
Local body regulations	13.4^{a} (5.4)	13.9^{ab} (5.7)	14.7^{ab} (6.3)	16.4^{b} (6.6)	13.1^{a} (5.7)	15.6^{ab} (6.4)	14.4 (6.1)	2.137*

1. Standard deviation in bracket
2. PRMS clusters with common superscripts are not different at the 0.1 level.
3. If no superscripts is reported then post-hoc test failed to identify any significant difference between PRMS.
4. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Pairwise comparison showed that the perceived opportunity arising from the availability of capital in PRMS 1, 3, and 6 clusters were significantly higher than PRMS 2, 4 and 5 clusters. Results of the pairwise comparison test revealed a trend for farmers in PRMS 2 to perceive less opportunity from milk prices. PRMS 6 farmers perceive significantly less opportunity from the "staff turnover" and the "availability of labour" than other PRMS clusters. This is not surprising because farmers in this PRMS did not have any employed staff. Regarding business relationships, farmers in PRMS 1 and PRMS 3 clusters perceived significantly higher opportunity than PRMS 4 farmers (Table 5-25). Finally, results of the pairwise comparisons showed a trend for PRMS 1 farmers to perceive more opportunity from global supply and demand for milk. Since farm gate milk price in New Zealand is greatly determined by the global market prices over a season (Dooley et al., 2017; Ma et al., 2018; Shadbolt & Olubode-Awosola, 2016), it is not surprising that the trend in the perceived opportunity scores from "global supply and demand for food" perception and "milk prices" are strongly correlated (Pearson's r=0.46).

The perceived threats that were significantly different across PRMS include the "government laws and policies" and the "local body regulations and laws" (Table 5-25). Pairwise comparisons showed that PRMS 4 farmers perceive significantly higher threat from these risks than farmers in PRMS 1 and PRMS 5 clusters (Table 5-25).

Examining the risk index scores (perceived opportunity score/perceived threat score) across PRMS highlighted another dimension of PRMS's risk perception. The index scores for four sources of risk were significantly different across PRSM clusters (Table 5-26).

Table 5-26: Risk index (upside/downside) scores for the selected risks across PRMS clusters.

Risk index [123]	**PRMS 1**	**PRMS 2**	**PRMS 3**	**PRMS 4**	**PRMS 5**	**PRMS 6**	**Sample**	***One-way ANOVA***[4]
Interest rate	1.14 (0.72)	0.83 (0.48)	1.08 (0.71)	0.89 (0.47)	0.99 (0.71)	0.89 (0.55)	0.98 (0.63)	1.891*
Milk prices	1.33 (1.06)	1.14 (0.78)	1.66 (1.41)	1.17 (0.43)	1.73 (2.27)	1.58 (1.28)	1.44 (1.34)	2.446**
Business relationships	2.64 [ab] (2.74)	2.67 [ab] (3.67)	2.89[a] (2.92)	1.70[b] (1.05)	2.93 [ab] (4.09)	2.19 [ab] (2.62)	2.52 (3.01)	3.060***
Reputation and image	1.40[a] (0.84)	1.03[ab] (0.76)	1.36 [ab] (2.09)	0.99[b] (0.47)	1.23 [ab] (1.34)	0.94[b] (0.52)	1.18 (1.21)	2.733**

1. Standard deviation in bracket
2. PRMS clusters with common superscripts are not different at the 0.1 level.
3. If no superscripts is reported then post-hoc test failed to identify any significant difference between PRMS clusters.
4. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

The pairwise comparison showed a trend among farmers in PRMS 1 and PRMS 3 clusters to be more optimistic than farmers in other PRMS clusters about the "interest rate" risk (Table 5-26). There was also a trend among farmers in PRMS 2 and PRMS 4 to be less optimistic than farmers in other PRMS clusters about the "milk price" risk. Hence, there was a trend among PRMS 4 farmers to be less optimistic than farmers in other PRMS clusters about the "business relationships". Finally, PRMS 1 farmers were significantly more optimistic than farmers in PRMS 4 and PRMS 6 clusters about the "reputation and image of the dairy industry" risk. For the "milk prices" and the "business relationships" the difference in risk index across PRMS clusters can be traced back to the difference in perceived opportunity scores (see Table 5-25). However, the significant difference of the "interest rate" and the "reputation and image" risk index cannot be attributed to either the difference in their perceived risk score or perceived threat scores. Therefore, examining perceived opportunity in relation to perceived threat highlighted yet another aspect of difference in farmers' risk perception.

5.11.3.6 *Determinants of financial management policy across PRMS clusters*

The surveyed farmers indicated the importance of a series of factors influencing debt management strategies of farmers over the long-term, factors influencing their Interest-rate management strategy as well as factors influencing their debt amortization strategy (Table 3-5). In terms of long-term debt strategy(leverage), except for the "tax deductibility of interest" none of the factors were significantly different across the PRMS clusters (Table 5-27). In terms of interest rates risk management policy, "forecasted interest rate at the time of borrowing" and the "flexibility of making additional repayment on floating-rate loans" were the only two significantly different factors across PRMS clusters (Table 5-27).

Table 5-27: Importance Scores for the selected financial management strategies statements across PRMS clusters.

Financial management policy [1,2]	**PRMS 1**	**PRMS 2**	**PRMS 3**	**PRMS 4**	**PRMS 5**	**PRMS 6**	**Sample**	***One-way ANOVA***[3]
Debt-to-assets								
Tax deductibility of interest	2.93[ab] (1.32)	2.47[b] (1.16)	3.13[a] (1.05)	3.10[a] (1.12)	2.94[ab] (1.11)	2.60[b] (0.86)	2.88 (1.14)	3.225***
Interest-rate								
Forecast interest rate (yield curve)	3.77 (0.91)	3.98 (0.64)	3.66 (0.96)	3.86 (0.77)	3.64 (0.98)	3.61 (0.67)	3.72 (0.87)	1.905*
Additional repayment flexibility on floating-rate loans	3.85[a] (0.93)	3.21[b] (1.15)	3.59[ab] (0.99)	3.67[ab] (1.00)	3.41[ab] (1.02)	3.61[ab] (1.00)	3.54 (1.03)	2.270*
Debt amortization								
Overall amount paid on table mortgages vs. overall amount paid on interest-only mortgages	3.42[a] (1.01)	2.55[b] (0.98)	2.93[ab] (1.02)	2.66[ab] (1.07)	3.07[a] (0.84)	3.06[a] (0.94)	2.94 (1.02)	3.934***
Higher tax deductibility potential of interest-only mortgages	3.02[a] (1.14)	2.41[b] (1.12)	3.16[ac] (1.04)	3.18[ac] (1.20)	2.66[ab] (0.83)	2.71[ab] (0.83)	2.87 (1.09)	3.564***
Flexibility in the repayments for interest-only mortgages.	3.77[ab] (1.09)	3.55[ab] (1.04)	3.81[ab] (0.89)	4.03[a] (0.90)	3.44[b] (0.99)	3.57[ab] (0.85)	3.68 (1.00)	2.103*

1. PRMS clusters with common superscripts are not different at the 0.1 level.
2. If no superscripts is reported then post-hoc test failed to identify any significant difference between PRMS clusters.
3. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

In terms of debt amortization policy, three factors were found to be significantly different across PRMS clusters (Table 5-27). PRMS 2 farmers' beliefs on the importance of the "overall amount paid on table versus the overall amount paid on interest-only mortgages" was significantly lower than PRMS 1, 5, and 6 farmers. Farmers in PRMS 2 believed that the "tax deductibility potential of interest-only mortgages" was significantly less important than farmers in PRMS clusters 1, 3, and 4. Finally, for farmers in the PRMS 5 cluster "flexibility in the repayments for interest-only mortgages" was less important than farmers in the PRMS 4 cluster.

5.11.3.7 *Utilization of risk management strategies across PRMS clusters*

Table 5-28 presents the percentages of individuals within each PRMS who used each of the 22 risk management strategies. The average and median usage rates for each of the risk management strategies across the sample also are reported along with the Pearson's Chi-square test values which indicate whether there is a statistically significant difference between two or more PRMS clusters.

Having feed reserves (92%), providing good working conditions for staff (88%), and using predominantly interest-only mortgages (81%) were the most frequently used risk management strategies. Use of a combination of interest-only and principal-and-interest loans (8%), predominately principal-and-interest loans (table loans) (11%), futures markets to sell milk (12%), and geographical diversification (18%) were the four least utilized risk management strategies. The next sections substantiate the statistically significant difference across PRMS clusters (For full comparison see appendix VIII to appendix X).

Table 5-28: Distribution of risk management strategy utilisation rate across PRMS (n=321).

Risk management strategies[1]	PRMS 1 (n=59)	PRMS 2 (n=49)	PRMS 3 (n= 64)	PRMS 4 (n= 53)	PRMS 5 (n= 54)	PRMS 6 (n= 42)	*μ[2]*	*Md [3]*	*X^2 values[4]*
1. Having feed reserves	100.0[a]	98.0[a]	95.3[a]	98.1[a]	61.1[b]	97.6[a]	*91.7*	*97.8*	79.2***
2. Not producing to full capacity	72.4[a]	27.6[b]	20.4[b]	56.9[a]	27.8[b]	45.2[ab]	41.5	*37*	*48.2****
3. Grazing dairy stock off-farm	59.3	79.6	79.4	69.8	79.6	73.8	*73.2*	*76.6*	*9.5*
4. Having irrigation	18.6[ac]	53.1[b]	14.1[a]	7.5[c]	25.9[a]	11.9[ac]	*21.7*	*16.4*	*40.3****
5. Owning a run-off (support block)	80.7[a]	60.4[b]	34.4[c]	49.1[bc]	37[c]	21.4[c]	*47.6*	*43.1*	*46.7****
6. Infrastructure for wet soil	72.9[a]	20.4[b]	89.1[c]	66[ad]	29.6[bd]	47.6[d]	*56.8*	*56.8*	*79.1****
7. Futures markets to sell milk	27.6[a]	20.4[a]	4.8[b]	5.7[b]	1.9[b]	12.2[ab]	11.9	9.0	*27.1****
8. Contracts to procure inputs	59.3[a]	79.6[b]	93.8[c]	56.6[a]	27.8[d]	64.3[ab]	*64.3*	*61.8*	*62.5****
9. Spreading sales	60.3[a]	14.6[b]	38.1[c]	11.3[b]	1.9[d]	24.4[bc]	*26.3*	*19.5*	*65.7****
10. Use of contract-milkers and/or share-milkers	27.6[a]	50.0[b]	56.2[b]	45.3[ab]	60.4[b]	2.4[c]	*41.8*	*47.7*	*46.2****
11. Employing experienced staff	86.2[a]	95.9[ab]	100.0[b]	69.8[c]	85.2[b]	2.4[d]	*76.6*	*85.7*	*164.6****
12. Providing training for staff	98.3[a]	85.4[b]	85.7[b]	55.8[c]	63.0[c]	7.1[d]	*68.8*	*74.2*	*117.3****
13. Technology to reduce labour	84.2[a]	67.3[b]	79.4[ab]	62.3[b]	63.0[b]	31[c]	*66.5*	*65.2*	*37.2****
14. Providing good working conditions for staff	100.0[a]	100.0[a]	100.0[a]	96.2[a]	96.3[a]	21.4[b]	*88.4*	*98.2*	*211.8****
15. Enterprises diversification	74.6[a]	49.0[b]	15.6[cd]	13.2[cd]	5.6[d]	28.6[c]	*31.2*	*22.1*	90.9***
16. Geographical diversification	50.8[a]	30.6[b]	10.9[c]	5.9[cd]	5.6[cd]	0.0[d]	*18.2*	*8.4*	*70.0****
17. Off-farm income	67.2[a]	49.0[ab]	45.3[b]	57.7[ab]	24.1[c]	28.6[bc]	*46.1*	*47.2*	*29.2****
<u>Financial management</u>									
18. intended low debt strategy (5-7 years)	72.9[a]	23.4[b]	42.2[c]	86.3[a]	52.8[c]	56.1[c]	*55.8*	*54.5*	*51.2****
<u>19. Interest rate risk management strategy</u> [5]									*19.8***
predominantly floating	44.6[a]	36.2[a]	47.6[a]	63.0[b]	30.0[a]	39.0[a]	*43.3*	*41.8*	
float & fix	30.4[a]	29.8[a]	34.9[a]	8.7[b]	40.0[a]	31.7[a]	*26.4*	*31.1*	
predominantly fix	25.0[a]	34.0[a]	17.5[a]	28.3[b]	30.0[a]	29.3[a]	*27.1*	*28.8*	
<u>20. Debt amortization strategy</u> [5]									*26.3****
predominantly IO	74.1[a]	91.3[b]	75.8[bc]	95.3[b]	81.6[abc]	66.7[ac]	*80.9*	*78.7*	
IO and P&I	3.7[a]	6.5[b]	14.5[bc]	0.0[b]	8.2[abc]	15.4[ac]	*8.2*	*7.4*	
predominantly P&I	22.2[a]	2.2[b]	9.7[bc]	4.7[b]	10.2[abc]	17.9[ac]	*10.9*	*10.0*	
<u>21. Cash reserve size</u> [5]									*162.4****
no cash	28.8[a]	81.6[b]	25.0[a]	13.2[c]	29.6[a]	47.6[d]	*35.7*	*29.2*	
short-term cash	40.7[a]	10.2[b]	40.6[a]	9.4[c]	29.6[a]	35.7[d]	*28.2*	*32.7*	
a year cash	22.0[a]	6.1[b]	28.1[a]	22.6[c]	37.0[a]	16.7[d]	*22.8*	*22.3*	
>1y cash	8.5[a]	2.0[b]	6.2[a]	54.7[c]	3.7[a]	0.0[d]	*13.2*	*5.0*	
<u>22. Overdraft size</u> [5]									*144.0****
no OD	3.4[a]	4.1[b]	0.0[a]	41.5[c]	5.6[a]	2.4[d]	*9.6*	*3.8*	
short-term OD	44.1[a]	8.2[b]	37.5[a]	17.0[c]	42.6[a]	19.0[d]	*29.4*	*28.3*	
a year OD	37.3[a]	30.6[b]	54.7[a]	26.4[c]	42.6[a]	54.8[d]	*41.1*	*40.0*	
>1y OD	15.3[a]	57.1[b]	7.8[a]	15.1[c]	9.3[a]	23.8[d]	*19.8*	*15.2*	

1. PRMS clusters with common superscripts are not different at the 0.1 level.
2. Average usage rate across the sample
3. Median usage rate across PRMS clusters
*4. * p < 0.1; ** p < 0.05; *** p < 0.001*
5. Column totals are 100 per cent

5.11.3.8 *PRMS 1*

Farmers in this PRMS comprise 18 per cent of the sample. Members in this group used a wide range of risk management strategies (Table 5-28). The risk attitude of farmers in the PRMS 1 was not different from other farmers in the sample. However, they tended to take on more financial risk. Farmers in PRMS 1 also appeared to be more confident about their ability to manage risks within the season and over the long-term. This is not surprising because the higher usage rate of a wide range of risk management strategies would provide them with the ability to manage most of the risks that potentially could happen within the season and over the longer term (Table 5-29).

Examining PRMS 1's risk management strategies could highlight some of the associations between risk management strategies within this portfolio. To begin with, the extensive use of "not producing to full capacity" can be attributed to the low-to-medium input use production system that these farmers adopted. Also, a relatively higher percentage of farmers in this group pursued the spreading sale strategy, presumably through winter milking. The expectation was that they use contracts to procure feed input during the winter season. However, the percentage of farmer who were utilising the "contracts to procure inputs" strategy was not significantly different from other farmers in other PRMS clusters. This suggest that the "owning a runoff" combined with a low-to-medium input system could enable these farmers to produce supplement during the spring, store and then feed it to the milking herd during late autumn and winter (when the pasture production is not high).

Farmers in PRMS 1 cluster were less likely to use "share-milkers or contract-milkers" to run their farms (Table 5-29). Instead, they used other human resource management strategies such as "providing training for staff" and, to a lesser extent, "employing experienced staff". The use of different diversification strategies including geographical diversification, off-farm income, and enterprise diversification, was another aspect of PRMS 1's risk management portfolio that particularly stands out for this group. Again, owning a runoff may allow PRMS 1 farmers to diversify into other pastoral farming enterprises such as rearing surplus cattle for beef production.

A significantly higher percentage of farmers in PRMS 1 used the geographical diversification strategy (Table 5-29), which suggests these farmers owned another property outside of the home farm region. However, except for the PRMS 6, cross tabulation did not show any significant difference between PRMS clusters in terms of the number of owned farms (Appendix Table 4). As such, it is possible that members of this PRMS have investment (i.e., share in an equity partnership) in a dairy farm somewhere other than the home farm region. A relatively higher number of farms in this cluster also used off-farm income strategy. It could be that the moderate farm size with low-to-medium intensive production system allowed a relatively higher percentage of farm household members in this group to work off farm.

Table 5-29: Summary of the main differences of PRMS 1 cluster with other PRMS clusters.

	PMRS 1 cluster mean	**Sample's mean**	**Comparison to other PRMS *(p=0.1)***
Farmer Characteristics			
Risk attitude:			
Overall financial risk attitude (out of 15)	10.53	10.12	-
Risk management self-efficacy:			
Within a season (out of 5)	4.1	3.8	H (2,3)
Long-term (out of 5)	3.9	3.8	H (2,3)
Importance scores for financial management strategies:			
Interest rate: Additional repayment flexibility on floating-rate loans	3.85	3.54	H (2)
Debt amortization: Overall amount paid on table mortgages vs. overall amount paid on interest-only mortgages	3.42	2.94	H (2,3,4)
Risk perception:			
Opportunity: availability of capital (out of 25)	13	11.2	H (2,4,6)
Opportunity: global supply & demand (out of 25)	16.8	15	H
Risk Index: Interest rate	1.14	0.98	H (2,4,5,6)
Risk Index: Reputation and image	1.4	1.18	H (4,6)
Farm Business Characteristics			
Milk solids per hectare	953	1065	L (2,3)
No of employed staff (FTE)	1.9	2.1	L (2,3)
Risk Management Strategies			
Not producing to full capacity	72%	42%	H (2,3,5,6)
Owning a run-off (support block)	81%	48%	H (2,3,4,4,6)
Infrastructure for wet soil	73%	57%	H (2,5,6); L (3)
Spreading sales	60%	26%	H
Futures markets to sell milk	28%	12%	H (3,4,5)
Use of contract-milkers and/or share-milkers	28%	48%	H (6); L (2,3,4,5)
Providing training for staff	98%	74%	H
Geographical diversification	51%	18%	H
Enterprises diversification	75%	31%	H
Off-farm income	67%	46%	H (5,6)
Intention for a low debt over the next 5-7 years	73%	56%	H (2,3,5)
Predominately IO mortgages	74%	81%	L (2,4)

H: significantly higher than PRMS clusters in bracket. No bracket means significantly higher than all other PRMS clusters.
L: significantly lower than PRMS clusters in bracket. No bracket means significantly lower than all other PRMS clusters.

73% of farmers in the PRMS 1 were more likely to target a low leverage ratio strategy. A relatively lower percentage of PRMS 1 farmers utilised interest-only mortgages as their preferred debt amortization policy. Minimising the overall amount paid on mortgages by quickly paying off principal was the reason why a relatively higher percentage of farmers in the group chose principal-and-interest mortgages (see Table 5-29). In terms of liquidity management, the size of the liquidity reserve for

PRMS 1 farmers was only large enough to cover short-term cash flow deficits that were provided through a combination of an overdraft line of credit and cash reserves.

PRMS 1 farmers risk perception can also be explained by examining the portfolio of risk management strategies that they utilise to manage risk. The opportunity arising from "access to capital" were perceived to be higher for farmers in PRMS 1. Moreover, farmers in this group tend to be more optimistic about interest rate risk. It is not surprising that farmers in this group, who generally are maintain a low debt ratio, perceived more opportunity from these two financial sources of risk.

5.11.3.9 *PRMS 2*

Farmers in the PRMS 2 comprise 15 per cent of the sample. They were more likely to be in the Marlborough-Canterbury and the Central Otago regions where irrigation is a necessity to support pasture production in summer. Farms in this group were relatively large and tended to have a more intensive (medium to high) production system (Table 5-30). The general risk attitude score of farmers in this group was not different from farmers in other PRMS clusters. However, they tended to be relatively more risk averse with respect to borrowing. This group of farmers also tended to have a lower self-efficacy to manage uncertainties both within a season and over the long-term.

In addition to irrigation, these farmers more extensively utilised input contracts to support feed supply for the milking herd. It appeared that utilising both irrigation and input contracts provides more certainty in terms of feed supply for these farmers. Therefore, not producing to full capacity were less likely to be utilised by farmers in this PRMS cluster.

The producing to full capacity also fits with the targeted debt strategy that was chosen by farmers in this group (Table 5-30). PRMS 2 farmers were less likely to intend for a low debt strategy (23%) and producing to full capacity allowed them to produce enough cash operating surplus to service the debt (pay interests and possibly repay the principal). Less likelihood of intending for a low debt may also be the reason that these farmers are less likely to use technology to reduce labour because implementing new farm technologies requires an increase in financial commitment (Borchers & Bewley, 2015). The size of the liquidity reserve for this group of farmers was large enough to cover more than a one year of cash flow deficit. However, their liquidity reserve was only available through an overdraft line of credit (no cash). Again, less likelihood of intending for a low debt may be the reason why these farmers relied heavily on a large overdraft line of credit to manage potential cash flow deficits (Table 5-30).

Table 5-30: Summary of the main differences of PRMS 2 cluster with other PRMS clusters.

	PMRS 2 cluster mean	Sample's mean	Comparison to other PRMS *(p=0.1)*
Farmer Characteristics			
<u>Risk attitude:</u>			
Borrowing attitude (out of 5)	3.7	3.9	L (1,3,4,5)
<u>Risk management self-efficacy:</u>			
Within a season (out of 5)	3.6	3.8	L (1,4)
Long-term (out of 5)	3.6	3.8	L (1,4)
<u>Importance scores for financial management strategies:</u>			
Intended long-term debt: Tax deductibility of debt (out of 5)	2.47	2.88	L (3,4)
Interest rate: Forecasted interest rate (yield curve) (out of 5)	3.98	3.72	H
Interest rate: Additional repayment flexibility on floating-rate loans (out of 5)	3.85	3.54	L (1)
Debt amortization: Overall amount paid on table-mortgages vs. overall amount paid on Interest-Only mortgages (out of 5)	2.55	2.94	L (1,5,6)
Debt amortization: Higher tax deductibility potential of interest-only mortgages (out of 5)	2.41	2.87	L (3,4)
<u>Risk perception:</u>			
Opportunity: availability of capital (out of 25)	9.8	11.2	L (1,3,5)
Opportunity: milk prices (out of 25)	13.5	15.2	L
Farm Business Characteristics			
Farm location	Marlborough-Canterbury & Central Otago	–	More likely than other PRMS clusters
MS production (tonnes)	244	167	H (1,4,5,6)
Milk solids per hectare (Kg)	1184	1065	H (1, 6)
Production system intensity	Low input	–	Less likely than PRMS clusters 1,4, and 6
Risk Management Strategies			
Owning a run-off (support block)	60%	48%	H (3,5,6)
Irrigation	53%	16%	H
Infrastructure for wet soil	20%	57%	L (1,3,4,6)
Future markets	20%	12%	H (3,4,5)
Input contracts	80%	64%	L (3); H (1,4,5,6)
Providing training for staff	86%	74%	L (1); H (4,5,6)
Geographical diversification	31%	18%	H (3,4,5,6)
Enterprise diversification	49%	31%	H (3,4,5,6)
Off-farm income	49%	46%	H (5,6)
Intention for a low debt over the next 5-7 years	23%	56%	L (1,3,4,5,6)
Predominately Interest-only mortgages	91%	81%	H (1,6)
No cash	82%	36%	L
>1 year OD	57%	20%	H

H: significantly higher than PRMS clusters in bracket. No bracket means significantly higher than all other PRMS clusters.
L: significantly lower than PRMS clusters in bracket. No bracket means significantly lower than all other PRMS clusters.

5.11.3.10 *PRMS 3*

Farmers in the PRMS 3 made up almost 20 per cent of the sample (Table 5-31). They were more likely to be in the Otago-Southland region where the use of a “wet-soil management” facility is an essential requirement for dairy farming. These farmers were slightly larger than the average farm size and tended to have more intensive production system however, they were relatively more inclined to take on financial risks. This group of farmers also tended to have a lower self-efficacy to manage uncertainties within a season.

In addition to having infrastructure for wet soil management infrastructure, input contracts were more extensively utilised to support feed supply by farmers in this group. As such, the use of the "not producing to full capacity" strategy was less relevant strategy for this PRMS (i.e., there is no point in utilising "not producing to full capacity" when feed supply is relatively certain with a “wet soil management facility” and “input contracts”). These strategies could increase the likelihood of utilising the “spreading sales” (i.e., winter milking) strategy among PRMS 3 farmers. However, unlike PRMS 1 farmers, these farmers did not pursue a spreading sales strategy (i.e., winter milking). The undesirable climatic conditions (prolonged wet winter seasons in the Otago-Southland region) appeared to be the main reason why these farmers did not extend their herd’s lactation into the winter and pursue the spreading sale strategy (Table 5-31).

Approximately half of the farmers in this group hired sharemilkers or contract-milkers to run their farms and chose to employ experienced staff in their businesses. Providing training for staff was another human resource management strategy that was extensively utilised by this group. However, the degree of training was less than farmers in PRMS 1 cluster. Finally, none of the diversification strategies particularly stand out for farmers in this group.

Approximately 40% of the farmers in PRMS 3 cluster intended for a low debt. Tax deductibility of interest was a more important factor in the choice of PRMS 3 farmers’ intended debt. These farmers also chose a balanced (a mix of fixed and floating interest rates) strategy to manage interest rate risk (Table 5-31). Like other PRMS clusters, they were more likely to utilise interest-only mortgages as their preferred debt amortization strategy. The flexibility in repaying debt and the higher tax deductibility potential of interest-only mortgages were two relatively important factors in their debt level and debt amortization strategy. Finally, the liquidity reserves of these farmers were available through both cash reserves and an overdraft line of credit (Table 5-31).

Table 5-31: Summary of the main differences of PRMS 3 cluster with other PRMS clusters.

	PMRS 3 cluster mean	Sample's mean	Comparison to other PRMS (*p=0.1*)
Farmer Characteristics			
Risk attitude:			
Overall financial risk attitude (out of 15)	10.59	10.12	-
Risk management self-efficacy:			
Within-a-season	3.5	3.8	L (1,4,5,6)
Risk perception:			
Opportunity: availability of capital (out of 25)	12.3	11.2	H (2,4,6)
Opportunity: business relationships (out of 25)	12.9	11.6	H (4,6)
Risk Index: Interest rate	1.08	0.98	H (2,4,5,6)
Farm Business Characteristics			
Farm location	Otago-Southland	_	More likely than other PRMS clusters
Milk solids per hectare (Kg)	1243	1065	H (1, 6)
Importance scores for financial management strategies:			
Intended long-term debt: Tax deductibility of debt (out of 5)	3.13	2.88	H (2,6)
Debt amortization: Higher tax deductibility potential of Interest-Only mortgages (out of 5)	3.16	2.87	H (2,5,6)
Risk Management Strategies			
Infrastructure for wet soil	89%	57%	H (1,2,4,5,6)
Future markets	5%	12%	L (1,2,6)
Input contracts	94%	64%	H
Providing training for staff	85%	74%	L (1); H (4,5,6)
Employing experienced staff	100%	76%	H
Off-farm income	45%	46%	H (5,6)

H: significantly higher than PRMS clusters in bracket. No bracket means significantly higher than all other PRMS clusters.
L: significantly lower than PRMS clusters in bracket. No bracket means significantly lower than all other PRMS clusters.

PRMS 3 farmers' risk perceptions also reflect their choice of risk management strategies. The higher likelihood of intending for a low debt suggest that the "availability of capital" provides relatively greater opportunity to them than farmers in other clusters. Extensive use of feed contracts provided farmers with the opportunity to implement a more intensive production system. As such, it is not surprising that these farmers perceived more opportunity from business relationships. These farmers were more likely to have an intensive (medium to high) production system and their reliance on bought-in feed to support pasture suggest that, on average, they have relatively higher operating expenses (Ma et al., 2018; Shadbolt et al., 2017). In addition to this, using contracts to procure bought-in feed suggest that they did not have much flexibility to adjust their feed cost in response to the changes in milk prices within a season (Dooley et al., 2017). Therefore, it is not surprising that the self-efficacy of the farmers in this group to manage risks within a season was relatively low.

5.11.3.11 *PRMS 4*

Farmers in PRMS 4 made up 16% of the sample. These farmers were more likely to own a single farm. The average farm size in this PRMS cluster was relatively smaller than those in other clusters, and their farm system were relatively less intensive (low input). The risk attitude of these farmers was significantly lower than that of farmers in other PRMS clusters. Hence, they were less inclined to take on financial risk. As with farmers in PRMS 1, these farmers appeared to be more confident about their ability to manage risk within the season and over the long-term (Table 5-32).

The use of a “not producing to full capacity” strategy (having a production buffer) was relatively higher in this cluster compared to other PRMS clusters. However, unlike PRMS 1 farmers, they did not pursue the spreading sale strategy (i.e., winter milking). Although almost half of the farms in this cluster owned support blocks (run-offs), enterprise diversification was not pursued by farmers in this cluster and having an off-farm job was the only diversification risk management strategy that particularly stands out for farmers in this PRMS cluster (Table 5-32).

A relatively higher percentage of the farmers in this group were intending for a low debt policy (86.3%). A significantly higher number of these farmers were utilising floating rate loans to manage interest rate risk. As with farmers in the PRMS 2 cluster, these farmers were more likely to use interest-only loans as their preferred debt amortization strategy. However, they had a different incentive to choose this debt amortization strategy (Table 5-32).

Flexibility in debt repayments and the higher tax deductibility potential for interest-only mortgages were particularly important factors in their choice of debt amortization strategy (Table 5-32). The liquidity management strategy of farmers in this PRMS cluster was also fundamentally different from other PRMS clusters. In that, a relatively high percentage of farmers in this PRMS cluster did not arrange an overdraft line of credit. Instead, their cash reserves were large enough to cover more than one year of potential cash-flow deficits.

Their risk management portfolio may explain why these farmers are relatively more confident about their ability to manage risk both within the season and over the long–term. Using a less intensive production system combined with cash reserves are two major strategies that would help farmers respond to uncertainty within a season. On the other hand, a strong equity position combined with the use of income diversification would allow them to believe that they can manage the risk over the longer term.

Table 5-32: Summary of the main differences of PRMS 4 cluster with other PRMS clusters.

	PMRS 4 cluster mean	Sample's mean	Comparison to other PRMS *(p=0.1)*
Farmer Characteristics			
Risk attitude:			
General risk attitude score (out of 5)	2.6	3	L
Overall financial risk attitude score (out of 15)	9.71	10.12	L (1,3)
Farm Business Characteristics			
Life-cycle stage of the business	Consolidation	_	More likely than PRMS clusters 3 and 5
Importance scores for financial management strategies:			
Intended long-term debt: Tax deductibility of debt (out of 5)	3.1	2.88	H (2,6)
Debt amortization: Higher tax deductibility potential of Interest-Only mortgages (out of 5)	3.18	2.87	H (2,5,6)
Debt amortization: Additional repayment flexibility in Interest-Only mortgages (out of 5)	4.03	3.68	H
Risk perception:			
Opportunity: availability of capital (out of 25)	9.8	11.2	L (1,3,5)
Risk Index: Milk prices	1.17	1.44	L (1,3,5,6)
Risk Index: Business relationships	1.7	2.52	L
Risk Management Strategies			
Not producing to full capacity	57%	42%	H (2,3,5)
Future markets	6%	12%	L (1,2,6)
Employing experienced staff	70%	86%	L (1,2,3,5)
Providing training for staff	56%	74%	L (1,2,3)
Off-farm income	58%	46%	H (5,6)
Intention for a low debt over the next 5-7 years	86%	56%	H (2,3,5,6)
Predominantly floating-rate loans	63%	43%	H
Predominately IO mortgages	95%	81%	H (1,6)
>1 year cash	55%	13%	H
No OD	42%	10%	H

H: significantly higher than PRMS clusters in bracket. No bracket means significantly higher than all other PRMS clusters.
L: significantly lower than PRMS clusters in bracket. No bracket means significantly lower than all other PRMS clusters.

Despite having a strong equity position, these farmers perceived less opportunity from the availability of capital. This might be because these farmers are less willing to take on financial risk. (no desire to borrow further funds). Because their general risk-attitude score is significantly lower than other PRMS clusters, these farmers in general, perceived less opportunity and greater threat from different sources of risk. For example, although they had a relatively less intensive production system, they perceive significantly more threat from government laws and local body regulations. Finally, the risk index score for these farmers shows that they are less optimistic about business relationships and the reputation and image of the dairy industry.

5.11.3.12 *PRMS 5*

Farmers in PRMS 5 made up 17% of the sample. Farmers in this PRMS appeared to be in locations that have relatively benign climatic conditions such as the Waikato and Taranaki regions. Farms in this group had a medium farm size and implemented a moderately intensive farm input system (close to the samples' average). PRMS 5 farmers' attitude to borrowing score was significantly higher than other PRMS clusters. That is, they were less averse to borrowing money in order to enhance their profitability and, ultimately, grow their equity (Table 5-33).

Table 5-33: Summary of the main differences of PRMS 5 cluster with other PRMS clusters.

	PMRS 5 cluster mean	**Sample's mean**	**Comparison to other PRMS *(p=0.1)***
Farmer Characteristics			
-			
Farm Business Characteristics			
-			
Importance scores for financial management strategies:			
Debt amortization: Higher tax deductibility potential of interest-only mortgages (out of 5)	2.66	2.87	L (3,4)
Risk perception:			
Opportunity: availability of capital (out of 25)	10.2	11.2	H (2,4,6)
Threat: government regulations (out of 25)	15.5	13.6	H (1,5)
Threat: local body regulations (out of 25)	16.4	14.1	H (1,5)
Risk Management Strategies			
Feed reserves	61%	92%	L
Infrastructure for wet soil	48%	57%	L (1,3,4)
Future markets	2%	12%	L (1,2,6)
Spreading sales	2%	26%	L
Input contracts	28%	64%	L
Off-farm income	24%	46%	L (1,2,3,4)
Providing training for staff	63%	74%	L (1,2,3)

H: significantly higher than PRMS clusters in bracket. No bracket means significantly higher than all other PRMS clusters.
L: significantly lower than PRMS clusters in bracket. No bracket means significantly lower than all other PRMS clusters.

It appears that farming in a relatively benign climate allowed farmers in this group to produce to full capacity. Interestingly, and compared to farmers in other PRMS clusters, farmers in this PRMS cluster were less likely to "maintain feed reserves" (Table 5-33). Similarly, marketing risk management strategy was less likely to be utilised by farmers in PRMS 5. That is, they were not using contracts to procure inputs. This might be explained by the fact that virtually none of the farmers in this cluster are using the spreading sales strategy. That is, these farmers are better able to match milking herd demand with the pasture growth curve throughout the season. None of the diversification strategies were extensively pursued by farmers in this group. Farms in this PRMS were less likely to have contract-milker and sharemilker.

Approximately half of the farmers in this group intended to maintain a low debt level. Similar to farmers in other clusters, interest-only mortgages were the preferred debt amortization policy. Minimising the overall amount paid on mortgages was a relatively more important factor in the choice of interest-only mortgages whereas flexibility in servicing debt was relatively less important for farmers in this PRMS cluster (see Table 5-27). The size of the liquidity reserve was only large enough to cover one year of cash flow deficit, and this liquidity was mostly provided through an overdraft line of credit and to a lesser extent through cash reserves.

These farmers appeared to be more optimistic about global supply and demand for food and milk prices than other farmers. It is likely that these farmers were farming in relatively benign climatic conditions that let them produce to full capacity without many feed reserves. So, they are less concerned about climatic variability and are able to produce milk at a relatively low cost. These farmers also perceived less threat from government laws and local government regulations which might reflect the fact that these farmers are running a less intensive production systems. The high self-efficacy scores of these farmers also reflected the fact that they farm in a relatively benign climate so they believe that they can manage risks both within a season and over the long term.

5.11.3.13 *PRMS 6*

Farmers in this PRMS made up 13% of the sample and use the least number of risk management strategies. Yet, their risk management self-efficacy was similar to other PRMS clusters. These farmers were mostly owner-operators who own a single farm and are running low input farm systems. PRMS 6 farmers were relatively younger and were more likely to be at either “entry” or “exit” stage of the business. There was a trend among farmers in this cluster to postpone investment until they really needed it. Similarly, their financial risk attitude score indicated that these farmers are relatively less inclined to take on financial risks (Table 5-34).

The average farm size was significantly smaller than those in other PRMS clusters (almost half of the size of the sample’s average) and the number of employed staff was significantly lower than in other PRMS clusters. That is, the farm family household constituted the majority of the farm labour. Examining PRMS 6’s risk management strategies highlighted some of the associations between risk management strategies within this portfolio. To begin with, the use of “not producing to full capacity” can be attributed to the relatively low input production system that these farmers adopted. None of the HR risk management strategies were utilised by farmers in the PRMS 6. Interestingly, the “technology to reduce labour” strategy, which could be utilised by all farms regardless of the number of staff, was not utilised by farmers in this PRMS (Table 5-34). Similarly, none of the diversification strategies were pursued by farmers in this cluster. A combination of relatively small farm size, significantly lower likelihood of owning a run-off and not having any employed staff on the farm could be the reasons why these farmers are not pursuing any of the diversification strategies (Table 5-34).

