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Survey of Rural Decision Makers in Canterbury, Southland and Waikato

Final Report for the Ministry for the Environment

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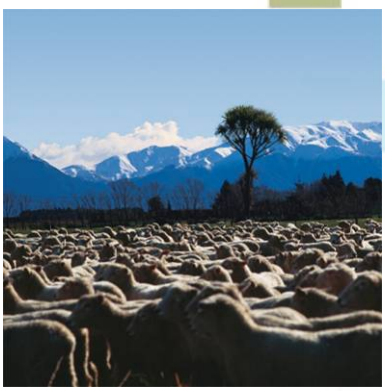

Survey of Rural Decision Makers in Canterbury, Southland and Waikato.

Report prepared for Ministry for the Environment

June 2013

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1. Executive Summary

1.1 Overview

1. This report presents the results of the research project undertaken to meet the specifications outlined in the Land Owner Behaviour 0165-01-RFP tendered by the Ministry for the Environment (MfE). MfE required a better understanding of farmers' responses to policies setting limits on the use of freshwater resources and wishes to use the resulting knowledge to improve current quantitative methods used for policy evaluation.
2. Obtaining these data will strengthen the analysis of land-use change and adoption of farm practices, which will provide more realistic predictions for responses to economic instruments because the prevailing profit-maximising, perfect information assumptions tend to understate the costs of economic instruments when compared to other options such as uptake of good management practices.
3. Scientists and governments are increasingly looking for ways to understand the complexity and outcomes of interactions between human agents and their environment – in particular, with regard to the impact of agricultural practices on the environment. Recent reviews by Matthews et al. (2007) and O'Sullivan (2008) have suggested that a promising approach in this endeavour is the use of agent-based models (ABMs) – a potentially important means of exploring emergent behaviours in complex systems.
4. ABMs are a valued technique in representing disaggregated decision-making. As their name suggests, agent-based models attempt to model the behaviour of a complex system by representing the behaviour of the various agents that make up the system (Klosterman and Pettit 2005).
5. Land-use and land-cover change (LUCC) models have been adapting agent-based approaches to enable the simulation and analysis of a variety of LUCC scenarios. The benefit for LUCC models in this approach is the explicit focus on human decision-making, which is important for examining the role and interactions of the actors who drive LUCC. Behaviour, types and goals in LUCC models can be embedded within the agents to mimic the agent's real-world counterparts. In the context of this report, agents would be rural decision-makers (mainly farmers). Differentiation in the types of farmers and the behaviours they employ could also be included in the model.
6. While the implementation of human decision-making processes is a key strength for ABMs, the agent attributes and understanding how they might behave requires detailed information from qualitative and/or quantitative empirical sources (Smajgl et al. 2011, Robinson et al. 2007, Rounsevell et al. 2011).
7. Knowing this, MfE put out a Request for Proposals (Land Owner Behaviour 0165-01-RFP) to better inform how farmers would respond to policies such as setting limits on the use of freshwater resources and to inform agents within the two agent-based models.

1.2 Literature review

8. To frame the project a literature review was undertaken. The way farmers take decisions on their farms is a topic of interest to numerous disciplines ranging from the purely sociological, to those that are concerned solely with the impact of agriculture on the environment or improving the productivity of agricultural

practices. As a consequence, there is an enormous quantity of literature on farm decision-making with numerous different objectives – and using a variety of different perspectives.

9. Smithers & Furman (2003) suggest that it is the role of the farm as a social unit, as well as a business, that results in farm management being focused on a wider range of goals than simply profit maximisation. In opposition to traditional econometric analysis that uses profit maximisation as the only driver of decision-making, ABMs incorporate both social and business aspects into the economic analysis. ABMs, therefore, aim to improve over purely economic analysis by building in knowledge of the social aspects of family farms decision-making. It is important to note that we expect that a New Zealand farmer's decision to change a land use, or to adopt an environmental practice, is more likely to be an infrequent, strategic decision as opposed to a frequent, tactical decision

10. It is important to note that ABMs do not model the psychological processes of decision-making as do, the theories of reasoned action or planned behaviour. While the processes themselves are relatively unimportant for ABMs, the psychological components that influence decision-making are important. Consequently it is important that the ABMs include these concepts (attitudes, norms, and perceived control) within their theoretical conceptualisation of the rural decision maker 'agent'.

11. This review identified psychological constructs (e.g. attitudes, norms, self-identity, and morality) that may influence farmers' behaviour. While the social relations, human capital, and farm structure provide the environment within which the decision-making can occur, the decision-making process itself is equally important for ensuring that the model produces accurate results

12. The role of life-cycle within farmer decision making was highlighted and reinforced (Burton, In Press). This is an interesting approach as it starts to capture the aspect of 'time' for the agent and its interactions and implicitly incorporates the role and importance of time within the land use change system. Models need to capture that farmers are bounded by the explicitly time-focused process of succession. There are numerous implications for agent based models, ranging from behavioural changes that result from the succession, expansion and diversification life-cycle stages.

13. A range of individual farmer characteristics were reviewed (education, age, beliefs and obligations, attitudes, risk, experience, external income sources, debt level) with key points being highlighted that shape the way in which the characteristic might alter behaviour. This process was also explored through the various characteristics of farm household (succession, role of spouse in decision making) and farm structure (income, farm size, and tenure). As these characteristics change (such as an increase in farm size or income) farm decision-making changes as farmers are enabled or restricted in their choice.

1.3 Survey creation and implementation

14. A workshop was held in Wellington on 5th March, 2013, that included representatives from AgResearch, Landcare Research, NZIER, MfE and MPI. The aim of the workshop was to confirm the scope of the study (policies, on-farm practices, farm systems) and agree on the survey instrument and methodology. The resulting survey was defined at the workshop but fine tuning of the wording and design continued over the following weeks.

15. The survey, titled 'Survey of Rural Decision Makers' was designed jointly by Landcare Research and AgResearch with input from the Ministry for the

Environment, the Ministry of Primary Industries, Dairy NZ, the developers of the two ABMs, and others. It collects detailed data on farmer demographics, farm characteristics, succession plans, risk tolerance, profitability, information sources, objectives, farm management practices, farmer intentions, perceived behavioural control, norms, and environmental attitudes.

16. 5,811 individuals were invited to participate in the survey via email. Some 784 surveys were initiated (Table 1). 536 were completed, representing a 68.4% yield on initiated surveys. This completion rate is commensurate with other Internet surveys undertaken by UMR Research, particularly given the complexity of our instrument. The analysed sample comprises 283 farmers in Canterbury (10.0% of those contacted), 136 in Southland (10.7% of those contacted), and 117 in Waikato (6.8% of those contacted). The overall response rate was 9.2%.

1.4 Descriptive and analytical results

17. Waikato rural decision makers have 10% more farming experience, on average, than respondents from Canterbury and Southland. The vast majority had worked on more than one farm in their career. Only 22.5% of respondents had selected a successor. If one was identified it was usually one of their own children. Waikato farms are predominantly Dairy which differs to the other two regions where sheep and beef is the main enterprise on the farm

18. Canterbury farms are larger than Southland and Waikato farms, on average. Most respondents do not lease land for their farming operation. Over half of the respondents stated that they are undertaking more than one enterprise on their farm. Over their time on the farm, 46% of respondents had changed the hectares associated with their enterprises by more than 20%. Canterbury rural decision makers changed enterprise mixes most recently. Decision makers in Canterbury were more educated than their counterparts in the other two regions.

19. Respondents in Southland (64.2%) and Waikato (61.2%) reported a higher share of farm profitability than respondents in Canterbury (47.8%). While 66.4% of Canterbury Sheep and Beef farmers responded that they were breaking even or unprofitable, only 17.1% of Dairy farmers feel the same way. Respondents in Southland are also statistically younger and less educated on average than the other two regions.

20. In all three regions, veterinarians are the most trusted and important source of information for respondents. Overall, other farmers are the third most trusted and important source of information for rural decision-makers after vets and accountants. The least three trusted and important source of information were Central government, Television and Radio, and Regional Councils.

21. The sizes of rural decision makers' social networks are similar between regions. Only 5.5% of farmers surveyed did not discuss farming with any other farmers. A similar figure was found (6.8%) did not visit any other working farms over the previous 12 months. Dairy farmers are considerably more connected through their peer networks than other farmers in all three regions.

22. While Southland respondents have a slightly more productivist orientation, they also acknowledge the importance of sustaining natural habitats for native fish and birds more than Waikato and Canterbury respondents. Rural decision-makers in Canterbury are more likely to hold intentions to intensify their enterprise mix than decision makers in either Southland or Waikato. The majority of respondents believe that they are unlikely to change their enterprise mix due to regulatory pressure in the next 5 years.

23. Tradition is a stronger motivator in Southland than in either Canterbury or Waikato. These results indicate that although tradition is not the primary motivation for farming for a majority of respondents, it is nonetheless an important motivator for some rural decision makers.

24. While most respondents believe that their family members and the farming community want them to farm in an environmentally sustainable manner, respondents in all three regions believe that the social expectation for farming sustainably is significantly stronger amongst the New Zealand public.

