Innovation adoption and farm management practices in the Canterbury dairy industry

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This research examined technology adoption behaviours of Canterbury (New Zealand) dairy farmers and the socio-demographic, farm and information seeking characteristics (ISCs) associated with adoption. Ten farm management practices (FMPs) were selected based on their adoption and promotion by the Lincoln University Dairy Farm (LUDF) which is a commercially orientated demonstration farm.

An email-based electronic questionnaire collected quantitative and qualitative data from Canterbury dairy farmers identified as holders of dairy effluent discharge consents. The questionnaire was distributed to 647 farmers for whom valid email addresses were available (64% of all consent holders). The response rate was 22%. Data was analysed using SPSS20.

Respondent ages ranged from less than 30 years to greater than 70 years and averaged 47 years. This compares to average farmer ages of 50 and 58 reported in 2012 media. Nearly half of respondents had greater than 20 years of industry experience and 52% had multiple farm interests compared with a New Zealand wide estimate of 20% reported by van Bysterveldt in 2012. Sixty six per cent of respondents had post-school education compared to 38% of Canterbury adults reported by Statistics New Zealand. Seventy nine per cent of respondents were farm owners/owner-operators and 12% were equity managers.

Average farm size was 231 effective hectares compared to an average Canterbury dairy farm of 226 hectares reported by LIC and DairyNZ in 2012. Average milksolids production of 433 kg per cow and 1538 kg per effective hectare were 9% and 13% higher respectively than Canterbury averages reported by LIC and DairyNZ in 2012. Seventy five per cent of respondent farmers were producing more than 1400 kg milksolids per hectare compared to average Canterbury production of 1360kg. Ninety two per cent of respondents operate a moderate input farming system (DairyNZ System 2-4).

Eighty five per cent of respondents visited the SIDDC/LUDF website and 51% attended LUDF focus days at least once in 2012. DairyNZ events were attended by 80% of respondents and 65% employed a private consultant/advisor. Respondents ranked the LUDF website, dairy newspapers and LUDF focus days as the most important information sources for learning about the LUDF's results, and ranked demonstration farms, DairyNZ events and other farmers as the most useful information sources for learning about new agricultural innovations.

The adoption level for individual FMPs ranged from 21-83% per cent. Adoption levels in descending order were: low and consistent grazing residuals (83%), re-grassing based on measurement of poor performing paddocks (81%), regular monitoring of cow body condition and responding with alternative management to achieve targets (71%), monitoring of soil moisture to drive irrigation practice (64%), creating a separate herd of young cows to enable preferential stock management to achieve targets (57%), pre-grazing mowing to lift animal intake (42%), a zero induction policy (40%), frequent small applications of nitrogen fertiliser and gibberellic acid simultaneously to promote production of high quality pasture (39%), use of Eco-n™ to mitigate urine nitrogen loss (33%), and synchronising of heifers to calve two weeks before the herd (21%).

In general, adoption behaviour in relation to specific FMPs correlated poorly with other FMPs, indicating that each adoption is a specific decision rather than as part of an adoption package. Respondents' comments indicated that non-adoption was typically a considered decision in relation to their specific FMPs and farming systems, rather than being the result of barriers such as unawareness, poor information or low education.

A measure of innovativeness was constructed using the number of innovations adopted by each farmer. The level of explanation provided by socio-economic characteristics was weak, as was the association with ISCs. There was some evidence of farm size and higher production per cow and per hectare being associated with the number of innovations adopted.

It is concluded that for this group of farmers, with generally high education and typically above average production per hectare, that the high variation in innovation adoption practices is very weakly associated with socio-demographics and ISCs, but is instead influenced by the relevance of an innovation based on its compatibility with farmers' needs, their capacity to adopt, and their existing FMPs. This has implications for extension professionals, policy makers, and innovation adoption theory.

Keywords: Farm management practices, dairy farmers, innovation adoption, Canterbury, New Zealand, socio-demographic characteristics, farm characteristics, information seeking characteristics

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Chapter 1
Introduction

1.1 Preview

This thesis examines the adoption of farm management practice (FMP) innovations in the Canterbury dairy industry (CDI) in New Zealand (NZ). Specifically, this study investigates how farmers' socio-demographics, their farm characteristics and their information seeking characteristics (ISCs) influence the adoption of FMPs. Although there is a wealth of literature available on agricultural innovation adoption, there is little surrounding the influence of these characteristics on the adoption of FMPs in the CDI. This study differs from many as it asked farmers to specify their reasons for adopting or not adopting these FMP innovations.

At the core of this research are the farmers, who are ultimately responsible for their FMPs, defined as "*the decisions and practical operations that shape the practical management of farms*" (Eurostat, 2013, p. 1). This exploratory study is based on both quantitative and qualitative data collected by an electronic survey distributed via email to Canterbury dairy farmers in December 2012. Data was collected on farmers' personal characteristics, their farm characteristics, their ISCs, their adoption or non-adoption of the ten FMPs and their reasons for their decisions as well as industry perspective and future research suggestions.

The FMPs of interest in this study are low and consistent grazing residuals, re-grassing based on measurement of poor performing paddocks, synchronising of heifers to calve two weeks before the herd, a zero induction policy, use of Eco-n[1], monitoring of soil moisture to drive irrigation practice, regular monitoring of cow condition to facilitate alternative management, creating a separate herd of young cows to enable alternative management, use of nitrogen fertiliser and gibberellic acid simultaneously to promote dry matter production and pre-graze mowing to increase animal intakes. These FMPs were selected due to their adoption and promotion by the Lincoln University dairy farm (LUDF) between 2001 and 2012. In 2001, Lincoln University and six commercial, education and research partners established a 161 hectare commerically orientated demonstration dairy farm and formed the South Island Dairy Development Centre (SIDDC) to demonstrate 'best practice' for South Island dairy farmers (siddc.org.nz, 2013a). The aim of this study was to better understand the tangible factors which influence farmers' decision making. The various motivations for innovation adoption such as farmers' goals, beliefs and values do not form part of this study.

[1] Eco-n ™ is a commercial product containing dicyandiamide (DCD). In January 2013, concerns regarding DCD residues in food led to the suspension of all sales and use of DCD treatments on farm land in NZ (MPI, 2013a).

1.2 Innovation, innovation adoption and FMP innovations

In this section, the concepts of innovation, innovation adoption and FMP innovations are presented. Definitions relevant to this research are also put forward to provide a clearer understanding of these commonly used terms in the context of this study.

Despite a vast literature, many different definitions of innovation exist. Baregheh, Rowley and Sambrook (2009, p. 1324) state that "*overall the number and diversity of definitions leads to a situation in which there is no clear and authoritative definition of innovation*".

Schumpeter (1939, p. 84) defined innovation as the setting up of a new production function and suggested that, innovation was "*in short, any "doing things differently" in the realm of economic life*…". He proposed that innovation had five dimensions which included (1) the production of a new product or a new quality of a product, (2) the introduction of a new production method, (3) opening of a new sales market, (4) conquest of a new supplier of raw materials or semi-finished products, and (5) completion of reorganization (Schumpeter, 1939, p. 80). He also asserted that the concept of innovation is not synonymous with invention (pp. 80-81). The distinction between invention and innovation is defined by Mohr (1969, p. 112) as "*invention implies bringing something new into being; innovation implies bringing something new into use*".

In this research, innovation is defined as planned changes in a firm's activities with a view to improving the firm's performance which involves new ways to perform tasks, new products and new procedures (Organisation for Economic Cooperation and Development [OECD], 2005, p. 34; Sunding & Zilberman, 1999, p. 1). By implication, an innovation involves something new. Rogers (1983, p. 11) defined an innovation as "*an idea, practice, or object that is perceived as new by an individual or other unit of adoption*" and proposed that if this idea, practice, or object seems new to an individual, regardless of when it was first available, then it is an innovation (Rogers, 1983, p. 12). This definition of an innovation is relevant to this study and will be used through-out to define an innovation.

Innovations can be divided between those that are embodied in capital goods or products, for example tractors, new seed varieties and new types of pesticides or fertilisers and those that are not embodied in any physical item (disembodied), for example management practices or budgeting (Sunding & Zilberman, 1999, pp. 1-3). In practice, embodied and disembodied innovations are likely to represent opposite ends of a continuum with most innovations consisting of a mixture of embodied and disembodied components. However, it is noted by Sunding and Zilberman (1999, pp. 1-3) that many disembodied innovations are practical knowledge that can be shared by many users. Therefore the FMP innovations of interest in this study are regarded as predominantly disembodied innovations or 'soft' technologies.

A practice has been defined as "*the actual application or use of an idea, belief, or method*…" (Oxford Dictionaries.com, 2013, p. 1). Farm management practices, as defined earlier, encompass a broad range of decisions on the practical operations that farmers make regarding the management of farms (Eurostat, 2013, p. 1). Based on Mol and Birkinshaw's (2009, p. 1) definition of management innovation, FMP innovations are defined in this study as the introduction of FMPs that are intended to enhance firm performance which may involve innovation in FMPs, processes and structures which affect the day-to-day work of management at an operational level or in management ideas or ideologies. These management practices may be completely new to the state of the art or simply new to the firm that is implementing them (Mol & Birkinshaw, 2009, p. 2).

The adoption of an innovation, also referred to as its uptake or implementation (Feder, Just & Zilberman, 1985; Torntazky & Klein, 1982), is defined as "*a decision to make full use of an innovation as the best course of action available*" (Rogers, 2003, p. 21). Lionberger (1961, p. 14), in a review of research dealing with the communication and adoption of ideas and practices, noted that for the adoption of an innovation to occur, an individual or firm must first recognise that current practices/products are no longer optimum for the achievement of given goals. Dissatisfaction leads to a search for alternatives, resulting in awareness, the first stage in the adoption process. Following awareness is interest, then evaluation, trial, and finally, adoption or rejection. Lionberger (1961, p. 4) noted that these five steps are not a rigid pattern, nor a set of exclusive or discrete categories with no overlap but are five sequences frequently identified by researchers and farmers.

1.3 Research background

The dairy industry is NZ's largest export earner, contributing 25 per cent to the country's merchandise export earnings with exports totalling NZ$12.1 billion in 2011 (MPI, 2013b). From 1999 to 2009 dairy export values grew by more than 8 per cent per annum as a result of substantial growth in the New Zealand dairy sector (Schilling, Zuccollo & Nixon, 2010). Rapid and sustained growth in the CDI has contributed significantly to national dairy industry growth (Dynes, Burggraaf, Goulter & Dalley, 2010; Pangborn, 2012). Between 1999 and 2011, the number of herds in Canterbury increased by 75 per cent (LIC & DairyNZ, 2012; LIC, 2000) and on average, Canterbury dairy farms are larger, have substantially larger herds, higher stocking rates and higher per cow and per hectare (ha) production than national averages (Table 1.1).

Table 1.1 New Zealand and Canterbury dairy industry figures (Adapted from LIC, 2000; LIC & DairyNZ, 2012)

	National dairy figures	Canterbury dairy figures	Differences (per cent)
Number of cows (million)	4.6	0.75	-
Average herd size	393	776	+97
Average farm size (ha)	139	226	+63
Number of herds	11798	972	-
Cows per effective ha	2.83	3.44	+22
Production per cow[a]	364	396	+9
Production per ha[a]	1028	1360	+32
Total milksolids[b]	1685	298	-

[a] kilograms of milksolids
[b] millions of kilograms of milksolids produced

Moynihan (2012, p. 1) and DairyNZ (2013) note that New Zealand dairy farmers have enjoyed a good run of returns, increased capital investment and strong asset growth, which has fuelled the significant expansion into new regions and the conversion of other land use. As a result, the dairy industry's average debt per kg of MS increased from NZ$8.05 in 1999 to NZ$21.93 in 2009 (Greig, 2010). Although milk production is forecast to increase (MPI, 2013b), higher production costs resulting from global market competition, increased cost of debt servicing and increasing market and regulatory demands are likely to constrain further production growth (Moynihan, 2012; DairyNZ, 2009; 2013). Predicted future growth rates are expected to be largely driven by increased resource efficiency and productivity (Moynihan, 2012).

In 2012, the NZ Government identified innovation, export markets, capital markets, natural resources, infrastructure and skilled and safe workplaces as key areas of focus to ensure increased and sustained business growth (New Zealand Government, 2012). "*Successful innovation improves competitiveness, increases our output, drives productivity growth, and creates successful exports by introducing new or improved products, processes, or methods into the economy*" (New Zealand Government, 2012, p. 5). Statistics New Zealand [StatsNZ] (2010) reported that in 2009, 33 per cent of agricultural businesses were innovative (had adopted, had on-going or had abandoned an innovation), however, this was below the overall innovation rate for all industries of 46 per cent. StatsNZ (2010, p. 1) reported that innovative businesses recorded increased sales, profitability and productivity.

The challenge of farm management lies in productively using farm resources while being responsive to an ever changing external environment (Shadbolt & Bywater, 2005, p. 16). In their assessment of labour practices and technology adoption on NZ dairy farms, Jago, Ohnstad and Reinemann (2007, p. 1) observed that many NZ dairy farmers were not using existing technologies, the adoption of which could result in greater farm productivity. DairyNZ (2009, p. 19) also reported that the adoption of existing beneficial technologies would result in increased farm productivity while a recent industry wide survey of technology transfer services to farmers in NZ reported that across the primary industries, the adoption of existing technologies could increase exports by NZ$3 billion annually (MPI, 2013c, p. 6).

1.4 Research aim

It is clear that research investigating farmers' adoption of innovations, and in particular FMP innovations, can help in increasing farmers' adoption rates and consequently improve farm productivity. The CDI has been selected due to its rapid expansion and subsequent increasing importance to the national economy. Accordingly, the primary aim of this research is to provide greater understanding of how farmers' personal characteristics, farm characteristics and ISCs influence Canterbury dairy farmers' decisions to adopt or not adopt FMPs.

The remainder of this thesis has the following structure. Chapter 2 identifies and discusses previous research thought relevant to this study. A number of theoretical frameworks are discussed and from this, the framework used to guide this research is presented. Chapter 3 discusses the research methodology and design, and also discusses data collection and analysis. The results of the data analysis, which detail the relationships between farmer characteristics, farm characteristics, their ISCs and their adoption of FMP innovations, are presented in Chapter 4. Finally, Chapter 5 draws the findings of this study together into an integrated discussion. Conclusions, future research suggestions and research limitations are also presented in Chapter 5.

Chapter 2

Innovation adoption literature

2.1 Introduction

"*Undoubtedly the second oldest concept in the study of innovation, next to that of "innovation" itself, is "adoption*" (Eveland, 1979, p. 1).

There is an overwhelming amount of literature available on the topics of innovation and innovation adoption. The purpose of this review is to document the literature that may help in understanding innovation adoption in the context of this study. Section 2.2 presents a review of previous innovation adoption research conducted in Canterbury and NZ thought relevant to this study. Section 2.3 introduces the general innovation adoption literature and section 2.4 reviews a number of theories which can be used to investigate agricultural innovation adoption. This review leads onto identifying the theoretical framework for this study in section 2.5. Section 2.6 reviews a number of empirical studies which examine the importance and influence of key farmer, farm and information seeking characterisitics to innovation adoption. Following this, section 2.7 reviews how certain socio-demographics may influence farmers' decision making. The summary of the literature review is presented in section 2.8. The knowledge gap and research questions are then presented in section 2.9 and section 2.10 respectively. This review will help frame this research and outline its applicability to dairy farming, which will assist in directing and designing the focus of this research.

2.2 Relevant innovation adoption research

Morris, Loveridge and Fairweather (1995) used qualitative methods to ascertain why 32 dairy farmers and 29 sheep/beef farmers in the Temuka/Geraldine area of Canterbury changed their farming practices. These farmers' personal accounts of why they did or did not adopt were analysed to identify the key orientating principles that guided their decision making. The results identified that the key orientating principle or goal of many dairy farmers was to increase their production, efficiency, control and monitoring, and that these goals influenced the innovations they adopted.

Morris et al. (1995, p. 124) suggest that the process of decision making is seen as similar for farmers of all types and that socioeconomic characteristics were largely linked to farmers' timing of adoption. Regarding timing of adoption, they observed that some farmers adopted one innovation relatively earlier than the majority of farmers (i.e. were early adopters) but for other innovations, they may have adopted later than the majority (i.e. late adopters). They also suggest that adoption is only likely to occur if the innovation is applicable to the individual’s situation.

It is noted by Morris et al. (1995, p. 123) that dairy farmers obtain information about innovations and changes in farming practices from a variety of sources which means they have good awareness of available innovations. Based on their results, Morris et al. (1995) suggest that dairy farmers examined each idea they come across on the basis of its relevance and suitability to their particular farm and the potential role of these new technologies in farming profitably.

This study suggests that farmers’ goals are the primary influence on innovation adoption. It is likely that many of Morris et al.’s (1995) conclusions regarding Canterbury dairy farmers’ motivations behind innovation adoption, i.e. practice change being motivated by a desire to increase production, efficiency, and control and monitoring, are still applicable. This research also indicates that where and how farmers receive their information is central to their adoption process. However, this study does not provide insight into how farmers’ socio-demographics and ISCs influence their decisions to adopt or not adopt an innovation.

In a study of factors affecting Canterbury farmers’ adoption and use of computerised information systems, Alvarez and Nuthall (2001) observed that adoption was linked to farmers’ computer technology alienation feelings ("knowledge gap"), information management skills, and the economic benefit perception of software use. Also related are farmer characteristics such as education, age, farming (sub) culture, advisory and farm circumstances. Non-adopters considered computerised systems as useless for their particular situations, saw themselves as far from computer technology (large knowledge gap), expressed their scepticism of potential economic benefits, and had neither the operational skills to operate a computer system, nor the information management skills compatible with this kind of technology.

Alvarez and Nuthall (2001) suggest that formal education is one of the main developers of knowledge so it is a direct contributor in reducing the farmers' "knowledge gap". At the same time, formal education also builds information management skills by providing problem solving frameworks, information searching strategies and peer groups. A negative relationship was found between age and education; the younger the farmer, the more educated, and Alvarez and Nuthall (2001, p. 18) suggest this may explain why age negatively influenced adoption.

Similar to formal education, Alvarez and Nuthall (2001) suggest that farming (sub) culture is another main developer of farmer knowledge as it involves the values, ideas, and principles that are shared by the farming community when farmers were children and developed their thinking. They go on to suggest that farmers usually belong to complex networks that involve family members, friends, neighbours, and colleagues. Part of this knowledge involves the usual procedures to deal with and solve problems or "rules of thumb". In this way other farmer opinions and experiences may become key components in a particular farmer's perception of the economic benefits of using computer technology.

Alvarez and Nuthall (2001) identified a positive relationship between the frequency of adviser visits and computerised system use. While not being as important as formal education and farming (sub) culture, the farmer-advisor relationship does contribute to the build-up of farmer knowledge, information management skills, and provides ideas for formulating the economic perception of technological changes. Other factors that can potentially impact on the view of the economic benefit, and so adoption, suggested by Alvarez and Nuthall (2001) were the size of the herd, the stage of development (this determines the priorities on work time, and how much time is left to perform decision-making activities) and "time scarcity”. Like the development stage, this factor determines priorities, and may impact on the opportunity cost of learning thus limiting a farmer’s capacity to adopt.

Despite its focus on a single innovation, Alveraz and Nuthall’s (2001) study suggests that socio-demographics, farm characteristics and ISCs can influence innovation adoption. However, the qualitative research methods, sample size and the increased importance of information technology to farm management in the past decade are likely to constrain the generalisability of their findings.

In their investigation of the adoption of environmental best practices amongst NZ dairy farmers, Beswell and Kaine (2005) used qualitative methods to gather data from dairy farmers in four NZ catchments. The environmental practices explored were; excluding stock from waterways, reducing phosphorus use, improving soil macroporosity, managing effluent and improving the efficiency of border-dyke irrigation. Beswell and Kaine’s (2005) results suggest that, similar to Alvarez and Nuthall (2001), a farmer’s decision to adopt management practices depends on their perception of the benefits of those practices. Similar to Morris et al. (1995), Beswell and Kaine (2005) suggest that this perception was based on their evaluation of the practices in terms of the characteristics of the production context of the individual farmer, and conclude that adoption or non-adoption was the result of “*pragmatic considerations in regard to the commercial and practical realities of dairying*” (Beswell & Kaine, 2005, p. 19).

In June 2008, Pangborn (2009) surveyed Canterbury and North Otago dairy farmers identified as being involved in dairy farming by LIC to ascertain their socio-demographics and to gauge whether

[2] LIC is a multinational dairy farmer owned cooperative providing a range of products and services to the dairy industry in New Zealand including genetics expertise, technology and information (lic.co.nz, 2014).

farmers had adopted a range of technologies demonstrated by the LUDF. The results indicated that the majority of respondents were owner-operators; that the average age of respondents was 45 years; and that 67 per cent of respondents had a post-school education. Average farm size and productivity per cow and per ha were greater than Canterbury averages reported by the LIC, and the majority of respondents operated a moderate input system (DairyNZ system 2-4). Results also showed that respondents obtain their information from multiple sources including DairyNZ events, LUDF information days (focus days), private consultants and other farmers.

The FMPs included in Pangborn's (2009) survey were; low grazing residuals, re-grassing based on measurement of poor performing paddocks, aggressive use of hormone intervention non-cycling technologies, synchronising heifers to calve one week before the herd and a zero induction policy. These innovations were demonstrated by the LUDF and Pangborn's (2009) results showed that they had varying levels of adoption. Respondents indicated why they had adopted or not adopted certain technologies which included economic considerations, the achievement of their production goals and philosophical reasons (this was evident for innovations such as zero induction policy, aggressive hormone treatments and synchronisation of heifers).

Pangborn's (2009) survey is particularly relevant to this study as it collected data on farmer socio-demographics and their adoption of innovations. However, it does not directly link farmers' socio-demographics with their adoption decisions. Furthermore, since 2008 the LUDF has introduced a number of FMPs to increase farm productivity while maintaining or reducing their environmental footprint. It is suggested that an increased focus on improving productivity, expansion of the CDI since 2008 and greater consumer focus on environmental stewardship may have altered farmers' adoption of certain FMP technologies. As a result, collecting new data will offer new insights into what is the current level of FMP adoption in the CDI as well as examining how farmers' socio-demographics, farm characteristics and ISCs affect FMP adoption.

These studies suggest that innovation adoption is a complex decision-making process influenced by a number of factors. A variety of innovations and research methods were used and although there is some similarity in the research findings, for the most part they do not offer an insight into how farmers' socio-demographics, farm characteristics and ISCs influence their innovation adoption. Therefore, it is suggested that this study is justified and will complement the current body of research on innovation adoption in Canterbury. To help better understand innovation adoption and provide guidance for this research, the following section introduces the general innovation adoption literature and reviews a number of theories which can be used to investigate innovation adoption. Following this review, the framework used to guide this study is identified.

2.3 The innovation adoption literature

Innovation adoption has been widely studied (Feder & Umali, 1993; Pannell, Marshall, Barr, Curtis, Vanclay & Wilkinson, 2006; Howley, O Donoghue & Heanue, 2012; Rogers, 2003). However, in a review of innovation adoption literature, Wolfe (1994) noted the only consistency in past research was that of inconsistency. He suggests that this arises due to the difficulties in understanding the complex, context-sensitive nature of innovation adoption; "*Innovation* (adoption) *cannot be understood without careful attention to the personal, organizational, technological, and environmental contexts within which it takes place*" (Tornatzky & Fleischer, 1990 as cited in Wolfe, 1994, p. 406). As a result, Wolfe (1994) suggests that this literature can offer little guidance to researchers.

Inconsistency in research results has also been noted by Pannell et al. (2006, p. 1407) who suggest the source of this inconsistency is the literature's "*disciplinary fragmentation*" with research conducted under the banner of economics, sociology, psychology, marketing, agricultural extension and anthropology. Pannell et al. (2006) and Nelson, Peterhansl and Sampat (2004) both suggest that this fragmentation creates inconsistency in research results thus constraining their comparability and generalisability. Similar to Wolfe (1994), Pannell et al. (2006, p. 1407) noted that the adoption of rural innovations depends on the innovation itself as well as a range of personal, social, cultural and economic factors.

Furthermore, Nelson et al. (2004) suggest that disciplinary fragmentation contributes to inconsistency as different disciplines tend to have different theories about innovation adoption due their diverse focus. Theory has been described by de Vaus (1995, p. 25) as a tentative attempt to find some plausible explanation for a set of facts which can help identify how to interpret observations, what observations are relevant and how these observations relate to one another, while also providing a context in which to place particular observations which helps to identify their significance and meaning.

Also noted by Nelson et al. (2004) was that different disciplinary theories are orientated towards different types of innovations and many innovations do not fit the idealised class presumed by a particular theory. As a result, they suggest that no one theory can be regarded as being generally right or wrong, and that there is merit in "*looking at what is going on through the lenses afforded by two or more theories*" (p. 679). Wolfe (1994, p. 406) also suggested that there can be no one theory of innovation, "*as the more we learn, the more we realise that 'the whole' remains beyond our grasp*".

Despite different disciplines and different theories, Pannell et al. (2006), Botha and Atkins (2005) and Nutley, Davies and Walter (2002) note that when looking through a cross-disciplinary lens, the perspectives and emphasis of many research traditions appear to complement one another. As a result, a number of theories used to investigate innovation adoption are reviewed in the following section. These include; extension theory, diffusion of innovations theory, consumer behaviour theory, bounded rationality theory, and the theory of reasoned action and planned behaviour. The emphasis of this review is to develop a framework to allow interpretation of this research's results, thus enabling a greater understanding of the influence of farmer's socio-demographics, farm characteristics and ISCs on FMP innovation adoption in the CDI. This review will expand Botha and Atkins' (2005) work where the focus of each theory was categorised as being on either the decision-making process, the personal factors influencing this process, the contextual factors which influence this process, or a combination of these elements.

2.4 Theoretical frameworks relevant to FMP innovation adoption

2.4.1 Agricultural extension theory

Extension science evolved from rural sociology and over time extension has become more aligned with social psychology and communication (Roling, 1988). Van der Ban and Hawkins (1996, p. 9) suggest that the term extension refers to the conscious use of communication of information to help people form sound opinions and make good decisions. In a review of extension theory and practice, Black (2000) separates extension strategies into four categories: 1) linear 'top-down' transfer of technology; 2) participatory 'bottom-up' approaches (also termed 'group empowerment'); 3) one-to-one advice or information exchange; and 4) formal or structured education and training.

1). According to Black (2000), the linear 'top-down' transfer of technology has traditionally been the dominant model of agricultural extension and is based on the assumption that new agricultural technologies and knowledge are typically developed and validated by research scientists, and that the task of extension agencies is to promote the adoption of these technologies by farmers, thereby increasing agricultural productivity. This approach has also been called the linear adoption or diffusion model, and has focused particularly on the farmers thought to be 'early adopters' and larger scale wealthier farmers in the expectation that their example will be followed by others.

2). Participatory 'bottom-up' approaches were developed by critics of the top-down approach. Black (2000) notes that a variety of participatory methodologies was developed which includes Agroecosystems analysis, Rapid assessment procedures and Rapid rural appraisal. He suggests that in the bottom-up approaches, rural peoples' participation tends to be limited to providing information to researchers, whose analysis generates solutions to be offered to farmers, while others are based on the assumption that farmers themselves have the ability to develop economically viable and ecologically sustainable farming systems.

3). One-to-one advice or information exchange is as the term suggests. This is increasingly provided by private consultants, agribusinesses, farmer organisations and other non-government bodies. It is noted by Black (2000) that concern is sometimes expressed over the lack of coordination and cooperation between agencies involved in information generation, validation and exchange.

4). Formal or structured education and training can help provide and refresh farmers' knowledge on a variety of subjects surrounding farm management. However, it is noted by Black (2000, p. 498) that although attitudes may be changing, most farmers are reluctant to undertake formal, long-term educational courses such as those offered by universities. Various factors contribute to this reluctance, such as: 1) a lack of time; 2) a questioning of the relevance of tertiary courses to farming; 3) a belief that the competencies required for farming are essentially practical, whereas formal courses tend to be theoretical; 4) a lack of awareness; 5) a lack of confidence by farmers in their ability to undertake the study required; and 6) prevailing attitudes in rural communities to the respective roles of men and women (Black, 2000).

2.4.1.1 Contribution of agricultural extension theory

The four models or frameworks of extension described by Black (2000) are all concerned with the organised and formal process of actively communicating information to elicit or facilitate voluntary behaviour change; "*The goal of extension is to determine how to convey information regarding a new innovation to a certain population (such as farmers) so that they will adopt it*" (Botha & Atkins, 2005, p. 3). Therefore, it is suggested that extension theory influences the decision-making process through the communication of information, with both the communication method and information influenced by contextual factors such as social, cultural, technological, economic and geographical factors.

2.4.2 Diffusion of innovations theory

There is a vast literature on innovation generally and on the diffusion of innovations, more specifically (Nutley et al., 2002, p. 5). Diffusion theories have their origins in the explanation of the adoption of innovations by farmers in the US during the 1950s (Rogers, 1983, p. 57). Nutley et al. (2002, p. 14) note that the diffusion of innovation literature draws together evidence and ideas from a wide range of underpinning disciplines including anthropology, education, geography and sociology.

Diffusion is defined by Rogers (1983, p. 5) as "*the process by which an innovation is communicated through certain channels over time among the members of a social system*". Stephenson (2003) has suggested that it is this theory which underpins the linear top down transfer of technology approach of extension theory. Rogers (1983, p. 5) notes that the adoption of an innovation is influenced by four factors which include: 1) the innovation itself, 2) the communication channels used to spread information about the innovation, 3) time, and 4) the nature of the society to whom it is introduced. Botha and Atkins (2005) note that diffusion theory is not a single, all-encompassing theory but consists of four theoretical perspectives that relate to the overall concept of diffusion. The four component theories include: the innovation-decision process theory, the individual innovativeness theory, the rate of adoption theory, and the theory of perceived attributes.

2.4.2.1 The innovation-decision process

There are a variety of staged models used to represent the innovation decision process, with the number of stages described being as high as ten (Lionberger, 1961; Rogers, 1983; Wolfe, 1994). Within Rogers' (1983, p. 164) model, the adoption decision process passes through five stages. These include:

1). Knowledge – the individual (or decision-making unit) is exposed to the innovation's existence and gains some understanding of how it functions.

2). Persuasion – the individual (or unit) forms a favourable or unfavourable attitude toward the innovation. This may involve, for example, a matching of the innovation to a perceived problem, and some kind of appraisal of the costs and benefits of adoption.

3). Decision – the individual (or unit) engages in activities that lead to a choice to adopt or reject the innovation. This may include interaction with forces of support or opposition that influence the process.

4). Implementation – the individual (or unit) puts an innovation into use.

5). Confirmation – the individual (or unit) seeks reinforcement for an innovation decision already made, but may reverse this decision.

Rogers (1983, Chapter 1) describes a variety of social factors that may accelerate or slow the diffusion process. These include whether the decision is made collectively, by individuals, or by a central authority; the communication channels used to acquire information about an innovation, whether mass media or interpersonal; the nature of the social system in which the potential adopters are embedded, its norms, and the degree of interconnectedness; and the extent of change agents (advertisers, development agencies) promotion efforts.

Communication is central in diffusion. Rogers (1983, p. 17) notes that "*the essence of the diffusion process is the information exchange by which one individual communicates a new idea to one or several others*". This process has four elements: 1) an innovation, 2) an individual or unit of adoption with knowledge or experience of the innovation, 3) another individual or unit of adoption that does not have knowledge or experience of the innovation, and 4) a communication channel.

He suggests that mass media channels are more effective in creating knowledge of innovations, whereas inter-personal channels are more effective in forming and changing attitudes toward a new idea, and thus in influencing the decision to adopt or reject a new idea. He also suggests that most individuals evaluate an innovation not on the basis of scientific research by experts but through the subjective evaluations of near peers who have adopted the innovation. These near peers thus serve as role models, whose innovation behaviour tends to be imitated by others in their system.

2.4.2.2 Individual innovativeness theory

It is proposed by Rogers (1983, p. 22) that the members of a social system can be categorised based on their innovativeness, defined as the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system. Based on innovativeness, a population of adopters can be partitioned into five adopter categories which include innovators, early adopters, early majority, late majority, and laggards (Figure 2.1).

Figure 2.1 Categories of adopters (Adapted from Rogers, 2003, p. 281)

Rogers (1983, pp. 248-250) suggests that the dominant attributes of each category are: Innovators-venturesome (very eager to try new ideas); early adopters-respect (have a great degree of opinion leadership in most social systems); early majority-deliberate (a deliberate willingness in adopting ideas, but seldom lead); late majority-sceptical (innovations are approached with a sceptical and cautious air and usually do not adopt until most others in their social system have done so); and laggards-traditional (decisions are often made with reference to past generations. Laggards typically interact with those who also have traditional values).

It is noted by Rogers (1983, p. 251) that past research has identified that relatively earlier adopters in a social system are no different to later adopters in age, but they tend to have more years of formal education, are more likely to be literate, have higher social status and a greater degree of upward social mobility, and have larger-sized units, such as farms or companies. These characteristics of adopter categories indicate that earlier adopters generally have higher socioeconomic status than later adopters.

Also noted by Rogers (1983, pp. 257-258) is that earlier adopters in a system also differ from later adopters in personality variables. Earlier adopters have greater empathy, less dogmatism, a greater ability to deal with abstractions, greater rationality, greater intelligence, a more favourable attitude toward change, a greater ability to cope with uncertainty and risk, a more favourable attitude toward science, less fatalism (fatalism is the degree to which an individual perceives a lack of ability to control his/her future), greater self-efficacy, higher aspirations for formal education, and have higher-status occupations than later adopters.

Finally, the adopter categories have different communication behaviour. Earlier adopters have more social participation, are more highly interconnected in the interpersonal networks of their social system, are more cosmopolite, have more contact with change agents, greater exposure to mass media channels, and greater exposure to interpersonal communication channels, engage in more active information seeking, have greater knowledge of innovations, and have a higher degree of opinion leadership (Rogers, 1983, pp. 258-259).

2.4.2.3 Theory of rate of adoption

The rate of adoption has been defined by Rogers (1983, p. 232) as the relative speed with which an innovation is adopted. The rate of adoption theory suggests that adoption of an innovation grows slowly in the beginning and as more people adopt the innovation and information becomes more readily available, there will be a period of rapid growth that will eventually taper off, become stable, and eventually decline (Rogers, 1983, p. 23). Nutley et al. (2002, p. 11) notes that the time over which the innovation diffuses varies, as does the percentage of the population who ultimately adopt the innovation.

The rate of adoption is dependent on time but can also be affected by a number of other factors (Figure 2.2, page 16).

Figure 2.2 Variables determining the rate of adoption of innovations (Adapted from Rogers, 1983, p. 233)

2.4.2.4 Theory of perceived attributes

Based on past writings and research, Rogers (1983, p. 211) identified five innovation characteristics or attributes. He suggests that the five innovation attributes (as perceived by an adopter) of relative advantage, compatibility, complexity, trialability, and observability, will affect innovation adoption and the rate of adoption. It is noted by Rogers (1983, p. 211) that each of these are empirically interrelated with the other four but are conceptually different. In their review of adoption literature, Tornatzky and Klein (1982) presented ten attributes (which include those identified above) most frequently addressed in the literature. These are: relative advantage, compatibility, complexity, trialability, observability, and communicability, cost, divisibility, profitability and social approval.

The innovation attributes identified by Rogers (1983) are presented below (1-5) and are followed by the additional five (6-10) identified by Tornatzky and Klein (1982).

1). Relative advantage is described by Rogers (1983, p. 213) as the degree to which an innovation is perceived as being better than the idea it supersedes and can be expressed as the ratio of the expected benefits and the costs of adoption.

2). Compatibility is the degree to which an innovation is perceived as consistent with existing values, past experiences and needs of potential adopters (Rogers, 1983, p. 223). An idea that is compatible is less uncertain to the potential adopter and fits more closely with an individual's situation. Any new idea is evaluated in comparison to existing practice. Compatibility has been found to be somewhat less important than relative advantage.

3). Complexity is the degree to which an innovation is perceived by the adopter as relatively difficult to understand and use, and can negatively affect adoption. Complexity may not be as important to adoption as relative advantage and compatibility. However for some innovations, complexity is an important barrier to adoption (Rogers, 1983, p. 231).

4). Trialability is the degree to which an innovation may be experimented with on a limited basis. The ability to trial the innovation on a small scale first will generally increase the rate of adoption. Trying a new idea may involve re-inventing it to more closely suit an adopters own particular circumstances. Relatively early adopters of an innovation are thought to perceive trialability as more important than late adopters.

5). Observability is the degree to which the results of an innovation are visible to others. Some ideas are easily observed and communicated to other people, whereas other innovations are not. The observability of an innovation as perceived by the members of a social system is positively related to its rate of adoption.

6). Communicability is described by Tornatzky and Klein (1982, p. 36) as the degree to which aspects of an innovation may be conveyed to others and it is noted by Tornatzky and Klein (1982) that communicability is similar to, and related to, observability.

7). Cost of an innovation is assumed to negatively affect adoption and implementation. The less expensive the innovation, the more likely it will be quickly adopted (Tornatzky & Klein, 1982).

8). Profitability is the level of profit to be gained from adopting an innovation. This is similar to relative advantage and Tornatzky and Klein (1982) note that perhaps counter intuitively, profitability is not always positively associated with adoption.

9). Divisibility is the "*extent to which an innovation can be tried on a small scale prior to adoption*" (Fliegel, Kivlin, & Sekhon, 1968, p. 446, as cited in Tornatzky & Klein, 1982, p. 37) and is positively associated with adoption and implementation. Divisibility is closely related to trialability. However, Tornatzky and Klein (1982, p. 37) note that not all trialable innovations are divisible; a trialable innovation may simply be a small scale, easily reversible, non-radical innovation.

10). Social approval refers to status gained within a social group and in particular, one's reference group. Social approval is a "*nonfinancial aspect of reward*" (Fliegel, Kivlin, & Sekhon, 1968, p. 445, as cited in Tornatzky & Klein, 1982, p. 37).

In a study of innovative beef farmers in Brazil, Pereira (2011, p. 213) notes that in Rogers'(1983) diffusion theory, there is no mention of any particular hierarchy among these attributes. Results from Pereira's (2011) research suggest that the relative importance of each attribute is not the same and it appears that compatibility and relative advantage (which includes profitability) of technologies are the most important attributes determining technology adoption. She suggests that observability and trialability facilitate, but do not by themselves either determine or preclude adoption. Similarly, technology complexity does not preclude adoption, but is given consideration relative to the technology advantages.

2.4.2.5 Contribution of diffusion theory

Diffusion theory consists of four sub-theories, the first of which describes the innovation-decision process, a mental process consisting of five stages. The second sub-theory is individual innovativeness which identifies the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system. Both of these sub-theories aid in understanding that an adopter's personal factors will influence the adoption decision as well as contextual factors such as their farm characteristics, the communication channels, the social system and the role of change agents.

The third sub-theory is the theory of rate of adoption which proposes that adoption begins slowly with the most innovative farmers (i.e. the innovators) and as more people adopt the innovation and information becomes more readily available, adoption rapidly increases. This reiterates the role of communication channels and the social system as contextual factors (Botha & Atkins, 2005, p. 6). The rate of adoption may also be seen as an innovation decision over a period of time which suggests that personal factors also contribute. The last of these sub-theories is the theory of perceived attributes. This highlights the role of the innovation itself and how it is perceived by the adopter. It is likely that contextual factors and personal factors will be involved in establishing the relative advantage, compatibility, complexity, trialability and observability of innovations.

Previous research has identified some limitations of the diffusion of innovations theory (Rogers, 1983, p. 87; Botha & Atkins, 2005, p. 8). The four major criticisms of diffusion of innovation theory and associated research identified by Rogers (1983, Chapter 3) include:

1). A pro-innovation bias, which implies that an innovation should be diffused to and adopted by all members of a social system, that it should be diffused rapidly, and that the innovation should be neither re-invented nor rejected.

2). The individual-blame bias, the tendency to hold an individual responsible for his or her problems, rather than the system of which the individual is a part.

3). The recall problem in diffusion research, which may lead to inaccuracies when respondents are asked to remember the time at which they adopted a new idea.

4). The issue of equality in the diffusion of innovations, as socioeconomic gaps among the members of a social system are often widened as a result of the spread of new ideas.

Other limitations of the diffusion of innovations model identified by Wolfe (1994, p. 408) include the assumption that a definable population of potential adopters, who are more or less equivalent, can be identified. Also noted is the theory's insufficient consideration of innovation characteristics and how these change over time. Additional limitations identified by Kole (2000) include that the theory does not take into account the fact that diffusion and adoption may fail because it was a bad idea to begin with; and that it associates the latest technologies with progress, thereby ignoring alternatives.

Diffusion theory is also criticised because it does not consider the possibility that people will reject an innovation even if they fully understand it (Waterman, 2004 as cited in Botha & Atkins, 2005, p. 9). According to Nutley et al. (2002) the diffusion of innovations is further complicated by contrasting straightforward adoption (replication) versus re-invention (adaptation). Re-invention is defined by Rogers (1983, pp. 16-17) as the degree to which an innovation is changed or modified by a user in the process of its adoption.

2.4.3 Consumer behaviour theory

In applying Consumer behaviour as a theory of innovation adoption in agriculture, Kaine (2004) notes that all the various models of adoption behaviour recognise that the fundamental factor influencing the decision to adopt an innovation is the extent to which the innovation better contributes to satisfying the needs of the purchaser. He suggests that there are three reasons for using consumer behaviour theory as the starting point for developing a procedure for determining how innovations can contribute to satisfying the needs of primary producers as managers of agricultural enterprises. First, consumer behaviour theory recognises that there are a variety of types of decisions, and that different decision processes are invoked in different circumstances. Second, consumer behaviour theory provides criteria for identifying the type of decision process that is invoked in a particular circumstance. Third, the theory explicitly recognises that different individuals purchase the same product to satisfy different needs.