Table 5-34: Summary of the main differences of PRMS 6 cluster with other PRMS clusters

	PMRS 6 cluster mean	Sample's mean	Comparison to other PRMS clusters *(p=0.1)*
Farmer Characteristics			
Age	Younger	–	More likely than other PRMS clusters
Risk attitude:			
Investment attitude (out of 5)	2.9	3.2	L (1,3)
Borrowing attitude (out of 5)	3.6	3.9	L (1,3,4,5)
Overall financial risk attitude (out of 15)	9.52	10.12	L (1,3)
Farm Business Characteristics			
Business structure	Owner-operator	–	More likely than other PRMS clusters
Life-cycle stage of the business	Entry and Exit		More likely than PRMS clusters 1, 3 and 5
MS production (tonnes)	81	167	L
Milk solids per hectare (Kg)	904	1065	L (2,3)
Production system intensity	Low input	–	More likely than PRMs clusters 2,3, and 5
No of employed staff (FTE)	0.4	2.1	L
Importance scores for financial management strategies:			
Intended long-term debt: Tax deductibility of debt (out of 5)	2.6	2.88	L (3,4)
Debt amortization: Higher tax deductibility potential of interest-only mortgages (out of 5)	2.71	2.87	L (3,4)
Risk perception:			
Opportunity: availability of capital (out of 25)	12.3	11.2	L (1,3,5)
Opportunity: availability of labour (out of 25)	8.0	10.8	Less likely than other PRMS clusters
Opportunity: staff turnover (out of 25)	5.4	8.0	Less likely than other PRMS clusters
Risk Management Strategies			
Owning a run-off (support block)	21%	48%	L (1,2)
Infrastructure for wet soil	48%	57%	L (1,3); H (2)
Future markets	12%	11%	H (3,4,5)
Use of contract-milkers and/or share-milkers	2%	42%	Less likely than other PRMS clusters
Employing experienced staff	2%	77%	
Providing training for staff	7%	69%	
Technology to reduce labour	31%	66%	
Providing good working conditions for staff	21%	88%	
Off-farm income	29%	46%	L (1,2,3,4)
Predominately Interest-Only mortgages	67%	81%	L (2,4)

H: significantly higher than PRMS clusters in bracket. No bracket means significantly higher than all other PRMS clusters.
L: significantly lower than PRMS clusters in bracket. No bracket means significantly lower than all other PRMS clusters.

Slightly more than 56% of the farmers in the PRMS 6 cluster intended for a low debt ratio. A lower percentage of PRMS 6 farmers utilised interest-only mortgages as their debt amortization policy. Like PRMS 1 farmers, minimising the overall amount paid on mortgages was the reason why a relatively higher percentage of farmers in this group chose principal-and-interest mortgages (see Table 5-27).

The size of the liquidity reserves for the PRMS 6 farmers appeared to be large enough to cover short-term cash flow deficits which were provided through a combination of overdraft and cash reserves. Yet, none of the farmers in this PRMS cluster had more than 1-year of cash reserves so they relied on the overdraft to manage unexpected cash-flow deficits that continued for more than one season.

These farmers did not employ any staff. As such, they perceive significantly less opportunity from human resource risk. However, they perceived relatively more opportunity from the availability of capital. Even though they have a relatively less intensive production system, as with farmers in PRMS 4, they perceived significantly more threat from government laws and local body regulations. Finally, they were less optimistic about the reputation and image of the dairy industry (Table 5-34).

5.11.4 Multivariate analysis of portfolios of risk management strategies

The use of the Pearson chi-square test and the subsequent post-hoc analyses (with Benjamini-Hochberg correction) allowed a straightforward interpretation about the nature of difference between clusters. However, this method is appropriate when the objective of statistical analyses is description of clusters, and it is not suitable for modelling and prediction (Agresti, 2002). Therefore, in this section a multivariate logit model is employed to identify the extent which the predictors that are proposed in the conceptual model suggested by Wilson, Dahlgran, & Conklin's (1993) could predict the membership in each of the PRMS's.

5.11.4.1 *Step 1: Variable selection and model fit estimation*

Results of the AIC and BIC estimation for some of the estimated models are presented in the Table 5-35. Comparing the AIC and BIC values of the models provides some useful insights into the contribution of each predictor to model fit estimation. Table 5-35 indicates that the variables "Age" (compared models 2 and 3) and "Location" (compared to models 8 and 9) considerably increase both the AIC and BIC values, which suggests exclusion of these two variables improves the model fit estimation. However, Exclusion of variable "location" from the regression model is problematic and can be misleading. The cross-tabulation of regions with PRMS showed that farm location is one of the variables that is significantly different across PRMS (Appendix Table 5). In particular, PRMS 2 and PRMS 3 clusters are closely associated with Marlborough - Canterbury and Otago-Southland regions, respectively. The suggested remedy for handling the perfect prediction in the MLM models was running the model without the problematic variable. Therefore, geographical location was excluded from the model. Results of the parameter estimation in the following should be treated with care because one of the important predictors of the membership in PRMS (geographical location) was excluded from the model.

Table 5-35: Model fit estimation using the AIC and BIC index.

	Predictors in the model	**AIC**	**BIC**
1	Null	1155	1173
2	Age + Education + Location + Business structure + MS Production	948	1285
3	Education + Location + Business structure + MS Production	877	1142
4	Education + Location + Business structure + log (MS Production)	883	1148
5	Education + Location + Business structure + log (MS Production) + MS per ha	889	1171
6	Education + Location + Business structure + log (MS Production) + MS per ha + Farm input system	760	1061
7	Education + Location + Business structure + log (MS Production) + MS per ha + Farm input system + Risk profile score	749	1066
8	Education + Location + Business structure + log (MS Production) + MS per ha + Farm input system + Risk profile score + Risk perception cluster membership (k:5)	743	1122
9	Education + Business structure + log (MS Production) + MS per ha + Farm input system + Risk profile score + Risk perception cluster membership (k:5)	725	989
10	Age + Education + Business structure + Location + Lifecycle stage of the business + log (MS Production) + Farm input system + Risk profile score + Risk perception cluster membership (k:5)	740	1250

5.11.4.2 *Step 2: Multinomial logit coefficient estimation and odds ratios*

The model provided (model 9 in Table 5-35) has an acceptable fit as reflected by the likelihood ratio χ^2 (P< *0.001,* McFadden R^2_{Adj}=0.367) which suggests that at least a subset of the predictors have non-zero effects (Table 5-36). For each significant independent variable, a regression coefficient (*b*), the level of significance, and the odds ratio were reported. In addition, the relevant reference category was reported for each categorical independent variable. The coefficients in the logit model are interpreted as the log of the relative risk ratio (sometimes referred to as an odds ratio) of being in each category relative to being in the reference category. The coefficients are converted to the odds ratio.

Results from the MLM (Table 5-36) revealed that an increase in milksolids production (as a proxy for farm size) is associated with an increase in the odds that an individual would be assigned to PRMS 2 rather than other PRMS (1, 3, 4, 5 and 6). Specifically, a tonne increases in milksolids production reduced the odds that a farmer would be assigned to PRMS 1, 3, 4, 5, and 6 by a factor of 0.244, 0.362, 0.131, 0.364 and 0.038, respectively.

Table 5-36: Multinomial Logit model results.

PRMS[1] and predictors	Reference category (categorical predictors)	Coefficients[3] (*b*) and (*SE*)	Odds ratio(s)
PRMS 1			
Farm physical performance:			
log (milksolids produced (,000 kg))		-1.409*** (0.539)	0.244***
Farm input system:			
Medium input	Low input	-1.628** (0.749)	0.196**
Risk Profile:			
Risk profile scores (out of 25)		0.402*** (0.125)	1.495***
PRMS 3			
Farm business structure:			
Owner with HOSM	Owner operator	1.934** (0.943)	6.918**
Owner with VOSM	Owner operator	1.716** (0.819)	5.562**
Farm physical performance:			
log (milk solids produced (,000 kg))		-1.016** (0.500)	0.362**
Farm input system:			
Medium input	Low input	-1.531** (0.699)	0.216**
Risk perception clusters:			
Highly uncertain and balanced	Slightly uncertain but optimist	2.271* (1.235)	9.685*
PRMS 4			
Education:			
University Degree	High school	-1.280* (0.769)	0.278*
Farm business structure:			
Owner with HOSM	Owner operator	1.778* (1.014)	5.921*
Owner with VOSM	Owner operator	1.554* (0.879)	4.729*
Farm physical performance:			
log (milk solids produced (,000 kg))		-2.033*** (0.564)	0.131***
Farm input system:			
Medium input	Low input	-2.050*** (0.747)	0.129***
Risk perception clusters:			
Moderately uncertain but optimist	Slightly uncertain but optimist	1.435* (0.793)	4.201*
PRMS 5			
Education:			
University Degree	High school	-1.554** (0.764)	0.211**
Farm business structure:			
Owner with manager	Owner operator	1.437* (0.736)	4.207*
Owner with VOSM	Owner operator	2.045** (0.855)	7.729**
Farm physical performance:			
log (milk solids produced (,000 kg))		-1.010* (0.549)	0.364*
PRMS 6			
Farm physical performance:			
log (milk solids produced (,000 kg))		-3.276*** (0.709)	0.038***
Farm input system:			
Medium input	Low input	-1.754* (0.905)	0.173*
1: "PRMS 2" is selected as the base category	2: *p<*0.1*; **p<*0.05*; ***p<*0.01*		
Number of observations = *302*	Log Likelihood $_{fit}$ = *-282.34*	Log Likelihood $_{Null}$ = *-572.38*	
McFadden R^2 (Adjusted) = *0.507 (0.367)*	LR Test = *152.25**** *(df = 80)*	IIA Hausman-McFadden test = *-15.31*	

In terms of risk profile scores, the results from the MLM revealed that a one-unit increase in the risk profile score increased the odds (1.495) that a farmer would be assigned to PRMS 1 rather than PRMS 2 (Table 5-36). The farm input system and business structure also affects assignment to the PRMS. With regard to farm input system, the odds that a farm with a "medium input" system would be assigned to PRMS 1 was less likely (0.196) than a farm with a "low input" system. A farm with a "medium input' system was less likely than a farm with a "low input" system to be assigned to PRMS 3 as indicated by odds ratio of 0.216. Similarly, a farm with a "medium input' system was less likely than a farm with a "low input" system to be assigned to PRMS 4 as indicated by odds ratio of 0.129. Finally, the odds that a farm with a "medium input" system would be assigned to PRMS 6 was less likely (0.173) than a farm with a "low input" system (Table 5-36). With regard to farm business structure, the odds that a farm with a HOSM and a VOSM would be assigned to PRMS 3 were, respectively, 6.918 and 5.562 times higher than an owner operated farm. Similarly, the odds that a farm with a HOSM and a VOSM would be assigned to PRMS 4 were respectively, 5.921 and 4.729 times higher than an owner operated farm. Finally, the odds that a farm with a manager (i.e., "owner with manager") and a VOSM would be assigned to PRMS 5 were respectively, 4.207 and 7.729 times higher than an owner operated farm (Table 5-36).

A farmer's level of education and their risk perception (as identified by the cluster analysis) also affected assignment to PRMS. In terms of education, a farmer with "university degree" was less likely than a farmer with "high school" education to be assigned to PRMS 4 and 5 as reflected by the odds ratio of 0.278 and 0.211, respectively (Table 5-36). Finally, with respect to risk perception, farmers with "highly uncertain and balanced" risk perceptions would be more likely than farmers with a "slightly uncertain, but optimist" risk perception to be assigned to PRMS 3 as indicated by the odds ratios of 9.658. Farmers with a "moderately uncertain, but optimist" risk perception would be more likely than a farmer with a "slightly uncertain, but optimist" risk perception to be assigned to cluster 4, as reflected by odds ratio of 4.201 (Table 5-36).

A thorough understanding of the association between all the categories is provided by varying the base category (Wulff, 2015). Table 5-37 shows that the risk profile score is the only predictor that is significantly different between farmers in the PRMS 1 and PRMS 4. Moreover, farm size is the only predictor that is significantly different between farmers in the PRMS 3 and PRMS 4.

Table 5-37: Full comparison of MLM odds ratios (varying base PRMS).

	PRMS 2	PRMS 3	PRMS 4	PRMS 5	PRMS 6
PRMS 1[1]	**Physical Performance:** log (MS tonnes) — 4.091*** **Input system:** Medium input — Low input[2] — 5.095** **Risk Profile:** Risk profile score — 0.669***	**Business Structure:** Owner with VOSM — Owner operator — 11.728*** Managing partner in an equity partnership — Owner operator — 8.491* **Risk Profile:** Risk profile scores — 0.771**	**Risk Profile:** Risk profile score — 0.686***	**Business Structure:** Owner with manager — Owner operator — 4.736** Owner with VOSM — Owner operator — 16.297*** **Risk Profile:** Risk profile score — 0.734***	**Physical Performance:** log (MS tonnes) — 0.155*** **Risk Profile:** Risk profile score — 0.731**
PRMS 2		**Business Structure:** Owner with HOSM — Owner operator — 6.918** Owner with VOSM — Owner operator — 5.562** **Physical Performance:** log (MS tonnes) — 0.362** **Input system:** Medium input — Low input — 0.216** **Risk perception clusters:** Highly uncertain and balanced — Slightly uncertain but optimist — 9.685*	**Education:** University Degree — High school — 0.278* **Business Structure:** Owner with HOSM — Owner operator — 5.921* Owner with VOSM — Owner operator — 4.729* **Physical Performance:** log (MS tonnes) — 0.131*** **Input system:** Medium input — Low input — 0.129*** **Risk perception clusters:**	**Education:** University Degree — High school — 0.211** **Business Structure:** Owner with manager — Owner operator — 4.207* Owner with VOSM — Owner operator — 7.729** **Physical Performance:** log (MS tonnes) — 0.364*	**Physical Performance:** log (MS tonnes) — 0.038*** **Input system:** Medium input — Low input — 0.173*

	PRMS 2	PRMS 3	PRMS 4	PRMS 5	PRMS 6
		-	Moderately uncertain but optimist / Slightly uncertain but optimist: 4.201*		
PRMS 3			**Physical Performance:** log (MS tonnes): 0.362**	**Input system:** High input / Low input: 3.885* **Physical Performance:** Milksolids per hectare (,00 kg): 0.805**	**Business Structure:** Owner with manager / Owner operator: 0.071** **Physical Performance:** log (MS tonnes): 0.104***
PRMS 4				**Physical Performance:** log (MS tonnes): 2.781* Milksolids per hectare (,00 kg): 0.813** **Input system:** Medium input / Low input: 3.766** High input / Low input: 7.334**	**Business Structure:** Owner with manager / Owner operator: 0.085** **Physical Performance:** log (MS tonnes): 0.288** **Input system:** High input / Low input: 6.406*
PRMS 5			-		**Business Structure:** Owner with manager / Owner operator: 0.036*** **Physical Performance:** log (MS tonnes) / -: 0.104***

1. The base category is indicated in the first column of each row;

2. The reference category for the categorical variable in that set is Underlined.

A closer look at Table 5-37 also revealed that farm size was one of the predictors that has a significant influence on the prediction of cluster membership across PRMS. In order to gain a better insight into the effect of farm size on the membership in each of the PRMS, the probabilities of being assigned to each category of outcome variable (membership in PRMS) at the mean values of the predictor variables is computed and illustrated using probability plots. As can be seen in Figure 5-20, as farm size increases, the probability of membership in PRMS 6 decreases whereas the probability of membership in PRMS 2 increases.

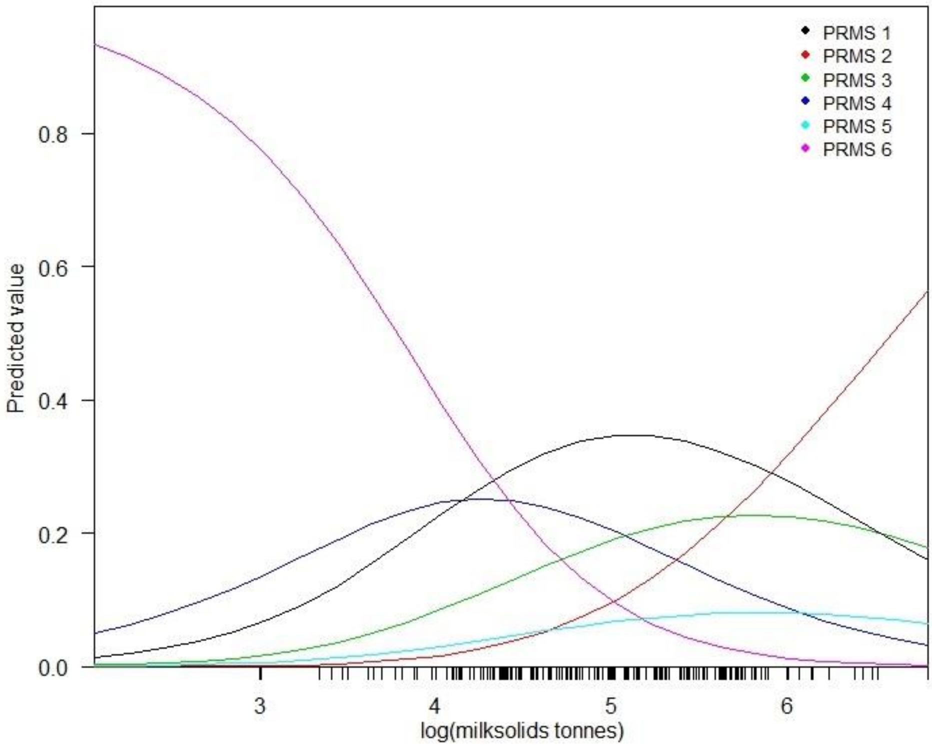


Figure 5-20: Probability plot for farm size and membership in the each of the PRMS

The probability plots of the probability of membership in each cluster across the distribution of other predictor variables (farm and farmer characteristics) are provided in Appendix XI.

5.12 Summary of the quantitative results

The results showed that farmers' age, farm size, geographical location, production system are significant on the choice of portfolio of risk management strategies. Past research of the impact of risk attitude (preferences) on the risk management behaviour of farmers show a range of findings from no statistical association (Shapiro & Brorsen, 1988; Tudor et al., 2014) to positive (direct) association (Davis et al., 2005) and negative (inverse) association (Goodwin & Schroeder, 1994). The variability across studies and lack of impacts found here highlights the difficulty in assessing how risk attitudes influence farmers' responses under risk. That is, except for PRMS 4 the risk attitude is not significantly different across other PRMS clusters. While some suggest self-assessment measure of risk attitude are not sufficient for robust inferences (Coffey & Schroeder, 2018; Pennings & Garcia, 2001), a recent empirical study of Meraner and Finger (2017) highlight that self-assessment methods are highly correlated with other risk attitude elicitation methods.

An interesting observation in this study was that although all dairy farmers virtually receive the same milk price (i.e., the so-called objective risk is similar for all dairy farmers) their perception to milk price risk is different. This observation is congruent with the psychometric paradigm of risk that proposes real risk and objective risk does not exist because every uncertainty need to be evaluated by a decision maker (Slovic, 1992). Accordingly, farmers' perception to risk is determined by their risk attitude as well as farm and farmer characteristics (van Winsen et al., 2014; Wilson et al., 1993).

Examining PRMS 1 risk perception combined with the content of portfolio of risk management strategies of this group of farmers provide evidences of feedback effect on farmers risk perception (Wilson et al., 1993). The feed-back effect proposes that risks that has been managed in the past may not perceived important anymore because farmers already implemented a series of strategies that allow them to manage risks. So, respondents start noticing other risks that potentially can alter their economic or non-economic wellbeing. For PRMS 1 farmers, higher perceived opportunity from the "availability of capital" can be related to their choice of debt strategy. That is, these farmers were more likely to intend for a low debt-to-assets ratio and capital is more likely to be readily available for farmers with low debt.

Despite having relatively high level of debt (above 30% debt) and low levels of MS price in the last two seasons (DairyNZ, 2019), only a small percentage of farmers are identified as capital constrained. These results showed that banks were taking a long-term view to support farmers. However, a decrease in the land price levels would have a profound impact on the financial position of the highly indebted farms (Dunstan, Skilling, Newman, & Mounsey, 2015). Historical data showed that farming sector in other countries have experienced significant drops in the land price. For example, the average agriculture land price dropped by 40% in the 1980s, which ultimately led to bankruptcy for many farmers in New Zealand (Dunstan et al., 2015). Farmers taking advantage of capital appreciation is a major driver for borrowing, farmers need to be mindful of the fact that land price inflation might not continue at the historical high rate of the past 16-year.

A considerable number of farmers did not have any cash reserves to cope with unexpected cash flow deficit and were rely on the overdraft line of credit. Although, this strategy does make sense in terms of costs (interest rate on cash reserves are merely close to interest rate on mortgages), farmers need to be aware that a regular overdraft line of credit[76] is an uncommitted facility in which the providing bank is not obliged to lend money to the borrower. As such, it can be withdrawn immediately by the providing bank. Therefore, the bank may request for the repayment of overdrawn money even if the borrower is not in default of the terms of the overdraft. Therefore, having cash, as a form of risk coping strategy for possible cash deficit, is still prudent.

Result of this study reinforces that the biophysical nature of the farm dictates much of the farm decisions at strategic level and there is a general alignment between biophysical characterises of the farm and the risk management portfolio that farmers chose to utilise. For example, high input dairy farm systems are more capable of capturing the opportunity of upswings in the milk prices whereas low input farm system are less capable to do it. As such, high input systems should be prepared to anticipate milk price volatility and plan their production system to capture the opportunities arising from upswings.

This warrant using a measure of caution in generalizing the findings of this study . It also emphasizes a perpetual challenge about how difficult it is to model farmer's risk responses using cross-sectional survey data. That is, the influence of the factors associated with dairy farmers' risk responses may be different over the long-term. Understanding the impact of utilising a particular portfolio of risk management strategy over the long-term may help further explain and understand the observed heterogeneity in farmers' risk responses.

The findings also show the presence of the adding-up effect: the phenomena that risk management tools that are less utilised on one group may become more useful and accordingly utilised by another group. Further, when comparing the determinants of farmers' risk responses across different PRMS clusters it appears that more general characteristics (e.g., location, size) are important drivers on all PRMS levels whereas more specific cognitive and personal characteristics (e.g., self-efficacy, risk perception, risk preferences) are significant only for some PRMS clusters.

[76] the actual terms and conditions might be vary based on the type of contract etc.

Unobservable and potential confounding variables are always challenging when the model tries to make causal inferences. In this study, for example, farm location proved to have confounding effect on the choice of risk management portfolio. Other exogenous variables such as farm soil type, slope can also influence the choice of risk management portfolios.

Chapter Six: General Conclusions

6.1 Introduction

This study set out to identify the diversity of risk management responses that New Zealand dairy farmers utilise within their farm businesses. The responses in this study were operationalised as a set of risk management strategies and referred to as a portfolio of risk management strategies. These entailed both business and financial risk management strategies. Previous studies have tended to focus on an acknowledged set of business (i.e., insurance, forward contracts), and abstract financial management strategies (such as keeping debt low and holding liquidity reserves). This latter point is a salient shortcoming in the New Zealand dairy farming context as the more recent studies have reported that these farmers had moved away from the traditional financial management strategies (such as keeping debt low and maintaining cash reserves) towards debt management, which is now perceived as the most important risk management strategy for New Zealand dairy farmers. However, little was known about what debt management entails. Therefore, the main aim of this research was to identify the diversity of risk management portfolios that New Zealand dairy farmers use to manage business (production, market, human resources) and financial risks, and to understand the factors that determine the farmers' choice of risk management portfolio. To achieve this aim, the following research questions were developed:

1. What are the business (production, market, human resources) and the financial risk management strategies, within the portfolio of risk management strategies, that New Zealand dairy farmers utilise to manage risk in their farm businesses?
2. What is the diversity of risk management portfolios that New Zealand dairy farmers employ to manage risk in their farm businesses?
3. What farm-specific and farmer-specific factors shape New Zealand dairy farmers' portfolio of risk management strategies?

These research questions were answered by addressing the following objectives:

- To describe the business risk management strategies that New Zealand dairy farmers utilise to manage risk in their businesses.
- To describe the financial risk management strategies that New Zealand dairy farmers utilise to manage the risks in their businesses.
- To identify and describe the diversity of risk management portfolios that New Zealand dairy farmers utilise to manage the risks in their farm business environment.

- To identify farmers‘ current risk perceptions, risk attitudes and other socio-economic variables that shape their portfolio of risk management strategies.

In this chapter the conclusions from the study are outlined and implications from the research for policy makers, extension agent, rural consultant, banking sector, and researchers are discussed. The research method is evaluated and areas for further research are identified.

6.2 Research conclusions

The notion of “risk management portfolios” was first introduced in the agricultural economic field as an expression that suggests the possible interrelationship between risk management strategies (Velandia et al., 2009). Accordingly, empirical studies in agricultural economics employed this concept to investigate the association between risk management strategies. However, in all of the studies only a limited number of risk management strategies were incorporated into the mix of risk management strategies such as insurance (e.g. crop, weather, and yield) and hedging, forward contracts and spreading sales (Coble et al., 2003; Mishra & El-Osta, 2002; Shapiro & Brorsen, 1988; Velandia et al., 2009; Zuniga et al., 2001), insurance and diversification (Hellerstein et al., 2013; Knapp et al., 2021), and insurance and irrigation (Foudi & Erdlenbruch, 2011). Empirical research in the farm management field (Cowan et al., 2013; Gray et al., 2014) viewed risk management portfolios from a more holistic perspective and investigated the interaction between these risk management strategies. However, the qualitative nature of these studies means that the results cannot be generalised to the population of study.

The primary contribution of the current study was that - by introducing a wide range of production, market, human resource, and financial risk management strategies - this study took a more holistic approach in operationalising risk management portfolios and identified the diversity of risk management portfolios among a sample of New Zealand dairy farm owner operators. The findings showed that dairy farmers in New Zealand used one of six different risk management portfolios, each of which has a different mix of risk management strategies and implications for the overall business strategy. The portfolios of risk management strategies that were identified in this study were extracted from a sample of dairy farmers, and it is possible that the differences between the risk management portfolios in the population are even greater than the statistical tests suggest. This study has intentionally focused on a relatively homogenous sample that would appear to have a low level of diversity, that is owner-operated dairy farms. The fact that dairy farmers utilising any one of the portfolios of risk management strategies have managed to survive in a competitive, unprotected economy suggests that any of these risk management portfolios may be successful.

Research of this nature is a useful starting point for understanding the integrated nature of farmers' risk management activities. While some activities appear to be complementary and provide synergistic benefits, others such as those associated with income spreading and market risk reduction or debt management and capital management, seem to be competing rather than complementary activities.

One of the objectives of this study was to identify what farm-specific and farmer-specific factors shape New Zealand dairy farmers' portfolio of risk management strategies. Farmers' socio-economic and psychological attributes, including risk attitude, risk perception, and self-efficacy to manage risk, as well as their farms' biophysical characteristics determine farmers' responses to risk (called portfolios of risk management strategies). In terms of farmers' socio-economic attributes, only age was found to have a weak association with membership in the PRMS groups. In small family businesses, such as dairy farm businesses, the owner's age reflects the lifecycle stage of the family business (Brodt et al., 2006; Tagiuri & Davis, 1992). The empirical evidence showed that businesses at different stages of their lifecycle had different strategic objectives and accordingly different views towards risk. So, it is not surprising that age, as a proxy for stage of the business lifecycle was found to be a determinant of PRMS membership (Brodt et al., 2006; Tagiuri & Davis, 1992). The result also confirmed previous empirical findings that farm location, farm size, and the farm production system are significant determinants of farmers' risk responses (membership in PRMS groups) (Flaten et al., 2005; Meraner & Finger, 2017; van Winsen et al., 2014).

Previous studies reported a range of findings from no statistical association (Shapiro & Brorsen, 1988; Tudor et al., 2014) to a positive (direct) association (Davis et al., 2005) and a negative (inverse) association between risk attitude (preferences) and farmers' risk responses (Goodwin & Schroeder, 1994). Similarly, this study did not find a systematic relationship between risk attitude and risk responses. This refutes the theoretical proposition in the farm management and agricultural economics literature that risk attitude is one of the main determinants of farmers' risk responses (Iyer et al., 2020), and confirms Pannell et al. (2000) conclusion that the impact of risk preferences on farmers' risk management behaviour is smaller than what is proposed in the farm management and agricultural economics literature. Finally, the results of this study confirm Pennings' (2008) argument that the variables that have been associated with farmers' risk response behaviour may not have the same influence for all respondents. That is, the risk attitude scores for only one of the PRMS groups (PRMS 4) was significantly lower than other PRMS groups (risk preferences scores were not significantly different across other PRMS clusters). Similarly, no consistent pattern of effects of farmers' risk perception on farmers' risk responses were found in this study. Again, this confirms Pennings' (2008) argument that the assumption of homogeneity regarding the factors that influence farmers' risk responses does not hold across different farm businesses (Pennings et al., 2008).

The weak predictive power of risk preferences and risk perception can be attributed to the dynamic and complex interrelationships between risk perception, risk attitude and risk behaviour (van Winsen et al., 2013; Wilson et al., 1993). The qualitative phase of this research provides evidence that showed risk perception is influenced not only by perceived past volatility, but also by the possible management actions that were taken in the past. This is particularly important because many of the on-farm risk management strategies are designed to control the undesirable outcomes of climatic variation by changing the biophysical characteristics of the farm (e.g., irrigation, wet soil management strategies). The change in the biophysical characteristics of the farm also changes farmers' perception towards risk. As Slovic (1987) stated "humans have an additional capability that allows them to alter their environment as well as respond to it. This capacity both creates and reduces risk" (p. 280). None of the previous studies in farm management discussed the feedback effect of farmers' risk management behaviour on the biophysical environment of the farm and accordingly on farm perception. By providing empirical evidence about this feedback effect, the present study contributes to the farm risk management literature.

A number of more specific conclusions in relation to financial management strategies can be drawn from this study. The empirical studies clearly showed that New Zealand dairy farmers have moved away from "keeping debt low" and now focus on "managing debt" as their main risk management strategy (Duranovich, 2015; Martin, 1994; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2013). This is despite the fact that the normative literature in financial management prescribed that keeping debt low and maintaining liquid assets are two of the main financial management strategies that should be used by farmers (Flaten et al., 2005; Meraner & Finger, 2017). As such, it was not clear what debt management in the New Zealand dairy farming context entails. This research was one of the first studies that provides a synthesis of farm business risk management and farm financial risk management through the perspective of risk management portfolio. Liquidity management, capital structure, and debt servicing strategies were a new dimension of financial management that were incorporated into the overall mix of risk management strategies that constitute risk management portfolios.

In terms of liquidity management,the results showed that rather than maintaining cash reserves, which is often suggested in the normative literature (Barry & Ellinger, 2012), dairy farmers in New Zealand are utilising an overdraft line of credit facilities to manage possible cashflow deficits. Hence, this research showed that an overdraft line of credit and cash reserves are a substitute for each other. This finding is generally consistent with the finding in the corporate finance literature (Denis, 2011; Lins et al., 2010; Opler et al., 1999). Similar to the empirical findings in the corporate finance literature, the difference between the cost of holding cash and the interest on overdraft was an important factor in farmers' decisions to utilise an overdraft line of credit facility over the use of cash reserves (Lins et al., 2010).

Almost a third of the respondents did not have any cash reserves. The milk production curve and the milk payment mechanism (a schedule payments involving both advance and deferred payments) in New Zealand dairy farming results in farmers continuously receiving income from milk (even in the winter period when the dairy herd is dried off) (Melyukhina, 2011). As such, compared to the arable and sheep and beef sectors, when farmers' earnings are not continuous and strongly seasonal (income at harvest or as animals are finished on pasture), the need for liquidity reserves is less crucial.

Income volatility was the most important determinant of leverage ratio. The importance of income volatility in relation to the leverage ratio is congruent with the Collins-Barry (1985) equilibrium model. Following this, financial flexibility (The ability to borrow further funds when unexpected opportunities and/or threats occur) was the second most important determinant of leverage ratio. This finding is inconsistent with the Collins- Barry (1985) model and confirms the importance of flexibility on the leverage ratio. Congruent with Anastassiadis et al.'s (2015) conclusion, this finding confirms that dairy farmers intentionally create an equity buffer that can be used when unexpected investment opportunity or threats occurs.

No empirical study in New Zealand has explored the factors that influence dairy farmers' choice between fixed-rate and floating-rate loans. The results of this study found that New Zealand dairy farmers are actively monitoring interest rate movements and switch between fixed and floating loans. This finding confirms Shadbolt and Martin (2005) notion that farmers switch between fixed and floating loans depending on their expectations about interest rates.

None of the studies in agricultural economics explored the impact of alternative debt amortization product (such as interest-only loans) on the financial management of dairy farmers. The results in this study highlighted that the ability to match farm income with debt repayments is the most important determinant of debt amortization policies among New Zealand dairy farmers. This form of liquidity management also noted by Gray et al. (2014), aligns with the next most important risk management strategy of "planning capital expenditure" noted in previous surveys (Duranovich, 2015; Pinochet-Chateau et al., 2005; Shadbolt & Olubode-Awosola, 2016). Both strategies suggest a strong focus on liquidity, or cash, with the farmers maintaining control on when cash is spent.

6.3 Implication of the findings

The findings from this study have a number of implications that go beyond the population of the study. This research purposely chose a relatively homogenous sub-sample (owner-operators) of dairy farms in New Zealand. However, the use of cluster analyses followed by MCA proved to be a useful tool to identify distinct dairy farm businesses based on subtle differences in their utilisation of risk management strategies. In their simplest form, farm members that cluster together were classified according to their risk management characteristics. However, the nature and membership in each cluster is not stable because dairy farms may adjust their portfolio by changing one or a group of risk management strategies. Therefore, the content and memberships of PRMS groups are subject to changes.

Although dairy farmers are operating under the same macroeconomic conditions, producing a uniform product, and pursuing a similar marketing strategy (receive the same milk price), the results from this study showed that even in a relatively homogenous population (such as owner-operated dairy farms), farm businesses are utilising markedly different risk management portfolios.

Each of the identified risk management portfolios contained a unique set of risk management strategies that are driven by the socio-economic characteristics of the farmer and the biophysical characteristics of the farm. This identified portfolio of risk management strategies can help extension specialists to provide risk management recommendations that best suit a farmer's risk profile and context. For example, extension specialist and rural consultants can focus on providing information about the overdraft line of credit and its limitations to PRMS 2 farmers because farmers in this cluster are heavily reliant on their overdraft as a liquidity management tool.

The results also help policy makers to better understand the existing diversity within the dairy sector and to provide targeted policy advice that is aligned with dairy farmers' motives and characteristics. In terms of risk perception, similar to the previous empirical studies (Duranovich, 2015; Shadbolt & Olubode-Awosola, 2013), this study found that risk associated with central government policy and local government regulations is perceived as a highly important threat across all PRMS clusters.

Most of the central government policy and local government regulations are claimed to be concerned with the environmental impact of highly intensive dairy farm systems (Baskaran et al., 2009; Foote et al., 2015). However, this study showed that, regardless of location and situation, there is no difference between farmers' perceptions when it comes to government policy and local government regulations. That is, both low input and highly intensive famers are equally concerned about those sources of risk. Both central government and local government need to send clear signals to reduce dairy farmers' concerns while developing a set of regulations to improve the environmental performance of highly intensive dairy farm systems.

The results in relation to financial management policies and practices of dairy farmers can be useful for bank managers to better understand farmers' rationale and intentions on the choice of financial services and products so that they can offer customized complementary financial management services (such as swaps, split mortgages, revolving credit etc.) that help farmers to manage the financial risks in their business.

Operating profit is a widely used metrics for benchmarking dairy farm performance in the dairy sector. Given the importance of debt management on the survivability of a farm business, other measures of farm performance which take into account the financial structure of the farm such as return on equity, debt servicing capacity, and liquidity should be emphasized as well.

The method employed in this study can be useful to investigate the diversity of risk management strategies in other farming sectors such as the sheep and beef and arable sectors. So, while the normative literature is full of examples of what and how farmers should manage their finances, there is a dearth of empirical research into how farmers actually manage their finances. In particular, the qualitative phase of the study highlighted some of the major aspects of dairy farmers' financial risk management that was unknown before this study. As such, in addition to normative and descriptive research in the field of farm risk management and agricultural economics, it is critical that researchers conduct in-depth face to face interviews to better understand farmers' risk perception and risk management responses.

6.4 Evaluation of the method

The use of the exploratory sequential mixed method provided evidence that helped the researcher to extend the definition of risk management portfolios and include additional financial risk management strategies. Although, the importance of financial risk management was evident in previous studies, different aspects of financial risk management were not fully known until the qualitative phase of the research was undertaken. The findings from the qualitative phase enhanced the researcher's understanding about different aspects of financial risk management and its impact on farmers' risk management portfolios.

One of the inherent challenges in mixed method designs, as pointed out by Creswell (2014), was the time it took to analyse the data. This problem was most evident in the qualitative phase of the study. Even though only two cases were selected for the qualitative phase, the author had to cease the qualitative data analysis and start designing the survey, while it was still possible to extract further useful themes and statements for the survey. This problem was exacerbated because the most suitable timeframe for the survey distribution to dairy farmers is in the winter season when the majority of farmers have their herds dried off. Distributing the survey at other times of the year might considerably reduce the response rate. Therefore, the researcher was faced with a dilemma between premature closure of the qualitative data analysis and a low response rate from the survey.

One of the contributions of the study was exploring the association between risk management strategies. By employing multiple correspondence analysis (MCA), this study illustrated the association between risk management strategies that are utilised by farmers in a multidimensional space (using low-dimensional maps).

In contrast to a multivariate logit (or probit) model that assumes the membership in each PRMS is independent from other PRMS, the multinomial logit (MLM) approach provided a richer interpretation, better inferences, and more information that may further enhance our understanding of dairy farmers' risk responses. However, communicating the findings of the MLM proved to be difficult. In particular, comparing six different risk management portfolios and interpreting regression coefficients in the form of odds ratio, which is the common approach in the binary logit and probit model, was onerous. Another challenge in using the odds ratio was the fact that the comparisons need to be undertaken with respect to the outcome variable's reference category (Croissant, 2012; Liu, 2016; Wulff, 2015) that is, one of the PRMS in this study. However, it proved difficult to choose a PRMS as the reference category because, none of the PRMS groups can be classified as the natural reference category (Croissant, 2012; Liu, 2016). The use of probability plots was found to be a more intuitive approach for communicating the MLM regression coefficients because it did not require a reference category (Wulff, 2015).