25. Questions around the update of farm management practices by enterprise provided a significant range of revealed preferences by rural decision makers in relation to the lack of willingness to adopt a management practice. Conversely, the number of respondents who have already adopted the practice is also telling.

26. These questions also highlighted a number of ways in which a rural decision maker might respond to the introduction of limit setting policies. Restriction on the number of dairy or beef cattle, or sheep would be resisted by all decision makers. Based on the level of implementation, their intention to implement, or consideration of reducing N use on the farm, more focused policies around N limits are expected to have greater acknowledgement and adoption. In addition dairy farmers in each of the three regions are more responsive to this management practice. Consequently, you could assume dairy farmers would also be more responsive than Sheep and Beef or Arable farmers to other N based polices in the future. Responses to the questions around their attitudes towards water resources highlight that more environmentally focused policies around the quality of freshwater resources might be understood and accepted. However, as noted in the descriptive analysis respondents may answer such questions in a fashion that reflects what they consider to be the most socially desirable response.

27. Thirty-two different hypotheses pertaining to attitudes, perceived behavioural controls, social norms, network size, risk tolerance, outlook, farming intentions, and the uptake of 13 specific farm management practices were specified and tested.

28. Enterprise type, Region, Age and Education all play a role in rural decision makers' views on the importance of preserving the purity and quality of water. Education, Enterprise type and Farm Size all play a role in shaping their views on their perceived behavioural control.

29. Dairy farmers report higher expectations for environmental responsibility within the farming community than arable farmers and other rural decision-makers. Interestingly, dairy farmers do not report higher expectations than others from family members or the New Zealand public.

30. The size of a farmer’s social networks is related to the age of the decision makers, their gender, their enterprise type and their farm size. For example, dairy farmers are 12.2% more likely to discuss farming practices with six or more farmers than arable farmers and other rural decision-makers, but are not statistically more likely to visit more farms.

31. Gender, Education level, Farm Size, aspects of Enterprise type, and Age all play a role in the level of tolerance for risk by rural decision makers. For example, men score themselves 16.0% higher on the risk-tolerance scale than women.

32. In conclusion, land use by itself is not a sufficient predictor of behaviour. Aspects that do shape the behaviour of decision makers are demographics (e.g., age and gender), land characteristics (e.g., size), location, attitudes, the level of personal control they believe they have over their farm, the social expectations on them as a farmer, and the size of their social network. Conversely, a decision makers’ tolerance of risk is not a sufficient predictor of behaviour.

1.5 Review and future plans

33. This report contains a significant amount of information about the behaviour of rural decision makers' in Canterbury, Southland and Waikato. The dataset is extremely valuable and is presented here in an easy to digest form. All aspects of this report and the survey dataset will contribute to the development of more robust ABM's that can explore rural decision makers' behaviour and their responses to social, economic and policy changes. This will enable Landcare Research, AgResearch and other interested parties to develop a better understanding of how rural decision makers respond to policies setting limits on the use of freshwater resources.

34. Based on the success of the survey in these three regions, Landcare Research is conducting a similar survey across the other 13 regions to provide national data. This will increase the overall sample size, which will increase the statistical precision of our estimates. This will also allow us to test the farmer behaviour and outlook attributes across more regions and land use types.

35. It is expected that both Landcare Research and AgResearch will be implementing and incorporating the information and statistics found in this report in the two existing agent-based models for testing within the three regions. It is expected that the recommendations outlined in the literature review will also be incorporated where appropriate.

36. Finally, we believe that the data collected in the survey is extremely rich, and we hope to further explore this dataset to improve our understanding of how rural decision makers differ in their responses to policy. In addition, further analysis of the dataset would improve the agent-based models that are being developed by incorporating additional behavioural aspects.

2. Preamble

2.1 Purpose

37. This report presents the results of the research project undertaken to meet the specifications outlined in the Land Owner Behaviour 0165-01-RFP tendered by the Ministry for the Environment (MfE). MfE required a better understanding of farmers' responses to policies setting limits on the use of freshwater resources and wishes to use the resulting knowledge to improve current quantitative methods used for policy evaluation. Obtaining these data will strengthen the analysis of land-use change and adoption of farm practices, which will provide more realistic predictions for responses to economic instruments because the prevailing profit-maximising, perfect information assumptions tend to understate the costs of economic instruments when compared to other options such as uptake of good management practices.
38. The research group proposed a project that combined qualitative and quantitative methods to achieve that purpose. At the core of the project was a survey of rural decision makers (i.e., farmers, foresters, and growers). While originally the results of the survey were to be used as inputs for two agent-based models and then applied to regional case studies, the funds available for the project dictated that the project just focus on producing empirical information that could inform quantitative modelling approaches (in this case, agent-based models developed by AgResearch and Landcare Research).

2.2 Scope

39. The scope of the report as contracted between MfE and the research group is as follows:
40. A brief literature review that documents the most relevant recent surveys and applied analysis pertaining to farmer behaviour in New Zealand, Australia, and the United Kingdom, followed by a summary of sociological theory underpinning behavioural research.
41. The outcomes from a workshop attended by the research providers, central and regional government officials, and relevant industry experts, which was held to confirm the scope of the study (policies, on-farm practices, farm systems) and to agree on the survey instrument and methodology.
42. The development of a survey to explore farmer responses and behaviour based on the outcomes of the workshop and the data requirements for the two agent-based models.
43. A survey of rural decision makers in Canterbury, Southland, and Waikato accompanied by a detailed statistical analysis of the results.

2.3 Structure

44. This report covers the research undertaken for this project. It begins with an introduction to the research project and the rationale for the work. It then transitions to a literature review of the various behavioural and sociological theories pertaining to farmer decision making with a focus on the attributes that have implications for agent-based models. The report then transitions to the survey design process, the sampling strategy, and response rates. The next section of the report provides descriptive results of the data. Using both the survey responses and the findings of

the literature review, a number of hypotheses are tested in the section titled 'Data Analysis'. Finally, the implications from the research project are reviewed, the limitations of the research are highlighted, and a number of areas for future research are outlined.

3. Introduction

45. Scientists and governments are increasingly looking for ways to understand the complexity and outcomes of interactions between human agents and their environment – in particular, with regard to the impact of agricultural practices on the environment. This reflects a recent shift in research emphasis away from narrow reductionist approaches to those that recognise "that the present and future paths of environmental dilemmas are inextricably linked to dynamics of coupled human and biophysical systems" (MacMynowski, 2007 – also see Naveh, 2005). Recent reviews by Matthews et al. (2007) and O'Sullivan (2008) have suggested that a promising approach in this endeavour is the use of agent-based models (ABMs) – a potentially important means of exploring emergent behaviours in complex systems.

46. On the other hand, being a 'good farmer' is still generally synonymous with production orientated behaviour even if agricultural policies have transitioned to a post-productivist phase (Burton, 2004b, Walford, 2003, Burton and Wilson, 2006). If environmental measures can be made to fit into productivist ideology by showing a relative advantage, they are more likely to be adopted. Australian research supports this viewpoint which highlights how a conservation innovation that shows a 'relative advantage' over the superseded practice and is trial-able is likely to be adopted. Innovations that offer no advantage (particularly in economic terms) and are difficult to trial are unlikely to succeed. This research argued that extension services quicken the rate of adoption but will not increase the rate of adoption, with possible exception being given to practices that do not produce readily visible results (Pannell et al., 2006). This finding was also confirmed by Scottish research concerning afforestation where the farmers who claimed to be unaware of afforestation schemes had characteristics consistent with non-adopters in any event (Crabtree et al., 1998). Economically driven production and environmentally friendly behaviour are not necessary mutually exclusive. Research in Holland found higher educated farmers were able to intensify their production without adverse environmental consequences. Farmers achieving better financial performance were also found to be better environmental managers (Ondersteijn et al., 2003). What is clearly evident is that a whole range of factors impact on farmers' decisions to adopt an innovative practice.

47. The way farmers take decisions on their farms is therefore a topic of interest to numerous disciplines ranging from the purely sociological, to those that are concerned solely with the impact of agriculture on the environment or improving the productivity of agricultural practices. As a consequence, there is an enormous quantity of literature on farm decision-making with numerous different objectives – and using a variety of different perspectives. In addition to studies focused solely on farming, there is a wealth of literature on generic 'decision-making', ranging from socio-psychological models to systems analytical approaches – each of which can contribute towards an understanding of decision-making and, therefore, each equally worthy of inclusion in a review of farmer decision-making.

48. This diversity of the literature available makes reviewing farmer decision-making simultaneously easier and more difficult. Easier because there is no shortage of literature on which to base a review; more difficult because there is also no shortage of conflicting views, varying conceptual frameworks, different modelling approaches, differing theoretical perspectives, and so on. Consequently, any attempt at a comprehensive review of this body of literature will, by necessity, only contain a small proportion of the available knowledge. In recognition of this issue, this literature review was not focused on agricultural decision-making in general, but specifically on aspects of strategic decision-making that may be of value to the basic theoretical development of ABMs.