Kaine (2004) proposes that consumers make purchase decisions in a variety of ways depending on the circumstances (Table 2.1). The way in which a decision to purchase is made is determined by two key factors; 1) the level of consumer involvement in the product and 2) the degree of effort the consumer is willing to invest in making a purchase decision (Assael, 1998 as cited in Kaine, 2004, p. 2). When involvement is high, consumers tend to engage in a complex decision-making process or in brand loyalty depending on the degree of effort they invest in the purchase decision. When involvement is low, consumers tend to engage in variety-seeking behaviour or in habit, depending on the degree of effort they invest in the purchase decision.

It is pointed out by Kaine (2004) that the adoption of an agricultural innovation involves consideration of the novel and unfamiliar. Usually the adoption of a new agricultural practice or technique has significant consequences for the future financial performance of the farm enterprise. It is also suggested by Kaine (2004) that innovation adoption is a high involvement purchase decision as the new technology or practice must be integrated into the existing mix of technologies, practices and resources that exist on the farm. He suggests that this means, generally speaking, the likely outcomes of adopting a particular technology or practice are difficult to predict as the compatibility of the technology or practice with the existing farm system, and the resulting benefits, depends on a range of contextual factors that are specific to each farm enterprise.

Table 2.1 Consumer purchase behaviour (Adapted from Kaine, 2004, p. 3).

As a result, Kaine (2004) notes that the decision to adopt an agricultural innovation is often financially risky and entails social and psychological risks for the individual, i.e. the outcomes affect the wellbeing of family members and can influence producers' feelings of achievement and self-fulfilment. In conclusion, Kaine (2004) suggests that the adoption of most agricultural innovations can thus be characterised as a form of high involvement purchase for primary producers that has enduring and situational components that are likely to encourage an extensive search for information before a decision is made.

2.4.3.1 Contribution of consumer behaviour theory

Consumer behaviour theory when applied to agricultural innovation adoption proposes that the decision to adopt an innovation is similar to a high involvement purchase decision where farmers are highly motivated to seek information on, learn about, and evaluate innovations that are highly relevant to their needs. Consumer behaviour contributes to the theoretical framework by emphasising the influence of the individual (level of involvement in the product and the degree of effort invested in making a purchase decision) and their specific needs which will be influenced by farm specific contextual factors (existing mix of technologies, practices and resources) on the adoption decision process (Kaine, 2004, pp. 2-8).

Botha and Atkins (2005, pp. 9-10) suggest other useful concepts in the adoption decision-making model identified by consumer behaviour theory is that there are a variety of decision types and that different decision processes are invoked in different circumstances; that different individuals purchase the same product (adopt the same innovation) to satisfy different needs; and also the notion of social and psychological risks and their influence on adoption decision-making.

2.4.4 Bounded rationality theory

According to Hoffrage and Reimer (2004, p. 441), bounded rationality recognises that humans often have limited information, resources, time and computational capacities when making decisions. As a result of these constraints, the optimal solution is often unachievable. Many problems are too complex to solve within a reasonable amount of time, even if all the relevant information is available to the decision maker (Hoffrage & Reimer, 2004, p. 441). The assumptions and propositions that underlie this theory of decision-making are attributed primarily to Herbert A. Simon (Ibrahim & Khaimah, 2009; Hoffrage & Reimer, 2004).

Bounded rationality challenges the classical economic theory that economic behaviour is essentially rational behaviour in which decisions are made on the basis of all available information and resources (including time) with a view to securing the optimum result possible for each decision maker (Botha & Atkins, 2005, p. 3). Simon (1947) proposed that rationality is bounded by the cognitive abilities of the individual (i.e. the ability of humans to gather, comprehend, and retrieve information from memory), by the resources available (i.e. time, money, other resources) to make a decision, by incomplete information arising from risk and uncertainty, and by complexity (Figure 2.3). Given these constraints, individuals try to make decisions that are good enough and that represent reasonable or acceptable outcomes, which is termed satisficing, i.e. the solution is both satisfying and sufficing (Hoffrage & Reimer, 2004, p. 441). Selten (1999, p. 3) notes that bounded rationality is not irrationality, but refers to rational optimisation under some cognitive bounds.

Figure 2.3 The concept of bounded rationality (Adapted from wikispaces.com, 2013, p. 1).

2.4.4.1 Contribution of bounded rationality theory

The theory of bounded rationality is about the whole decision-making process. Bounded rationality explains why human beings faced with immense complexity and cognitive limitations deal with their decision-making tasks by constructing simple models of reality and employing heuristics (trial and error) (Hoffrage & Reimer, 2004). It helps inform the adoption process by identifying the influence of personal factors (an individual's cognitive abilities and goals) and contextual factors (resources such as time, and money) and the role of information, albeit imperfect information, in the decision-making process.

2.4.5 Theory of reasoned action and the theory of planned behaviour

The theory of planned behaviour is an extension of the theory of reasoned action, made necessary by the original model's limitations in dealing with behaviours over which people have incomplete volitional control (Figure 2.4) (Ajzen, 1991, p. 181). According to this model, a person's behaviour is determined by their behavioural intention to perform it. This intention is itself determined by the person's attitudes and subjective norms towards the behaviour. This model was developed by Fishbein and Ajzen (1975) and defines the links between beliefs, attitudes, norms, intentions, and the behaviour of individuals.

The central factor in the theory of planned behaviour is the individual's intention to perform a given behaviour, for example adopting an innovation. Ajzen (1991) notes that intentions are assumed to capture the motivational factors that influence a behaviour and they are indications of how hard people are willing to try or how much of an effort they are planning to exert in order to perform the behaviour. Generally, the stronger the intention to engage in a behaviour, the more likely will be its performance.

Figure 2.4 Theories of reasoned action and planned behaviour (Adapted from National Cancer Institute, 2005, p. 18).

The theory of planned behaviour proposes three conceptually independent causes of intention. The first is the attitude toward the behaviour and refers to the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question. The second predictor is a social factor termed subjective norm which refers to the perceived social pressure to perform or not to perform the behaviour. The third antecedent of intention is the degree of perceived behavioural control which refers to the perceived ease or difficulty of performing the behaviour and it is assumed to reflect past experience as well as anticipated impediments and obstacles.

However, Ajzen (1991) notes that an intention can only result in the performance of behaviour if the behaviour in question is under volitional control, i.e. if the person can decide at will to perform or not perform the behaviour. Ajzen (1991) suggests that although some behaviour may meet this requirement, the performance of most behaviour depends at least to some degree on such non-motivational factors such as the availability of required opportunities and resources (e.g. time, money, skills, cooperation of others). Collectively, these factors represent people’s actual control over the behaviour. The resources and opportunities available to a person to some extent dictate the likelihood of behavioural achievement.

2.4.5.1 Contribution of the theory of reasoned action and planned behaviour

Theory of reasoned action and the theory of planned behaviour are psychological theories and add to the personal factors of the adoption process (Botha & Atkins, 2005). The capacity of the individual to perform a behaviour is also influenced by volitional control. However, these theories do not account for the contextual factors such as the availability of requisite opportunities and resources, e.g. time, money, skills, and the cooperation of others, which can influence volitional control. The theory of reasoned action describes the drivers of an individual‘s behaviour but does not shed light on how the individual makes a decision to adopt or reject an innovation. Beliefs, attitudes and subjective norm are part of the individual. The concept of intention to behave in a particular manner may be useful to better understand adoption decision-making and is part of the personal factors of the adoption decision-making model (Botha & Atkins, 2005).

The Boston University School of Public Health (2013, p. 3) note a number of limitations of these theories which include the following.

1). Although noted by Ajzen (1991), these theories do not account for the effect of non-motivational or contextual factors which affect the expression of behavioural intention. While it does consider normative influences, it still does not take into account other contextual factors such as environmental or economic factors that may influence a person's intention to perform a behaviour.

2). The theory of planned behaviour assumes that human beings are rational and make systematic decisions based on available information.

3). It does not account for other variables that factor into behavioural intention and motivation, such as fear, threats, mood, or past experience.

4). It assumes that behaviour is the result of a linear decision-making process, and does not consider that it can change over time.

5). The time frame between intent and behavioural action is not addressed.

2.5 Theoretical framework for this research

The review of the theoretical frameworks suggests that the innovation adoption decision-making process is influenced by a range of factors. Of interest in this study is the influence of Canterbury dairy farmers’ personal characteristics and farm characteristics or farmers’ socio-demographics. The theoretical frameworks also indicate that information is an important factor influencing the innovation adoption decision.

Botha and Atkins’ (2005) framework integrates the complimentary aspects of the different theories. They view innovation adoption as decision-making by individuals that requires cognition, i.e. it requires the use of an individual‘s abilities to perceive, understand, and interact with their environment in an intelligent manner, and in this sense the person and their environment play a role in the process. They suggest that an individual's personal characteristics and contextual factors such as social and cultural contexts, climate and geography, and resources and economic conditions influence the adoption decision-making process. However, given the importance of information to the decision making process identified by all of the reviewed theories, it is proposed to expand this framework to include farmers' ISCs as a discrete set of influential factors (Figure 2.5).

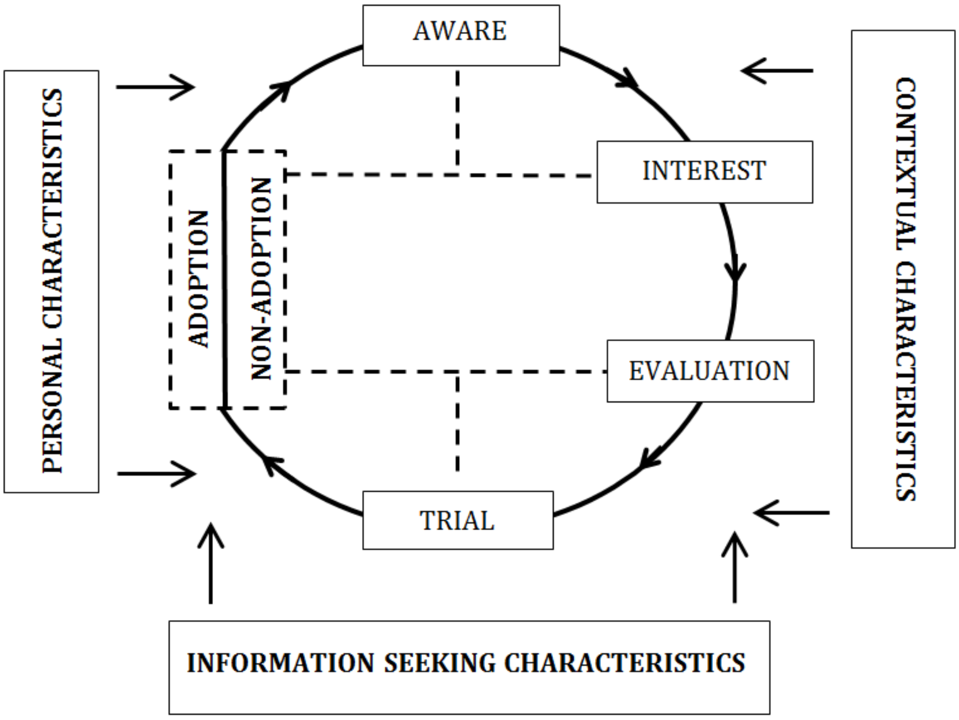

Figure 2.5 Theoretical framework used to guide this research (Adapted from Botha & Atkins, 2005, p. 3, Lionberger, 1961, p. 4).

This framework will help in interpreting the results of this research as it recognises the decision-making process as a discrete process which is influenced by personal and contextual factors as well as potential adopters' ISCs. Socio-demographics include personal factors such as age, education and experience and farm characteristics include factors such as farm size, farm type and the operating system which are likely to be influenced by personal and contextual factors. The following section presents a number of empirical studies which have investigated the influence of farmers' socio-demographics and farm characteristics on innovation adoption. This will identify the characteristics which are commonly used in innovation adoption research. Following this section, suggestions from the literature as to how common socio-demographic and farm characteristics may influence the decision to adopt a FMP innovation are presented.

2.6 Empirical research findings on innovation adoption in agriculture

Based on the importance of personal and contextual factors outlined above, a number of empirical studies which investigated the influence of farmer and farm characteristics on agricultural innovation adoption are presented. These studies are relevant to this research as they establish the variety and type of variables used in the investigation of FMP adoption among dairy farmers. Although contextual variables (social, cultural, market orientation and geographical) are likely to constrain comparisons between all studies, only three studies conducted in developing countries have been included due to their relatively low relevance to the CDI.

The importance of herd expansion and socio-demographics to adoption was examined by El-Osta and Morehart (1999) using data from the United States Department of Agriculture's (USDA) 1993 Farm costs and returns survey. El-Osta and Morehart (1999) identified age, farm size, and specialisation in dairy production as important in increasing the likelihood of adopting a capital-intense technology, while education and size of operation positively impacted the decision to adopt a management-intense technology. Age, education, credit reserves, size of operation (and increased usage of hired labour) positively influenced the decision to adopt a combined capital and management intense technology. The researchers noted that farms which adopted technological innovations had higher levels of productivity.

Paudel, Gauthier, Westra and Hall (2008) assessed the impact of socioeconomic factors on the best management practices (BMPs) adoption decisions of dairy farmers in the state of Louisiana, USA. BMPs were defined by Paudel et al. (2008, p. 203) as voluntary practices producers adopt, or structures they build, to manage resources and mitigate environmental pollution from agriculture. Farmer data was collected via a farmer questionnaire mailed to 325 dairy farmers. Paudel et al. (2008) identified that the likelihood of adoption of a specific BMP was related to a set of socio-economic and financial variables which included years of experience in dairy farming, education, presence of a successor, net farm incomes, debt-to-asset ratios, non-agricultural value of the farm, and the farmer's environmental ethos. Farmers identified the Louisiana State University Agricultural Centre, USDA, Natural Resource Conservation Service, Hoard's Dairyman[3], and similar dairy-specific publications as the most important sources of information influencing their adoption of BMPs.

In Irish agriculture, Howley, O' Donoghue and Heanue (2012) examined what farm or farmer characteristics affected the probability of dairy farmers using artificial insemination (AI). The data source used was the Irish national farm survey 1995 to 2009. Howley et al. (2012) found that having a successor as well as participation in a farm advisory programme positively affected adoption.

[3] Hoard's Dairyman is an American magazine with international circulation first issued in 1885. Also known as the National Dairy Farm Magazine, it contains information for and about the dairy industry (hoards.com, 2013).

Age and having off-farm income negatively affected adoption. The authors note that the results suggest significant heterogeneity exists among farm households, both in the characteristics of the farmer as well as structural farm factors, all of which were found to significantly affect the probability of a farmer adopting this particular agricultural innovation.

In an investigation of the adoption of a range of BMPs among dairy farmers in Turkey, Boz, Akbay, Bas and Budak (2011) reported results similar to Paudel et al. (2008). Their results showed that age, income, investment and the owning of improved breeds of animals positively influenced adoption. Use of the internet, contact with extension personnel, veterinarians and members of an agricultural faculty all increased the level of adoption among farmers. Reading of newspapers, use of television and radio, and travels to provincial centres were shown to have no significant impact on adoption. The BMPs included the use of AI, concentrated feeds, vitamins, proteins, silage, veterinary services, and inoculations.

The adoption of innovations among dairy farms in the Menoufia province in Egypt was researched by Shahin (2004). Farmer data was collected via a questionnaire and showed that the amount of labour devoted to crop production (level of specialisation) and farmer age significantly negatively influenced the adoption of most buffalo dairy innovations. Farmer education was positively correlated with the adoption of most innovations as was the use of a veterinarian, and cosmopoliteness[4]. It is noted that the influence of cosmopoliteness contrasts with Boz et al.'s (2011) results. Mass media exposure, credit and contact with veterinarians were positive and significant for adoption of some innovations as was herd size, farm size and the effect of milk sales. In contrast with Howley, et al. (2012), Shanin's (2004) results showed that the effects of extension on farmers did not influence the adoption of most dairy production innovations while additional income positively and significantly influenced the adoption of AI and other innovations.

Rezaei and Bagheri (2011) conducted a comparative analysis of the characteristics of adopters and non-adopters of AI among Iranian farmers. Data analysis revealed that adopters and non-adopters of AI were significantly different in the case of variables such as animal husbandry experience, farm size (pasture), perceived ease of use and perceived usefulness of AI, profitability of AI and the need to use AI. Logistic regression analysis showed that the key determinants of predicting innovation adoption were farmer need and innovation proneness. The results also indicated that non-adopters had more experience than adopters, thought to indicate that experienced farmers are resistant to change.

[4] Cosmopoliteness refers to an interest in people, topics, and ideas outside one's immediate social system (Rogers, 1983, p. 200). Cosmopolites, as opposed to localites, are more likely to travel more extensively, particularly outside of their local region and country, have a diversity of interests, and a diversity of interpersonal communication networks (Rogers, 1983, p. 200; Jeffres, Atkin, Bracken & Neuendorf, 2004).

Investigating innovation adoption in Dutch agriculture, Diederen, van Meijl and Wolters (2003) found that innovation adoption among Dutch farmers in 1998 was positively related to past adoption behaviour, labour resources (which is highly correlated to farm size), access to information and market position, but was negatively related to solvency (thought to indicate that farms with a high solvency rate are risk averse and not eager to innovate) and to the business environment, in particular the degree of market regulation. In contrast to Howley et al. (2012), Diederen et al. (2003) found that the influence of heterogeneity was limited and was not statistically significant.

A meta-analysis of research literature undertaken by Prokopy, Floress, Klotthor-Weinkauf and Baumgart-Getz (2008) identified that education levels, capital, income, farm size, access to information, utlilisation of social networks, environmental awareness and positive environmental attitudes are generally, positively associated with the adoption of BMPs. However, they noted that none of these factors were consistently positive nor are any of them positive at an overwhelming rate (Prokopy et al., 2008, p. 310). Ghadim and Pannell (1999, p. 145) also note that "*the results from different studies are often contradictory regarding the importance and influence of any given variable*".

A study by Beswell and Kaine (2004) investigated the relationships between the adoption of pest and disease management practices and the characteristics of farmers and their enterprises. No consistent relationships were found across industries and countries between these management practices and variables such as enterprise characteristics and farmers' characteristics such as age, education and experience. They go on to suggest that farmers learn about, experiment with, and evaluate management options within the particular context of their enterprises (given the constraints imposed by the realities of commercial production) (Beswell & Kaine, 2004, p. 682).

Although not concerning socio-demographics directly, evidence presented by Ormrod (1990) strongly suggests that geographic location, which ultimately influences an adopter's environmental, social, cultural and economic circumstances, as well as the compatibility of an innovation to a particular location, is also an important consideration when investigating innovation adoption. Eurostat (2013, p. 1) suggests that site-specific agricultural and environmental conditions are likely to influence FMPs and this may explain some of the inconsistencies noted above. Ormord's (1990) research did not concern agricultural innovations. However, the influence of geographic location, i.e. aspect, topography, climate and resource availability (e.g. water availability) was identified by Pangborn (2012) as a being a major contributor to growth in the CDI.

Table 2.2 Summary of empirical research findings on innovation adoption in agriculture

Research details and variables identified
El-Osta & Morehart (1999): USA dairy farmers' adoption of capital and management intensive technologies Age, farm size, and specialisation in dairy production (capital-intensive). Education and size of operation (management-intense). Age, education, credit reserves, size of operation and usage of hired labour (combined capital and management-intense technology).
Paudel, Gauthier, Westra & Hall (2008): USA dairy farmers' adoption of BMPs Years of experience, education, presence of a farm successor, net farm incomes, debt-to-asset ratios, non-agricultural value of the farm, farmers' environmental ethos. Information sources identified as important: Louisiana State University Agricultural Centre, USDA, Natural Resource Conservation Service (NRCS), dairy-specific publications.
Howley, O Donoghue & Heanue (2012): Irish dairy farmers' adoption of A.I. Family circumstances i.e. the presence of an heir, involvement in extension, age, off-farm job.
Boz, Akbay, Bas & Budak (2011): Turkish dairy farmers' adoption of various innovations. Age, income, investment and the owning of improved breeds of animals. Use of the internet, contact with extension personnel, veterinarians and members of an agricultural faculty. Reading of newspapers, use of the television and radio and travels to provincial centres were shown to have no significant impact on adoption.
Shahin (2004): Egyptian smallholder buffalo dairy farmers' adoption of management practice innovations. Level of specialisation, farmer age, farmer education, use of a veterinarian and cosmopoliteness, mass media exposure, credit availability, contact with veterinarians, herd size, farm size, milk sales, additional income, extension.
Rezaei & Bagheri (2011): Iranian dairy farmers' adoption of A.I. Animal husbandry experience, agro-pasture landholding size, perceived ease of use and perceived usefulness, farmer need and farmer innovation proneness.
Diederen, van Meijl & Wolters (2003): Dutch farmers' adoption characteristics Past adoption behaviour, labour resources (which is highly correlated to farm size), access to information, market position, solvency, the business environment (in particular the degree of market regulation).
Prokopy, Floress, Klotthor-Weinkauf & Baumgart-Getz (2008): Meta-analysis of research literature on the adoption of BMPs Education levels, capital, income, farm size, access to information, utilisation of social networks, environmental awareness, and positive environmental attitudes. However, inconsistencies evident.
Beswell & Kaine (2004): Adoption of pest and disease management practices No consistent relationships found between socio-demographics and adoption of these FMPs suggesting that farmers learn about, evaluate and adopt FMP based on the context of their production systems.

2.7 The influence of socio-demographics on innovation adoption

A broad range of variables associated with innovation adoption in agriculture were identified in section 2.6 above. Inconsistencies in the importance and influence of any given variable were identified but the literature suggests that farmer age, education, experience and farm size are commonly assessed socio-demographic variables.

In a literature review of the influence of farmer demographic characteristics on environmental behaviour, Burton (2014, p. 19) suggests that both quantitative and qualitative investigations of farmers' behaviour almost always include measures of the characteristics of the farm owner/manager including their age, education, and experience. He suggests that these personal features are measured because they influence the choices people make, and consequently provide an indication of how one group of farmers (e.g. older, less experienced, better educated) will behave given a particular circumstance. Pannell et al. (2006) also suggest that demographic and situational variables are important because they will influence the goals of the landholder and potentially influence the capacity to adopt an innovation while Boz et al. (2011, p. 252) suggest that as adoption is an individual decision, different characteristics of individuals may influence their adoption process.

There has been a wealth of research investigating the effect of farmers' socio-demographics on decision-making. In a review of this literature, Edwards-Jones (2006, p. 784) identified that the farmer characteristics shown to be important in adoption decisions include age, education, gender, attitude to risk and personality, and that farm characteristics likely to influence decision-making include farm type, farm size and debt to asset ratio. Important variables influencing adoption decisions included in the social milieu include the level of extension, information flows, local culture, social capital, attitude of trusted friends, the policy environment and the structure and impact of a range of institutions (Edwards-Jones, 2006).

Regarding the influence of age, Burton (2014) suggests that within the literature four main causal explanations have been postulated. First, the farmer's age reflects the social cohort (farming sub-culture) within which he/she was raised. Cohort effects occur when attitudes and beliefs become fixed to a particular historical social context through education, socialisation, or the accumulation of preferences and experiences around a set of practices or technologies related to a particular time period. Second, age influences both physical and mental efficacy which in turn affects enterprise choice, labour decisions (and time allocation) and land use decisions. Third, researchers often observe a high correlation between age and measures of experience. Fourth, age can represent the life-cycle stage of the farm family which can have a direct impact on management decisions as different phases are accompanied by different motivations and interests, e.g. alternating emphasis on commercial and amenity goals over the life-time of the farmer.

Regarding farmer experience, Burton (2014) summarised from the literature that first, farmer experience is believed to increase the level of skill and knowledge at a particular practice (similarly to education) which, in turn, increases the efficacy of the behaviour. As farmers become more proficient at a particular type of farming, the appeal of alternatives is likely to diminish. Conversely, this knowledge may enable farmers to better identify the potential benefits of FMP innovations. Second, in an agricultural context, experience increases the extent to which decision-making is intuitive rather than planned. Third, Burton (2014) identified literature which suggests that experience with environmental degradation resulting from agriculture normalises environmental damage such that farmers come to regard it as part of agriculture rather than problematic. In the context of this research, the same may be true for farmers who practice poor or antiquated FMPs. Fourth, experience represents the extent to which farmers are structurally/culturally locked in to their current form of production. For example, when combined with existing farm structures, experience has been said to represent the past legacy of land use and increases the likelihood that historical land use will continue.

Burton (2014) suggests that, first, education influences decision-making through initiating attitude change, which according to the theory of planned behaviour is one of the antecedents for behaviour change. It is suggested that education can introduce new knowledge which helps farmers to recognise problems. Second, as with experience, education has been associated with the level of cultural capital held by an individual via status generated by improved efficacy of management, which can tie people into socially accepted courses of action. However, researchers have also observed that in farming communities educational qualifications tend to be less valued than the skills and knowledge generated by experience in the practice of agriculture. Third, education is believed to increase the efficacy of farm management through the enhancement of technical skills required to operate new technological innovations.

In a survey of rural decision makers in the Canterbury, Southland and Waikato regions of NZ, Brown et al. (2013, p. 35) reviewed literature surrounding the influence of farm size and note that farm-size is seen as having a critical role in influencing decision-making. They suggest that as well as representing past strategic and entrepreneurial behaviour; it also represents the farmer's future capacity for generating agricultural income from the farm and provides leverage for borrowing capital. Larger farms are also less vulnerable to a range of economic and environmental conditions and consequently, it has been suggested that increasing farm size decreases risk aversion. In general, the literature suggests that larger farms (i.e. with more resources) are more likely to adopt innovations because of economies of scale (Brown et al., 2013).

Brown et al. (2013, p. 35) note Jørgensen, Jørgensen and Clausen's (2007) suggestion that system-oriented strategists tend to manage bigger farms, whereas those who rely on experience (experience based strategists) operate medium to low farm sizes. They suggest that one reason for this difference is that the role of the farmer changes as the farm size gets larger from a 'hands-on' land manager to a business manager and as a consequence, the manager takes a more system-oriented approach rather than relying on intrinsic knowledge. Consequently, in addition to farm size, the necessary personal characteristics of the manager also influences the options available to farmers; "*… larger farms have complex management systems requiring their managers to be more managerially oriented (and therefore potentially hold higher educational qualifications than farmers on small family farms)*" (Brown et al., 2013, p. 35).

2.8 Summary of the literature review

This review of the innovation adoption literature provides several points of guidance for the current study into FMP innovation adoption in the CDI. This has been achieved by reviewing literature on the theories and assumptions, and empirical research concerning the phenomenon of innovation adoption. A graphical interpretation of these findings from the literature review has been expressed in figure 2.5, page 25. This model suggests that the decision to adopt an innovation is a multi-step process which is influenced by personal and contextual factors. A review of empirical research supports this framework and has identified a number of personal and contextual factors or socio-demographic variables that have been shown to influence innovation adoption.

A common theme through-out this review has been the inconsistency of previous research results which stem from the investigation of a complex, context-sensitive phenomenon conducted by a number of different disciplines. Inconsistencies have also been observed in empirical research results surrounding the importance and influence of a number of commonly assessed variables. The inconsistency in the literature has created the knowledge gap surrounding what factors influence innovation adoption in the current CDI. The multidisciplinary approach taken in this literature review will enable a greater understanding of the importance of these factors.

2.9 Knowledge gap

The lack of New Zealand research investigating the influence of farmer, farm and information seeking characteristics on FMP innovation adoption contributes to a knowledge gap. The inconsistency in the importance of any given variable along with the influence of geography on FMPs (Eurostat, 2013) and innovation adoption (Ormrod, 1990), represent a knowledge gap in relation to innovation adoption on dairy farms in Canterbury. The disciplinary fragmentation constraining comparability and generalisability of research results, also contributes to this gap. To help bridge this gap, this research guided by the framework adapted from Botha and Atkins (2005) and Lionberger (1961) (Figure 2.5, page 25), will investigate the influence of farmers' personal and farm characteristics and ISCs on FMP innovation adoption in the CDI.

2.10 Research questions

Based on the findings from the literature review, this research will seek to provide understandings of FMP innovation adoption on dairy farms in Canterbury, New Zealand. Thus the research questions that will be answered are:

1). What are the farmer characteristics, farm characteristics and ISCs of Canterbury dairy farmers?

2). What is the level of adoption of a range of FMP innovations in the CDI?

3). How do farmer characteristics, farm characteristics and ISCs influence FMP innovation adoption in the CDI, and to what extent?

4). What other factors may be influencing Canterbury dairy farmers' adoption of FMP innovations?

5). What theory(s) can be used to best explain FMP innovation adoption in the CDI?

6). Can existing theory be modified/updated to accommodate Canterbury dairy farmer innovation adoption?

Chapter 3

Research methodology and methods

3.1 Introduction

This chapter presents the research design and methodology, and data collection and analysis. Section 3.2 presents the philosophical assumptions underpinning this research while section 3.3 details the research approach. The method of data collection and sample selection are presented in section 3.4. Data analysis is presented in section 3.5 and the chapter is summarised in section 3.6.

3.2 Philosophical assumptions

"*Without some knowledge of philosophy or context, technique can become an empty process*" (Ryan, 2006, p. 12).

A philosophical assumption or paradigm has been defined as "*an entire way of looking at the world*" (Davidson & Tolich, 2003, p. 26). For this research, the adoption or rejection of an innovation is viewed as the result of a process influenced by a number of different variables. Of interest to this study are Canterbury dairy farmers' socio-demographic and farm variables, and their ISCs. This represents a deterministic philosophy or that of postpositivism (Creswell, 2003). Postpositivism is concerned with determination (cause and effect), reductionism (reducing ideas into small discrete sets of ideas to test), empirical observation and measurement, and theory verification. "*Thus developing numeric measures of observations and studying the behaviour of individuals become paramount for the postpositivist*" (Creswell, 2003, p. 7).

3.3 Research approach

The objective of this exploratory research is to determine the characteristics of Canterbury dairy farmers, their farms and their ISCs to examine how these influence the adoption of a range of FMP innovations in the CDI. A quantitative research approach is thought the most appropriate for this study as it allows the examination of patterns across many cases, and it can identify the relationships between variables and show that a relationship between variables is numerically significant as well as providing unambiguous information (Ryan, 2004, p. 21).

The data generated by a quantitative approach (which can be experimental designs or non-experimental designs such as surveys (Creswell, 2003, p. 6)) are numerical; they are information about the world in the form of numbers (Punch, 2005, p. 55). In their review of the innovation adoption literature, Tornatzky and Klein (1982, p. 39) suggested that non experimental research designs such as surveys were methodologically adequate to investigate innovation adoption as they permit both replicability and some degree of cross-study comparability. A survey in the form of an electronic questionnaire was used to collect the data for this research. To facilitate a greater understanding of innovation adoption among Canterbury dairy farmers, qualitative data in the form of respondents' comments as to why they adopted or rejected a particular innovation were also collected using this questionnaire.

3.4 Method of data collection

Data was collected using a survey in the form of an electronic questionnaire delivered via email. Surveys collect information about the same variables from a number of cases resulting in a variable by case matrix or a structured data matrix (de Vaus, 1995, p. 3). The production of a data matrix is central to data analysis which is based on the comparison of cases (de Vaus, 1995, p. 5). Questionnaires ensure this structured data matrix and are a commonly used technique in survey research (de Vaus, 1995, p. 5; Punch, 2005, p. 75).

Internet based or email surveys can offer large cost and time efficiencies when compared with postal surveys through the near elimination of paper, postage and data entry costs (Dillman, 2007, p. 352). Greater time efficiencies in survey design, implementation and the processing of survey data are also an attractive feature of electronic surveys. Some disadvantages of email based surveys include internet connection/access, deliverability (accurate email addresses and spam filters), computer literacy and online survey fatigue (relentless requests to participate in online surveys), which may lead to reduced response rates (Dillman, 2007; Ilieva, Baron, & Healy, 2002; Pecoraro, 2012). In general, response to email surveys is in the 5-10 per cent range (Semler, 2010, p. 1).

3.4.1 Farmer questionnaire background

The survey was conducted with the help of the Department of Agricultural Management and Property Studies at Lincoln University and was funded by the SIDDC with a postgraduate student summer scholarship. The online questionnaire was to determine the socio-demographics, farm characteristics and ISCs of Canterbury dairy farmers, and to assess the level of adoption of ten innovations that had been trialled by the LUDF between 2001 and 2012. Data was also collected on additional topics of interest to the SIDDC, for example farmers' suggestions regarding future research for the SIDDC. This data was not relevant to this study and a result has been excluded.

Qualtrics, a secure online survey software application available through Lincoln University was used in the design, distribution and preliminary evaluation of the electronic questionnaire. Qualtrics provides rigorous privacy standards with account password protection and real-time data replication (Qualtrics.com, 2012). Pangborn's (2009) postal questionnaire was used as a template in the design and construction of the electronic questionnaire. After consultation with selected staff members from SIDDC and Lincoln University, the questionnaire was tested on a trial group of individuals involved in dairy farming, agricultural extension, and research. Suggestions from this group as to question content and survey format were included in the final questionnaire. The questionnaire was submitted for review and approval by the Lincoln University Human Ethics Committee, with approval granted on 28/11/2012 (application number 2012-46, Appendix A, page 121).

3.4.2 Questionnaire format and content

The electronic questionnaire consisted of three sections. Section one gathered quantitative data on farmer and farm characteristics which included the position of the person answering questions, highest level of formal education, gender, age, dairy farming experience, if they had a financial/managerial interest in more than one dairy farm, farm size (effective ha), production per cow and per effective ha (kg of milksolids (MS) to the factory), farming system (as defined by DairyNZ), pre-dominant breed of dairy cow, replacement dairy stock management and farmer opinion on standoff facilities/partial housing for livestock.

Section two collected quantitative data on attendance at industry extension events and reasons for attendance at these events, and asked farmers to rank sources of information used for learning about LUDF results, and new agricultural technology and innovations. Section two also asked farmers to indicate their adoption or rejection of ten FMP innovations practiced by the LUDF and briefly comment on their decisions. These FMP innovations included low and consistent grazing residuals, re-grassing based on measurement of poor performing paddocks, synchronising of heifers to calve two weeks before the herd, zero induction policy, use of Eco-n, monitoring of soil moisture to drive irrigation practice, regular monitoring of cow condition to facilitate alternative management, creating a separate herd of young cows to facilitate alternative management, use of nitrogen fertiliser and gibberellic acid simultaneously to promote dry matter production and pre-graze mowing to increase animal intakes. A description of these FMP innovations is provided in Chapter 4, section 4.4.2.

The final part of the questionnaire, section three, contains questions on the farmer's use of a private consultant/advisor, the services provided by their consultant and how information is received from their consultant. Farmers were also asked to indicate the degree of difficulty experienced when obtaining relevant industry information on a number of topics. The final question regarded planned changes to farm infrastructure to accommodate environmental concerns and asked farmers to comment on what these changes might be.
A paper copy of the electronic questionnaire is provided in Appendix B, pages 122-130.

3.4.3 Sample selection

The primary objective of this research was to determine how Canterbury dairy farmer, dairy farm and farmer information seeking characteristics influence the adoption/rejection of a range of FMP innovations. To achieve this, the survey sample should include every person responsible for production/management decision-making on Canterbury dairy farms. However, the availability of reliable and current farmer contact details ultimately influenced sample selection. For this research, the farmer email contact list used to distribute the electronic survey was supplied by the Canterbury Dairy Effluent Group (CDEG) and consisted of dairy effluent discharge consent holders. The Canterbury Dairy Effluent Group includes AgITO, DairyNZ, Environment Canterbury, Federated Farmers, Fonterra, NZ Dairies, SIDDC, Synlait and Westland Milk Products (Beck, 2012).

Dairy effluent discharge consents require a detailed knowledge of the dairy production system and of the land on which dairy effluent is to be discharged, as evidenced by the consent application form (see Environment Canterbury, 2013). The discharge consent holders are responsible for compliance with consent conditions and are typically land owner(s) but may also be lessees or the occupier of the land. Non-compliance with the conditions specified in the consent can result in the issuing of infringement notices, abatement notices and/or prosecution by the Canterbury Regional Council (Beck, 2012). Therefore, it is assumed that the dairy effluent consent holder will occupy a position of authority and/or high responsibly on-farm and as a result, will also be intimately involved in on-farm decision making.

The CDEG contact list contained the contact information for 1012 dairy effluent discharge consent holders identified by a unique consent identification number. After duplicate email addresses (i.e. same email address associated with more than one discharge consent number) and contacts which had no or an invalid email address were removed, the final list contained 647 dairy farmer email addresses (64 per cent of the population).

3.4.4 Distribution of the electronic questionnaire

The survey was emailed to the 647 farmer email addresses on the 12th December 2012. A reminder to participate in the survey was distributed on the 21st December 2012 with a second reminder distributed on 15th January 2013. This is in line with research which suggests multiple contacts may help increase online survey response rates (Dillman, 2007; Kaplowitz, Lupi, Couper, & Thorp, 2012). The opportunity to win a choice of two prizes (an iPad or two free registrations to the SIDE 2013 conference) was also used to incentivise participation. A total of 144 surveys were returned by 15th February 2013 giving a response rate of 22 per cent.

3.5 Data analysis

The statistical software package for social sciences (SPSS 20) was used to conduct data analysis. Consultations with staff members in the Department of Agricultural Management and Property Studies at Lincoln University helped provide guidance and feedback throughout the analysis process.

3.5.1 Survey data

The electronic questionnaire contained 37 questions covering a broad range of topics. To enable prompt completion of the questionnaire, 29 questions asked respondents to select from a number of pre-determined answers or categories. As a result, these questions provided categorical data. Five questions asked respondents to enter a number, e.g. farm size, production per cow and per effective ha, how often the respondent visited the SIDDC/LUDF website and number of attendances at DairyNZ events. These questions produced continuous or scale data. The remaining three questions specifically asked for respondents' written comments or views thus providing qualitative data. Eleven questions, included in the 29 categorical questions above, collected both categorical data and qualitative data in the form of respondents' written comments.

3.5.2 Variable types included in the analysis

A variable is defined as a characteristic of the participants or situation for a given study that has different values (Morgan, Leech, Gloeckner & Barrett, 2007, p. 1). The questionnaire produced a total of 119 variables of which 114 consisted of categorical data and 5 of continuous data (Morgan et al., 2007, pp. 37-42). Variables consisting of categorical data can be dichotomous (have only two categories which in some cases may be ordered (i.e. can be treated as an ordinal variable), ordinal (where categories can be ranked in some meaningful way) or nominal (categories have no implied order or rank) while variables consisting of continuous data are referred to as scale variables (Morgan et al., 2007, pp. 39-40).

The distinctions between dichotomous, ordinal, nominal, and scale variables are important when choosing and interpreting appropriate statistics (Morgan et al., 2007, p. 41). The dichotomous variables included in the analysis are financial/managerial interest in more than one farm, use of a private consultant, and adoption or non-adoption of the 10 innovations. These variables have been treated as ordinal. It was assumed that having an interest in more than one farm and using a private consultant would have a positive effect on innovation adoption as a result of greater resources and scale, and greater access to extension information. Adoption and non-adoption of each innovation is also treated as ordinal, as this research is interested in what variables influence the adoption of the innovations rather than non-adoption.

The remainder of the categorical variables included in the analysis have a logical order and are treated as ordinal. For example age, years of experience, highest level of formal education, position of person answering the questions, and 5 point Likert scales used to rank information sources. The scale variables included in the analysis are also treated as ordinal, based on Morgan et al. (2007, p. 41) who recommend that if a variable contains five or more ordered values and its frequency distribution is substantially non-normal, then the variable should be treated as ordinal.

For normally distributed data, the mean, median and mode are equal, and the skew and kurtosis values are 0 (Field, 2009, p. 19). Skew is a measure of the symmetry of the frequency distribution while kurtosis refers to the degree to which scores cluster at the tails of the distribution (Field, 2009, p. 19) and how peaked or pointy the distribution is (Morgan et al., 2007, p. 50). A skew or kurtosis value close to 1 or -1 indicates non-normal distribution of the data (Morgan et al., 2007, p. 50). Data distribution can also be assessed visually and by using the Kolmogorov-Smirnov test (Field, 2009, p. 145). The Kolmogorov-Smirnov test compares the scores in a sample to a normally distributed set of scores with the same mean and standard deviation (Field, 2009, p. 145). If the test is significant (Sig. or p <.05) the distribution is significantly different from normal (Field, 2009, p. 144).

The skew and kurtosis values for all variables with the exception of production per ha, indicate that the data is not normally distributed (Table 3.1). The Kolmogorov-Smirnov test results indicate that the data is significantly different from normal distributed data in all five variables (Table 3.2).