A challenge in interpreting the results of the MLM was the fact that one of the predictors (farm location) had a strong association with other predictors as well the membership in each of the groups (also called confounded). This confounding effect complicates the interpretation of such empirically derived relationships. The confounding effect was assessed by comparing the pseudo-R^2 values, AIC, and BIC of the regression models with, and without, the problematic variable. The remedy suggested in the literature was to exclude the problematic variable from the model, but this was not practical due to the uniqueness of farming systems in at least two locations. However, methods such as the generalized linear mixed model (GLMM) (Stroup, 2012) for cross sectional data or the multinomial logit model with fixed effects (Malchow-Møller & Svarer, 2003) may be a better remedy for confounding variables in such models.

6.5 Areas for further research

The conclusions developed within this thesis present a number of avenues worthy of further research. Farmers may be willing to sacrifice some level of returns in a year in exchange for limited risk exposure or enhanced farm-level profits over the long run. Hence, some of the risk management strategies are inherently long-run strategies. As such, evaluating the impacts of any long-run strategy in a single year may lead to incorrect conclusions. Undertaking time-series research studies would allow a better understanding of the association between the impact of utilising each of the risk management portfolios and performance, as well as the mediating role of the external attributes on the choice of the risk management portfolios and farm performance. Replicative cross-sectional studies also would be useful to explore whether farmers move from one risk management portfolio to another and provide information regarding how farmers' risk management portfolios change over time.

Previous empirical studies showed that there are significant differences between sharemilkers and owner operators in terms of the risk perception and the importance of risk management strategies (Pinochet-Chateau et al., 2005). This study provides detailed insight into the diversity of risk management strategies among different owner-operated farms such as an owner with a sharemilker, and owner operated farms with an equity-partnership structure. Future research could compare the risk management portfolios among owner-operated farms that have different structures (i.e., owners with sharemilkers and, or equity partnership owner operator farms).

The findings in the qualitative phase of the study confirm that the choice of wintering strategies has an impact on production, finance and accordingly a farmer's overall risk management responses (French et al., 2015; Kaine, 2015). However, the information about the choice, motivations and impact of the different wintering strategies from a risk management perspective is still limited (Edwards et al., 2017; Samarasinghe & Brown, 2016). Future research could investigate different aspects of farmers' wintering strategies and investigate the impact of this choice on the overall portfolio of risk management strategies that dairy farmers utilise to respond to risk.

In general, there is a dearth of empirical evidence on New Zealand dairy farms' financial management strategies and the factors that drive the choice of their risk management strategies. A framework such as the Collins-Barry model (1985) could be a starting point to understand the drivers of farmers' financial management strategies. This study showed that financial flexibility in the form of untapped borrowing capacity is extensively used by farmers to cope with the risks in their farm businesses. However, only a limited numbers of studies in agriculture have investigated the impact of flexibility on farm capital structure (Anastassiadis et al., 2015; Anastassiadis & Mußhoff, 2013). Future research could also employ the theories developed in corporate finance (DeAngelo & DeAngelo, 2007; Denis & McKeon, 2012; Gamba & Triantis, 2008) to investigate the impact of financial flexibility on farmers' financial management strategy.

Congruent with the findings in the literature, the results from this study showed that financial management plays a crucial role in the overall survivability of dairy farm businesses. Yet, except for the work of Gray et al. (2014), little is known about the process of financial planning that is used by dairy farmers. More importantly, little is known about the impact of an improved understanding of finance (beyond just liquidity) and the adoption rate of emerging tools to manage risk (swaps, futures etc) by farmers. So, future research could further explore the financial knowledge and practices of dairy farmers and how it influences their farms' physical and financial performance.

The conceptual framework proposed in the section 4.5 can be tested in future research to clarify the dynamic relationship between risk perception and farmers' risk responses and how they affect each other over time through a longitudinal study. A longitudinal (multi-year) case study research design (Creswell, 2013; Yin, 2011) may be able to provide better evidence of the feedback effects of risk responses on farm and farmer characteristics and accordingly on farmers' risk perceptions.

References

Abdi, H., & Valentin, D. (2007). Multiple correspondence analysis. In N. Salkind (Ed.), *Encyclopedia of Measurement and Statistics* (pp. 651-657). Thousand Oaks - California: SAGE Publications Ltd.

Acharya, V. V., Almeida, H., & Campello, M. (2013). Aggregate Risk and the Choice between Cash and Lines of Credit. *The Journal of Finance, 68*(5), 2059-2116. doi: https://10.1111/jofi.12056

Adelaja, A. O., Hailu, Y. G., Tekle, A. T., & Seedang, S. (2010). Evidence of land hoarding behavior in US agriculture. *Agricultural Finance Review, 70*(3), 377-398. doi: https://doi.org/10.1108/00021461011088503

Agresti, A. (2002). *Categorical data analysis* (Second ed.). Hoboken, New Jersey: John Wiley & Sons, Ltd.

Ahrendsen, B. L., Collender, R. N., & Dixon, B. L. (1994). An empirical analysis of optimal farm capital structure decisions. *Agricultural Finance Review, 47*(1), 108-119.

Ahsan, D. A. (2011). Farmers' motivations, risk perceptions and risk management strategies in a developing economy: Bangladesh experience. *Journal of Risk Research, 14*(3), 325-349. doi: Pii 934312844 10.1080/13669877.2010.541558

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control* (pp. 11-39). Berlin- Heidelberg: Springer.

Ajzen, I. (1991). Theories of Cognitive Self-RegulationThe theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. doi: http://dx.doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2012). The Theory of Planned Behavior. In P. Van Lange, A. Kruglanski & E. Tory Higgins (Eds.), *Handbook of Theories of Social Psychology* (Vol. 1, pp. 438-460). London: SAGE Publications Ltd.

Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behavior. In D. Albarracín, B. T. Johnson & M. P. Zanna (Eds.), *The handbook of attitudes* (pp. 173-221): Lawrence Erlbaum Associates Publishers.

Alem, H., Lien, G., Kumbhakar, S. C., & Hardaker, B. (2019). Are diversification and structural change good policy? An empirical analysis of Norwegian agriculture. *Journal of Agricultural and Applied Economics, 51*(1), 1-26. doi: 10.1017/aae.2018.17

Allen, J., & Kloeten, N. (2016). Dairy Progression Pathways and the Impact of Volatility. Waikato New Zealand: AgFirst

Allen, J. K. (2005). *Managing the transition from the single family farm to multiple property ownership: pitfalls and recommendations* (Masters of Professional Studies-Agribusiness), Lincoln University, Christchurch, New Zealand.

Alvarez, A., & Arias, C. (2003). Diseconomies of size with fixed managerial ability. *American Journal of Agricultural Economics, 85*(1), 134-142.

Alvarez, J., & Nuthall, P. (2001). The Relationships Between Computer Use and Canterbury Dairy Farmers' Goals, Personality Traits and Learning Styles (pp. 52). Canterbury, New Zealand: Farm and Horticultural Management Group Lincoln University.

Anastassiadis, F., Liebe, U., & Mußhoff, O. (2015). Financial Flexibility in Agricultural Investment Decisions: A Discrete Choice Experiment. *Agricultural Economics Review, 16*(1), 47.

Anastassiadis, F., & Mußhoff, O. (2013). *Evaluating the role of financial flexibility in farmers' investment decisions using latent class analysis*. Paper presented at the 87th Annual Conference of the Agricultural Economics Society, Warwick University, Coventry, UK.

Apergis, N., & Papoulakos, D. (2013). The New Zealand dollar and milk prices. *International Journal of Financial Services Management, 6*(1), 1-16. doi: doi:10.1504/IJFSM.2013.052874

Armitage, C. J., & Conner, M. (2001). Efficacy of the Theory of Planned Behaviour: a meta-analytic review. *Br J Soc Psychol, 40*(Pt 4), 471-499. doi: 10.1348/014466601164939

Astigarraga, L., & Ingrand, S. (2011). Production flexibility in extensive beef farming systems. *Ecology and Society, 16*(1), 7.

Austin, E. J., Deary, I. J., & Willock, J. (2001). Personality and intelligence as predictors of economic behaviour in Scottish farmers. *European Journal of Personality, 15*(S1), S123-S137. doi: Doi 10.1002/Per.421

Aven, T., & Renn, O. (2009). On risk defined as an event where the outcome is uncertain. *Journal of Risk Research, 12*(1), 1-11. doi: Pii 90792086910.1080/13669870802488883

Bagrie, C., Williams, C., & Croy, D. (2014). Equity partnerships – a look under the bonnet *Agri Focus* (Vol. April, pp. 2-10): ANZ Research.

Bagrie, C., Williams, C., & Smith, M. (2015). Reality Bites: A Dairy Tale *New Zealand Economics ANZ Agri Focus* (pp. 31). Wellington, New Zealand: ANZ Bank New Zealand Limited.

Baker, C. B. (1976). variable amortization plan to manage farm mortgage risks. *Agricultural Finance Review, 36*(1), 1-6.

Baker, R. (2016). Implementation of the Fonterra Palm Kernel Guideline *Kellogg Rural Leadership Programme* Kellogg Rural Leadership Programme

Ballingall, J., & Pambudi, D. (2017). Dairy trade's economic contribution to New Zealand (pp. 34). Dairy Companies Association of New Zealand (DCANZ): New Zealand Institute of Economic Research (NZIER).

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W H Freeman/Times Books/ Henry Holt & Co.

Bandura, A. (2012). On the Functional Properties of Perceived Self-Efficacy Revisited. *Journal of Management, 38*(1), 9-44. doi: 10.1177/0149206311410606

Baptiste, I. (2001). Qualitative Data Analysis: Common Phases, Strategic Differences. *2001, 2*(3). http://www.qualitative-research.net/index.php/fqs/article/view/917/2002

Baquet, A., Patrick, G., Coble, K., Jaramillo, M., Knight, T., & Rejesus, R. (2008). Preference for risk management information sources: implications for extension and outreach programming.

Baquet, A. E., Hambleton, R., & Jose, D. (1997). *Introduction to risk management: understanding agricultural risks: production, marketing, financial, legal, human Resources*: US Department of Agriculture, Risk Management Agency.

Bar-Shira, Z., Just, R. E., & Zilberman, D. (1997). Estimation of farmers' risk attitude: an econometric approach. *Agricultural Economics, 17*(2-3), 211-222. doi: Doi 10.1016/S0169-5150(97)00021-2

Barbieri, C., & Mahoney, E. (2009). Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers. *Journal of Rural studies, 25*(1), 58-66. doi: https://doi.org/10.1016/j.jrurstud.2008.06.001

Bard, S. K., & Barry, P. J. (2000). Developing a scale for assessing risk attitudes of agricultural decision makers. *The International Food and Agribusiness Management Review, 3*(1), 9-25.

Barham, E. H. B., Robinson, J. R., Richardson, J. W., & Rister, M. E. (2011). Mitigating cotton revenue risk through irrigation, insurance, and hedging. *Journal of Agricultural and Applied Economics, 43*(4), 529-540.

Barnes, A., Hansson, H., Manevska-Tasevska, G., Shrestha, S., & Thomson, S. (2015). The influence of diversification on long-term viability of the agricultural sector. *Land Use Policy, 49*, 404-412. doi: 10.1016/j.landusepol.2015.08.023

Barry, P., Baker, C., & Sanint, L. (1981). Farmers' credit risks and liquidity management. *American Journal of Agricultural Economics, 63*(2), 216-227.

Barry, P. J., & Baker, C. B. (1971). Reservation Prices on Credit Use: A Measure of Response to Uncertainty. *American Journal of Agricultural Economics, 53*(2), 222-227. doi: 10.2307/1237435

Barry, P. J., Bierlen, R. W., & Sotomayor, N. L. (2000). Financial structure of farm businesses under imperfect capital markets. *American Journal of Agricultural Economics, 82*(4), 920-933.

Barry, P. J., & Ellinger, P. N. (2012). *Financial management in agriculture* (7th ed.). Upper Saddle River, N.J Prentice Hall

Barry, P. J., & Robison, L. J. (2001). Agricultural finance: Credit, credit constraints, and consequences. *Handbook of agricultural economics, 1*, 513-571.

Barry, P. J., & Stanton, B. F. (2003). Major ideas in the history of agricultural finance and farm management (D. o. A. E. a. Management, Trans.) (Vol. WP 2003, pp. 37). Ithaca, New York Cornell University.

Basarir, A. (2002). *Multidimensional goals of farmers in the beef cattle and dairy industries.* (Doctor of Philosophy (PhD)), Louisiana State University, Baton Rouge, Louisiana.

Baskaran, R., Cullen, R., & Colombo, S. (2009). Estimating values of environmental impacts of dairy farming in New Zealand. *New Zealand Journal of Agricultural Research, 52*(4), 377-389. doi: https://doi.org/10.1080/00288230909510520

Beijeman, A., Shadbolt, N. M., & Gray, D. (2009). *Strategy recognition and implementation by New Zealand pastoral farming strategists.* Paper presented at the International Farm Management Congress Illinois- USA.

Bendixen, M. T. (1995). Compositional perceptual mapping using chi-squared trees analysis and correspondence analysis. *Journal of Marketing Management, 11*(6), 571-581.

Bennett, M., Pangborn, M., & Bywater, A. (2012). Perceptions of sustainability of dairy support land farmers. Agribusiness Economics Research Unit (AERU): Lincoln University- New Zealand.

Berger, A. N., & Udell, G. F. (1998). The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. *Journal of Banking & Finance, 22*(6), 613-673.

Bergfjord, O. J. (2009). Risk perception and risk management in Norwegian aquaculture. *Journal of Risk Research, 12*(1), 91-104. doi: Pii 90792129110.1080/13669870802488941

Beukes, P. C., Romera, A. J., Clark, D. A., Dalley, D. E., Hedley, M. J., Horne, D. J., . . . Laurenson, S. (2013). Evaluating the benefits of standing cows off pasture to avoid soil pugging damage in two dairy farming regions of New Zealand. *New Zealand Journal of Agricultural Research, 56*(3), 224-238. doi: 10.1080/00288233.2013.822002

Beux Garcia, L., Shadbolt, N., & Dooley, A. E. (2015). *Dairy farming systems – what drives efficiency?* Paper presented at the 20th International Farm Management Congress, Québec City, Québec, Canada.

Bewley, J., Boehlje, M., Gray, A., Hogeveen, H., Kenyon, S., Eicher, S., & Schutz, M. (2010). Assessing the potential value for an automated dairy cattle body condition scoring system through stochastic simulation. *Agricultural Finance Review, 70*(1), 126-150. doi: https://doi.org/10.1108/00021461011042675

Bhamra, R., Dani, S., & Burnard, K. (2011). Resilience: the concept, a literature review and future directions. *International Journal of Production Research, 49*(18), 5375-5393.

Bierlen, R., & Featherstone, A. M. (1998). Fundamental q, cash flow, and investment: evidence from farm panel data. *Review of Economics and Statistics, 80*(3), 427-435.

Billikopf, G., & González, G. (2012). Turnover rates are decreasing in California dairies. *California Agriculture, 66*(4).

Binswanger, H. P. (1980). Attitudes toward Risk - Experimental-Measurement in Rural India. *American Journal of Agricultural Economics, 62*(3), 395-407. doi: Doi 10.2307/1240194

Birks, M., & Mills, J. (2011). *Planning a grounded theory study* M. Birks & J. Mills (Eds.), *Grounded theory: A practical guide*

Bitsch, V., Kassa, G. A., Harsh, S. B., & Mugera, A. W. (2006). Human resource management risks: Sources and control strategies based on dairy farmer focus groups. *Journal of Agricultural and Applied Economics, 38*(01), 123-136.

Bocquého, G., Jacquet, F., & Reynaud, A. (2014). Expected utility or prospect theory maximisers? Assessing farmers' risk behaviour from field-experiment data. *European Review of Agricultural Economics, 41*(1), 135-172. doi: 10.1093/erae/jbt006

Boehlje, M., Dobblins, C., & Miller, A. (2001). Are your farm business management skills ready for the 21st Century. *Self-assessment checklists to help you tell. Retrieved in March*.

Boehlje, M., Gray, A., & Detre, J. (2005). Strategy Development in a Turbulent Business Climate: Concepts and Methods. *International Food and Agribusiness Management Review, 8*(2).

Boehlje, M., Gray, A., Dobbins, C., Miller, A., & Ehmke, C. (2003). Implementing Strategy: The Key Strategic Decisions for the Farm Business: Purdue University, Department of Agricultural Economics.

Boehlje, M., & Roucan-Kane, M. (2009). Strategic Decision Making Under Uncertainty: Innovation and New Technology Introduction during Volatile Times1. *International Food and Agribusiness Management Review, 12*(4).

Boehlje, M., Roucan-Kane, M., & Broring, S. (2011). Future Agribusiness Challenges: Strategic Uncertainty, Innovation and Structural Change. *International Food and Agribusiness Management Review, 14*(5), 53-81.

Boehlje, M., & Schiek, W. (1998). Critical Success Factors in a Competitive Dairy Market. *Journal of Dairy Science, 81*(6), 1753-1761. doi: 10.3168/jds.S0022-0302(98)75744-3

Boehlje, M. D., & Lins, D. A. (1998). Risks and risk management in an industrialized agriculture. *Agricultural Finance Review, 58*(1), 1-16.

Boggess, W. G., Anaman, K. A., & Hanson, G. D. (1985). Importance, causes and management responses to farm risks: evidence from Florida and Alabama. *Southern Journal of Agricultural Economics, 17*(2), 105-116.

Boncinelli, F., & Casini, L. (2014). A Comparison of the Well-Being of Agricultural and Non Agricultural Households Using a Multicriterial Approach. *Social Indicators Research, 119*(1), 183-195.

Borchers, M. R., & Bewley, J. M. (2015). An assessment of producer precision dairy farming technology use, prepurchase considerations, and usefulness. *Journal of Dairy Science, 98*(6), 4198-4205. doi: https://doi.org/10.3168/jds.2014-8963

Brester, G. W., & Penn, J. B. (1999). Strategic business management principles for the agricultural production sector in a changing global food system *Policy Issue Paper*. Montana State University– Bozeman: Department of Agricultural Economics and Economics, Trade Research Center.

Briggeman, B. C., Towe, C. A., & Morehart, M. J. (2009). Credit Constraints: Their Existence, Determinants, and Implications for U.S. Farm and Nonfarm Sole Proprietorships. *American Journal of Agricultural Economics, 91*(1), 275-289. doi: 10.1111/j.1467-8276.2008.01173.x

Britt, J., Cushman, R., Dechow, C., Dobson, H., Humblot, P., Hutjens, M., . . . Stevenson, J. (2018). Invited review: Learning from the future- A vision for dairy farms and cows in 2067. *Journal of Dairy Science, 101*(5), 3722-3741.

Brodt, S., Klonsky, K., & Tourte, L. (2006). Farmer goals and management styles: Implications for advancing biologically based agriculture. *Agricultural Systems, 89*(1), 90-105. doi: http://dx.doi.org/10.1016/j.agsy.2005.08.005

Brown, P., & Roper, S. (2017). Innovation and networks in New Zealand farming. *Australian Journal of Agricultural and Resource Economics, 61*(3), 422-442. doi: 10.1111/1467-8489.12211

Burnham, K. P., & Anderson, D. R. (2004). Multimodel Inference:Understanding AIC and BIC in Model Selection. *Sociological methods & research, 33*(2), 261-304. doi: 10.1177/0049124104268644

Butler, P. (2013). 50/50 Sharemilking: where are we in 2013? *The New Zealand Kellogg Rural Leaders Programme, Lincoln University* (pp. 23): The New Zealand Kellogg Rural Leaders Programme.

Cameron, R. (2009). A sequential mixed model research design: Design, analytical and display issues. *International Journal of Multiple Research Approaches, 3*(2), 140-152.

Campbell-Hunt, C. (2000). What have we learned about generic competitive strategy? A meta-analysis. *Strategic Management Journal, 21*(2), 127-154. doi: 10.1002/(sici)1097-0266(200002)21:2<127::aid-smj75>3.0.co;2-1

Campbell, J. Y., & Cocco, J. F. (2003). Household risk management and optimal mortgage choice. *The Quarterly Journal of Economics, 118*(4), 1449-1494.

Campello, M., Giambona, E., Graham, J. R., & Harvey, C. R. (2011). Liquidity Management and Corporate Investment During a Financial Crisis. *The Review of Financial Studies, 24*(6), 1944-1979. doi: 10.1093/rfs/hhq131

Campello, M., Graham, J. R., & Harvey, C. R. (2010). The real effects of financial constraints: Evidence from a financial crisis. *Journal of financial economics, 97*(3), 470-487. doi: http://dx.doi.org/10.1016/j.jfineco.2010.02.009

Cao, Y., Weersink, A., & Ferner, E. (2019). A Risk Management Tool or an Investment Strategy? Understanding the Unstable Farm Insurance Demand via a Gain-Loss Framework. *Agricultural and Resource Economics Review*, 1-27. doi: 10.1017/age.2019.15

Carlson, J. M., Heckerman, D., & Shani, G. (2009). Estimating false discovery rates for contingency tables *Technical Report*. Microsoft Research: MSR-TR-2009-53.

Castro, P., Fernández, M. T. T., & Tapia, B. A. (2014). The role of life cycle on the firm's capital structure= El papel del ciclo de vida en la estructura de capital de la empresa. *Pecvnia: Revista de la Facultad de Ciencias Económicas y Empresariales, Universidad de León*(19), 131-155.

Chapman, D., Malcolm, B., Neal, M., & Cullen, B. (2007). *Risk and uncertainty in dairy production systems: Research concepts, tools and prospects.* Paper presented at the 3rd Dairy Science Symposium: Meeting the Challenges for Pasture-Based Dairying, University of Melbourne, Victoria, Australia.

Chavas, J.-P., Chambers, R. G., & Pope, R. D. (2010). Production Economics and Farm Management: a Century of Contributions. *American Journal of Agricultural Economics, 92*(2), 356-375. doi: 10.1093/ajae/aaq004

Chavas Jean-Paul. (2004). *Risk Analysis in Theory and Practice*. San Diego, California: Elsevier Academic Press.

Chavas, J. P. (2008). On the economics of agricultural production. *Australian Journal of Agricultural and Resource Economics, 52*(4), 365-380.

Chavas, J. P., & Holt, M. T. (1996). Economic behavior under uncertainty: A joint analysis of risk preferences and technology. *Review of Economics and Statistics, 78*(2), 329-335. doi: Doi 10.2307/2109935

Chen, C. C., Greene, P. G., & Crick, A. (1998). Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? *Journal of Business Venturing, 13*(4), 295-316. doi: http://dx.doi.org/10.1016/S0883-9026(97)00029-3

Chikazhe, T. L., Mashlan, K. A., Beukes, P. C., Glassey, C. B., Haultain, J., & Neal, M. B. (2017). The implications of winter milk premiums for sustainable profitability of dairy systems. *Animal Feed Science and Technology, 131*, 389-417.

Cho, J., & Lee, J. (2006). An integrated model of risk and risk-reducing strategies. *Journal of Business Research, 59*(1), 112-120. doi: https://doi.org/10.1016/j.jbusres.2005.03.006

Chrystal, J., Monaghan, R., Hedley, M., & Horne, D. (2016). Design of a low cost winter stand-off pad for reducing nutrient losses to water from winter forage crops grazed by dairy cows *Occasional Report No. 29* (pp. 9). Palmerston North, New Zealand: Fertilizer and Lime Research Centre, Massey University.

Ciaian, P., Fałkowski, J., & Kancs, d. A. (2012). Access to credit, factor allocation and farm productivity: Evidence from the CEE transition economies. *Agricultural Finance Review, 72*(1), 22-47. doi: https://doi.org/10.1108/00021461211222114

Ciaian, P., & Fałkowski, J. J. A. F. R. (2012). Access to credit, factor allocation and farm productivity: Evidence from the CEE transition economies.

Cichosz, P. (2014). (Dis)similarity measures *Data Mining Algorithms : Explained Using R* (pp. 314-327). Somerset, United Kingdom: John Wiley & Sons, Ltd.

Clark, A., Mullan, B., & Porteous, A. (2011). Scenarios of Regional Drought under Climate Change. New Zealand: National Institute of Water & Atmospheric Research Ltd.

Coble, K. H., Zuniga, M., & Heifner, R. (2003). Evaluation of the interaction of risk management tools for cotton and soybeans. *Agricultural Systems, 75*(2–3), 323-340. doi: http://dx.doi.org/10.1016/S0308-521X(02)00073-2

Cocco, J. F. (2013). Evidence on the benefits of alternative mortgage products. *The Journal of Finance, 68*(4), 1663-1690.

Coffey, B. K., & Schroeder, T. C. (2018). Factors influencing Midwestern grain farmers' use of risk management tools. *Agricultural Finance Review, 79*(2), 192-203. doi: https://doi.org/10.1108/AFR-04-2018-0026

Collins, R. A. (1985). Expected Utility, Debt-Equity Structure, and Risk Balancing. *American Journal of Agricultural Economics, 67*(3), 627-629. doi: 10.2307/1241085

Conforte, D., Garnevska, E., Kilgour, M., Locke, S., & Scrimgeour, F. (2008). Key elements of success and failure in the NZ dairy industry (pp. 85). Agribusiness and Economics Research Unit (AERU): Lincoln University, New Zealand.

Connelly, B. L., Certo, S. T., Ireland, R. D., & Reutzel, C. R. (2010). Signaling Theory: A Review and Assessment. *Journal of Management, 37*(1), 39-67. doi: 10.1177/0149206310388419

Cook, S. J., Hays, J. C., & Franzese, R. J. (2018). Fixed effects in rare events data: a penalized maximum likelihood solution. *Political Science Research and Methods*, 1-14.

Cook, S. J., Niehaus, J., & Zuhlke, S. (2018). A warning on separation in multinomial logistic models. *Research & Politics, 5*(2), 2053168018769510.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology, 13*(1), 3-21.

Corong, E., Hensen, M., & Journeaux, P. (2014). Value of irrigation in New Zealand: An economy-wide assessment (pp. 55). prepared for Ministry for Primary Industries.

Coulibaly, B., & Li, G. (2009). Choice of Mortgage Contracts: Evidence from the Survey of Consumer Finances. *Real Estate Economics, 37*(4), 659-673. doi: 10.1111/j.1540-6229.2009.00259.x

Cowan, L., Kaine, G., & Wright, V. (2013). The Role of Strategic and Tactical Flexibility in Managing Input Variability on Farms. *Systems Research and Behavioral Science, 30*(4), 470-494. doi: https://doi.org/10.1002/sres.2137

Crane, L., Gantz, G., & Isaacs, S. I. (2013). *Introduction to risk management: understanding agricultural risks: production, marketing, financial, legal, human Resources* (2nd ed.): The United States Department of Agriculture Extension Risk Management Education and Risk Management Agency.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). Thousand Oaks- California: SAGE Publications Ltd.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks-California: SAGE Publications Ltd.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and Conducting Mixed Methods Research* (2nd ed.). Thousand Oaks- California: SAGE Publications Ltd.

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced Mixed Methods Research Designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (1st ed., pp. 209-240). Thousand Oaks, California: SAGE Publications Ltd.

Creswell, J. W., & Zhang, W. (2009). The application of mixed methods designs to trauma research. *Journal of Traumatic Stress, 22*(6), 612-621. doi: https://doi.org/10.1002/jts.20479

Croissant, Y. (2012). Estimation of multinomial logit models in R: The mlogit Packages. *R package version, 0.2-2*. https://cran.r-project.org/package=mlogit

DairyNZ. (2009). DairyNZ Economic Survey 2007-08 (pp. 56). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2010). DairyNZ Economic Survey 2008-09 (pp. 56). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2012). DairyNZ Economic Survey 2010-11 (pp. 59). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2013). DairyNZ Economic Survey 2011-12 (pp. 59). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2014). DairyNZ Economic Survey 2012-13 (pp. 68). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2014). New Zealand Dairy Statistics 2013-14 (pp. 52). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2015). New Zealand Dairy Statistics 2014-15 (pp. 50). Hamilton, New Zealand: DairyNZ Ltd.

DairyNZ. (2016). DairyNZ Economic Survey 2014-15 (pp. 63). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2016). New Zealand Dairy Statistics 2015-16 (pp. 55). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2017). DairyNZ Economic Survey 2015-16 (pp. 63). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2017). New Zealand Dairy Statistics 2016-17 (pp. 54). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2018). DairyNZ Economic Survey 2016-17 (pp. 72). Hamilton, New Zealand: DairyNZ.

DairyNZ. (2019). DairyNZ Economic Survey 2017-18 (pp. 72). Hamilton, New Zealand: DairyNZ.

Dalley, D. (2010). *Achieving wintering targets–critical success factors for different wintering systems in Southland.* Paper presented at the South Islan Dairy Event (SIDE).

Dalley, D. (2011). *The challenges of animal wintering from a sustainability perspective.* Paper presented at the Proceedings of the New Zealand Society of Animal Production.

Dalley, D., Wilson, D., Edwards, G., & Judson, H. (2008). *Getting the most from your dairy support land-tips for allocating winter forages.* Paper presented at the South Island Dairy Event (SIDE), Lincoln University.

Darnhofer, I. (2014). Resilience and why it matters for farm management. *European Review of Agricultural Economics, 41*(3), 461-484. doi: 10.1093/erae/jbu012

Darnhofer, I., Bellon, S., Dedieu, B., & Milestad, R. (2010). Adaptiveness to enhance the sustainability of farming systems. A review. *Agronomy for Sustainable Development, 30*(3), 545-555. doi: 10.1051/agro/2009053

Darnhofer, I., Fairweather, J., & Moller, H. (2010). Assessing a farm's sustainability: insights from resilience thinking. *International journal of agricultural sustainability, 8*(3), 186-198.

Davis, S. B., Price, T. J., Wetzstein, M. E., & Rieger, M. W. (1997). Reducing yield variation in peach orchards by geographic scattering. *American Journal of Agricultural Economics, 79*(4), 1119-1126.

de Brauw, A., & Eozenou, P. (2014). Measuring risk attitudes among Mozambican farmers. *Journal of Development Economics, 111*(0), 61-74. doi: https://doi.org/10.1016/j.jdeveco.2014.08.002

de Mey, Y., van Winsen, F., Wauters, E., Vancauteren, M., Lauwers, L., & Van Passel, S. (2014). Farm-level evidence on risk balancing behavior in the EU-15. *Agricultural Finance Review, 74*(1), 17-37. doi: http://dx.doi.org/10.1108/AFR-11-2012-0066

DeAngelo, H., & DeAngelo, L. (2007). Capital structure, payout policy, and financial flexibility *working paper no. FBE (02-06)*. Marshall school of business: University of Southern California.

DeAngelo, H., DeAngelo, L., & Whited, T. M. (2011). Capital structure dynamics and transitory debt. *Journal of financial economics, 99*(2), 235-261. doi: https://doi.org/10.1016/j.jfineco.2010.09.005

Dedieu, B. (2009). Qualification of the adaptive capacities of livestock farming systems. *Revista brasileira de zootecnia, 38*(SPE), 397-404.

Denis, D. J. (2011). Financial flexibility and corporate liquidity. *Journal of corporate finance, 17*(3), 667-674.

Denis, D. J., & McKeon, S. B. (2012). Debt Financing and Financial Flexibility Evidence from Proactive Leverage Increases. *The Review of Financial Studies, 25*(6), 1897-1929. doi: 10.1093/rfs/hhs005

Densberger, K. (2014). The self-efficacy and risk-propensity of entrepreneurs. *Journal of Enterprising Culture, 22*(04), 437-462.

Detre, J., Briggeman, B., Boehlje, M., & Gray, A. W. (2006). Scorecarding and heat mapping: tools and concepts for assessing strategic uncertainty. *International Food and Agribusiness Management Review, 9*(1), 71-92.

DeVellis, R. F. (2017). *Scale development: Theory and applications* (4th ed.). Los Angeles - California: SAGE Publications Ltd.

Dey, I. (2003). *Qualitative Data Analysis: A User Friendly Guide for Social Scientists* (pp. 300). doi:https://doi.org/10.4324/9780203412497

Di Falco, S., & Chavas, J.-P. (2006). Crop genetic diversity, farm productivity and the management of environmental risk in rainfed agriculture. *European Review of Agricultural Economics, 33*(3), 289-314.

Díaz-Pichardo, R., Cantú-González, C., López-Hernández, P., & McElwee, G. (2012). From Farmers to Entrepreneurs The Importance of Collaborative Behaviour. *Journal of Entrepreneurship, 21*(1), 91-116.

Díaz-Solís, H., Grant, W. E., Kothmann, M. M., Teague, W. R., & Díaz-García, J. A. (2009). Adaptive management of stocking rates to reduce effects of drought on cow-calf production systems in semi-arid rangelands. *Agricultural Systems, 100*(1), 43-50. doi: https://doi.org/10.1016/j.agsy.2008.12.007

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences. *Journal of the European Economic Association, 9*(3), 522-550. doi: https://doi.org/10.1111/j.1542-4774.2011.01015.x

Dooley, A. E., Shadbolt, N. M., Khatami, K., & Tauer, L. W. (2017). Application of the Adjusted Weak Axiom of Profit Maximization to New Zealand Dairy Farming. *Journal of Applied Farm Economics, 1*(2), 49-61. doi: http://doi.org/10.7771/2331-9151.1013

Dooley, L. M. (2002). Case Study Research and Theory Building. *Advances in Developing Human Resources, 4*(3), 335-354. doi: https://doi.org/10.1177/1523422302043007

Drever, E. (2003). *Using Semi-Structured Interviews in Small-Scale Research. A Teacher's Guide* (2nd ed.). Glasgow-Scotland: Scottish Council For Research In Education.

Dries, L., Pascucci, S., & Gardebroek, C. (2012). Diversification in Italian farm systems: are farmers using interlinked strategies? *New Medit : Mediterranean Journal of Economics, Agriculture and Environment, 11*(4), 7-16.

Dunstan, A., Skilling, H., Newman, M., & Mounsey, Z. (2015). An updated assessment of dairy sector vulnerabilities. *The Reserve Bank of New Zealand (RBNZ) Bulletin* (Vol. 78, pp. 3). Wellington- New Zealand: The Reserve Bank of New Zealand (RBNZ.

Duranovich, F. N. (2015). *Resilience attributes of New Zealand dairy farmers.* (Masters in AgriCommerce), Massey University, Palmerston North, New Zealand.

Durst, P. T., Moore, S. J., Ritter, C., & Barkema, H. W. (2018). Evaluation by employees of employee management on large US dairy farms. *Journal of Dairy Science, 101*(8), 7450-7462. doi: https://doi.org/10.3168/jds.2018-14592

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth: Harcourt Brace Jovanovich College Publishers.

Eastwood, C., Greer, J., Schmidt, D., Muir, J., & Sargeant, K. (2018, 2018). *New dairy workplace design the challenge of attracting and retaining staff to the NZ dairy farm of 2030.* Paper presented at the International agricultural workforce conference, Moorepark Dairy Levy Research Update - Cork.

Eastwood, C., & Kenny, S. (2009). Art or science?: Heuristic versus data driven grazing management on dairy farms. *Extension Farming Systems Journal, 5*(1), 95-102.

Eastwood, C., Rue, B. D., & Gray, D. (2017). Using a 'network of practice'approach to match grazing decision-support system design with farmer practice. *Animal Production Science, 57*(7), 1536-1542.

Eastwood, C. R., Jago, J. G., Edwards, J. P., & Burke, J. K. (2016). Getting the most out of advanced farm management technologies: roles of technology suppliers and dairy industry organisations in supporting precision dairy farmers. *Animal Production Science, 56*(10), 1752-1760. doi: https://doi.org/10.1071/AN141015

Edwards, J., Mashlan, K., Dalley, D., & Pinxterhuis, J. (2017). A survey of dairy cow wintering practices in Canterbury, New Zealand. *Animal Production Science, 57*(7), 1323-1329. doi: https://doi.org/10.1071/AN16459

Edwards, J., Rue, B. D., & Jago, J. (2015). Evaluating rates of technology adoption and milking practices on New Zealand dairy farms. *Animal Production Science, 55*(6), 702-709. doi: https://doi.org/10.1071/AN14065

Eidman, V. T. (1990). Quantifying and Managing Risk in Agriculture. *Agrekon, 29*(1), 11-23. doi: http://dx.doi.org/10.1080/03031853.1990.9524161

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *The Academy of Management Review, 14*(4), 532-550. doi: https://doi.org/10.2307/258557

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management journal, 50*(1), 25. doi: https://doi.org/10.5465/amj.2007.24160888

Ellinger, P. N., Barry, P. J., & Lins, D. A. (1983). Farm Financial Performance under Graduated Payment Mortgages. *North Central Journal of Agricultural Economics, 5*(2), 47-53. doi: https://doi.org/10.2307/1349139

Escalante, C. L., & Barry, P. J. (2001). Risk balancing in an integrated farm risk management plan. *Journal of Agricultural and Applied Economics, 33*(3), 413-430. doi: https://doi.org/10.1017/S1074070800020927

Escalante, C. L., & Barry, P. J. (2003). Determinants of the strength of strategic adjustments in farm capital structure. *Journal of Agricultural and Applied Economics, 35*(01), 67-78. doi: https://doi.org/10.1017/S1074070800005940

Fairweather, J., & Mulet-Marquis, S. (2009). Changes in the age of New Zealand farmers: Problems for the future? *New Zealand Geographer, 65*(2), 118-125. doi: https://doi.org/10.1111/j.1745-7939.2009.01154.x

Fairweather, J. R., & Keating, N. C. (1994). Goals and Management Styles of New-Zealand Farmers. *Agricultural Systems, 44*(2), 181-200. doi: https://doi.org/10.1016/0308-521X(94)90160-H

Faulkender, & Petersen. (2006). Does the source of capital affect capital structure? *Review of financial studies, 19*(1), 45-79.