49. ABMs are a valued technique in representing disaggregated decision-making. As their name suggests, agent-based models (also referred to as multi-agent systems) attempt to model the behaviour of a complex system by representing the behaviour of the various agents that make up the system (Klosterman and Pettit 2005). ABMs are best suited to simulating individuals and/or groups with behaviour and traits and the capacity for spatial mobility and communication (Benenson and Torrens 2004, Jager and Janssen 2003).

50. An agent-based model is a computer-based representation of a system comprised of multiple, interacting actors called agents (Brown et al. 2005, Ferber 1999, Page 2008). Agents are discrete entities defined in terms of both their attributes and behaviour and by what the model is examining (Brown et al. 2005). The roles the agent (or agents) will simulate are usually anyone who makes decisions or takes actions that affect the underlying system state (Evans et al. 2005, Page 2008). It is claimed that agent-based models have the potential to advance most disciplines they are applied to, as they include more realistic assumptions about behaviour, structure and timing than previous methods of modelling (Page 2008).

51. In this vein, land-use and land-cover change (LUCC) models have been adapting agent-based approaches to enable the simulation and analysis of a variety of LUCC scenarios. The benefit for LUCC models in this approach is the explicit focus on human decision-making, which is important for examining the role and interactions of the actors who drive LUCC. An excellent review of multi-agent systems in LUCC can be found in Parker et al. (2003).

52. Behaviour, types and goals in LUCC models can be embedded within the agents to mimic the agent's real-world counterparts. In the context of this report, agents would be rural decision-makers (mainly farmers). Differentiation in the types of farmers and the behaviours they employ, such as based on the size of their farming operation, could also be included in the model.

53. The information used to support the creation of agents and their behaviours within the ABMs needs to be based on empirical information. While the implementation of human decision-making processes is a key strength for ABMs, the agent attributes and behavioural response functions that represent these processes require knowledge support from qualitative and/or quantitative empirical sources (Smajgl et al. 2011, Robinson et al. 2007, Rounsevell et al. 2011).

54. To capture the empirical characterisation and parameterisation of the agents and their decision-making processes, a range of methods could be employed such as: expert knowledge, surveys, interviews, and participant observation. A comparison of these and more methods to inform ABMs can be found in Smajgl et al. (2011).

55. Landcare Research has developed a spatially explicit agent-based economic model titled Agent-based Rural Land Use New Zealand (or ARLUNZ). ARLUNZ is capable of analysing the impact of a variety of policies on plot level-land use, farm returns and several environmental indicators such as nutrient loadings and soil erosion. The model can also forecast the resulting land use effects caused by changes in social networks and decision-making.

56. AgResearch and NZIER, through the Rural Futures programme, have developed the Multi-Agent Simulation (or MAS) Model. The MAS model looks at biophysical, behavioural and economic pressures on farming systems. It models the behaviour of representative farmers on a landscape defined using data from actual regions, such as Southland. These farmer-agents are subjected to drivers and changes like drought, price fluctuations, and new policies, and their reactions produce outputs from the model.

57. Aware of the two existing ABMs, MfE put out a Request for Proposals (Land Owner Behaviour 0165-01-RFP) to better inform how farmers would respond to policies such as setting limits on the use of freshwater resources and to inform agents within the two agent-based models. Responses that were to be analysed included, farmers willingness to adopt new management practices, likely changes to farming systems, or in more extreme cases, land use change. All this also needed to explore the context of changes in land uses and practices driven by other external drivers. In the Request for Proposals, MfE acknowledged that a survey of landowners would be required to obtain the necessary information. While the original tender was to also include model scenarios being run by the two ABMs, it was determined that based on the level of financial resources available, the model scenarios would not be run for this report.

4. Literature Review

58. The objective of this research project was to elicit data appropriate for use in ABMs of farmer behaviour for the purpose of understanding farmers' responses to policies setting limits on the use of freshwater resources. Responses to be analysed in the ABMs include: farmers willingness to adopt new management practices, likely changes to farming systems, or in more extreme cases, land use change; all this occurring against a context of changes in land uses and practices driven by other external drivers.

59. This literature review was focused on providing a broad theoretical framework behind strategic decision-making, using international and NZ literature to examine basic relationships between features of farms (e.g. farmer age, successional status) and decision-making to provide a basis for ABM development. This theoretical framework was used to design a survey to acquire the data necessary to develop ABMs. A spatially explicit agent based model that is heavily tied into sociological and behavioural theory probably represents the most effective way to model this plethora of factors. No two farms operations are alike, models that can best account for this heterogeneity are most likely to produce plausible results.

60. The structure of the literature review begins with a review of the sociological and economic theories relating to behavioural research. It then moves to an overview of farmer behavioural typologies that have been discussed in the literature. It then highlights key investigations of farmer behaviour undertaken within the literature, with a focus on New Zealand, Australian and European examples to identify the aspects of the behaviour that influence the choices they make.

61. When appropriate, specific points of relevance for ABM design have been included in several sections of the literature review.

4.1 Sociological theory of human behaviour

62. While there is an increasing move towards corporate farming in New Zealand, farming is still, on the whole, dominated by family farms (Nuthall 2006). Unlike corporately owned businesses, the management structure of family businesses is closely tied to the structure of the farm family and, consequently, the social workings of the family exert a strong influence on the workings of the business. Thus, as Bokemeier & Garkovitch (1987: 17) observed, the decisions made by the family "reflect the size, structure, and interaction of the family as a social unit"[1]. Smithers & Furman (2003) suggest that it is the role of the farm as a social unit, as well as a business, that results in farm management being focused on a wider range of goals than simply profit maximisation.

63. In opposition to traditional econometric analysis that uses profit maximisation as the only driver of decision-making, ABMs incorporate both social and business aspects into the economic analysis. Bokemeier & Garkovitch's (1987) identified the influence of the farm family social unit on decision-making in two areas: a) the influence of the family structure (i.e. the role of the spouse, the age of family members, the stage of the life-cycle and successional status), and b) aspects of the human capital of the farm family (i.e. labour availability, the educational level of family members, and the farming experience of family members).

64. As noted above, researchers have increasingly moved away from the economic models that dominated our understanding of decision-making in the 1950s. Perhaps

[1] This has also been found in New Zealand where the 'household structure' and 'age' of the farmer were found by Jay (2005) to exert an influence on the likelihood of farmers adopting sustainability practices.

the key feature for this was the introduction of Simon's (1957) 'satisficing' concept, which acknowledged that people do not necessarily indulge in economically optimal decision-making, but instead may optimise social, intrinsic and/or expressive goals. The impact of this work was such that, by the mid-1960s Wolpert (1964: 537) reported that the "value of theory predicated upon the existence of an omniscient and single-directed rational being" was being questioned to an increasing degree. Perhaps the first framework to be introduced looking at non-economic goals in decision-making was that of Gasson (1973; 1974). In a study of 100 farmers in Bedfordshire (UK) Gasson explored farmers' intrinsic (valued as an activity in its own right), instrumental (viewed as a means of obtaining income and security with pleasant working conditions), social (valued for interpersonal relations – being part of the community) and expressive (farming is a means to self-expression or personal fulfilment) goals and found that, rather than emphasising instrumental goals, farmers two main goals were intrinsic – i.e. independence and doing the work they liked.

65. ABMs, therefore, aim to improve over purely economic analysis by building in knowledge of the social aspects of family farms decision-making.

4.2 Economic theory of human behaviour

66. Economic models of human behaviour have been mentioned and some aspects and problems discussed previously. In this section, we provide a brief description of the concept.

67. Traditional economic models of human behaviour take as their underlying principle that human behaviour and decision making can be explained by the assumption of "homo economicus", that is, the belief that humans are rational, self-interested, maximisers of personal utility and private economic profit at minimal cost expenditure, with the assumption of perfect access to all relevant information.

68. This principle has been subject to heavy criticism both from outside and within economics (e.g., Polanyi, 1944/2001; Kahneman, 2003; Sen, 1977; Simon, 1957; Tversky & Kahneman, 1991) on at least four accounts that appear irreconcilable with observations of human behaviour. These are the assumption of human rationality, the assumption of pure self-interest, the assumption of perfect information, and the inference that humans are perfect calculating machines.

69. More sophisticated economic models acknowledge these empirical limitations and therefore consider that it is necessary to account for a range of other behavioural influences. For example, Ostrom (1997) identified the need to expand the range of rational choice models to better understand social dilemmas and collective action.

70. Agent based models are part of what she identified as second-generation models of rationality (Poteete, et al., 2010). Gistis (2007) also identified implications of economic theory for policy analysis while concluding: "It is clear that economic theory has much to offer in formulating principles of environmental regulation and in evaluating environmental policies, but its contributions will be considerably more valuable when H. economicus is replaced by a more accurate model of individual choice and strategic interaction".

71. The current project takes this position and considers how various sociological and psychological factors might be utilised by ABMs to provide better predictive models of land user behaviour.

4.3 Behavioural research

72. Focusing only on the structural/family influences on decision-making neglects the psychological process of decision-making. How do attitudes influence behaviour? What is the role of the subjective and social norms (i.e. perceived influence from others) on the decisions made? Clearly, these psychological processes play a critical role in influencing the outcome of the decision-making process.