Table 3.1 Descriptive statistics for the scale variables included in the data analysis

	Farm size (effective ha)	Production per cow (kg MS)	Production per ha (kg MS)	Use of website (times per year)	Attendance at DairyNZ events (times per year)
n	116	107	111	74	93
Mean	340	433	1538	13	3
Median	194	430	1565	7	3
Mode	300	400[a]	1600	6[a]	4
Std. Deviation	620	47	288	14	2.5
Skewness	6.30	.21	-.34	1.81	.79
Std. Error of Skewness	.23	.23	.23	.28	.25
Kurtosis	45.86	3.29	.62	2.90	.97
Std. Error of Kurtosis	.45	.46	.46	.55	.50
Range	46-5467	280-630	680-2300	0-60	0-12

[a] Multiple modes exist. The smallest value is shown

Table 3.2 Results of the Kolmogorov-Smirnov test for the scale variables

	Kolmogorov-Smirnov[a]		
	Statistic	df[b]	Sig.
Farm size (effective ha)	.34	116	.001
Production per cow (kg MS)	.12	107	.001
Production per ha (kg MS)	.10	111	.01
Use of website (times per year)	.23	74	.001
Attendance at DairyNZ events (times per year)	.11	93	.01

[a] Lilliefors Significance Correction
[b] df denotes degrees of freedom and here it is equal to sample size (n)

3.5.3 Statistics used in data analysis

3.5.3.1 Descriptive statistics and univariate analysis

The first objective of this research (research question 1) is to determine Canterbury dairy farmer and dairy farm characteristics as well as farmers' ISCs. The second objective (research question 2) is to determine the degree of adoption of a range of innovations among Canterbury dairy farmers. Univariate analysis, which uses descriptive statistics to describe a single variable in terms of its unit of analysis (for example mean, median, standard deviation, and range) (Babbie, 2010, p. 426) is used to describe and summarise Canterbury dairy farmer and farm characteristics, their ISCs and the level of innovation adoption among these farmers.

3.5.3.2 Descriptive statistics and bivariate analysis

The third objective of this study is to determine the relationships between Canterbury dairy farmers, their dairy farms, and their ISCs, and the relationships between these variables and the adoption of FMP innovations in the CDI. To achieve this, bivariate analysis and multivariate analysis are used.

Bivariate analysis, which is largely descriptive, analyses two variables simultaneously to determine their empirical relationship or correlation (Babbie, 2010, p. 437). Cross tabulation is used to construct percentage tables to explore the data and calculate a correlation coefficient. Non-parametric tests are used for the analysis of categorical data (Field, 2009, p. 691). Non-parametric statistics are also used to analyse continuous data (scale variables) if the data is not normally distributed; an assumption required for the use of parametric tests (Field, 2009, p. 133). The Kendall correlation coefficient, Kendall tau, a non-parametric measure of association is used to determine the direction, strength and significance of the relationships between variables. The rationale behind using Kendall's tau for data sets of this type can be found in Morgan et al. (2007, p. 89 and p. 110), Field (2009, p. 181) and Noether (1990).

3.5.3.2.1 Effect sizes and significance

The correlation coefficient is the effect size and indicates the strength of the relationship (Field, 2009, p. 192). Tau-b (τb) is used for square tables while tau-c (τc) is used for rectangular tables (Morgan et al., 2007, p. 112). The values of tau range from −1 (perfect negative association) to +1 (perfect positive association) with a value of zero indicating no association. Kendall's tau is not directly comparable with Spearman's rs or Pearson's r, as it represents a probability (Field, 2009, p. 193). Conversion from the tau coefficient to equivalent values for Pearson's r is calculated using the formula presented by Walker (2003, p. 526); r = SIN(3.141592654*τ*.5) (Table 3.3). A comprehensive conversion table is provided in Appendix C, page 132. As a general guide, to convert a Kendall τ value to Spearman's rs and Pearson's r, increase the τ value by approxiamtely one third (Field, 2009, p. 193).

It is noted by Morgan et al. (2007, p. 95) and Field (2009, p. 193) that effect sizes need to be interpreted with caution as the choice of correlation coefficient can make a substantial difference to the size of the effect. Morgan et al. (2007, p. 94) also note that effect size measures are not direct indices of the importance of the finding as the effect size will depend on the area studied, methods used and context.

Table 3.3 Effect sizes (Adapted from Morgan et al., 2007, p. 94; Walker, 2003, p. 526).

	Kendall tau[a]	The *r* family
Interpretation of effect sizes	τ	*r* and ϕ
Much larger than typical	≥.49	≥.70
Large or larger than typical	>.33	>.50
Medium or typical	>.20	>.30
Small or smaller than typical	>.07	>.10

[a] The formula used to convert from τ to *r* is *r* = SIN(3.141592654*τ*.5) (Walker, 2003, p. 526).

Significance tests determine the likelihood or probability that a relationship between two or more variables is due to chance occurrence (Sweet & Grace-Martin, 2008, p. 96). A significance level with a low probability (Sig. or $p < .05$) rejects the null hypothesis, i.e. chance is unlikely to explain the pattern in the data, and a high significance value (Sig. or $p > .05$) supports the opposite hypothesis, i.e. chance is likely to have caused the pattern in the data (Sweet & Grace-Martin, 2008, p. 99). If the Sig. or *p* value is small (typically $p < .05$, $p < .01$ or $p < .001$) the finding is statistically significant (Morgan et al., 2007, p. 92). A statistically significant relationship does not necessarily mean that the relationship is strong, reflects causality, or that the relationship is important (Sweet & Grace-Martin, 2008, p. 96).

All significance values reported in this thesis are two tailed unless otherwise indicated.

3.5.3.2.2 Secondary bivariate data analysis

As a result of the number of question categories and the final number of valid responses (n=123), some categories contain a small number of responses (<5). To provide support to the primary analysis and to increase the possibility of discovering significant (p <.05) relationships, similar categories within individual variables were combined. This created new variables which have fewer categories and larger numbers of respondents in each category. The scale variables were also transformed into categorical variables for analysis. This also allows the comparison of groups of farmers, i.e. those with large farms and those with smaller farms. This also enabled a more user-friendly presentation of this data. The number of categories/where to split the data, was guided by the frequency distribution of respondents with the objective of having approximately equal numbers of respondents in each new category (giving a more even distribution of respondents).

For example 'Farm size' (n=116) is a scale variable containing continuous data. A new variable was created, 'Farm size 3.0'. The continuous data was divided based on the frequency of respondents. Farm size 3.0 contains three categories: (category 1) ≤169 ha (n=40), (category 2) 170-254 ha (n=35), and (category 3) ≥255 ha (n=41). Details of the other variables' transformations is provided in Appendix F, pages 167-171.

The number of categories in these new variables range from two to five categories as this better facilitates the use of cross tabulation for analysis. Bivariate analysis using the Kendall tau correlation coefficient is used to determine the relationships between these new categorical variables. The likelihood of significance depends both on sample size (n) and the degrees of freedom. Degrees of freedom refers to the number of observations in a sample that are free to vary (Sweet & Grace-martin, 2008, p. 164). Combining categories increases the degrees of freedom increasing the test's ability to find significant effects. As a result, some additional significant relationships may be identified as significant.

The secondary analysis returned similar results to that obtained in the primary data analysis and these results are provided in Appendix G, pages 172-187. However, a number of additional significant relationships were discovered and these are presented in Chapter 4 along with the results from the primary data analysis.

3.5.3.3 Multivariate analysis

3.5.3.3.1 Logistic regression

Logistic regression is used to analyse the relationships between multiple explanatory variables and a single dependant variable (Sweet & Grace-Martin, 2008, p. 175). In this research, the farmer, farm, and information seeking characteristics are the explanatory variables, and the dependent variable is the adoption or non-adoption of each particular FMP innovation (resulting in ten dependant variables). The explanatory variables can be either continuous or categorical and the dependent variable is typically a dichotomous categorical variable. Logistic regression uses the explanatory variables to predict the likelihood of occurrence of one of the categories of the binary dependant variable, i.e. adoption or non-adoption in this research (Sweet & Grace-martin, 2008, p. 175).

Initially, the likelihood of occurrence of one of the categories in the dependant variable (i.e. adoption or non-adoption) is estimated without including any of the explanatory variables. This initial model or base model provides a reference point with which to judge the improved predictive capability or 'fit' of the models which do include the explanatory variables. Logistic regression generates a number of statistics which are used to determine how well the initial model and the subsequent models which contain the explanatory variables fit the data. Logistic regression also generates coefficients and statistics for the explanatory variables included in the model.

The overall fit of the model is shown by the -2 log likelihood statistic and its associated chi-square statistic (Field, 2009, p. 290). If the significance of the chi-square statistic is $p<.05$, then the model (X^2) is a significant fit to the data. For each variable in the model, a regression coefficient (B), which measures the direction and strength of the relationship between the explanatory variables and the binary dependant variable, is also calculated (Sweet & Grace-martin, 2012, p. 193). Associated with each co-efficient is a Wald statistic which identifies whether the B value is significantly different from zero. If the explanatory variable is significantly different from zero ($p<.05$), it is assumed to be making a significant contribution to the prediction of the outcome (Field, 2009, p. 287).

The strength of a relationship is difficult to gauge with the coefficients as they are measured on a log scale (Sweet & Grace-martin, 2012, p. 193). To overcome this, an odds ratio (Exp(B)), which indicates the change in odds resulting from a unit change in the explanatory variable is calculated (Field, 2009, p. 270). If the value is greater than 1 then it indicates that as the explanatory variable increases, the odds of the event occurring increase, and a value less than 1 indicates that as the explanatory variable increases, the odds of the outcome occurring decrease (Field, 2009, p. 271).

Standard error (SE) and confidence intervals (CI) are also reported. SE is a measure of how representative a sample is likely to be of the population (Field, 2009, p. 43). A large SE indicates the sample may not be representative of the population while a small SE indicates the opposite (Field, 2009, p. 43). Confidence intervals are limits constructed so that for 95 per cent of the time, the true value of the population mean will fall within these limits (Field, 2009, p. 45).

For a comprehensive explanation of logistic regression the reader is referred to Field (2009, Chapter 8) and Sweet and Grace-martin (2012, Chapter 8).

3.5.3.3.2 Linear regression

Linear regression is used to determine the relationships between multiple explanatory variables and a single dependant variable. The farmer, farm and information seeking characteristics are again the explanatory variables. However, the number of innovations adopted by each respondent is the single dependant variable. Similar to logistic regression, linear regression generates a number of statistics which are used to determine how well a model containing the explanatory variables fit the data. Linear regression also generates coefficients and statistics for the explanatory variables included in the model.

R values are the values of the multiple correlation coefficients between the explanatory variables and the dependant variable, and R^2 values are a measure of how much of the variability in the outcome is accounted for by the explanatory variables (Field, 2009, p. 235). For example if the R^2 value for a model is .250, then this model accounts for 25 per cent of the variability in the outcome. The adjusted R^2 is a measure of how well the model generalises and Field (2009, p. 235) suggests that it should ideally be close to the R^2 value. Sig. or *p* values in the ANOVA tables also indicate how well a model fits the data, with Sig. or *p* values of <.05 indicating a significant fit.

The contribution of the individual explanatory or predictor variables is represented as *b* (beta) values (B). The values also indicate to what degree each explanatory variable affects the outcome if the effects of all the other predictors are held constant (Field, 2009, p. 238). For example if a *b* value of a given variable was .250, as this variable increases by one unit, the outcome would increase by .25 units. In addition to *b* values, *t* values and an associated significance value are also calculated for each variable and if the Sig. or *p* value is <.05, the variable is making a significant contribution to the model (Field, 2009, p. 239).

For a comprehensive explanation of linear regression, the reader is referred to Field (2009, Chapter 7).

3.6 Summary

The philosophical assumption underlying this research is that of post-positivism. A quantitative research approach was used to guide the design of this research and data collection consisted of a survey in the form of an electronic questionnaire distributed to dairy farmers via email. Qualtrics survey software was used in the design, distribution and collection of survey data. The survey sample consisted of dairy farmers identified as being holders of dairy effluent discharge consents by the CDEG. It is assumed that the dairy effluent consent holder will hold a position of authority and/or high responsibly on-farm and as a result, will also be intimately involved in on-farm decision-making.

The survey was emailed to the 647 farmer email addresses on 12/12/2012 with a reminder to participate distributed on the 21/12/2012 and a second and final reminder distributed on the 15/01/2013. A total of 144 surveys were returned by 15/02/2013, a response rate of 22 per cent. The analysis of the survey data was conducted using SPSS 20 software and was guided by staff in the Department of Agricultural Management and Property Studies at Lincoln University.

Univariate analysis was used to explore, understand and describe Canterbury dairy farmer and farm characteristics, their ISCs and the level of adoption of the ten FMP innovations of interest in this study. Bivariate analysis was used to determine the strength, direction and significance of the relationships which exist between the various explantory variables (farmer, farm and information seeking characteristics) and the dependant variables (the adoption of each individual FMP innovation, and the number of FMP innovations adopted by each respondent). Multivariate analysis includes logisitc regression, which used the explanatory variables to predict the likelihood of adoption or non-adoption for each individual FMP innovation, and linear regression, which used the same explantory variables to determine their influence on the total number of innovations adopted by each respondent.

Chapter 4

Results

4.1 Introduction

The analysis of the survey data is directed by research questions 1-3. Section 4.2 presents the analysis of Canterbury dairy farmer and farm characteristics, and ISCs (research question 1). Section 4.3 explores the relationships between Canterbury dairy farmers and their dairy farms, as well as the relationships between Canterbury dairy farmers, their dairy farms, and farmers' ISCs.
Innovation adoption is presented in section 4.4 (research question 2 and 3) with the level of adoption for the ten FMP innovations presented first. This is followed by the results of bivariate and multivariate analysis, which explored the relationships between the adoptions of individual innovations as well as the relationships between farmer, farm and information seeking characteristics, and the adoption of individual FMP innovations. Finally, the results of bivariate and multivariate analysis exploring the relationships between farmer, farm and information seeking characteristics, and the total number of innovations adopted by each individual respondent (a measure of respondent innovativeness) are presented.

4.2 Univariate analysis of survey data

4.2.1 Canterbury dairy farmer characteristics

4.2.1.1 Gender and on-farm position of person completing the survey

There were 123 valid responses to the 2012 electronic questionnaire. Of these, 90 per cent were from males. The high number of farm owners, owner-operators and equity managers compared with sharemilkers and managers (Table 4.1) may reflect the nature of the survey population which was sourced from the names on the CDEG list of dairy effluent discharge consent holders.

Table 4.1 Position of person answering questions

Position (n = 123)	Per cent
Owner	57
Owner-Operator	23
Equity Manager	12
50/50 Sharemilker	2
Manager	2
Lower Order Sharemilker	1
Other	3
Total	100

4.2.1.2 Farmer education

Fifty three per cent of respondents had a university education, 13 per cent had an AgITO or Polytechnic education and 34 per cent had a high school education. Overall, 66 per cent of respondents had a post-school education.

4.2.1.3 Dairy farming experience

Nearly 75 per cent of respondents had more than 10 years of industry experience and less than 15 per cent had less than 5 years (Table 4.2).

Table 4.2 Numbers of years actively involved in dairy farming in New Zealand

Experience (n = 123)	Per cent
< 5 years	14
5-10 years	13
10-20 years	24
>20 years	49
Total	100

4.2.1.5 Financial/managerial interest in more than one dairy farm

The level of financial/managerial interest in more than one dairy farm among respondents was 52 per cent.

4.2.2 Canterbury dairy farm characteristics

For farm-based questions, respondents who have a financial/managerial interest in more than one farm were asked to complete the survey using information from the single dairy farm property that they were most familiar with.

4.2.2.1 Size of milking platform (effective hectares)

The most common farm size was 100-200 effective ha and 81 per cent of respondents operated farms of less than 300 ha (Table 4.3). The average milking platform was 340 ha. However, when five farms of greater than 1000 ha were excluded, the average platform size was 231 ha. LIC and DairyNZ (2012) estimate a Canterbury average of 226 ha for 2012.

Table 4.3 Size of milking platform 2011/12 season (effective ha)

Size of milking platform in 2011/12 season (effective hectares) (n = 116)	Per cent
≤100 ha	10
101-200	44
201-300	27
301-400	5
401-500	6
≥501	8
Total	100
	Hectares
Mean	340
Median	194
Interquartile Range	151 - 300
Range	46 - 5513

4.2.2.2 Predominant dairy breed

The predominant breeds of dairy cow among survey respondents were 'Kiwi Cross' (or Friesian X Jersey crossbreed) and Friesian (Table 4.4). Less than 10 per cent of respondents milked Jersey cows.

Table 4.4 Predominant breed of dairy cow in milking herd

Breed of dairy cow in milking herd (n = 119)	Per cent
Kiwi Cross (Friesian x Jersey crossbreed)	58
Friesian	35
Jersey	6
Ayrshire	1
Total	100

4.2.2.3 Farming system

The median farming system used by respondents in the past three seasons is system three while approximately one quarter of respondents operated a system two and a system four. There has been a slight shift away from system two and three in the last three seasons with increasing percentages of respondents operating farming systems four and five (Table 4.5).

Table 4.5 Farming systems (as defined by DairyNZ) for the past three seasons

	System 1: All grass (no feed imported)	System 2: (4-14% feed imported)	System 3: (10-20% feed imported)	System 4: (20-30% feed imported)	System 5: (30-40% feed imported)	Total
Season	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
2010/2011 (n =117)	4	29	41	24	2	100
2011/2012 (n = 115)	5	25	40	27	3	100
2012/2013 (n =116)	5	24	40	28	3	100

4.2.2.4 Milksolids production in kilograms per cow and per effective hectare

Respondents' production per cow fell into three key ranges with 18 per cent producing less than 400 kg, 52 per cent producing between 400-450 kg and the remaining 30 per cent producing greater than 450 kg MS per cow (Table 4.6). Respondents produced an average of 433 kg per cow. LIC and DairyNZ (2012) estimate the 2011/12 Canterbury average at 396 kg MS per cow.

Table 4.6 Milksolids production per cow 2011/12 season (kg to factory)

Production per cow 2011/12 season (kg MS to factory) (n = 107)	Per cent
<350	4
350-400	14
401-450	52
451-500	24
501-550	5
>550	1
Total	100
	Kg milksolids per cow
Mean	433
Median	430
Std. deviation	47
Interquartile Range	406 - 462
Range	280 - 630

Production per ha was significantly, positively correlated with production per cow (τc =.33, $p < .001$, Table 4.21, page 60). Production per ha can also be divided into three key groups, with 25 per cent of respondents producing less than 1400 kg per ha, 50 per cent producing between 1400 and 1700 kg milksolids per ha and 25 per cent producing greater than 1700 kg per ha (Table 4.7). The average production per ha among respondents was 1538 kg. The 2011/12 Canterbury average estimated by LIC and DairyNZ (2012) was 1360 kg.

Table 4.7 Milksolids production per ha 2011/12 season (kg to factory per effective ha)

Production per hectare 2011/12 season (kg to factory per effective ha) (n = 111)	Per cent
≤1000	4
1001-1100	4
1101-1200	6
1201-1300	4
1301-1400	7
1401-1500	16
1501-1600	21
1601-1700	13
1701-1800	6
1801-1900	10
1901-2000	4
≥2001	5
Total	100
	Kg per hectare
Mean	1538
Median	1565
Std. deviation	288
Interquartile Range	1400 - 1700
Range	680 - 2300

4.2.2.5 Mean stocking rate (cows per effective hectare)

Stocking rate was not elicited directly, but has been calculated from milk solids per cow and milk solids per ha (Table 4.8). This is very similar to the 2011/12 Canterbury average at 3.4 cows/ha (LIC & DairyNZ, 2012).

Table 4.8 Respondents mean stocking rate (cow per effective ha)

Respondents stocking rate (n = 105)	cows per effective ha
Mean	3.6
Median	3.6
Std. Deviation	0.5
Interquartile Range	3.4 - 3.9
Range	2.1 - 4.5

4.2.2.6 Dairy replacement young stock management

Use of 'own land' (owned or leased) was the most popular method for rearing heifer calves while contract grazing was the most popular method for rearing yearling heifers (Table 4.9). Respondents tended to use the same management for the two, i.e. used their own land or used contract grazing for both their heifer calves and yearling heifers.

Table 4.9 Dairy replacement young stock management

	Own land (leased or owned)	Contract grazing	Managed by an associated business	Other	Total
Category of livestock	Per cent	Per cent	Per cent	Per cent	Per cent
Heifer calves (weaning to April 30th) (n = 119)	50	40	8	2	100
Yearling heifers (May 1st to April 30th) (n = 117)	42	50	8	0	100
Both heifer calves and yearling heifers (n = 116)	42	41	7	10 [a]	100

[a] Own land used for rearing of heifer calves and contract grazing used for yearling heifers

4.2.2.7 Views of standoff facilities/partial housing for livestock

Eleven per cent of respondents currently have some form of standoff or housing facility and 22 per cent consider it a likely future component of their system (Table 4.10). Approximately one third of respondents consider these facilities inappropriate for New Zealand dairy systems, and more than half consider they are difficult to justify financially.

Table 4.10 Farmers' views of standoff facilities/partial housing for livestock

Views of standoff facilities/partial housing for livestock (n = 120)	Frequency	Per cent
Difficult to justify financially	65	54
Nice to have to minimise treading/pugging damage on the milking platform	56	47
Not appropriate for NZ's pasture/grazing based agricultural sector and market reputation	37	31
Likely future component of milking platform and wintering facility	26	22
Currently part of my farm system for milking platform only	8	7
Currently part of my farm system for wintering and milking	4	3
Currently part of my farm system for wintering only	1	1
Total	197[a]	-

[a] Percentages = frequency/n. A total of 120 respondents answered this question, with many giving multiple responses. Percentages are calculated relative to the number of respondents and hence total more than 100%.

4.2.3 Canterbury dairy farmer ISCs

4.2.3.1 Attendance at LUDF focus days in past three seasons

LUDF focus days are hosted by the SIDDC and are held quarterly on the LUDF where a range of information is provided for South Island dairy farmers with the objective of helping with decision-making (siddc.org.nz, 2013b). Attendance at LUDF focus days has decreased slightly over the past three seasons with nearly half of respondents not attending focus days and fewer respondents attending two or more focus days in 2011/2012 (Table 4.11). Farmers appear to be selective as to whether or not they attend specific focus days with less than 5 per cent attending all four focus days in any of the three years.

Table 4.11 Attendance at any of the four LUDF focus days in the past three seasons

Season	Mean number of times	S.E mean [a]	None	One	Two	Three	Four	Total
			Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
2009/2010 (n = 112)	1.1	0.11	42	22	22	10	4	100
2010/2011 (n = 110)	1.0	0.11	45	24	20	10	2	100
2011/2012 (n = 115)	0.9	0.10	49	24	19	6	2	100

[a] Standard error of mean

4.2.3.2 Reasons for attendance at LUDF focus days

Respondents attended LUDF focus days for multiple reasons. Access to benchmarking information was the most popular reason for attendance with farm management information appearing less important to respondents (Table 4.12). Meeting other farmers was identified by 27 per cent of respondents as a reason for their attendance.

Table 4.12 Reasons for attendance at LUDF focus days

Reasons for attendance at LUDF focus days (n = 82)	Frequency	Per cent[a]
To learn how LUDF is performing	66	80
To compare your farm to LUDF	57	70
For the financial information provided	44	54
To learn about grazing management	38	46
To learn about environmental management at LUDF (minimising nutrient losses, water efficiency etc.)	36	44
To learn about herd/animal management	29	35
To meet other farmers	22	27
To visit with agri-business professionals (bankers, suppliers, etc.)	6	7
Other	3	4
Total	301	-

[a] Percentages = frequency/n. A total of 82 respondents answered this question, with many giving multiple responses. Percentages are calculated relative to the number of respondents and hence total more than 100%.

4.2.3.3 Importance of different information sources for learning about LUDF results

Respondents used multiple information sources for learning about results obtained at the LUDF. All of the information sources were of similar importance to respondents except for 'Tuesday farm walks', which was ranked as the least important (Table 4.13). Tuesday farm walks are conducted weekly by the LUDF farm management team to assess pasture levels on the LUDF and farmers may participate to learn about the LUDF and LUDF farm management (siddc.org.nz, 2013c). The most useful sources of information were the 'SIDDC/LUDF website', 'Dairy newspapers' and 'LUDF focus days'.

Table 4.13 Importance of different information sources for learning about LUDF results

		Very important 1	2	3	4	Not at all important 5	Total
Information source	Mean Ranking	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
SIDDC / LUDF website (n= 107)	2.4	32	33	15	4	16	100
Dairy newspapers (n= 110)	2.5	24	30	29	11	6	100
Focus days (n= 110)	2.5	27	26	26	13	8	100
Other farmers (n= 106)	2.6	16	35	31	12	6	100
Other media publications (n= 105)	2.8	10	31	35	15	9	100
Discussion groups[a] (n= 107)	2.9	13	28	26	24	9	100
Consultants (n=107)	2.9	11	28	35	14	12	100
Tuesday farm walks (n= 97)	4.0	5	9	14	18	54	100

[a] Discussion groups are informal and voluntary gatherings of dairy farmers, usually in person, to exchange ideas, information, and suggestions on needs, problems and subjects of mutual interest (BusinessDictionary.com, 2013).

4.2.3.4 Use of the SIDDC/LUDF website

Eighty five per cent of respondents used the SIDDC/LUDF website in 2012. Respondents visited the website an average of 13 times per year with a median of 7 visits per year (Table 4.14).

Table 4.14 Use of the SIDDC/LUDF website

Use of the SIDDC/LUDF website (number of visits per year) (n= 74)	Per cent
0	15
1-12	55
>12	30
Total	100
	Number of visits per year
Mean	13
Median	7
Interquartile Range	4-20
Range	0-60

4.2.3.5 Importance of different sources of information for learning about new agricultural technology and innovation

Respondents used multiple information sources for learning about new agricultural technology and innovation, with the majority of these information sources ranked as useful or very useful (Table 4.15). 'Demonstration Farms', 'DairyNZ Events' and 'Other farmers' were ranked as the most useful while 'Conferences' and 'Sales/technical staff of suppliers' were ranked as the least useful sources of information for learning of new technologies.

Table 4.15 Usefulness of different sources for learning about new agricultural technology and innovation

		Very useful 1	2	3	4	Not at all useful 5	Total
Information sources	Mean	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Demonstration farms (n= 109)	2.0	35	36	20	8	1	100
DairyNZ events (including discussion groups) (n= 108)	2.0	34	33	25	7	1	100
Other farmers (n= 108)	2.0	31	40	22	6	1	100
Media (TV, magazines, newspapers) (n= 110)	2.3	29	31	27	10	3	100
Consultants (n= 106)	2.3	28	34	18	15	5	100
Conferences (n= 105)	2.5	16	34	39	10	1	100
Sales/technical staff of suppliers (n= 102)	3.0	6	23	39	25	7	100

4.2.3.6 Attendance at DairyNZ events (excluding LUDF focus days)

Eighty per cent of respondents attend DairyNZ events with an average attendance of three events per year (Table 4.16).

Table 4.16 Attendance at DairyNZ events (excluding LUDF focus days)

Attendance at DairyNZ events (excluding LUDF focus days) (times per year) (n= 93)	Per cent
0	20
1	10
2	14
3	13
4	19
>4	24
Total	100
	Number of attendances per year
Mean	3
Median	3
Interquartile Range	1 - 4
Range	0 - 12

4.2.3.7 Regular use of and services provided by, private consultants/advisors

Sixty five per cent of respondents regularly use a private farm consultant/advisor. Respondents employ private consultants/advisors to provide information on a range of topics related to their dairy farm businesses (Table 4.17).

Table 4.17 Use of services provided by private consultants/advisors

Services provided by private consultant/advisors (n = 71)	Frequency	Per cent[a]
Whole farm strategic input	60	85
Financial / farm business advice	47	66
Periodic feed budgeting	35	49
Regular farm supervision and week to week management advice	10	13
Nutritional, technical and other farm management advice[b]	8	11
Staff management/contract advice/employment advice[b]	7	9
Financial and future planning advice[b]	2	3
Total	169	-

[a] Percentages = frequency/n. A total of 71 respondents answered this question, with many giving multiple responses. Percentages are calculated relative to the number of respondents and hence total more than 100%.
[b] Other services provided by farm consultants/advisors were specified by some survey respondents resulting in these three categories.

4.2.3.8 Communication with private consultants/advisors

Respondents use multiple modes of communication to exchange information with their consultant/advisor (Table 4.18). Nearly all respondents engaged one on one with their private consultant, with email and phone calls being the next most popular methods of communication.

Table 4.18 Information communication with private consultants/advisors

Method of communication (n = 83)	Frequency	Per cent[a]
Personal visits	78	94
Email	51	61
Phone call	37	45
Post	4	5
Website	2	3
Fax	1	1
Other	4	5
Total	177	-

[a] Percentages = frequencies/n. A total of 83 respondents answered this question, with many giving multiple responses. Percentages are calculated relative to the number of respondents and hence total more than 100%.

4.2.3.9 Experience with obtaining relevant industry information

Survey respondents found information on day-to-day or shorter term farm management subjects the easiest to find, with information on long term or more strategic areas more difficult (Table 4.19).

Table 4.19 Experience with obtaining relevant industry information

		Have not looked	Easy to find 1	2	3	4	Difficult to find 5	Total
Subject area	Mean	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Animal production (n = 109)	1.9	6	47	33	11	3	0	100
Environment and nutrient management (n = 109)	2.4	3	27	34	21	10	5	100
Farm labour solutions (n = 106)	2.9	9	15	32	26	16	2	100
Dairy farm strategic business advice (n = 109)	3.1	12	12	29	27	14	6	100
Succession planning (n = 107)	3.3	14	10	25	31	12	8	100
Dairy farm business governance (n = 109)	3.3	11	8	24	27	23	7	100

4.3 Bivariate analysis of survey data

4.3.1 Introduction

This section presents the bivariate analysis of the survey data. Bivariate analysis, which is largely descriptive analyses two variables simultaneously to determine their empirical relationship (or correlation). The results of bivariate analysis showing the relationships between farmer characteristics are presented in section 4.3.2., the relationships between farm characteristics are presented in section 4.3.3., and the relationships between farmer ISCs are presented in section 4.3.4. The inter-relationships between these three groups of variables are then presented. Section 4.3.5 presents the relationships between farmer characteristics and farm characteristics. This is followed by the relationships between farmer and farm characteristics, and farmer ISCs.

Bivariate analysis permits greater insight into the relationships between the groups of variables. For example, is farm size significantly correlated with age or education? Cross tabulation was used to further explore the significant relationships ($p < .05$) and this information is presented in Appendix D, pages 132-148. Secondary bivariate analysis using newly created categorical variables (detailed in Appendix F, pages 166-170) identified additional significant relationships. These correlations are presented in Appendix G, page 172-187 and are included in the text below.

4.3.2 Canterbury dairy farmer characteristics

Farmer characteristics include farmer age, highest level of formal education, years of dairy farming experience in NZ, position held on-farm, and financial/managerial interest in more than one dairy farm (or multiple farm interests).

Table 4.20 Correlation of farmer characteristics

		Education (3)	Experience (7)	Position (7)	Multiple farm interests (2)
Age (12)[a]	n	122	123	123	123
	τc	**-.20***	**.28****	**.33****	.10
	Sig.	**.01**	**.00**	**.00**	.32
Education (3)	n		122	122	123
	τc		**-.15***	**-.16***	.15
	Sig.		**.05**	**.02**	.11
Experience (7)	n			123	123
	τc			**.14***	**.25***
	Sig.			**.02**	**.01**
Position (7)	n				123
	τc				**-.31****
	Sig.				**.00**

[a] The number in parenthesis denotes the number of categories within each variable
** (p<.001), * (p<.05)

4.3.2.1 Farmer age

Farmer age was significantly positively correlated with years of dairy farming experience ($\tau c = .28$, $p < .001$) and position held on farm ($\tau c = .33$, $p < .001$) but was significantly negatively correlated with highest level of formal education ($\tau c = -.20$, $p < .05$) (Table 4.20). As age increased, levels of formal education decreased with older respondents having the lowest levels of post-high school education (Table D-1). Older respondents tended to be the most experienced. However, 26 per cent of 45-54 year olds and 7 per cent of those aged 55 or older indicated that they had less than 10 years' experience. Age was also positively correlated with position held on farm and although the majority of respondents were farm owners/owner-operators, as age increased the percentage of farm owners also increased (Table D-1). Younger respondents (19-44 years) were the most likely to be sharemilking or managing dairy farms, with 22 per cent of 19-44 year old respondents equity managers compared with 10 per cent of 45-54 year olds and 5 per cent of respondents aged greater than 55 years.

4.3.2.2 Farmer education

The highest level of formal education was significantly negatively correlated with age, years of experience ($\tau c = -.15$, $p < .05$) and to the position held on farm by respondents ($\tau c = -.16$, $p < .05$) (Table 4.20). As the level of formal education increased, the amount of dairy farming experience and percentage of farm owners tended to decrease. AgITO/Polytechnic and university educated respondents tended to have less dairy farming experience than high school educated respondents, who were the most likely to be farm owners. University graduates were the most likely to be farm managers, and AgITO/Polytechnic educated respondents the most likely to be sharemilking (Table D-2).

Secondary analysis identified that the highest level of formal education was significantly positively correlated with having a financial/managerial interest in more than one dairy farm ($\tau b = .18$, $p < .05$, Table G-1). Respondents with a university education were significantly more likely to have multiple farm interests than those with a high school or AgITO/Polytechnic education (Table D-2).

4.3.2.3 Farmer experience

Farmer experience was significantly positively correlated with age, position respondents held on farm ($\tau c = .14$, $p < .05$) and to having a financial/managerial interest in more than one dairy farm ($\tau c = .24$, $p < .05$) (Table 4.20). As experience increased, the likelihood of being a farm owner and having an interest in more than one dairy farm increased (Table D-3). Nearly two thirds of respondents with greater than 20 years' experience had an interest in more than one farm compared with approximately 40 per cent of respondents with less than 20 years' experience. Equity managers tended to be more experienced than 50/50 sharemilkers and farm manager respondents but had less experience than farm owners (Table D-3).

4.3.2.4 Position of respondents

Position held on farm was significantly positively correlated with having an interest in more than one dairy farm (τc =.31, *p* <.001, Table 4.20). Farm owners were the most likely to have an interest in more than one dairy farm followed by equity managers and then owner-operators (Table D-4). Sharemilking and farm manager respondents were the least likely to have an interest in more than one dairy farm.

4.3.3 Canterbury dairy farm characteristics

Dairy farm characteristics include farm size (effective hectares), farm system (as defined by DairyNZ), production per cow and production per effective ha (kg MS to factory), and replacement dairy stock management. Secondary analysis identified no new significant relationships (Table G-2).

Table 4.21 Correlation of farm characteristics

		Production per cow	Production per ha	Stocking rate	Farm system (5)	Heifer calf management (4)	Yearling heifer management (4)
Farm size	n	103	106	101	110	102	102
	τc	**.14***	.10	.04	**.17***	.05	.02
	Sig.	**.05**	.15	.56	**.03**	.50	.86
Production per cow	n		105	105	102	94	94
	τc		**.33****	**.19***	**.35****	.10	.05
	Sig.		**.00**	**.01**	**.00**	.24	.57
Production per ha	n			105	106	98	98
	τc			**.62****	**.35***	.08	.05
	Sig.			**.00**	**.01**	.32	.60
Stocking rate	n				100	101	103
	τc				**.23****	.02	.02
	Sig.				**.00**	.83	.83
Farm system (5)[a]	n					102	103
	τc					.13	**.23***
	Sig.					.08	**.01**
Heifer calf management (4)	n						**116**
	τc						**.71****
	Sig.						**.00**

[a] The number in parenthesis denotes the number of categories within each variable, ** (*p*<.001), * (*p*<.05)

4.3.3.1 Farm size

Farm sizes are presented as small (<169 ha), medium (170-254 ha) and large (>255 ha) based on the distribution of respondents and farm size data in this survey (Table F-6).

Farm size was significantly positively correlated with production per cow ($\tau c = .14$, $p < .05$) and with farm system ($\tau c = .17$, $p < .05$) (Table 4.21). Large and medium dairy farms were the most likely to operate a high input farming system (system four or five) and achieve high production per cow (kg of MS). Nearly two thirds of medium and large farms produced greater than 430 kg per cow compared with one third of small farms (Table D-5).

4.3.3.2 Farm system

Farm system was significantly positively correlated with milksolids production per cow ($\tau c = .35$, $p < .001$) and per effective hectare ($\tau c = .35$, $p < .05$), stocking rate (cows/effective ha) ($\tau c = .23$, $p < .05$), and use of an associated business for rearing of replacement yearling heifers ($\tau c = .23$, $p < .05$) (Table 4.21). Higher input systems (system four and five) tended to produce more milksolids per cow than moderate or low input systems (Table D-6). High input systems also tended to have higher stocking rates and higher production per ha. Approximately half of all systems used contract grazing for rearing of yearling heifer replacement stock. However, as stocking rate and the level of inputs increased, use of an 'associated business' to manage yearling heifer replacements rather than 'own land' also increased.

4.3.3.3 Milksolids production

Milksolids production per cow and per effective ha were significantly positively correlated ($\tau c = .33$, $p < .001$, Table 4.21). In general, high production per cow corresponded with high production per ha, and visa versa (Table D-8).

4.3.3.4 Stocking rate

Stocking rate was significantly positively correlated with production per cow ($\tau c = .19$, $p < .05$), production per ha ($\tau c = .62$, $p < .05$) and farm system ($\tau c = .23$, $p < .05$) (Table 4.21). There was no significant relationship between stocking rate and farm size. Respondents with higher stocking rates tended to have higher production per cow and per effective ha (Table D-7).

4.3.3.5 Replacement young stock management

The management of heifer calves was significantly positively correlated with the management of replacement yearling heifers ($\tau c = .71$, $p < .001$, Table 4.21). Respondents generally used the same management strategies, i.e. using own land, contract grazing or associated business for the rearing of both heifer calves and yearling heifers (Table D-8).

4.3.4 Canterbury dairy farmer ISCs

4.3.4.1 Introduction

Farmers' ISCs include attendance at LUDF focus days, attendance at DairyNZ events, use of a private consultant/advisor, and use of the SIDDC/LUDF website (Table 4.22). The three most important information sources used for learning about the LUDF's results, and the three most useful information sources used for learning of new agricultural technology and innovation, as ranked by respondents (Table 4.13, page 54 and Table 4.15, page 55) are included for analysis (Table 4.23).

The literature review in Chapter two identified information as a key factor in the decision-making process of adopters. All of these FMP innovations were trialled by the LUDF. Consequentially, the LUDF's information sources and their use by farmers are thought particularly relevant to the adoption of these innovations. However, primary analysis identified no significant relationships (p <.05) between LUDF focus day attendance, attendance at DairyNZ events, use of a private consultant, and use of the SIDDC/LUDF website (Table G-3). Secondary analysis identified four significant relationships which are presented in Table 4.22.

4.3.4.2 Correlations between ISCs

Table 4.22 Correlation of farmers' information seeking characteristics

		DairyNZ event attendance (2)	Use of private consultant (2)	Use of SIDDC website (2)
LUDF focus day attendance (2)[a]	n	123	109	119
	τb	**.18***	-.01	**.23***
	Sig.	**.04**	.96	**.01**
DairyNZ event attendance (2)	n		109	119
	τb		.12	**.48****
	Sig.		.23	**.00**
Use of a private consultant (2)	n			109
	τb			**.31****
	Sig.			**.00**

[a] All variables are dichotomous (i.e. attend/do not attend or, use/do not use)
** (p<.001), * (p<.05)

Use of the SIDDC/LUDF website was significantly positively correlated with attending LUDF focus days (τc = .23, p <.01), attending DairyNZ events (τc = .48, p <.00), and use of a private consultant/advisor (τc = .31, p <.01) (Table 4.22). Respondents who used the website were significantly more likely to attend LUDF focus days, attend DairyNZ events, and use a private consultant than respondents who did not use the website (Table D-10). Attendance at LUDF focus days and attendance at DairyNZ events was also significantly positively correlated (τc = .18, p <.05) (Table 4.22) indicating that respondents who attended LUDF focus days were significantly more likely to attend DairyNZ events than respondents who did not attend (Table D-10).

There was no significant relationship between use of a private consultant and attendance at LUDF focus days and DairyNZ events (Table 4.22).

4.3.4.3 Correlations between sources of information used for learning

The majority of respondents considered all of the information sources included in Table 4.23 important for learning (Table D-11 - D-17). Bivariate analysis revealed twenty four significant relationships (Table 4.23 and Table G-4) suggesting that Canterbury dairy farmers use multiple information sources for learning about the LUDF's results and for learning about new agricultural technology and innovation.

Respondents who attend focus days, DairyNZ events and use the SIDDC/LUDF website consider these useful sources of information to learn of the LUDF's results and learn of new technologies. Although other farmers were ranked as the third most useful source of information to learn of new technologies, only those respondents who ranked the focus days and DairyNZ events as important consider other farmers as useful. Respondents who ranked the SIDDC/LUDF website and newspapers as important for learning were less likely to rank other farmers as useful for learning about new technologies. DairyNZ events had the largest number of significant correlations suggesting that the majority of respondents considered these events useful for learning.