Faulkender, M. (2005). Hedging or Market Timing? Selecting the Interest Rate Exposure of Corporate Debt. *The Journal of Finance, 60*(2), 931-962. doi: 10.1111/j.1540-6261.2005.00751.x

Fausett, B. J., Rowarth, J. S., & Scrimgeour, F. G. (2015). The true cost of maize silage. *Journal of New Zealand Grasslands, 77*, 77-82. doi: https://doi.org/10.33584/jnzg.2015.77.490

Fausett, B. J., Rowarth, J. S., & Scrimgeour, F. G. (2015). The true cost of maize silage. *Journal of New Zealand Grasslands*, 77-82.

Fausti, S., & Gillespie, J. (2006). Measuring risk attitude of agricultural producers using a mail survey: how consistent are the methods? *The Australian Journal of Agricultural and Resource Economics, 50*(2), 171-188. doi: 10.1111/j.1467-8489.2006.00328.x

Featherstone, A. M., Ibendahl, G. A., Randy Winter, J., & Spaulding, A. (2005). Farm financial structure. *Agricultural Finance Review, 65*(2), 97-117. doi: http://dx.doi.org/10.1108/00214660580001163

Ferguson, R., & Hansson, H. (2013). Expand or exit? Strategic decisions in milk production. *Livestock Science, 155*(2-3), 415-423. doi: 10.1016/j.livsci.2013.05.019

Fernandez-Perez, A., Frijns, B., Gafiatullina, I., & Tourani-Rad, A. (2019). Profit Margin Hedging in the New Zealand Dairy Farming Industry. https://acfr.aut.ac.nz

Fetsch, R. J., Bastian, C., Kaan, D. A., & Koontz, S. R. (2001). A two-state comparison of farmers' and ranchers' risk management education needs. *Journal of the American Society of Farm Managers and Rural Appraisers, 64*(1), 8192.

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs—principles and practices. *Health Services Research, 48*(6pt2), 2134-2156. doi: https://doi.org/10.1111/1475-6773.12117

Fiksel, J. (2003). Designing resilient, sustainable systems. *Environmental science & technology, 37*(23), 5330-5339.

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making, 13*(1), 1-17. doi: Doi 10.1002/(Sici)1099-0771(200001/03)13:1<1::Aid-Bdm333>3.0.Co;2-S

Fishbein, M., & Ajzen, I. (2011). *Predicting and Changing Behavior: The Reasoned Action Approach*. New York: Taylor & Francis.

Fishburn, P. C. (1988). Expected utility: An anniversary and a new era. *Journal of Risk and Uncertainty, 1*(3), 267-283. doi: 10.1007/bf00056138

Flaten, O., Lien, G., Koesling, M., Valle, P. S., & Ebbesvik, M. (2005). Comparing risk perceptions and risk management in organic and conventional dairy farming: empirical results from Norway. *Livestock Production Science, 95*(1-2), 11-25. doi: 10.1016/j.livprodsci.2004.10.014

Foote, K. J., Joy, M. K., & Death, R. G. (2015). New Zealand Dairy Farming: Milking Our Environment for All Its Worth. *environmental Management, 56*(3), 709-720. doi: 10.1007/s00267-015-0517-x

Foudi, S., & Erdlenbruch, K. (2011). The role of irrigation in farmers' risk management strategies in France. *European Review of Agricultural Economics, 39*(3), 439-457.

Fox, J., & Weisberg, S. (2018). *An R companion to applied regression* (3rd ed.). Thousand Oak: California: SAGE Publications Ltd.

Franco, G. (2016). Multiple correspondence analysis: one only or several techniques? *Quality & Quantity: International Journal of Methodology, 50*(3), 1299-1315.

Frank, M. Z., & Goyal, V. K. (2003). Testing the pecking order theory of capital structure. *Journal of financial economics, 67*(2), 217-248.

Frank, M. Z., & Goyal, V. K. (2007). Trade-off and pecking order theories of debt. *Available at SSRN 670543*.

Frank, M. Z., & Goyal, V. K. (2009). Capital Structure Decisions: Which Factors Are Reliably Important? *Financial Management, 38*(1), 1-37. doi: 10.1111/j.1755-053X.2009.01026.x

French, P., Driscoll, K., Horan, B., & Shalloo, L. (2015). The economic, environmental and welfare implications of alternative systems of accommodating dairy cows during the winter months. *Animal Production Science, 55*(7), 838-842.

Friendly, M., & Meyer, D. (2015). *Discrete data analysis with R: visualization and modeling techniques for categorical and count data*: Chapman and Hall/CRC.

Gabriel, S. C., & Baker, C. B. (1980). Concepts of Business and Financial Risk. *American Journal of Agricultural Economics, 62*(3), 560-564. doi: 10.2307/1240215

Gall, R. G., & Schroder, B. (2006). Agricultural producer cooperatives as strategic alliances. *International Food and Agribusiness Management Review, 9*(1030-2016-82591), 26.

Gamba, A., & Triantis, A. (2008). The value of financial flexibility. *The Journal of Finance, 63*(5), 2263-2296.

Ganzach, Y. (2000). Judging Risk and Return of Financial Assets. *Organ Behav Hum Decis Process, 83*(2), 353-370. doi: 10.1006/obhd.2000.2914

Ganzach, Y., Ellis, S., Pazy, A., & Ricci-Siag, T. (2008). On the perception and operationalization of risk perception. *Judgment and Decision Making Journal, 3*(4), 317-324.

Gardner, J., & Bennett, R. (2011). *Sharemilking in New Zealand.* Paper presented at the International Farm Management Congress.

Gardner, J., & Shadbolt, N. M. (2005). Wealth Creation. In N. M. Shadbolt & S. K. Martin (Eds.), *Farm management in New Zealand* (pp. 267-304): Oxford University Press.

Geary, U., Lopez-Villalobos, N., Garrick, D. J., & Shalloo, L. (2014). Spring calving versus split calving: effects on farm, processor and industry profitability for the Irish dairy industry. *The Journal of Agricultural Science, 152*(3), 448.

Gebreegziabher, K., & Tadesse, T. (2013). Risk perception and management in smallholder dairy farming in Tigray, Northern Ethiopia. *Journal of Risk Research, 17*(3), 367-381. doi: 10.1080/13669877.2013.815648

Gellynck, X., & Molnár, A. (2009). Chain governance structures: the European traditional food sector. *British Food Journal, 111*(8), 762-775.

Gibbs, S. R. (2009). Exploring the influence of task-specific self-efficacy on opportunity recognition perceptions and behaviors. *Frontiers of Entrepreneurship Research, 29*(6), 1.

Gilovich, T., Griffin, D., & Kahneman, D. (2002). *Heuristics and biases: The psychology of intuitive judgment*. Cambridge: UK: Cambridge University Press.

Gloy, B. A., & LaDue, E. L. (2003). Financial management practices and farm profitability. *Agricultural Finance Review, 63*(2), 157-174. doi: http://dx.doi.org/10.1108/00215060380001147

Goodwin, B. K., & Mishra, A. K. (2004). Farming Efficiency and the Determinants of Multiple Job Holding by Farm Operators. *American Journal of Agricultural Economics, 86*(3), 722-729. doi: 10.1111/j.0002-9092.2004.00614.x

Goodwin, B. K., & Schroeder, T. C. (1994). Human Capital, Producer Education Programs, and the Adoption of Forward-Pricing Methods. *American Journal of Agricultural Economics, 76*(4), 936-947. doi: 10.2307/1243753

Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: Evidence from the field. *Journal of financial economics, 60*(2), 187-243.

Gray, D., Dooley, E., & Shadbolt, N. M. (2008). Risk and dairy farm management in New Zealand: A review of literature: AgResearch.

Gray, D., Kemp, P., Kenyon, P., Morris, S., Brookes, I., Matthew, C., & Osborne, M. (2008). *Strategies used to manage climatic risk: Lessons from farmers with expertise in dryland farming.* Paper presented at the Proceedings of the New Zealand Grassland Association.

Gray, D., & Lockhart, J. (1996). *Management of summer feed deficits on three highperforming dairy farms in the Manawatu.* Paper presented at the Proceedings of the New Zealand Grassland Association, Oamaru.

Gray, D., Reid, J., & Horne, D. (2011). *The management of risk in a dryland environment.* Paper presented at the The New Zealand Grassland Association, Gisborne.

Gray, D., Walcroft, J., Shadbolt, N., & Turner, J. (2014). Dairy On-Farm Financial Risk Project: Cross-Case Report (pp. 213). Palmerston North, New Zealand: One Farm: Centre of Excellence in Farm Business Management.

Gray, D. I., Parker, W. J., & Kemp, E. (2009). Farm Management Research: a Discussion of Some of the Important Issues. *Journal of International Farm Management, 5*(1), 1-24.

Greenacre, M. (2017). *Correspondence analysis in practice*: Chapman and Hall/CRC.

Greenhalgh, J., & Tipples, R. (2013). Literature Review: From human resource management to employment relations – people focussed employers in dairy farming (pp. 40): Centre of Excellence in Farm Business Management, Lincoln University.

Greig, B. (2010). *New Zealand dairy farm debt.* Paper presented at the South Island Dairy Event (SIDE) conference, Invercargill.

Greig, B., Nuthall, P., & Old, K. (2018). The reality of net capital gains and annual profit on NZ primary producing businesses: data from a recent survey of all farm types. *Kōtuitui: New Zealand Journal of Social Sciences Online, 13*(2), 261-270. doi: 10.1080/1177083X.2018.1489291

Greig, B., Nuthall, P., & Old, K. (2019). Farmers' characteristics' and the propensity to reduce debt: The case for New Zealand (NZ) primary producers. *Agricultural Finance Review, 79*(5), 614-632. doi: https://doi.org/10.1108/AFR-02-2019-0020

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods, 18*(1), 59-82.

Gujarati, D. N. (2015). *Econometrics by example* (2nd ed.). London- UK: Macmillan Education, Palgrave.

Gunderson, M. A., Boehlje, M. D., Neves, M. F., & Sonka, S. T. (2014). Agribusiness Organization and Management. In N. K. Van Alfen (Ed.), *Encyclopedia of agriculture and food systems* (pp. 51-70). Oxford: Academic Press.

Gustafson, C. R., Pederson, G. D., & Gloy, B. A. (2005). Credit risk assessment. *Agricultural Finance Review, 65*(2), 201-217. doi: https://doi.org/10.1108/00214660580001173

Hair, J. (2010). *Multivariate Data Analysis*: Prentice Hall.

Hair, J. F., Money, A. H., Samouel, P., & Page, M. (2007). *Research methods for business*. Chichester: John Wiley and Sons, Ltd.

Hall, D. C., Knight, T. O., Coble, K. H., Baquet, A. E., & Patrick, G. F. (2003). Analysis of beef producers' risk management perceptions and desire for further risk management education. *Review of Agricultural Economics, 25*(2), 430-448. doi: Doi 10.1111/1467-9353.00148

Hansson, H., & Ferguson, R. (2011). Factors influencing the strategic decision to further develop dairy production - A study of farmers in central Sweden. *Livestock Science, 135*(2-3), 110-123. doi: 10.1016/j.livsci.2010.06.157

Hansson, H., Ferguson, R., & Olofsson, C. (2010). Understanding the diversification and specialization of farm businesses. *Agricultural and Food Science, 19*(4), 269-283.

Hansson, H., Ferguson, R., & Olofsson, C. (2012). Psychological Constructs Underlying Farmers' Decisions to Diversify or Specialise their Businesses - An Application of Theory of Planned Behaviour. *Journal of Agricultural Economics, 63*(2), 465-482. doi: 10.1111/j.1477-9552.2012.00344.x

Hansson, H., Ferguson, R., Olofsson, C., & Rantamäki-Lahtinen, L. (2013). Farmers' motives for diversifying their farm business – The influence of family. *Journal of Rural studies, 32*, 240-250. doi: https://doi.org/10.1016/j.jrurstud.2013.07.002

Hansson, H., & Lagerkvist, C. J. (2012). Measuring farmers' preferences for risk: a domain-specific risk preference scale. *Journal of Risk Research, 15*(7), 737-753. doi: 10.1080/13669877.2012.657217

Hardaker, J. B. (2006). Farm risk management: past, present and prospects. *Journal of Farm Management, 12*(10), 593-612.

Hardaker, J. B., Huirne, R. B., Anderson, J. R., & Lien, G. (2004). *Coping with risk in agriculture 2nd Edition*. Oxfordshire-UK: CABI publishing.

Hardaker, J. B., Huirne, R. B., Anderson, J. R., & Lien, G. (2015). *Coping with Risk in Agriculture : Applied Decision Analysis 3rd Edition*. Oxfordshire-UK: CABI publishing.

Hardaker, J. B., & Lien, G. (2010). Probabilities for decision analysis in agriculture and rural resource economics: The need for a paradigm change. *Agricultural Systems, 103*(6), 345-350. doi: https://doi.org/10.1016/j.agsy.2010.01.001

Hardaker, J. B., & Lien, G. D. (2007). Rationalising Risk Assessment: Applications to Agricultural Business. *Australasian Agribusiness Review, 15*.

Harrison, R. L., & Reilly, T. M. (2011). Mixed methods designs in marketing research. *Qualitative Market Research: An International Journal, 14*(1), 7-26.

Harwood, J. L., Heifner, R., Coble, K., Perry, J., & Somwaru, A. (1999). Managing risk in farming: concepts, research, and analysis *Agricultural Economic Report* Washington, District of Columbia: US Department of Agriculture, Economic Research Service.

Hausman, J., & McFadden, D. (1984). Specification Tests for the Multinomial Logit Model. *Econometrica, 52*(5), 1219-1240.

Heady, E. O. (1952). *Economics of agricultural production and resource use*. Englewood Cliffs, N.J: Prentice-Hall.

Hellerstein, D., Higgins, N., & Horowitz, J. (2013). The predictive power of risk preference measures for farming decisions. *European Review of Agricultural Economics, 40*(5), 807-833. doi: 10.1093/erae/jbs043

Helmsing, A. B., & Vellema, S. (2012). *Value chains, social inclusion and economic development: Contrasting theories and realities*: Routledge.

Hilkens, A., Reid, J. I., Klerkx, L., & Gray, D. I. (2018). Money talk: How relations between farmers and advisors around financial management are shaped. *Journal of Rural studies, 63*, 83-95.

Hirsch, S., Mishra, A., Möhring, N., & Finger, R. (2019). Revisiting firm flexibility and efficiency: evidence from the EU dairy processing industry. doi: 10.1093/erae/jbz003

Hirst, C., Donaghy, D., Gray, D., Wood, B., & McCarthy, S. (2014). *Exploring operational management used by dairy farmers to manage grazing.* Paper presented at the Proceedings of the 5th Australasian Dairy Science Symposium.

Ho, C. K. M., Newman, M., Dalley, D. E., Little, S., & Wales, W. J. (2013). Performance, return and risk of different dairy systems in Australia and New Zealand. *Animal Production Science, 53*(9), 894-906. doi: 10.1071/AN12287

Holling, C. S. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems, 4*(5), 390-405.

Holmes, C. W., Wilson, G. F., Mackenzie, D., Flux, D., Brookes, I., & Davey, A. (1987). *Milk production from pasture*: Butterworths of New Zealand Ltd.

Houghton, C., Murphy, K., Shaw, D., & Casey, D. (2015). Qualitative case study data analysis: an example from practice. *Nurse researcher, 22*(5), 8-12.

Howard, W. H., & McEwan, K. A. (1989). Human resource management: a review with applications to agriculture. *Canadian Journal of Agricultural Economics, 37*(4), 733.

Howes, J., Horne, D., & Shadbolt, N. (2014). A Calculator for Estimating the Profitability of Irrigation on new Zealand Dairy Farms: Massey University.

Hubbard, R. G., & Kashyap, A. K. (1992). Internal net worth and the investment process: An application to US agriculture. *Journal of Political Economy, 100*(3), 506-534.

Husson, F., Josse, J., & Pages, J. (2010). Principal component methods-hierarchical clustering-partitional clustering: why would we need to choose for visualizing data. *Applied Mathematics Department*.

Husson, F., Le, S., & Pagès, J. (2017). *Exploratory Multivariate Analysis by Example Using R, Second Edition*. London, UK: Chapman and Hall/CRC.

Ingrand, S., Astigarraga, L., Chia, E., Coquil, X., David, C., & Fiorelli, J. L. (2017). Securing Sustainable Livestock Production Systems in an Uncertain Economic Climate: Nurturing Flexibility and Resilience *Livestock Science*: InTech.

Ingrand, S., Bardey, H., Brossier, J., with the collaboration of, B. D., Degrange, B., Lémery, B., & Pasdermadjian, P. (2007). Flexibility of Suckler Cattle Farms in the Face of Uncertainty within the Beef Industry: A Proposed Definition and an Illustration. *The Journal of Agricultural Education and Extension, 13*(1), 39-48. doi: 10.1080/13892240601162098

Iyer, P., Bozzola, M., Hirsch, S., Meraner, M., & Finger, R. (2020). Measuring Farmer Risk Preferences in Europe: A Systematic Review. *Journal of Agricultural Economics, 71*(1), 3-26. doi: https://doi.org/10.1111/1477-9552.12325

Jack, E. P., & Raturi, A. (2002). Sources of volume flexibility and their impact on performance. *Journal of Operations Management, 20*(5), 519-548.

Jackson-Smith, D., Trechter, D., & Splett, N. (2004). The Contribution of Financial Management Training and Knowledge to Dairy Farm Financial Performance. *Review of Agricultural Economics, 26*(1), 132-147.

Jago, J., Eastwood, C., Kerrisk, K., & Yule, I. (2013). Precision dairy farming in Australasia: adoption, risks and opportunities. *Animal Production Science, 53*(9), 907-916. doi: https://doi.org/10.1071/AN12330

Jalilvand, A., & Harris, R. S. (1984). Corporate Behavior in Adjusting to Capital Structure and Dividend Targets: An Econometric Study. *The Journal of Finance, 39*(1), 127-145. doi: 10.2307/2327672

Jensen, F. E., & Langemeier, L. N. (1996). Optimal leverage with risk aversion: empirical evidence. *Agricultural Finance Review, 56*(1), 85-97.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of financial economics, 3*(4), 305-360. doi: https://doi.org/10.1016/0304-405X(76)90026-X

Jiang, N., & Sharp, B. (2014). Cost Efficiency of Dairy Farming in New Zealand: a stochastic frontier analysis. *Agricultural and Resource Economics Review, 43*(3), 406.

Johnson, D. G. (1950). The nature of the supply function for agricultural products. *The American economic review, 40*(4), 539-564.

Johnson, G., & Haver, C. (1954). Managerial Concepts for Agriculturists, Kentucky Agr. Exp. Sta. *Bull, 619*, 14.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher, 33*(7), 14-26. doi: 10.3102/0013189x033007014

Jolly, R. W. (1983). Risk Management in Agricultural Production. *American Journal of Agricultural Economics, 65*(5), 1107-1113. doi: 10.2307/1240429

Judge, T. A., Erez, A., Bono, J. E., & Thoresen, C. J. (2003). The core self-evaluations scale: Development of a measure. *Personnel psychology, 56*(2), 303-331. doi: DOI 10.1111/j.1744-6570.2003.tb00152.x

Julian, J. W., & Seavert, C. F. (2011). AgProfit™: a net present value and cash flow based decision aid for agriculture producers. *Agricultural Finance Review, 71*(3), 366-378. doi: https://doi.org/10.1108/00021461111177620

Junqueira, R. (2010). *Governance structure and supply chain management practices in the dairy value chain: a comparative study between New Zealand and Brazil.* (Master's Degree), Massey University, Auckland, New Zealand.

Just, D., & Peterson, H. H. (2003). Diminishing marginal utility of wealth and calibration of risk in agriculture. *American Journal of Agricultural Economics, 85*(5), 1234-1241. doi: DOI 10.1111/j.0092-5853.2003.00536.x

Just, D., & Peterson, H. H. (2010). Is expected utility theory applicable? A revealed preference test. *American Journal of Agricultural Economics, 92*(1), 16-27.

Just, D. R. (2011). Calibrating the wealth effects of decoupled payments: Does decreasing absolute risk aversion matter? *Journal of Econometrics, 162*(1), 25-34. doi: https://doi.org/10.1016/j.jeconom.2009.10.006

Just, D. R., Khantachavana, S. V., & Just, R. E. (2010). Empirical Challenges for Risk Preferences and Production. *Annual Review of Resource Economics, 2*(1), 13-31. doi: 10.1146/annurev.resource.012809.103902

Just, R. E. (2003). Risk research in agricultural economics: opportunities and challenges for the next twenty-five years. *Agricultural Systems, 75*(2-3), 123-159. doi: https://doi.org/10.1016/S0308-521X(02)00063-X

Just, R. E., & Pope, R. D. (2003). Agricultural risk analysis: Adequacy of models, data, and issues. *American Journal of Agricultural Economics, 85*(5), 1249-1256. doi: DOI 10.1111/j.0092-5853.2003.00538.x

Kaefer, F. (2014). *Credibility at stake? News representations and discursive constructions of national environmental reputation and place brand image: The case of clean, green New Zealand.* (Doctor of Philosophy (PhD) Doctoral), University of Waikato, Hamilton, New Zealand. Retrieved from https://hdl.handle.net/10289/8834

Kahan, D. (2013). *Farm business analysis using benchmarking*: Food and Agriculture Organization of the United Nations (FAO).

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.

Kaine, G. (2015). Factors influencing standing off and wintering off dairy livestock in New Zealand. *Rural Extension and Innovation Systems Journal, 11*(1), 23.

Kaine, G., & Cowan, L. (2011). Using general systems theory to understand how farmers manage variability. *Systems Research and Behavioral Science, 28*(3), 231-244. doi: 10.1002/sres.1073

Kaine, G., & Tozer, P. (2005). Stability, resilience and sustainability in pasture-based grazing systems. *Agricultural Systems, 83*(1), 27-48. doi: https://doi.org/10.1016/j.agsy.2004.03.001

Kalaugher, E., Beukes, P., Bornman, J. F., Clark, A., & Campbell, D. I. (2017). Modelling farm-level adaptation of temperate, pasture-based dairy farms to climate change. *Agricultural Systems, 153*, 53-68. doi: https://doi.org/10.1016/j.agsy.2017.01.008

Kaplan, R. S., & Mikes, A. (2012). MANAGING RISKS: A NEW FRAMEWORK. *Harvard Business Review, 90*(6), 48-60.

Kaplan, R. S., & Mikes, A. (2016). Risk Management—the Revealing Hand. *Journal of Applied Corporate Finance, 28*(1), 8-18. doi: 10.1111/jacf.12155

Katchova, A. L. (2008). A Comparison of the Economic Well-Being of Farm and Nonfarm Households. *American Journal of Agricultural Economics, 90*(3), 733-747.

Katchova, A. L., & Miranda, M. J. (2004). Two-Step Econometric Estimation of Farm Characteristics Affecting Marketing Contract Decisions. *American Journal of Agricultural Economics, 86*(1), 88-102.

Kay, R. D., Edwards, W. M., & Duffy, P. A. (1994). *Farm management*: McGraw-Hill New York.

KC, B., Mohssen, M., Chau, H., Curtis, A., Cuenca, R., Bright, J., . . . Safa, M. (2018). Irrigation Strategies for Rotational Grazing Pasture in Canterbury, New Zealand, and Impacts on Irrigation Efficiency. *Irrigation and Drainage, 67*(5), 779-789. doi: 10.1002/ird.2290

Khoju, M. R., Nelson, C. H., & Barry, P. J. (1993). Debt Service Reserve Fund as a Response to Repayment Risk. *Applied Economic Perspectives and Policy, 15*(2), 217-232. doi: 10.2307/1349444

Kimura, S., Antón, J., & LeThi, C. (2010). *Farm Level Analysis of Risk and Risk Management Strategies and Policies: Cross Country Analysis* (Vol. 48). Paris: OECD

Kislev, Y., & Peterson, W. (1996). Economies of scale in agriculture: a reexamination of the evidence. *The Economics of Agriculture: Papers in Honor of D. Gale Johnson, 2*, 156-170.

Knapp, L., Wuepper, D., Dalhaus, T., & Finger, R. (2021). Revisiting the diversification and insurance relationship: Differences between on– and off-farm strategies. *Climate Risk Management, 32*, 100315. doi: https://doi.org/10.1016/j.crm.2021.100315

Koeman, J., & Bialkowski, J. P. (2015). Cross-Hedging on the Milk-Derived Product Market. Available at SSRN: https://ssrn.com/abstract=2639958

Koesling, M., Ebbesvik, M., Lien, G., Flaten, O., Valle, P. S., & Arntzen, H. (2004). Risk and risk management in organic and conventional cash crop farming in Norway. *Food Economics-Acta Agriculturae Scandinavica, Section C, 1*(4), 195-206.

Kortenkamp, K. V., & Moore, C. F. (2010). Psychology of Risk Perception. *Wiley Encyclopedia of Operations Research and Management Science*.

Kraus, S. J. (1995). Attitudes and the prediction of behavior: A meta-analysis of the empirical literature. *Personality and social psychology bulletin, 21*(1), 58-75.

Krueger Jr, N. F., & Dickson, P. R. (1993). Perceived self-efficacy and perceptions of opportunity and threat. *Psychological reports, 72*(3_suppl), 1235-1240.

Krueger, N., & Dickson, P. R. (1994). How Believing in Ourselves Increases Risk Taking: Perceived Self-Efficacy and Opportunity Recognition. *Decision Sciences, 25*(3), 385-400. doi: 10.1111/j.1540-5915.1994.tb00810.x

Kuethe, T. H., & Morehart, M. (2012). The profit impacts of risk management tool adoption. *Agricultural Finance Review, 72*(1), 104-116. doi: doi:10.1108/00021461211222178

La Rocca, M., La Rocca, T., & Cariola, A. (2011). Capital Structure Decisions During a Firm's Life Cycle. *Small Business Economics, 37*(1), 107-130. doi: 10.1007/s11187-009-9229-z

LaCour-Little, M., & Yang, J. (2010). Pay Me Now or Pay Me Later: Alternative Mortgage Products and the Mortgage Crisis. *Real Estate Economics, 38*(4), 687-732.

LaDue, E., & Zook, G. (1984). Variable Interest Rates and the Financial Performance of Dairy Farm Businesses. *Northeastern Journal of Agricultural and Resource Economics, 13*(2), 229-237.

LaDue, E. L., & Leatham, D. J. (1984). Floating versus Fixed-Rate Loans in Agriculture: Effects on Borrowers, Lenders, and the Agriculture Sector. *American Journal of Agricultural Economics, 66*(5), 607-613. doi: 10.2307/1240963

Lagerkvist, C. J. (2005). *Assessing farmers' risk attitudes based on economic, social, personal, and environmental sources of risk: evidence from Sweden.* Paper presented at the American Agricultural Economics Association Annual meeting. July.

Lam, T., Jansen, J., Van den Borne, B., Renes, R., & Hogeveen, H. (2011). What veterinarians need to know about communication to optimise their role as advisors on udder health in dairy herds. *New Zealand veterinary journal, 59*(1), 8-15.

Lambert, D. K., & Bayda, V. V. (2005). The impacts of farm financial structure on production efficiency. *Journal of Agricultural Applied Economics, 37*(1379-2016-112674), 277-289.

Langemeier, M. (2018). Exploring Changes in the Current Ratio from 2006 to 2017. *farmdoc daily, 8*(163). https://farmdocdaily.illinois.edu/2018/08/exploring-changes-in-the-current-ratio-from-2006-to-2017.html

Langemeier, M., & Featherstone, A. (2018). Examining Trends in Liquidity for a Sample of Kansas Farms. *farmdoc daily, 8*(163). https://farmdocdaily.illinois.edu/2018/08/exploring-changes-in-the-current-ratio-from-2006-to-2017.html

Langley, S., Somwaru, A., & Normile, M. A. (2006). Trade Liberalization in International Dairy Markets: Estimated Impacts *Economic Research Report*: United States Department of Agriculture, Economic Research Service.

Larsen, L. S., Munk, C., Sejer Nielsen, R., & Rangvid, J. (2018). How Do Homeowners Use Interest-Only Mortgages?

Larsen, R., Leatham, D., & Sukcharoen, K. (2015). Geographical diversification in wheat farming: a copula-based CVaR framework. *Agricultural Finance Review, 75*(3), 368-384. doi: https://doi.org/10.1108/AFR-07-2014-0020

Le Cren, N., Lyons, J., & Dana, L.-P. (2009). The role of collective action in the New Zealand dairy industry: An international comparison. *International Journal of Entrepreneurship and Small Business, 8*(1), 154-169. doi: https://doi.org/10.1504/IJESB.2009.02411

Lê, S., Josse, J., & Husson, F. (2008). FactoMineR: An R Package for Multivariate Analysis. *Journal of statistical software, 25*(1), 18. doi: https://doi.org/10.18637/jss.v025.i01

Leatham, D. J., & Baker, T. G. (1988). Farmers' choice of fixed and adjustable interest rate loans. *American Journal of Agricultural Economics, 70*(4), 803-812. doi: https://doi.org/10.2307/1241921

Ledgard, S., & Falconer, S. (2015). Total Greenhouse Gas Emissions from Farm Systems with Increasing Use of Supplementary Feeds Across Different Regions of New Zealand *SLMACC-AGR30624; Milestone 12* (pp. 67). Hamilton- New Zealand: AgResearch Ltd.

Leech, N. L., & Onwuegbuzie, A. J. (2009). A typology of mixed methods research designs. *Quality & Quantity, 43*(2), 265-275. doi: https://doi.org/10.1007/s11135-007-9105-3

Leeper, T. J. (2018). Interpreting Regression Results using Average Marginal Effects with R's margins.

Leeper, T. J. (2018). margins: Marginal Effects for Model Objects. *R package version, 0.3.25.*

Liebe, U., Mariel, P., Beyer, H., & Meyerhoff, J. (2018). Uncovering the Nexus Between Attitudes, Preferences, and Behavior in Sociological Applications of Stated Choice Experiments. *Sociological methods & research, 50*(1), 310-347. doi: https://doi.org/10.1177%2F0049124118782536

Lien, G. (2002). Non-parametric estimation of decision makers' risk aversion. *Agricultural Economics, 27*(1), 75-83. doi: https://doi.org/10.1016/S0169-5150(01)00063-9

Lins, K. V., Servaes, H., & Tufano, P. (2010). What drives corporate liquidity? An international survey of cash holdings and lines of credit. *Journal of financial economics, 98*(1), 160-176. doi: http://dx.doi.org/10.1016/j.jfineco.2010.04.006

Liu, X. (2016). Mixed-effects multinomial logit model for nominal outcomes. In X. Liu (Ed.), *Methods and Applications of Longitudinal Data Analysis* (pp. 343-378). Oxford- UK: Academic Press.

Lorenzo-Seva, U. (2011). Horn's parallel analysis for selecting the number of dimensions in correspondence analysis. *Methodology: European Journal of Research Methods for the Behavioral and Social Sciences, 7*(3), 96-102. doi: https://doi.org/10.1027/1614-2241/a000027

Løyland, K., & Ringstad, V. (2001). Gains and structural effects of exploiting scale-economies in Norwegian dairy production. *Agricultural Economics, 24*(2), 149-166. doi: https://doi.org/10.1016/S0169-5150(00)00057-8

Ma, W., Bicknell, K., & Renwick, A. (2019). Feed use intensification and technical efficiency of dairy farms in New Zealand. *Australian Journal of Agricultural and Resource Economics, 63*(1), 20-38. doi: https://doi.org/10.1111/1467-8489.12283

Ma, W., Renwick, A., & Bicknell, K. (2018). Higher Intensity, Higher Profit? Empirical Evidence from Dairy Farming in New Zealand. *Journal of Agricultural Economics, 69*(3), 739-755. doi: https://doi.org/10.1111/1477-9552.12261

Ma, W., Renwick, A., & Greig, B. (2019). Modelling the heterogeneous effects of stocking rate on dairy production: an application of unconditional quantile regression with fixed effects. *Applied Economics*, 1-12. doi: https://doi.org/10.1080/00036846.2019.1602710

Ma, W., Renwick, A., & Zhou, X. (2020). The relationship between farm debt and dairy productivity and profitability in New Zealand. *Journal of Dairy Science, 103*(9), 8251-8256. doi: https://doi.org/10.3168/jds.2019-17506

Mac an Bhaird, C. (2010). SME Financing: A Life Cycle Approach *Resourcing Small and Medium Sized Enterprises* (pp. 23-43). Physica, Heidelberg: Springer.

Mac an Bhaird, C., & Lucey, B. (2010). Determinants of capital structure in Irish SMEs. *Small Business Economics, 35*(3), 357-375. doi: https://doi.org/10.1007/s11187-008-9162-6

Maccrimmon, K. R., & Wehrung, D. A. (1990). Characteristics of Risk-Taking Executives. *Management Science, 36*(4), 422-435. doi: DOI 10.1287/mnsc.36.4.422

Macdonald, K. A., Beca, D., Penno, J. W., Lancaster, J. A. S., & Roche, J. R. (2011). Short communication: Effect of stocking rate on the economics of pasture-based dairy farms. *Journal of Dairy Science, 94*(5), 2581-2586. doi: https://doi.org/10.3168/jds.2010-3688

Macdonald, K. A., Penno, J. W., Lancaster, J. A. S., Bryant, A. M., Kidd, J. M., & Roche, J. R. (2017). Production and economic responses to intensification of pasture-based dairy production systems. *Journal of Dairy Science, 100*(8), 6602-6619. doi: https://doi.org/10.3168/jds.2016-12497

Macko, A., & Tyszka, T. (2009). Entrepreneurship and Risk Taking. *Applied Psychology-an International Review-Psychologie Appliquee-Revue Internationale, 58*(3), 469-487. doi: 10.1111/j.1464-0597.2009.00402.x

MAF. (2009). Regional and national impacts of the 2007-2009 drought (pp. 32). New Zealand: Ministry of Agriculture and Forestry.

Malchow-Møller, N., & Svarer, M. (2003). Estimation of the multinomial logit model with random effects. *Applied Economics Letters, 10*(7), 389-392. doi: https://doi.org/10.1080/1350485032000082018

March, J. G., & Shapira, Z. (1987). Managerial Perspectives on Risk and Risk-Taking. *Management Science, 33*(11), 1404-1418. doi: DOI 10.1287/mnsc.33.11.1404

Markos, A., D'Enza, A. I., & van de Velden, M. (2018). Beyond Tandem Analysis: Joint Dimension Reduction and Clustering in R. *Journal of Statistical Software (Online)*.

Martin, S. (1994). *Risk perceptions and management responses to risk in pastoral farming in New Zealand.* Paper presented at the Proceedings of the New Zealand Society of Animal Production.

Martin, S. (1996). Risk management strategies in New Zealand agriculture and horticulture. *Review of Marketing and Agricultural Economics, 64*, 31-44.

Martin, S., & McLeay, F. (1998). The Diversity of Farmers' Risk Management Strategies in a Deregulated New Zealand Environment. *Journal of Agricultural Economics, 49*(2), 218-233. doi: 10.1111/j.1477-9552.1998.tb01265.x

Martin, S. K. (2005). Risk Management. In N. M. Shadbolt & S. K. Martin (Eds.), *Farm management in New Zealand* (pp. 201-220): Oxford University Press.

Martin, S. K., & Shadbolt, N. M. (2005). Strategic Management. In N. M. Shadbolt & S. K. Martin (Eds.), *Farm management in New Zealand* (pp. 95-122): Oxford University Press.

Martin, W. E., Martin, I. M., & Kent, B. (2009). The role of risk perceptions in the risk mitigation process: the case of wildfire in high risk communities. *Journal of environmental management, 91*(2), 489-498.

McBride, W. D., & Johnson, J. D. (2006). Defining and Characterizing Approaches to Farm Management. *Journal of Agricultural and Applied Economics, 38*(1), 155-167. doi: 10.1017/S1074070800022136

McCown, R. L. (2005). New thinking about farmer decision makers. In J. L. Hatfield (Ed.), *The Farmer's Decision: Balancing Economic Agriculture Production with Environmental Quality* (pp. 11-44). Ankeney. Iowa, USA: Soil and Water Conservation Society.

McElwee, G. (2006). Farmers as entrepreneurs: developing competitive skills. *Journal of Developmental Entrepreneurship, 11*(03), 187-206.

McElwee, G., & Bosworth, G. (2010). Exploring the strategic skills of farmers across a typology of farm diversification approaches. *Journal of Farm Management, 13*(12), 819-838.

McLeay, F., Martin, S., & Zwart, T. (1996). Farm business marketing behavior and strategic groups in agriculture. *Agribusiness, 12*(4), 339-351. doi: doi:10.1002/(SICI)1520-6297(199607/08)12:4<339::AID-AGR4>3.0.CO;2-#

Meertens, R. M., & Lion, R. (2008). Measuring an Individual's Tendency to Take Risks: The Risk Propensity Scale1. *Journal of Applied Social Psychology, 38*(6), 1506-1520. doi: 10.1111/j.1559-1816.2008.00357.x

Melhim, A., & Shumway, C. R. (2011). Enterprise diversification in US dairy: impact of risk preferences on scale and scope economies. *Applied Economics, 43*(26), 3849-3862. doi: 10.1080/00036841003724478

Melyukhina, O. (2011). Risk Management in Agriculture in New Zealand *OECD Food, Agriculture and Fisheries Papers* (Vol. 42, pp. 79): OECD

Menapace, L., & Colson, G. (2012). *On the validity of gamble tasks to assess farmers' risk attitudes*.

Meraner, M., & Finger, R. (2017). Risk perceptions, preferences and management strategies: evidence from a case study using German livestock farmers. *Journal of Risk Research*, 1-26.

Merriam-Webster. (n.d.). Amortization *In Merriam-Webster.com dictionary*. Retrieved January 26, 2021: https://www.merriam-webster.com/dictionary/amortization.

Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*: SAGE Publications Ltd.

Meuwissen, M., Hardaker, J., Huirne, R., & Dijkhuizen, A. (2001). Sharing risks in agriculture; principles and empirical results. *Netherlands Journal of Agricultural Science, 49*(4), 343-356.

Meuwissen, M., Huirne, R., & Hardaker, J. B. (1999). Perceptions of risk and risk management strategies: An analysis of Dutch livestock farmers. *American Journal of Agricultural Economics, 81*(5), 1284-1285.

Meuwissen, M., Huirne, R., & Hardaker, J. B. (2001). Risk and risk management: an empirical analysis of Dutch livestock farmers. *Livestock Production Science, 69*(1), 43-53. doi: Doi 10.1016/S0301-6226(00)00247-5

Meuwissen, M. P. M., Feindt, P. H., Spiegel, A., Termeer, C. J. A. M., Mathijs, E., Mey, Y. d., . . . Reidsma, P. (2019). A framework to assess the resilience of farming systems. *Agricultural Systems, 176*, 102656. doi: https://doi.org/10.1016/j.agsy.2019.102656

MfE. (2001). *Valuing New Zealand's clean green image*. (ME 405). Wellington: Ministry for the Environment

MfE. (2020). *New Zealand’s Greenhouse Gas Inventory 1990-2018* (MFE 1496). Wellington, New Zealand: Ministry for the Environment (MfE).

Milestad, R., Dedieu, B., Darnhofer, I., & Bellon, S. (2012). Farms and farmers facing change: The adaptive approach. In I. Darnhofer, D. Gibbon & B. Dedieu (Eds.), *Farming Systems Research into the 21st Century: The New Dynamic* (pp. 365-385). Dordrecht: Springer Netherlands.

Miller, A., Boehlje, M., & Dobbins, C. L. (1998). Positioning The Farm Business: Purdue University, Department of Agricultural Economics.

Miller, A., Dobbins, C., Boehlje, M., Barnard, F., & Olynk, N. (2000). Farm Business Management for the 21st Century *Measuring & Analyzing Farm Financial Performance* (pp. 40). West Lafayette, IN: Department of Agricultural Economics Purdue University.

Miller, A., Dobbins, C., Pritchett, J., Boehlje, M., & Ehmke, C. (2004). Risk management for farmers (Vol. Staff Paper 04-11, pp. 27). West Lafayette, Indiana: Purdue University.

Miller, L. H., Ellinger, P. N., Barry, P. J., & Lajili, K. (1993). Price and nonprice management of agricultural credit risk. *Agricultural Finance Review*.

Mingers, J., & Brocklesby, J. (1997). Multimethodology: towards a framework for mixing methodologies. *Omega, 25*(5), 489-509.

Mirza, N., Reddy, K., Hasnaoui, A., & Yates, P. (2020). A Comparative Analysis of the Hedging Effectiveness of Farmgate Milk Prices for New Zealand and United States Dairy Farmers. *Journal of Quantitative Economics, 18*(1), 129-142. doi: 10.1007/s40953-019-00172-0

Mishra, A. K., El-Osta, H. S., Morehart, M. J., Johnson, J. D., & Hopkins, J. W. (2002). Income, Wealth, And The Economic Well-Being Of Farm Households: United States Department of Agriculture, Economic Research Service.

Mishra, A. K., & El-Osta, H. S. J. A. F. R. (2002). Managing risk in agriculture through hedging and crop insurance: what does a national survey reveal?

Mishra, A. K., & Lence, S. H. (2005). Risk management by farmers, agribusinesses, and lenders. *Agricultural Finance Review, 65*(2), 131-148. doi: http://dx.doi.org/10.1108/00214660580001169

Mitchell, A. A., & Dacin, P. A. (1996). The Assessment of Alternative Measures of Consumer Expertise. *Journal of Consumer Research, 23*(3), 219-239. doi: 10.1086/209479

Mittoo, U. R., Bancel, F., & Mittoo, U. R. (2011). Financial flexibility and the impact of the global financial crisis: Evidence from France. *International Journal of Managerial Finance, 7*(2), 179-216.

Modigliani, F., & Miller, M. H. (1958). The cost of capital, corporation finance and the theory of investment. *The American economic review*, 261-297.

Modigliani, F., & Miller, M. H. (1963). Corporate income taxes and the cost of capital: a correction. *The American economic review, 53*(3), 433-443.

Moeller, R. (2007). *COSO enterprise risk management: understanding the new integrated ERM framework*. Hoboken- New Jersey: John Wiley & Sons.

Molina-Azorín, J. F. (2010). The use and added value of mixed methods in management research. *Journal of Mixed Methods Research*, 1558689810384490.

Mongin, P. (1997). Expected utility theory. In J. Davis, W. Hands & U. Mäki (Eds.), *Handbook of economic methodology* (pp. 342-350). Cheltenham: Edward Elgar Publishing.

Monsen, E., & Urbig, D. (2009). Perceptions of efficacy, control, and risk: A theory of mixed control *Understanding the entrepreneurial mind* (pp. 259-281): Springer.

Moral-Benito, E. (2015). Model averaging in economics: an overview. *Journal of Economic Surveys, 29*(1), 46-75. doi: 10.1111/joes.12044

Morgan, S. P., & Teachman, J. D. (1988). Logistic regression: Description, examples, and comparisons. *Journal of Marriage and Family, 50*(4), 929-936.

Morris, S. T. (2013). Sheep and beef cattle production systems. In J. Dymond (Ed.), *Ecosystem Services in New Zealand–Conditions and Trends*. Lincoln, New Zealand: Manaaki Whenua Press.

Morris, S. T. (2017). Overview of sheep production systems. In D. M. Ferguson, C. Lee & A. Fisher (Eds.), *Advances in Sheep Welfare* (pp. 19-35): Woodhead Publishing.

Morris, S. T., & Kenyon, P. R. (2014). Intensive sheep and beef production from pasture — A New Zealand perspective of concerns, opportunities and challenges. *Meat Science, 98*(3), 330-335. doi: https://doi.org/10.1016/j.meatsci.2014.06.011

Moschini, G., & Hennessy, D. A. (2001). Uncertainty, risk aversion, and risk management for agricultural producers *Handbook of agricultural economics* (Vol. Volume 1, Part A, pp. 87-153): Elsevier.

Mousavi, S., & Gigerenzer, G. (2014). Risk, uncertainty, and heuristics. *Journal of Business Research, 67*(8), 1671-1678.

MPI. (2017). Situation and outlook for primary industries - December 2017. Wellington, New Zealand: Ministry for Primary Industries.

Mugera, A. W., & Bitsch, V. (2005). Managing labor on dairy farms: A resource-based perspective with evidence from case studies. *International Food and Agribusiness Management Review, 8*(1030-2016-82605), 79.

Mugera, A. W., & Nyambane, G. G. (2015). Impact of debt structure on production efficiency and financial performance of B roadacre farms in Western Australia. *Australian Journal of Agricultural Resource Economics, 59*(2), 208-224.

Musser, W. N., & Patrick, G. F. (2002). How much does risk really matter to farmers? *A comprehensive assessment of the role of risk in US Agriculture* (pp. 537-556): Springer.

Musser, W. N., Patrick, G. F., & Eckman, D. T. (1996). Risk and grain marketing behavior of large-scale farmers. *Review of Agricultural Economics, 18*(1), 65-77.

Myers, S. C. (1984). The capital structure puzzle. *The Journal of Finance, 39*(3), 574-592.

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of financial economics, 13*(2), 187-221.

Nag, R., Hambrick, D. C., & Chen, M.-J. (2007). What is strategic management, really? Inductive derivation of a consensus definition of the field. *Strategic Management Journal, 28*(9), 935-955. doi: 10.1002/smj.615

Nartea, G., & Barry, P. (1994). Risk Efficiency and Cost Effects of Geographic Diversification. *Review of Agricultural Economics, 16*(3), 341-351. doi: 10.2307/1349694

Nastis, S. A., Mattas, K., & Baourakis, G. (2019). Understanding Farmers' Behavior towards Sustainable Practices and Their Perceptions of Risk. *Sustainability, 11*(5), 1303.

Neal, M., & Roche, J. R. (2020). Profitable and resilient pasture-based dairy farm businesses in New Zealand *Animal Production Science, 60*(1), 169-174. doi: https://doi.org/10.1071/AN18572

Nenadic, O., & Greenacre, M. (2007). Correspondence analysis in R, with two-and three-dimensional graphics: The ca package. *Journal of statistical software, 20*(3).

Nettier, B., Dobremez, L., Lavorel, S., & Brunschwig, G. (2017). Resilience as a framework for analyzing the adaptation of mountain summer pasture systems to climate change. *Ecology and Society, 22*(4).

Newman, M., & Journeaux, P. (2015). *The economic and nutrient loss impacts of constructing and running cow housing facilities-a case study of five South Island freestall barns*. Paper presented at the 2015 Conference (59th), February 10-13, 2015, Rotorua, New Zealand.

Ng, D. W., & Siebert, J. W. (2009). Toward better defining the field of agribusiness management. *International Food and Agribusiness Management Review, 12*(1030-2016-82760), 1.

Nicol, R. M., Ortmann, G. F., & Ferrer, S. R. (2007). Perceptions of key business and financial risks by large-scale sugarcane farmers in KwaZulu-Natal in a dynamic socio-political environment. *Agrekon, 46*(3), 351-370.

Nimpagaritse, F., & Culver, D. (2002). A Broader Perspective of Measuring the well-being of Rural Farm and non-Farm Households. *Agriculture and Agri-Food Canada*.

Nosic, A., & Weber, M. (2010). How riskily do I invest? The role of risk attitudes, risk perceptions, and overconfidence. *Decision Analysis, 7*(3), 282-301.

Nozieres, M.-O., Moulin, C.-H., & Dedieu, B. (2011). The herd, a source of flexibility for livestock farming systems faced with uncertainties? *Animal, 5*(09), 1442-1457.

Nuthall, P. (2009). Modelling the origins of managerial ability in agricultural production. *Australian Journal of Agricultural and Resource Economics, 53*(3), 413-436.

Nuthall, P. L. (2006). Determining the important management skill competencies: The case of family farm business in New Zealand. *Agricultural Systems, 88*(2-3), 429-450. doi: https://doi.org/10.1016/j.agsy.2005.06.022

Nuthall, P. L. (2010). *Farm business management : the human factor*. Wallingford, Oxfordshire, UK: CAB International.

O'Callaghan, T. F., Mannion, D., Apopei, D., McCarthy, N. A., Hogan, S. A., Kilcawley, K. N., & Egan, M. (2019). Influence of Supplemental Feed Choice for Pasture-Based Cows on the Fatty Acid and Volatile Profile of Milk. *Foods, 8*(4), 137.

OECD. (2009). *Managing Risk in Agriculture A Holistic Approach: A Holistic Approach*. Paris OECD Food, Agriculture and Fisheries Papers.

OECD. (2020). *Taxation in Agriculture.* Paris: OECD Publishing.

OECD, Food, & Nations, A. O. o. t. U. (2017). *OECD-FAO Agricultural Outlook 2017-2026*.

Ondersteijn, C. J. M., Giesen, G. W. J., & Huirne, R. B. M. (2006). Perceived environmental uncertainty in Dutch dairy farming: The effect of external farm context on strategic choice. *Agricultural Systems, 88*(2–3), 205-226. doi: http://dx.doi.org/10.1016/j.agsy.2005.03.012

Onwuegbuzie, A. J., & Leech, N. L. (2006). Linking Research Questions to Mixed Methods Data Analysis Procedures 1. *The Qualitative Report, 11*(3), 474-498.

Onwuegbuzie, A. J., & Leech, N. L. (2007). A call for qualitative power analyses. *Quality & Quantity, 41*(1), 105-121.

Onwuegbuzie, A. J., & Leech, N. L. (2007). Sampling Designs in Qualitative Research: Making the Sampling Process More Public. *The Qualitative Report, 12*(2), 238-254.

Opler, T., Pinkowitz, L., Stulz, R., & Williamson, R. (1999). The determinants and implications of corporate cash holdings. *Journal of financial economics, 52*(1), 3-46.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2013). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health and Mental Health Services Research, 42*(5), 533-544. doi: 10.1007/s10488-013-0528-y

Pang, N. S.-K., & Pisapia, J. (2012). The Strategic Thinking Skills of Hong Kong School Leaders: Usage and Effectiveness. *Educational Management Administration & Leadership, 40*(3), 343-361. doi: 10.1177/1741143212436962

Pangborn, M., Woodford, K., & Nuthall, P. (2015). Development of a dairy industry in a new area-land use change in Canterbury, New Zealand. *International Journal of Agricultural Management, 5*(1-2), 20-24.

Pannell, D. J., Malcolm, B., & Kingwell, R. S. (2000). Are we risking too much? Perspectives on risk in farm modelling. *Agricultural Economics, 23*(1), 69-78.

Parker, W., Shadbolt, N., & Gray, D. (1997). *Strategic planning in grassland farming: Principles and applications*.

Parminter, T., & Perkins, A. (1997). *Applying an understanding of farmers' values and goals to their farming styles*.

Patrick, G., & Alexander, C. E. (2004). Sources of and Responses to Risk: Have Crop Producers' Opinions Changed? *Purdue Agricultural Economics Report* (pp. 1-5). West Lafayette, IN.: Department of Agricultural Economics, Purdue University Cooperative Extension Service.

Patrick, G. F. (1992). Managing risk in agriculture *NCR Extension Publications* (pp. 30). West Lafayette, IN: Purdue University.

Patrick, G. F., Blake, B. F., & Whitaker, S. H. (1983). Farmers' goals: uni-or multi-dimensional? *American Journal of Agricultural Economics, 65*(2), 315-320.

Patrick, G. F., & Musser, W. N. (1997). Sources of and responses to risk: factor analyses of large-scale US cornbelt farmers. In R. B. M. Huirne, J. B. Hardaker & A. A. Dijkhuizen (Eds.), *Risk management strategies in agriculture: State of the Art and Future Perspectives*. Wageningen: Wageningen Agricultural University

Patrick, G. F., Musser, W. N., & Eckman, D. T. (1998). Forward marketing practices and attitudes of large-scale Midwestern grain producers. *Review of Agricultural Economics, 20*(1), 38-53.

Patrick, G. F., Peiter, A. J., Knight, T. O., Coble, K. H., & Baquet, A. (2007). Hog producers' risk management attitudes and desire for additional risk management education. *Faculty Publications: Agricultural Economics*, 73.

Patrick, G. F., & Ullerich, S. (1996). Information sources and risk attitudes of large-scale farmers, farm managers, and agricultural bankers. *Agribusiness, 12*(5), 461-471. doi: 10.1002/(sici)1520-6297(199609/10)12:5<461::aid-agr5>3.0.co;2-4

Patrick, G. R., Wilson, P. N., Barry, P. J., Boggess, W. G., & Young, D. L. (1985). Risk perceptions and management responses: producer-generated hypotheses for risk modeling. *Southern Journal of Agricultural Economics, 17*(2), 231-238.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*: SAGE Publications Ltd.

Paulson, N. D., Katchova, A. L., & Lence, S. H. (2010). An Empirical Analysis of the Determinants of Marketing Contract Structures for Corn and Soybeans. *Journal of Agricultural & Food Industrial Organization, 8*(1), 1-25.

Payne, T., Shadbolt, N., Dooley, E., Smeaton, D., & Gardner, J. (2007). *Dairy farm ownership and management structures: Focus group research.* Paper presented at the 16th International Farm Management Congress Ireland.

Pederson, G., Duffy, M., Boehlje, M., & Craven, R. (1991). Adjustable-Term Financing of Farm Loans. *Western Journal of Agricultural Economics, 16*(2), 268-279.

Pennings, J. M., & Garcia, P. (2004). *Strategic Risk Management Behavior: What Can Utility Functions Tell Us?* Paper presented at the 2004 Annual meeting, August 1-4, Denver, CO.

Pennings, J. M., Isengildina-Massa, O., Irwin, S. H., Garcia, P., & Good, D. L. (2008). Producers' complex risk management choices. *Agribusiness, 24*(1), 31-54.

Pennings, J. M., Isengildina, O., Irwin, S. H., & Good, D. L. (2004). The impact of market advisory service recommendations on producers' marketing decisions. *Journal of Agricultural and Resource Economics*, 308-327.

Pennings, J. M. E., & Garcia, P. (2001). Measuring producers' risk preferences: A global risk-attitude construct. *American Journal of Agricultural Economics, 83*(4), 993-1009. doi: Doi 10.1111/0002-9092.00225

Perry, C. (1998). Processes of a case study methodology for postgraduate research in marketing. *European journal of marketing, 32*(9/10), 785-802.

Pinochet-Chateau, Shadbolt, Holmes, & Lopez-Villalobos. (2005). *Drivers of Risk in New Zealand Dairy Systems.* Paper presented at the International Farm Management Association.

Pinochet-Chateau, Shadbolt, Holmes, & Lopez-Villalobos. (2005). *Risk perceptions and risk management strategies on New Zealand dairy farms according to ownership structure and geographic location.* Paper presented at the Proceedings of the New Zealand Grassland Association.

Pinochet-Chateau, R., Shadbolt, N. M., Holmes, C., & Lopez-Villalobos, N. (2005). Changes in risk perception and risk management strategies in New Zealand dairy farming. *International Food and Agribusiness Management Association*.

Poon, J. M. L., Ainuddin, R. A., & Junit, S. H. (2006). Effects of self-concept traits and entrepreneurial orientation on firm performance. *International Small Business Journal, 24*(1), 61-82. doi: 10.1177/0266242606059779

Porter, M. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press.

Postiglione, V. S. (2013). Wintering in Canterbury/North Otago: business relationship between dairy farmers *Kellogg Rural Leaders Programme* (Vol. 343, pp. 65). New Zealand: Lincoln University.

Pratt, J. W. (1964). Risk-Aversion in the Small and in the Large. *Econometrica, 32*(1-2), 122-136. doi: Doi 10.2307/1913738

Prestidge, R., Barker, G., & Pottinger, R. (1991). *The economic cost of Argentine stem weevil in pastures in New Zealand.* Paper presented at the Proceedings of the Forty Fourth New Zealand Weed and Pest Control Conference.

Purdy, B. M., Langemeier, M. R., & Featherstone, A. M. (1997). Financial performance, risk, and specialization. *Journal of Agricultural and Applied Economics, 29*(01), 149-161.

Quiggin, J. (1993). *Generalized Expected Utility Theory: The Rank-Dependent Model* doi:10.1007/978-94-011-2182-8

Rabin, M. (2000). Risk aversion and expected-utility theory: A calibration theorem. *Econometrica, 68*(5), 1281-1292. doi: Doi 10.1111/1468-0262.00158

Rabin, M., & Thaler, R. H. (2001). Anomalies - Risk aversion. *Journal of Economic Perspectives, 15*(1), 219-232. doi: Doi 10.1257/Jep.15.1.219

Rada, N. E., & Fuglie, K. O. (2019). New perspectives on farm size and productivity. *Food Policy, 84*, 147-152. doi: https://doi.org/10.1016/j.foodpol.2018.03.015

Raedts, P. J. M., Garcia, S. C., Chapman, D. F., Edwards, G. R., Lane, N., & Rawnsley, R. P. (2017). Is systems research addressing the current and future needs of dairy farms? *Animal Production Science, 57*(7), 1311-1322. doi: https://doi.org/10.1071/AN16647

Rahman, M. L., & Barry, P. J. (1981). Financial control and variable amortization under uncertainty: An application to Texas rice farms. *Journal of Agricultural and Applied Economics, 13*(1), 99-103.

Rahman, M. T., Nielsen, R., Khan, M. A., & Ankamah-Yeboah, I. (2020). Impact of management practices and managerial ability on the financial performance of aquaculture farms in Bangladesh. *Aquaculture Economics & Management, 24*(1), 79-101.

Ramsbottom, G., Horan, B., Berry, D. P., & Roche, J. (2015). Factors associated with the financial performance of spring-calving, pasture-based dairy farms. *Journal of Dairy Science, 98*(5), 3526-3540.

Rawlings, K. M. (1999). *Key performance indicators for goal attainment in dairy farming: essential elements for monitoring farm business performance* (Master of Applied Science), Massey University, Palmerston North, New Zealand.

RBNZ. (2016). Financial Stability Report May 2016 (pp. 66). Wellington- New Zealand: Reserve Bank of New Zealand.

RBNZ. (2018). Financial Stability Report May 2018 (pp. 36). Wellington- New Zealand: Reserve Bank of New Zealand.

RBNZ. (2019). *Credit conditions survey*. Retrieved from: http://www.rbnz.govt.nz

RBNZ. (2019). *Monthly wholesale interest rates (% pa)*. Retrieved from: http://www.rbnz.govt.nz

Reekers, L., Shadbolt, N. M., Dooley, L., & Bewsell, D. (2007). *Dairy farm ownership structures and their management; Case study research.* Paper presented at the International Farm Management Association (IFMA) 16, Cork-Ireland.

Renn, O. (1998). Three decades of risk research: accomplishments and new challenges. *Journal of Risk Research, 1*(1), 49-71. doi: 10.1080/136698798377321

Renn, O., & Rohrmann, B. (2000). Cross-cultural risk perception: State and challenges *Cross-Cultural Risk Perception* (pp. 211-233): Springer.

Renner, S., Glauben, T., & Hockmann, H. (2014). Measurement and decomposition of flexibility of multi-output firms. *European Review of Agricultural Economics, 41*(5), 745-773.

Reynaud, A., & Couture, S. (2012). Stability of risk preference measures: results from a field experiment on French farmers. *Theory and Decision, 73*(2), 203-221. doi: 10.1007/s11238-012-9296-5

Rigolot, C., Roturier, S., Dedieu, B., & Ingrand, S. (2014). Climate variability drives livestock farmers to modify their use of collective summer mountain pastures. *Agronomy for Sustainable Development, 34*(4), 899-907. doi: 10.1007/s13593-014-0224-7

Ripley, B., & Venables, W. (2016). Package 'nnet'. *R package version, 7 .3-12*, 700.

Robison, L. J., & Barry, P. J. (1987). *The Competitive Firm's Response to Risk*. New York: Macmillan.

Robison, L. J., Barry, P. J., & Burghardt, W. G. (1987). Borrowing Behavior under Financial Stress by the Proprietary Firm: A Theoretical Analysis. *Western Journal of Agricultural Economics, 12*(2), 144-151.

Robison, L. J., Barry, P. J., Kliebenstein, J. B., & Patrick, G. F. (1984). Risk attitudes: concepts and measurement approaches.

Robison, L. J., Shupp, R. S., & Myers, R. J. (2010). Expected utility paradoxes. *The Journal of Socio-Economics, 39*(2), 187-193. doi: http://dx.doi.org/10.1016/j.socec.2009.12.005

Roche, J., Ledgard, S., Sprosen, M., Lindsey, S., Penno, J., Horan, B., & Macdonald, K. (2016). Increased stocking rate and associated strategic dry-off decision rules reduced the amount of nitrate-N leached under grazing. *Journal of Dairy Science, 99*(7), 5916-5925.

Rodrigues, A. C. O., Caraviello, D. Z., & Ruegg, P. L. (2005). Management of Wisconsin dairy herds enrolled in milk quality teams. *Journal of Dairy Science, 88*(7), 2660-2671.

Ross, S. A. (1977). The Determination of Financial Structure: The Incentive-Signalling Approach. *The Bell Journal of Economics, 8*(1), 23-40. doi: 10.2307/3003485

Rotherham, F. (2015). Kiwi dairy farmers feeling the pinch are right – their payout is the world's lowest 2015, from http://www.nbr.co.nz/article/kiwi-dairy-farmers-feeling-pinch-are-right-heir-payout-worlds-lowest-b-178108

Rubin, H. J., & Rubin, I. S. (2005). *10 The First Phase of Analysis: Preparing Transcripts and Coding Data. Qualitative Interviewing (2nd ed.): The Art of Hearing Data. SAGE Publications, Inc*. Thousand Oaks, CA: SAGE Publications Ltd.

Russell, L., Langemeier, M., & Briggeman, B. (2013). The impact of liquidity and solvency on cost efficiency. *Agricultural Finance Review, 73*(3), 413-425. doi: https://doi.org/10.1108/AFR-09-2012-0047

Ryde, J., & Nuthall, P. L. (1984). Farmers record keeping and planning practices: a postal survey (Vol. 81). Agricultural Economics Research Unit (AERU): Lincoln College-Canterbury.

Sabasi, D., & Kompaniyets, L. (2015). Impact of credit constraints on profitability and productivity in US agriculture.

Sabasi, D., Shumway, C. R., & Astill, G. M. (2019). Off-farm work and technical efficiency on U.S. dairies. *Agricultural Economics, 50*(4), 379-393. doi: 10.1111/agec.12497

Samarasinghe, O., & Brown, P. (2016). Winter grazing practices of dairy farmers across New Zealand. *Policy Brief no: 16*. Landcare Research Manaaki Whenua: http://www.landcareresearch.co.nz/__data/assets/pdf_file/0005/125816/Policy-Brief-16-Winter-Grazing-Practices.pdf.

Sandelowski, M. (2000). Focus on research methods combining qualitative and quantitative sampling, data collection, and analysis techniques. *Research in nursing & health, 23*, 246-255.

Sartwelle, J., O'Brien, D., Tierney, W., & Eggers, T. (2000). The effect of personal and farm characteristics upon grain marketing practices. *Journal of Agricultural and Applied Economics, 32*(1), 95-111.

Saunders, C. M., & Saunders, J. (2012). The economic value of potential irrigation in Canterbury.

Savage, L. J. (1954). *The foundations of statistics*. New York: John Wiley & Sons, Ltd.

Schewe, R. L., Kayitsinga, J., Contreras, G. A., Odom, C., Coats, W. A., Durst, P., . . . Erskine, R. J. (2015). Herd management and social variables associated with bulk tank somatic cell count in dairy herds in the eastern United States. *Journal of Dairy Science, 98*(11), 7650-7665. doi: https://doi.org/10.3168/jds.2014-8840

Schiere, J. B., Darnhofer, I., & Duru, M. (2012). Dynamics in farming systems: of changes and choices. In I. Darnhofer, D. Gibbon & B. Dedieu (Eds.), *Farming Systems Research into the 21st Century: The New Dynamic* (pp. 337-363). Dordrecht- Netherlands: Springer.

Schnitkey, G. D., & Novak, F. S. (1989). *A Dynamic Programming Analysis of a Variable Amortization Loan Plan*. Paper presented at the Application of Dynamic Programming to Agricultural

Decision Problems, Auburn, Alabama.

Schumpeter, J. (1928). The Instability of Capitalism. *The Economic Journal, 38*(151), 361-386. doi: 10.2307/2224315

Schutt, R. K. (2011). *Investigating the Social World: The Process and Practice of Research*: SAGE Publications Ltd.

Seidman, I. (2013). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*: Teachers college press.

Shadbolt, N. (2008). Strategic management of farm businesses: the role of strategy tools with particular reference to the Balanced Scorecard. *Journal of Farm Management, 13*(3), 205-218.

Shadbolt, N. (2012). Competitive strategy analysis of NZ pastoral dairy farming systems. *International Journal of Agricultural Management, 1*(3), 19-27.

Shadbolt, N., & Apparao, D. (2016). Factors Influencing the Dairy Trade from New Zealand. *International Food and Agribusiness Management Review, Special Issue -19*(B), 241-255.

Shadbolt, N., Olubode-Awasola, F., Gray, D., & Dooley, E. (2010). Risk - An Opportunity or Threat for Entrepreneurial Farmers in the Global Food Market? *International Food and Agribusiness Management Review, 13*(4), 75-95.

Shadbolt, N., & Olubode-Awosola, F. (2013). New Zealand Dairy Farmers and Risk: Perceptions of, Attitude to, Management of and Performance under Risk and Uncertainty (pp. 57). Palmerston North, New Zealand: One Farm: Centre of Excellence in Farm Business Management.

Shadbolt, N., Olubode-Awosola, F., & Rutsito, B. (2013). Resilience of New Zealand Dairy Farm Businesses (pp. 43). Palmerston North, New Zealand: One Farm: Centre of Excellence in Farm Business Management.

Shadbolt, N., Olubode-Awosola, F., & Rutsito, B. (2013, July 2013). *Resilience, to 'Bounce Without Breaking', in New Zealand Dairy Farm Businesses.* Paper presented at the 19th International Farm Management Congress, Warsaw, Poland.

Shadbolt, N., Siddique, M. I., & Hammond, N. (2017). *Pastoral dairy farming systems and intensification, challenges in interpretation.* Paper presented at the 21st International Farm Management Congress, Edinburgh, Scotland.

Shadbolt, N. M., & Bywater, A. (2005). The Dimensions of Management. In N. M. Shadbolt & S. K. Martin (Eds.), *Farm management in New Zealand* (pp. 23-42): Oxford University Press.

Shadbolt, N. M., & Martin, S. K. (Eds.). (2005). *Farm management in New Zealand*. Melbourne, Vic. ; Auckland [N.Z.]: Oxford University Press.

Shadbolt, N. M., & Olubode-Awosola, F. (2016). Resilience, Risk and Entrepreneurship. *International Food and Agribusiness Management Review, 19*(2), 33.

Shakir, M. (2002). The selection of case studies: strategies and their applications to IS implementation case studies.

Shapiro, B. I., & Brorsen, B. W. (1988). Factors Affecting Farmers' Hedging Decisions. *North Central Journal of Agricultural Economics, 10*(2), 145-153. doi: 10.2307/1349215

Sharpe, D. (2015). Your chi-square test is statistically significant: now what? *Practical assessment, research & evaluation, 20*.

Simon, H. A. (1959). Theories of Decision-Making in Economics and Behavioral-Science. *American Economic Review, 49*(3), 253-283.

Simtowe, F., Diagne, A., & Zeller, M. (2008). Who is credit constrained? Evidence from rural Malawi. *Agricultural Finance Review, 68*(2), 255-272. doi: http://dx.doi.org/10.1108/00214660880001229

Sinnett, A., Ho, C. K. M., & Malcolm, B. (2017). Expanding a dairy business affects business and financial risk. *Animal Production Science, 57*(10), 2167-2174.

Sitkin, S., & Weingart, L. (1995). Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity. *Academy of Management journal, 38*(6), 1573-1592.

Sitkin, S. B., & Pablo, A. L. (1992). Reconceptualizing the Determinants of Risk Behavior. *Academy of management review, 17*(1), 9-38. doi: Doi 10.2307/258646

Sjöberg, L. (2000). Factors in risk perception. *Risk analysis, 20*(1), 1-12.

Sjöberg, L., Moen, B.-E., & Rundmo, T. (2004). Explaining risk perception. In T. Rundmo (Ed.), *An evaluation of the psychometric paradigm in risk perception research*. Trondheim, Norway: Norwegian University of Science and Technology.

Slack, N. (1987). The flexibility of manufacturing systems. *International Journal of Operations & Production Management, 7*(4), 35-45.

Slijper, T., de Mey, Y., Poortvliet, P. M., & Meuwissen, M. P. M. (2020). From risk behavior to perceived farm resilience: a Dutch case study. *Ecology and Society, 25*(4). doi: 10.5751/ES-11893-250410

Slovic, P. (1987). Perception of risk. *science, 236*(4799), 280-285.

Slovic, P. (1992). Perception of risk: Reflections on the psychometric paradigm. In S. Krimsky & D. Golding (Eds.), *Social Theories of Risk* (pp. 117--152): Praeger.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk analysis, 24*(2), 311-322. doi: DOI 10.1111/j.0272-4332.2004.00433.x

Slovic, P., & Peters, E. (2006). Risk perception and affect. *Current directions in psychological science, 15*(6), 322-325. doi: DOI 10.1111/j.1467-8721.2006.00461.x

Slovic, P. E. (2000). *The perception of risk*: Earthscan publications.

Small, B., Brown, P., & Montes de Oca Munguia, O. (2016). Values, trust, and management in New Zealand agriculture. *International journal of agricultural sustainability, 14*(3), 282-306.

Sonka, S. T., Dixon, B. L., & Jones, B. L. (1980). Impact of Farm Financial Structure on the Credit Reserve of the Farm Business. *American Journal of Agricultural Economics, 62*(3), 565-570. doi: 10.2307/1240216

Sonka, S. T., & Patrick, G. F. (1984). Risk management and decision making in agricultural firms.

Spaans, O. K., Macdonald, K. A., Neal, M., Auldist, M. J., Lancaster, J. A. S., Bryant, A. M., . . . Roche, J. R. (2019). A quantitative case study assessment of biophysical and economic effects from altering season of calving in temperate pasture-based dairy systems. *Journal of Dairy Science, 102*(12), 11523-11535. doi: https://doi.org/10.3168/jds.2018-15911

Stake, R. E. (1995). The art of case study research.

Stewart Jr, W. H., & Roth, P. L. (2001). Risk propensity differences between entrepreneurs and managers: A meta-analytic review. *Journal of Applied Psychology, 86*(1), 145-153. doi: 10.1037/0021-9010.86.1.145

Stone, K. E. (1976). *Effects of a variable amortization payment plan on the financial organization of Illinois cash-grain farms.* (Doctor of Philosophy (PhD)), University of Illinois at Urbana-Champaign, Ann Arbour - Michigan.

Stringleman, H. (2017). Cut debt or go. from http://farmersweekly.co.nz/section/dairy/view/cut-debt-or-go

Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications* (1st ed.). Boca Raton- Florida CRC press.

Stup, R. E., Hyde, J., & Holden, L. A. (2006). Relationships Between Selected Human Resource Management Practices and Dairy Farm Performance. *Journal of Dairy Science, 89*(3), 1116-1120. doi: http://dx.doi.org/10.3168/jds.S0022-0302(06)72180-4

Sufi, A. (2009). Bank Lines of Credit in Corporate Finance: An Empirical Analysis. *Review of financial studies, 22*(3), 1057-1088. doi: 10.1093/revfin/hhm007

Tagiuri, R., & Davis, J. A. (1992). On the goals of successful family companies. *Family business review, 5*(1), 43-62.

Taleb, N. N. (2007). *The black swan: The impact of the highly improbable* (Vol. 2): Random house.

Tashakkori, A., & Teddlie, C. (2010). *Sage handbook of mixed methods in social & behavioral research*: SAGE Publications Ltd.

Taunton, E. (2018). PKE penalties could cost farmers thousands. 2019, from https://www.stuff.co.nz/business/farming/104847452/pke-penalties-could-cost-farmers-thousands

Taunton, E. (2019). Compensation for Mycoplasma bovis tops $50m. 2019, from https://www.stuff.co.nz/business/farming/111428419/compensation-for-mycoplasma-bovis-tops-50m

Taylor, G. (2011). An assessment of the balance in demand and supply of skilled employees in the on-farm workforce. Hamilton, New Zealand: DairyNZ.

Thaler, R. H. (2000). From homo economicus to homo sapiens. *Journal of Economic Perspectives, 14*(1), 133-141.

Tipples, R. S. (2017). New Zealand agricultural employment relations, migration, and'pledge washing': The new recipe for the 21st century.

Tozer, P. (2017). *Impact of feeding systems on the profit and efficiency of New Zealand dairy farms.* Paper presented at the 21st International Farm Management Congress, Edinburgh, Scotland.

Tudor, K., Spaulding, A., Roy, K., & Winter, R. (2014). An analysis of risk management tools utilized by Illinois farmers. *Agricultural Finance Review, 74*(1), 69-86. doi: http://dx.doi.org/10.1108/AFR-09-2012-0044

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *science, 185*(4157), 1124-1131. doi: 10.1126/science.185.4157.1124

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *science, 211*(4481), 453-458.

Tversky, A., & Kahneman, D. (1992). Advances in Prospect-Theory - Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty, 5*(4), 297-323. doi: Doi 10.1007/Bf00122574

Ullah, A., & Zheng, C. Why would dairy farmers care about human resource management practices?

Van der Ploeg, J. D., & Roep, D. Multifunctionality and rural development: the actual situation in Europe.

Van Praag, B., & Frijters, P. (1999). The Measurement of Welfare and Well-Being: The Leyden Approach. In E. Diener, D. Kahneman & N. Schwarz (Eds.), *Well-being: the foundations of hedonic psychology* (pp. 413-433). New York: Russell Sage Foundation.

van Raaij, W. F. (1981). Economic psychology. *Journal of Economic Psychology, 1*(1), 1-24. doi: 10.1016/0167-4870(81)90002-7

van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., & Wauters, E. (2013). Cognitive mapping: A method to elucidate and present farmers' risk perception. *Agricultural Systems, 122*, 42-52. doi: https://doi.org/10.1016/j.agsy.2013.08.003

van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., & Wauters, E. (2014). Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies. *Journal of Risk Research*, 1-23. doi: 10.1080/13669877.2014.940597

van Winsen, F., Wauters, E., Lauwers, L. H., de Mey, Y., Van Passel, S., & Vancauteren, M. (2011). *Combining risk perception and risk attitude: A comprehensive individual risk behavior model.* Paper presented at the 2011 International Congress, August 30-September 2, 2011, Zurich, Switzerland.

Velandia, M., Rejesus, R. M., Knight, T. O., & Sherrick, B. J. (2009). Factors affecting farmers' utilization of agricultural risk management tools: the case of crop insurance, forward contracting, and spreading sales. *Journal of Agricultural and Applied Economics, 41*(1), 107-123.

Vickery, J. (2008). How and why do small firms manage interest rate risk? *Journal of financial economics, 87*(2), 446-470. doi: http://dx.doi.org/10.1016/j.jfineco.2006.09.011

Vigani, M., & Kathage, J. (2019). To Risk or Not to Risk? Risk Management and Farm Productivity. *American Journal of Agricultural Economics, 101*(5), 1432-1454. doi: 10.1093/ajae/aaz020

Vogt, S. C. (1994). The role of internal financial sources in firm financing and investment decisions. *Review of Financial Economics, 4*(1), 1-24. doi: https://doi.org/10.1016/1058-3300(94)90002-7

Von Keyserlingk, M., Martin, N., Kebreab, E., Knowlton, K., Grant, R., Stephenson, M., . . . Smith, S. (2013). Invited review: Sustainability of the US dairy industry. *Journal of Dairy Science, 96*(9), 5405-5425.