73. Despite the importance of the decision-making processes, conducting a thorough review of the various decision-making models would not greatly assist with the construction of ABMs. The key reason for this is that, ABMs do not model the psychological processes of decision-making as do, for example, the theories of reasoned action (TORA) (Fishbein & Ajzen, 1975) or planned behaviour (TpB) (Ajzen, 1991) or Fazio's (1990) MODE model. While ABMs are based around the decisions made by individual agents this does not mean that the agent's 'thought' process forms the centre of the model. How the decision is made is of little importance. What is important is what decision is made, under what circumstances and what implications it has for other behaviours and outcomes.

74. Nevertheless, while the processes themselves are relatively unimportant, the psychological components that influence decision-making are important. For example, the TpB suggests that, in order to understand intended behaviour (and thereby behaviour) it is important to understand (a) the attitudes[2] (belief * evaluation), (b) subjective norm (perceived social norm * willingness to comply) and (c) the perceived behavioural control (the perceived likelihood that an attempt to undertake the behaviour will be efficacious), as depicted in Figure l. Modelling these through ABMs is not an option at present because of the nature of the data required to run the TORA/TpB (psychometric scaled data) and because the TORA/TpB are applicable only to very specific behaviours at the centre of the study – for example, the use of pesticides on brassica crops (Tait, 1983) or conservation behaviour (e.g. hedge removal/planting, field margin management, pesticide use) (Carr, 1988; Carr & Tait, 1991; Beedell & Rehman, 2000). However, it is important that the ABMs include these concepts (attitudes, norms, and perceived control) within their theoretical conceptualisation of the farmer 'agent'.

75. Of particular concern is to ensure that the model moves away from simplistically modelling agents as single, independent, economically rational decision-makers. Since the introduction of Simon's (1957) "satisficing" concept in the 1950s, research has been increasingly moving towards the idea that farmers' decision-making is neither necessarily economically motivated nor does it necessarily seek to optimise economic outcomes. If farmers are not economically optimising their outcomes, is it their attitude to other benefits from farming (e.g. intrinsic benefits) that drive decision-making? Given the increasing recognition of the role of social factors in decision-making, what role do other farmers have in the process? Are there any other issues that need to be considered in ABMs – for example, the influence of self-identity, morality, and so on?

4.3.1 Theory of Planned Behaviour

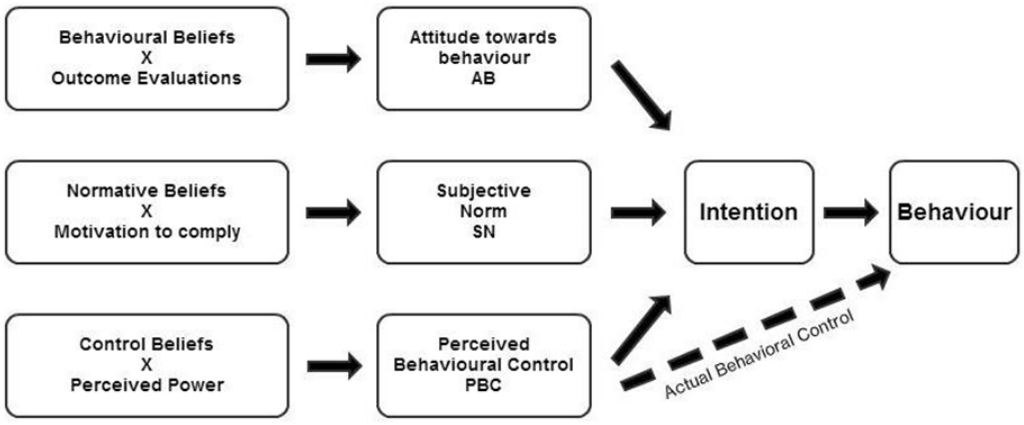
76. Thus, being able to understand the psychological components that influence decision-making will address the most common criticism of the behavioural research approach: an excessive emphasis on the attitude of the decision-maker alone as being the main predictor of a decision being taken (Wicker, 1969). This

[2] ''A psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour'' (Eagly and Chaiken, 1993).

criticism has also been directed at research concerning agricultural decision-making. The use of a more sophisticated framework than a simplified attitude-decision model is a proposed solution (Burton, 2004a). The dominance of the attitude-decision approach has been attributed to its relative simplicity from a data survey perspective and that results are easily conveyed to policy makers and research funders alike (Edwards-Jones, 2006). As mentioned above, both the 'Theory of Planned Behaviour' (Ajzen, 1991) which is an extension of the earlier 'Theory of Reasoned Action' (Ajzen and Fishbein, 1980, Fishbein and Ajzen, 1975) are the two most dominant behavioural theories covered in this review. TORA and TpB consider the wider milieu surrounding a decision-maker and they are considered as a suitable base framework from which to develop a conceptual model for this project. The strengths, weaknesses and extensions applied to TpB and TORA in existing research are outlined so as to provide a more complete description of the behavioural approach to decision-making.

77. Ajzen (2006) defines behavioural intention as "an indication of a person's readiness to perform a given behaviour, and it is considered to be the immediate antecedent of behaviour. The intention is based on attitude towards the behaviour, subjective norm, and perceived behavioural control." He defines behaviour as "Behaviour is a manifest, observable response in a given situation with respect to a given target. Single behavioural observations can be aggregated across contexts and times to produce a more broadly representative measure of behaviour. In the TpB, behaviour is a function of compatible intentions and perceptions of behavioural control. Conceptually, perceived behavioural control is expected to moderate the effect of intention on behaviour, such that a favourable intention produces the behaviour only when perceived behavioural control is strong. In practice, intentions and perceptions of behavioural control are often found to have main effects on behaviour, but no significant interaction." For the purposes of the current work, a behaviour or behavioural domain may be the adoption of a specific technology or farm management practice or the adoption of a set of technologies or farm management practices. Thus, we talk about adopting a new technology or (farm management) practice. Adopting a new practice is also sometimes referred to as "practice change".

Figure 1: Theory of Planned Behaviour



Source:(Ajzen, 1991)

78. Figure 1 depicts the TpB in the form of a structural diagram. The TpB extends the TORA by adding another component of perceived behavioural control which allows for situations where a person feels that the behaviour is not entirely under

their volition. In TpB the most immediate determinant of behaviour is intention. A stronger intention results in a higher probability of the behaviour occurring. There are three independent antecedents that collectively account for the total intention of a person to carry out a particular behaviour. Attitude towards the behaviour is predicted by the perceived outcomes of the behaviour and weighted by whether those outcomes are viewed positively or negatively by the decision-maker. The decision-maker may have many beliefs about the behaviour, but at a given moment only a few of these beliefs are accessible. Subjective norms are a person's perceived behavioural expectations of all important referent individuals such as a person's spouse, family, close friends and, depending on the specific behaviour, doctor, bank manager, etc. weighted by a motivation to comply with their views. Control beliefs are the perceived presence of factors that may facilitate or impede performance of the behaviour. Perceived behavioural control (PBC) refers to a person's perceptions of their ability to perform a given behaviour. This is calculated by aggregating each control belief weighted by their respective perceived power. Actual behavioural control is the actual amount of skills, resources and other factors that a person has available to them in order to carry out a particular behaviour. Perceived behavioural control is used as a proxy for actual behavioural control because it is more easily measured (Ajzen, 1991).

79. As an example, take a man who is considering reducing the amount of salt in his diet (the behaviour) in order to reduce his blood pressure level (the outcome). This man believes if he carries out this behaviour then his blood pressure will decline (behavioural belief). He would like to be healthier in order to carry out more activities with his family (positive attitude). His partner and children are strongly in favour of healthy eating so he perceives that they favour a lower salt intake (normative beliefs). This man has a strong desire to behave in a manner that his partner and children approve of (motivation to comply) so he has a positive subjective norm with regard to this behaviour. As this man chooses to add additional salt to all his meals (control beliefs) and given his determination (perceived power) he feels that he can lower his salt intake as it is within his perceived behavioural control. His actual behavioural control may be different as the food served in his work place canteen may have much added salt over which he has no control (actual behavioural control).

80. In an agricultural context a modification of the TpB was put forward by Defra as a conceptual approach to examine the behaviour of English farmers. This conceptual approach included additional components to account for roles (group behaviour), habit (measured by frequency of past behaviour) and external factors (market conditions, cost and policy interventions) (Pike, 2008). The Theory of Interpersonal Behaviour is an alternative behavioural approach that accounts for habitual decision-making (Triandis, 1977). This theory has been applied far less than TpB so there is much less research to draw upon.

81. A New Zealand farmer's decision to change a land use, or to adopt an environmental practice, is more likely to be an infrequent, strategic decision as opposed to a frequent, tactical decision. This project focuses on strategic decisions because potential failings of TpB are that much of our behaviour is habitual as opposed to planned, attitudes are salient and subjective norms fail to account for how behaviour may impact on a person's self-identity in groups that they are a member of (Armitage and Conner, 1999). In the example provided, the man may habitually add salt to all his meals without giving it any thought. His attitudes may change as he may decide food tastes nicer by adding salt. If his close group of friends define themselves by their hard living lifestyles then his self-identity within this group may be impacted by this new healthy behaviour, which would be at odds with his in-group norms.