Table 4.23 Correlation of sources of information used for learning

		SIDDC/LUDF website[b] (LUDF Results)	Newspapers[b] (LUDF Results)	LUDF focus days[b] (LUDF Results)	Demonstration farms [b](new tech. and innovation)	DairyNZ events[b] (new tech. and innovation)	Other farmers[b] (new tech. and innovation)
LUDF focus day attendance	n	95	108	108	108	107	107
	τc	**.18***	.00	**.40****	**.23****	**.13***	.04
	Sig.	**.05**	.95	**.00**	**.00**	**.05**	.59
DairyNZ event attendance	n	80	91	91	91	89	90
	τc	.04	.07	**.25****	.02	**.22***	.01
	Sig.	.62	.43	**.00**	.83	**.01**	.86
Use of a private consultant/ advisor (2)[a]	n	93	106	106	106	105	105
	τc	.04	.04	.15	.20	.08	.01
	Sig.	.68	.72	.16	.06	.43	.92
Use of SIDDC website	n	65	72	73	73	72	72
	τc	.04	.02	**.27****	**.30****	**.21***	.01
	Sig.	.63	.82	**.00**	**.00**	**.01**	.89
SIDDC/LUDF website[b] (LUDF Results)	n		103	106	105	103	102
	τc		.09	**.49****	**.47****	**.21****	-.02
	Sig.		.29	**.00**	**.00**	**.00**	.79
Newspapers[b] (LUDF Results)	n			106	106	105	105
	τc			**.16***	.09	**.25****	.10
	Sig.			**.05**	.24	**.00**	.19
LUDF focus days[b] (LUDF Results)	n				108	106	105
	τc				**.51****	**.33****	**.15***
	Sig.				**.00**	**.00**	**.05**
Demonstration farms[b] (new tech. and innovation)	n					106	106
	τc					**.37****	.03
	Sig.					**.00**	.72
DairyNZ events[b] (new tech. and innovation)	n						106
	τc						**.17***
	Sig.						**.03**

[a] The number in parenthesis denotes the number of categories within each variable
[b] These variables were ranked using a 5 point Likert scale
** (*p*<.001), * (*p*<.05)

4.3.5 Correlations between Canterbury dairy farmers and their dairy farms

The previous sections presented the correlations between farmer, farm and ISCs in isolation. The following sections present the inter-correlations between these three categories of variables. Section 4.3.5 presents the correlations between Canterbury dairy farmers and their farms and section 4.3.6 presents the correlations between Canterbury dairy farmers and dairy farm characteristics and farmer ISCs.

There were a total of six significant correlations between farmer characteristics and farm characteristics, four identified by primary analysis (Table 4.24) and an additional two significant relationships identified by secondary analysis (Table G-5).

Table 4.24 Correlation of farmer and farm characteristics

		Farm size	Production per cow	Production per ha	Farm system (5)	Heifer calf management (4)	Yearling heifer management (4)
Age (12)[a]	n	116	107	111	116	119	117
	τc	**-.19***	-.09	-.09	**-.22****	-.03	-.10
	Sig.	**.01**	.23	.24	**.00**	.69	.25
Education (3)	n	115	107	110	115	118	116
	τc	.11	-.05	-.10	.14	.03	.06
	Sig.	.20	.58	.26	.10	.70	.42
Experience (7)	n	116	107	111	116	119	117
	τc	-.11	-.08	-.03	-.07	-.05	.01
	Sig.	.12	.29	.69	.38	.49	.87
Position (7)	n	116	107	111	116	119	117
	τc	.07	-.04	-.06	.08	.10	.11
	Sig.	.28	.56	.33	.22	.13	.12
Multiple farm interests (2)	n	116	106	111	116	119	117
	τc	.02	**.21***	**.23***	.06	-.05	-.03
	Sig.	.89	**.05**	**.04**	.56	.67	.77

[a] The number in parenthesis denotes the number of categories within each variable
** (*p*<.001), * (*p*<.05)

4.3.5.1 Farmer age

Farmer age was significantly negatively correlated with farm size (τc= -.19, $p < .05$) and farm system (τc =-.22, p <.05) (Table 4.24). Older respondents (greater than 55 years) were the most likely to operate small farms (<169 ha), respondents aged 45-54 to operate medium sized farms (170-255 ha) and respondents aged 19-44 to operate large dairy farms (>255 ha) (Table D-9). Respondents under the age of 55 were significantly more likely to operate a high input system compared to those over 55 years. Despite the significant negative relationship between age and farm size and farm system, there was no significant relationship (p <.05) between age and production per cow or per effective ha (Table 4.24).

4.3.5.2 Financial/managerial interest in more than one dairy farm

Production per cow and per ha were significantly positively correlated with having a financial/managerial interest in more than one dairy farm (per cow τc = .21, p <.05 and per ha τc = .23, p <.05, Table 4.24). Respondents with higher production per cow and per ha were significantly more likely to have an interest in more than one dairy farm (Table D-9).

4.3.5.3 Position of person answering the questions

Position held on-farm was significantly correlated with dairy replacement stock management (heifer calves τc = .22, p <.05 and yearling heifer management τc = .21, p <.05, Table G-5). Owners and owner-operators were more likely to use their own land (owned or leased) for replacement dairy stock management while sharemilkers, managers and others were more likely to use contract grazing (Table D-9).

4.3.6 Correlations between dairy farmers, dairy farms and farmers' ISCs

4.3.6.1 Introduction

The farmer variables include age, experience and education, position of respondents and multiple farm interests (Table 4.25). The farm variables include farm size, farm system, production per cow and production per ha (Table 4.26). ISCs include attendance at LUDF focus days, attendance at DairyNZ events, use of a private consultant/advisor, and use of the SIDDC/LUDF website, the three most important information sources used to learn about the LUDF's results, and the three most useful information sources used to learn of new agricultural technology and innovation, as ranked by respondents.

Table 4.25 Correlation of farmer characteristics and sources of information used

						Information sources used to learn of LUDF results[b]			Information sources used to learn of new agricultural technologies[b]		
		LUDF focus day attendance	DairyNZ event attendance	Use of a private consultant (2)	Use of SIDDC /LUDF website	SIDDC /LUDF website	News-papers	Focus days	Demo. Farms	DairyNZ events	Other farmers
Age (12)[a]	n	115	93	109	74	106	109	109	109	108	108
	τc	.02	**-.18***	-.10	-.02	.06	-.06	.00	**.14***	-.07	-.07
	Sig.	.75	**.01**	.38	.81	.43	.39	.99	**.05**	.35	.35
Experience (7)	n	115	93	109	74	106	109	109	109	108	108
	τc	-.02	-.14	**-.26****	.10	.01	.07	.00	.00	-.12	-.02
	Sig.	.80	.06	**.00**	.22	.91	.33	.93	.93	.13	.78
Education (3)	n	114	93	109	74	106	109	109	109	108	108
	τc	**.15***	.13	-.05	.03	**.18***	.11	**.24****	.14	.14	-.06
	Sig.	**.04**	.16	.61	.77	**.04**	.19	**.00**	.08	.12	.42
Position (7)	n	115	93	109	74	106	109	109	109	108	108
	τc	-.03	.10	.03	.06	-.08	-.01	-.12	-.05	-.07	-.08
	Sig.	.67	.16	.77	.35	.35	.89	.14	.44	.30	.24
Multiple farm interests (2)	n	115	93	109	74	106	109	109	109	108	108
	τc	-.12	.05	.01	.13	.02	.02	.01	-.05	.04	.04
	Sig.	.23	.70	.96	.18	.81	.82	.93	.66	.72	.66

[a] The number in parenthesis denotes the number of categories within each variable, [b] These information sources were ranked on a 5 point Likert scale, ** ($p<.001$), * ($p<.05$

4.3.6.2 Farmer characteristics and ISCs

There were a total of eight significant relationships between farmer characteristics and ISCs, six identified in primary analysis (Table 4.25) and an additional two identified in secondary analysis (Table G-6).

Farmer age was significantly negatively correlated with attendance at DairyNZ events (τc = - .18, p <.01, Table 4.25) and with using the SIDDC/LUDF website (τc = -.22, p <.05, Table G-6). Younger farmers were more likely to attend DairyNZ events and use the SIDDC/LUDF website than older respondents (Table D-18). Farmer experience was significantly negatively correlated with use of a farm consultant (τc = -.26, p <.01, Table 4.25) with less experienced respondents the most likely to use a private consultant/advisor (Table D-19).

Farmer education was significantly positively correlated with attendance at LUDF focus days (τc = .15, p <.05), DairyNZ event attendance (τc = .21, p <.05, Table G-6), and with ranking the SIDDC/LUDF website (τc = .18, p <.05) and LUDF focus days (τc = .24, p <.01) as important for learning (Table 4.25). As the level of education increased, participation in industry events increased along with the level of importance attributed to the SIDDC/LUDF website and LUDF focus days (Table D-20).

4.3.6.3 Farm characteristics and ISCs

There were a total of sixteen significant relationships between farm characteristics and ISCs, thirteen identified by primary analysis (Table 4.26) and three from secondary analysis (Table G-7). Farm system and farm size accounted for the majority of the significant relationships.

Farm size was significantly positively correlated with use of a private consultant (τc = .23, p <.05), use of the SIDDC/LUDF website (τc = .30, p <.01), and ranking LUDF focus days (τc = .19, p <.01) and demonstration farms (τc= .15, p <.05) as important sources of information (Table 4.26). Farm size was also significantly positively correlated with ranking of DairyNZ events as useful sources of information (τc = .12, p <.05, Table G-7). As farm size increased, the likelihood of using a consultant/advisor and using the SIDDC/LUDF website increased. Although the majority of respondents ranked LUDF focus days, demonstration farms and DairyNZ events as important, medium sized farms (170-254 ha) were the most likely to rank these information sources as important followed by large and then small dairy farms (Table D-21).

Table 4.26 Correlation of farm characteristics and sources of information used

						Information sources used to learn of LUDF results[b]			Information sources used to learn of new agricultural technologies[b]		
		LUDF focus day attendance	DairyNZ event attendance	Use of a private consultant/ advisor	Use of SIDDC /LUDF website	SIDDC /LUDF website	News-papers	LUDF Focus days	Demo. farms	DairyNZ events	Other farmers
Farm size	n	108	87	102	71	100	102	101	102	103	103
	τc	.11	.10	**.23***	**.23***	**.30****	.04	**.19***	**.15***	.08	.11
	Sig.	.17	.18	**.03**	**.01**	**.00**	.65	**.01**	**.05**	.24	.15
Farm system (5)[a]	n	109	88	103	69	100	104	101	103	102	102
	τc	.09	**.22***	.17	.13	**.14***	.13	**.19***	**.17***	**.15***	-.10
	Sig.	.22	**.01**	.10	.17	**.05**	.09	**.01**	**.01**	**.04**	.13
Production per cow (kg MS)	n	103	82	97	66	96	97	96	97	98	97
	τc	.06	.10	**.21***	.05	.04	**.15***	.01	.13	.07	-.06
	Sig.	.41	.24	**.05**	.60	.65	**.05**	.88	.10	.41	.47
Production per ha (kg MS)	n	106	87	69	102	100	101	102	101	101	100
	τc	.04	.05	.04	.16	-.01	**.15***	.01	.08	.02	-.04
	Sig.	.58	.51	.65	.14	.90	**.05**	.90	.35	.82	.65

[a] The number in parenthesis denotes the number of categories within each variable
[b] These information sources were ranked on a 5 point Likert scale
** (p<.001), * (p<.05)

Farm system was significantly positively correlated with attending DairyNZ events (τc = .23, p <.05), and ranking of the SIDDC website (τc = .14, p <.05), LUDF focus days (τc = .19, p <.01), demonstration farms (τc = .15, p <.05) and DairyNZ events (τc = .15, p <.05) as important sources of information (Table 4.26). Farm system was also significantly positively correlated with use of the SIDDC/LUDF website (τc = .35, p <.01, Table G-7). However, farm system was significantly negatively correlated with ranking other farmers as important sources of information (τc = - .10, p <.05, Table G-7). The majority of farmers with moderate and high input farming systems attended DairyNZ events and used the SIDDC/LUDF website while the majority of low input farmers did not. Moderate and high input systems were the most likely to rank LUDF focus days, demonstration farms and DairyNZ events as important while low input systems were the most likely to rank other farmers as an important source of information regarding new agricultural technology and innovation (Table D-22).

Production per cow was significantly positively correlated with using a private consultant (τc = .21, p <.05) and with the ranking of dairy newspapers as important sources of information for learning of LUDF results (τc = .15, p <.05) (Table 4.26). Production per cow was also significantly positively correlated with attending DairyNZ events (τc = .34, p <.01, Table G-7). Similar to production per cow, production per ha was significantly positively correlated with ranking newspapers as important (τc = .15, p <.05) (Table 4.26). As milksolid production increased, attendance at DairyNZ events and use of a private consultant/advisor increased as did the percentage of respondents ranking newspapers as an important source of information to learn of LUDF results (Table D-22).

4.4 Innovation Adoption

4.4.1 Introduction

Canterbury dairy farmers, their farms and their ISCs have been introduced and explored in the previous sections. This section details innovation adoption in the CDI. The rate of adoption of the ten FMP innovations of interest in this study is presented first. The Kendall Tau-b correlation coefficient is used to determine the direction and strength of the relationships between the adoptions of innovations i.e. are respondents who adopt one innovation more likely to adopt another innovation? This is presented in section 4.4.2. The correlations between Canterbury dairy farmer, dairy farm, farmer information seeking characteristics, and the adoption of individual innovations are presented in section 4.4.3. The results from logistic regression analysis are also considered in this section. In section 4.4.4, the correlations between Canterbury dairy farmers, Canterbury dairy farms and farmers' ISCs, and the total number of innovations adopted by each respondent are presented, along with results of linear regression analysis. The total number of FMP innovations adopted by individual farmers is considered important and is used as a measure of farmer innovativeness, i.e. a high number of FMP innovations adopted equates to a high level of innovativeness.

4.4.2 Rate of FMP innovation adoption in the CDI

Respondents were asked to indicate their adoption or non-adoption of ten innovations and briefly comment on their decisions. All ten innovations were trialled by the LUDF between 2001 and 2012. Three innovations had high levels of adoption (71-83 per cent), two innovations had medium levels of adoption (57-64 per cent) and the remaining five had low levels of adoption (21-42 per cent) (Table 4.27). A description of each innovation and a summary of respondents' comments regarding their decisions to adopt or not adopt are presented below.

Table 4.27 Levels of adoption of FMP innovations

FMP innovation	Per cent **Adopted**	Per cent **Not adopted**
Low and consistent grazing residuals (n = 112)	83	17
Re-grassing based on measurement of poor performing paddocks (n = 111)	81	19
Regular monitoring of cow body condition and responding with alternative management to ensure targets are achieved (n = 109)	71	29
Monitoring of soil moisture to drive irrigation practice (n = 111)	64	36
Creating a separate herd of young cows to enable preferential stock management to ensure targets are achieved (n = 111)	57	43
Pre-grazing mowing to lift animal intake (n = 113)	42	58
Zero induction policy (n = 113)	40	60
Frequent small application of N and gibberellic acid simultaneously to promote on-farm production of high quality pasture (n = 111)	39	61
Eco-n^{TM} to mitigate urine N loss (n = 110)	33	67
Synchronising of heifers to calve two weeks before herd (n = 113)	21	79

4.4.2.1 Low and consistent grazing residuals (Graze)

Grazing residual refers to the residual pasture remaining in a paddock after grazing. Some studies (Irvine, Freeman & Rawnley, 2010; Lee, Donaghy & Roche, 2008; Holmes & Hoogendoorn, 1983) have suggested that maintaining low and consistent grazing residuals (approximately 1500-1650 kg dry matter (DM)/ha) can lead to improved pasture quality and increased milk production. Eighty three per cent of respondents adopted this innovation (Table 4.27). Of the 112 respondents, 69 respondents (61 per cent) commented on their decision (Table 4.28).

Table 4.28 Reasons for adopting/not adopting low and consistent grazing residuals

Reasons for adopting (n=56)		Reasons for not adopting (n=13)	
Improved pasture quality, utilisation and/or pasture production	36	Did not suit current farming system	8
Always followed this practice	9	Cows would be inadequately fed	3
Improved pasture management	8		
Other	3	Other	2
Number of respondents	56	Number of respondents	13

4.4.2.2 Re-grassing based on measurement of poor performing paddocks (Re-grass)

Re-grassing refers to the process of pasture renewal. Measurement of pasture production (typically in kg of DM produced per ha per year) is used to identify low producing or poor performing paddocks which may benefit most from renewal i.e. provide the greatest return on investment. Eighty one per cent of respondents adopted re-grassing based on measurement (Table 4.27). Of the 111 respondents, 60 respondents (54 per cent) commented on their decision (Table 4.29).

Table 4.29 Reasons for adopting/not adopting re-grassing based on measurement of poor performing paddocks

Reasons for adopting (n=41)		Reasons for not adopting (n=19)	
Increased pasture quality and production	14	Used different means of identifying paddocks i.e. visual assessment, grass species, pugging damage, palatability	12
Common sense, was logical or made financial sense	13	Did not measure pasture	3
Entered their annual re-grassing percentage	6	Lack of good information/good record keeping	2
Always followed this practice	4		
Factored re-grassing into their winter cropping programme	3		
Other	1	Other	2
Number of respondents	41	Number of respondents	19

4.4.2.3 Regular monitoring of cow body condition and responding with alternative management to ensure targets are achieved (CowBCS)

Body condition score (BCS) is a useful management tool for assessing the nutritional status of cows (Garnsworthy, 2006). Poor body condition has been associated with subnormal milk production and reproductive performance. Seventy one per cent of respondents adopted regular monitoring of cow body condition and responded with alternative management to ensure their targets were achieved (Table 4.27). Of the 109 respondents, 60 respondents (55 per cent) commented on their decision (Table 4.30).

Table 4.30 Reasons for adopting/not adopting regular monitoring of cow body condition and responding with alternative management to ensure targets are achieved

Reasons for adopting (n=45)		Reasons for not adopting (n=15)	
Adopted but only at critical times of the year, typically before mating and drying off	21	All cows were adequately fed	4
Always followed this practice	9	Logistics, poor organisation	4
Improved herd mating and production performance	8	Too difficult, uneconomic	4
Used once a day milking or drying light cows off early	7	Unaware of this innovation Other	1 2
Number of respondents	45	Number of respondents	15

4.4.2.4 Monitoring of soil moisture to drive irrigation practice (Soilmoist)

Monitoring of soil moisture provides data which can help optimise resource efficiency. The LUDF uses AQUAFLEX sensors to monitor soil moisture levels. The AQUAFLEX sensors are three metre long flexible tapes that are laid in the root zone and measure soil moisture and temperature (Streat Instruments, 2013). Sixty four per cent of respondents adopted monitoring of soil moisture to drive irrigation practice (Table 4.27). Of the 111 respondents, 60 respondents (55 per cent) commented on their decision (Table 4.31).

Table 4.31 Reasons for adopting/not adopting monitoring of soil moisture to drive irrigation practice

Reasons for adopting (n=45)		Reasons for not adopting (n=15)	
Increased resource efficiencies (water and power) and provided an economic return	22	Did not believe in the effectiveness of this innovation/too expensive	10
Used AQUAFLEX technology to monitor moisture	7	Did not suit their current farming system (e.g. no irrigation)	5
Did monitor soil moisture but used alternative methods (spade, electric fence standard, monitoring of rainfall, farm experience, neighbours, gut feel)	11		
Other	5		
Number of respondents	45	Number of respondents	15

4.4.2.5 Creating a separate herd of young cows to enable preferential management (2herds)

Fifty seven per cent of respondents adopted the creation of a separate herd of young cows to enable preferential stock management when required to ensure targets were achieved (Table 4.27). Of the 111 respondents, 60 respondents (54 per cent) commented on their decision (Table 4.32).

Table 4.32 Reasons for adopting/not adopting creating a separate herd of young cows

Reasons for adopting (n=35)		Reasons for not adopting (n=25)	
Improved cow body condition and conception rates	18	Did not suit current farm system (labour constraints, staff capability, logistics, small herd size, large herd size already with multiple herds)	19
Always followed this practice	8	All cows were being adequately fed	6
Preferentially fed herd but include any at risk cow regardless of age	7		
Run two herds but due to logistic, i.e. small yard size	2		
Number of respondents	35	Number of respondents	25

4.4.2.6 Pre-grazing mowing to lift animal intake (Premow)

Forty two per cent of respondents adopted pre-grazing mowing (Table 4.27). Out of the 113 respondents, 66 respondents (58 per cent) commented on their decision (Table 4.33).

Table 4.33 Reasons for adopting/not adopting pre-grazing mowing to lift animal intakes

Reasons for adopting (n= 29)		Reasons for not adopting (n= 37)	
Only when necessary and for pasture quality rather than to increase animal intake	24	Uneconomic (repairs, fuel, labour)	15
Always followed this practice	2	Did not suit their current farm system (rough or stony land, high/low stocking rate, feed supply, farm owner/staff attitudes)	10
Maximise intake	3		
		Time constraints	6
		Mow after grazing (topping)	2
		Other	4
Number of respondents	29	Number of respondents	37

4.4.2.7 Zero induction policy (Noinduct)

Calving induction is the practice of pharmaceutically inducing premature calving. It is generally done during the third trimester of pregnancy on cows with a late calving due date (typically later than eight weeks into the seasonal calving period) with little risk to the cow but often with reduced viability of the early calf (Animal Health Australia, 2013; Blackwell, Burke & Verkerk, 2010). Forty per cent of respondents adopted a zero induction policy (Table 4.27). Of the 113 respondents, 67 respondents (59 per cent) commented on their decision (Table 4.34).

Table 4.34 Reasons for adopting/not adopting a zero induction policy

Reasons for adopting (n= 22)		Reasons for not adopting (n= 45)	
Practiced zero induction for past 2-12 years	7	Considered a useful management tool to reduce cull cow numbers, condense calving and/or grow cow numbers	26
Felt inductions were unnatural	6		
Did not need to or considered it poor practice	4	Could not financially afford to	7
Had never induced cows	3	Adhered to industry guidelines governing the use of induction	7
Animal welfare concerns	2		
		Actively reducing use of induction and planning to implement a zero induction policy in the near future	5
Number of respondents	22	Number of respondents	45

4.4.2.8 Frequent small applications of nitrogen fertiliser and gibberellic acid simultaneously to promote on-farm production of high quality pasture (NGibb)

Gibberellic acid is one of a group of Gibberellins (a group of plant hormones that activate dormant enzyme systems). Typically sprayed onto grazed pasture, it can stimulate out of season growth or accelerate growth through reserve mobilisation, and leaf and stem elongation (Matthew, Hofmann & Osborne, 2009, p. 213). The LUDF applies gibberellic acid and nitrogen fertiliser simultaneously to maximise pasture dry matter production. Thirty nine per cent of respondents adopted this innovation (Table 4.27). Of the 111 respondents, 57 respondents (51 per cent) commented on their decision (Table 4.35).

Table 4.35 Reasons for adopting/not adopting frequent small application of nitrogen fertiliser and gibberellic acid simultaneously

Reasons for adopting (n= 16)		Reasons for not adopting (n= 41)	
Use gibberellic acid but only at crucial times of the season, typically in spring and autumn	5	Did use nitrogen fertiliser but did not use gibberellic acid	18
To maximise pasture production and reduce feed deficits	2	Results too variable and so too costly	8
		Did not suit current farm system (larger more infrequent nitrogen applications, staff capabilities and attitudes, use and cost of contractor to apply)	6
		Not as yet but may trial in the future	5
		Did not believe in gibberellic acid/ did not know enough about it	2
Other	9	Never heard of gibberellic acid	2
Number of respondents	16	Number of respondents	41

4.4.2.9 Eco-N^{TM} to mitigate urine nitrogen loss (EcoN)

Dicyandiamide (DCD) is the active ingredient of Ravensdown Fertiliser Ltd.'s product Eco-N, which is applied as a fine particle suspension spray to grazed pastures to control nitrogen losses from cow urine patches (Ravensdown.co.nz, 2013). Thirty three per cent of respondents adopted the use of Eco-N^{TM} (Table 4.27). Of the 110 respondents, 61 respondents (55 per cent) commented on their decision (Table 4.36). Note: In January 2013, concerns regarding DCD residues in food led to the voluntary suspension of all sales and use of DCD treatments on farm land in New Zealand (MPI, 2013a).

Table 4.36 Reasons for adopting/not adopting Eco-N™ to mitigate urine nitrogen loss

Reasons for adopting (n= 13)		Reasons for not adopting (n= 48)	
Felt it reduced nitrogen losses, it benefitted the environment and/or increased pasture production	10	Sceptical of the results and science behind the product (possible conflict of interest, variable results, and effectiveness on different soil types)	16
Used on wintering area only	2	Too expensive, represented a poor return on investment	16
Adopted Eco-N as was thought likely to become a future component of dairy farming	1	Did not suit current farm system i.e. dry land farming	7
		Have trialled but due to poorer than expected results did not adopt	6
		May adopt depending on future regulatory requirements surrounding nutrient management	3
Number of respondents	13	Number of respondents	48

4.3.2.10 Synchronising of heifers to calve two weeks before herd (Synchro)

Synchronisation is the practice of pharmaceutically inducing oestrus and ovulation in a group of animals simultaneously, typically to facilitate artificial insemination to control calving date (Xu & Burton, 1999). Twenty one per cent of respondents had adopted the synchronisation of heifers (Table 4.27). Of the 113 respondents, 65 respondents (58 per cent) commented on their decision (Table 4.37).

Table 4.37 Reasons for adopting/not adopting synchronisation of heifers to calve two weeks before herd

Reasons for adopting (n= 19)		Reasons for not adopting (n= 46)	
Did synchronise heifers but choose to start calving heifers 2-10 days before main herd	13	Preferred no intervention and natural breeding	18
More time for heifers (1st calvers) to cycle and improved conception rates	4	Did not suit current farm system (added complexity and work load, heifers grazing away)	13
Had always followed this practice	2	Too expensive or thought to have adverse effects on fertility	6
		Tight spring feed supply	2
		Other	7
Number of respondents	19	Number of respondents	46

4.4.3 Correlations between the adoption of individual FMP innovations

In this section, the relationships between the adoptions of individual innovations are explored. The correlations and in particular the significant correlations indicate whether the innovations are adopted in groups (i.e. are respondents who adopt one innovation more likely to adopt another?). The innovations are presented in Table 4.38 in descending order of their rate of adoption. Cross tabulations further exploring the significant relationships are provided in Appendix E, pages 150-166.

Table 4.38 Correlations between adoptions of individual FMP innovations

		Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Graze[a]	n	109	105	109	107	109	110	106	108	110
	τ_b	**.28****	-.01	.15	.06	.08	-.03	.16	**.22***	.07
	Sig.	**.00**	.94	.13	.57	.39	.77	.07	**.01**	.45
Re-grass	n		104	108	106	108	109	105	108	109
	τ_b		**.28***	.09	.06	.07	-.09	.13	**.29****	**.18***
	Sig.		**.01***	.38	.57	.44	.34	.15	**.00**	**.01**
CowBCS	n			105	107	107	106	105	104	106
	τ_b			.03	**.24***	.04	-.07	.05	.06	-.10
	Sig.			.73	**.02**	.65	.46	.62	.51	.34
Soilmoist	n				107	109	110	106	108	110
	τ_b				.15	.15	-.12	.05	**.23***	.08
	Sig.				.13	.12	.23	.58	**.01**	.39
2herds	n					109	108	108	106	108
	τ_b					-.01	-.11	.06	.04	-.08
	Sig.					.94	.25	.51	.69	.41
Premow	n						111	109	108	111
	τ_b						.03	**.24***	.04	.13
	Sig.						.76	**.01**	.68	.19
Noinduct	n							108	109	112
	τ_b							-.05	.06	.03
	Sig.							.59	.54	.79
NGibb	n								105	108
	τ_b								**.20***	.05
	Sig.								**.05**	.62
EcoN	n									109
	τ_b									.04
	Sig.									.72

[a] All variables are dichotomous (i.e. adopted or not adopted)
** (*p*<.001), * (*p*<.05)

Results show that 80 per cent of the correlations between the adoptions of these FMP innovations are not significant (Table 4.38) suggesting that these FMP innovations are not generally adopted in particular groups but that farmers adopt a mix of FMP innovations. However, 20 per cent of correlations are significant and these correlations are outlined below.

The results show that the adoption of Graze was significantly correlated to the adoption of Re-grass (τb =.28, p <.01) and EcoN (τb =.22, p <.01) indicating that these three innovations tended to be adopted by the same respondents (i.e. respondents who adopted one of these innovations were significantly more likely to adopt the others, than respondents who did not adopt any of these three innovations). Although not significant, the adoption of Graze was also positively correlated with the adoption of NGibb (τb =.16, p <.07) (Table 4.38).

As well as Graze, respondents adopting Re-grass tended to also adopt CowBCS, EcoN, and Synchro (Table 4.38). Synchro was not significantly correlated with the adoption of any other FMP while CowBCS was only significantly correlated with the adoption of 2herds. This suggests that respondents who condition score their cows to facilitate alternative management (CowBCS) are likely to create a separate herd of cows to facilitate this management (2herds).

The adoption of EcoN was significantly positively correlated with the adoption of four other innovations: Graze, Re-grass, Soilmoist and NGibb (Table 4.38). Soilmoist was not significantly correlated with the adoption of any other innovation while the adoption of NGibb was only significantly correlated with the adoption of Premow.

4.4.4 Correlations between farmers, farms and ISCs, and the adoption of individual FMP innovations

4.4.4.1 Farmer characteristics and adoption of individual innovations

Farmer characteristics include farmer age, position on-farm, highest level of formal education, years of industry experience, and financial/managerial interest in more than one dairy farm. There were a total of five (10 per cent) significant correlations between farmer characteristics and the adoption of innovations (Table 4.39), four identified in primary analysis and one additional significant correlation identified in secondary analysis (Table G-8).

Age was significantly positively correlated with adoption of Re-grass (τc = .18, p <.05) and CowBCS (τc = .20, p <.05) (Table 4.39) but was significantly negatively correlated with the adoption of 2herds (τc = -.21, p <.05, Table G-8). Older respondents were the most likely to adopt Graze, Re-grass, CowBCS but the least likely to adopt 2herds (Table E-6) despite the significant, positive relationship between CowBCS and 2herds (τc = .24, p <.05, Table 4.38).

Table 4.39 Correlations between farmer characteristics and the adoption of individual FMP innovations

		Graze[b]	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Age (12)[a]	n	111	110	108	110	110	112	112	110	109	112
	τc	.13	**.18***	**.20***	-.07	-.16	-.04	.17	.01	.04	.13
	Sig.	.10	**.04**	**.04**	.49	.15	.70	.10	.92	.73	.17
Position (7)	n	111	110	108	110	110	112	112	110	109	112
	τc	.00	-.05	-.01	-.09	-.03	-.03	.02	-.03	-.01	**.17***
	Sig.	.98	.48	.93	.34	.74	.78	.84	.79	.90	**.02**
Education (3)	n	110	109	108	110	110	112	112	110	109	112
	τc	.07	.01	.04	.05	.08	-.04	.01	.08	.04	.08
	Sig.	.35	.95	.66	.61	.42	.70	.91	.43	.65	.31
Experience (7)	n	111	110	108	110	110	112	112	110	109	112
	τc	.03	.11	-.05	-.07	-.13	-.05	.01	-.09	.16	-.03
	Sig.	.72	.17	.59	.50	.21	.62	.90	.41	.10	.71
Multi-farm Interests (2)	n	111	110	108	110	110	112	112	110	109	112
	τc	.09	.02	.13	.00	**.23***	.08	-.10	-.03	.10	.07
	Sig.	.33	.86	.19	.97	**.01**	.39	.28	.79	.30	.47

[a] The number in parenthesis denotes the number of categories in each variable, [b] All innovation variables are dichotomous (i.e. adopted or not adopted), ** (p<.001), * (p<.05)

The position of respondents was significantly correlated with the adoption of Synchro ($\tau c = .17$, $p < .05$, Table 4.39). Farm owners were the most likely to adopt Synchro followed by owner-operators and then equity managers (Table E-7).

Having an interest in more than one dairy farm was significantly correlated with adoption of 2herds ($\tau c = .23$, $p < .05$, Table 4.39) indicating that respondents with multiple farm interests were more likely to adopt 2herds when compared with respondents without multiple farm interests (Table E-8).

4.4.4.2 Farm characteristics and adoption of individual innovations

Farm characteristics include farm size, farm system (as defined by DairyNZ), production per cow and per effective ha, and replacement dairy stock management. There were a total of twelve (20 per cent) significant correlations between farm characteristics and the adoption of individual innovations, nine identified from primary analysis (Table 4.40) and an additional three from secondary analysis (Table G-9).

Farm size was significantly positively correlated with the adoption of Soilmoist ($\tau c = .20$, $p < .05$) and 2herds ($\tau c = .52$, $p < .01$) but significantly negatively correlated with the adoption of Noinduct ($\tau c = -.32$, $p < .01$) (Table 4.40). Medium and large farms were more likely to adopt Soilmoist and 2herds than small farms (<169 ha) (Table E-9). However, small farms were the most likely to adopt Noinduct with 55 per cent adopting compared with 24 per cent of large farms (Table E-9).

Farm system was significantly positively correlated with Re-grass ($\tau c = .19$, $p < .05$, Table G-9) with higher input systems the most likely to adopt this FMP. Farm system was not significantly correlated with the adoption of any other FMP innovation (Table 4.40).

Production per cow and production per ha were significantly positively correlated with the adoption of Premow ($\tau c = .35$, $p < .01$ and $\tau c = .25$, $p < .05$ respectively) (Table 4.40). Respondents achieving high levels of production per cow and per ha were significantly more likely to have adopted Premow than respondents with low levels of production (Table E-10).

Heifer calf management and yearling heifer management were significantly correlated with adoption of Graze ($\tau c = .14$, $p < .05$ and $\tau c = .14$, $p < .05$ respectively) (Table 4.40). Respondents using own land for rearing of heifer calves and yearling heifers were the least likely to adopt Graze while respondents using an associated business for replacement dairy stock management were the most likely to adopt Graze (Table E-11 and E-12).

Heifer calf management was also significantly correlated with the adoption of Synchro ($\tau c = .19$, $p < .05$) (Table 4.40) with respondents using own land for heifer rearing having the highest levels of Synchro adoption while those using an associated business had the lowest levels of adoption (Table

E-11). Yearling heifer management was significantly correlated with the adoption of Noinduct (τc = .20, p <.05, Table 4.40) and with the adoption of Premow (τc = -.20, p <.05, Table G-9). Respondents using own land were significantly more likely to adopt Noinduct than respondents using an associated business (Table E-12) but significantly less likely to adopt Premow.

Table 4.40 Correlations between farm characteristics and the adoption of individual FMP innovations

		Graze[b]	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Farm size	n	105	104	102	104	104	105	105	103	103	105
	τc	.08	.12	.01	**.20***	**.52****	.05	**-.32****	.02	.03	-.03
	Sig.	.27	.16	.86	**.05**	**.00**	.66	**.00**	.76	.68	.70
Farm system (5)[a]	n	105	104	102	104	104	106	106	104	103	106
	τc	.05	.17	.06	.01	.03	.09	-.11	.03	.05	.03
	Sig.	.60	.06	.53	.90	.75	.32	.23	.75	.57	.73
Production per cow	n	101	100	96	99	98	101	101	98	98	101
	τc	-.05	.07	.10	.13	.20	**.32****	-.04	.13	.03	.09
	Sig.	.60	.45	.32	.25	.08	**.00**	.77	.25	.77	.29
Production per ha	n	104	102	100	102	101	104	104	101	101	104
	τc	-.06	-.07	.04	.12	.14	**.25***	-.17	.17	.13	.06
	Sig.	.45	.42	.72	.28	.24	**.02**	.12	.14	.21	.50
Heifer calf management (4)	n	108	107	105	107	107	109	107	107	106	109
	τc	**.14***	.09	.04	.06	-.02	.04	-.13	.14	-.06	**.19***
	Sig.	**.04**	.32	.68	.56	.85	.68	.17	.17	.55	**.03**
Yearling heifer management (4)	n	106	105	103	105	105	107	107	105	104	107
	τc	**.14***	.01	.01	.11	-.05	-.05	**.20***	.08	-.04	-.11
	Sig.	**.05**	.90	.95	.25	.62	.63	**.03**	.39	.65	.19

[a] The number in parenthesis denotes the number of categories in each variable, [b] All innovation variables are dichotomous (i.e. adopted or not adopted), ** (p<.001), * (p<.05)

4.4.4.3 ISCs and adoption of individual innovations

ISCs include LUDF focus day attendance, DairyNZ event attendance, use of a private consultant/advisor and use of the SIDDC/LUDF website (Table 4.41). There were a total of eleven (28 per cent) significant correlations between farmers' ISCs and the adoption of individual innovations, nine identified from primary analysis (Table 4.41) and an additional two from secondary analysis (Table G-10).

Use of the SIDDC/LUDF website was significantly positively correlated with adoption of Graze and Re-grass ($\tau c = .36$, $p < .001$ and $\tau c = .34$, $p < .001$ respectively) (Table 4.41). Respondents who used the website were significantly more likely to adopt Graze and Re-grass than those who did not use the SIDDC/LUDF website (Table E-14). Attendance at LUDF focus days and DairyNZ events was significantly positively correlated with the adoption of Soilmoist ($\tau c = .24$, $p < .001$ and $\tau c = .18$, $p < .05$ respectively) (Table 4.41). Use of a private consultant was significantly positively correlated with adoption of 2herds ($\tau c = .22$, $p < .05$, Table 4.41).

Attendance at LUDF focus days and use of the SIDDC/LUDF website was significantly negatively correlated with the adoption of Noinduct ($\tau c = -.24$, $p < .001$, Table 4.41 and $\tau c = -.21$, $p < .05$, Table G-10 respectively). Respondents attending focus days and using the website were significantly less likely to adopt Noinduct than respondents who did not attend LUDF focus days or use the SIDDC/LUDF website (Table E-14 and E-15). However, respondents who used the website were significantly more likely to adopt NGibb ($\tau c = .22$, $p < .05$) and EcoN ($\tau c = .19$, $p < .05$) than those who did not use the website (Table E-14). Attendance at LUDF focus days was also significantly positively correlated with adoption of NGibb ($\tau c = .19$, $p < .05$, Table G-10).

The adoption of CowBCS, Premow, and Synchro was not significantly correlated with any information sources (Table 4.41 and Table G-10).

Table 4.41 Correlations between ISCs and the adoption of individual FMP innovations

		Graze[b]	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
LUDF focus day attend	n	110	109	107	109	109	111	111	109	108	111
	τc	.04	.02	.01	**.24****	.01	.08	**-.24****	.15	.01	.13
	Sig.	.67	.86	.95	**.00**	.92	.37	**.00**	.09	.95	.18
DairyNZ event attend	n	89	88	89	89	90	92	91	90	88	91
	τc	.17	.04	-.07	**.18***	.14	.11	-.13	.11	.12	-.05
	Sig.	.06	.66	.45	**.05**	.13	.22	.15	.23	.16	.61
Use of private consultant (2)[a]	n	105	104	105	105	106	108	107	106	104	107
	τc	.11	.18	.03	.07	**.22***	.14	-.10	.16	-.08	.13
	Sig.	.30	.09	.73	.48	**.02**	.15	.29	.08	.42	.14
Use of the SIDDC/LUDF website	n	72	72	71	72	72	74	73	72	72	73
	τc	**.36****	**.34****	.07	.11	.10	.11	-.19	**.22***	**.19***	.05
	Sig.	**.00**	**.00**	.52	.31	.30	.27	.07	**.02**	**.04**	.56

[a] The number in parenthesis denotes the number of categories in each variable, [b] All innovation variables are dichotomous (i.e. adopted or not adopted), ** (p<.001), * (p<.05)

4.4.4.4 Correlations between information sources used for learning of LUDF results and adoption of individual innovations

Respondents were asked to rank eight predetermined information sources which could be used for learning about the results obtained at the LUDF using a 5 point Likert scale which ranged from (1) very important to (5) not at all important. The information sources are presented in descending order based on their mean rank as ranked by respondents (Table 4.42). The mean rank for Tuesday farm walks was 4.0 while the mean ranks for the remaining information sources ranged from 2.4 to 2.9 (Table 4.13, page 54) indicating that the majority of respondents considered these information sources as important for learning about the LUDF's results.

There were a total of twenty (25 per cent) significant correlations between the information sources used for learning of results obtained at the LUDF and the adoption of individual innovations, fifteen identified by primary analysis (Table 4.42) and an additional five from secondary analysis (Table G-11).

Ranking the SIDDC/LUDF website as an important information source for learning of LUDF results was significantly positively correlated with the adoption of Graze ($\tau c = .25$, $p < .001$) and Re-grass ($\tau c = .24$, $p < .05$) but it was significantly negatively correlated with the adoption of Noinduct ($\tau c = -.25$, $p < .01$) (Table 4.42).

Ranking newspapers and other media publications as important information sources was significantly positively correlated with the adoption of NGibb ($\tau c = .25$, $p < .05$ and $\tau c = .32$, $p < .001$ respectively) (Table 4.42). Respondents who ranked newspapers and other media publications as important were significantly more likely to adopt NGibb than those respondents who did not consider these information sources as important. Ranking newspapers as important was also significantly positively correlated with adoption of CowBCS ($\tau c = .25$, $p < .05$, Table 4.42) and Re-grass ($\tau b = .28$, $p < .05$, Table G-11).

Ranking the LUDF focus days as an important information source was significantly correlated with the same innovations as the SIDDC/LUDF website (Table 4.42). Respondents ranking focus days and the SIDDC/LUDF website as important were significantly more likely to adopt Graze, Re-grass and significantly less likely to adopt Noinduct than respondents who did not rank these information sources as important.