Von Neumann, J., & Morgenstern, O. (1944). *Theory of games and economic behavior*.

Vrieze, S. I. (2012). Model selection and psychological theory: A discussion of the differences between the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). *Psychological methods, 17*(2), 228-243. doi: 10.1037/a0027127

Wauters, E., de Mey, Y., van Winsen, F., Van Passel, S., Vancauteren, M., & Lauwers, L. (2015). Farm household risk balancing: implications for policy from an EU perspective. *Agricultural Finance Review, 75*(4), 450-468. doi: https://doi.org/10.1108/AFR-04-2015-0017

Weary, D. M., & von Keyserlingk, M. A. G. (2017). Public concerns about dairy-cow welfare: how should the industry respond? . *Animal Production Science, 57*(7), 1201-1209. doi: https://doi.org/10.1071/AN16680

Webby, R. W., Johnstone, L. C. J., & Sherlock, R. (2001). *Reducing the impact of adverse summer-autumn pasture conditions on livestock performance: results from farmer experience.* Paper presented at the Proceedings of the New Zealand Grassland Association, Hamilton- New Zealand.

Weber, E. U. (2010). Risk attitude and preference. *Wiley Interdisciplinary Reviews-Cognitive Science, 1*(1), 79-88. doi: 10.1002/wcs.5

Weber, E. U., Blais, A. R., & Betz, N. E. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making, 15*(4), 263-290.

Weber, E. U., & Milliman, R. A. (1997). Perceived risk attitudes: Relating risk perception to risky choice. *Management Science, 43*(2), 123-144. doi: DOI 10.1287/mnsc.43.2.123

Wenlu, C. (2014). *Empirical Studies on Human Resource Management (HRM) in Agricultural Sector: Case Studies from China and Japan.* (Doctor's Program in Life and Food Sciences), Niigata University, Niigata, Japan.

Westbrooke, V. (2013). Business options and strategies: A study of small herd owners views in the Waikato, New Zealand. *Extension Farming Systems Journal, 9*(1), 60.

Westpac. (2009). Buffet or buffer? Does the exchange rate hinder or help commodity exporters? : Westpac.

Wilcock, R. J., Monaghan, R. M., Quinn, J. M., Srinivasan, M. S., Houlbrooke, D. J., Duncan, M. J., . . . Scarsbrook, M. R. (2013). Trends in water quality of five dairy farming streams in response to adoption of best practice and benefits of long-term monitoring at the catchment scale. *Marine and Freshwater Research, 64*(5), 401-412.

Willebrands, D., Lammers, J., & Hartog, J. (2012). A successful businessman is not a gambler. Risk attitude and business performance among small enterprises in Nigeria. *Journal of Economic Psychology, 33*(2), 342-354. doi: https://doi.org/10.1016/j.joep.2011.03.006

Willock, J., Deary, I. J., Edwards-Jones, G., Gibson, G. J., McGregor, M. J., Sutherland, A., . . . Grieve, R. (1999). The role of attitudes and objectives in farmer decision making: Business and environmentally-oriented behaviour in Scotland. *Journal of Agricultural Economics, 50*(2), 286-303. doi: 10.1111/j.1477-9552.1999.tb00814.x

Willock, J., Deary, I. J., McGregor, M. M., Sutherland, A., Edwards-Jones, G., Morgan, O., . . . Austin, E. (1999). Farmers' attitudes, objectives, behaviors, and personality traits: The Edinburgh Study of Decision Making on Farms. *Journal of Vocational Behavior, 54*(1), 5-36. doi: DOI 10.1006/jvbe.1998.1642

Wilson, J., & Tipples, R. S. (2008). Employment trends in dairy farming in New Zealand, 1991-2006.

Wilson, P. N., Dahlgran, R. D., & Conklin, N. C. (1993). "Perceptions as Reality" on Large-Scale Dairy Farms. *Review of Agricultural Economics, 15*(1), 89. doi: 10.2307/1349714

Wilson, P. N., Luginsland, T. R., & Armstrong, D. V. (1988). Risk Perceptions and Management Responses of Arizona Dairy Producers. *Journal of Dairy Science, 71*(2), 545-551. doi: DOI 10.3168/jds.S0022-0302(88)79588-0

Wolf, C. A. (2012). Dairy farmer use of price risk management tools. *Journal of Dairy Science, 95*(7), 4176-4183. doi: https://doi.org/10.3168/jds.2011-5219

Wolf, C. A., Lupi, F., & Harsh, S. (2011). Farmer demand for financial record-keeping system attributes. *Agricultural Finance Review, 71*(2), 259-276. doi: https://doi.org/10.1108/00021461111152609

Wolf, C. A., & Widmar, N. J. O. (2014). Adoption of milk and feed forward pricing methods by dairy farmers. *Journal of Agricultural and Applied Economics, 46*(4), 527.

Wright, W., & Brown, P. J. N. Z. E. P. (2019). Succession and investment in New Zealand farming. *53*(2), 203-214.

Wu, F., Guan, Z., & Myers, R. (2014). Farm capital structure choice: theory and an empirical test. *Agricultural Finance Review, 74*(1), 115-132. doi: http://dx.doi.org/10.1108/AFR-08-2012-0041

Wulff, J. N. (2015). Interpreting results from the multinomial logit model: Demonstrated by foreign market entry. *Organizational Research Methods, 18*(2), 300-325. doi: https://doi.org/10.1177/1094428114560024

Xu, P., Alexander, C., Patrick, G., & Musser, W. (2005). Effects of Farmers' Risk Attitudes and Personality Types on Production and Marketing Decisions: Purdue University, College of Agriculture, Department of Agricultural Economics.

Ye, T., Liu, Y., Wang, J., Wang, M., & Shi, P. (2015). Farmers’ crop insurance perception and participation decisions: empirical evidence from Hunan, China. *Journal of Risk Research*, 1-14.

Yin, R. K. (2011). *Applications of case study research*: SAGE Publications Ltd.

Yin, R. K. (2013). *Case study research: Design and methods*: SAGE Publications Ltd.

Young, L. M., & Hobbs, J. E. (2002). Vertical Linkages in Agri-Food Supply Chains: Changing Roles for Producers, Commodity Groups, and Government Policy. *Applied Economic Perspectives and Policy, 24*(2), 428-441. doi: 10.1111/1467-9353.00107

Zhao, H., Seibert, S. E., & Hills, G. E. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. *J Appl Psychol, 90*(6), 1265-1272. doi: 10.1037/0021-9010.90.6.1265

Zhao, J., Barry, P. J., & Katchova, A. L. (2008). Signaling credit risk in agriculture: implications for capital structure analysis. *Journal of Agricultural and Applied Economics, 40*(03), 805-820.

Zhao, J., Barry, P. J., & Schnitkey, G. D. (2008). Financing strategies under combined capital structure theories: a farm-level simulation analysis. *Agricultural Finance Review, 68*(2), 321-338. doi: http://dx.doi.org/10.1108/00214660880001233

Zuniga, M., Coble, K. H., & Heifner, R. (2001). *Evaluation of hedging in the presence of crop insurance and government loan programs*.

Appendix

Appendix I Case study information sheet and consent from

Information Sheet

<u>An analysis of the portfolios of risk management strategies utilized by New Zealand dairy farmers: A mixed method study. (Information sheet)</u>

Researcher(s) Introduction

My name is Koohyar Khatami and I am currently undertaking a PhD in the College of Sciences at Massey University. My research supervisors are Prof. Nicola Shadbolt, Dr David Gray and Dr Elizabeth Dooley from the Institute of Agriculture and Environment (IAE). My research project is titled: "An analysis of the portfolios of risk management strategies utilized by New Zealand dairy farmers: A mixed method study" and is supported by AgriOne, The Centre of Excellence in Farm business Management. This work is part of a "The Centre of Excellence in Farm Business Management" (CEFBM) project, partially funded by DairyNZ, studying farmer's decision making under risk (see www.agrione.ac.nz). The study seeks to understand the risk management portfolios used by dairy farmers to manage risk and what factors dictate the choice of the mix of risk management strategies within a farmer's portfolio. The study also aims to determine the impact that different risk management portfolios have on the financial performance of the farm business.

Participant Identification and Recruitment

I am seeking your input into this research because you are a dairy farmer. Therefore, you have a professional position in the industry, and you have knowledge and experience that is likely to be of value to the research.

Project Procedures

In the first phase of this research project, three dairy farm owner-operators will be asked to provide information regarding their beliefs about risk and uncertainty within the farm business environment. They will also be asked about what risk management strategies they have within their risk management portfolio and why they have chosen that particular set of strategies. In order to provide a rich context about the farmers' risk management strategies, different sources of information will be used. Findings from this phase of the study will be used to design a new survey instrument to assess the extent of differences in risk management across dairy farms in New Zealand.

I would appreciate if you would be willing to participate in this research project. If you are willing to participate, you will be first asked to complete a written questionnaire and answer questions on your personal characteristics such as education and training, goals, long-term plans and objectives, as well as information on your risk management strategies, and beliefs about risks within the farm business environment. The questionnaire is designed to take about 30-40 minutes of your time. You can choose not to answer a question should you prefer not to do so.

Following to that, an interview will be organised to ask you about your risk management portfolio, the factors that influence the structure of your risk management portfolio and how you manage risk on your farm. With your agreement the interview will be tape recorded to ensure accuracy in data collection and to assist the data analysis process. The taped interviews will be summarized. The recordings and summary will be stored as digital files. Interviews will be undertaken at a time and location that is agreed to by you. Interviews will be a maximum of 90 minutes. You will be provided with a copy of the transcript or case report to ensure that you are satisfied with what is included in the thesis. You will also have the opportunity to amend the transcript or case report if required.

Only researchers on the project will be privy to information such as questionnaire responses, and tapes and interview transcripts. Unless consent is given, your name and identity will not be stated explicitly in the research. No data linked to an individual's identity will be published and only relatively generic information on you and your business will be provided to minimise the likelihood of your being identified.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- decline to answer any particular question in the questionnaire;
- decline to answer any particular question during the interview;
- ask for the recorder to be turned off at any time during the interview;
- ask any questions about the study at any time during participation;
- be given access to the interview recording should you want this, and a copy of the transcript or case report, with the right to modify the transcript or case report within two weeks of receiving this;
- withdraw from the study up to two weeks after receiving the transcript or case report;
- provide information with the expectation that your name will not be used in reporting;
- Be given access to a summary of the project findings when it is concluded;

Project Contacts

If you have any questions about the project, please contact the researcher and / or the supervisors:

Koohyar Khatami, s.khatami@massey.ac.nz; phone 06 356 9099 ext. 85782;

Professor Nicola Shadbolt, N.M.Shadbolt@massey.ac.nz

Dr. David Gray, D.I.Gray@massey.ac.nz

Dr. Elizabeth Dooley, A.E.Dooley@massey.ac.nz

This project has been evaluated by peer review and judged to be low risk (Ethics Notification Number: 4000016229). Consequently, it has not been reviewed by one of Massey University's Human Ethics Committees. The researchers named above are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researchers, please contact Dr Brian Finch, Director - Ethics, Massey University, telephone 06 356 9099 ext. 86015, email humanethics@massey.ac.nz.

Yours sincerely,

Koohyar Khatami

PARTICIPANT CONSENT FORM

An analysis of the portfolios of risk management strategies utilized by New Zealand dairy farmers: A mixed method study.

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree to fill out the questionnaire.

Yes No

I agree to the interview being tape recorded;

Yes No

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... Date: ....

Full Name – printed: ....

Appendix II Case study written questionnaire

1- You and your farm business

1.1 Respondent characteristics

1.1.1 **Fill-in** or **circle** what best describes **you**.

Please **fill-in** the total number of years you have been involved in dairy farming	

1.1.2 Given the years of experience indicated above, allocate **these years to the most predominant role at the time:**

A	Farm worker	
B	Farm manager and/or contract milker and/or variable order sharemilker	
C	Herd-owning sharemilker	
D	Farm owner (operator and/or non-operator)	
E	Equity partner (operator and/or non-operator)	

1.1.3 Please **circle** your age according the following ranges:

A	20-30 years
B	31-40 years
C	41-50 years
D	51-60 years
E	61-70 years
F	71 years or more

1.1.4 Please **circle** your highest level of formal education:

A	NCEA level 1 / school certificate
B	University entrance / bursary / NCEA level 2 or 3
C	Diploma graduate
D	Degree graduate
E	Postgraduate
E	Technical training qualification
F	Other (please describe)

1.1.5 Please **circle** the letter that best describes your **current situation**:

A	A farm owner-operator
B	A farm owner-non-operator
C	A farm owner operator with multiple operations
D	An equity partnership managing-partner
E	Other (please specify):

1.2 Farm business characteristics

Please **circle** the option that best describes the situation of **your farm business** today. If you operate more than one farm business, please answer with reference to the business in which you have the most influence.

1.2.1 Please circle the letter that best describes the stage of the business.

A	Entry
B	Growth by expanding the farm size
C	Consolidation (to maintain my farm as it is)
D	Retrenchment (improving farm performance)
E	Entry of next generation
F	Exit

1.2.2 Please fill-in the following figures for your farm business

Number of dairy farms	
Milking platform area (effective ha)	
Non-milking area and/or runoff (effective ha)	
What type of system are you running	
Total kg MS produced for 2015/2016 season	
Cows milked at peak for 2015/2016 season	
Any distinctive features of your farm or system (e.g. irrigated, organic, intensive, housed cows, once a day milking, winter milking, other enterprises, and difficult terrain). Please specify:	

1.2.3 Please fill-in the following figures for your farm business

No of staff you employ (full time equivalents)	
No. of family members involved in farm duties (full time equivalents)	

2- Goals and management style

For each of the following goals, please tick the box which best reflects your point of view.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I aim to minimise the use of agricultural chemicals on the farm to protect the environment.					
I am willing to sacrifice farm profitability to conserve water and other resources.					
I do everything I can to conserve the land I farm.					
I use whatever fertilizers and pesticides are necessary to get the job done.					
I aim to make the largest possible profit.					
It is important to have the best quality livestock/pasture.					
I aim to diversify my assets by having on-farm and off-farm investments.					
I am willing to reduce my work load and improve the quality of my life.					
Production goals take priority over personal goals.					
There is a conflict between my farm goals and family goals					
My farm-business benefits greatly from the contributions made by family members.					
I want to make enough money to maintain a balanced lifestyle that incorporates interests outside of the farm.					
I aim to keep the farm a closely held family business.					
It is important to stay in farming whatever happens.					
I believe a successful farmer concentrates on production and is not side-tracked by interests or activities outside the farm.					
I want to operate this farm for the rest of my life and pass it on to my children.					
I want to sell the farm for a reasonable price when I get close to retirement.					
I want to build a strong farm that is saleable in the event such a decision should become advisable at some point.					

3- Strategic thinking

For each of the following questions, please tick the box that best reflects your point of view.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My strategic decision-making is driven by my vision for my farm business					
I know what my farm business weaknesses and strengths are					
I use practical planning steps in my farm business to correct the discrepancy between what is desired and what exists in reality					
I can see where my farm business will be within five years					
I review my strategic goals and plans on a regular basis (e.g. annually)					
I seek other farmers' opinions about important decisions					
I consider how different parts of the farm system are connected to each other					
I try to identify how external factors affect different parts of my farm system					
I engage in discussions with accountants, bankers, and rural advisors in relation to my business					
I try to find common goals when two or more objectives are in conflict					
I define the entire problem before breaking it down into parts					
When confronted with a new situation, I consider the results of past actions in similar situations					
I do not search for patterns when confronted with rich information					
I frame problems in ways that allow me to understand them					
I ask "WHY" questions to develop an understanding of uncertain problems					
When resolving a problem, I consider a range of possibilities					
I try to understand how uncertainties that an impact on the other stakeholders have (e.g. lenders, contractors, dairy companies) affect my farm business					
When thinking about past decisions and actions, I try to evaluate how I could handle the situation better					
No matter what happens outside the farm, I always stick to my plan					
It is better to create a fast solution to a problem, even if the nature and implication of the problem is not clear					

4- Risk profile

For each of the following questions, please tick the box which best reflects your point of view.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
When there are a number of solutions to a problem, I find it difficult to make a choice.					
I find planning difficult because the future is so uncertain.					
Within a season, I am able to manage almost all uncertainty that occurs.					
When it comes to business, I like to play it safe.					
Over the long term, I am able to manage almost all uncertainty that occurs.					
I am more concerned about a large loss in my farm operation than missing a substantial gain.					
I am willing to take more risks than my colleagues with respect to production.					
I am willing to take more risks than my colleagues with respect to market risks.					
I am willing to take more risks than my colleagues with respect to financial issues.					
I am willing to take more risks than my colleagues with respect to human resource issues.					
I do not like to take risky decisions concerning my farm.					
I take challenges more often than other dairy farmers do.					
I postpone investments until they really need to be done.					
I am not afraid to borrow money in order to undertake investments that can enhance profitability.					

5- PERCEIVED ENVIRONMENTAL UNCERTAINTY

5.1. Over a number of years, the business environment evolves as changes occur in our global markets, legislation, and technology to name a few. The results of these uncertainties could be beneficial, harmful or combination of both to your business. For each of the sources of uncertainty listed below, please indicate:

1. What you believe is the **potential** for your business **to benefit** in the **coming five years** (Very low, Very high)**;** 2. What you believe is the **likelihood** of this **opportunity** happening for your business in **the coming five years** (Rare, Almost certain).

Sources of uncertainty	The potential to benefit from uncertainty					The likelihood of this opportunity happening				
	Very low	Low	Medium	High	Very high	Rare	Un likely	Possible	Likely	Almost certain
Climate variation										
Pasture/crop/animal health										
Interest rates										
Land values										
Availability of capital										
Milk prices										
Input prices and availability										
Availability of quality labour (family, employees, and contractors)										
Staff and/or personal injury										
Staff turnover										
Skills and knowledge of those associated with the business										
Technological changes										
Business relationships (with input providers)										
Dairy industry structure										
The global economic and political situation										
Global supply and demand for food										
Global competitors and competition										
Reputation and image of the dairy industry										
Government laws and policies										
Local body laws and regulations										
Other (please specify)										

5.2. Over a number of years, the business environment evolves as changes occur in our global markets, legislation, and technology to name a few. The results of these uncertainties could create opportunities, threats, or combination of both to your business. For each of the sources of change listed below, please indicate:

1. What you believe is the **potential** for your business **to lose** in the coming five years (Very low, Very high).
2. What you believe is the **likelihood** of this **threat** happening in the coming five years (Rare, Almost certain).

Sources of uncertainty	**The potential to lose from uncertainty**					**The likelihood of this threat happening**				
	Very low	**Low**	**Medium**	**High**	**Very high**	**Rare**	**Un likely**	**Possible**	**Likely**	**Almost certain**
Climate variation										
Pasture/crop/animal health										
Interest rates										
Land values										
Availability of capital										
Milk prices										
Input prices and availability										
Availability of quality labour (family, employees, and contractors)										
Staff and/or personal injury										
Staff turnover										
Skills and knowledge of those associated with the business										
Technological changes										
Business relationships (with input providers)										
Dairy industry structure										
The global economic and political situation										
Global supply and demand for food										
Global competitors and competition										
Reputation and image of the dairy industry										
Government laws and policies										
Local body laws and regulations										
Other (please specify)										

5.3. When facing uncertainties, managers apply different strategies to manage outcomes. For each of the following sources of uncertainties, please indicate how often you feel **you know how to respond to these uncertainties?**

Sources of uncertainty	**How often you feel you know how to respond**				
	Never	**Rarely**	**Some-times**	**Very often**	**Always**
Climate variation					
Pasture/crop/animal health					
Interest rates					
Land values					
Availability of capital					
Milk prices					
Input prices and availability					
Availability of quality labour (family, employees, and contractors)					
Staff and/or personal injury					
Staff turnover					
Skills and knowledge of those associated with the business					
Technological changes					
Business relationships (with input providers)					
Dairy industry structure					
The global economic and political situation					
Global supply and demand for food					
Global competitors and competition					
Reputation and image of the dairy industry					
Government laws and policies					
Local body laws and regulations					
Other (please specify)					

6. RISK MANAGEMENT

There are a number of recognised strategies for managing risk; the following list includes some, but by no means all, of the strategies observed on dairy farms.

For each of the following management strategies please indicate:

1. Do you use this strategy on your farm(s)? (Yes, No, Not Applicable)
2. If you use this strategy, indicate how important you believe this strategy is for managing risk **on your dairy farm business** (very low, very high).

Risk management strategy	**Use of risk management strategy**			**Importance**				
	Yes	**No**	**Not Applicable**	**Very Low**	**Low**	**Moderate**	**High**	**Very high**
Adjusting drying-off date								
Having feed reserves on farm								
Buying-in feed								
Not producing to full capacity								
Monitoring programmes for pest and diseases control								
Routine spraying and drenching								
Rearing your own young stock								
Once-a-day milking								
Using consultants and advisors								
Adjusting stocking rate between years								
Grazing dairy stock off-farm								
Having irrigation								
Owning or leasing a run-off								
Having infra structure for wet soil management (barns, pads, drainage)								
Enterprise diversification								
Geographical diversification through having farms in different areas								
Managing debt levels								
Arranging overdraft reserves								

Risk management strategy	Use of risk management strategy			Importance				
	Yes	No	Not Applicable	Very Low	Low	Moderate	High	Very high
Having cash reserves								
Planning capital spending								
Flexibility of drawings and/or dividends								
Detailed financial planning								
Gathering market information about interest and exchange rates								
Having income protection insurance								
Having off-farm investments								
Main operator or family members working off-farm								
Keeping debt low or increasing equity								
Maintaining good relationships with bankers								
Leasing rather than owning								
Using futures markets								
Using contracts to sell products								
Using contracts to procure feed in advance at a fixed price								
Spreading sales (reducing seasonality in milk production)								
Gathering market information about output prices								
Gathering market information about inputs (feed, fertilizer, young stock) prices								
Having a health & safety plan								
Keeping health and safety manuals up to date								
Avoiding having staff undertaking high risk tasks (e.g. chainsawing)								
Training staff in health and safety issues								
Monitoring health and safety practices on a regular basis								

Risk management strategy	Use of risk management strategy			Importance				
	Yes	No	Not Applicable	Very Low	Low	Moderate	High	Very high
Accident insurance								
Life insurance								
Selecting skilled staff								
Adopting a low labour system (e.g. robotic milking, once-a-day milking)								
Use of contractors and sharemilkers								
Use of staff performance planning, review, and appraisal								
Having good relationships with staff								
Providing above average compensation (salary, wages)								
Offering good working conditions (e.g. hours of work, house, and vehicle)								
Offering financial incentives to staff								
Offering performance-based pay to staff								
Providing career development opportunities for staff								
Provide training opportunities for staff								
Developing standard operation procedures (e.g. milking, calving, and effluent) for staff								
Avoiding staff undertaking tasks that can have a large impact on the business (e.g. effluent, mating)								

Appendix III Interview protocol

Appendix I: Background information

1. **Provide me with a brief history of your farm and your farming experience**

Probes: When did you start? How long have you been on this farm?

2. **Tell me about your long-term goals**

Probes:
What are the planning time frames you use for your long-term goals?
Briefly describe what is the road map to achieve the above goals?

3. **Tell me about your farm resources**

Land
Area: milking area, runoff (total and effective area)
Land topography (contour),
Climate: Rainfall, temperature, wind; etc.
Altitude (higher altitude more climatic risk)
Soil types, soil fertility, and fertilizer history
Pasture grown or harvested per hectare per annum
Labour
Labour units, role of the staff
Family or non-family labour
Other key people
Capital items
Stock numbers, breed, and genetics,
Pasture species and areas and regrassing program;
Forage crops – type and area
Subdivision and races
Drainage (area in need/area that is drained);
Water supply;
Irrigation (area in need/ area that is irrigated);
Buildings and dairy shed;
Effluent system;
Vehicle, plant and machinery (key items)
Stock performance
Milksolids production – total, per hectare and per cow
Stocking rate: - wintered and peak milked
Comparative stocking rate
Number of replacement stock 1st July
Days in milk (drying off date)
Reproductive performance: submission rates, conception rates, empty rates
Calving spread (calving date)
Cow wastage %
Replacement rate (%)
Feed imported into the system (from outside milking area)
Palm kernel
Maize silage
Grain
Balage
Silage
Hay
Number of cows grazed off and for the period?? Young stock grazed off?

Farming system
How would you classify your system type (1 – 5)
Why do you run this type of system?
Calving date
Normal average pasture cover at calving and balance date
Normal drying off date
Normal average pasture cover at drying off
Farm business
Would you classify your debt levels as low, moderate or high?
Would you classify your cost of milk production as low, moderate or high?
Would you classify your profitability as low, moderate or high?
Sources of risk

a) What are your most important sources of risk?
b) Why do you rate these as the most important sources of risk?
c) Do you rate upside risk as important as downside risk?
d) Why is this?

Your risk management portfolio

1. **In the written questionnaire you mention that xxx are the most important sources of risk and create both opportunities and threats for your farm business.**

Downside risk

1) How do you manage **threats** arising from this risk source?

Probes:

2) Why do you use these strategies?
3) What factors influence your choice of these strategies?
4) How do you go about choosing a risk management strategy?
5) Could you provide an example of this process?
6) Do you consider risk trade-offs when choosing a strategy?
7) Can you provide examples of such trade-offs in relation to strategies used for this risk source?
8) Do you use them every year? Does it differ from year to year? Why?
9) Can you use these strategies to also manage upside risk? Why is that?
10) What other options are there for you to manage this risk?
11) Why do you not use these strategies?
12) What factors influenced your decision not to use them?

Upside risk

1) How do you exploit opportunities arising from this risk source?

Probes:

2) Why do you use these strategies?
3) What factors influence your choice of these strategies?
4) How do you go about choosing a risk management strategy?
5) Could you provide an example of this process?
6) Do you consider risk trade-offs when choosing a strategy?
7) Can you provide examples of such trade-offs in relation to strategies used for this risk source?
8) Do you use them every year? Does it differ from year to year? Why?
9) Can you use these strategies to also manage downside risk? Why is that?
10) What other options are there for you to manage this risk?
11) Why do you not use these strategies?
12) What factors influenced your decision not to use them?

Appendix IV Survey letter and questionnaire

Dear Farmer,

Dairy farm risk management has been a hot topic in recent years. Researchers have investigated how farmers manage risk, but surprisingly few have explored the portfolios of risk management strategies dairy farmers use to manage risk.

My name is Koohyar Khatami. I am trying to identify the sets of risk management strategies New Zealand dairy farmers utilise, and in particular, risk management strategies associated with financial management on dairy farms. My research supervisors are Prof Nicola Shadbolt, Dr David Gray and Dr Elizabeth Dooley from the Institute of Agriculture and Environment (IAE), Massey University. For more information about the project or myself, please see the “information sheet” enclosed with this letter.

We are surveying a random sample of dairy farmers from across New Zealand. The more responses we get, the more accurately we can interpret the findings. So your response is valuable.

This survey is designed to take about 30 minutes of your time. You can refuse to answer any of the questions in the survey. Your answers will remain anonymous and confidential. In addition, data will be analysed collectively so that no individual can be identified from the results of this project.

By completing this survey you are eligible for the prize draw of an “RD1 Gift Card” valued at $250. Please don’t forget to respond the last question in the survey if you want to be included in the draw.

A summary of the results will be available at www.agrione.ac.nz at the end of this research project.

Thank you very much for your time and participation in this project.

Yours sincerely,

Koohyar Khatami- PhD Student
Massey University
Palmerston North
Phone: 022 013 24 68
Email: s.khatami@massey.ac.nz

1 You and your farm business

1.1 Please **choose** your age range:

20-30 years	31-40 years	41-50 years	51-60 years	61-70 years	71 years or more

1.2 Please **choose** the total years of experience you have had in **farm owner, managing equity partner and 50-50 sharemilker roles.**

Less than 5 years	6-10 years	11-15 years	16-20 years	21-25 Years	More than 25 years

1.3 Please **circle** the letter that best describes your highest level of formal education:

A	NCEA level 1 / School Certificate
B	University Entrance / Bursary / NCEA level 2 or 3
C	Diploma graduate
D	Degree graduate
E	Postgraduate
F	Technical training qualification
G	Other (please specify)

1.4 Please **circle** the letter that best describes the stage of the dairy farm businesses **today.**

A	Entry
B	Growth
C	Consolidation
D	Entry of next generation
E	Exit

1.5 For each of the following questions, please **tick** the box which best reflects your point of view.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I take risks more often than other dairy farmers do.					
2	I postpone investments until they really need to be done.					
3	I am not afraid to borrow money in order to undertake investments that can enhance profitability.					
4	When there are a number of solutions to a problem, I find it difficult to make a choice.					
5	I find planning difficult because the future is so uncertain.					
6	Within a season, I am able to manage almost all uncertainty that occurs.					
7	When it comes to business, I like to play it safe.					
8	Over the long term, I am able to manage almost all uncertainty that occurs.					

2 Dairy farm(s) characteristics

2.1 Fill-in the following information for your dairy farm(s). If you own more than one dairy farm, please answer with reference to the three dairy farms that you are most actively involved with.

	Farm 1	Farm 2	Farm 3
Location (please choose your farm's region from the New Zealand map on the bottom of this page e.g. write "K" if the farm is located in "Wairarapa")			
Your role in the business (please choose from the below table e.g. write "D" if you are an owner with a manager)			
Type of dairy farm system (1 to 5)			
Milking platform area (effective ha)			
Non-milking area and/or runoff area (effective ha)			
Total Kg MS produced for 2016/2017 season			
Cows milked at peak for 2016/2017 season			
No. of employed staff (full time equivalents)			
No. of family members involved in the farm (full time equivalents)			
Other distinctive features of your farm(s). Please **tick** any that apply.			
Irrigated			
Organic farm			
Intensive			
Once a day milking (OAD)			
Housed cows			
Winter milking			
Difficult terrain			
Other (Please specify)			

Dairy farm(s) geographical location:

Your role in the dairy farm(s):

A	Farm owner-operator	D	Farm owner with manager
B	Farm owner with 50-50 sharemilker(s)	E	Managing-partner in an equity partnership
C	Farm owner with variable order sharemilker(s)/ contract milker(s)	F	Other

3 Financial structure

Please answer the questions in this section with reference to your overall dairy farm business (all dairy farms that you own).

3.1 Capital

3.1.1 Please indicate the **current debt-to-asset ratio (%)** for your dairy farm business.

No debt	1-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%	>100%

3.1.2 Compared to the current debt-to-asset ratio (section 3.1.1), please indicate where you believe your debt-to-assets ratio should be <u>over the next 5-7 years</u>?

More than 20% lower	11%-20% lower	6%-10% lower	1%-5% lower	Same as current level	1%-5% higher	6%-10% higher	11%-20% higher	More than 20% higher

3.1.3 How important do you believe the factors below are when deciding on the debt level for your dairy farms? For each statement please **tick** the box which best reflects your point of view.

		Very Low	Low	Moderate	High	Very High
1	Interest rates					
2	Income volatility					
3	Tax deductibility of interest					
4	The likelihood of insolvency or bankruptcy					
5	Availability of own funds					
6	Farm creditworthiness (as assigned by banks)					
7	The ability to borrow further funds when unexpected opportunities and/or threats occur					
8	Other (please specify)					

3.1.4 Have you applied for a new term-loan for your dairy farm business <u>over the past 3 years</u>?

A	Yes
B	No (Go to section 3.1.6)

3.1.5 Has an application for a new term-loan been **rejected** <u>over the past 3 years</u>?

A	Yes (Go to section 3.2)
B	No (Go to section 3.2)

3.1.6 Identify the main reason for **not applying for a new term-loan** over the past 3 years?

A	I was not sure if the loan would be approved.
B	The size or the maturity of the loan was insufficient for what I was considering funding.
C	Interest rates were unfavourable.
D	I was not sure whether I could service the debt.
E	I did not need funds.

3.2 Debt

Please answer the questions in this section with reference to your overall dairy farm business (all dairy farms that you own).

3.2.1 Fixed versus floating interest

3.2.1.1 Please indicate the percentage of your dairy farm business mortgages that are **fixed.**

Not Fixed | 1-10% | 11-20% | 21-30% | 31-40% | 41-50% | 51-60% | 61-70% | 71-80% | 81-90% | 91-100%

3.2.1.2 How important do you believe the factors below are when deciding the ratio of **fixed to floating mortgages**? For each statement please **tick** the box which best reflects your point of view.

		Very Low	Low	Moderate	High	Very High
1	Forecast interest rates at the time of borrowing					
2	Income volatility					
3	The difference between fixed and floating rates at time of borrowing					
4	The flexibility of making additional repayment on floating loans					
5	The flexibility of restructuring or exiting a floating loan					
6	Certainty over interest rates on fixed-rate loans					
7	Other (please specify)					

3.2.2 Table mortgage versus interest-only mortgage

3.2.2.1 Please indicate the percentage of your dairy farm business mortgages that are **table mortgages**.

No Table-mortgage | 1-10% | 11-20% | 21-30% | 31-40% | 41-50% | 51-60% | 61-70% | 71-80% | 81-90% | 91-100%

3.2.2.2 How important do you believe the factors below are when deciding the ratio of **table versus interest-only mortgages**? For each statement please **tick** the box which best reflects your point of view.

		Very Low	Low	Moderate	High	Very High
1	The difference between the initial amount paid on table-mortgages and the initial amount paid on interest only-mortgages					
2	The difference between the overall amount paid on table-mortgages and the overall amount paid on interest-only mortgages					
3	Higher tax deductibility potential for interest-only mortgages					
4	Flexibility in the repayments for interest-only mortgages					
5	Potential to borrow more on interest-only mortgages					
6	Other (please specify)					

3.3 Liquidity

Please answer the questions in this section with reference to your overall dairy farm business (all dairy farms that you own).

3.3.1 Cash reserves

3.3.1.1 Please **circle** the statement which best describes the **cash reserves** situation for your dairy farm business.

A	My cash reserves cover **short-term** cash-flow deficits.
B	My cash reserves cover the cash-flow deficits **over the year.**
C	My cash reserves cover the cash-flow deficit for **more than one year**.
D	I **do not maintain** cash reserves in order to cover cash-flow deficits.

3.3.1.2 How important do you believe the factors below are when deciding on the amount of cash reserves to hold? For each statement please **tick** the box which best reflects your point of view.

		Very Low	Low	Moderate	High	Very High
1	The difference between the Interest rate received on cash reserves and the interest rate paid on debt.					
2	Having funds available when they are needed.					
3	The time it takes to raise money when funds are needed.					
4	The amount of undrawn financial overdraft available.					
5	The size of the expected cash-flow deficit.					
6	A preference to self-fund					
7	Other (please specify)					

3.3.2 Financial overdraft

3.3.2.1 Please **circle** the statement which best describes the **size of your overdraft facility** for your dairy farm business (all dairy farms that you own).

A	My financial overdraft covers **short-term** cash-flow deficits.
B	My financial overdraft covers cash-flow deficits **over a year**.
C	My financial overdraft covers cash-flow deficits over **more than one year**.
D	I **have not arranged** a financial overdraft (Go to section 4)

3.3.2.2 In your decision on whether to use your financial overdraft facility, how important are the following factors? For each statement please **tick** the box which best reflects your point of view.

		Very Low	Low	Moderate	High	Very High
1	The interest rates on the financial overdraft facility					
2	The time it takes to raise funds through other sources of funds					
3	The amount of cash reserves that I hold					
4	Other (please specify)					

3.3.2.3 For each of the following questions, please **tick** the box which best describes how you have used your financial overdraft facility over the past 3 years:

		Never	Rarely	Some-times	Almost Always	Always
1	How often do you use financial overdraft?					
2	How often do you reach your financial overdraft limit?					

3.3.2.4 Have you applied for an extension to the size of your financial overdraft facility over the past 3 years?

A	Yes
B	No

3.3.2.5 Have you carried your overdraft over to the next year over the past 3 years?

A	Yes
B	No

4 Financial management practices

4.1 Farm performance practices

4.1.1 There are a number of performance measures you can use to monitor dairy farm performance. For each of the following measures, please indicate whether you use this to monitor your dairy farm business performance over time (Yes, No, Not applicable).

If yes, please indicate how often you use this (At least weekly to Annually).

		Use of method			How often do you monitor performance using these measures?				
		Yes	No	N/A	Weekly	Monthly	Quarterly	Half-yearly	Annually
1	Milk production								
2	Bank balance								
3	Cash surplus								
4	Cost breakdown								
5	Projected vs real cash-flow analysis								
6	Overdraft facility level								
7	Other (please specify)								

4.1.2 Which of these business analysis practices do you use to evaluate dairy farm business performance? (**Circle** all that apply)

A	Benchmarking tools (e.g. DairyBase) to compare farm performance with other farms
B	Tracking profitability and efficiency over time (trend analysis between seasons)
C	Annual formal business analysis review
D	Other (please specify)

4.2 Investment analysis practices

4.2.1 Which of these methods do you use when you want to analyse major capital investments? (**Circle** all that apply)

A	Calculate in my head
B	Rough back of the envelope analysis
C	Detailed written analysis
D	Spreadsheet analysis
E	Hire a consultant or accountant to undertake an analysis.
F	Other (please specify)

4.2.2 Which of these metrics do you use when you want to analyse proposed capital investments? (**Tick** all that apply)

		Payback Period	Projected Cash Flow (ability to cash-flow investment)	Net Present Value or Internal Rate of Return	Partial budget
1	Major expansion				
2	Equipment replacement (e.g. machinery)				
3	Expanding herd size by more than 10%				
4	Please comment if any other metrics are used and for which investment type.				