4.3.2 Subjective norm

82. Subjective norm is the social norm (social pressure) – but rather than the 'real' social norm (i.e. what others in the peer group actually think), it represents how the decision-maker *thinks* others will assess his/her decision to perform or not perform a behaviour (Ajzen et al., 2004). This acknowledges that the agent is not able to know what others are actually thinking. The reason subjective norm was initially included in the TORA was that it recognises (unlike economic models) that individuals do not act independently of cultural/social influences but rather are generally concerned about what their peer group (friends, family, etc.) thinks[3]. Thus, whereas an individual may hold a positive attitude towards a particular behaviour, if peer pressure is strong enough they may not undertake the behaviour (e.g. Charng et al., 1988; Ajzen and Driver, 1992). The extent to which an individual is influenced by social pressure depends, to a large extent, on features of their personality (Ajzen and Fishbein, 1980; DeBono and Omoto, 1993).

83. Studies exploring the influence of others in decision-making have often concluded that farmers' decision-making is not influenced by their neighbouring farmers (e.g. Wilson, 1996; Battershill and Gilg, 1997) – however, Burton (2004a) attributes this to methodological problems in the way the farmers were approached. When farmers are asked whether they care what their neighbours think the majority (in an industry known for its pride and independence – Sullivan et al., 1996) will simply deny any influence. In one of the few studies where the TORA was implemented in its entirety (i.e. the subjective norm was correctly measured) Carr and Tait (1990: 228) concluded that "The most important sources of influence were those within the farming community itself or closely associated with it." Evidence from the field also points towards the peer group having a vital influence on decision-making as is indicated by, for example, a tendency to provide mutual assistance for some farm tasks (Mather & Thompson, 1995), over-investment in roadside fields and observation of neighbouring farms from the road (Higgins & Seabrook, 1986; Seabrook & Higgins, 1988; Burton et al., 2008) the use of farm-size, tenure system and husbandry practices as status symbols (Bell & Newby, 1974; Saunders et al., 1978) and purchase of equipment as status symbols (Goldstein & Eichhorn, 1961; Rogers, 1983; Higgins & Seabrook, 1986; Seabrook & Higgins, 1988).

84. In a meta-analysis of 185 studies that applied TpB, the weakest antecedent of intention was found to be the subjective norm (Armitage and Conner, 2001). Researchers have tried to incorporate group norms into the TpB to address this issue. For ABMs this suggests there is a need to include the influence of others on decision-making. A key factor to consider here is that, while attitude is seen to be the central construct around which behaviour is based, "the relative contributions of attitudes and subjective norms vary across behaviours and subject populations" (Ajzen, 2001: 48). Thus, the models should consider the variable influence of subjective norm both within the individual agents, and between sub-populations in the model.

85. To model the influence of others, ABMs could: attribute to farmer agents a tendency to be influenced by others or not in order to model the influence of personality, vary the influence of social norms depending on the stability of the community of farmers engaged in similar approaches to farming – the more change the lower the influence of subjective norm, and consider the influence of personal norms by increasing the likelihood that a farmer will be resistant to social pressure to change depending on the length of time they have been performing an activity –

[3] This could also be conceptualised in terms of the generation of alternative forms of capital as behaviours the peer groups disapprove of are likely to result in diminished cultural and social capital.

the longer they have been engaged, the less likely they will change under social pressure.

4.3.3 Self-identity

86. Identity also provides a frame of reference with which an individual can judge which actions or potential actions are socially appropriate (Burke & Reitzes, 1981) and is thus "all important as an influence on behaviour" (Johnston, 1991: 214). For example, in an agricultural context, self-identity has been said to define the components of appropriate farming practice (Seabrook & Higgins, 1988; Shucksmith, 1993) and thus has the ability to reduce the likelihood of change. For example, Rogers (1983: 223) contends that in the innovation diffusion literature, "many illustrations can be provided of how the incompatibility of an innovation with cultural values blocks its adoption" (also see Burton, 2004a). Within the identity groups exist the 'positional roles', or "behaviours characteristic of those sharing a commonly recognised identity or social position" (Biddle, 1979: 66).

87. Over the last 20 years the self-concept has become a central theme in the social psychology literature (Hales, 1985; Deschamps and Devos, 1998) and, accordingly, a number of conceptual frameworks for looking at behaviour now have identity at their core (e.g. social identity theory (SIT), Tajfel and Turner, 1979, Hogg and Abrams, 1988; identity theory, Stryker, 1994; cultural identity theory, Collier, 1998 and self-categorisation theory (SCT), Turner et al., 1987). In addition, researchers applying the TORA/TpB model have found that the addition of a self-identity variable can add significantly to the explanatory value of the model (e.g. Charng et al., 1988; Terry et al., 1999). However, as Burton & Wilson (2006) observe, while there are some exceptions – for example Seabrook & Higgins (1988) – and identity has also played a role in the widely used 'farming styles' approach (van der Ploeg, 1993; Howden & Vanclay, 2000; Vanclay et al., 2006), in general, little consideration has been given to self-identity directly. There are several relevant examples of the application of these theories in agriculture: research examining management of riparian zones in Australia extended TpB by incorporating core aspects of SIT. It was found that the behaviour of land holders who were high group identifiers was influenced by in-group behaviour whereas the behaviour of land holders who were low group identifiers was influenced by out-group as well as in-group behaviour (Fielding et al., 2008). In other examples, afforestation was found to be more common on part-time Irish farms (Farrelly, 2006), and participation in Agri-environmental schemes (AES) on British farms (Wilson, 1997), where the farmer consulted with their family about the decision, provide interesting parallels. This indicates that farmers who are possibly more loosely bound to farmer groups, due to off-farm employment and greater role given to their family, are more inclined to adopt different behaviours.

88. That farmers can differentiate different identity groups in farming has been noted in Higgins & Seabrook (1986) and Seabrook & Higgins' (1988) investigation into the role of farmers' self-concept in determining agricultural behaviour in the UK. They suggest, largely from participant observation, that "producers recognise a variety of sub-groups, defined by the behavioural patterns to which affiliation preferences are expressed," and that "this system of perceptions has the ability to reject change and reduce flexibility or to predispose individuals towards particular areas of change" (Higgins & Seabrook, 1986: 21). Their argument is backed up by references their participants make to alternative groups, strongly indicating that identity sub-cultures are recognised by the farming methods that typify the group. For example: "God help us, I'd do it if I had to [give up dairy farming] but I really do not want to become that sort of a bloke" (Higgins & Seabrook, 1986: 21) and, "George R. ..... has all these check lists, but of course he's a business man, he's not a proper

stockman [He then suggests that spending more time with the cows than the family qualifies him as a 'proper stockman']" (Seabrook & Higgins, 1988: 104). The ability of farmers to identify different social groups in agriculture is also one of the main theoretical premises behind the widely used 'farming styles' approach.

89. It seems doubtful that multiple self-identity should be directly included in ABMs. However, this section does emphasise the importance of incorporating a measure of social pressure into the models. In addition, because identity represents an internalised peer group, if social pressure is modelled 'identity' should be included as a form of peer (self) pressure. This becomes important in situations where the peer group has disappeared (generally for older farmers) and is replaced by another with different social norms. In this case, if the self-identity is strong, self-esteem may be obtained by comparison with the internalised norms (regardless of what other farmers think)[4]. This represents older farmers who are 'stuck in their ways'.

4.4 Farmer behavioural typologies

90. Previous sections have outlined factors that may influence decision-making on the farm. With agent-based models, however, a critical factor in the success of the model is to be able to model the behaviour of individual farmers operating within the farming system – and this adds a completely new level of complexity to the situation. In order to grasp that complexity, many ABMs develop typologies of farm managers to model the heterogeneity in the population. For example, in the FEARLUS model, farmers are divided into "subpopulations" which represent types of land managers. For modelling purposes, each subpopulation has a particular algorithm associated with it which will govern its behaviour within the model (e.g. Cioffi-Revilla & Gotts, 2003). Getting the classification of these subpopulations correct is therefore a very important part of developing effective agent based models. This section specifically explores the literature on farm/farmer typologies in order to examine their construction and identify appropriate classification schemes that might apply in the New Zealand context.

91. Classifying people into groups in order to understand behaviour is not a new concept. Sachs (1973) for example, observes how Schumpter (1926 – cited in Sachs, 1973) produced a classification of entrepreneur activity early in the 20th Century. That it is a useful tool is evident from the long-standing use of typologies within the European Union which devised an economically based farm typology for agricultural holdings in 1985 (EEC, 1985) based on the production type weighted by the standard gross margin. The main reason for constructing farmer typologies (and typologies in general) is that they provide a means of presenting and understanding features of a multivariate distribution, i.e. where the contributing factors are complex, typologies can identify patterns or 'types' in the data (Ilbery, 1981). Thus, they enable the researcher (and others) to explore possible development paths through the creation of ideal types (e.g. Daskalopoulou & Petrou, 2002; Evans, 2009) and enable farmers to be located within wider systems of social stratification (Whatmore et al., 1987a, b). This asserts, as (O'Brian, 2005) suggests, that variable centred approaches focusing on the examination of differences between individuals are incorrectly based on the assumption that the same processes apply to all individuals – whereas a typology is able to identify subgroups of individuals that differ from one another in important ways.