Table 4.42 Correlation between information sources used for learning about LUDF results and the adoption of individual FMP innovations

		Graze[b]	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
SIDDC/LUDF website[a]	n	103	102	105	101	103	104	106	105	104	102
	τc	**.25***	**.24***	.13	.17	.19	.01	**-.25***	.11	.06	-.08
	Sig.	**.00**	**.01**	.20	.10	.08	.91	**.01**	.29	.55	.32
Newspapers	n	105	104	107	104	105	106	108	107	106	105
	τc	.01	.16	**.25***	.14	-.02	.15	-.16	**.25***	.16	-.07
	Sig.	.94	.09	**.01**	.16	.88	.15	.12	**.01**	.11	.42
LUDF focus days	n	105	104	107	104	105	106	108	107	106	104
	τc	**.18***	**.18***	-.09	.14	.19	.05	**-.21***	.11	-.02	.01
	Sig.	**.04**	**.03**	.34	.18	.07	.62	**.05**	.32	.83	.89
Other farmers	n	101	100	103	100	102	102	104	103	102	100
	τc	.04	.11	-.14	**.20***	.10	.07	**-.29***	.13	.01	-.04
	Sig.	.69	.24	.17	**.05**	.38	.52	**.01**	.21	.93	.65
Other media publications	n	100	99	102	99	100	101	103	102	101	99
	τc	.08	**.24***	.18	.11	-.02	.06	-.08	**.32****	.10	-.04
	Sig.	.37	**.01**	.09	.32	.90	.58	.48	**.00**	.33	.66
Discussion groups	n	102	102	104	101	103	103	105	104	103	102
	τc	**.17***	.14	.06	.17	-.16	-.02	-.06	.10	.08	.10
	Sig.	**.03**	.10	.59	.09	.14	.87	.62	.37	.45	.22
Consultants	n	103	102	105	101	104	103	106	105	103	102
	τc	**.27***	.12	.17	**.23***	-.03	.02	-.05	.16	.10	.00
	Sig.	**.00**	.22	.10	**.03**	.77	.83	.62	.13	.33	.98
Tuesday farm walks	n	93	93	95	91	93	93	96	95	93	93
	τc	.07	-.03	.13	-.01	.05	-.16	-.17	-.01	-.15	.05
	Sig.	.31	.74	.21	.96	.68	.14	.09	.94	.12	.61

[a] The variables on the Y axis were ranked using a 5 point Likert scale, [b] All innovation variables are dichotomous (i.e. adopted or not adopted), ** (p<.001), * (p<.05)

Ranking other farmers as important sources of information for learning about LUDF results was significantly positively correlated with the adoption of Soilmoist ($\tau c = .20$, $p <. 05$, Table 4.42) and NGibb ($\tau b = .24$, $p <.05$, table G-11). Similar to ranking the SIDDC/LUDF website and LUDF focus days as important, ranking other farmers as important was significantly negatively correlated with the adoption of Noinduct ($\tau c = -.29$, $p <.05$, Table 4.42).

Also similar to the SIDDC/LUDF website and LUDF focus days, ranking other media publications as important for learning of LUDF results was significantly positively correlated with the adoption of Re-grass ($\tau c = .24$, $p <.05$, Table 4.42). Ranking other media publications as important for learning of LUDF results was also significantly positively correlated with the adoption of NGibb ($\tau c = .32$, $p <.001$, Table 4.42), as was newspapers.

Ranking discussion groups and consultants as important information sources was significantly positively correlated with the adoption of Graze ($\tau c = .17$, $p <.05$) similar to the SIDDC/LUDF website and LUDF focus days (Table 4.42). Similar to ranking other farmers as important, ranking consultants as important information sources was significantly positively correlated with the adoption of Soilmoist ($\tau c = .23$, $p <.05$, Table 4.42). Discussion groups, when ranked as an important information source, were significantly negatively correlated with the adoption of 2herds ($\tau b = -.22$, $p <.05$, Table G-11).

Secondary analysis identified that ranking Tuesday farm walks as important was significantly negatively correlated with adoption of Noinduct ($\tau b = -.22$, $p <.05$, Table G-11) which is similar to the SIDDC/LUDF website, LUDF focus days, and other farmers.

There were no significant correlations between these eight information sources and the adoption of CowBCS, 2herds, Premow, EcoN and Synchro (Table 4.42).

4.4.4.5 Correlations between information sources used for learning about new agricultural technology and innovation, and adoption of individual innovations

Respondents were asked to rank seven information sources which could be used for learning about new agricultural technology and innovation using a 5 point Likert scale ranging from (1) very useful to (5) not at all useful. The information sources are presented in Table 4.43 in descending order according to their mean rank (as indicated by respondents in Table 4.15, page 55). The mean ranks for the seven information sources ranged from 2.0 to 3.0 indicating that the majority of respondents considered these information sources as useful.

There were a total of sixteen (23 per cent) significant correlations between information sources used for learning about new agricultural innovations and the adoption of individual innovations, ten identified by primary analysis (Table 4.43) and an additional six from secondary analysis (Table G-12).

Ranking demonstration farms as useful sources to learn about new agricultural technology and innovation was significantly positively correlated with the adoption of Graze, Re-grass and CowBCS (Table 4.43). Respondents ranking demonstration farms as important were significantly more likely to adopt Graze, Re-grass and CowBCS than those who did not consider demonstration farms as useful information sources (Table E-24). Respondents who considered DairyNZ events important were significantly more likely to adopt Re-grass ($\tau c = .18$, $p <.05$, Table 4.43) and Soilmoist ($\tau b = .36$, $p <.05$, Table G-12) than respondents who did not consider DairyNZ events as useful.

Ranking other media publications as useful for learning about new technology and innovations was significantly positively correlated with the adoption of CowBCS ($\tau c = .22$, $p <.05$, Table 4.43) and Eco-N ($\tau b =.24$, $p <.05$, Table G-12) but was significantly negatively correlated with the adoption of 2herds ($\tau c = -.21$, $p <.05$, Table 4.43). Ranking consultants as useful sources of information about new technology was significantly positively correlated with the adoption of Soilmoist ($\tau c = .26$, $p <.05$) and NGibb ($\tau c = .21$, $p <.05$) (Table 4.43). Respondents who considered conferences as useful were significantly more likely to adopt 2herds ($\tau c = .20$, $p <.05$, Table 4.43) and Eco-N ($\tau b = .20$, $p <.05$, Table G-12) than respondents who did not consider conferences as useful.

Ranking of sales/technical staff of suppliers as useful was significantly positively correlated with the adoption of Synchro ($\tau c = .16$, $p <.05$, Table 4.43) and Soilmoist ($\tau b = .20$, $p <.05$), Premow ($\tau b = .25$, $p <.001$) and NGibb ($\tau b = .17$, $p <.05$) (Table G-10). Respondents ranking sales and technical staff of suppliers were more likely to adopt these four innovations.

Ranking of other farmers as important was not significantly correlated with the adoption of any innovations (Table 4.43 and Table G-10).

Table 4.43 Correlation of information sources used for learning about new agricultural innovation, and the adoption of individual FMP innovations

		Graze[b]	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	Eco-N	Synchro
Demonstration farms[a]	n	105	104	104	105	106	108	107	106	104	107
	τc	**.21***	**.26***	**.23***	.15	.20	.07	-.03	.07	.04	.01
	Sig.	**.02**	**.00**	**.01**	.14	.06	.50	.98	.47	.71	.90
DairyNZ events	n	104	104	103	104	105	107	106	105	104	106
	τc	.15	**.18***	.13	.13	-.02	.01	-.08	.09	.14	.10
	Sig.	.06	**.03**	.19	.25	.84	.93	.43	.39	.17	.25
Other farmers	n	104	103	103	104	105	107	106	105	103	106
	τc	-.02	-.14	-.07	.08	-.01	-.05	-.14	.08	.01	-.04
	Sig.	.79	.09	.48	.43	.92	.65	.19	.43	.92	.68
Other media (TV, magazines and newspapers)	n	106	106	105	106	107	109	108	107	105	108
	τc	-.07	.09	**.22***	-.04	**-.21***	.05	-.08	.13	.13	.04
	Sig.	.37	.24	**.01**	.68	**.05**	.63	.44	.22	.18	.68
Consultants	n	103	102	101	103	103	106	105	103	102	105
	τc	.08	.02	.14	**.26***	.11	.04	-.10	**.21***	-.09	.10
	Sig.	.34	.82	.16	**.01**	.31	.74	.33	**.04**	.41	.20
Conferences	n	102	102	100	102	102	105	104	102	102	104
	τc	.07	.07	.00	.14	**.20***	-.03	-.10	.06	.06	-.08
	Sig.	.43	.38	.99	.18	**.05**	.79	.32	.59	.58	.40
Sales /technical staff	n	99	99	97	99	99	102	101	99	99	101
	τc	-.03	.01	-.06	.20	.05	.14	-.12	.16	.01	**.16***
	Sig.	.70	.90	.55	.07	.68	.19	.26	.11	.91	**.05**

[a] The variables on the Y axis were ranked using a 5 point Likert scale, [b] All innovation variables are dichotomous (i.e. adopted or not adopted), ** ($p<.001$), * ($p<.05$)

4.4.4.6 Logistic regression results

The predictor variables included in the logistic regression were selected based on the significant correlations identified in this study between farmer, farm and ISCs variables, and the adoption of individual FMP innovations. The variables include: age, farm size, production per cow, focus day attendance, DairyNZ event attendance, use of the SIDDC/LUDF website, and use of a private consultant. The results of the logistic regression analysis are provided in Appendix H, pages 188-191.

The logistic regression results show that the farmers' socio-demographic, farm and ISCs included in the model did not significantly influence the adoption or non-adoption of these ten FMP innovations (Table H-1- H-10, pages 187-190). The same model was used for all ten innovations and the significance value of the change in the log-likelihood (Model X^2) indicated that for Graze, Re-grass and 2herds, this model was significantly better at predicting the outcome than the base model. However, for the remaining innovations, this model was not significantly better than the base model. The Homser and Lemeshow, Cox and Snell, and Nagelkerke R^2 values also indicate that for Graze, Re-grass and CowBCS, the model containing the predictor variables was a better fit for the data than for the remaining innovations. The value of the Hosemer and Lemeshow R^2 ranges from 0-1, with 1 indicating perfect prediction. The value of Hosmer and Lemeshow R^2 for the model containing the explantory variables ranged from .05 -.23 indicating that this model has limited predictive capacity.

The significance (*p* value) of the Wald statistic indicates whether the variables are significantly different from zero. If p <.05 the variables are making a significant contribution to the model and to the outcome. Age was shown to significantly contribute to the adoption of Graze (*p*=.02, Table H-1) and Re-grass (*p*= .01, Table H-2) and although not significant (*p* =.07, Table H-5), age also contributed to the adoption of CowBCS. Farm size significantly contributed to the adoption of 2herds (*p*= .00, Table H-5) and production per cow significantly contributed to the adoption of Premow (*p*=.04, Table H-6). LUDF focus day attendance significantly positively contributed to the adoption of Soilmoist (*p*=.04, Table H-4) and although not significant, negatively contributed to the adoption of Noinduct (*p*=.08, Table H-7). Overall, the results of the logistic regression indicate that farmers' socio-demographic characteristics, farm characteristics and ISCs did not significantly influence farmers' adoption or non-adoption of these ten FMP innovations.

4.4.5 Number of FMP innovations adopted (farmer innovativeness)

The relationships between the explanatory variables (farmer, farm and farmer ISCs) and the adoption of individual innovations have been explored in the previous section. In this section, the relationships between the explanatory variables and the total number of innovations adopted by each respondent are explored. The total number of innovations adopted by each respondent is used as a measure of innovativeness, i.e. the higher the number of FMP innovations adopted; the higher a farmer's innovativeness. This measure is important as it allows the investigation of whether these farmers' socio-demographic characteristics, farm characteristics and ISCs influence their innovativeness.

4.4.6.1 The number of innovations adopted

The number of innovations adopted was computed from the data. Respondents adopted an average of five innovations (Table 4.44). Half of respondents (the interquartile range) adopted between four and six innovations, and nearly 90 per cent of respondents adopted between two and seven innovations. No respondent adopted all ten FMP innovations.

Table 4.44 Descriptive statistics for number of innovations adopted

Number of innovations adopted (n = 115)	Per cent
0	1
1	2
2	10
3	10
4	13
5	21
6	20
7	14
8	6
9	3
10	0
Total	101
	Number of adoptions
Mean	5
Median	5
Std. deviation	2
Interquartile Range	4 - 6

4.4.6.2 Farmer characteristics and farmer innovativeness

There were no significant correlations between farmer characteristics and farmer innovativeness (Table 4.45, page 93). For these farmers, age, the position held on farm, level of education, years of experience, and having multiple farms interests did not influence their innovativeness (i.e. the number of innovations adopted).

Table 4.45 Correlations between farmer characteristics and innovativeness

		Age (12)	Position (7)	Education (3)	Experience (7)	Multi-farm interests (2)
Number of FMP adoptions (10)[a]	n	115	115	114	115	115
	τc	.09	-.08	.13	-.04	.14
	Sig.	.14	.30	.11	.60	.20

[a] The number in parenthesis denotes the number of categories in each variable, ** (p<.001), * (p<.05)

4.4.6.3 Farm characteristics and farmer innovativeness

There were a total of three (50 per cent) significant correlations between farm characteristics and farmer innovativeness, two identified by primary analysis (Table 4.46) and one additional significant correlation identified by secondary analysis (Table G-14).

Table 4.46 Correlations between farm characteristics and innovativeness

		Farm size	Farm system (5)	Production per cow	Production per ha	Heifer calf mgt.[b] (4)	Yearling heifer mgt. (4)
Number of FMP adoptions (10)[a]	n	108	109	103	106	112	110
	τc	**.13***	.12	**.16***	.11	.03	-.02
	Sig.	**.04**	.16	**.01**	.09	.72	.86

[a] The number in parenthesis denotes the number of categories in each variable, [b] mgt.= management, ** (p<.001), * (p<.05)

Farm size was significantly positively correlated with the number of innovations adopted (τc = .13, *p* <.05) (Table 4.46). Large farms (>255 ha) had the highest levels of adoption, adopting an average of six innovations compared to an average of five innovations for small and medium sized farms. Thirty five per cent of large farms (>255 ha) adopted between seven and nine FMP innovations compared with 21 per cent of medium farms (170-255 ha) and 16 per cent of small farms (<169 ha) (Table E-27).

Production per cow was also significantly positively correlated with the number of innovations adopted by respondents (τc = .16, *p* <.01) (Table 4.46). Respondents with higher production per cow tended to adopt more innovations. However, respondents producing between 430-460 kg MS per cow appear to be the most innovative. Half of these respondents adopted between seven and nine innovations compared with 19 per cent of respondents producing greater than 460 kg MS, 24 per cent of respondents producing 405-430 kg MS, and just 4 per cent respondents producing less than 405 kg MS per cow (Table E-27).

Production per ha was also significantly positively correlated with the number of innovations adopted by respondents (τb = .16, p <.05) (Table G-14). Respondents with higher production per ha tended to adopt more innovations. Thirty seven per cent of respondents producing between 1500-1700 kg MS per ha adopted between seven and nine innovations compared with 28 per cent of respondents producing greater than 1700 kg MS per ha, and 15 per cent of respondents producing less than 1400 kg MS per ha (Table E-27).

4.4.6.4 Farmer ISCs and farmer innovativeness

There were three significant correlations between farmers' ISCs and farmer innovativeness (Table 4.47).

Table 4.47 Correlations between ISCs and innovativeness

		LUDF focus day attend	DairyNZ event attend	Use of private consultant (2)	Use of SIDDC website
Number of FMP adoptions (10)[a]	n	114	93	109	74
	τc	.09	**.15***	**.23***	**.27****
	Sig.	.20	**.05**	**.03**	**.001**

DairyNZ event attendance, use of a private consultant and use of the SIDDC/LUDF website were all significantly positively correlated with the number of innovations adopted. This indicates that respondents using these information sources tended to adopt more innovations (were more innovative) than respondents who did not use these information sources (Table 4.47).

4.4.6.5 Information sources used for learning about LUDF results and farmer innovativeness

Primary analysis identified no significant correlations between seven information sources used for learning of the LUDF's results and farmer innovativeness (Table 4.48). However, secondary analysis identified two significant correlations (Table G-16). Ranking of newspapers and other media publications as important for learning about the LUDF's results was significantly positively correlated with farmer innovativeness ($\tau b = .18$, $p < .05$ and $\tau b = .26$, $p < .05$ respectively) (Table G-16). Respondents ranking newspapers and other media publications as important for learning of the LUDF's results tended to adopt more innovations than those respondents who did not consider these information sources as important.

4.4.6.6 Information sources used for learning about new agricultural technology and innovations, and farmer innovativeness

There were two significant correlations between these eight information sources and farmer innovativeness (Table 4.49, page 96 and Table G-17). Respondents who ranked demonstration farms and DairyNZ events as useful for learning about new agricultural technology and innovations were more innovative than respondents who did not consider these information sources as useful.

Table 4.48 Correlations between the information sources used for learning about LUDF results and innovativeness

		SIDDC/LUDF website[b]	Newspapers	LUDF focus days	Other farmers	Other media publications	Discussion groups	Consultants	Tuesday farm walks
	n	106	109	109	105	104	106	106	96
Number of adoptions (10)[a]	τc	.16	.12	.12	.20	.10	.10	.16	.01
	Sig.	.06	.14	.15	.84	.20	.26	.08	.89

[a] The number in parenthesis denotes the number of categories in each variable, [b] The variables on the X axis were ranked using a 5 point Likert scale, ** (p<.001), * (p<.05). The information sources are presented in descending order according to their mean rank as indicated by respondents in Table 4.13, page 54.

Table 4.49 Correlations between the information sources used for learning about new agricultural technology and innovation and innovativeness

		Demonstration farms[b]	DairyNZ events	Other farmers	Other media publications	Consultants	Conferences	Sales /technical staff
	n	108	107	107	109	105	104	101
Number of adoptions (10)[a]	τc	**.22***	.10	.12	.03	.15	.08	.12
	Sig.	**.01**	.19	.16	.73	.08	.31	.15

[a] The number in parenthesis denotes the number of categories in each variable, [b] The variables on the X axis were ranked using a 5 point Likert scale, ** (p<.001), * (p<.05). The information sources are presented in descending order according to their mean rank as indicated by respondents in Table 4.15, page 55.

4.4.6.7 Linear regression

The explanatory or predictor variables included in the linear regression model were selected based on the significant correlations identified in this study between farmer, farm and ISC variables, and the number of innovations adopted. The variables include: farm size, production per cow, production per ha, DairyNZ event attendance, use of the SIDDC/LUDF website, and use of a private consultant. The correlation coefficients identified in the significant correlations suggest a medium sized effect may occur. Field (2009, p. 223) suggests that, when expecting a medium sized effect and using between three and seven explanatory variables, a sample size of between 80 and 100 is sufficient.

4.4.6.7.1 Linear regression results

The R^2 values of the models (step 1 and step 2, Table 4.50) indicate that these models account for between 2 and 6 per cent of the variation in the number of innovations adopted. The B values indicate the strength and direction of the relationship between farmer innovativeness and the explanatory variables. They also indicate to what degree each explanatory variable affects the outcome if the effects of all other predictors are held constant. The B values, *t* values and their associated Sig. values indicate that these explanatory variables do not significantly contribute to farmer innovativeness (Table 4.50).

Table 4.50 Linear regression results

		B	SE B	β	*t*	Sig.
Step 1	Constant	3.93	2.22	-	1.77	.08
(n=	Farm size	.00	.00	.16	1.17	.25
	Production per cow	.00	.01	.11	.46	.65
	Production per ha	.00	.00	-.08	-.31	.76
Step 2	Constant	3.74	2.20	-	1.70	.10
	Farm size	.00	.00	.08	.59	.56
	Production per cow	.00	.01	.05	.20	.84
	Production per ha	.00	.00	-.04	-.15	.88
	Website use	.03	.02	.25	1.81	.08
	DairyNZ event attend	.05	.10	.07	.49	.63
	Consultant use[a]	.41	.56	.10	.73	.47

[a] Use of a consultant is a dichotomous variable consisting of use (coded as 1) and do not use (coded as 0)

For step 1; R = .13, R^2 =.02 (p= .74). For step 2; R =.25, R^2 =.06 (p=.59).

4.5 Chapter summary

The data analysis presented in this chapter was guided by the research questions 1-3. Univariate analysis, which uses descriptive statistics to describe a single variable in terms of its unit of analysis (for example mean, median, standard deviation, and range) was used to describe and summarise Canterbury dairy farmer and farm characteristics, their ISCs and the level of innovation adoption among these farmers. Bivariate analysis, which analyses two variables simultaneously, was used to determine the empirical relationship or correlation between Canterbury dairy farmers, their dairy farms, and their ISCs, and the relationships between these variables and the adoption of innovations in the CDI. Multivariate analysis was used to determine the relationship between multiple explanatory variables and the adoption of each individual FMP practice, and between multiple explanatory variables and farmer innovativeness (the number of innovations adopted by each respondent).

4.5.1 Farmer socio-demographic characteristics

Seventy nine per cent of respondents were dairy farm owners and owner-operators, with a further 12 per cent being equity managers. Respondents ranged in age from less than 30 to greater than 70 with the average age estimated at 47 years. Two thirds of respondents have a post-high school education. Approximately half of respondents have greater than 20 years industry experience and a similar percentage had a financial/managerial interest in more than one dairy farm.

Significant correlations between the different groups of variables identified that older farmers tended to have a high school education, have high levels of industry experience and be farm owners/owner-operators. They were also the most likely to operate a small dairy farm (<169 ha) and operate a low input farming system. Younger farmers tended to be university educated, have lower levels of experience, be sharemilking or managing dairy farms and operate medium (170-254 ha) and large farms (>255 ha). Farm owners were the most likely to have a financial/managerial interest in more than one farm, which was significantly positively correlated with high production per cow and per effective ha.

Respondents' average farm size was 231 effective ha, average production per cow was 433 kg MS and their average production per effective ha was 1538 kg MS. Forty per cent of respondents operated a system three dairy farm, 24 per cent operated a system two and 28 per cent a system four. The average stocking rate among respondents was 3.6 cows per effective ha and the predominant breeds of dairy cow milked by respondents were Friesian x Jersey cross breeds at 58 per cent, and Friesians at 35 per cent. Replacement dairy stock was grazed on farm or at an associated business by approximately half of respondents with contract grazers managing 40 per cent of heifer calves and 50 per cent of yearling heifers.

Larger farms tended to be operated by younger respondents, have a high input farming system and achieve the highest levels of production per cow. Higher input systems tended to produce higher production per cow and per effective ha, and have higher stocking rates (cows per effective ha) than medium and low input farming systems. High input systems were also more likely to use an associated business and contract grazing for the rearing of replacement dairy stock than low input systems.

4.5.2 Farmer ISCs

Eighty five per cent of respondents use the SIDDC/LUDF website with an average of 13 visits per year. Just over half of respondents attend LUDF focus days. Attendance at LUDF focus days was centred primarily on benchmarking information with less emphasis on information regarding grazing management, environmental issues and herd management. Farmers learn about the results obtained at the LUDF from a wide range of sources with the SIDDC/LUDF website, focus days and newspapers ranked as the most important information sources for learning about LUDF results. Farmers also use a range of information sources to learn about new agricultural innovations, ranking demonstration farms, DairyNZ events and other farmers as the most useful sources of information for learning about new technologies.

DairyNZ events were attended by 80 per cent of respondents with an average attendance of three events per year. Sixty five per cent of respondents also regularly use a private consultant/advisor. Consultants were employed primarily for whole farm strategic input, financial/farm business advice and periodic feed budgeting through personal visits, email and phone calls. When it came to obtaining relevant industry information, respondents found information on day-to-day or shorter-term farm management subjects the easiest to find, with information on long term or more strategic areas more difficult.

Respondents who use the SIDDC/LUDF website also tend to use a private consultant and attend DairyNZ events and LUDF focus days, while respondents who attend focus days were more likely to also attend DairyNZ events. Respondents with high levels of education were the most likely to attend LUDF focus days. Younger more educated respondents, those operating a high input farm system, and respondents achieving higher than average production per cow were the most likely to attend DairyNZ events. Similarly, younger respondents and those operating larger farms (>170 ha) and high input systems were the most likely to use the SIDDC/LUDF website. Private consultants were more likely to be employed by less experienced respondents, respondents operating larger farms, and respondents achieving high production per cow.

When it came to learning about LUDF results, respondents with higher levels of education ranked the SIDDC/LUDF website and LUDF focus days as important, as did respondents operating large farms and high input systems. Respondents with high levels of milksolids production were the most likely to rank newspapers as an important source for learning of LUDF results. When learning about new technologies, older respondents and respondents operating larger farms and high input systems were most likely to rank demonstration farms as useful for learning about new technologies. High input systems and larger dairy farms were also the most likely to rank DairyNZ events as useful sources of information for learning about new technologies. However, high input systems were the least likely to rank other farmers as useful sources of information regarding new technologies, with low input systems the most likely to rank other farmers as useful.

4.5.3 Innovation adoption in the CDI

The ten innovations of interest in this study had varying levels of adoption. Three innovations had high levels of adoption (71-83 per cent), two innovations had medium levels of adoption (57-64 per cent) and five innovations had low levels of adoption (21-42 per cent). The adoption of a number of FMP innovations was significantly correlated with the adoption of other FMP innovations but in general farmers adopted a mix of innovations.

Low and consistent grazing residuals, re-grassing based on the measurement of poor performing paddocks and use of Eco-N tended to be adopted by the same respondents while respondents adopting condition scoring of cows to facilitate alternative management were the most likely to also adopt the creation of a separate herd of young cows to facilitate alternative management, re-grassing based on measurement of poor performing paddocks, use of Eco-N and synchronising of heifers to calve before the main herd.

Respondents adopting monitoring of soil moisture to drive irrigation practice also tended to adopt the creation of a separate herd of young cows to facilitate alternative management. Frequent small applications of nitrogen fertiliser and gibberellic acid simultaneously, pre-graze mowing to lift animal intakes and the use of Eco-N tended to be adopted by the same respondents. The adoption of a zero induction policy was not significantly correlated with the adoption of any of the other innovations.

4.5.4 Farmer characteristics and innovation adoption

Ten per cent of the correlations between farmer characteristics and the adoption of innovations were significant. Farmer age was significantly correlated with three innovations, with older respondents the most likely to adopt re-grassing based on the measurement of poor performing paddocks and body condition scoring of cows to facilitate alternative management but they were the least likely to adopt the creation of a separate herd of young cows to facilitate alternative management.

Having a financial/managerial interest in more than one dairy farm was significantly correlated to the adoption of synchronisation of heifers to calve before the herd, with farm owners the most likely to adopt synchronisation followed by owner-operators and then equity managers. The adoption of the creation of a separate herd of young cows to facilitate alternative management was significantly correlated to having multiple farm interests, with respondents having multiple farm interests the most likely to adopt this innovation.

4.5.5 Farm characteristics and innovation adoption

Eighteen per cent of the correlations between farm characteristics and the adoption of individual innovations were significant. Respondents operating larger dairy farms were the most likely to adopt soil moisture monitoring to drive irrigation practice and the creation of a separate herd of young cows but were the least likely to adopt a zero induction policy.

Farm system was only significantly correlated with the adoption of re-grassing based on the measurement of poor performing paddocks, with high input farms the most likely to adopt this innovation.

The adoption of pre-graze mowing to lift animal intakes was significantly positively correlated with production per cow and per effective ha. Respondents who had adopted pre-graze mowing had the highest levels of milksolids production.

Young stock management was correlated to the adoption of five innovations. Respondents using their own land for heifer calf management were the least likely to adopt low and consistent grazing residuals, but the most likely to adopt the synchronisation of heifers to calve before the herd. Respondents using their own land to manage yearling heifers were also the least likely to adopt low grazing residuals and were the least likely to adopt pre-graze mowing to lift animal intakes, but were the most likely to adopt a zero induction policy.

4.5.6 Farmer ISCs and innovation adoption

The ISCs include attendance at LUDF focus days, attendance at DairyNZ events, use of a private consultant and use of the SIDDC/LUDF website. Twenty eight per cent of the correlations between these information sources and the adoption of innovations were significant.

Use of the SIDDC/LUDF website was correlated with the adoption of six of the ten innovations, and the number of innovations adopted. Respondents who use the SIDDC/LUDF website were more likely than non-users to adopt low and consistent grazing residuals, re-grassing based on the measurement of poor performing paddocks, monitoring of soil moisture to drive irrigation practice, frequent small applications of nitrogen fertiliser and gibberellic acid simultaneously, and use EcoN, but were less likely to adopt a zero induction policy than respondents who did not use the website.

DairyNZ event attendance and use of a private consultant were only significantly correlated with the adoption of a single innovation. Respondents who attend DairyNZ events were more likely to adopt monitoring of soil moisture to drive irrigation practice while respondents who use a private consultant were more likely to adopt the creation of a separate herd of young cows to facilitate alternative management compared with respondents who did not use these information sources.

Attendance at LUDF focus days was significantly correlated with the adoption of three FMP innovations. Respondents attending LUDF focus days were more likely to adopt monitoring of soil moisture and frequent small applications of nitrogen fertiliser and gibberellic acid. However, they were less likely to adopt a zero induction policy than respondents who did not attend focus days.

4.6.6.1 Information sources used for learning of LUDF results and innovation adoption

Respondents were asked to rank eight predetermined information sources which could be used for learning about the results obtained at the LUDF. Twenty five per cent of correlations between these information sources and the adoption of individual innovations were significant.

Respondents ranking the SIDDC/LUDF website, focus days, discussion groups and consultants as important were the most likely to adopt low and consistent grazing residuals. The adoption of re-grassing based on measurement of poor performing paddocks was also significantly positively correlated with ranking the SIDDC/LUDF website and focus days as important as well as newspapers, and other media publications. Ranking of newspapers as important was also significantly positively correlated with the adoption of condition scoring of cows to facilitate alternative management.

Frequent small applications of nitrogen fertiliser and gibberellic acid was more likely to be adopted by respondents who ranked newspapers, other media publications and other farmers as important information sources for learning about results obtained at the LUDF. Respondents ranking other farmers and consultants as useful information sources for learning about new technologies were also the most likely to adopt soil moisture monitoring. Ranking consultants as useful was also positively correlated with the adoption of EcoN while ranking Tuesday farm walks as useful was significantly negatively correlated to the adoption of EcoN.

The adoption of a zero induction policy was significantly negatively correlated with ranking of the SIDDC/LUDF website, focus days, Tuesday farm walks and other farmers as important. Respondents ranking these information sources as important were less likely to adopt a zero induction policy than respondents who did not consider these information sources important.

The adoption of pre-graze mowing, the creation of a separate herd of young cows to facilitate alternative management and the synchronisation of heifers to calve before the herd, was not significantly correlated with any of the information sources used for learning about the LUDF's results.

4.6.6.2 Information sources used for learning of new agricultural innovations and innovation adoption

Respondents were asked to rank seven information sources which could be used to learn about new agricultural technology and innovation. Twenty three per cent of the correlations between these information sources and the adoption of individual innovations were significant.

Respondents who considered DairyNZ events as a useful source of information for learning of new technologies were significantly more likely to adopt re-grassing based on measurement of poor performing paddocks and the monitoring of soil moisture to drive irrigation practice than respondents who did not consider DairyNZ events as useful. Respondents ranking demonstration farms as useful were significantly more likely to adopt low and consistent grazing residuals, re-grassing based on the measurement of poor performing paddocks, and the condition scoring of cows to facilitate alternative management.

Ranking other media publications and conferences as useful was significantly positively correlated with the adoption of EcoN. Ranking other media publications as useful was also significantly positively correlated with adopting condition scoring of cows to facilitate alternative management but significantly negatively correlated with adopting the creation of a separate herd of young cows.

Ranking consultants and the sales/technical staff of suppliers as useful sources of information about new technology was significantly positively correlated with the adoption of soil moisture monitoring to drive irrigation practice, and the frequent small application of nitrogen fertiliser and gibberellic acid simultaneously. Ranking of sales/technical staff of suppliers as useful was also significantly positively correlated with the adoption of pre-graze mowing to lift animal intakes and the synchronisation of heifers.

The ranking of other farmers as useful sources of information was not significantly correlated with the adoption of any innovation, i.e. respondents who consider farmers as useful sources of information for learning about new technologies were no more likely to adopt an innovation than those respondents who did not consider other farmers as useful sources of information.

4.5.7 The number of innovations adopted (farmer innovativeness)

The total number of innovations adopted by a respondent was used as a measure of innovativeness. No significant correlations exist between farmer characteristics and the number of innovations adopted, indicating that age, position held on-farm, education, experience and multiple farm interests do not influence respondents' innovativeness. There were three significant correlations between farm characteristics and innovativeness with farm size, production per cow and production per effective ha positively influencing innovativeness.

Regarding ISCs and innovativeness, respondents who attend DairyNZ events, use a private consultant and use the SIDDC/LUDF website tended to be the most innovative. Respondents who ranked newspapers and other media publications as important sources for learning of LUDF's results, and respondents who ranked demonstration farms and DairyNZ events as useful for learning of new agricultural innovations were more innovative than respondents who did not consider these information sources important or useful.

4.5.8 Results from logistic and linear regession

Logistic regression was used to explore the relationships between the explanatory variables and the adoption of each of the ten FMP innovations. The variables included in the logistic regression model were farmer age, farm size, production per cow, LUDF focus day attendance, DairyNZ event attendance, use of the SIDDC/LUDF website, and use of a private consultant. These variables were selected based on the significant correlations identified between farmer, farm, and ISCs, and the adoption of individual FMP innovations. Although results show that this model had a limited predictive capacity, when the model was a good fit for the data, the majority of the variables did not significantly influence the outcome. Similar to the results of the bivariate analysis, age, farm size, production per cow, and focus day attendance were shown to significantly influence the adoption and non-adoption of only a small number of FMP innovations. The results indicate that the variables included in the model do not significantly influence the adoption of these FMPs among respondents.

Linear regression was used to explore the relationships between the explanatory variables and farmer innovativeness. The variables included in the linear regression model were farm size, production per cow, production per ha, DairyNZ event attendance, use of the SIDDC/LUDF website, and use of a private consultant. These variables were selected based on the significant correlations identified between farmer, farm, and ISCs, and the number of FMP innovations adopted by each respondents (farmer innovativeness). The results of linear regression indicate that the model containing these explanatory variables had limited explanatory power, only accounting for 6 per cent of the variability in the number of innovations adopted. Results also showed that these variables do not significantly contribute to the number of innovations adopted by respondents, i.e. respondent innovativeness.

Chapter 5

Discussion

5.1 Introduction

The primary objective of this research was to determine Canterbury dairy farmers' socio-demographic, farm and information seeking characteristics, and to assess whether these characteristics influence the adoption of a range of FMP innovations in the CDI. The second objective was to identify the theory(s) which best explain the adoption decisions of Canterbury dairy farmers, and to determine if existing theory can be modified/updated to accommodate Canterbury dairy farmer innovation adoption. In the previous chapter, results from this study were presented. In this chapter, all the findings are brought together into an integrated discussion. The main findings associated with innovation adoption in the CDI are explored relative to other adoption literature. The literature review presented in Chapter 2 provides the framework for the following discussions.

This chapter begins with a statement of the major findings of this study. A discussion of respondents' socio-demographic, farm and information seeking characteristics follows. This answers research question 1, "what are the farmer characteristics, farm characteristics and ISCs of Canterbury dairy farmers?" This discussion will then turn to innovation adoption and the influence of farmer characteristics, farm characteristics and ISCs on the adoption of FMP innovations in the CDI is discussed. This answers research question 2, "what is the level of adoption of a range of FMP innovations in the CDI?" and research question 3, "how do farmer characteristics, farm characteristics and ISCs influence FMP innovation adoption in the CDI, and to what extent?" This section will also answer research question 4, "What other factors may be influencing Canterbury dairy farmers' adoption of FMP innovations?"

The theoretical implications of the findings are then discussed. This answers research question 5, "what theory(s) can be used to best explain the adoption decisions of Canterbury dairy farmers?", and research question 6, "Can existing theory be modified/updated to accommodate Canterbury dairy farmer innovation adoption?" The practical implications, some limitations and future research directions are then considered. Finally, the conclusions are presented.

5.2 The major findings of this study

The results show that for these relatively well-educated dairy farmers with high levels of industry experience using a wide range of information sources and operating large, highly productive dairy farm businesses, their socio-demographic characteristics, farm characteristics and ISCs are very weakly associated with their adoption and non-adoption of FMP innovations, and with their innovativeness.

Results show adoption levels of these FMP innovations ranged from 21-83 per cent, and that in general, respondents adopted a mix of innovations. Respondents' comments indicate that farmers adopt those innovations which best suit their existing FMPs and farming systems; that the characteristics of an innovation, in particular compatibility and profitability, are of primary importance; and that the adaptation of innovations by respondents is prevalent. Finally, results indicate that non-adoption was a considered decision, a key finding of this study.

5.3 Canterbury dairy farmer respondents

The electronic survey used to collect the data had a participation rate of 22 per cent, which is higher than the typical response rate of 5-10 per cent (Semler, 2010). The number of valid responses (n=123) represented 12 per cent of the population of dairy effluent consent holders surveyed. Respondents represented a broad cross-section of Canterbury dairy farmers with a range of socio-demographic characteristics, farm characteristics and ISCs.

The respondents had an average age of 47 years, which compares with average farmer ages of 50 and 58 reported in 2012 media (Vaughan, 2012; Fairfax News, 2012). Sixty six per cent of respondents' had post-school education compared with 38 per cent of Canterbury adults (StatsNZ, 2012). Forty nine per cent of respondents had more than two decades of industry experience and 52 per cent had a financial/managerial interest in more than one dairy farm compared to a New Zealand wide estimate of 20 per cent (van Bysterveldt, 2012). This is likely to reflect the recent expansion in the CDI.

The majority of respondents (92 per cent) operate a moderate input system (DairyNZ System 2-4). Respondents' average farm size of 231 ha is similar to the Canterbury average of 226 ha reported by LIC and DairyNZ (2012). However, respondents' average milksolids production per cow (433 kg) and per effective ha (1538 kg), is 9 per cent and 13 per cent higher respectively than the Canterbury dairy industry averages (LIC & DairyNZ, 2012). Seventy five per cent of respondents produced greater than 1400 kg MS/ha (Table 4.7, page 50) compared to the Canterbury average of 1360 kg (LIC & DairyNZ, 2012).

Pangborn (2009) reported similar socio-demographics despite the population of farmers surveyed being different. Average age of respondents was 45 years and their post-school education level was 67 per cent. Respondents' farm sizes and their productivity per cow and per ha were also greater than Canterbury dairy industry averages. Eighty six per cent operated a moderate input system (system 2-4).

Eighty five per cent of respondents visited the SIDDC/LUDF website and 51 per cent attended LUDF focus days at least once in 2012. DairyNZ events were attended by 80 per cent of respondents and 65 per cent employed a private consultant/advisor. Respondents ranked the LUDF website, dairy newspapers and LUDF focus days as the most important information sources for learning about the LUDF's results, and ranked demonstration farms, DairyNZ events and other farmers as the most useful information sources for learning about new agricultural innovations. This suggests that, similar to Morris et al.'s (1995) observations, these farmers have a good awareness of these FMP innovations.

5.4 Farmer characteristics and innovation adoption

A measure of farmer innovativeness was constructed using the number of innovations adopted by each respondent; the higher the number of adoptions, the higher their innovativeness. Results show that innovativeness spans a range of farmer characteristics with respondents adopting an average of five innovations. However, results also show that the farmer characteristics of age, experience, education, position held-on-farm, and multiple farm interests are only weakly associated with farmer innovativeness.

Farmer characteristics are also weakly associated with the adoption of individual FMPs, indicated by the relatively low number (10 per cent) of significant correlations and results of logistic regression analysis. Age, position held on-farm and having multiple farm interests are significantly correlated with the adoption of some FMP innovations, while education and experience are not.

Although weakly associated with innovativeness ($\tau c = .09$, $p = .14$, Table 4.41), age is significantly ($p < .05$) positively correlated with the adoption of two innovations but significantly negatively correlated with the adoption of another. This inconsistency suggests that age may not be the determining factor. Significant correlations between farmer characteristics, farm characteristics and the adoption of FMP innovations suggests respondents' existing FMPs or farm systems may be ultimately responsible. Age is negatively correlated with farm size and farm system with older respondents the most likely to operate small dairy farms (<169 ha) and operate a low input system. The negative correlation between age and the adoption of a separate herd of young cows to facilitate alternative management (2herds) may reflect the farming systems on smaller, low input dairy farms (i.e. operating a single herd system and/or limited use of hired labour).

In Chapter 2, other research investigating the adoption of FMPs identified that age, education and experience generally, positively influence the adoption of FMPs. However, similar to this research, Ghadim and Pannell (1999), Beswell and Kaine (2004), and Prokopy et al. (2008) observed inconsistencies in research results regarding the direction and strength of the relationships between socio-demographics and FMPs. Shahin (2004) and Howley et al. (2012) both observed that age negatively impacted on innovation adoption and Rezaei and Bagheri (2011) observed that farmer experience also negatively influences adoption. These researchers suggested the negative impact resulted from older and more experienced farmers being more risk averse.

Inconsistency may result from contextual factors such as policy, social and cultural contexts, climate, geography, and economic conditions (Botha & Atkins, 2005; Ormord, 1990). However, Beswell and Kaine (2004) observed no consistent relationships across industries and countries between the adoption of management practices and variables such as enterprise characteristics and farmers' socio-demographics. Similar to Morris et al. (1995), Alvarez and Nuthall (2001) and Beswell and Kaine (2004; 2005), the results of this study suggest that the particular context of an enterprise and the constraints imposed by the realities of commercial production are likely to influence the FMPs farmers learn about, evaluate and adopt.

5.5 Farm characteristics and innovation adoption

Similar to the studies included in Chapter 2, results identified that farm size and productivity are significantly correlated with innovativeness (the number of innovations adopted). The literature suggests that farm size influences innovation adoption through reduced costs and increased benefits per unit of production arising from economies of scale and resource availability (Brown et al., 2013). Yule and Eastwood (2011) suggest that larger farms may also have a greater need for technologies due to a scarcity of skilled labour and increased management complexity. The relationship between large farms and the number of innovations adopted may also result from the linear 'top-down' transfer of technology which Black (2000) suggests has focused particularly on larger, wealthier farmers and farmers thought to be 'early adopters' in the expectation that their example will be followed by others. Whether the latter is applicable to the CDI, where farm sizes have increased as a consequence of recent expansion is uncertain.