4.3. Relationship with lending institutions

4.3.1 How many lending institutions (e.g. banks) are you working with?

One — Two — Three — Four — Five — More than five

4.3.2 Please indicate the length of the relationship with your **main lending institution**?

Less than 5 years — 6-10 years — 11-15 years — 16-20 years — 21-25 Years — More than 25 years

4.3.3 How often do you communicate with your bank manager(s)?

A	Fortnightly
B	Monthly
C	Quarterly
D	Half Yearly
E	Yearly
F	Other (please specify)

4.3.4 How often do you compare interest rates and services **across lending institutions**? (**Circle** all that apply)

A	Every time I borrow additional funds
B	When borrowing a significant amount of money
C	When there has been a change in the lender relationship such as a new bank manager or regulations
D	Annually
E	Never
F	Other (please explain)

4.3.5 There are a number of recognised strategies for maintaining a good relationship with bank managers. The statements below identify some strategies used to build this relationship.

For each of the following strategies please indicate whether you use this strategy for your dairy farm businesses (Yes, No, Not Applicable).

If yes, indicate how important you believe this strategy is (Very low to Very high).

	strategy	Use of strategy			Importance				
		Yes	No	Not Applicable	Very Low	Low	Moderate	High	Very High
1	Producing and sharing realistic cash-flow statements with your bank manager(s).								
2	Being proactive when the projected cash-flow is not going to plan and discussing this with your bank manager(s).								
3	Sharing investment opportunity plans with your bank manager(s) before officially applying for a loan.								
4	Sharing your risk management plans with your bank manager(s) in tough times.								
5	Other (please specify)								

5. Perceived business environment uncertainty

The business environment evolves over time as changes occur in global markets, legislation, and technology to name a few. These changes create opportunities for your business. The potential to benefit from these changes differs according to the source of change and the scope you have to respond.

5.1 For each of the sources of change listed below, please indicate what you believe is:
1. The **potential for your business to benefit** long term (Very Low to Very High)
2. The **likelihood of this potential benefit happening** long term (Rare to Almost Certain)

Sources of uncertainty	The potential to benefit from this change					The likelihood of this potential benefit happening				
	Very Low	Low	Medium	High	Very High	Rare	Un-likely	Possible	Likely	Almost Certain
Climate variation										
Pasture/crop/animal health										
Interest rates										
Land values										
Availability of capital										
Milk prices										
Input prices and availability										
Availability of quality labour (employees and contractors)										
Staff turnover										
Skills and knowledge of those associated with the business										
Technological changes										
Business relationships										
Dairy industry structure										
The global economic and political situation										
Global supply and demand for food										
Reputation and image of the dairy industry										
Government laws and policies										
Local body regulations and laws										
Other (please specify)										

The business environment evolves over time as changes occur in global markets, legislation, and technology to name a few. These changes create threats for your business. The potential to lose from these changes differs according to the source of change and the scope you have to respond.

5.2 For each of the sources of change listed below, please indicate what you believe is:

1. The **potential for your business to lose** long term (Very Low to Very High)
2. The **likelihood of this potential loss happening** long term (Rare to Almost Certain)

Sources of uncertainty	**The potential to lose from this change**					**The likelihood of this potential loss happening**				
	Very Low	Low	Medium	High	Very High	Rare	Un-likely	Possible	Likely	Almost Certain
Climate variation										
Pasture/crop/animal health										
Interest rates										
Land values										
Availability of capital										
Milk prices										
Input prices and availability										
Availability of quality labour (employees and contractors)										
Staff turnover										
Skills and knowledge of those associated with the business										
Technological changes										
Business relationships										
Dairy industry structure										
The global economic and political situation										
Global supply and demand for food										
Reputation and image of the dairy industry										
Government laws and policies										
Local body regulations and laws										
Other (please specify)										

6 Business risk management strategies and practices

Please answer the questions in this section with reference to Farm 1 in Question 2.1.

There are a number of recognised strategies for managing risk. The following list includes some, but by no means all, of the strategies observed on dairy farms.

6.1 For each of the following strategies please indicate, whether you use this strategy on your dairy farm (Yes, No, Not Applicable). If you use this strategy, indicate how important you believe this strategy is for managing risk on your dairy farm business (Very Low to Very High).

Farm Risk management strategy	Use of strategy			Importance				
	Yes	No	Not Applicable	Very Low	Low	Moderate	High	Very High
Having feed reserves on farm for unexpected events								
Not producing to full capacity within the current farming system								
Grazing dairy stock off-farm								
Having irrigation								
Owning a run-off								
Having infrastructure for wet soil management (e.g. barns, pads)								
Using futures markets to sell milk								
Using contracts to procure inputs in advance at a fixed price								
Spreading sales (reducing seasonality in milk production)								
Use of contract milkers and/or sharemilkers								
Employing experienced staff								
Providing training and/or career development opportunities for staff								
Using technology to reduce labour								
Providing good working conditions for staff								
Having other enterprises on your property								
Geographical diversification through having properties in different areas								
Having off-farm sources of income								
Other (please specify)								

Appendix V Distribution of respondents' risk perception and risk importance index

Appendix Table 2: Assessment of risk sources that create benefit

Opportunity	N	Risk score	Proportion of respondents (%)*	Index	Rank
Milk prices	318	15.27	61.9	945	1
Global supply and demand for food	312	15.04	62.2	935	2
Technological changes	311	13.66	47.9	654	3
Pasture/crop/ animal health	315	13.43	46.7	627	4
Skills and knowledge of associates with the business	306	12.73	40.8	519	5
Land values	316	12.09	35.8	433	6
Reputation and image of the dairy industry	313	11.89	35.1	417	7
Business relationships	309	11.74	34.6	406	8
The global economic and political situation	311	11.44	32.5	372	9
Availability of capital	308	11.24	27.9	314	10
Availability of quality labour	309	10.86	28.8	313	11
Input prices and availability	308	10.84	26.6	288	12
Interest rates	314	10.39	22.6	235	13
Government laws and policies	312	9.71	21.2	206	14
Local body regulations and laws	315	9.16	21.9	201	15
Dairy industry structure	309	9.74	19.7	192	16
Climate variation	317	9.23	16.1	149	17
Staff turnover	295	8.09	14.6	118	18

* Proportion of respondents with risk score of 15 and higher

Appendix Table 3: Assessment of risk sources that create threat

Threat	N	Risk score	Proportion of respondents (%)*	Index	Rank
Local body regulations and laws	302	14.43	50.7	732	1
Government laws and policies	303	13.59	46.9	637	2
Milk prices	300	13.46	44.3	596	3
Input prices and availability	301	12.9	39.9	515	4
The global economic and political situation	301	12.69	37.5	476	5
Reputation and image of the dairy industry	300	12.44	36.3	452	6
Interest rates	303	12.35	35.6	440	7
Global supply and demand for food	300	11.24	33.7	379	8
Availability of quality labour	300	11.21	29.7	333	9
Climate variation	309	10.63	27.2	289	10
Staff turnover	289	9.25	17	157	11
Pasture/crop/animal health	305	8.65	14.8	128	12
Dairy industry structure	299	8.79	12.7	112	13
Skills and knowledge of associates with the business	300	8.3	12.7	105	14
Land values	303	8.35	11.2	94	15
Availability of capital	299	8.25	9	74	16
Technological changes	299	7.26	8	58	17
Business relationships	300	6.99	7.3	51	18

* Proportion of respondents with risk score of 15 and higher

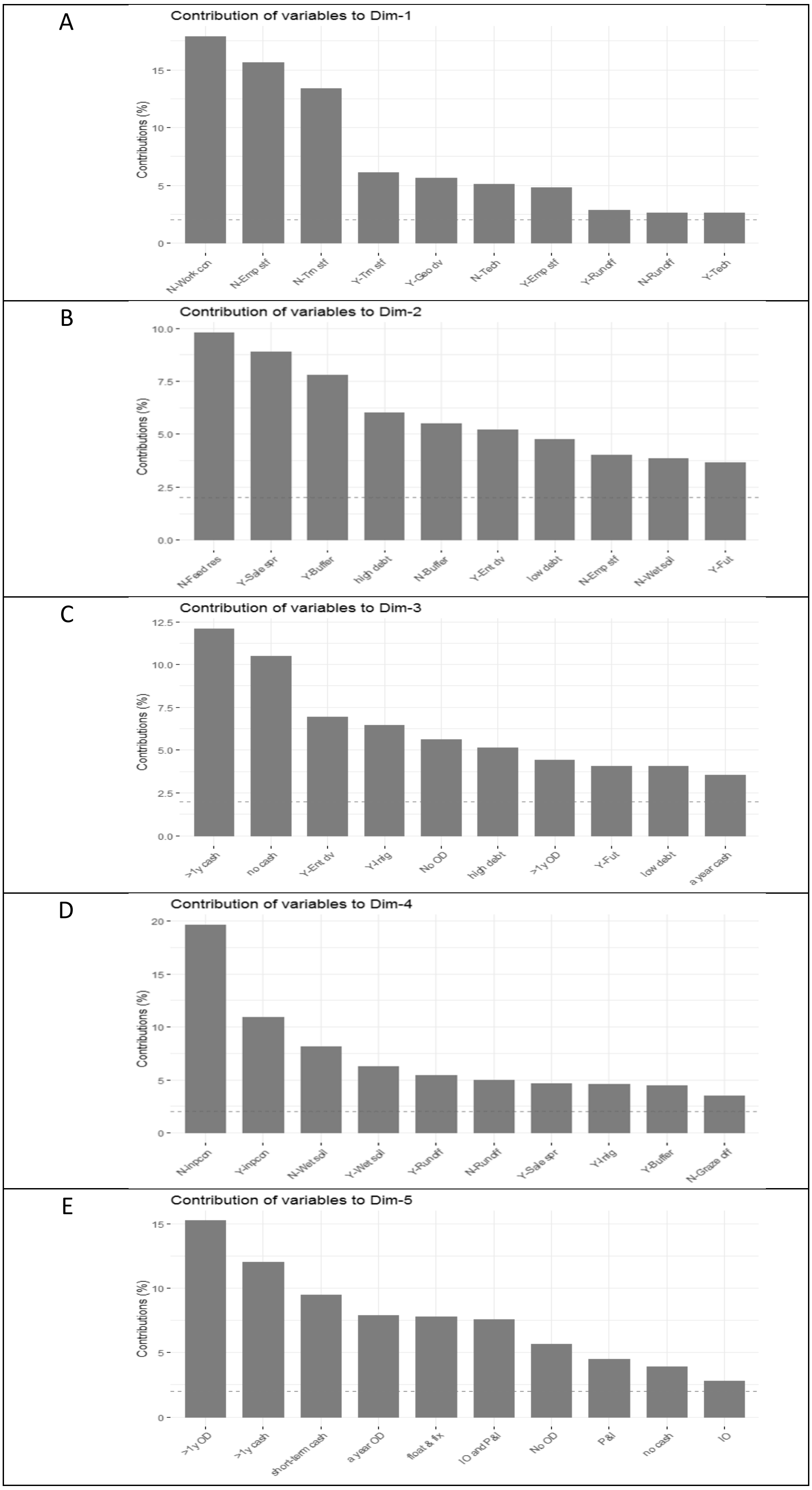
Appendix VI Distribution of respondents by risk management strategies and importance of strategies

	Strategies	Usage					Importance				
		N	Use	No use	N/A	Mean	Very High (%)	Mean	Index	Rank in domain	Rank in total
Production	Having feed reserves on farm for unexpected events	329	91%	8%	1%	1.91	24.9	3.91	97	1	3
	Not producing to full capacity within the current farming system	323	41%	52%	7%	1.34	7	3.06	21	6	14
	Grazing dairy stock off-farm	326	73%	22%	5%	1.68	18.9	3.60	68	3	6
	Having irrigation	327	22%	43%	35%	0.87	19.7	2.69	53	5	9
	Owning a run-off	324	48%	34%	17%	1.00	18.5	3.37	62	4	7
	Having infrastructure for wet soil management (e.g. barns, pads)	329	57%	34%	10%	1.47	25.9	3.62	94	2	4
Marketing	Using futures markets to sell milk	323	12%	65%	23%	0.90	4.1	2.28	9	2	15
	Using contracts to procure inputs in advance at a fixed price	327	65%	27%	9%	1.56	15.5	3.31	51	1	10
	Spreading sales (reducing seasonality in milk production)	324	27%	57%	17%	1.10	2.8	2.63	7	3	16
Human resource	Use of contract milkers and/or sharemilkers	323	30%	51%	20%	1.02	18.1	3.26	59	4	8
	Employing experienced staff	326	77%	11%	12%	1.65	29.6	3.95	117	2	2
	Providing training and/or career development opportunities for staff	322	69%	17%	14%	1.55	22.3	3.69	82	5	5
	Using technology to reduce labour	324	66%	25%	9%	1.57	10.6	3.37	36	12	12
	Providing good working conditions for staff	324	88%	4%	7%	1.81	37.5	4.22	158	1	1
Diversification	Having other enterprises on your property	326	31%	60%	9%	1.23	9.9	2.81	28	2	13
	Geographical diversification through having properties in different areas	324	19%	70%	11%	1.07	2.8	2.34	7	3	17
	Having off-farm sources of income	324	46%	48%	6%	1.40	14.7	3.24	48	1	11

Appendix VII Variables in portfolios of risk management strategies

Appendix Table 4: Description of variables used in creating risk management portfolio(s)

Code	Type	Description
Feed res	Nominal with 2 levels (Y; N)	Having feed reserves
Buffer	Nominal with 2 levels (Y; N)	Not producing to full capacity
Graze off	Nominal with 2 levels (Y; N)	Grazing dairy stock off-farm
Irrig	Nominal with 2 levels (Y; N)	Having irrigation
Runoff	Nominal with 2 levels (Y; N)	Owning a run-off
Wet soil	Nominal with 2 levels (Y; N)	infrastructure for wet soil
Fut	Nominal with 2 levels (Y; N)	futures markets to sell milk
Inpcon	Nominal with 2 levels (Y; N)	contracts to procure inputs
Sale spr	Nominal with 2 levels (Y; N)	Spreading sales
SM/CM	Nominal with 2 levels (Y; N)	Use of contract milkers and/or sharemilkers
Empl staff	Nominal with 2 levels (Y; N)	Employing experienced staff
Trn staff	Nominal with 2 levels (Y; N)	Providing training for staff
Tech	Nominal with 2 levels (Y; N)	Technology to reduce labour
Work con	Nominal with 2 levels (Y; N)	Providing good working conditions for staff
Ent div	Nominal with 2 levels (Y; N)	Other enterprises on your property
Geo div	Nominal with 2 levels (Y; N)	Geographical diversification
Inc div	Nominal with 2 levels (Y; N)	off-farm sources of income
Low debt	Nominal with 2 levels: intention for less than 30% low debt-to-asset: “low debt” No intention for less than 30% low debt-to-asset: “high debt”	Intended debt level in the coming 5-7 years
Fixed vs floating	Ordinal with 3 levels: Predominantly floating (>70%): "floating" Floating and fixed combined: “float & fix” Predominantly fixed (>70%); “fix”	Percentage of loans that is set up as fixed or floating
PI vs IO	Ordinal with 3 levels: Predominantly IO (>70%): “IO” IO and P&I (31% to 69%): “IO and P&I” Predominantly P&I (>70%): “P&I”	Percentage of loans that is set up as IO or P&I
Cash reserves	Ordinal with 4 levels No cash-reserve: “no cash” Covers short-term cash-flow deficits: “short-term cash” Covers the cash-flow deficit over the year: “a year cash” Cover the cash-flow deficit for more than one year: “>1y cash”	Cash reserve size
Overdraft size	Ordinal with 4 levels: No overdraft: “No OD” Covers short-term cash-flow deficits: “short-term OD” Covers cash-flow deficits over a year: “a year OD” Covers cash-flow deficits over more than one year: “>1y OD”	Overdraft size



Appendix Figure 1: MCA outputs: contribution of each category of risk management strategies to MCA dimensions 1-5 (A to E)

Appendix VIII Pairwise comparison of portfolios of risk management strategies

Appendix Table 5: Pairwise comparison of risk management strategies across PRMS

Risk management strategies	X^2	PRMS 1 vs. 2	PRMS 1 vs. 3	PRMS 1 vs. 4	PRMS 1 vs. 5	PRMS 1 vs. 6	PRMS 2 vs. 3	PRMS 2 vs. 4	PRMS 2 vs. 5	PRMS 2 vs. 6	PRMS 3 vs. 4	PRMS 3 vs. 5	PRMS 3 vs. 6	PRMS 4 vs. 5	PRMS 4 vs. 6	PRMS 5 vs. 6
Having feed reserves	79.2^{***a}	0.79^{b}	0.61	0.79	**0.00**	0.79	0.86	1.00	**0.00**	1.00	0.86	**0.00**	1.00	**0.00**	1.00	**0.00**
Not producing to full capacity	48.2^{***}	**0.00**	**0.00**	0.15	**0.00**	**0.02**	0.54	**0.01**	1.00	0.13	**0.00**	0.45	**0.02**	**0.01**	0.38	0.13
Grazing dairy stock off-farm	*9.5*	0.18	0.18	0.68	0.18	0.54	1.00	0.68	1.00	0.87	0.68	1.00	0.87	0.68	1.00	0.87
Having irrigation	40.3^{***}	**0.00**	0.67	0.22	0.52	0.52	**0.00**	**0.00**	**0.02**	**0.00**	0.52	0.27	1.00	**0.05**	0.58	0.23
Owning a run-off	46.7^{***}	**0.05**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	0.34	**0.05**	**0.00**	0.18	0.85	0.24	0.28	**0.02**	0.18
Infrastructure for wet soil	79.1^{***}	**0.00**	**0.05**	0.54	**0.00**	**0.02**	**0.00**	**0.00**	0.39	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	0.11	0.11
Futures markets to sell milk	27.1^{***}	0.58	**0.01**	**0.01**	**0.00**	0.16	**0.05**	0.09	**0.01**	0.50	1.00	0.67	0.43	0.50	0.44	0.16
Contracts to procure inputs	62.5^{***}	0.06	**0.00**	0.85	**0.00**	0.73	0.06	**0.03**	**0.00**	0.20	**0.00**	**0.00**	**0.00**	**0.01**	0.61	**0.00**
Spreading sales	65.7^{***}	**0.00**	**0.03**	**0.00**	**0.00**	**0.00**	**0.02**	0.77	**0.04**	0.31	**0.00**	**0.00**	0.23	0.08	0.13	**0.00**
Use of contract-milkers and/or share-milkers	46.2^{***}	**0.05**	**0.00**	0.12	**0.00**	**0.00**	0.66	0.71	0.40	**0.00**	0.37	0.71	**0.00**	0.26	**0.00**	**0.00**
Employing experienced staff	164.6^{***}	0.12	**0.00**	0.06	1.00	**0.00**	0.20	**0.00**	0.12	**0.00**	**0.00**	**0.00**	**0.00**	0.09	**0.00**	**0.00**
Providing training for staff	117.3^{***}	**0.03**	**0.02**	**0.00**	**0.00**	**0.00**	1.00	**0.00**	**0.02**	**0.00**	**0.00**	**0.01**	**0.00**	0.59	**0.00**	**0.00**
Technology to reduce labour	37.2^{***}	0.10	0.73	**0.03**	**0.04**	**0.00**	0.26	0.73	0.73	**0.00**	0.10	0.10	**0.00**	1.00	**0.01**	**0.01**
Providing good working conditions for staff	211.8^{***}	1.00	1.00	0.38	0.38	**0.00**	1.00	0.68	0.68	**0.00**	0.38	0.38	**0.00**	1.00	**0.00**	**0.00**
Other enterprises on your property	90.9^{***}	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.08	0.80	0.16	0.16	0.22	0.10	**0.01**
Geographical diversification	70.0^{***}	0.07	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.00**	**0.00**	**0.00**	0.54	0.39	0.07	1.00	0.32	0.32
Off-farm sources of income	29.2^{***}	0.13	**0.04**	0.41	**0.00**	**0.00**	0.71	0.49	**0.04**	0.10	0.27	**0.04**	0.16	**0.00**	**0.02**	0.69
Intention to have low debt	51.2^{***}	**0.00**	**0.00**	0.13	**0.05**	**0.10**	**0.07**	**0.00**	**0.01**	**0.00**	**0.00**	0.29	0.26	**0.00**	**0.00**	0.84
Interest rate risk management	19.8^{**}	0.72	0.72	0.07	0.55	0.90	0.30	**0.05**	0.72	0.90	**0.03**	0.30	0.65	**0.01**	**0.05**	0.72
Debt amortization	26.3^{***}	**0.04**	0.10	**0.04**	0.28	0.26	0.20	0.49	0.36	**0.04**	**0.04**	0.62	0.50	0.20	**0.02**	0.40
Cash reserve size	162.4^{***}	**0.00**	0.84	**0.00**	0.30	**0.10**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.56	**0.07**	**0.00**	**0.00**	**0.07**
Overdraft line of credit size	144.0^{***}	**0.00**	0.12	**0.00**	0.73	**0.06**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	0.23	**0.03**	**0.00**	**0.00**	**0.04**

a. * p < 0.1; ** p < 0.05; *** p < 0.001

b. Adjusted p-value with BH correction

Appendix IX Pairwise comparison of illustrative variables (farm and farmer characteristics)

Appendix Table 6: Pairwise comparison of categorical illustrative variables PRMS

Farm and Farmer characteristics (categorical)	***χ2***	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Farmer's age[1]	37.9	**0.043**	0.29[a]	0.29	0.29	0.57	0.20	0.29	0.29	0.45	0.45	0.29	0.49	0.29	0.94	0.20	0.24
Farmer's level of education[2]	12.7	0.244	0.44	0.81	1.00	1.00	1.00	1.00	0.26	0.26	0.44	0.44	0.49	0.83	1.00	1.00	1.00
Farmer's risk perception[3]	12.4	0.916	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Lifecycle stage of the farm business[4]	41.4	**0.005**	0.54	0.46	0.13	0.40	**0.04**	0.42	0.46	0.22	0.22	**0.05**	0.57	**0.01**	**0.05**	0.54	**0.01**
Farm number (single vs. multiple)	13.4	**0.019**	0.72	0.72	0.72	0.82	**0.03**	1.00	0.29	0.89	**0.01**	0.27	0.89	**0.01**	0.40	0.22	**0.01**
Farm location[5]	71.9	**0.000**	**0.01**	**0.00**	0.14	0.83	0.99	**0.03**	**0.00**	**0.00**	**0.01**	0.06	0.06	**0.03**	0.38	0.38	0.99
Farm business structure[6]	60.0	**0.000**	0.18	**0.00**	0.25	0.18	**0.00**	0.36	0.20	0.86	**0.00**	0.25	0.74	**0.00**	0.58	**0.00**	**0.00**
Farm input system[7]	26.9	**0.003**	**0.03**	0.20	0.84	0.45	0.44	0.44	**0.02**	0.34	**0.00**	0.09	0.84	**0.02**	0.37	0.44	0.09

1. 20-30 years; 31-40 years; 41-50 years; 51-60 years; 61-70 years; 71 years or more
2. High school; Diplomas; University Degree
3. Highly uncertain and balanced; Certain but pessimist; Slightly uncertain but optimist; Moderately uncertain and optimist; Certain and balanced
4. Entry; Growth; Consolidation; Entry of next generation; Exit
5. Northland; Waikato; Bay of Plenty; Taranaki; Lower North Island; West Coast; Marlborough-Canterbury; Otago-Southland
6. Owner operator; with HOSMs; with manager; with VOSM; manging partner in an equity partnership
7. Low input (system 1&2); Moderate input (system 3); High input (system 4&5)

a. Adjusted p-value with BH correction

Appendix Table 7: Pairwise comparison of continuous illustrative variables PRMS

Farm and Farmer characteristics (continuous)	***F ratio***	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Farm size (effective hectare)	11.95	**0.000**	**0.03**	0.49	0.26	0.93	**0.00**	**0.09**	**0.00**	**0.02**	**0.00**	**0.06**	0.44	**0.00**	0.26	0.00	**0.00**
Farm Production (tonnes of MS)[1]	21.34	**0.000**	**0.00**	**0.00**	0.61	0.37	**0.00**	0.45	**0.04**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	0.14	**0.00**	**0.00**
Farm MS per ha (hundred kg)[2]	7.46	**0.000**	**0.00**	**0.00**	0.43	0.12	0.45	0.43	**0.03**	0.13	**0.00**	**0.00**	0.01	**0.00**	0.43	0.18	**0.03**
Farm size (effective hectare)	11.95	**0.000**	**0.03**	0.49	0.26	0.93	**0.00**	**0.09**	**0.00**	**0.02**	**0.00**	**0.06**	0.44	**0.00**	0.26	**0.00**	**0.00**
Farm stocking rate (cow per ha)[3]	4.99	**0.000**	**0.00**	**0.00**	0.38	**0.09**	0.86	0.86	**0.07**	0.27	0.19	**0.00**	0.17	**0.00**	0.44	0.31	**0.07**
No of employed staff (FTE)	37.21	**0.000**	**0.00**	**0.01**	0.56	0.50	**0.00**	0.27	0.37	**0.01**	**0.00**	0.72	0.12	**0.00**	0.72	**0.00**	**0.00**
No of family involved (FTE)	0.90	0.484															

1. As a proxy for gross farm income
2. As a proxy for physical productivity
3. As a proxy for farm production intensity
a. Adjusted p-value with BH correction

Appendix Table 8: Pairwise comparison of risk profile statements scores across PRMS

Risk profile statements	***F ratio***	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Choices	*1.604*	*0.163*	0.71[a]	0.45	0.13	0.52	0.68	0.67	0.28	0.71	0.84	0.45	0.84	0.71	0.45	0.36	0.82
Future Planning	*1.328*	*0.256*	0.56	0.88	0.42	0.92	0.42	0.42	0.85	0.61	0.85	0.42	0.85	0.42	0.42	0.99	0.44
Within season	*3.385*	***0.006***	**0.02**	**0.01**	0.28	0.28	0.28	0.73	0.10	0.14	0.20	**0.06**	**0.08**	0.10	0.93	0.93	0.93
Play it safe	*2.284*	***0.049***	0.62	0.44	0.27	0.62	0.48	0.77	0.15	0.27	0.25	0.10	0.17	0.15	0.62	0.78	0.78
Long term	*2.067*	***0.073***	**0.07**	0.38	0.88	0.85	0.41	0.38	**0.07**	0.12	0.38	0.38	0.50	0.94	0.75	0.38	0.55
Overall risk profile	7.89	0.163	0.28	0.51	0.22	0.60	0.28	0.68	0.83	0.60	0.97	0.60	0.83	0.68	0.51	0.83	0.60

a. Adjusted p-value with BH correction

Appendix Table 9: Pairwise comparison of financial risk-taking statements scores across PRMS

Financial risk-taking statements	***F ratio***	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Risk-taking	*2.271*	***0.051***	0.95	0.82	**0.05**	0.78	0.78	0.82	**0.05**	0.78	0.78	**0.06**	0.82	0.82	0.11	0.17	0.95
Investment	*1.936*	***0.092***	0.59	0.83	0.59	0.40	0.14	0.57	0.98	0.64	0.40	0.57	0.30	0.13	0.64	0.40	0.57
Borrowing	*2.102*	***0.069***	0.37	0.61	0.61	0.61	0.29	0.13	0.60	0.13	0.83	0.37	0.95	0.13	0.37	0.46	0.13
Overall financial risk attitude	10.18	**0.070**	0.47	0.85	0.26	0.63	0.14	0.39	0.66	0.68	0.47	0.21	0.52	0.14	0.48	0.66	0.30

a. Adjusted p-value with BH correction

Appendix Table 10: Pairwise comparison of risk sources scores that create opportunity across the PRMS

Sources of risk	***F ratio[1]***	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Availability of capital	3.707	**0.004**	**0.025**[a]	0.721	**0.025**	**0.030**	0.786	**0.059**	0.974	0.829	**0.084**	**0.060**	**0.084**	0.974	0.829	**0.086**	0.127
Milk prices	1.898	**0.099**	0.210	0.890	0.760	0.760	0.890	0.140	0.510	0.110	0.310	0.670	0.770	0.880	0.470	0.760	0.760
Availability of labour	2.296	**0.049**	0.942	0.918	0.918	0.918	**0.044**	0.918	0.918	0.942	**0.046**	0.942	0.918	**0.054**	0.918	**0.078**	**0.035**
Staff turnover	3.032	**0.013**	0.936	0.348	0.523	0.523	**0.044**	0.348	0.523	0.523	0.110	0.940	0.936	**0.008**	0.952	**0.035**	**0.035**
Business relationships	3.465	**0.006**	0.588	0.667	**0.053**	0.680	0.152	0.260	0.166	0.742	0.381	**0.007**	0.386	**0.036**	0.110	0.639	0.260
Global supply	2.332	**0.046**	*0.100*	0.400	*0.100*	0.220	*0.110*	0.370	1.000	0.730	1.000	0.310	0.680	0.380	0.730	1.000	0.730

1. Only significant p value (<0.1) is reported.
a. Adjusted p-value with BH correction

Appendix Table 11: Pairwise comparison of risk sources scores that create threat across the PRMS

Sources of risk	***F ratio[1]***	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Government laws	2.382	**0.042**	0.760[a]	0.370	**0.064**	0.826	0.173	0.584	0.146	0.668	0.288	0.288	0.338	0.584	**0.064**	0.668	0.173
Local body regulations	2.137	**0.065**	0.740	0.450	**0.100**	0.740	0.280	0.630	0.210	0.630	0.370	0.370	0.370	0.630	**0.100**	0.650	0.220

1. Only significant p value (<0.1) is reported.
a. Adjusted p-value with BH correction

Appendix Table 12: Pairwise comparison of risk index scores across the PRMS (adjusted p values with BH correction)

Sources of risk	*F ratio[1]*	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Interest rate	1.891	**0.097**	0.22[a]	0.76	0.23	0.55	0.24	0.23	0.65	0.46	0.72	0.30	0.65	0.32	0.65	0.95	0.65
Milk prices	2.446	**0.038**	0.46	0.35	0.46	0.46	0.46	0.14	0.85	0.24	0.24	0.14	0.85	0.85	0.24	0.24	0.85
Business relationships	3.060	**0.012**	0.97	0.86	0.19	0.86	0.81	0.86	0.35	0.86	0.81	**0.09**	0.97	0.68	0.26	0.68	0.68
Reputation and image	2.733	**0.022**	0.11	0.90	**0.02**	0.69	**0.02**	0.48	0.85	0.60	0.74	0.48	0.81	0.48	0.48	0.80	0.48

1. Only significant p value (<0.1) is reported.
a. Adjusted p-value with BH correction

Appendix Table 13: Pairwise comparison of survey responses scores to the question "How important do you believe the factors below are when deciding on the debt level" across PRMS

	F ratio[1]	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Tax deductibility of interest	*3.225*	***0.009***	0.16[a]	0.55	0.61	0.94	0.26	**0.04**	**0.04**	0.11	0.64	0.94	0.55	**0.04**	0.61	**0.06**	0.18

Only significant p value (<0.1) is reported.
a. Adjusted p-value with BH correction

Appendix Table 14: Pairwise comparison of survey responses scores to the question "How important do you believe the factors below are when deciding the ratio of fixed-rate to floating-rate mortgages" across PRMS

	F ratio[1]	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Forecasted interest rate (yield curve)	*1.905*	***0.097***	0.47[a]	0.71	0.71	0.71	0.61	0.23	0.71	0.23	0.15	0.47	0.93	0.90	0.47	0.40	0.92
Additional repayment flexibility on floating-rate loans	*2.270*	***0.051***	**0.04**	0.34	0.46	0.17	0.42	0.24	0.21	0.46	0.24	0.79	0.46	0.91	0.42	0.85	0.46

Only significant p value (<0.1) is reported.
a. Adjusted p-value with BH correction

Appendix Table 15: Pairwise comparison of survey responses scores to the question "How important do you believe the factors below are when deciding the ratio of table-mortgages to interest-only mortgages" across PRMS

	F ratio[1]	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
The difference between the overall amount paid on table-mortgages and the overall amount paid on interest-only mortgages	*3.934*	***0.003***	**0.00**[a]	**0.06**	**0.01**	0.14	0.15	0.14	0.70	**0.06**	**0.08**	0.31	0.57	0.62	0.14	0.15	0.96
Higher tax deductibility potential for interest-only mortgages	*3.564*	***0.005***	**0.06**	0.63	0.63	0.17	0.28	**0.02**	**0.04**	0.35	0.28	0.90	**0.04**	**0.07**	**0.07**	0.12	0.83
Flexibility in the repayments for interest-only mortgages	*2.103*	***0.070***	0.50	0.88	0.42	0.42	0.50	0.42	0.16	0.73	0.92	0.42	0.21	0.42	**0.09**	0.16	0.67

Only significant p value (<0.1) is reported.
a. Adjusted p-value with BH correction

Appendix Table 16: Pairwise comparison of survey responses on using overdraft line of credit facility

	χ2	***p-value***	**PRMS 1 vs 2**	**PRMS 1 vs 3**	**PRMS 1 vs 4**	**PRMS 1 vs 5**	**PRMS 1 vs 6**	**PRMS 2 vs 3**	**PRMS 2 vs 4**	**PRMS 2 vs 5**	**PRMS 2 vs 6**	**PRMS 3 vs 4**	**PRMS 3 vs 5**	**PRMS 3 vs 6**	**PRMS 4 vs 5**	**PRMS 4 vs 6**	**PRMS 5 vs 6**
Frequency of using overdraft	123.66	0.000	**0.01**[a]	0.58	**0.00**	0.17	0.56	**0.00**	**0.00**	**0.00**	0.30	**0.00**	0.29	0.17	**0.00**	**0.00**	0.27
Frequency of reaching overdraft limit																	

a. Adjusted p-value with BH correction

Appendix X Cross tabulation of illustrative variables with PRMS (%)

Appendix Table 1: Cross tabulation of age groups with PRMS clusters (%)

PRMS	20-30 years (n=6)[1]	31-40 years (n=38)	41-50 years (n=62)	51-60 years (n=114)	61-70 years (n=76)	71 years or more (n=25)	Row Total
PRMS 1 (n=59)	0.0 (0)	20.3 (31.6)	11.9 (11.3)	32.2 (16.7)	28.8 (22.4)	6.8 (16.0)	**18.4**
PRMS 2 (n=49)	4.1 (33.3)	8.2 (10.5)	24.5 (19.4)	30.6 (13.2)	30.6 (19.7)	2.0 (4.0)	**15.3**
PRMS 3 (n=64)	3.1 (33.3)	12.5 (21.1)	15.6 (16.1)	**46.9** **(26.3)**	15.6 (13.2)	6.3 (16.0)	**19.9**
PRMS 4 (n=53)	1.9 (16.7)	5.6 (7.9)	18.9 (16.1)	32.1 (14.9)	24.5 (17.1)	**17.0** **(36.0)**	**16.5**
PRMS 5 (n=54)	1.8 (16.7)	11.1 (15.8)	16.7 (14.5)	31.5 (14.9)	25.9 (18.4)	**13.0** **(28.0)**	**16.8**
PRMS 6 (n= 42)	**0.0** **(0.0)**	11.9 (13.2)	**33.3** **(22.6)**	**38.1** **(14.0)**	16.7 (9.2)	**0.0** **(0)**	**13.1**
Column Total %	**(1.9)**	**(11.8)**	**(19.3)**	**(35.5)**	**(23.7)**	**(7.8)**	**N=321**

1. Column total (%) in bracket

Appendix Table 2: Cross tabulation of education with PRMS clusters (%)

PRMS	High school (n=116)[1]	Diplomas (n=92)	University Degree (n=77)	Row Total
PRMS 1 (n=51)	45.1 (19.8)	31.4 (17.4)	23.5 (15.6)	**17.9**
PRMS 2 (n=44)	**27.3** **(10.3)**	29.6 (14.1)	**43.2** **(24.7)**	**15.4**
PRMS 3 (n=62)	**33.9** **(18.1)**	32.3 (21.7)	**33.9** **(27.3)**	**21.8**
PRMS 4 (n=45)	48.9 (19.0)	33.3 (16.3)	17.8 (10.4)	**15.8**
PRMS 5 (n=51)	47.1 (20.7)	33.3 (18.5)	19.6 (13.0)	**17.9**
PRMS 6 (n=32)	43.8 (12.1)	34.4 (12.0)	21.9 (9.1)	**11.2**
Column Total %	**(40.7)**	**(32.3)**	**(27.0)**	**N=285**

1. Column total (%) in bracket

Appendix Table 3: Cross tabulation of lifecycle stage of the farm business with PRMS clusters (%)

PRMS	Entry (n=12)	Growth (n=69)	Consolidation (n=147)	Entry of next generation (n=71)	Exit (n=21)	Row Total
PRMS 1 (n=59)	5.08 (25)	28.81 (24.64)	40.68 (16.33)	23.73 (19.72)	1.69 (4.76)	**18.4**
PRMS 2 (n=49)	2.04 (8.33)	22.45 (15.94)	55.1 (18.37)	16.33 (11.27)	4.08 (9.52)	**15.3**
PRMS 3 (n=64)	0 (0)	21.88 (20.29)	43.75 (19.05)	31.25 (28.17)	3.12 (9.52)	**20**
PRMS 4 (n= 53)	**7.55** **(33.33)**	**11.32** **(8.7)**	54.72 (19.73)	16.98 (12.68)	9.43 (23.81)	**16.6**
PRMS 5 (n=53)	0 (0)	26.42 (20.29)	**33.96** **(12.24)**	32.08 (23.94)	7.55 (19.05)	**16.6**
PRMS 6 (n=42)	**9.52** **(33.33)**	**16.67** **(10.14)**	50 (14.29)	7.14 (4.23)	**16.67** **(33.33)**	**13.1**
Column Total %	**(37)**	**(21.6)**	**(45.9)**	**(22.2)**	**(6.6)**	**N=320**

1. Column total (%) in bracket

Appendix Table 4: Cross tabulation of number of farm's owned by farmer with PRMS clusters (%)