92. Evans (2009) observes that typologies of farm trajectories (business development paths) can be interpreted as a reaction against the difficulties of undertaking macro-

[4] "Internalised norms" have been considered to influence decision-making in other studies, for example, Terry et al. (1999) and Friedkin (2001)

level analysis, i.e. addressing 'a need for a middle-order theorizing that builds on existing work but establishes concepts that are more readily investigated empirically' (Moran et al., 1993: 38 – cited in Evans, 2009). Further, he believes that to obtain a coherent picture of agricultural restructuring requires the linking of "multiple aspects of business change rather than through analysis of an individual element or simple bivariate comparison (for example, looking simplistically at the influence of farm size over on-farm diversification)." (219) A common use of typologies in agricultural studies is as a means of integrating attitudinal factors with structural (and economic) components to identify groups with observable differences in management styles (Austin et al., 1996). The inclusion of socio-psychological factors, in particular, is important for agent based-modelling as land use decisions are dependent on farmers' attitudes such as their views on expansion, diversification and conservation. At the same time, structural factors are important in the typology as they relate to the farmers' ability to carry out an action (Valbuena et al., 2008 – also see Siebert et al, 2006) and the family life-cycle, as discussed, provides considerable impetus for behaviour.

93. Farmer typologies are therefore a tool used by agricultural scientists and policy makers to meaningfully categorise farmers. As explained above, typologies help to simplify complexity, account for heterogeneity in agriculture and help policy makers target measures towards particular farms/farmers. It is assumed that there is a greater likelihood of communication and imitation among like-minded agents (Schmit and Rounsevell, 2006). Behavioural typologies allow an ABM to accommodate the heterogeneity in agent decision-making (Acosta-Michlik and Espaldon, 2008). The creation of accurate behavioural typologies is extremely problematic, as Burton (2004a) states 'If the typology bears little relation to behaviour, how relevant is the typology?' The empirical practise of creating behavioural typologies has much overlap with identity theories such as SIT and SCT.

94. A key point to note here is that, regardless of how carefully a classification is constructed, the criteria used to construct it are initially chosen subjectively by the researcher. Thus, while some have claimed otherwise (e.g. Fairweather & Klonsky, 2007) a typology does not reflect real (i.e. directly identifiable to the farmers themselves) decision-making or behavioural groups but rather is a tool to understand behaviour with a given theoretical framework and set of research questions. Further, as the choice of variables and the final number of classified groups are based on subjective decisions, no classification is objective (Ilbery, 1981) – there is no single 'correct' typology of farmers. A final point is that most typologies are very much simplified representations of the diversity of structure and management – ranging between three and six categories. One of the most comprehensive studies in the literature conducted on the small island of Reunion estimated that 26 'types' were required to represent the overall diversity of livestock effluent management situations (Aubry et al., 2006). When one considers that this typology covers only one aspect of farming (effluent management) over a small geographical area it is clear that comprehensive, detailed typologies covering all aspects of farm management are likely to be very much an exception (if they exist at all).

4.4.1 Static typology types

95. There are four distinct typological approaches for farmers that have relevance for implementation within an agent-based model that we discuss in this document: *farming sector, farming attribute, production process, and life-stage*. Each of these approaches has advantages and disadvantages, and they can also be used in

combination. They all improve upon a single rational profit-maximiser perspective that is still used in a range of agricultural simulation models and economic models.

96. A typology based on *farming sector* at its most basic level in New Zealand would most likely include Sheep, Beef, Dairy, Forestry, Horticulture and mixed Sheep & Beef. Such a typology might be used for prediction of future system change. The most widely applied farmer typology in the world is the community typology of agricultural holdings used by all 27 EU member states. This typology is based on a combination of farming type, economic size of farm measured by standard output and the level of farm household income from other gainful activity (Hennessy et al., 2011). Farming sector typologies are more appropriate in a land use modelling system where human behaviour is not modelled directly.

97. *Farming attribute* typologies are mainly based on physical farming characteristics such as farm size, family structure and land capability (i.e. the New Zealand Land Use Capability classification – LUC). They can be used to differentiate farmer types because physical attributes significantly contribute to the potential behaviour of the farmer and their family. O'Rourke (2012) used variables relating farming intensity, farming continuity and extent of semi natural vegetation to create a typology of sheep farmers in the biodiversity rich Iveragh uplands in Ireland. The purpose of these typologies was to enable the delivery of more targeted policy (O'Rourke et al., 2012).

98. Typologies using *production process* combine social and physical characteristics, and aim to capture differentiated stages within the farming process and the behaviours that are associated with these stages. A farmer typology of this nature was created for the Mertola municipality in Portugal. The following variables were used to create four typologies: farmer's age and level of education, property size, distance from residence, and the number of animals owned. The typologies created were active, innovative, old and absentee. As a validation each field in the municipality was linked to a particular typology. Using cadastral information to control for slope, remoteness, aspect and soil quality the links between the farmer typologies and historical land use changes, including afforestation, abandonment and restoration of the traditional Montado system were examined. This study can be used as an example of successful validation of typologies at a regional level. The study found strong links between the farmer typologies defined by the study with cadastral information and observed land use changes. This research was successful in understanding how different typologies are likely to select alternative land use changes when given land with comparable features (Bakker and van Doorn, 2009).

99. Another application of a *production process* typology was undertaken for farmers in the Northern Philippines. Acosta-Michlik & Espaldon (2008) identified four types of farmers who were associated with the intensity of the farming operation; traditional, subsistence, diversified, and commercial. Using these typologies an agent-based model was built to examine the vulnerability of farmers to climate change and evaluate a range of adaptation options to minimise their vulnerability to climatic and market risks (Acosta-Michlik and Espaldon, 2008).

100. In some respects, these three typologies are mainly *static*. Farmers are represented as static agents who are compartmentalised from the changes that are occurring in and around them. That is not to say that the agents are unable to change and move between types, but is not clear how agents can transition between them.

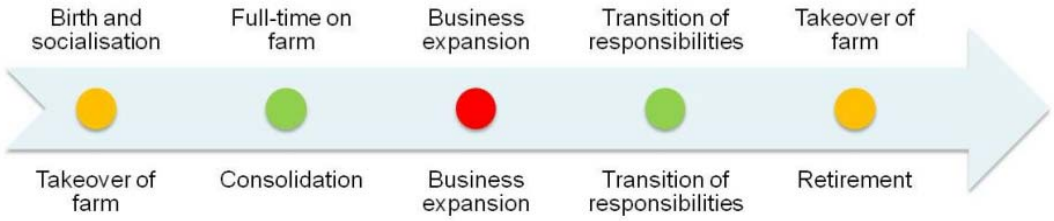
4.4.2 The life-cycle stage typology

101. One of the more recent and promising applications of farmer typologies is the move towards capturing the *life-cycle stage* of the farmer. This is an interesting approach as it starts to capture the aspect of 'time' for the agent and its interactions and

implicitly incorporates the role and importance of time within the land use change system. Burton (In press) in his recent review of these types of approaches, mentions that farmers are bounded by the explicitly time-focused process of succession.

102. In recognizing that farm decision-making varies throughout their life-span as farmers' objectives in agriculture change, fixing a set of 'characteristics' to a single farming agent within the ABM throughout the 'life-span' may create problems. It is, therefore, desirable to introduce dynamic typologies in an ABM as an improvement on static typologies. Burton's life-cycle stage typology has been designed for that purpose. Figure 2 depicts the likely life cycle stages that a farm transitions through. From an analysis of typological literature Burton created the following farmer typologies incorporating this temporal flexibility; "hobby farms, semi-retired farms, persisting farms, transitional farms, diversified farms (expansionist and non-expansionist), large capitalist farms and corporate farms" (Burton, In Press).

Figure 2: Stages of farm family life cycle



Source: (Burton, In Press)

103. There are several implications of the implementation of this typology in agent based models: As, after a certain stage (where it is accepted that succession will not occur), the behaviour of farmers with successors is likely to differ from those without successors, this should be modelled as a key 'decision-point' for farmers. Those with successors should follow a trajectory of attempting to grow the business through intensification, expansion or diversification, and those without should begin the process of decreasing the intensity of land use. The trajectory of a farm can therefore change from withdrawal to business expansion with the arrival of a successor. Where a successor is included within the model, a farm on a trajectory of withdrawal may suddenly change to follow an aggressive expansion strategy. Similarly, an expanding farm that appears to be on an ever upward trajectory may begin to decrease its emphasis on business growth if no successor is present. Whether succession occurs or not (the decision-point) will, in part, depend on the success of the business to that point. A more successful business is more likely to attract a successor. The smallest businesses are unlikely to attract successors. Additionally, change in land use (typically attributable to age factors) is more likely to occur in farms at points where a new successor has taken over the farm, a new land manager has taken over the farm with the retirement of the older farmer, and the farmer confirms the availability of a successor. The presence of a successor, or even the possibility of succession, increases the planning horizon of the farm. Finally, the birth of a potential successor may lead to increased vigour on the farm as the farmer attempts to make the farm attractive for succession and provide opportunities for the successor to work on the farm.