Farm size is significantly positively correlated with the adoption of soil moisture monitoring and the creation of a separate herd of young cows to facilitate alternative management but is significantly negatively correlated with the adoption of a zero induction policy. It is suggested that the adoption of soil moisture monitoring by large farms is likely to reflect economies of scale and aid in the management of a complex, resource dependant business while the adoption of a separate herd of young cows is likely to reflect existing FMPs on large farms. Large farms are likely to be already operating a two herd system due to cow numbers and resource constraints such as yard size. This is supported by the very strong (τc =.52, p <.001, Table 4.42, page 87) significant positive correlation. This suggests that the adoption of a separate herd of young cows is particularly suited to larger dairy farms.

The strong negative correlation between farm size and a zero induction policy again highlights the inconsistency in the relationships between farm characteristics and FMP innovation adoption. Respondents' comments indicate that calving induction is used to grow cow numbers, tighten calving pattern, and reduce cull cow numbers, suggesting that the non-adoption of this FMP is based largely on economics for many farmers. Farm size is positively correlated with more intensive farming systems and increased productivity per cow, and in addition to skilled labour shortages and complex management (Yule & Eastwood, 2011), this suggests that a zero induction policy may not be financially or practically feasible on larger farms.

Production per cow and production per ha is significantly positively correlated with farmer innovativeness and with the adoption of pre-graze mowing to lift animal intakes. Rather than a determinant of FMP innovation adoption, it is likely that this increased level of productivity has resulted from adopting this FMP innovation. Regarding farmer innovativeness, production per cow and per ha is significantly positively correlated with farm size and farm system and it is suggested that the relationship between productivity and innovativeness (the number of innovations adopted) may reflect this relationship, i.e. the need and capacity of larger farms to adopt a greater number of innovations.

Young stock management is significantly correlated with the adoption of five innovations. Farmers using their own land to rear heifer calves and yearling heifers are significantly less likely to adopt low and consistent grazing residuals than respondents using a contract grazer or an associated business (Table E11 and E12). It is likely that these farmers may use their young stock to 'clean up' after the milking herd (i.e. using young stock to maintain pasture quality). Young stock management is also significantly correlated with synchronisation of heifers to calve before the main herd with respondents who used their own land more likely to adopt synchronisation of heifers. Some respondents' comments indicate that non-adoption of synchronisation is largely due to time constraints and logistics, i.e. heifers grazing away from the main farm. Consequently, using own land, which is likely to be close to the main farm, may facilitate the adoption of synchronisation. Using own land to manage yearling heifers is significantly negatively correlated with the adoption of pre-graze mowing but significantly positively correlated with the adoption of a zero induction policy.

Overall, less than 20 per cent of the correlations between farm characteristics and the adoption of individual innovations are significant, many of which appear to complement existing FMPs. Inconsistencies in the direction and strength of these relationships suggest that for this cohort of Canterbury dairy farmers, socio-demographic and farm characteristics are reasonably poor indicators of farmer innovativeness, and do not significantly influence the adoption of these FMP innovations. The results of linear regression and logistic regression analysis add further support to this assessment.

5.6 Farmer ISCs and innovation adoption

Respondents use multiple information sources to access information with the majority using the SIDDC/LUDF website, attending DairyNZ events and employing a farm consultant. Half of respondents also attend LUDF focus days. This cohort of dairy farmers use industry sources to gather information on a wide range of topics with benchmarking and financial/strategic information relatively more important than practical farm management information. This suggests that these farmers constantly search for information to better manage their business(es), to assess business performance, and to aid in decision-making. A number of significant correlations between farmers' socio-demographics and information sources indicate that different farmers tend to use different information sources.

For example, less experienced respondents and those operating large farms are the most likely to use a private consultant, while younger more educated respondents, who are more likely to sharemilk or manage a large intensive dairy farm, tend to use the SIDDC/LUDF website and attend DairyNZ events. Older, more experienced respondents are more likely to operate a low input, small (<169 ha) dairy farm and may consider these information sources irrelevant.

Results show that using the SIDDC/LUDF website, attending DairyNZ events and employing a farm consultant are significantly correlated with innovativeness (the number of innovations adopted) and nearly 30 per cent of the correlations between ISCs and the adoption of individual innovations are significant. This supports Kaine's (2004) proposition that innovation adoption among farmers is akin to a high involvement purchase decision where a farmer will extensively search for information before a decision is made, will put significant effort into learning and discovery, and will evaluate both prior and after purchase.

Respondents' motivation to learn is reflected in their use of a wide variety of information sources with almost all of these sources ranked as important or very important for learning. The use of these information sources by a wide range of farmers also suggests that these farmers are continually learning. Twenty per cent of the information sources used to learn about LUDF results and new agricultural technologies are significantly correlated with innovativeness and approximately 25 per cent of the correlations between these sources and the adoption of individual innovations are significant. The importance of the SIDDC/LUDF information to these farmers, who use this information primarily for benchmarking purposes, is reflected in their ranking of demonstration farms as the most useful source of information for learning of new technologies.

Of note is the importance of the SIDDC/LUDF website. The website is used by 85 per cent of respondents, is ranked as the most important source for learning about the LUDF's results, is significantly correlated with the adoption of six of the ten innovations and has a significant positive correlation ($\tau c = .27$, $p<.001$, Table 4.43, page 90) with innovativeness. Given the range of farmers who responded to this on-line survey, it is clear that the internet is becoming increasingly important as an information source for Canterbury dairy farmers. However, these farmers were surveyed using an email based electronic survey and it is likely that these farmers are regular users of on-line resources. The relative importance and effectiveness of the internet as a management tool is not evident from the findings of this research and further assessment is required.

As well as using the information generated by the SIDDC/LUDF, farmers indicated that they learn about new technologies from other farmers. Respondents' comments such as "*have been doing that all my farming life*", "*have done this for 20 plus years*", "*been standard practice for years*" and "*have always done so*" for 70 per cent of the FMP innovations indicate that many of these FMPs are well established on farms within the CDI. This enables farmers to learn about these innovations from their peers. Morris et al. (1995, p. 8) suggests that information is freely shared in New Zealand because farmers are not competing directly with each other to sell products on a limited domestic market. This also supports Rogers (1983) proposition that many individuals evaluate an innovation not on the basis of scientific research by experts but through the subjective evaluations of near peers who have adopted the innovation. Rogers (1983) suggests that these near peers thus serve as role models, whose innovative behaviour tends to be imitated by others in their social system. This is supported by respondents ranking of other farmers as the third most useful source of information for learning about new technologies (Table 4.15, page 55).

Farmers' comments regarding their decisions to adopt or not adopt indicate that farmers also learn about and evaluate FMP innovations by trialling them; the comments "*tried this*", "*have tried this a little*", and "*tried it when first available in alternate paddocks and could not justify costs*" were made. These indicate that for some farmers, trialling of technologies is an important stage in their adoption decision-making process. This supports Botha and Atkins (2005) framework which includes a five step decision making process including; awareness, interest, compare, test, adopt or reject, and ignore. It also indicates that trialability is an important characteristic of an innovation allowing farmers to assess its compatibility with existing practices and farming systems.

The findings of this study correspond with previous research identified in Chapter 2 where dairy specific publications, contact with university extension programmes and faculty members, use of industry and private consultants and use of the internet were all shown to positively influence innovation adoption among farmers. However, regression results also show that despite being relatively more influential than personal and farm characteristics, ISCs are weakly associated with the adoption of individual FMP innovations and with farmer innovativeness.

5.7 Innovation adoption in the CDI

This research differs from many agricultural innovation adoption studies as it asked farmers why they adopted or did not adopt a range of FMP innovations. Results show that the adoption rate of these FMPs ranges from 21-83 per cent and that in general, respondents have adopted a mix of innovations. Respondents' comments provide insight into these results and indicate that their decisions were strongly influenced by the characteristics of an innovation, in particular an innovation's compatibility with their unique circumstances, and its profitability. This is similar to Morris et al.'s (1995) observations. It also supports Rogers' (1983, p. 211) proposition that an innovation's characteristics are relevant to the adoption of innovations.

Respondents' comments suggest that the compatibility, the degree to which an innovation is perceived as consistent with existing values, past experiences and the needs of potential adopters (Rogers, 1983, p. 223), is an important factor influencing the adoption and non-adoption of FMP innovation among this cohort of farmers. The comments include: "*needs to fit in the system", "not comparable to our situation*", "*not realistic in a single person set-up*", "*only run a small herd*", "*have tried in the past but complicates management too much when* *we already have two herds*", "*too hard with our herd size and shape of farm*". Comments also suggest that the compatibility of an innovation with their philosophies also influences farmers' decisions. This was particularly evident for the synchronisation of heifers ("*think it is wrong*", "*we do not believe in intervention of rising two years olds*", "*All farming practices are as nature determines*") and for a zero induction policy ("*don't like inducing*", "*unnatural to induce*", "*agree in principle*").

Regarding compatibility, comments such as "*the sharemilker does not yet understand the importance of doing this*", "*financial constraints*", "*current equity manager's personal preference is to run one herd for ease of staff management*" , "*have considered it but time has been a restricting factor*", "*too many stones, sharemilkers won't mow*", "*current equity manager doesn't believe in this practice*", supports Ajzen's (1991) proposition that a behaviour will only be expressed if the behaviour is under volitional control (i.e. if the person can decide at will to perform or not perform the behaviour). He suggests that the resources and opportunities available to a person dictate whether they will perform a behaviour. This suggests adoption can be restricted by a farmer's capacity to adopt (i.e. control, time and cost constraints, and the cooperation of others).

In addition to compatibility, comments such as "*it made a significant improvement in our financials*", "*obvious improvement in production*", "*cost and hassle*", "*have done this but can't justify the costs*", "*proven performance*", "*ensures most economic decisions are made*", "*best use of the cheapest feed we have, low cost milk production*", indicate that profitability is also important. The inconsistency in respondents' comments regarding the profitability of an innovation suggests farmers and their farm systems differ, but it also indicates that farmers have trialled innovations and based on their results, have decided to reject or discontinue adoption. Lionberger (1961, p. 4), Rogers (1983, p. 164) and Botha and Atkins' (2005, p. 3) propose that there are five distinguishable stages in the adoption process which include awareness, interest, evaluation and trial leading to adoption or non-adoption. Non-adoption following trial suggests that those respondents have a detailed knowledge of the innovation and their non-adoption was thus an informed choice.

Respondents' comments suggest that cost of adoption, complexity and the observability of the results are also important and indicate that these characteristics are responsible for gibberellic acid, Eco-N and the synchronisation of heifers having the lowest levels of adoption. Conversely, the less complex, less costly and more observable FMPs innovations of low and consistent grazing residuals, re-grassing based on measurement of poor performing paddocks, and regular monitoring of cow body condition and responding with alternative management to ensure targets are achieved have the highest levels of adoption. The relative importance of compatibility and profitability (relative advantage) compared with complexity, cost and observability was also observed by Pereira (2011) among innovative Brazilian beef farmers.

Social approval also influences the decision to adopt or not adopt among some farmers. This is evident from comments regarding the use of Eco-N ("*is economical and shows dairy farmers do care about environmental effects*", "*economic with environmental and public perception benefits*", "*bit of a greeny*"), and having a zero induction policy ("*haven't induced for 12 years because of worries about outside opinions affecting the industry*").

The adaptation of innovations among respondents is also evident from respondents' comments; "*good to maintain quality, but need to balance this with cow performance*", "*also needs to fit in the system, sometimes need to juggle things around*", "*my version*", "*would like to put probes into the soil but (…) monitor rainfall and dig holes with a shovel to check moisture*". Rogers (1983, p. 211) proposed that adapting or re-inventing an innovation is one aspect of an innovation's trialability. However, comments suggest that the adaptability of an innovation to their specific circumstances is a discrete characteristic which in itself influences adoption and non-adoption. The adaptation of innovations suggests that farmers are creative when it comes to FMPs. This may reflect these farmers' high levels of experience and resulting intuitive knowledge of their farm systems.

By indicating that the characteristics of an innovation are influential, comments demonstrated that the respondents who did not adopt a particular innovation had a sensible justification for non-adoption. These included the incompatibility of the FMP innovation with their existing FMPs and farming system and particular constraints, among others. Results suggest farmers strategically select the FMPs that best fit and enhance their farming systems.

This finding does not fit with that of Rogers (1983, p. 247), who proposed that there were five categories of adopters based on respondents' innovativeness, defined as the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system. The five categories included innovators, early adopters, early majority, late majority and laggards. Rogers (1983, pp. 248-250) suggested that innovators had more years of formal education, were more likely to be literate, engage in more active information seeking, have greater knowledge of innovations and be the most innovative, while laggards are traditional, sceptical, less intelligent, more adverse to risk, had less social participation and had less contact with change agents.

The categorisation of adopters was directly related to their time of adoption. Non-adopters were not included as a category as non-adoption was thought to result from a lack of awareness, information, education, or other similar barrier. This highlights the pro-technology bias of Rogers' diffusion theory (Rogers, 1983, p. 87) that all technology is good and should be adopted. Comments indicate that a number of these FMPs are well established within the CDI, and similar to Morris et al.'s (1995) observations, results indicate that these farmers adopted some innovations and did not adopt others suggesting that these farmers may be 'innovators' in regards to one innovation and 'laggards' in regards to another. The findings of this study demonstrate that adoption and non-adoption among these farmers is likely to be strongly influenced by the characteristics of an innovation and farmers' existing farming practices and systems. Therefore, Rogers' (1983, p. 247) definition of innovativeness, and categorisation of adopters based on their timing of adoption may be misrepresentative.

The discussion above provides evidence that farmer innovativeness and FMP innovation adoption among this cohort of farmers is not significantly influenced by farmer socio-demographic characteristics, farm characteristics or farmer ISCs. It also demonstrates that existing FMPs and the characteristics of an innovation appear to have the strongest influence on the adoption and non-adoption of FMPs. The compatibility and profitability of an innovation along with its adaptability, complexity, cost and observability are important factors. A key finding of this study is that non-adoption is an informed decision.

5.8 Contribution of this study

In completing the first objective of this study, it is shown that the collection of both quantitative and qualitative data enabled a greater understanding of the adoption and non-adoption decisions of Canterbury dairy farmers, compared with if only one type was collected. The second objective of this study was to establish what theory(s) can be used to best explain the adoption decisions of Canterbury dairy farmers, and whether existing theory can be modified/updated to accommodate Canterbury dairy farmer innovation adoption. With regards to the former, it is suggested that using the perspectives afforded by extension theory, the theory of planned behaviour, consumer behaviour theory and diffusion theory has enabled a more holistic understanding of innovation adoption among this cohort of farmers. This supports Nelson et al. (2004) and Wolfe (1994) who suggested that there can be no one theory of innovation and that there is merit in having multiple perspectives. The findings of this research also support Pannell et al. (2006), Botha and Atkins (2005) and Nutley et al. (2002) who noted that despite different disciplines and different theories, the perspectives and emphases' of many research traditions are complementary when looking through a cross-disciplinary lens. Regarding modifying existing theory, one contribution of this research is the expansion of Botha and Atkins' (2005) conceptual framework. The central role of information in the adoption decision-making process was identified in Chapter 2, and it was proposed that, in addition to personal and contextual factors, farmer ISCs would also influence the decision-making process (see page 25). Although weakly associated, significant correlations suggest that ISCs do influence the adoption and non-adoption of FMPs, and that for these farmers, were relatively more influential than socio-demographic and farm characteristics.

In addition to ISCs, results indicate that the characteristics of an innovation also influence respondents' decisions to adopt or not adopt an innovation. This has been reported in the literature. However, based on this finding, the framework used to guide this study can be further expanded to include the characteristics of an innovation as a set of influential factors. Existing FMPs and farming systems were also shown to influence the adoption of FMPs and although these are contextual factors, their relative importance to the adoption of FMP innovations suggests their specific inclusion in this framework is warranted (Figure 5.1).

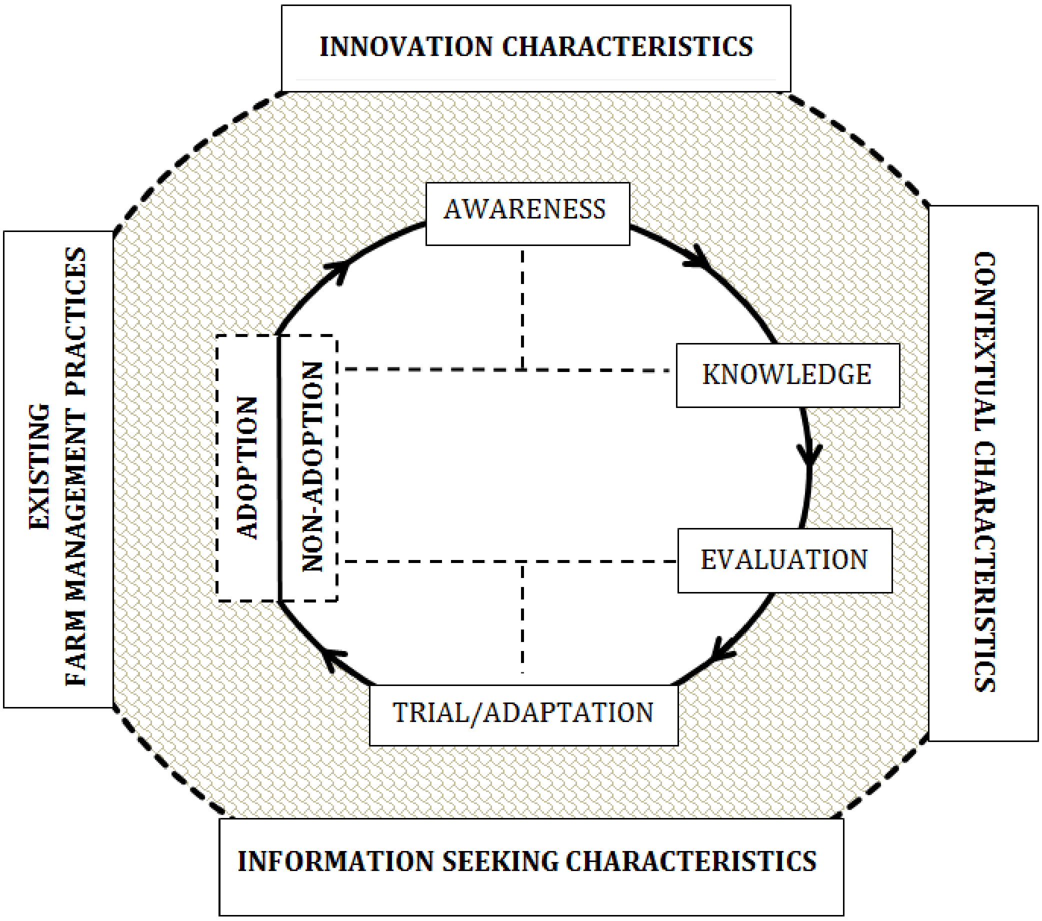

Figure 5.1 Expanded theoretical framework for investigating FMP innovation adoption (adapted from Botha & Atkins, 2005, p. 3; Lionberger, 1961, p. 4).

Socio-demographic or personal factors have been excluded based on the findings of this research. The innovation adoption decision consists of a number of stages and is located at the centre of the innovation adoption process. The five steps include 1) awareness, 2) knowledge, 3) evaluation 4) trail and/or adaptation and 5) adoption or non-adoption (which may occur after each stage of this process). The expansion of this framework includes specifically recognising the influence of farmers' ISCs, existing FMPs, and the characteristics of the innovation. The results suggest that these four sets of factors are interdependent, and this is represented by the dotted line joining these factors.

Other contributions of this study include the finding that of the ten attributes of innovations proposed by Rogers (1983, p. 211) and Tornatzky and Klein (1982), compatibility and profitability appear to be the most important, with trialability, cost, observability, and complexity also shown to be important. The relative importance of compatibility and profitability when compared to the other innovation characteristics has been reported in the literature (Pereira, 2011). However, it has not previously been reported in the CDI. Their importance reinforces the view that existing FMPs are an essential piece of the puzzle when investigating the adoption and non-adoption of FMPs.

Another contribution is the finding that both adopters and non-adopters of a FMP innovation make informed decisions. Again this has been reported in the literature but has not been observed in the CDI. This suggests that non-adoption of an innovation should not be viewed as the result of a barrier but needs to be understood within the context of the existing FMPs and systems (Morris et al., 1995; Alvarez & Nuthall, 2001; Beswell & Kaine, 2005, Pereira, 2011).

5.9 Practical implications

The findings of this research are of use to policy makers and those involved in agricultural extension. Results indicate that focussing on a farmer's existing FMPs and farming systems may be more fruitful than concentrating on a farmer's socio-demographics when it comes to establishing a farmer's capacity to adopt FMP innovations. This would also allow extension professionals to establish a farmer's specific needs and aid in assessing the relevance of particular innovations. Grouping farmers according to their FMPs may also enable a more resource efficient targeted approach to promoting FMP change.

The results regarding farmers' ISCs suggests that providing farmers with information relevant to their production systems may also aid in promoting FMP change. The importance of the SIDDC/LUDF website to these farmers indicates that on-line resources may have a role to play. The range of information sources used by farmers suggests that publicising research results in a variety of information sources may help increase farmers' awareness and knowledge of existing and evolving farm management practices and technologies.

5.10 Limitations of findings

The main limitation of this study is the generalisation of its findings to the wider population of dairy farmers. The sample population and the modest number of valid responses restrict the extrapolation of these results. In addition, the relatively high survey participation rate may have resulted from farmers who have an affinity with the SIDDC and/or LUDF being more likely to participate in this research, thus leading to biased results. However, results indicate that the majority of farmers who participated in this research achieve above average productivity (per cow and per effective ha). This suggests that this study does not relate to the wider population of CDI farmers but applies only to the higher producing CDI dairy farmers.

The nature of the CDI, i.e. large herd sizes, large farm sizes, high levels of production and recent rapid expansion may also restrict generalisation. Approximately half of respondents did not comment on their reasons for adopting or not adopting each particular innovation. This is also a limitation.

Other limitations relate to the research methods used here. The use of an email based electronic survey excluded farmers whose email addresses were not known (of the farmers included in the CDEG contact list (N=1012), 647 (64 per cent) had known email addresses). Also excluded were farmers who may have changed their email address, or due to email account settings which automatically re-direct some emails via spam filters did not receive the email. The pre-determined answers provided for some questions limited respondents' ability to provide new information. In addition, the resulting categorical data also curtailed the use of more commonly used methods for data analysis.

In addition, many respondents identified themselves as farm owners (as opposed to owner-operators) indicating that they may delegate the management of their farms. Consequently FMPs may not be their direct responsibility and this may have excluded some farm management decision makers from this research.

5.11 Future research suggestions

Suggestions for future research include applying the expanded framework presented in this research to conduct similar research into FMP adoption in other dairy regions of New Zealand. The findings regarding the importance of innovation characteristics could be further investigated to establish their importance to the adoption of other types of innovations.

There is also scope to further research the importance of farmers' information sources, in particular internet usage, to investigate their importance to farmers' decision-making processes regarding other areas of farm management.

5.12 Conclusions

The results show that studying innovation adoption among this particular sub-group of relatively well educated, high producing dairy farmers should not focus on their socio-demographic and farm characteristics, but should instead concentrate on establishing the relevance of an innovation to the potential adopter. Results indicate personal characteristics were only very weakly associated with the number of innovations adopted, and only a handful of significant relationships existed between socio-demographics and the adoption of individual innovations. These farmers adopted some innovations and not others, and the relationships between farmers' personal and farm characteristics suggest that this is largely due to their existing FMPs and farming systems. Comments indicating that the characteristics of an innovation, especially their compatibility and profitability, were important considerations for farmers when adopting or not adopting support this conclusion. This suggests that defining innovativeness as a function of time and that the categorisation of farmers based on when they adopt an innovation relative to others in the same social system may be misrepresentative.

Respondents' comments also indicate that the adoption decision is complex and context sensitive. Furthermore, comments indicate that these farmers make informed decisions regarding what innovations they adopt/do not adopt based on information obtained from a range of sources including industry sources, other farmers and the trialling of innovations. Non-adoption resulted from an innovation's incompatibility with farmers' needs, their capacity to adopt and/or existing FMPs, and was not the result from a lack of information, lack of education, poor social connectedness or other such barrier.

Appendix A

Lincoln University Human Ethics Committee approval

Research and Commercialisation Office

T 64 3 325 3838
F 64 3 325 3630
PO Box 84, Lincoln University
Lincoln 7647, Christchurch
New Zealand

www.lincoln.ac.nz

Application No: 2012-46 28 November 2012

Title: Survey of dairy farmer opinions of the Lincoln University Dairy Farm (LUDF)

Applicant: Marvin Pangborn

The Lincoln University Human Ethics Committee has reviewed the above noted application.

Thank you for your detailed response to the questions which were forwarded to you on the Committee's behalf, however the Research Information Sheet should indicate to prospective participants the source (ECan) from which their contact information was obtained.

I am satisfied on the Committee's behalf that the issues of concern have been satisfactorily addressed.

I am pleased to give final approval to your project. Please advise Alison Hind when you have completed your research and confirming that you have complied with the terms of the ethical approval.

May I, on behalf of the Committee, wish you success in your research.

Yours sincerely

Professor Grant Cushman
Chair, Human Ethics Committee

cc Professor Keith Woodford

PLEASE NOTE: The Human Ethics Committee has an audit process in place for applications. Please see 7.3 of the Human Ethics Committee Operating Procedures (ACHE) in the Lincoln University Policies and Procedures Manual for more information.

Appendix B

LUDF 2012 online questionnaire

Lincoln University
Te Whare Wānaka o Aoraki
CHRISTCHURCH, NEW ZEALAND

Welcome to Part 1: Farmer background

1.01 Position of the person answering questions

Owner	Owner-Operator	50/50 Sharemilker	Lower Order Sharemilker	Manager	Equity Manager	Other (please specify)
◯	◯	◯	◯	◯	◯	◯

1.02 Highest level of formal education (please tick appropriate answer)

High School	Ag ITO/Polytechnic	University
◯	◯	◯

1.03 Gender (please tick appropriate answer)

Female	Male
◯	◯

1.04 Age of person answering questions (please tick appropriate answer)

less than 19	(20-24)	(25-29)	(30-34)	(35-39)	(40-44)	(45-49)	(50-54)	(55-59)	(60-64)	(65-69)	70+
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

1.05 Number of years actively involved in dairy farming in New Zealand? (please tick appropriate answer)

less than 1 year	1-2 years	3-4 years	4-5 years	5-10 years	10-20 years	+20 years
◯	◯	◯	◯	◯	◯	◯

1.06 Do you have a financial / managerial interest in more than one farm?

- ◎ Yes
- ◎ No

Note: If you have a financial / managerial interest in more than one dairy farm business, please answer the remaining questions in relation to the dairy farm which you are most familiar with

1.07 Pre-dominant breed of dairy cow in milking herd

- ◎ Friesian
- ◎ Jersey
- ◎ Kiwi cross
- ◎ Other (please specify)

1.08 Size of milking platform in 2011/12 season (effective hectares)

1.09 Average production per cow in 2011/12 season (kilograms of milksolids to factory)

1.10 Average production per hectare in 2011/12 season (kilograms of milksolids to the factory per effective hectare)

1.11 Dairy NZ has identified five types of farming systems

- **System 1:** All grass, self contained
- **System 2:** Feed imported either as supplement or grazing off and fed to cows (4-14% of feed imported)
- **System 3:** Feed imported to extend lactation and for dry cows (10-20% of feed imported)
- **System 4:** Feed imported and used at both ends of lactation and for dry cows (20-30% of feed imported)
- **System 5:** Imported feed used all year (30-40% of feed imported)

Please indicate which type of farming system you have used in the past three seasons

	System 1: All grass (no feed imported)	**System 2:** (4-14% feed imported)	**System 3:** (10-20% feed imported)	**System 4:** (20-30% feed imported)	**System 5:** (30-40% feed imported)
2010/2011 Season	○	○	○	○	○
2011/2012 Season	○	○	○	○	○
2012/2013 Season	○	○	○	○	○

1.12 Please indicate the system that best describes your dairy replacement YOUNG stock management

	Own land (leased or owned)	**Contract grazing**	**Managed by an associated business**	**Other**
Heifer Calves (weaning to April 30th)	○	○	○	○
Yearling heifers (May 1st to April 30th)	○	○	○	○

1.13 Please indicate which of the following options best describes your view of standoff facilities/ partial housing for livestock (can be more than one)

- ☐ Not appropriate for NZ's pasture/grazing based agricultural sector and market reputation
- ☐ Difficult to justify financially
- ☐ Nice to have to minimise treading/pugging damage on the milking platform
- ☐ Likely future component of milking platform and wintering facility
- ☐ Currently part of my farm system for **wintering and milking**
- ☐ Currently part of my farm system for **milking platform only**
- ☐ Currently part of my farm system for **wintering only**

>>

Part 2: Lincoln University Dairy Farm (LUDF) and South Island Dairy Development Centre (SIDDC)

2.01 How often did you attend any of the four LUDF Focus days in these seasons?

	One	Two	Three	All	None
2009/2010 season	○	○	○	○	○
2010/2011 season	○	○	○	○	○
2011/2012 season	○	○	○	○	○

2.02 If you have attended a LUDF Focus day, why did you attend? Please tick any or all.

- ☐ To meet other farmers
- ☐ To learn about grazing management
- ☐ To learn about herd/animal management
- ☐ For the financial information provided
- ☐ To visit with Agri-business professionals (bankers, suppliers, etc.)
- ☐ To learn how LUDF is performing
- ☐ To learn about environmental management at LUDF (minimising nutrient losses, water efficiency etc.)
- ☐ To compare your farm to LUDF
- ☐ Other (please specify)

2.03 Previous messages from LUDF are listed below. Please indicate your use of them by ticking yes or no, and briefly comment on why you have or have not adopted these management practices

2.03.1 Low and consistent grazing residuals

- Yes
- No

2.03.2 Re-grassing based on measurement of poor performing paddocks

- Yes
- No

2.03.3 Synchronising of heifers to calve two weeks before herd

- Yes
- No

2.03.4 Zero induction policy

- Yes
- No

2.03.5 Use of Eco-n to mitigate urine N loss

- Yes
- No

2.03.6 Monitoring soil moisture to drive irrigation practice

- Yes
- No

2.04 The following changes were made at the LUDF in the 2011-2012 season. Please indicate your use of them by ticking yes or no, and briefly comment on why you have or have not adopted these management practices

2.04.1 Regular monitoring of cow body condition and responding with alternate management to ensure targets are achieved

- Yes
- No

2.04.2 Creating a separate herd of young cows to enable preferential stock management when required to ensure growth rates and condition score targets are achieved

- Yes
- No

2.04.3 Frequent small applications of Nitrogen and use of Gibberellic Acid simultaneously to promote on farm production of high quality pasture

- Yes
- No

2.04.4 Pre-graze mowing to lift intake

- Yes
- No

2.05 How important to you are the following sources to learn about the results obtained at the LUDF?
(1 is very important, 5 is not at all important)

	Very important 1	2	3	4	Not at all important 5
Attending Tuesday Farm Walks	○	○	○	○	○
SIDDC / LUDF Website	○	○	○	○	○
Focus days	○	○	○	○	○
Consultants	○	○	○	○	○
Discussion Groups	○	○	○	○	○
Dairy newspapers	○	○	○	○	○
Other farmers	○	○	○	○	○
Other media publications	○	○	○	○	○

2.06 If you have used the SIDDC / LUDF website, how often do you visit the website in a year? (number of times)

2.07 When you think of learning about new agricultural technology or innovations, please rank the following as sources of information by ticking the relevant box in each row (1 is very useful, 5 is not at all useful)

	Very useful 1	2	3	4	Not at all useful 5
Media (TV, magazines, newspapers)	○	○	○	○	○
DairyNZ events (inc. discussion groups)	○	○	○	○	○
Demonstration farms	○	○	○	○	○
Conferences	○	○	○	○	○
Other farmers	○	○	○	○	○
Sales/technical staff of suppliers	○	○	○	○	○
Consultants	○	○	○	○	○

2.08 What is the one change you would most like to see at LUDF?

2.09 What other changes would you like to see at LUDF, or further areas to focus/demonstrate, or future projects at LUDF?

2.10 What is the most important aspect of LUDF for you and your business?

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CHRISTCHURCH, NEW ZEALAND

Part 3: Industry Perspective

3.01 How often do you attend DairyNZ events (**excluding** LUDF Focus days) (times per year)

[ ]

3.02 Do you regularly use a private consultant / advisor?

Yes ○ No ○

3.03 Please indicate which of the following services your consultant / advisor provides (can be more than one)

- ☐ Regular farm supervision and week to week management advice
- ☐ Periodic feed budgeting
- ☐ Whole farm strategic input
- ☐ Financial / farm business advice
- ☐ other (please specify)

[ ]

3.04 Please indicate how you receive information from your private consultant / advisor

- [ ] Personal visits
- [ ] Email
- [ ] Phone call
- [ ] Website
- [ ] Fax
- [ ] Post
- [ ] Other (please specify)

3.05 Please indicate your experience when it comes to obtaining relevant industry information on the following subject areas (1 very easy, 5 very difficult)

	Easy to find 1	2	3	4	Difficult to find 5	Have not looked
Animal production	○	○	○	○	○	○
Farm labour solutions	○	○	○	○	○	○
Succession planning	○	○	○	○	○	○
Dairy farm strategic business advice	○	○	○	○	○	○
Dairy farm business governance	○	○	○	○	○	○
Environment and nutrient management	○	○	○	○	○	○

3.06 Do you intend to make any changes to your farming system / farm infrastructure to accommodate environmental and nutrient management concerns? Please indicate by ticking the appropriate answer, and briefly describe what changes you intend to make below

Yes	Maybe	No
○	○	○

Briefly describe any proposed changes to your farming system

<< >>

Appendix C

Conversion table from τ to r values

Table C-1 Conversion table from τ to *r* values (Adapted from Walker, 2003, p. 530)

τ	***r***	**τ**	***r***	**τ**	***r***	**τ**	***r***
0.00	0.00	0.25	0.38	0.50	0.71	0.75	0.92
0.01	0.02[a]	0.26	0.40	0.51	0.72	0.76	0.93
0.02	0.03	0.27	0.41	0.52	0.73	0.77	0.94
0.03	0.05	0.28	0.43	0.53	0.74	0.78	0.94
0.04	0.06	0.29	0.44	0.54	0.75	0.79	0.95
0.05	0.08	0.30	0.45	0.55	0.76	0.80	0.95
0.06	0.09	0.31	0.47	0.56	0.77	0.81	0.96
0.07	0.11	0.32	0.48	0.57	0.78	0.82	0.96
0.08	0.13	0.33	0.50	0.58	0.79	0.83	0.96
0.09	0.14	0.34	0.51	0.59	0.80	0.84	0.97
0.10	0.16	0.35	0.52	0.60	0.81	0.85	0.97
0.11	0.17	0.36	0.54	0.61	0.82	0.86	0.98
0.12	0.19	0.37	0.55	0.62	0.83	0.87	0.98
0.13	0.20	0.38	0.56	0.63	0.84	0.88	0.98
0.14	0.22	0.39	0.58	0.64	0.84	0.89	0.99
0.15	0.23	0.40	0.59	0.65	0.85	0.90	0.99
0.16	0.25	0.41	0.60	0.66	0.86	0.91	0.99
0.17	0.26	0.42	0.61	0.67	0.87	0.92	0.99
0.18	0.28	0.43	0.63	0.68	0.88	0.93	0.99
0.19	0.29	0.44	0.64	0.69	0.88	0.94	1.00
0.20	0.31	0.45	0.65	0.70	0.89	0.95	1.00
0.21	0.32	0.46	0.66	0.71	0.90	0.96	1.00
0.22	0.34	0.47	0.67	0.72	0.90	0.97	1.00
0.23	0.35	0.48	0.68	0.73	0.91	0.98	1.00
0.24	0.37	0.49	0.70	0.74	0.92	0.99	1.00
0.25	0.38	0.50	0.71	0.75	0.92	1.00	1.00

[a.] The formula used to compute *r* = SIN(3.141592654 * τ * .5)(Walker, 2003, p. 529).