PRMS	Single Farm (n=258)	Multiple Farms (n=63)	Row Total
PRMS 1 (n=59)	79.7 (19)	20.3 (18.2)	**18.4**
PRMS 2 (n=49)	73.5 (20.6)	26.5 (14)	**15.3**
PRMS 3 (n=64)	73.4 (27)	26.6 (18.2)	**19.9**
PRMS 4 (n= 53)	**86.8** **(11.1)**	**13.2** **(17.8)**	**16.5**
PRMS 5 (n=54)	75.9 (20.6)	24.1 (15.9)	**16.8**
PRMS 6 (n=42)	**97.6** **(1.6)**	**2.4** **(15.9)**	**13.1**
Column Total %	**(80.4)**	**(19.6)**	**N=321**

1. Column total (%) in bracket

Appendix Table 5: Cross-tabulation of regions with PRMS clusters (%)

PRMS	Northland (n=11)[1]	Waikato (n=102)	BoP (n=13)	Taranaki (n=34)	Lower NI (30)	West Coast (48)	Marlborough -Canterbury (n=37)	Otago-Southland (n=38)	Row Total
PRMS 1 (n=58)	5.2 (27.3)	**25.9** **(14.7)**	1.7 (7.7)	12.1 (20.6)	**17.2** **(33.3)**	22.4 (27.1)	8.6 (13.5)	7 (10.5)	**18.5**
PRMS 2 (n=47)	8.5 (36.4)	12.8 (5.9)	4.3 (15.4)	8.5 (11.8)	8.5 (13.3)	6.4 (6.3)	**32.0** **(40.5)**	**19.2** **(23.7)**	**15**
PRMS 3 (n=63)	1.6 (9.1)	42.9 (26.4)	6.4 (30.8)	7.9 (14.7)	3.2 (6.7)	4.8 (6.3)	**14.3** **(24.3)**	**19.0** **(31.6)**	**20.1**
PRMS 4 (n= 50)	2.0 (9.1)	40.0 (19.6)	6.0 (23.1)	10.0 (14.7)	8.0 (13.3)	18.0 (18.7)	0 (0)	16.0 (21.1)	**16**
PRMS 5 (n=54)	1.9 (9.1)	**37.0** **(19.6)**	3.7 (15.4)	13 (20.6)	**7.4** **(13.3)**	22.2 (25)	9.3 (13.5)	5.6 (7.9)	**17.3**
PRMS 6 (n=41)	2.4 (9.1)	34.2 (13.7)	2.4 (7.7)	14.6 (17.6)	14.6 (20)	19.5 (16.7)	7.3 (8.1)	4.9 (5.3)	**13.1**
Column Total %	**(3.5)**	**(32.6)**	**(4.2)**	**(11)**	**(9.6)**	**(15.3)**	**(11.8)**	**(12.1)**	**N=313**

1. Column total (%) in bracket

Appendix Table 6: Cross tabulation of business structure with PRMS clusters (%)

PRMS	Owner operator (n= 124)[1]	Owner with HOSMs (n= 37)	Owner with manager (n=58)	Owner with VOSM (n= 55)	managing partner in an equity partnership (n= 22)	Row Total %
PRMS 1 (n=55)	49.1 (21.8)	14.6 (21.6)	25.5 (24.1)	7.3 (7.3)	3.6 (9.1)	**18.6**
PRMS 2 (n=46)	37 (13.7)	6.5 (8.1)	23.9 (19.0)	19.6 (16.4)	13.0 (27.3)	**15.5**
PRMS 3 (n=59)	22.0 (10.5)	15.3 (24.3)	20.3 (20.7)	30.5 (32.7)	11.9 (31.8)	**19.9**
PRMS 4 (n=50)	36.0 (14.5)	20.0 (27.0)	20.0 (17.2)	22.0 (20)	2.0 (4.6)	**16.9**
PRMS 5 (n=47)	34.0 (12.9)	**10.6** **(13.5)**	21.3 (17.2)	25.5 (21.8)	**8.5** **(18.2)**	**15.9**
PRMS 6 (n=39)	**84.6** **(26.6)**	**5.1** **(5.4)**	**2.6** **(1.7)**	**2.6** **(1.8)**	**5.1** **(9.1)**	**13.2**
Column Total %	**(41.9)**	**(12.5)**	**(19.6)**	**(18.6)**	**(7.4)**	**N=296**

Appendix Table 7: Cross tabulation of farm input system with PRMS clusters (%)

PRMS	Low input (n=109)[1]	Medium input (n=83)	High input (n=67)	Row Total
PRMS 1 (n=45)	**51.1** **(21.1)**	26.7 (14.5)	22.2 (14.9)	**17.4**
PRMS 2 (n=37)	18.9 (6.4)	51.4 (22.9)	**29.7** **(16.4)**	**14.3**
PRMS 3 (n=57)	29.8 (15.6)	36.8 (25.3)	**33.3** **(28.4)**	**22.0**
PRMS 4 (n= 42)	**54.8** **(21.1)**	28.6 (14.5)	**16.7** **(10.4)**	**16.2**
PRMS 5 (n=41)	36.6 (13.8)	34.2 (16.9)	29.3 (17.9)	**15.8**
PRMS 6 (n=37)	**64.9** **(22.0)**	13.5 (6.0)	21.6 (11.9)	**14.3**
Column Total %	**(42.1)**	**(32.0)**	**(25.9)**	**N=259**

1. Column total (%) in bracket

Appendix Table 8: Cross tabulation of risk perception clusters with PRMS clusters (%)

PRMS	1. Highly uncertain and balanced (n=26)[1]	2. Certain but pessimist (n=15)	3. Slightly uncertain but optimist (n=114)	4. Moderately uncertain and optimist (n=68)	5. Certain and balanced (n=86)	Row Total
PRMS 1 (n=58)	8.6 (19.2)	3.6 (13.3)	37.9 (19.3)	24.1 (20.6)	25.9 (17.4)	**18.8**
PRMS 2 (n=48)	2.1 (3.8)	2.1 (6.7)	41.7 (17.5)	25.0 (17.6)	29.2 (16.3)	**15.5**
PRMS 3 (n=61)	11.5 (26.9)	4.9 (20)	39.3 (21.1)	21.3 (19.1)	23.0 (16.3)	**19.7**
PRMS 4 (n= 52)	9.6 (19.2)	3.9 (13.3)	30.8 (14)	28.9 (22.1)	26.9 (16.3)	**16.8**
PRMS 5 (n=50)	10.0 (19.2)	6.0 (20)	38.0 (16.7)	**14.0** **(10.3)**	32.0 (18.6)	**16.2**
PRMS 6 (n=40)	7.5 (11.5)	10.0 (26.7)	32.5 (11.4)	**17.5** **(10.3)**	32.5 (15.1)	**12.9**
Column Total %	**(8.4)**	**(4.9)**	**(36.9)**	**(22.0)**	**(27.8)**	**N=309**

1. Column total (%) in bracket

Appendix Table 9: Cross tabulation of frequency of using overdraft across PRMS clusters (%)

PRMS	Not applicable (n=26)	Never (n=12)	Rarely (n= 64)	Sometimes (n=70)	Almost always (n=89)	Always (n= 56)	Row Total
PRMS 1 (n=58)	1.7 (3.85)	0 (0)	19 (17.19)	29.3 (24.29)	31 (20.22)	19 (19.64)	18.3
PRMS 2 (n=48)	2.1 (3.85)	4.2 (16.67)	6.2 (4.69)	8.3 (5.71)	52.1 (28.09)	27.1 (23.21)	15.1
PRMS 3 (n=64)	0 (0)	1.6 (8.33)	28.1 (28.12)	31.2 (28.57)	25 (17.98)	14.1 (16.07)	20.2
PRMS 4 (n= 52)	38.5 (76.92)	7.7 (33.33)	19.2 (15.62)	15.4 (11.43)	15.4 (8.99)	3.8 (3.57)	16.4
PRMS 5 (n=54)	5.6 (11.54)	7.4 (33.33)	27.8 (23.44)	25.9 (20)	16.7 (10.11)	16.7 (16.07)	17.0
PRMS 6 (n=41)	2.4 (3.85)	2.4 (8.33)	17.1 (10.94)	17.1 (10)	31.7 (14.61)	29.3 (21.43)	12.9
Column Total %	**(8.2)**	**(3.8)**	**(20.2)**	**(22.1)**	**(28.1)**	**(17.7)**	**N=317**

1. Column total (%) in bracket

Appendix Table 10: Average (Standard deviation) of risk profile statements scores across the PRMS clusters (%)

PRMS	Choices[12]	Future planning	Within season	Play it safe	Long term
PRMS 1	3.98 (0.80)	3.63 (1.08)	4.05 (2.71)	2.71 (0.89)	3.93 (0.67)
PRMS 2	3.90 (0.74)	3.41 (1.10)	3.59 (2.84)	2.84 (0.83)	3.55 (0.79)
PRMS 3	3.77 (0.77)	3.68 (0.95)	3.50 (2.91)	2.91 (0.90)	3.75 (0.85)
PRMS 4	3.56 (0.87)	3.31 (1.01)	3.88 (2.46)	2.46 (0.83)	3.96 (0.71)
PRMS 5	3.80 (0.88)	3.59 (0.96)	3.87 (2.57)	2.57 (0.88)	3.89 (0.69)
PRMS 6	3.86 (0.72)	3.31 (1.16)	3.86 (2.52)	2.52 (0.86)	3.76 (0.76)
Total sample	**3.80 (0.80)**	**3.50 (1.16)**	**3.78 (2.68)**	**2.68 (0.88)**	**3.81 (0.75)**

1. Standard deviation in bracket
2. All scores is out of 5

Appendix Table 11: Average (Standard deviation) of attitude statements scores across the PRMS clusters (%)

PRMS	Risk-taking[12]	Investment	Borrowing
PRMS 1	3.20 (1.11)	3.39 (0.95)	3.93 (0.94)
PRMS 2	3.18 (1.05)	3.22 (1.19)	3.67 (0.90)
PRMS 3	3.11 (1.04)	3.44 (0.92)	4.05 (0.88)
PRMS 4	2.62 (1.01)	3.23 (1.11)	3.82 (0.87)
PRMS 5	3.04 (0.95)	3.09 (1.03)	4.04 (0.82)
PRMS 6	3.02 (1.02)	2.88 (1.11)	3.62 (0.91)
Total sample	**3.03 (1.04)**	**3.23 (1.05)**	**3.86 (0.90)**

1. Standard deviation in bracket
2. Likert scale (Out of 5)

Appendix Table 12: Comparison of perceived opportunity scores across the PRMS clusters (%)

Risk sources	PRMS 1[1]	PRMS 2	PRMS 3	PRMS 4	PRMS 5	PRMS 6	Total Sample
Climate variation	10.12 (5.64)	9.07 (5.34)	8.77 (4.03)	9.04 (5.00)	8.61 (5.80)	9.28 (4.51)	9.17 (5.06)
Pasture/crop/ animal health	13.59 (5.25)	14.79 (5.33)	14.15 (5.24)	12.41 (5.05)	12.84 (5.54)	12.70 (5.97)	13.39 (5.40)
Interest	11.02 (5.17)	9.67 (4.81)	10.85 (5.90)	10.00 (5.09)	10.20 (5.72)	9.90 (4.68)	10.30 (5.25)
Land values	12.07 (5.55)	11.69 (5.10)	11.68 (5.10)	12.90 (5.79)	11.36 (5.95)	12.65 (5.80)	12.00 (5.53)
Availability of capital	12.96 (5.49)	9.76 (4.92)	12.25 (5.44)	9.82 (5.31)	10.18 (4.69)	12.29 (5.91)	11.21 (5.42)
Milk prices	15.65 (5.84)	13.50 (4.86)	15.82 (5.18)	14.81 (5.34)	16.32 (5.34)	15.49 (5.68)	15.22 (5.42)
Input prices	11.73 (5.19)	10.38 (4.74)	11.30 (6.35)	10.49 (5.42)	10.94 (5.10)	9.88 (5.28)	10.83 (5.37)
Availability of labour	11.29 (5.28)	11.40 (6.03)	10.82 (5.02)	10.90 (6.26)	11.65 (4.94)	8.03 (5.61)	10.79 (5.56)
Staff turnover	7.74 (3.86)	7.52 (4.45)	8.84 (4.62)	8.67 (6.15)	8.59 (5.81)	5.38 (4.25)	7.96 (4.97)
Skills of associates	12.91 (5.20)	12.91 (4.97)	13.28 (5.45)	11.86 (5.76)	12.24 (5.09)	11.61 (4.62)	12.54 (5.20)
Technology	14.31 (5.88)	13.89 (4.83)	14.40 (5.33)	12.27 (5.39)	13.74 (5.81)	12.15 (6.16)	13.53 (5.59)
Business relationships	12.40 (5.62)	11.60 (4.80)	12.92 (4.18)	9.80 (4.69)	11.92 (4.86)	10.42 (4.13)	11.57 (4.87)
Dairy industry	11.07 (5.81)	8.53 (4.25)	10.29 (5.19)	9.90 (5.15)	9.28 (4.39)	9.13 (4.72)	9.74 (5.02)
Global econ & political	12.40 (5.31)	10.85 (5.02)	10.98 (5.17)	12.64 (5.28)	11.08 (5.42)	10.08 (5.31)	11.36 (5.29)
Global supply	16.82 (5.06)	14.15 (5.56)	15.67 (4.96)	14.08 (5.16)	14.82 (5.71)	14.15 (5.82)	14.99 (5.45)
Reputation	13.64 (5.60)	10.98 (5.31)	11.34 (5.99)	11.88 (5.77)	11.56 (5.27)	11.78 (5.98)	11.85 (5.70)
Government laws	9.98 (5.72)	10.64 (6.28)	9.56 (5.78)	9.47 (6.79)	8.72 (6.34)	9.49 (6.16)	9.60 (6.13)
Local body regulations	9.33 (5.74)	9.15 (6.00)	9.39 (6.66)	9.00 (7.09)	8.64 (6.70)	8.85 (5.78)	9.08 (6.32)

1. Standard deviation in bracket

Appendix Table 13: Comparison of perceived threat scores across the PRMS clusters (%)

Risk sources	PRMS 1	PRMS 2	PRMS 3	PRMS 4	PRMS 5	PRMS 6	Total Sample
Climate variation	10.27 (4.88)	10.79 (4.56)	11.11 (5.25)	10.12 (4.88)	10.30 (5.20)	11.64 (5.09)	10.65 (4.97)
Pasture/crop/ animal health	9.17 (4.25)	8.27 (4.37)	9.25 (5.81)	8.19 (4.04)	7.86 (4.68)	9.42 (5.67)	8.67 (4.85)
Interest	11.85 (5.56)	13.07 (4.77)	12.45 (6.38)	11.96 (5.36)	11.57 (5.22)	12.74 (5.75)	12.25 (5.52)
Land values	8.81 (4.70)	8.51 (3.94)	8.73 (5.22)	8.15 (5.30)	7.42 (4.38)	8.50 (7.20)	8.36 (5.09)
Availability of capital	8.58 (4.75)	9.53 (4.74)	8.12 (4.19)	7.06 (3.60)	7.90 (2.75)	8.42 (4.90)	8.25 (4.22)
Milk prices	13.84 (5.79)	13.87 (4.90)	12.67 (6.49)	13.68 (5.10)	13.94 (6.75)	12.68 (6.30)	13.42 (5.92)
Input prices	12.94 (5.57)	12.40 (4.61)	13.25 (5.80)	14.08 (5.52)	11.85 (4.94)	12.76 (5.75)	12.88 (5.37)
Availability of labour	10.83 (5.56)	11.53 (6.01)	12.15 (5.63)	11.36 (5.42)	11.52 (4.72)	8.97 (6.49)	11.20 (5.64)
Staff turnover	8.63 (4.52)	10.00 (5.69)	10.17 (5.20)	9.65 (6.03)	9.04 (4.30)	6.97 (5.40)	9.24 (5.21)
Skills of associates	8.20 (4.88)	8.20 (4.56)	8.68 (4.47)	8.74 (5.33)	8.32 (4.67)	7.46 (3.61)	8.34 (4.67)
Technology	7.53 (4.14)	6.94 (4.02)	6.90 (4.14)	7.92 (5.06)	7.00 (4.52)	7.21 (4.53)	7.24 (4.37)
Business relationships	7.26 (4.19)	7.26 (3.94)	7.02 (4.19)	7.15 (4.25)	6.29 (3.34)	7.47 (4.31)	7.04 (4.02)
Dairy industry	9.26 (4.48)	8.81 (4.25)	8.22 (3.62)	9.93 (5.67)	8.24 (5.74)	8.47 (4.93)	8.76 (4.79)
Global econ & political	12.47 (5.05)	12.00 (3.82)	12.50 (5.90)	13.69 (5.17)	12.96 (6.11)	12.58 (5.77)	12.62 (5.38)
Global supply	10.98 (6.29)	11.32 (5.46)	10.68 (6.55)	12.68 (6.25)	10.33 (6.00)	11.34 (6.26)	11.16 (6.19)
Reputation	11.36 (4.82)	12.77 (5.17)	12.61 (6.02)	13.13 (4.67)	11.88 (5.31)	13.21 (5.59)	12.40 (5.33)
Government laws	12.58 (5.11)	12.98 (5.38)	13.83 (5.70)	15.51 (5.82)	12.35 (5.74)	14.79 (5.57)	13.56 (5.67)
Local body regulations	13.43 (5.35)	13.87 (5.67)	14.65 (6.29)	16.45 (6.59)	13.06 (5.75)	15.62 (6.40)	14.38 (6.12)

1. Standard deviation in bracket

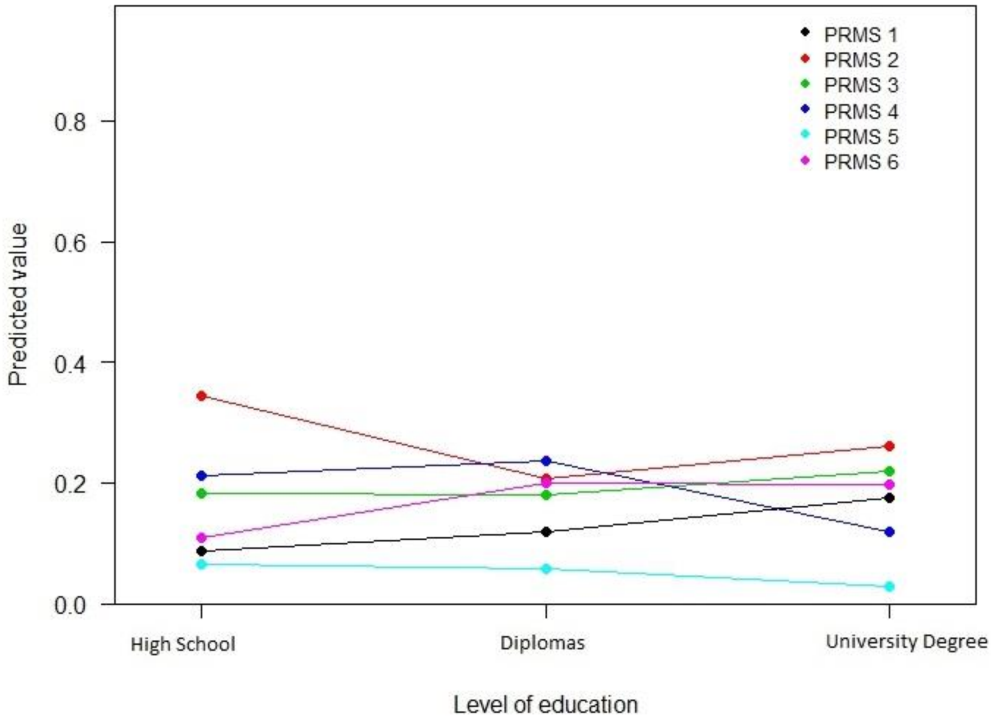
Appendix Table 14: Full comparison of MLM odds ratios (varying base PRMS)

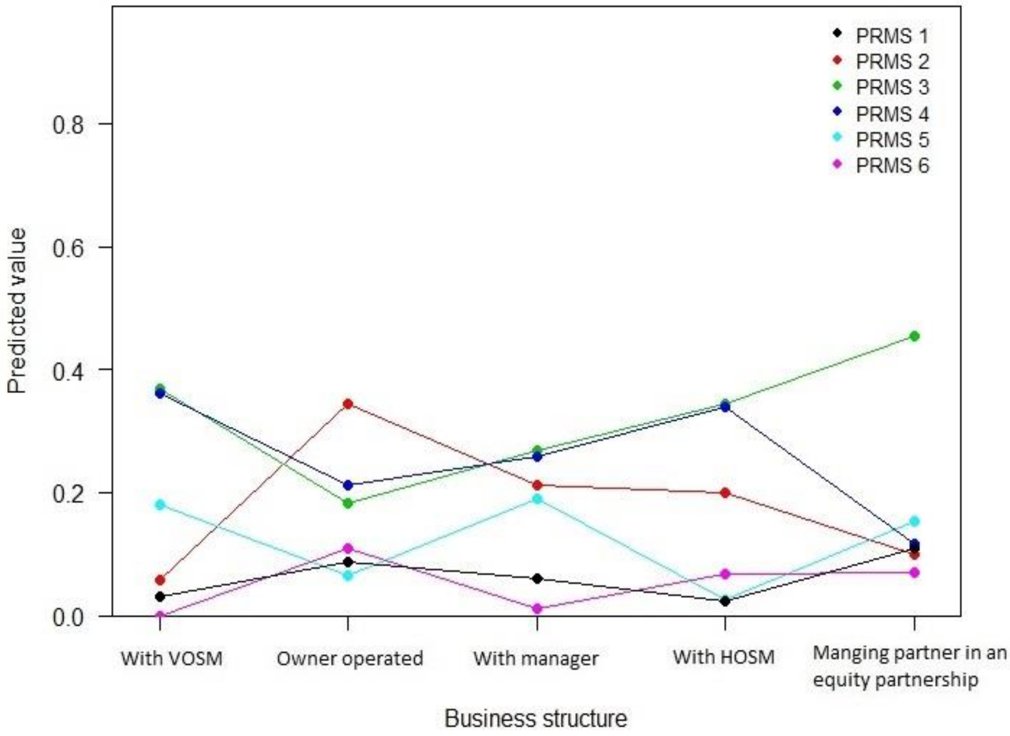
	PRMS 2			PRMS 3			PRMS 4			PRMS 5			PRMS 6		
PRMS 1[1]	**Physical Performance:**			**Business Structure:**			**Risk Profile:**			**Business Structure:**			**Physical Performance:**		
	log (MS tonnes)		4.091***	Owner with VOSM	Owner operator	11.728***	Risk profile score		0.686***	Owner with manager	Owner operator	4.736**	log (MS tonnes)		0.155***
	Input system:			Managing partner in an equity partnership	Owner operator	8.491*				Owner with VOSM	Owner operator	16.297***	**Risk Profile:**		
	Medium input	Low input[2]	5.095**	**Risk Profile:**						**Risk Profile:**			Risk profile score		0.731**
	Risk Profile:			Risk profile scores		0.771**				Risk profile score		0.734***			
	Risk profile score		0.669***												
PRMS 2				**Business Structure:**			**Education:**			**Education:**			**Physical Performance:**		
				Owner with HOSM	Owner operator	6.918**	University Degree	High school	0.278*	University Degree	High school	0.211**	log (MS tonnes)		0.038***
				Owner with VOSM	Owner operator	5.562**	**Business Structure:**			**Business Structure:**			**Input system:**		
				Physical Performance:			Owner with HOSM	Owner operator	5.921*	Owner with manager	Owner operator	4.207*	Medium input	Low input	0.173*
				log (MS tonnes)		0.362**	Owner with VOSM	Owner operator	4.729*	Owner with VOSM	Owner operator	7.729**			
				Input system:			**Physical Performance:**			**Physical Performance:**					
				Medium input	Low input	0.216**	log (MS tonnes)		0.131***	log (MS tonnes)		0.364*			
				Risk perception clusters:			**Input system:**								
				Highly uncertain and balanced	Slightly uncertain but optimist	9.685*	Medium input	Low input	0.129***						
							Risk perception clusters:								

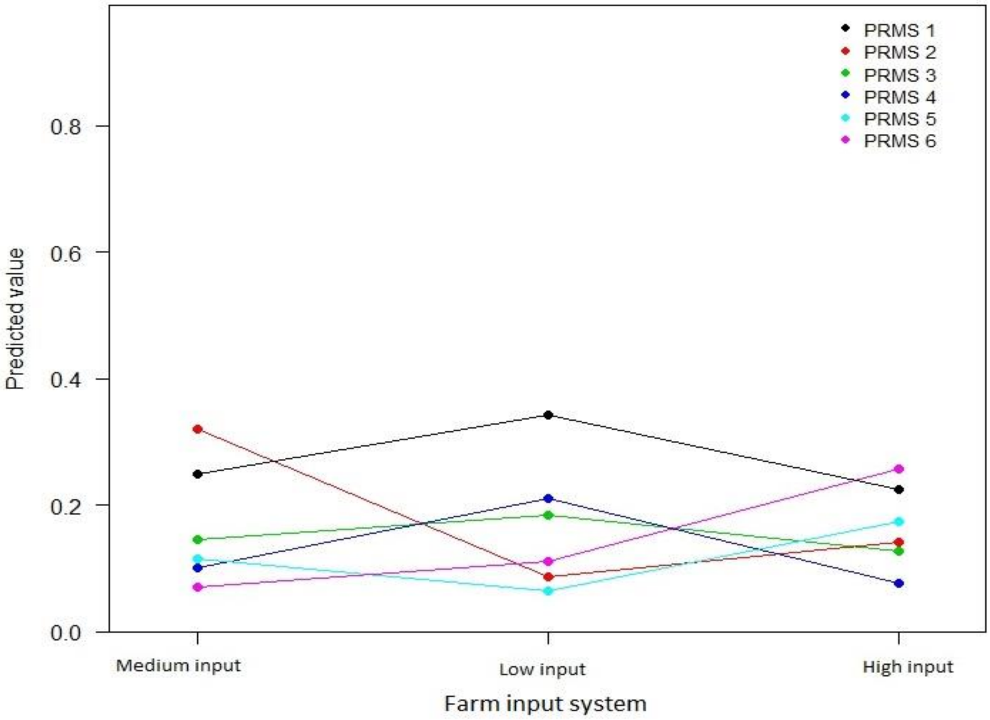
	PRMS 2	PRMS 3	PRMS 4	PRMS 5	PRMS 6
		-	Moderately uncertain but optimist / Slightly uncertain but optimist: 4.201*		
PRMS 3			**Physical Performance:** log (MS tonnes): 0.362**	**Input system:** High input / Low input: 3.885* **Physical Performance:** Milksolids per hectare (,00 kg): 0.805**	**Business Structure:** Owner with manager / Owner operator: 0.071** **Physical Performance:** log (MS tonnes): 0.104***
PRMS 4				**Physical Performance:** log (MS tonnes): 2.781* Milksolids per hectare (,00 kg): 0.813** **Input system:** Medium input / Low input: 3.766** High input / Low input: 7.334**	**Business Structure:** Owner with manager / Owner operator: 0.085** **Physical Performance:** log (MS tonnes): 0.288** **Input system:** High input / Low input: 6.406*
PRMS 5			-		**Business Structure:** Owner with manager / Owner operator: 0.036*** **Physical Performance:** log (MS tonnes) / -: 0.104***

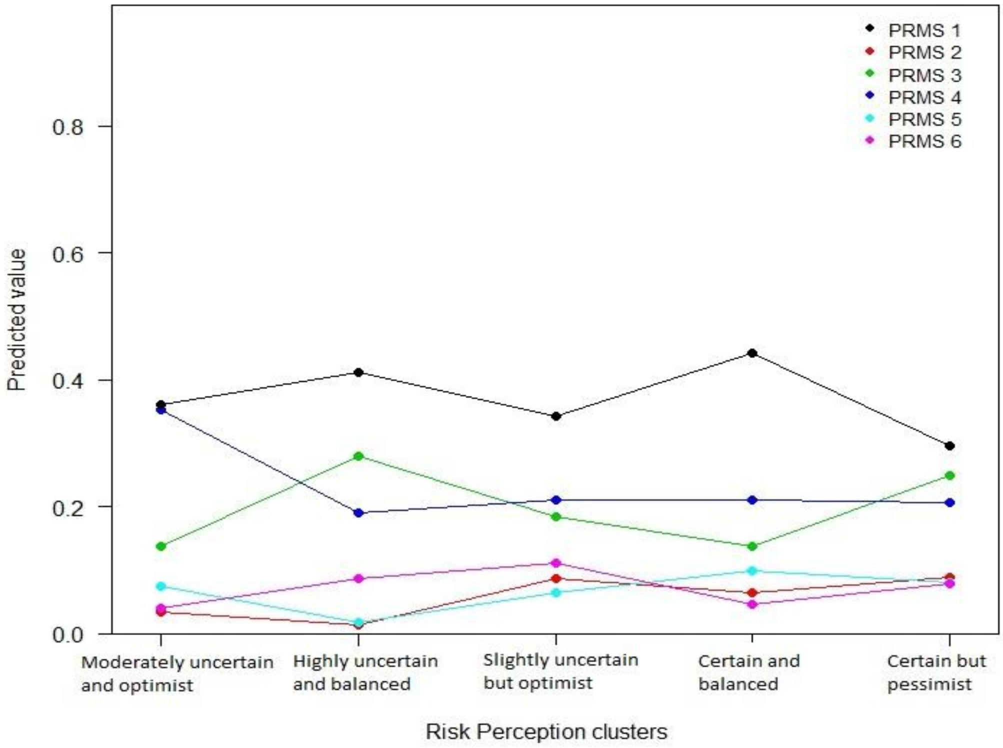
1. The base category is indicated in the first column of each row;
2. The reference category for the categorical variable in that set is Underlined.

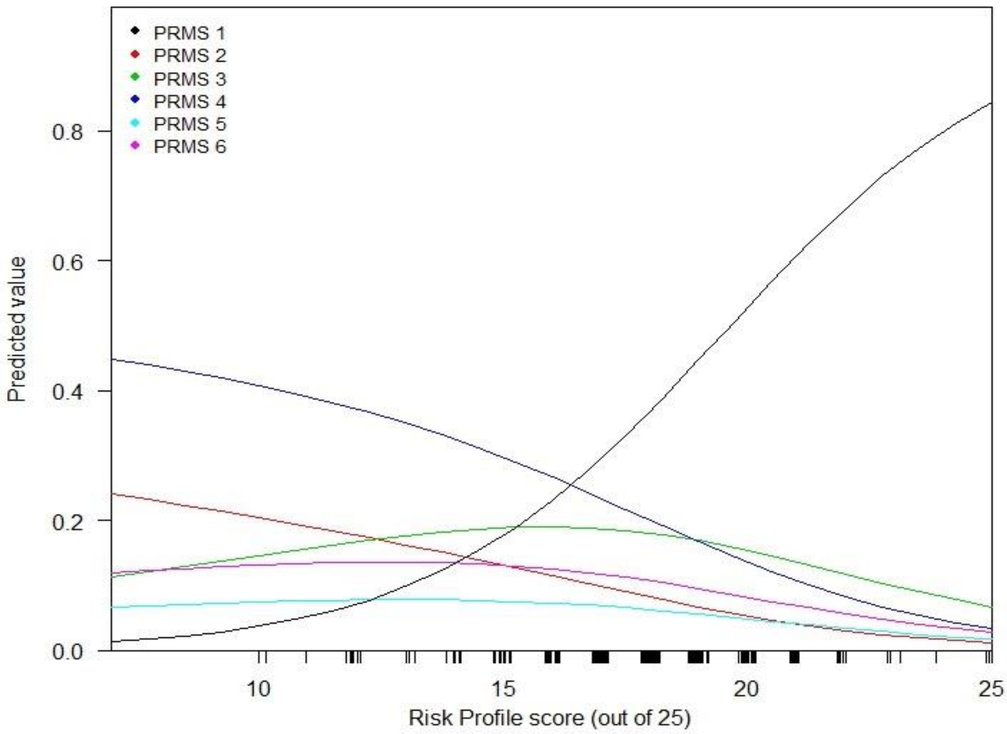
Appendix XI Probability plots of multinomial logit model predictors

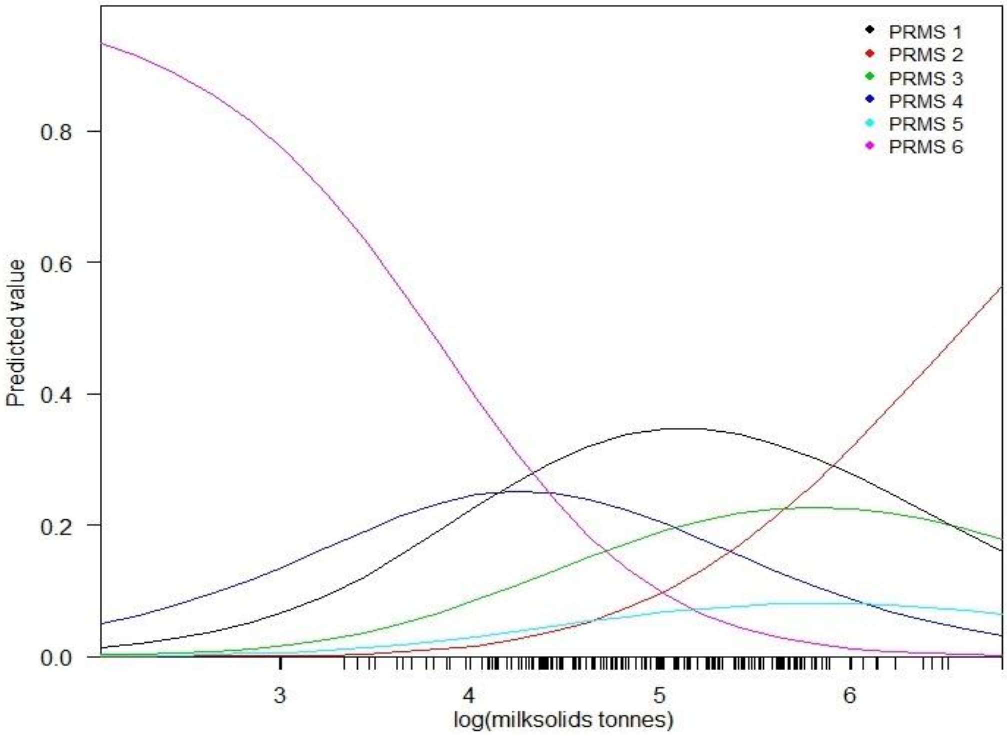


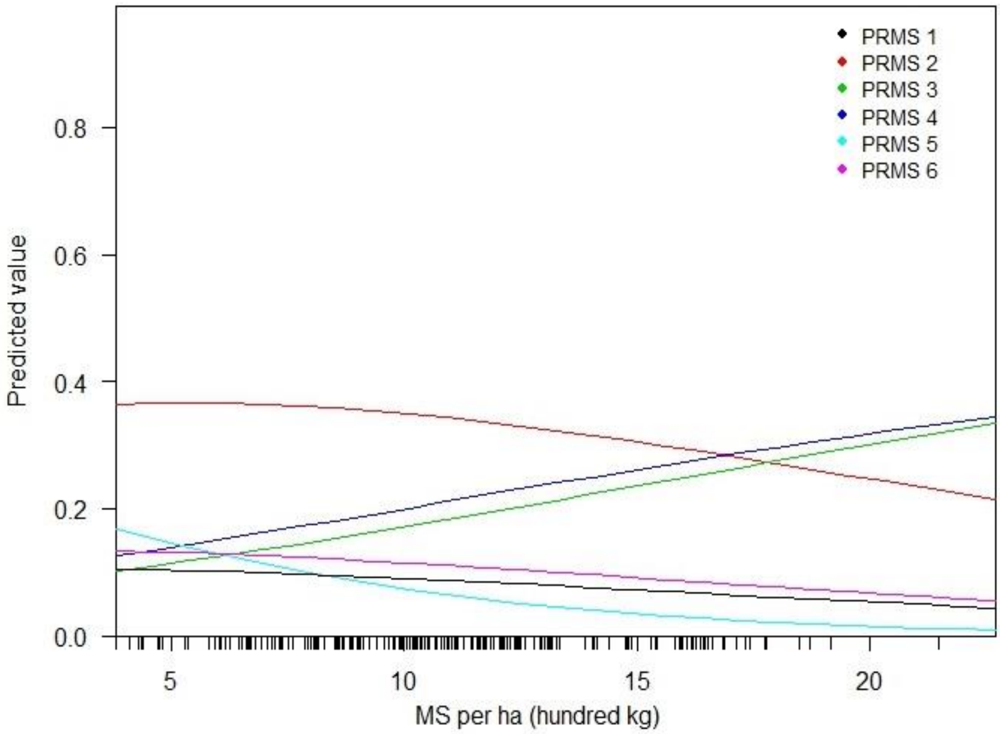



PRMS 1
PRMS 2
PRMS 3
PRMS 4
PRMS 5
PRMS 6
0.0
0.2
0.4
0.6
0.8
Predicted value
Medium input
Low input
High input
Farm input system


PRMS 1
PRMS 2
PRMS 3
PRMS 4
PRMS 5
PRMS 6
0.8
0.6
0.4
0.2
0.0
Predicted value
Moderately uncertain and optimist
Highly uncertain and balanced
Slightly uncertain but optimist
Certain and balanced
Certain but pessimist
Risk Perception clusters


PRMS 1
PRMS 2
PRMS 3
PRMS 4
PRMS 5
PRMS 6
0.8
0.6
0.4
0.2
0.0
Predicted value
10
15
20
25
Risk Profile score (out of 25)


PRMS 1
PRMS 2
PRMS 3
PRMS 4
PRMS 5
PRMS 6
Predicted value
0.0
0.2
0.4
0.6
0.8
3
4
5
6
log(milksolids tonnes)


PRMS 1
PRMS 2
PRMS 3
PRMS 4
PRMS 5
PRMS 6
Predicted value
0.0
0.2
0.4
0.6
0.8
5
10
15
20
MS per ha (hundred kg)