4.4.3 Further considerations for typology definition

104. *Non-farming income – diversification & pluriactivity*. Off-farm income is an important factor affecting the farming sector. The OECD estimates that between 30-50% of New Zealand farms households have non-agricultural employment (OECD, 2009). In Ireland, in 2006, 57.9% of all farm households had off-farm employment. This declined to 49.5% of all farm households in 2011. In 2006, 41.7% of all farm operators specifically held off-farm employment, whereas by 2011 this declined to 31.8% (Connolly et al., 2006, Hennessy et al., 2011). Some research has found important differences in behaviour between part-time and full-time farmers. For instance, part-time farmers in Ireland are more likely to establish forestry on some of their farm land (Collier et al., 2002, Hannan and Commins, 1993), and where the farm operator works off-farm they are found less likely to invest in machinery and on farm investment in general. When the farmer operator's spouse has an off-farm income there are no changes in investment in machinery, but there is an increase in on-farm investment in general (Hennessy and O'Brien, 2007). If this finding were to carry through to New Zealand, farmer typologies might also be impacted by the availability of non-agricultural employment. An analysis of non-agricultural employment was carried out on 60 farm families in the Ashburton district, New Zealand in 2003. The motivations for seeking off-farm employment were complex and economic necessity alone was not the only driver (Taylor and McClintock, 2004). Other studies in a variety of contexts show younger farmers are more likely to look for work off the farm (e.g. Benjamin et al., 1996; Ahituv & Kimhi, 2002) and engage in on-farm diversification (e.g. Ilbery, 1988; Altman et al., 1998).

105. *Regional differences*. Defra created a segmentation analysis of English farmers where the farmers were placed along a continuum, as opposed to belonging to one defined typology (Pike, 2008). The five segments were loosely defined as "custodians, lifestyle choice, pragmatists, modern family business, challenged enterprises". Research by Wilson showed that farmers often linked to multiple segments and moved between segments according to the life cycle stage of their farm family (Wilson et al., 2013). This finding by Wilson further supports the creation of a more dynamic typology as proposed by Burton, while underlying the difficulties in grouping farmers according to their likely cognitive strategies.

106. *Diffusion of Innovation Theory*. Rogers (1983) seminal work on diffusion of innovation theory was developed to explain how an innovation (e.g., new idea, new product or new behaviour) spreads (i.e., diffuses and is adopted) through a given social system over time. Adoption of an innovation does not occur simultaneously throughout the system but rather tends to start out slowly, gather momentum, and then taper off at saturation; it follows an S-shaped curve. Rogers identified five idealised categories of innovators along a continuum that form a network in a locality. The categories were defined by the time stage that a person adopted an innovation. The categories were innovators, early adopters, early majority, late majority and laggards. The innovators were typically cosmopolite, venturesome, financially well resourced, had good cognitive ability, less attached to local networks and the most influenced by mass media communication of all the five types. At the other end of the spectrum the laggards were considered to be the most localised, only influenced by interpersonal communication from similar minded individuals, bound to tradition, and the most risk averse. Rogers identified how these categories were all influenced in different ways to adopt an innovation. This further supports the concept of using typologies in an ABM that makes allowance for agents' inherent behavioural heterogeneity. A study used to illustrate how typologies have different communication influences was the diffusion of a novel method to teach maths among teachers in Pittsburgh from 1958 to 1963. The first

maths teacher to adopt this method was largely isolated from the other maths teachers. The innovation diffused among the other 38 maths teachers only once 6 opinion leaders, among the maths teachers, adopted the innovation (Carlson, 1965). This example is used to show how individuals loosely bound to their local network are often necessary to introduce an innovation, but its subsequent diffusion in the following innovator categories is dependent on interpersonal communication among peers within the network. The early adopter is the role model and opinion leader within a network. Many diffusion policies try to target the early adopter to champion a new innovation.

107. *Social Learning theory*. Rogers identified Social Learning Theory (SLT) (Bandura, 1977) as having much in common with his innovation diffusion framework, as learning occurs via information exchange between individuals through network links. SLT postulates that a person can learn simply by observing another person's (the modeller) activities even without a verbal exchange of information, but often the two are combined. The observer then performs a similar activity using information gathered from the model (Rogers, 1983). Television and internet are media that facilitate observation. An example of SLT theory is the tendency of non-native English speakers to use American word pronunciations if they were largely exposed to English speaking via television and movies originating in America.

4.5 Farmer decision-making

108. Edwards-Jones (2006) carried out a review of research into farmer decision-making. Factors shown to have an influence on farmer decisions were grouped into the following categories:

- Farmer characteristics (Socio-demographics and psychological)
- Farm household
- Farm structure
- Social milieu
- Characteristics of the innovation to be adopted

109. The current review of agricultural decision-making research will use the same categories identified by Edwards-Jones followed by a brief summary section. Pannell et al. (2006) examined the adoption of conservation practices by Australian rural land holders. The typical process by which a land holder considers an innovation was identified by Pannell et al. (2006) as;

- Awareness of problem or opportunity
- Non trial evaluation
- Trial evaluation
- Adoption
- Review and modification
- Non adoption

Research by Pannel et al. (2006) and further developed by Greiner et al. (Greiner et al., 2009) surmised that "*Farmers adopt an innovation if they expect that the practice will help them achieve their goals, which may include economic, social and environmental goals.*"

4.6 Farmer characteristics

110. Research has identified many farmer characteristics that impact upon their management decisions, including financial and environmental.

4.6.1 Education

111. One of the most frequently explored human capital factors contributing to farmer decision-making is the formal educational level of the farmer. Levels of education in the farming community are increasing as farmers decreasingly derive their knowledge from lived experience and more from training and education (Morris, 2006). It is seen as an indicator of decision-making for two key reasons. First, it is widely believed that education increases the quality of the human capital (Defrancesco et al., 2008) and, consequently, higher education results in better decision-making and more effective farm management. Second, education increases the breadth of knowledge the farmer has and, as a consequence, the farmer simply has more options that appear open to him/her – particularly as far as diversifying the farm business is concerned (Kerridge, 1978 – cited in Ondersteijn et al., 2003; Chaplin et al., 2004). While this can work to support the farm by opening up new options, it can also contribute to a lack of commitment to the farm if farmers move towards the off-farm opportunities (Coughenour, 1995) or introduce new ideas about farm management such as the need for conservation or organic farming.

112. One of the key areas in which education is said to influence farmers' decision-making is in terms of their relationship with the environment. A number of European studies have demonstrated a relationship between entry into environmental schemes and the education level of the farmer (e.g. Falconer, 2000; Wilson & Hart, 2001; Lambert et al., 2007). Relationships have also been found with more farm oriented conservation measures. Kessler (2006) in a South American study showed a significant correlation between educational level and soil and water conservation investments (Kessler, 2006) and Jay (2005) in a New Zealand study, found that education affected the likelihood of farmers adopting environmental and sustainability practices. Education levels have been found to be important in the uptake of "management intensive" conservation technologies in the United States (Saltiel et al., 1994).

113. There are a number of theories as to why education is likely to influence environmental decision-making. One suggestion is that education serves as a general indicator for human capital (Wilson, 1996) with those with higher levels of education also being those with higher levels of human capital (specifically cultural capital – Bourdieu, 1983) – and therefore being more likely to engage in such schemes. This is based on the implicit assumption in many studies that environmental or sustainability decision-making is the 'smart' option and thus education, through teaching this perspective, increases the likelihood that the 'smart' option will be chosen. For example, Wilson & Hart (2001) suggest that education helps farmers develop conservation-oriented attitudes and, therefore, increases the participation in such schemes. The assumption may be aided by studies showing that farmers with higher levels of educational qualification are more likely to be members of environmental organisations than those with lower qualifications (e.g. Beedell & Rehman, 1999).

114. The second suggestion is that education is of more assistance in the administrative process of conservation activities. Pfeifer et al. (2009) for example, found that higher education levels increased the probability of uptake of 'green services' (such as landscape, biodiversity and wildlife habitat maintenance). In this case, however, the authors suggest that education helps farmers in terms of providing the knowledge required to understand the administrative process and sign a contract with the government. If this is the major impact of education this suggests that education is likely to have less impact in New Zealand than in European countries where the government is more heavily engaged in environmental policies and

practices. However, if new schemes are put in place to deal with issues such as carbon trading and nitrogen caps, and education is important for administrative and contractual reasons, then education could play an important role in determining the rate of change.

115. A third explanation is that education assists farmers to obtain and understand information about environmental and conservation issues, for example, through showing a significantly higher ability to identify species of conservation value (O'Leary et al., 2000). Traore et al. (1998) – in finding a positive relationship between education and adoption of soil conservation measures – suggest that higher educational levels should be associated with the probability that farmers recognise environmental damage on their farm and thereby adopt practices to conserve water and soil quality. Similarly, Dupraz et al. (2000 – cited in Vanslembrouck et al., 2002) suggest that farmers' likelihood of adoption of extensive field margin management resulted from a greater understanding of the utility of the measure as a result of their education level. In addition to having a greater understanding of the pros and cons of different management practices, Bakker & van Doorn (2008) also suggest that farmers with higher education levels are likely to be more informed about government policies. In their case they were referring to government subsidy schemes – however, this could equally apply to a greater understanding of regulatory requirements that might be put in place in carbon trading or nitrogen caps.