Appendix D

Cross tabulations of the significant correlations between farmer, farm and information seeking characteristics

D.1 Cross tabulation of farmer characteristics

Table D-1 Cross tabulation of age x position, experience and education

		Position							
Age (years)		Owner (n=70)	Owner-Operator (n=28)	50/50 Sharemilker (n=3)	Lower Order Sharemilker (n=1)	Manager (n=2)	Equity Manager (n=15)	Other[a] (n=4)	Total (n=123)
19-44 (n= 41)	Per cent	32	29	5	2	5	22	5	100
45-54 (n= 39)	Per cent	59	26	3	0	0	10	3	100
55-70+ (n= 43)	Per cent	79	14	0	0	0	5	2	100
Total (n=123)	Per cent	57	23	2	1	2	12	3	100

		Experience (years)			
Age (years)		<10 (n= 33)	10-20 (n= 30)	>20 (n=60)	Total (n=123)
19-44 (n= 41)	Per cent	49	22	29	100
45-54 (n= 39)	Per cent	26	23	51	100
55-70+(n= 43)	Per cent	7	28	65	100
Total (n= 123)	Per cent	27	24	49	100

		Education			
Age (years)		High School (n=42)	AgITO/Polytechnic (n=16)	University (n=64)	Total (n=122)
19-44 (n= 40)	Per cent	18	23	60	100
45-54 (n= 39)	Per cent	39	10	51	100
55-70+ (n= 43)	Per cent	47	7	47	100
Total (n= 122)	Per cent	34	13	53	100

[a] 'Other' included contract milker, owner and 50/50, part owner

Table D-2 Cross Tabulation of education x position, experience and multiple farm interests

		Position							
Education		Owner (n=70)	Owner-Operator (n=28)	50/50 Sharemilker (n=3)	Lower Order Sharemilker (n=1)	Manager (n=2)	Equity Manager (n=15)	Other[a] (n=4)	Total (n=123)
High School (n= 42)	Per cent	71	24	0	0	0	2	2	100
AgITO/Polytech (n=16)	Per cent	38	31	13	6	0	13	0	100
University (n= 64)	Per cent	53	20	0	0	3	19	5	100
Total (n= 123)	Per cent	57	23	2	1	2	12	3	100

		Multiple farm interests		
Education		No (n=58)	Yes (n=64)	Total (n= 122)
High School (n= 42)	Per cent	52	48	100
AgITO/Polytech (n=16)	Per cent	69	31	100
University (n= 64)	Per cent	39	61	100
Total (n= 122)	Per cent	48	52	100

		Education			
Experience (years)		High School (n= 42)	AgITO/Polytech (n= 16)	University (n= 64)	Total (n=122)
<10 (n= 32)	Per cent	19	16	66	100
10-20 (n= 30)	Per cent	33	20	47	100
>20 (n=60)	Per cent	43	8	48	100
Total (n= 122)	Per cent	34	13	53	100

[a] 'Other' included contract milker, owner and 50/50, part owner

Table D-3 Cross tabulation experience x position and multiple farm interests

Experience (years)		Owner (n=70)	Owner-Operator (n=28)	50/50 Sharemilker (n=3)	Lower Order Sharemilker (n=1)	Manager (n=2)	Equity Manager (n=15)	Other[a] (n=4)	Total (n=123)
		Position							
<10 (n= 33)	Per cent	39	24	9	0	6	18	3	100
10-20 (n= 30)	Per cent	57	30	0	3	0	10	0	100
>20 (n= 60)	Per cent	67	18	0	0	0	10	5	100
Total (n= 123)	Per cent	57	23	2	1	2	12	3	100

Experience (years)		No (n=58)	Yes (n=64)	Total (n= 122)
		Multiple farm interests		
<10 (n=33)	Per cent	58	42	100
10-20 (n= 30)	Per cent	63	37	100
>20 (n=60)	Per cent	35	65	100
Total (n= 122)	Per cent	48	52	100

[a] 'Other' included contract milker, owner and 50/50, part owner

Table D-4 Cross tabulation of position x multiple farm interests

Position		No (n=59)	Yes (n=64)	Total (n= 123)
		Multiple farm interests		
Owner (n= 70)	Per cent	33	67	100
Owner-Operator (n= 28)	Per cent	71	29	100
50/50 Sharemilker (n= 3)	Per cent	100	0	100
Lower Order Sharemilker (n= 1)	Per cent	100	0	100
Manager (n= 2)	Per cent	100	0	100
Equity Manager (n= 15)	Per cent	60	40	100
Other[a] (n= 4)	Per cent	25	75	100
Total (n= 123)	Per cent	48	52	100

[a] 'Other' included contract milker, owner and 50/50, part owner

D.2 Cross tabulation of farm characteristics

Table D-5 Cross tabulation of farm size x farm system x production per cow and per ha

Farm size (hectares)		Farm system: System 1+2 (n=31)	System 3 (n=43)	System 4+5 (n=36)	Total (n= 110)
< 169 (n= 39)	Per cent	33	49	18	100
170 – 254 (n= 32)	Per cent	31	28	41	100
>255 (n=39)	Per cent	21	39	41	100
Total (n=110)	Per cent	28	39	33	100

Farm size (hectares)		Production per cow (kg MS): <405 (n= 23)	405 - 428 (n= 25)	429 - 460 (n= 28)	>460 (n= 27)	Total (n= 103)
< 169 (n= 36)	Per cent	42	22	19	17	100
170 – 254 (n= 29)	Per cent	7	28	31	35	100
>255 (n=38)	Per cent	16	24	32	29	100
Total (n=103)	Per cent	22	24	27	26	100

Table D-6 Cross tabulation of farm system x production per cow and per ha, stocking rate and yearling heifer management

Farm system		Production per cow (kg MS): <405 (n= 25)	405 - 428 (n= 25)	429 - 460 (n= 28)	>460 (n= 24)	Total (n= 102)
System 1+2 (n=30)	Per cent	44	27	27	3	100
System 3 (n= 40)	Per cent	20	30	23	28	100
System 4+5 (n= 32)	Per cent	13	16	34	38	100
Total (n= 102)	Per cent	25	25	28	24	100

Farm system		Production per ha (kg MS): <1400 (n= 28)	1401-1550 (n= 24)	1551-1700 (n= 29)	>1700 (n= 25)	Total (n= 106)
System 1+2 (n=31)	Per cent	45	19	32	3	100
System 3 (n= 43)	Per cent	26	26	28	21	100
System 4+5 (n= 32)	Per cent	9	22	22	47	100
Total (n= 106)	Per cent	26	23	27	24	100

Table D-6 Continued

Farm system		Stocking rate (cows/effective ha) <3.00 (n= 11)	3.00-3.50 (n= 22)	3.51-3.70 (n= 22)	3.71-4.00 (n= 30)	>4.00 (n= 10)	Total (n= 95)
System 1+2 (n=27)	Per cent	19	30	15	33	4	100
System 3 (n= 38)	Per cent	16	21	29	29	5	100
System 4+5 (n= 30)	Per cent	0	20	23	33	23	100
Total (n= 95)	Per cent	12	23	23	32	11	100

Farm system		Yearling heifer management Own Land (n= 48)	Contract Grazing (n= 55)	Associated Business (n= 9)	Total (n= 112)
System 1+2 (n=33)	Per cent	55	45	0	100
System 3 (n= 45)	Per cent	44	51	5	100
System 4+5 (n= 34)	Per cent	29	50	21	100
Total (n= 112)	Per cent	43	49	8	100

Table D-7 Cross tabulation of stocking rate x production per cow and per ha

Stocking rate (cows/effective ha)		Production per cow (kg MS) <405 (n= 24)	405 - 428 (n= 24)	429 - 460 (n= 26)	>460 (n= 26)	Total (n= 100)
<3.00 (n= 12)	Per cent	67	8	8	17	100
3.00-3.50 (n= 23)	Per cent	30	17	30	22	100
3.51-3.70 (n= 23)	Per cent	17	17	39	26	100
3.71-4.00 (n= 31)	Per cent	16	36	19	29	100
>4.01 (n= 11)	Per cent	0	36	27	36	100
Total (n= 100)	Per cent	24	24	26	26	100

Stocking rate (cows/effective ha)		Production per ha (kg MS) <1400 (n= 25)	1401-1550 (n= 22)	1551-1700 (n= 26)	>1700 (n= 27)	Total (n= 100)
<3.00 (n= 12)	Per cent	100	0	0	0	100
3.00-3.50 (n= 23)	Per cent	48	44	8	0	100
3.51-3.70 (n= 23)	Per cent	4	35	39	22	100
3.71-4.00 (n= 31)	Per cent	3	13	45	39	100
>4.01 (n= 11)	Per cent	0	0	9	91	100
Total (n= 100)	Per cent	25	22	26	27	100

Table D-8 Cross tabulation of production per cow x production per ha, and heifer calf x yearling heifer management

Production per cow (kg MS)		Production per ha (kg MS) <1400 (n= 25)	1401-1550 (n= 24)	1551-1700 (n= 29)	>1700 (n= 27)	Total (n= 105)
<405 (n= 25)	Per cent	68	28	4	0	100
405 - 428 (n= 26)	Per cent	15	27	46	12	100
429 - 460 (n= 28)	Per cent	7	25	46	21	100
>460 (n= 26)	Per cent	8	12	12	70	100
Total (n= 105)	Per cent	24	23	28	26	100

Heifer calf management		Yearling heifer management Own Land (n= 49)	Contract Grazing (n= 58)	Associated Business (n= 9)	Total (n= 116)
Own Land (n= 60)	Per cent	82	17	2	100
Contract Grazing (n= 46)	Per cent	0	100	0	100
Associated Business (n= 10)	Per cent	0	20	80	100
Total (n= 116)	Per cent	43	50	8	100

D.3 Cross tabulation of farmer x farm characteristics

Table D-9 Cross tabulation of age x farm size and farm system; and multi farm interests x production per ha

		Farm size (hectares)			
Age (years)		< 170 (n= 401)	170-255 (n= 35)	>255 (n= 41)	Total (n= 116)
19-44 (n= 39)	Per cent	33	18	49	100
45-54 (n= 37)	Per cent	24	38	38	100
55-70+ (n= 40)	Per cent	45	35	20	100
Total (n= 116)	Per cent	35	30	35	100

		Farm system			
Age (years)		System 1+2 (n=34)	System 3 (n= 46)	System 4+5 (n= 36)	Total (n= 116)
19-44 (n= 37)	Per cent	27	35	38	100
45-54 (n= 38)	Per cent	18	40	42	100
55-70+ (n= 41)	Per cent	42	44	15	100
Total (n= 116)	Per cent	29	40	31	100

		Multi-farm interests		
Production per cow (kg MS)		No (n= 48)	Yes (n= 55)	Total (n= 107)
<405 (n= 26)	Per cent	62	38	100
406-428 (n= 26)	Per cent	38	62	100
429-460 (n= 28)	Per cent	39	61	100
>460 (n= 27)	Per cent	40	60	100
Total (n= 107)	Per cent	45	55	100

		Multi-farm interests		
Production per ha (kg MS)		No (n= 51)	Yes (n= 60)	Total (n= 111)
<1400 (n= 29)	Per cent	62	38	100
1401-1550 (n= 26)	Per cent	46	54	100
1551-1700 (n= 29)	Per cent	38	62	100
>1700 (n= 27)	Per cent	37	63	100
Total (n= 111)	Per cent	46	54	100

D.4 Cross tabulation of ISCs

Table D-10 Cross tabulation of LUDF focus day attendance x DairyNZ event attendance; and use of the SIDDC/LUDF website, DairyNZ event attendance and use of a private consultant/advisor x use of the SIDDC/LUDF website

		DairyNZ event attendance		
LUDF focus day attendance		Do not attend (n= 49)	Attend (n= 74)	Total (n= 123)
Do not attend (n=49)	Per cent	48	52	100
Attend (n= 57)	Per cent	31	69	100
Total (n= 106)	Per cent	40	60	100

		Use of the SIDDC/LUDF website		
LUDF focus day attendance		Not used (n= 56)	Used (n= 63)	Total (n= 119)
Do not attend (n=51)	Per cent	58	42	100
Attend (n= 58)	Per cent	36	64	100
Total (n= 109)	Per cent	47	53	100

		Use of the SIDDC/LUDF website		
DairyNZ event attendance		Not used (n= 56)	Used (n= 63)	Total (n= 119)
Do not attend (n=51)	Per cent	78	22	100
Attend (n= 58)	Per cent	28	72	100
Total (n= 109)	Per cent	47	53	100

		Use of the SIDDC/LUDF website		
Use of private consultant/advisor		Not used (n= 46)	Used (n= 63)	Total (n= 109)
Do not attend (n=52)	Per cent	63	37	100
Attend (n= 56)	Per cent	31	69	100
Total (n= 108)	Per cent	42	58	100

Table D-11 Cross tabulation of LUDF focus day attendance x ranking of SIDDC/LUDF website, LUDF focus days, demonstration farms, and DairyNZ events as information sources

		SIDDC/LUDF website (LUDF results)		
LUDF focus day attendance		Not important (n= 21)	Important (n= 85)	Total (n= 106)
Do not attend (n=49)	Per cent	33	67	100
Attend (n= 57)	Per cent	9	91	100
Total (n= 106)	Per cent	20	80	100

		LUDF focus days (LUDF results)		
LUDF focus day attendance		Not important (n= 23)	Important (n= 86)	Total (n= 109)
Do not attend (n=51)	Per cent	39	61	100
Attend (n= 58)	Per cent	5	95	100
Total (n= 109)	Per cent	21	79	100

		Demonstration farms (new technology and innovation)		
LUDF focus day attendance		Not useful (n= 10)	Useful (n= 99)	Total (n= 109)
Do not attend (n=51)	Per cent	17	83	100
Attend (n= 58)	Per cent	2	98	100
Total (n= 109)	Per cent	9	91	100

		DairyNZ events (new technology and innovation)		
LUDF focus day attendance		Not useful (n= 8)	Useful (n= 100)	Total (n= 108)
Do not attend (n=52)	Per cent	14	86	100
Attend (n= 56)	Per cent	2	98	100
Total (n= 108)	Per cent	7	93	100

Table D-12 Cross tabulation of DairyNZ event attendance x ranking of LUDF focus days and DairyNZ events as information sources

		LUDF focus days (LUDF results)		
DairyNZ event attendance		Not useful (n= 23)	Useful (n= 86)	Total (n= 109)
Do not attend (n=36)	Per cent	31	69	100
Attend (n= 73)	Per cent	16	84	100
Total (n= 109)	Per cent	21	79	100

		DairyNZ events (new technology and innovation)		
DairyNZ event attendance		Not useful (n= 8)	Useful (n= 100)	Total (n= 108)
Do not attend (n=35)	Per cent	17	83	100
Attend (n= 73)	Per cent	3	97	100
Total (n= 108)	Per cent	7	93	100

Table D-13 Cross tabulation of use of SIDDC/LUDF website x ranking of demonstration farms, LUDF focus days and DairyNZ event attendance as information sources

		LUDF focus days (LUDF results)		
Use of SIDDC website		Not useful (n= 23)	Useful (n= 86)	Total (n= 109)
Do not use (n=46)	Per cent	35	65	100
Use(n= 63)	Per cent	11	89	100
Total (n= 109)	Per cent	21	79	100

		Demonstration farms (new technology and innovation)		
Use of SIDDC website		Not useful (n= 10)	Useful (n= 99)	Total (n= 109)
Do not use (n=47)	Per cent	21	79	100
Use(n= 62)	Per cent	0	100	100
Total (n= 109)	Per cent	7	93	100

		DairyNZ events (new technology and innovation)		
Use of SIDDC website		Not useful (n= 8)	Useful (n= 100)	Total (n= 108)
Do not use (n=46)	Per cent	11	79	100
Use(n= 62)	Per cent	5	95	100
Total (n= 108)	Per cent	7	93	100

Table D-14 Cross tabulation of LUDF focus days ranking x ranking of SIDDC/LUDF website and newspapers

		SIDDC website (LUDF results)		
LUDF focus days (LUDF results)		Not important (n= 22)	Important (n= 84)	Total (n= 106)
Unimportant (n= 23)	Per cent	61	39	100
Important (n= 83)	Per cent	8	92	100
Total (n=106)	Per cent	20	80	100

		Newspapers (LUDF results)		
LUDF focus days (LUDF results)		Not important (n= 18)	Important (n= 88)	Total (n= 106)
Unimportant (n= 22)	Per cent	27	73	100
Important (n= 84)	Per cent	14	86	100
Total (n=106)	Per cent	17	83	100

Table D-15 Cross tabulation of demonstration farm rankings x SIDDC/LUDF website and LUDF focus days ranking as information sources

Demonstration farms (new technology and innovation)		SIDDC website(LUDF results) Not important (n= 21)	Important (n= 84)	Total (n= 105)
Unimportant (n= 10)	Per cent	70	30	100
Important (n= 95)	Per cent	15	85	100
Total (n=105)	Per cent	20	80	100

Demonstration farms (new technology and innovation)		LUDF focus days (LUDF results) Not important (n= 22)	Important (n= 86)	Total (n= 108)
Unimportant (n= 10)	Per cent	60	40	100
Important (n= 98)	Per cent	16	84	100
Total (n=108)	Per cent	20	80	100

Table D-16 Cross tabulation of other farmers as information sources x LUDF focus days as an information source

Other farmers (new technology and innovation)		LUDF focus days (LUDF results) Not important (n= 21)	Important (n= 84)	Total (n= 105)
Unimportant (n=7)	Per cent	14	86	100
Important (n= 98)	Per cent	20	80	100
Total (n=105)	Per cent	20	80	100

Table D-17 Cross tabulation of DairyNZ events x SIDDC/LUDF website, newspapers, LUDF focus days and demonstration farms

DairyNZ events (new technology and innovation)		SIDDC/LUDF website (LUDF results) Not important (n= 21)	Important (n= 82)	Total (n= 103)
Unimportant (n= 8)	Per cent	50	50	100
Important (n= 95)	Per cent	18	82	100
Total (n=103)	Per cent	20	80	100

DairyNZ events (new technology and innovation)		Newspapers (LUDF results) Not important (n= 17)	Important (n= 88)	Total (n= 105)
Unimportant (n= 8)	Per cent	50	50	100
Important (n= 97)	Per cent	13	87	100
Total (n=105)	Per cent	16	84	100

Table D-17 Continued

DairyNZ events (new technology and innovation)		LUDF focus days (LUDF results) Not important (n= 22)	Important (n= 84)	Total (n= 106)
Unimportant (n= 8)	Per cent	38	62	100
Important (n= 98)	Per cent	19	81	100
Total (n=106)	Per cent	21	79	100

DairyNZ events (new technology and innovation)		Demonstration farms (new technology and innovation) Not useful (n= 22)	Useful (n= 84)	Total (n= 106)
Unimportant (n= 8)	Per cent	38	62	100
Important (n= 98)	Per cent	7	93	100
Total (n=106)	Per cent	9	91	100

DairyNZ events (new technology and innovation)		Other farmers (new technology and innovation) Not useful (n= 22)	Useful (n= 84)	Total (n= 106)
Unimportant (n= 8)	Per cent	13	87	100
Important (n= 98)	Per cent	6	94	100
Total (n=106)	Per cent	7	93	100

D.5 Cross tabulation of farmer socio-demographics x farmer ISCs

Table D-18 Cross tabulation between farmer age x DairyNZ event attendance and SIDDC/LUDF website to learn of LUDF Results

		DairyNZ event attendance		
Age (years)		Do not attend (n= 49)	Attend (n= 74)	Total (n= 123)
19-44 (n= 41)	Per cent	24	76	100
45-54 (n= 39)	Per cent	39	61	100
55-70+ (n=43)	Per cent	56	44	100
Total (n=123)	Per cent	40	60	100
		Use of the SIDDC/LUDF website		
Age (years)		Not used (n= 56)	Used (n= 63)	Total (n= 119)
19-44 (n= 41)	Per cent	39	61	100
45-54 (n= 39)	Per cent	39	61	100
55-70+ (n=39)	Per cent	64	36	100
Total (n=119)	Per cent	47	53	100

Table D-19 Cross tabulation of experience x use of a private consultant

		Use of a private consultant		
Experience (years)		Not used (n= 38)	Used (n= 71)	Total (n= 109)
<10 (n= 28)	Per cent	18	82	100
10-20 (n= 26)	Per cent	30	70	100
>20 (n=55)	Per cent	46	54	100
Total (n=109)	Per cent	35	65	100

Table D-20 Cross tabulation of education x LUDF focus day attendance, DairyNZ event attendance, and SIDDC/LUDF website and focus days as sources to learn of LUDF results

		LUDF focus day attendance		
Education		Do not attend (n= 64)	Attend (n= 58)	Total (n= 122)
High School (n= 42)	Per cent	64	36	100
AgITO/Polytech (n=16)	Per cent	69	31	100
University (n= 64)	Per cent	41	59	100
Total (n=103)	Per cent	52	48	100

		DairyNZ event attendance		
Education		Do not attend (n= 48)	Do not attend (n= 74)	Total (n= 122)
High School (n= 42)	Per cent	52	48	100
AgITO/Polytech (n=16)	Per cent	44	56	100
University (n= 64)	Per cent	30	70	100
Total (n=122)	Per cent	39	61	100

		SIDDC/LUDF website (LUDF results)		
Education		Not important (n= 21)	Important (n= 85)	Total (n= 106)
High School (n= 32)	Per cent	31	69	100
AgITO/Polytech (n=15)	Per cent	20	80	100
University (n= 59)	Per cent	14	86	100
Total (n=106)		20	80	100

		LUDF Focus Days (LUDF results)		
Education		Not important (n= 23)	Important (n= 86)	Total (n= 109)
High School (n= 34)	Per cent	32	68	100
AgITO/Polytech (n=15)	Per cent	40	60	100
University (n= 60)	Per cent	10	90	100
Total (n=109)		21	79	100

Table D-21 Cross tabulation of farm size x use of a private consultant/advisor, use of the SIDDC/LUDF website, focus days to learn of LUDF results and usefulness of demonstration farms and DairyNZ events to learn of new technologies

Farm size (hectares)		Use of private consultant/advisor: Do not use (n= 35)	Use (n= 67)	Total (n= 102)
< 169 (n= 35)	Per cent	46	54	100
170 – 254 (n= 30)	Per cent	33	66	100
>255 (n=37)	Per cent	24	76	100
Total (n= 102)	Per cent	35	65	100

Farm size (hectares)		Use of the SIDDC/LUDF website: Do not use (n= 51)	Use (n= 61)	Total (n= 112)
< 169 (n= 40)	Per cent	58	42	100
170 – 254 (n= 33)	Per cent	52	48	100
>255 (n=39)	Per cent	28	72	100
Total (n= 112)	Per cent	46	54	100

Farm size (hectares)		LUDF focus days (LUDF results): Not important (n= 21)	Important (n= 82)	Total (n= 103)
< 169 (n= 36)	Per cent	25	75	100
170 – 254 (n= 30)	Per cent	13	86	100
>255 (n=37)	Per cent	22	78	100
Total (n= 103)	Per cent	20	80	100

Farm size (hectares)		Demonstration farms (new technology and innovation): Not useful (n= 10)	Useful (n= 92)	Total (n= 102)
< 169 (n= 36)	Per cent	22	78	100
170 – 254 (n= 30)	Per cent	0	100	100
>255 (n=36)	Per cent	5	95	100
Total (n= 102)	Per cent	10	90	100

Farm size (hectares)		DairyNZ events (new technology and innovation): Not useful (n= 8)	Useful (n= 95)	Total (n= 103)
< 169 (n= 37)	Per cent	16	84	100
170 – 254 (n= 30)	Per cent	3	97	100
>255 (n=36)	Per cent	3	97	100
Total (n= 103)	Per cent	8	92	100

Table D-22 Cross tabulation of farm system x DairyNZ event attendance, use of the SIDDC/LUDF website, SIDDC/LUDF website and focus days to learn of LUDF results, and the usefulness of demonstration farms, DairyNZ events and other farmers to learn of new technologies and innovation

		DairyNZ event attendance		
Farm system		Do not attend (n= 47)	Attend (n= 69)	Total (n= 116)
System 1+2 (n=34)	Per cent	65	35	100
System 3 (n= 46)	Per cent	35	65	100
System 4+5 (n= 36)	Per cent	25	75	100
Total (n= 116)	Per cent	40	60	100

		Use of SIDDC/LUDF website		
Farm system		Do not use (n= 54)	Use (n= 59)	Total (n= 113)
System 1+2 (n=33)	Per cent	73	27	100
System 3 (n= 45)	Per cent	42	58	100
System 4+5 (n= 35)	Per cent	31	69	100
Total (n= 113)	Per cent	48	52	100

		SIDDC/LUDF website (LUDF results)		
Farm system		Do not use (n= 21)	Use (n= 79)	Total (n= 100)
System 1+2 (n=28)	Per cent	32	68	100
System 3 (n= 41)	Per cent	20	80	100
System 4+5 (n= 31)	Per cent	13	87	100
Total (n= 100)	Per cent	21	79	100

		LUDF focus days (LUDF results)		
Farm system		Not important (n= 22)	Important (n= 81)	Total (n= 103)
System 1+2 (n=28)	Per cent	32	68	100
System 3 (n= 42)	Per cent	21	79	100
System 4+5 (n= 33)	Per cent	12	88	100
Total (n= 103)	Per cent	21	79	100

		Demonstration farms (new technology and innovation)		
Farm system		Not useful (n= 9)	Useful (n= 94)	Total (n= 103)
System 1+2 (n=28)	Per cent	18	82	100
System 3 (n= 42)	Per cent	7	93	100
System 4+5 (n= 33)	Per cent	3	97	100
Total (n= 103)	Per cent	9	91	100

Table D-22 Continued.

Farm system		DairyNZ events (new technology and innovation) Not useful (n= 8)	Useful (n= 94)	Total (n= 102)
System 1+2 (n=27)	Per cent	11	89	100
System 3 (n= 42)	Per cent	2	98	100
System 4+5 (n= 33)	Per cent	12	88	100
Total (n= 102)	Per cent	8	92	100

Farm system		Other farmers (new technology and innovation) Not useful (n= 6)	Useful (n= 96)	Total (n= 102)
System 1+2 (n=28)	Per cent	0	100	100
System 3 (n= 41)	Per cent	5	95	100
System 4+5 (n= 33)	Per cent	12	88	100
Total (n= 102)	Per cent	6	94	100

Table D-23 Cross tabulation of production per cow x DairyNZ event attendance, use of a private consultant/advisor and newspapers to learn of LUDF results

Production per cow (kg MS)		DairyNZ event attendance Do not attend (n= 40)	Attend (n= 67)	Total (n= 107)
<405 (n= 26)	Per cent	62	38	100
405 - 428 (n= 26)	Per cent	46	54	100
429 - 460 (n= 28)	Per cent	18	82	100
>460 (n= 27)	Per cent	26	74	100
Total (n= 107)	Per cent	37	63	100

Production per cow (kg MS)		Use of private consultant/advisor Do not use (n= 35)	Use (n= 62)	Total (n= 97)
<405 (n= 23)	Per cent	44	56	100
405 - 428 (n= 25)	Per cent	44	56	100
429 - 460 (n= 25)	Per cent	36	64	100
>460 (n= 24)	Per cent	21	79	100
Total (n= 97)	Per cent	36	64	100

Production per cow (kg MS)		Newspapers (LUDF results) Not important (n= 17)	Important (n= 80)	Total (n= 97)
<405 (n= 25)	Per cent	24	76	100
405 - 428 (n= 24)	Per cent	21	79	100
429 - 460 (n= 24)	Per cent	16	84	100
>460 (n= 24)	Per cent	8	92	100
Total (n= 97)	Per cent	18	82	100

Appendix E

Cross tabulations of the significant correlations associated with the adoption of individual FMP innovations

E.1 Cross tabulations between the adoptions of individual FMPs innovations

Table E-1 Cross tabulation of Graze, Re-grass and EcoN

		Re-grass		
Graze		Adopted (n= 19)	Not adopted (n= 90)	Total (n= 109)
Adopted (n= 89)	Per cent	87	13	100
Not Adopted (n= 20)	Per cent	58	42	100
Total (n= 109)	Per cent	82	18	100

		EcoN		
Graze		Adopted (n= 35)	Not adopted (n= 73)	Total (n= 108)
Adopted (n= 89)	Per cent	63	37	100
Not Adopted (n= 19)	Per cent	90	10	100
Total (n= 108)	Per cent	33	67	100

		Graze		
Re-grass		Adopted (n= 90)	Not adopted (n= 19)	Total (n= 109)
Adopted (n= 89)	Per cent	88	12	100
Not Adopted (n= 20)	Per cent	60	40	100
Total (n= 109)	Per cent	82	18	100

		Graze		
Eco-N		Adopted (n= 89)	Not adopted (n= 19)	Total (n= 108)
Adopted (n= 35)	Per cent	94	6	100
Not Adopted (n= 73)	Per cent	77	23	100
Total (n= 108)	Per cent	82	18	100

Table E-2 Cross tabulation of Re-grass, Graze, CowBCS and Eco-N

Re-grass		Graze Adopted (n= 90)	Graze Not adopted (n= 19)	Graze Total (n= 109)
Adopted (n= 89)	Per cent	88	12	100
Not Adopted (n= 20)	Per cent	60	40	100
Total (n= 109)	Per cent	82	18	100

Re-grass		CowBCS Adopted (n= 74)	CowBCS Not adopted (n= 30)	CowBCS Total (n= 104)
Adopted (n= 84)	Per cent	77	23	100
Not Adopted (n= 20)	Per cent	45	55	100
Total (n= 104)	Per cent	71	29	100

Re-grass		EcoN Adopted (n= 36)	EcoN Not adopted (n= 72)	EcoN Total (n= 97)
Adopted (n= 88)	Per cent	40	60	100
Not Adopted (n= 20)	Per cent	5	95	100
Total (n= 108)	Per cent	33	67	100

Re-grass		Synchro Adopted (n= 34)	Synchro Not adopted (n= 71)	Synchro Total (n= 105)
Adopted (n= 41)	Per cent	44	56	100
Not Adopted (n= 64)	Per cent	25	75	100
Total (n= 105)	Per cent	33	67	100

Graze		Re-grass Adopted (n= 19)	Re-grass Not adopted (n= 90)	Re-grass Total (n= 109)
Adopted (n= 89)	Per cent	87	13	100
Not Adopted (n= 20)	Per cent	58	42	100
Total (n= 109)	Per cent	82	18	100

CowBCS		Re-grass Adopted (n= 84)	Re-grass Not adopted (n= 20)	Re-grass Total (n= 104)
Adopted (n= 30)	Per cent	88	12	100
Not Adopted (n= 74)	Per cent	63	37	100
Total (n= 104)	Per cent	81	19	100

Table E-2 Continued

EcoN		Re-grass Adopted (n= 88)	Not adopted (n= 20)	Total (n= 108)
Adopted (n= 36)	Per cent	97	3	100
Not Adopted (n= 72)	Per cent	74	26	100
Total (n= 108)	Per cent	81	19	100

Synchro		Re-grass Adopted (n= 89)	Not adopted (n= 20)	Total (n= 109)
Adopted (n= 22)	Per cent	96	4	100
Not Adopted (n= 87)	Per cent	78	22	100
Total (n= 109)	Per cent	82	18	100

Table E-3 Cross tabulation of CowBCS, Re-grass and 2herds

CowBCS		Re-grass Adopted (n= 84)	Not adopted (n= 20)	Total (n= 107)
Adopted (n= 74)	Per cent	88	12	100
Not Adopted (n= 30)	Per cent	63	37	100
Total (n= 104)	Per cent	81	19	100

CowBCS		2herds Adopted (n= 61)	Not adopted (n= 46)	Total (n= 107)
Adopted (n= 76)	Per cent	65	35	100
Not Adopted (n= 31)	Per cent	39	61	100
Total (n= 107)	Per cent	57	43	100

Re-grass		CowBCS Adopted (n= 74)	Not adopted (n= 30)	Total (n= 104)
Adopted (n= 84)	Per cent	77	23	100
Not Adopted (n= 20)	Per cent	45	55	100
Total (n= 104)	Per cent	71	29	100

2herds		CowBCS Adopted (n= 76)	Not adopted (n= 31)	Total (n= 107)
Adopted (n= 61)	Per cent	80	20	100
Not Adopted (n= 46)	Per cent	59	41	100
Total (n= 107)	Per cent	71	29	100

Table E-4 Cross tabulation of EcoN, Graze, Regrass, Soilmoist and NGibb

		Graze		
EcoN		Adopted (n= 89)	Not adopted (n= 19)	Total (n= 108)
Adopted (n= 35)	Per cent	94	6	100
Not Adopted (n= 73)	Per cent	77	23	100
Total (n= 108)	Per cent	82	18	100

		Re-grass		
EcoN		Adopted (n= 88)	Not adopted (n= 20)	Total (n= 108)
Adopted (n= 36)	Per cent	97	3	100
Not Adopted (n= 72)	Per cent	74	26	100
Total (n= 108)	Per cent	81	19	100

		Soilmoist		
EcoN		Adopted (n= 69)	Not adopted (n= 39)	Total (n= 108)
Adopted (n= 35)	Per cent	80	20	100
Not Adopted (n= 73)	Per cent	56	44	100
Total (n= 108)	Per cent	82	18	100

		NGibb		
EcoN		Adopted (n= 41)	Not adopted (n= 64)	Total (n= 105)
Adopted (n= 34)	Per cent	53	47	100
Not Adopted (n= 71)	Per cent	32	68	100
Total (n= 105)	Per cent	39	61	100

		EcoN		
Graze		Adopted (n= 35)	Not adopted (n= 73)	Total (n= 108)
Adopted (n= 89)	Per cent	63	37	100
Not Adopted (n= 19)	Per cent	90	10	100
Total (n= 108)	Per cent	33	67	100

		EcoN		
Re-grass		Adopted (n= 36)	Not adopted (n= 72)	Total (n= 97)
Adopted (n= 88)	Per cent	40	60	100
Not Adopted (n= 20)	Per cent	5	95	100
Total (n= 108)	Per cent	33	67	100

Table E-4 Continued

Soilmoist		EcoN Adopted (n= 35)	Not adopted (n= 73)	Total (n= 108)
Adopted (n= 69)	Per cent	40	60	100
Not Adopted (n= 39)	Per cent	18	82	100
Total (n= 108)	Per cent	33	67	100

NGibb		EcoN Adopted (n= 34)	Not adopted (n= 71)	Total (n= 105)
Adopted (n= 41)	Per cent	44	56	100
Not Adopted (n= 64)	Per cent	25	75	100
Total (n= 105)	Per cent	33	67	100

Table E-5 Cross tabulation of NGibb and Premow

NGibb		Premow Adopted (n= 46)	Not adopted (n= 63)	Total (n= 109)
Adopted (n= 42)	Per cent	57	43	100
Not Adopted (n= 67)	Per cent	33	67	100
Total (n= 109)	Per cent	42	58	100

Premow		NGibb Adopted (n= 42)	Not adopted (n= 67)	Total (n= 109)
Adopted (n= 46)	Per cent	52	48	100
Not Adopted (n= 63)	Per cent	29	71	100
Total (n= 109)	Per cent	39	61	100

E.2 Cross tabulations of farmer characteristics x adoption of individual FMP innovations

Table E-6 Cross tabulation of farmer age x Re-grass, CowBCS and 2herds

		Re-grass		
Age (years)		Adopted (n= 90)	Not adopted (n= 20)	Total (n= 110)
19-44 (n= 38)	Per cent	68	32	100
45-54 (n= 35)	Per cent	85	14	100
55-70+ (n=37)	Per cent	92	8	100
Total (n=110)	Per cent	82	18	100
		CowBCS		
Age (years)		Adopted (n= 77)	Not adopted (n= 31)	Total (n= 108)
19-44 (n= 37)	Per cent	57	43	100
45-54 (n= 36)	Per cent	78	22	100
55-70+ (n=35)	Per cent	80	20	100
Total (n=108)	Per cent	71	29	100
		2herds		
Age (years)		Adopted (n= 62)	Not adopted (n= 48)	Total (n= 110)
19-44 (n= 37)	Per cent	62	38	100
45-54 (n= 35)	Per cent	69	31	100
55-70+ (n=38)	Per cent	40	60	100
Total (n=110)	Per cent	56	44	100

Table E-7 Cross tabulation of position x Synchro

		Synchro		
Position		Adopted (n=24)	Not adopted (n=88)	Total (n= 112)
Owner (n= 63)	Per cent	29	71	100
Owner-Operator (n= 27)	Per cent	15	85	100
50/50 Sharemilker (n= 2)	Per cent	0	100	100
Lower Order Sharemilker (n= 1)	Per cent	0	100	100
Manager (n= 1)	Per cent	0	100	100
Equity Manager (n= 14)	Per cent	14	86	100
Other[a] (n= 4)	Per cent	0	100	100
Total (n= 112)	Per cent	21	79	100

[a] 'Other' included contract milker, owner and 50/50, part owner

Table E-8 Cross tabulation of Multiple farm interests x 2herds

Multiple farm interests		2herds Adopted (n= 62)	Not adopted (n= 48)	Total (n= 110)
Yes (n= 58)	Per cent	67	33	100
No (n= 52)	Per cent	44	56	100
Total (n= 110)	Per cent	56	44	100

E.3 Cross tabulations between farm characteristics and adoption of individual FMP innovations

Table E-9 Cross tabulation of farm size x Soilmoist, 2herds and Noinduct

		Soilmoist		
Farm size (hectares)		Adopted (n= 66)	Not adopted (n= 38)	Total (n= 104)
< 169 (n= 37)	Per cent	62	38	100
170 – 254 (n= 30)	Per cent	53	47	100
>255 (n=37)	Per cent	73	27	100
Total (n= 104)	Per cent	64	36	100

		2herds		
Farm size (hectares)		Adopted (n= 59)	Not adopted (n= 45)	Total (n= 104)
< 169 (n= 39)	Per cent	28	72	100
170 – 254 (n= 30)	Per cent	70	30	100
>255 (n=35)	Per cent	77	23	100
Total (n= 104)	Per cent	57	43	100

		Noinduct		
Farm size (hectares)		Adopted (n= 40)	Not adopted (n= 65)	Total (n= 105)
< 169 (n= 38)	Per cent	55	45	100
170 – 254 (n= 30)	Per cent	33	67	100
>255 (n=37)	Per cent	24	76	100
Total (n= 105)	Per cent	38	62	100

Table E-10 Cross tabulation of production per cow and per effective ha x Premow

		Premow		
Production per cow (kg MS)		Adopted (n= 43)	Not adopted (n= 58)	Total (n= 101)
<405 (n= 26)	Per cent	23	77	100
405 - 428 (n= 25)	Per cent	36	64	100
429 - 460 (n= 25)	Per cent	52	48	100
>460 (n= 25)	Per cent	60	40	100
Total (n= 101)	Per cent	43	57	100

		Premow		
Production per ha (kg MS)		Adopted (n= 43)	Not adopted (n= 61)	Total (n= 104)
<1400 (n= 28)	Per cent	29	71	100
1401-1550 (n= 26)	Per cent	39	62	100
1551-1700 (n= 26)	Per cent	39	62	100
>1700 (n= 24)	Per cent	63	38	100
Total (n= 104)	Per cent	41	58	100

Table E-11 Cross tabulation of heifer calf management x Graze and Synchro

Heifer calf management		Graze Adopted (n= 90)	Graze Not adopted (n= 17)	Graze Total (n= 107)
Own Land (n= 53)	Per cent	77	23	100
Contract Grazing (n= 44)	Per cent	86	14	100
Associated Business (n= 10)	Per cent	100	0	100
Total (n= 107)	Per cent	83	17	100

Heifer calf management		Synchro Adopted (n= 23)	Synchro Not adopted (n= 86)	Synchro Total (n= 108)
Own Land (n= 55)	Per cent	29	71	100
Contract Grazing (n= 43)	Per cent	14	86	100
Associated Business (n= 10)	Per cent	10	90	100
Total (n= 108)	Per cent	21	79	100

Table E-12 Cross tabulation of Yearling heifer management x Graze and Noinduct

Yearling heifer management		Graze Adopted (n= 89)	Graze Not adopted (n= 17)	Graze Total (n= 106)
Own Land (n= 43)	Per cent	77	23	100
Contract Grazing (n= 54)	Per cent	87	13	100
Associated Business (n= 9)	Per cent	100	0	100
Total (n= 106)	Per cent	84	16	100

Yearling heifer management		Noinduct Adopted (n= 43)	Noinduct Not adopted (n= 64)	Noinduct Total (n= 107)
Own Land (n= 45)	Per cent	51	49	100
Contract Grazing (n= 53)	Per cent	34	66	100
Associated Business (n= 9)	Per cent	22	78	100
Total (n= 107)	Per cent	40	60	100

E.4 Cross tabulations between farmer ISCs and the adoption of individual FMP innovations

Table E-13 Cross tabulation of use of the SIDDC/LUDF website x Graze, Re-grass, NGibb, Eco-N and Noinduct

		Graze		
Use of SIDDC website		Adopted (n= 92)	Not adopted (n= 19)	Total (n= 111)
Do not use (n=49)	Per cent	74	26	100
Use(n= 62)	Per cent	90	10	100
Total (n= 111)	Per cent	83	17	100

		Re-grass		
Use of SIDDC website		Adopted (n= 90)	Not adopted (n=20)	Total (n= 110)
Do not use (n=48)	Per cent	75	25	100
Use(n= 62)	Per cent	87	13	100
Total (n= 110)	Per cent	82	18	100

		NGibb		
Use of SIDDC website		Adopted (n= 43)	Not adopted (n= 67)	Total (n= 110)
Do not use (n= 49)	Per cent	29	71	100
Use(n= 61)	Per cent	48	52	100
Total (n= 110)	Per cent	39	61	100

		EcoN		
Use of SIDDC website		Adopted (n= 36)	Not adopted (n= 73)	Total (n= 109)
Do not use (n=47)	Per cent	28	72	100
Use(n= 62)	Per cent	37	63	100
Total (n= 109)	Per cent	33	67	100

		Noinduct		
Use of SIDDC website		Adopted (n= 44)	Not adopted (n= 68)	Total (n= 112)
Do not use (n=49)	Per cent	51	49	100
Use(n= 63)	Per cent	30	70	100
Total (n= 112)	Per cent	39	61	100

Table E-14 Cross tabulation of LUDF focus day attend x Soilmoist and Noinduct

LUDF focus day attendance		Soilmoist Adopted (n= 70)	Not adopted (n= 40)	Total (n= 110)
Do not attend (n=53)	Per cent	55	45	100
Attend (n=57)	Per cent	72	28	100
Total (n= 110)	Per cent	64	36	100

LUDF focus day attendance		Noinduct Adopted (n= 44)	Not adopted (n= 68)	Total (n= 112)
Do not attend (n=54)	Per cent	52	48	100
Attend (n=58)	Per cent	28	72	100
Total (n= 112)	Per cent	39	61	100

Table E-15 Cross tabulation of DairyNZ event attend x Soilmoist

DairyNZ event attendance		Soilmoist Adopted (n= 70)	Not adopted (n= 40)	Total (n= 110)
Do not attend (n=39)	Per cent	49	51	100
Attend (n= 71)	Per cent	72	28	100
Total (n= 110)	Per cent	64	36	100

Table E-16 Cross tabulation of Graze x information sources used to learn of LUDF results

SIDDC/LUDF website (LUDF results)		Graze Adopted (n=86)	Not adopted (n= 17)	Total (n= 103)
Unimportant (n= 19	Per cent	58	42	100
Important (n=84)	Per cent	89	11	100
Total (n=103)	Per cent	84	15	100

LUDF focus days (LUDF results)		Graze Adopted (n= 88)	Not adopted (n= 17)	Total (n= 105)
Unimportant (n= 22)	Per cent	64	36	100
Important (n=83)	Per cent	89	11	100
Total (n= 105)	Per cent	84	16	100

Discussion groups (LUDF results)		Graze Adopted (n= 86)	Not adopted (n= 16)	Total (n= 102)
Unimportant (n= 32)	Per cent	75	25	100
Important (n= 70)	Per cent	87	11	100
Total (n= 102)	Per cent	84	16	100

Table E-16 Continued.

Consultants (LUDF results)		Graze Adopted (n= 86)	Not adopted (n= 17)	Total (n= 103)
Unimportant (n= 28)	Per cent	64	36	100
Important (n= 75)	Per cent	91	9	100
Total (n= 103)	Per cent	84	16	100

Table E-17 Cross tabulation of Re-grass x information sources used to learn of LUDF results

SIDDC/LUDF website (LUDF results)		Re-grass Adopted (n= 84)	Not adopted (n= 14)	Total (n= 102)
Unimportant (n= 19)	Per cent	58	42	100
Important (n= 83)	Per cent	88	12	100
Total (n= 102)	Per cent	82	18	100

LUDF focus days (LUDF results)		Re-grass Adopted (n= 86)	Not adopted (n= 18)	Total (n= 104)
Unimportant (n= 22)	Per cent	73	27	100
Important (n=82)	Per cent	85	15	100
Total (n= 104)	Per cent	83	17	100

Other media (LUDF results)		Re-grass Adopted (n= 80)	Not adopted (n= 19)	Total (n= 99)
Unimportant (n= 25)	Per cent	64	36	100
Important (n= 74)	Per cent	87	13	100
Total (n= 99)	Per cent	81	19	100

Newspapers		Re-grass Adopted (n= 85)	Not adopted (n= 19)	Total (n= 104)
Unimportant (n= 17)	Per cent	59	41	100
Important (n= 87)	Per cent	86	14	100
Total (n= 104)	Per cent	82	18	100

Table E-18 Cross tabulation of CowBCS x information sources used to learn of LUDF results

Newspapers (LUDF results)		CowBCS Adopted (n= 73)	Not adopted (n= 31)	Total (n= 104)
Unimportant (n= 18)	Per cent	56	44	100
Important (n= 86)	Per cent	73	27	100
Total (n= 104)	Per cent	70	30	100

Table E-19 Cross tabulation of Soilmoist x information sources used to learn of LUDF results

		Soilmoist		
Other farmers (LUDF results)		Adopted (n= 66)	Not adopted (n= 36)	Total (n= 102)
Unimportant (n= 19)	Per cent	58	42	100
Important (n= 83)	Per cent	66	34	100
Total (n= 102)	Per cent	65	36	100

		Soilmoist		
Consultants (LUDF results)		Adopted (n= 67)	Not adopted (n= 37)	Total (n= 104)
Unimportant (n= 2)	Per cent	46	54	100
Important (n= 76)	Per cent	71	29	100
Total (n= 104)	Per cent	64	36	100

Table E-20 Cross tabulation of NGibb x information sources used to learn of LUDF results

		NGibb		
Newspapers (LUDF results)		Adopted (n= 41)	Not adopted (n= 65)	Total (n= 106)
Unimportant (n= 16)	Per cent	25	75	100
Important (n= 90)	Per cent	41	59	100
Total (n= 106)	Per cent	39	61	100

		NGibb		
Other media (LUDF results)		Adopted (n= 40)	Not adopted (n= 61)	Total (n= 101)
Unimportant (n= 24)	Per cent	12	88	100
Important (n= 77)	Per cent	48	52	100
Total (n= 101)	Per cent	40	60	100

		NGibb		
Other farmers (LUDF results)		Adopted (n= 40)	Not adopted (n= 62)	Total (n= 102)
Unimportant (n= 18)	Per cent	17	83	100
Important (n= 84)	Per cent	44	56	100
Total (n= 102)	Per cent	40	60	100

Table E-21 Cross tabulation of Graze x information sources used to learn of LUDF results

		Noinduct		
SIDDC/LUDF website (LUDF results)		Adopted (n= 39)	Not adopted (n= 66)	Total (n= 105)
Unimportant (n= 20)	Per cent	50	50	100
Important (n= 85)	Per cent	34	66	100
Total (n= 105)	Per cent	37	63	100

		Noinduct		
LUDF focus days (LUDF results)		Adopted (n=39)	Not adopted (n=68)	Total (n= 107)
Unimportant (n= 23)	Per cent	48	52	100
Important (n=84)	Per cent	33	67	100
Total (n=107)	Per cent	36	64	100

		Noinduct		
Other farmers (LUDF results)		Adopted (n= 39)	Not adopted (n= 64)	Total (n= 103)
Unimportant (n= 19)	Per cent	74	26	100
Important (n= 84)	Per cent	30	70	100
Total (n= 103)	Per cent	38	62	100

		Noinduct		
Tuesday farm walks (LUDF results)		Adopted (n= 35)	Not adopted (n= 60)	Total (n= 95)
Unimportant (n= 68)	Per cent	43	57	100
Important (n= 27)	Per cent	22	78	100
Total (n= 95)	Per cent	37	63	100

Table E-22 Cross tabulation of demonstration farms as information sources used to learn about new agricultural technology and innovation x adoption of Graze, Re-grass and CowBCS

Demonstration farms (new technology and innovation)		Graze Adopted (n= 87)	Not adopted (n= 18)	Total (n= 105)
Unimportant (n= 9)	Per cent	44	56	100
Important (n= 96)	Per cent	87	13	100
Total (n=105)	Per cent	83	17	100

Demonstration farms (new technology and innovation)		Re-grass Adopted (n= 85)	Not adopted (n= 19)	Total (n= 104)
Unimportant (n= 9)	Per cent	44	56	100
Important (n= 95)	Per cent	85	15	100
Total (n=104)	Per cent	82	18	100

Demonstration farms (new technology and innovation)		CowBCS Adopted (n= 73)	Not adopted (n= 31)	Total (n= 104)
Unimportant (n= 10)	Per cent	70	30	100
Important (n= 94)	Per cent	70	30	100
Total (n=104)	Per cent	70	30	100

Table E-23 Cross tabulation of DairyNZ events as an information source used to learn about new agricultural technology and innovation x adoption of Regrass

DairyNZ events (new technology and innovation)		Re-grass Adopted (n= 88)	Not adopted (n= 16)	Total (n= 104)
Unimportant (n= 8)	Per cent	62	38	100
Important (n= 96)	Per cent	87	13	100
Total (n=104)	Per cent	85	15	100

Table E-24 Cross tabulation of other media as an information source used to learn about new agricultural technology and innovation x adoption of CowBCS and 2herds

		CowBCS		
Media (TV, mags and newspapers) (new technology and innovation)		Adopted (n= 76)	Not adopted (n= 29)	Total (n= 105)
Unimportant (n= 13)	Per cent	62	38	100
Important (n= 92)	Per cent	74	26	100
Total (n=105)	Per cent	72	28	100

		2herds		
Media (TV, mags and newspapers) (new technology and innovation)		Adopted (n= 59)	Not adopted (n= 48)	Total (n= 107)
Unimportant (n= 13)	Per cent	62	38	100
Important (n= 94)	Per cent	54	46	100
Total (n=107)	Per cent	55	45	100

Table E-25 Cross tabulation of consultants as an information source used to learn about new agricultural technology and innovation x adoption of Soilmoist and NGibb

		Soilmoist		
Consultants (new technology and innovation)		Adopted (n= 66)	Not adopted (n= 37)	Total (n= 103)
Unimportant (n= 20)	Per cent	40	60	100
Important (n= 83)	Per cent	70	30	100
Total (n=103)	Per cent	64	36	100

		NGibb		
Consultants (new technology and innovation)		Adopted (n= 39)	Not adopted (n= 64)	Total (n= 103)
Unimportant (n= 21)	Per cent	14	86	100
Important (n= 82)	Per cent	44	56	100
Total (n=103)	Per cent	38	62	100

Table E-26 Cross tabulation of conferences as an information source used to learn about new agricultural technology and innovation x adoption of 2herds

		2herds		
Conferences (new technology and innovation)		Adopted (n= 57)	Not adopted (n= 45)	Total (n= 102)
Unimportant (n= 10)	Per cent	30	70	100
Important (n= 92)	Per cent	59	41	100
Total (n=102)	Per cent	56	44	100

Table E-27 Cross tabulation of farm size, production per cow and production per ha x number of FMP innovations adopted

Number of FMP innovations adopted		Farm size (hectares) < 170 (n=39)	170-255 (n= 32)	>255 (n= 37)	Total (n=108)
1-3 adoptions (n=22)	Per cent	18	25	19	20
4-6 adoptions (n=60)	Per cent	65	53	46	56
7-9 adoptions (n=26)	Per cent	16	22	35	24
Total (n= 99)	Per cent	102	100	100	100

Number of FMP innovations adopted		Production per cow (kg MS) <405 (n= 25)	405 - 428 (n= 25)	429 - 460 (n= 26)	>460 (n= 26)	Total (n= 100)
1-3 adoptions (n=22)	Per cent	28	24	15	19	22
4-6 adoptions (n=55)	Per cent	68	52	35	62	54
7-9 adoptions (n=25)	Per cent	4	24	50	19	25
Total (n= 102)	Per cent	100	100	100	100	100

Number of FMP innovations adopted		Production per ha (kg MS) <1400 (n= 27)	1400 - 1550 (n= 26)	1551-1700 (n= 27)	>1700 (n= 25)	Total (n= 100)
1-3 adoptions (n=22)	Per cent	26	19	26	12	21
4-6 adoptions (n=58)	Per cent	59	65	37	60	55
7-9 adoptions (n=25)	Per cent	15	15	37	28	24
Total (n= 105)	Per cent	100	100	100	100	100

Appendix F

Details of variable transformations

F.1 Details of farmer variable transformation

Note the original variables are located on the left of each table. The numbers in parenthesis denotes the number of categories or groups and n is the number of respondents

Table F-1 Details of farmer age variables

Age (12)[a]	n	Age (3)	n
<19 years	0	19-44 years	41
20-24 years	1	45-54 years	39
25-29 years	1	55-70+ years	43
30-34 years	10		
35-39 years	11		
40-44 years	18		
45-49 years	17		
50-54 years	22		
55-59 years	21		
60-64 years	16		
65-69 years	4		
70+ years	2		
Total	123	Total	123

Table F-2 Details of farmer education variables

Education (3)	n	Education (2)	n
High School	42	School and AgITO/Polytec	58
Ag ITO/Polytechnic	16		
University	64	University	64
Total	122	Total	122

Table F-3 Details of farmer dairying farming experience variables

Experience (7)	n	Experience (3)	n
< 1 year	2	<10 years	33
1-2 years	2	10-20 years	30
3-4 years	4	>20 years	60
4-5 years	9		
5-10 years	16		
10-20 years	30		
+20 years	60		
Total	122	Total	122

Table F-4 Details of farmer position held variables

Position (7)	n	Position (3)	n
Owner	70	Owner, Owner-Operator	98
Owner-Operator	28	Sharemilkers, Managers, and Others	25
50/50 Sharemilker	3		
Lower Order Sharemilker	1		
Manager	2		
Equity Manager	15		
Other (please specify)	4		
Total	123	Total	123

Table F-5 Details of farmer financial/managerial interest in more than one dairy farm variable

Financial/managerial interest in more than one farm (2)	n
Yes	64
No	59
Total	123

F.2 Details of farm variable transformation

Table F-6 Details of farm size variables

Farm size	n	Farm size (3)	n
Farm size (effective ha)	116	≤169 ha	40
		170 - 254 ha	35
		≥ 255 ha	41
Missing	7	Missing	7
Total	123	Total	123

Table F-7 Details of farm system variables

Farm system (5)	n	Farm system (3)	n
System 1	6	System 1+2	34
System 2	28	System 3	46
System 3	46	System 4+5	36
System 4	33		
System 5	3		
Missing	7	Missing	7
Total	123	Total	123

Table F-8 Details of production per cow variables

Production per cow	n	Production per cow (4)	n
kg MS/cow	107	<405 kg	26
		405 – 428 kg	26
		429 – 460 kg	28
		>460 kg	27
Missing	16	Missing	16
Total	123	Total	123

Table F-9 Details of farm production per ha variables

Production per ha	n	Production per ha (4)	n
kg MS/eff. ha	111	<1400 kg	29
		1400-1550 kg	26
		1551-1700 kg	29
		>1700 kg	27
Missing	12	Missing	12
Total	123	Total	123

Table F-10a Details of farm variable 'replacement heifer calf management'

Heifer calf (4)	n	Heifer calf (2)	n
Own land	60	Own land	60
Contract grazing	48	Contract grazing	48
Associated business	10		
Other	1		
Missing	4	Missing	4
Total	123	Total	112

Table F-10b Details of farm variable 'replacement yearling heifer management'

Yearling heifer (4)	n	Yearling heifer (2)	n
Own land	50	Own land	50
Contract grazing	58	Contract grazing	58
Associated business	9		
Other	0		
Missing	6	Missing	6
Total	123	Total	114

F.3 Details of farmer ISC variable transformation

Table F-11 Details of LUDF focus day attendance variables

LUDF focus day attendance (5)	n	LUDF focus day attendance (2)	n
None	56	Attended	59
One	28	Did not attend [a]	64
Two	22		
Three	7		
All (four)	2		
Missing	8		
Total	115	Total	123

[a.] For respondents who did not enter a response (missing), it has been assumed that they do not attend focus days

Table F-12 Details of DairyNZ event attendance variables

DairyNZ event attendance (93)	n	DairyNZ event attendance (2)	n
Number of respondents	93	Attended	74
		Did not attend [a]	49
Missing	30		
Total	123	Total	123

[a] Out of a total of 93 respondents, 19 respondents indicated that they did not attend DairyNZ events. For respondents who did not enter a response (missing), it has been assumed that that they do not attend DairyNZ events.

Table F-13 Details of use of the SIDDC/LUDF website variables

Use of SIDDC/LUDF website (74)	n	Use of SIDDC/LUDF website (2)	n
Number of respondents	74	Used	63
		Did not use [a]	59
Missing	49	Missing	1
Total	123	Total	123

[a] For respondents who did not enter a response (missing), it was assumed that they do not use to SIDDC/LUDF website

Table F-14 Details of use of private consultant/advisor variables

Use of private consultant/advisor (2)	n
Yes	71
No	38
Missing	14
Total	123

Table F-15 Details of information source variables (sources used to learn of LUDF results)

Information sources used to learn about results obtained at the LUDF [a] (5)	Information sources used to learn about results obtained at the LUDF (2)
1 Very important	Important
2	Not important
3	
4	
5 Not at all important	

[a]. The information sources included the SIDDC/LUDF website, newspapers, other media publications, LUDF focus days, other farmers, discussion groups, consultants and LUDF Tuesday farm walks.

Table F-16 Details of information source variables (sources used to learn of LUDF results)

Information sources used to learn about new agricultural technology and innovation [a] (5)	Information sources used to learn about new agricultural technology and innovation (2)
1 Very useful	Useful
2	Not useful
3	
4	
5 Not at all useful	

[a] These information sources included demonstration farms, DairyNZ events, other farmers, media (TV, magazines and newspapers), consultants, conferences, and sales /technical staff of suppliers

F.4 Details of innovation adoption variables

The ten adoption variables are dichotomous consisting of ‘Adopted’ and ‘Not adopted’ and remain unchanged when included in secondary analysis.

Appendix G

Results of secondary data analysis

The details of each variable are detailed in Appendix F.

Table G-1 Correlation of farmer characteristics (corresponding Table 4.20)

		Education (2)	Experience (3)	Position (2)	Multiple Farm Interests (2)
Age (3)[a]	n	122	123	123	123
	τc	-.12	**.32****	**.29****	.06
	Sig.	.22	**.00**	**.00**	.52
Education (2)	n		122	122	123
	τc		-.13	**-.15***	**.18***
	Sig.		.17	**.04**	**.05**
Experience (3)	n			123	123
	τc			**.16***	**.24***
	Sig.			**.05**	**.01**
Position (2)	n				123
	τc				-.31
	Sig.				.07

[a] The number in parenthesis denotes the number of categories within each variable
** (p<.001), * (p<.05)

Table G-2 Correlation of farm characteristics (corresponding with Table 4.21)

		Production per cow (4)	Production per ha (4)	Stocking rate (4)	Farm system (3)	Heifer calf management (2)	Yearling heifer management (2)
Farm size (3)[a]	n	103	106	101	110	102	102
	Tc	**.21***	.10	.03	**.17***	.01	.07
	Sig.	**.02**	.28	.73	**.03**	.93	.44
Production per cow (4)	n		105	105	102	94	94
	τc		**.57***	**.19***	**.34***	.03	.11
	Sig.		**.00**	**.03**	**.00**	.79	.32
Production per ha (5)	n			105	106	98	98
	τc			**.68****	**.36****	.02	.10
	Sig.			**.00**	**.00**	.85	.32
Stocking rate (4)	n				100	101	103
	τc				**.26****	.04	.01
	Sig.				**.00**	.73	.96
Farm system (3)	n					102	103
	τc					.03	.03
	Sig.					.77	.80
Heifer calf management (2)	n						**116**
	τc						**.76****
	Sig.						**.00**

[a] The number in parenthesis denotes the number of categories within each variable
** (*p*<.001), * (*p*<.05)

Table G-3 Correlations between sources of information (corresponding Table 4.22)

		DairyNZ event attendance	Use of private consultant/ Advisor (2)	Use of SIDDC website
LUDF Focus Day attendance (5)	n	123	108	119
	τb	.12	-.02	.16
	Sig.	.17	.81	.08
DairyNZ event attendance	n		93	119
	τb		.03	.15
	Sig.		.79	.10
Use of private consultant/advisor (2)	n			109
	τb			.12
	Sig.			.35

[a] The number in parenthesis denotes the number of categories within each variable
** (p<.001), * (p<.05)

Table G-4 Correlation of sources of information used for learning (corresponding Table 4.23)

		SIDDC/LUDF website (2) (LUDF Results)	Newspapers (2) (LUDF Results)	Focus Days (2) (LUDF Results)	Demonstration Farms (2) (new tech. and innovation)	DairyNZ events (2) (new tech. and innovation)	Other farmers (2) (new tech. and innovation)
LUDF Focus Day attendance (2)[a]	n	95	108	108	108	107	107
	τb	**.30***	.04	**.42****	**.28***	**.22***	-.03
	Sig.	**.01**	.70	**.00**	**.01**	**.05**	.77
DairyNZ event attendance (2)	n	80	91	91	91	89	90
	τb	**.26***	.10	.16	.18	**.26***	-.11
	Sig.	**.02**	.33	.11	.10	**.03**	.19
Use of a private consultant/ advisor (2)	n	103	106	106	106	105	105
	τb	**.27***	.08	.06	**.25***	-.12	.05
	Sig.	**.01**	.42	.52	**.04**	.16	.64
Use of SIDDC website (2)	n	106	72	73	73	72	72
	τb	**.45****	.05	**.29****	**.37****	.11	-.08
	Sig.	**.00**	.58	**.00**	**.00**	.26	.39
SIDDC/LUDF website (2) (LUDF Results)	n		103	106	105	103	102
	τc		**.28***	**.54****	**.41***	.21	-.04
	Sig.		**.03**	**.00**	**.01**	.12	.68
Newspapers (2) (LUDF Results)	n			106	106	105	105
	τc			.14	.04	.26	**-.12***
	Sig.			.21	.74	.09	**.01**
LUDF focus days (2) (LUDF Results)	n				108	106	105
	τc				**.31***	.12	-.04
	Sig.				**.03**	.33	.66
Demonstration farms (2) (new tech. and innovation)	n					106	106
	τc					.27	.04
	Sig.					.12	.70
DairyNZ events (2) (new tech. and innovation)	n						106
	τc						.07
	Sig.						.60

[a] The number in parenthesis denotes the number of categories within each variable
** (*p*<.001), * (*p*<.05)

Table G-5 Correlation of farmer and farm characteristics (corresponding Table 4.24)

		Farm size (4)	Production per cow (4)	Production per ha (4)	Farm system (3)	Heifer calf management (2)	Yearling heifer management (2)
Age (3)[a]	n	116	107	111	116	119	117
	τc	**-.18***	-.06	-.10	**-.19***	-.02	-.06
	Sig.	**.03**	.56	.25	**.02**	.85	.51
Education (2)	n	115	107	110	115	118	116
	τc	.07	.03	-.03	.16	.01	.10
	Sig.	.44	.74	.75	.07	.90	.26
Experience (3)	n	116	107	111	116	119	117
	τc	-.11	-.07	-.07	-.09	-.08	-.03
	Sig.	.16	.38	.39	.30	.33	.71
Position (2)	n	116	107	111	116	119	117
	τc	.04	-.04	.01	.10	**.22***	**.21***
	Sig.	.63	.67	.95	.27	**.02**	**.02**
Multiple farm interests (2)	n	116	106	111	116	119	117
	τc	.03	.15	**.21***	.02	**-.19***	-.17
	Sig.	.75	.16	**.04**	.82	**.03**	.06

[a] The number in parenthesis denotes the number of categories within each variable

** (*p*<.001), * (*p*<.05)

Table G-6 Correlation of farmer and farm characteristics x sources of information used (corresponding Table 4.25)

						Information sources used to learn of LUDF results			Information sources used to learn of new agricultural technology and innovation		
		LUDF focus day attendance (2)	DairyNZ event attendance (2)	Use of a private consultant/ advisor (2)	Use of SIDDC /LUDF website (2)	SIDDC /LUDF website (2)	News-papers (2)	Focus days (2)	Demo. farms (2)	DairyNZ Events (2)	Other farmers (2)
Age (3)[a]	n	123	93	109	74	106	109	109	109	108	108
	τc	-.02	**-.28****	-.07	**-.22***	.11	.03	.10	.09	-.07	-.03
	Sig.	.83	**.00**	.52	**.02**	.19	.64	.26	.16	.35	.43
Experience (3)	n	123	123	109	119	106	109	109	109	108	108
	τc	-.01	-.10	**-.25***	-.02	-.01	-.11	.03	.01	.09	.02
	Sig.	.88	.27	**.01**	.98	.29	.10	.73	.80	.13	.63
Education (2)	n	114	93	109	74	106	109	109	109	108	108
	τc	**.25***	**.20***	-.02	.16	.14	.04	**.24****	-.02	-.02	-.04
	Sig.	**.04**	**.02**	.86	.07	.08	.58	**.00**	.79	.64	.36
Position (2)	n	123	123	109	119	106	109	109	109	108	108
	τc	.04	.122	-.02	-.01	.12	-.02	.14	.08	.06	.04
	Sig.	.65	.16	.87	.92	.14	.82	.08	.34	.50	.64
Multiple farm interests (2)	n	123	123	109	119	106	109	109	109	108	108
	τc	-.06	.02	.01	.13	-.05	.02	.06	-.04	-.06	-.02
	Sig.	.54	.86	.96	.17	.59	.83	.56	.65	.56	.81

[a] The number in parenthesis denotes the number of categories within each variable

** (p<.001), * (p<.05)

Table G-7 Correlation of farmer and farm characteristics x sources of information used (corresponding Table 4.26)

						Information sources used to learn of LUDF results			Information sources used to learn of new agricultural technology and innovation		
		LUDF focus day attendance (2)	DairyNZ event attendance (2)	Use of a private consultant/ advisor (2)	Use of SIDDC /LUDF website (2)	SIDDC /LUDF website (2)	News-papers (2)	Focus days (2)	Demo. farms (2)	DairyNZ events (2)	Other farmers (2)
Farm size (4)[a]	n	116	87	102	71	100	102	101	102	103	103
	τc	.12	.17	**.20***	**.27***	**.28****	-.03	.03	**.15***	**.12***	.05
	Sig.	.22	.08	**.05**	**.01**	**.00**	.72	.74	**.04**	**.04**	.34
Farm System (3)	n	116	88	103	69	100	104	101	103	102	102
	τc	.05	**.33****	.15	**.35***	.16	.12	**.19***	**.17***	.12	**-.10***
	Sig.	.63	**.01**	.15	**.01**	.07	.18	**.01**	**.05**	.06	**.04**
Production per cow (kg MS) (4)	n	107	82	97	105	96	97	98	97	98	97
	τc	.02	**.34***	.19	.06	.09	.13	-.04	.08	.07	-.05
	Sig.	.89	**.01**	.07	.57	.37	.12	.72	.32	.37	.17
Production per ha (kg MS) (4)	n	111	111	102	109	100	101	102	101	101	100
	τc	.04	.16	.18	.05	-.02	.08	.04	.13	-.01	-.01
	Sig.	.70	.12	.09	.61	.80	.36	.66	.07	.93	.86

[a] The number in parenthesis denotes the number of categories within each variable
** (*p*<.001), * (*p*<.05)

Table G-8 Correlations between farmer characteristics x adoption of innovations (corresponding Table 4.39)

		Graze[b]	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Age (3)[a]	n	115	110	108	110	110	112	112	110	109	112
	τc	.16	**.24***	**.20***	-.07	**-.21***	-.04	.11	.00	.01	.13
	Sig.	.06	**.01**	**.05**	.32	**.05**	.97	.24	1.0	.86	.12
Position (3)	n	111	110	108	110	110	112	112	110	109	112
	τc	.06	.01	.02	-.10	-.05	-.08	-.06	-.02	-.01	**-.15***
	Sig.	.53	.91	.76	.17	.52	.24	.37	.77	.92	**.05**
Education (2)	n	110	109	108	110	110	112	112	110	109	112
	τc	.09	.06	.07	-.01	.12	.02	.04	.09	.05	.10
	Sig.	.24	.47	.40	.98	.21	.87	.68	.31	.56	.16
Experience (3)	n	111	110	108	110	110	112	112	110	109	112
	τc	.02	.10	-.08	-.05	-.13	-.06	.05	-.10	.15	-.01
	Sig.	.81	.29	.37	.61	.18	.57	.61	.31	.10	.90
Multi-farm Interests (2)	n	111	110	108	110	110	112	112	110	109	112
	τc	.07	.00	.10	.02	**.23***	.09	-.10	-.02	.08	.05
	Sig.	.35	.98	.26	.86	**.01**	.44	.26	.87	..37	.50

[a] The number in parenthesis denotes the number of categories in each variable
[b] All innovation variables are dichotomous (i.e. adopted or not adopted)
** (*p*<.001), * (*p*<.05)

Table G-9 Correlation between farm characteristics x adoption of innovations (corresponding Table 4.40)

		Graze[b]	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Farm size (4)[a]	n	105	104	102	104	104	105	105	103	103	105
	τc	.08	.11	.01	.12	**0.41****	.07	**-.27***	.02	-.03	-.04
	Sig.	.25	.18	.94	.21	**.00**	.51	**.01**	.85	.74	.66
Farm system (3)	n	105	104	102	104	104	106	106	104	103	106
	τc	.09	**.19***	.07	.04	.05	.08	-.10	.06	.09	.04
	Sig.	.33	**.03**	.48	.68	.65	.42	.35	.55	.33	.61
Production per cow (4)	n	101	100	96	99	98	101	101	98	98	101
	τc	-.02	.11	.07	.14	.18	**0.30****	-.02	.10	.07	.06
	Sig.	.84	.24	.51	.22	.10	**.00**	.84	.33	.46	.51
Production per ha (4)	n	104	102	100	102	101	104	104	101	101	104
	τc	.02	.02	.08	.14	.12	**0.23***	-.14	.21	.15	.06
	Sig.	.86	.80	.45	.18	.28	**.03**	.20	.26	.13	.50
Heifer calf management (2)	n	108	107	105	107	107	109	107	107	106	109
	τc	.04	.07	.01	.07	.04	-.17	-.16	.06	-.05	-.13
	Sig.	.56	.34	.94	.43	.65	.06	.06	.48	.56	.07
Yearling heifer management (2)	n	106	105	103	105	105	107	107	105	104	107
	τc	.08	-.06	-.05	.07	-.04	**-.21***	-.20	.07	-.12	-.12
	Sig.	.25	.41	.55	.46	.66	**.02**	.18	.43	.15	.11

[a] The number in parenthesis denotes the number of categories in each variable
[b] All innovation variables are dichotomous (i.e. adopted or not adopted)
** (p<.001), * (p<.05)

Table G-10 Correlations between sources of information and the adoption of innovations (corresponding Table 4.41)

		Graze	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
LUDF focus day attend (2)	n	110	109	107	109	109	111	111	109	108	111
	τc	.10	.29	-.09	**.18***	.08	.07	**-.23***	**.17***	.09	.06
	Sig.	.19	.71	.32	**.05**	.41	.47	**.01**	**.05**	.31	.44
DairyNZ event attend (2)	n	89	88	89	89	90	92	91	90	88	91
	τc	.03	.07	.05	**.21***	.14	.13	-.12	.08	.13	-.05
	Sig.	.70	.34	.55	**.02**	.11	.13	.19	.34	.09	.50
Use of private consultant (2)	n	105	104	105	105	106	108	107	106	104	107
	τc	.12	.13	-.07	.10	**.18***	.14	-.08	.13	-.07	.11
	Sig.	.12	.10	.93	.27	**.05**	.12	.40	.12	.45	.11
Use of the SIDDC/LUDF website (2)	n	72	72	71	72	72	74	73	72	72	73
	τc	**.20***	**.16***	-.04	**.20***	.00	.11	**-.18***	**.19***	.11	.05
	Sig.	**.01**	**.03**	.64	**..03**	.99	.21	**.05**	**.03**	.18	.56

[a] The number in parenthesis denotes the number of categories in each variable
[b] All innovation variables are dichotomous (i.e. adopted or not adopted)
** (*p*<.001), * (*p*<.05)

Table G-11 Correlation between information sources used to learn about LUDF results x adoption of innovations (corresponding Table 4.42)

		Graze	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
SIDDC/LUDF website (2)	n	103	102	105	101	103	104	106	105	104	102
	τc	**.19***	**.18***	.07	.10	.04	-.04	-.10	.13	.10	-.04
	Sig.	**.02**	**.02**	.34	.20	.57	.60	.21	.08	.14	.56
Newspapers (2)	n	105	104	107	104	105	106	108	107	106	105
	τc	.11	**.15***	.10	.10	-.04	.09	-.04	.08	.11	.03
	Sig.	.11	**.04**	.17	.20	.61	.20	.63	.19	.08	.63
LUDF focus days (2)	n	105	104	107	104	105	106	108	107	106	104
	τc	**.17***	.08	.02	.02	.20	.01	-.01	.42	.01	.04
	Sig.	**.03**	.23	.82	.82	.83	.92	.22	.59	.21	.57
Other farmers (2)	n	101	100	103	100	102	102	104	103	102	100
	τc	.08	.01	.08	.05	-.02	.05	**-.26****	**.16***	-.04	-.03
	Sig.	.25	.18	.28	.50	.84	.53	**.00**	**.02**	.63	.66
Other media publications (2)	n	100	99	102	99	100	101	103	102	101	99
	τc	.11	**.17***	.14	.15	-.03	.13	.03	**.26****	.07	-.03
	Sig.	.14	**.04**	.10	.08	.77	.09	.70	**.00**	.39	.64

Table G-11 (Continued) Correlation between information sources used to learn about LUDF results x adoption of innovations

		Graze	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Discussion groups (2)	n	102	102	104	101	103	103	105	104	103	102
	τc	.12	.09	.01	.08	-.16	.05	-.06	.04	.07	.10
	Sig.	.12	.22	.93	.35	.07	.60	.49	.62	.44	.12
Consultants (2)	n	103	102	105	101	104	103	106	105	103	102
	τc	**.21***	.15	.10	**.19***	-.01	.06	-.13	.14	**.16***	-.01
	Sig.	**.01**	.06	.27	**.03**	.26	.46	.14	.08	**.04**	.94
Tuesday farm walks (2)	n	93	93	95	91	93	93	96	95	93	93
	τc	.11	-.05	.08	.01	.02	-.01	**-.16***	-.03	**-.18***	.11
	Sig.	.06	.55	.34	.89	.82	.29	**.05**	.73	**.02**	.18

[a] The number in parenthesis denotes the number of categories in each variable; [b] All innovation variables are dichotomous (i.e. adopted or not adopted), ** (p<.001), * (p<.05)

Table G-12 Correlation of information sources used to learn about agricultural new technology and innovation x adoption of innovation (corresponding Table 4.43)

		Graze	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Demonstration farms (2)	n	105	104	104	105	106	108	107	106	104	107
	τc	**.13***	**.13***	.00	.07	.02	.01	-.06	.07	.08	.00
	Sig.	**.04**	**.05**	.99	.23	.71	.86	.25	.16	.06	.96
DairyNZ events (2)	n	104	104	103	104	105	107	106	105	104	106
	τc	.07	.02	-.02	**.16***	.02	-.02	-.02	.04	.07	.03
	Sig.	.21	.60	.73	**.01**	.72	.68	.97	.37	.10	.44
Other farmers (2)	n	104	103	103	104	105	107	106	105	103	106
	τc	.03	-.01	.00	.06	-.00	-.04	-.05	.03	.05	-.06
	Sig.	.47	.75	.97	.29	.96	.48	.31	.50	.18	.27
Other media (TV, Magazines and Newspapers) (2)	n	106	106	105	106	107	109	108	107	105	108
	τc	-.01	.03	.05	-.02	-.03	.04	-.03	.05	**.13***	.00
	Sig.	.87	.64	.39	.73	.62	.54	.69	.40	**.01**	.99

Table G-12 (Continued) Correlation of information sources used to learn about agricultural new technology and innovation x adoption of innovation

		Graze	Re-grass	CowBCS	Soilmoist	2herds	Premow	Noinduct	NGibb	EcoN	Synchro
Consultants (2)	n	103	102	101	103	103	106	105	103	102	105
	τc	.03	.05	.07	**.19***	.07	.07	-.06	**.19***	.02	.08
	Sig.	.66	.45	.37	**.02**	.37	.38	.43	**.04**	.80	.14
Conferences (2)	n	102	102	100	102	102	105	104	102	102	104
	τc	.19	.04	-.02	.08	.10	.06	-.03	.02	**.11***	-.10
	Sig.	.43	.45	.77	.20	.10	.31	.62	.70	**.03**	.10
Sales /technical staff (2)	n	99	99	97	99	99	102	101	99	99	101
	τc	-.02	.04	-.08	**.20***	.00	**.25****	-.05	**.17***	.01	**.13***
	Sig.	.77	.65	.36	**.03**	1.0	**.00**	.58	**.04**	.87	**.04**

[a] The number in parenthesis denotes the number of categories in each variable, [b] All innovation variables are dichotomous (i.e. adopted or not adopted), ** (p<.001), * (p<.05)

Table G-13 Correlations between the number of innovations adopted (innovativeness) x farmer characteristics (corresponding Table 4.45)

		Age (3)	Position (2)	Education (2)	Experience (3)	Multi-farm interests (2)
Number of FMP adoptions (10)[a]	n	115	115	114	115	115
	τc	.08	-.09	.15	-.04	.12
	Sig.	.32	.26	.16	.61	.26

[a] The number in parenthesis denotes the number of categories in each variable, ** (p<.001), * (p<.05)

Table G-14 Correlations between the number of innovations adopted (innovativeness) x farm characteristics (corresponding Table 4.46)

		Farm size (4)	Farm system (3)	Production per cow (4)	Production per ha (4)	Heifer calf management (2)	Yearling heifer management (2)
Number of FMP adoptions (10)[a]	n	108	109	103	106	112	110
	τc	.11	.15	**.19***	**.16***	-.07	-.17
	Sig.	.18	.13	**.01**	**.04**	.47	.10

[a] The number in parenthesis denotes the number of categories in each variable, ** (p<.001), * (p<.05)

Table G-15 Correlations between the number of innovations adopted (innovativeness) x farmer's ISCs (corresponding Table 4.47)

		LUDF focus day attend (2)	DairyNZ event attend (2)	Use of private consultant (2)	Use of SIDDC website (2)
Number of FMP adoptions (10)[a]	n	114	93	109	74
	τc	.12	**.21***	**.23***	**.21***
	Sig.	.28	**.04**	**.03**	**.05**

[a] The number in parenthesis denotes the number of categories in each variable, ** (p<.001), * (p<.05)

Table G-16 Correlations between the number of innovations adopted (innovativeness) x information sources used to learn of LUDF's results (corresponding Table 4.48)

		SIDDC/LUDF website[b]	Newspapers	LUDF focus days	Other farmers	Other media publications	Discussion groups	Consultants	Tuesday farm walks
Number of FMP adoptions (10)[a]	n	106	109	109	105	104	106	106	96
	τc	.17	**.18***	.06	.02	**.26***	.09	.18	-.04
	Sig.	.10	**.05**	.53	.86	**.01**	.40	.13	.68

[a] The number in parenthesis denotes the number of categories in each variable, [b] The variables on the X axis are dichotomous (i.e. important or not important), ** (p<.001), * (p<.05)

Table G-17 Correlations between the number of innovations adopted (innovativeness) x information sources used to learn about new agricultural technologies and innovations (corresponding Table 4.49)

		Demonstration farms[b]	DairyNZ events	Other farmers	Other media publications	Consultants	Conferences	Sales /technical staff
Number of FMP adoptions (10)[a]	n	108	107	107	109	105	104	101
	τc	**.15***	.10	-.01	.03	**.20***	**.11***	**.21***
	Sig.	**.03**	.07	.86	.70	**.05**	**.05**	**.03**

[a] The number in parenthesis denotes the number of categories in each variable, [b] The variables on the X axis are dichotomous (i.e. important or not important), ** (p<.001), * (p<.05)

Appendix H

Results of logistic regression analysis

Table H-1 Logistic regression results for low and consistent grazing residuals (n=77)

	B (S.E.)	Sig.	Exp(B)	95% C.I. for EXP(B)	
				Lower	Upper
Age	.101 (.042)	.02	1.107	1.020	1.201
Farm size	.001 (.002)	.53	1.001	.998	1.005
MS kg per cow	.003 (.008)	.73	1.003	.988	1.018
Focus day attend	-.065 (.342)	.85	.937	.479	1.831
Website use	.064 (.040)	.11	1.066	.986	1.153
DairyNZ event attend	.349 (.191)	.07	1.418	.975	2.060
Consultant use	.819 (.730)	.26	2.268	.543	9.483
Constant	-6.440 (4.45)	.15	.002		
R^2 = .21 (Hosmer & Lemeshow), .17 (Coz & Snell), .29 (Nagelkerke), Model X^2 (1) = 14.7, p=.04					

Table H-2 Logistic regression results for re-grassing based on measurement (n=76)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	.122 (.046)	.01	1.130	1.032	1.237
Farm size	-.001 (.001)	.50	.999	.998	1.001
MS kg per cow	-.001 (.008)	.93	.999	.983	1.015
Focus day attend	-.484 (.361)	.18	.616	.304	1.251
Website use	.058 (.037)	.12	1.059	.986	1.138
DairyNZ event attend	.302 (.203)	.14	1.353	.909	2.013
Consultant use	.620 (.772)	.42	1.859	.409	8.445
Constant	-4.49 (4.65)	.33	.011		
R^2 = .23 (Hosmer & Lemeshow), .18 (Coz & Snell), .31 (Nagelkerke), Model X^2 (1) = 15.1, p=.03					

Table H-3 Logistic regression results for condition scoring of cow for alternative management (n=75)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	.056 (.031)	.07	1.058	.996	1.123
Farm size	.000 (.001)	.51	1.000	.999	1.002
MS kg per cow	.007 (.006)	.28	1.007	.995	1.019
Focus day attend	.131 (.280)	.64	1.139	.659	1.971
Website use	.006 (.022)	.80	1.006	.963	1.051
DairyNZ event attend	-.063 (.110)	.56	.939	.757	1.164
Consultant use	-.479 (.632)	.45	.619	.179	2.137
Constant	-4.17 (3.38)	.22	.015		
R^2 = .06 (Hosmer & Lemeshow), .06 (Coz & Snell), .10 (Nagelkerke), Model X^2 (1) = 5.4, *p*=.61					

Table H-4 Logistic regression results for soil moisture monitoring (n=76)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	.018 (.029)	.53	1.018	.962	1.078
Farm size	.001 (.001)	.37	1.001	.999	1.003
MS kg per cow	-.002 (.006)	.72	.998	.987	1.009
Focus day attend	.611 (.289)	.04	1.843	1.045	3.249
Website use	.006 (.021)	.78	1.006	.965	1.049
DairyNZ event attend	.126 (.113)	.27	1.134	.909	1.416
Consultant use	.106 (.591)	.86	1.111	.349	3.536
Constant	-.514 (3.17)	.87	.598		
R^2 = .09 (Hosmer & Lemeshow), .12 (Coz & Snell), .16 (Nagelkerke). Model X^2 (1) = 9.44, *p*=.22					

Table H-5 Logistic regression results for creating a separate herd of young cows to facilitate alternative management (n=76)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	-.009 (.029)	.76	.991	.936	1.049
Farm size	.009 (.003)	.00	1.009	1.003	1.014
MS kg per cow	.000 (.006)	1.0	1.000	.989	1.011
Focus day attend	-.426 (.270)	.12	.653	.385	1.110
Website use	-.032 (.025)	.21	.969	.922	1.018
DairyNZ event attend	.153 (.114)	.18	1.165	.932	1.457
Consultant use	.106 (.580)	.86	1.112	.357	3.464
Constant	-1.22 (3.32)	.71	.296		
R^2 = .22 (Hosmer & Lemeshow), .26 (Coz & Snell), .34 (Nagelkerke), Model X^2 (1) = 22.4, *p*=.00					

Table H-6 Logistic regression results for pre-graze mowing (n=78)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	.016 (.026)	.55	1.016	.965	1.069
Farm size	.000 (.001)	.60	1.000	.999	1.001
MS kg per cow	.012 (.006)	.04	1.012	1.000	1.024
Focus day attend	.260 (.233)	.27	1.297	.821	2.047
Website use	.024 (.019)	.21	1.024	.987	1.063
DairyNZ event attend	-.035 (.106)	.74	.966	.785	1.188
Consultant use	.514 (.541)	.34	1.671	.579	4.828
Constant	-6.82 (3.19)	.03	.001		
R^2 = .08 (Hosmer & Lemeshow), .11 (Coz & Snell), .15 (Nagelkerke). Model X^2 (1) = 8.94, p=.26					

Table H-7 Logistic regression results for a zero induction policy (n=77)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	.002 (.028)	.94	1.002	.949	1.058
Farm size	-.001 (.001)	.37	.999	.997	1.001
MS kg per cow	.002 (.005)	.75	1.002	.991	1.012
Focus day attend	-.475 (.271)	.08	.622	.366	1.057
Website use	-.009 (.022)	.66	.991	.950	1.033
DairyNZ event attend	-.031 (.105)	.77	.970	.789	1.192
Consultant use	-.289 (.563)	.61	.749	.248	2.258
Constant	-.534 (3.11)	.86	.586		
R^2 = .07 (Hosmer & Lemeshow), .08 (Coz & Snell), .11 (Nagelkerke). Model X^2 (1) = 6.49, p=.48					

Table H-8 Logistic regression results for application of nitrogen fertiliser and gibberllic acid simultaneously (n=75)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	.011 (.026)	.67	1.011	.961	1.063
Farm size	.000 (.001)	.82	1.000	.999	1.001
MS kg per cow	.001 (.005)	.80	1.001	.991	1.012
Focus day attend	.234 (.232)	.31	1.263	.801	1.993
Website use	.016 (.019)	.38	1.016	.980	1.054
DairyNZ event attend	-.009 (.103)	.93	.991	.810	1.211
Consultant use	.862 (.554)	.12	2.369	.800	7.014
Constant	-2.41 (2.97)	.42	.090		
R^2 = .05 (Hosmer & Lemeshow), .06 (Coz & Snell), .09 (Nagelkerke). Model X^2 (1) = 4.96, p=.66					

Table H-9 Logistic regression results for the use of Eco-N (n=75)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	-.009 (.028)	.74	.991	.938	1.046
Farm size	.000 (.001)	.93	1.000	.999	1.001
MS kg per cow	-.004 (.006)	.44	.996	.985	1.007
Focus day attend	-.258 (.247)	.30	.773	.476	1.254
Website use	.016 (.018)	.37	1.016	.981	1.054
DairyNZ event attend	.167 (.109)	.13	1.181	.954	1.462
Consultant use	-.714 (.561)	.20	.490	.163	1.469
Constant	1.73 (3.10)	.58	5.623		

R^2 = .07 (Hosmer & Lemeshow), .08 (Coz & Snell), .12 (Nagelkerke). Model X^2 (1) = 6.54, *p*=.48

Table H-10 Logistic regression results for synchronisation of heifers (n=78)

	B (S.E.)	Sig.	Exp(B)	95% C.I.for EXP(B)	
				Lower	Upper
Age	.015 (.034)	.67	1.015	.949	1.086
Farm size	-.001 (.001)	.48	.999	.996	1.002
MS kg per cow	.005 (.007)	.48	1.005	.992	1.018
Focus day attend	.428 (.301)	.15	1.534	.851	2.765
Website use	.007 (.024)	.78	1.007	.961	1.055
DairyNZ event attend	-.225 (.166)	.18	.799	.577	1.105
Consultant use	.779 (.758)	.30	2.179	.493	9.636
Constant	-4.47 (3.94)	.26	.011		

R^2 = .08 (Hosmer & Lemeshow), .08 (Coz & Snell), .12 (Nagelkerke). Model X^2 (1) = 6.01, *p*=.53

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