116. A meta-analysis of research concerning adoption of best management practices by farmers in the USA found that the type of education delivered was also important. Targeted extension training was found to be very effective, whereas, formal education was found to be insignificant. Using networks to implement extension education was proposed as a potential improvement on existing methods (Baumgart-Getz et al., 2012). Research examining which information sources had the greatest influence on British farmers with regard to bovine tuberculosis had similar findings. Farmers were far more influenced by information conveyed to them by their private vet as opposed to government officials. This was attributed to the longevity, the consistency of information and the frequency of contact between a farmer and their private vet, which lead to a higher amount of trust (Fisher, 2013).

117. If education changes are modelled in ABMs, two pathways could be modelled consisting of agricultural education (which may have the impact of increasing the intensity of farming, managerial efficiency, etc.) and general education (which broadens the experience, may affect environmental attitudes and increases likelihood of diversifying away from production). However, the effect of education on environmental decision-making should not be modelled as a simple correlative relationship (e.g. more educated farmers are likely to engage in environmental programs) as other factors such as the age or life-cycle stage of the farmer can override the influence of education.

4.6.2 Age

118. The age of the principal decision-maker (the usually male person who exerts the financial and managerial control over the farm unit – Morris and Evans, 2004) is known to have a strong influence over strategic decision-making as it provides important information concerning the social dimensions of the farm and therefore for farm management strategies (Thenail, 2002). Age has been associated with farm structural and managerial features as diverse as debt levels, financial sophistication, commitment to farming, contact with agents, risk averseness, engagement with forestry, farming ideology and attitudes, on-farm pluriactivity, response to policy, record keeping, size of farming operation and education (e.g. Wolpert, 1964; Flinn and Johnson, 1974; Gasson and Hill, 1990; Ward and Lowe, 1994; Coughenour,

1995; Battershill and Gilg, 1996; Grant and Macnamara, 1996; Lewis, 1998; Walford, 2002; Roberts *et al*., 2002; Lobley and Potter, 2004; Kristensen *et al*., 2004).

119. However, while many studies have found age to be an important driver of decision-making, the evidence in the literature is not conclusive. Rougoor *et al*. (1998: 268) reviewed personal aspects responsible for farmers' management decisions and concluded the influence of age is not straightforward as while "biographical aspects can affect farm results, technically as well as financially, the results are diffuse, sometimes an effect is found, sometimes it is not." This difference in results is not determined simply by the farm structure or management feature concerned. For example, while it is commonly perceived that younger farmers are more likely to diversify production on the farm (e.g. Halliday, 1989; Kelly and Ilbery, 1995), others have found no relationship (e.g. Damianos and Skuras, 1996; Ondersteijn *et al*., 2003).

120. A considerable number of studies have examined the relationship between age and environmental stewardship. Results suggest that, in general, younger (and more educated) farmers are more likely to undertake environmental enhancements than older farmers (e.g. Siebert et al., 2006). However, this is again not a simple relationship. In Belgium, younger farmers were more inclined to join agri-environmental schemes than older farmers (Vanslembrouck et al., 2002), in Ireland, attitudes to afforestation were more positive among young people (Clinch, 1999), in Britain, participation in AES was not correlated with farmer age. However, younger farmers were found to select less profitable components of AES than older farmers indicating that younger farmers are more conservation orientated, whereas, older farmers possibly view AES as an income source (Wilson, 1997)

121. In a New Zealand context Jay (2005: 18) notes that age plays a role in the likelihood of farmers adopting environmental and sustainability practices and suggests a relationship between age and the presence of native bush on the farm, noting:

> "As farmers get older, up to the 45–54-year-old age category, they are more and more likely to report bush on their farm, but there is an abrupt drop among farmers in the 55–64-year- old age group who are least likely to report bush (apart from two in the 60-plus age group)."

122. One of the commonly given reasons for younger farmers being more conservation oriented (based largely on unsophisticated correlative evidence) is that the environmental attitudes of younger farmers are different to older farmers as a result of changes in social paradigm towards a more environmentalist perspective. As Brodt et al. (2005) observe. "It is also almost a cliché that younger farmers have grown up in an era of heightened environmental concern and therefore may be more likely to take a stewardship approach to farming."

123. This 'cliché' is drawn, in a large part, from the productivist – post-productivist literature that dominated the discourse during the 1990s. A number of researchers attributed older farmers' 'productivist' attitudes to the post-war agricultural era where increasing production was emphasised (both rhetorically and through agricultural policy). Thus older farmers were thought to have been socialised to view increasing production, intensification, technological development and so on as typical of "good farming" – leaving them with a more 'productivist' ideology than their younger counterparts (Ward & Lowe, 1994; Wilson, 2001).

4.6.3 Behavioural beliefs and moral obligations

124. In Europe, farmers who doubt that environmental measures will cause an environmental improvement are less likely to participate in AES and to incorporate environmental practices into their farming (Mettepenningen et al., 2013, Vanslembrouck et al., 2002, Lankester et al., 2009, Beedell and Rehman, 1999). Research exploring adoption of best management practices by farmers in USA advised that information concerning pollution from agriculture should be made farm specific. By making farmers aware of likely pollution resulting from their own farm activities as opposed to agriculture in general it becomes more persuasive (Baumgart-Getz et al., 2012).

125. Moral obligation has been incorporated within the TORA/TpB model in order to explore its implications for behaviours where there may be a moral imperative to perform or not perform the behaviour (e.g. environmental behaviour – Beedell & Rehman, 2000). Thus, there are situations where the individual's attitudes may be put aside in favour of their beliefs about the morality (or immorality) of the act.

126. Studies have suggested that environmental concern has a strong moral component (Villa, 1999; Corralliza & Berenguer, 2000; Schultz & Tabanico, 2007) as does the moral obligation to one's family (Haugen, 1998). Thus, in these areas, moral obligation may have some influence over farmers' decision-making. In one of the few studies that looked at the influence of morality on farm decision-making, Beedell & Rehman (2000) found that moral obligation was influencing farmers' environmental behaviours and, furthermore, that the 'moral obligation' component of their model appeared to be assessing something different to the subjective norm.

127. What this suggests is that ABMs could include a component to cover the perceived moral cost of making particular decisions – particularly with respect to the environment. For example, a value could be attributed to public concern for the environment and farmers' likelihood of compliance increased the stronger the moral pressure. Decisions taken to decrease contributions to global warming could well come into this category, i.e. farmers may not completely agree with it and may hold contradictory attitudes, but feel the moral pressure to take action.

128. Including moral obligation in the ABMs may therefore be important where policy measures are implemented in order to try to achieve public goods (e.g. nutrient limits). This will depend on the perceived importance of the issue and the level to which it is perceived as a moral issue (i.e. is associated with higher order values concerning what is morally right and wrong).

4.6.4 Attitudes

129. Studies have shown that a farmer's attitude can have a bearing on their management decisions. Australian graziers with a strong conservation and lifestyle motivation were more likely to adopt best management conservation practices. Graziers who were strongly economically motivated required external incentives to adopt best management conservation practices (Greiner and Gregg, 2011). Irish research has found that farmers who believed the natural Irish landscape is either partially or substantially forested were 14.2 times more likely to establish forestry than farmers who disagreed with this belief (Howley et al., 2012).

4.6.5 Risk

130. Adoption of best management conservation practices in Australia was found to be strongly predicated by Graziers' perceptions of risk. Graziers found to take higher

market and production risks were found to be more likely to adopt best management conservation practises (Greiner and Gregg, 2011).

4.6.6 Experience

131. Farmers are known from a number of studies to place considerable emphasis on the value of experience in terms of decision-making. As Fazy et al. (2006: 1) suggest – "experiential knowledge will always play a role in decision-making". This 'experience' with how the natural environment behaves in different circumstances on their farm (e.g. natural climatic and economic variability) and fluctuations in returns for produce is often used to contest the 'codified' knowledge of experts (Morris, 2006). Thus, in a sense, experience can act as a counter-balance to the codified forms of knowledge provided by education. In fact, as Errington (1986: 302) suggests, it is experience based knowledge – defined as "the store of past perceptions accumulated over a lifetime" – that leads to decisions being seen as 'instinctive', i.e. experience can lead farmers to not employ cognitive reasoning in decision-making but go on experience based 'instinct'. Similarly, Fountas et al. (2006: 194) suggest that 'intuition' is a result of experience with a particular farm and notes that while it may be impossible to adequately model intuition it "needs to be accommodated in any comprehensive model of the decision-making process." Thus, whereas education provides (in many cases) new knowledge that pushes farmers in new directions, experience often contributes towards maintenance of the status quo. Mather (1992), for example, observes that experience represents to some extent the past legacy of land use and, when combined with the legacy of buildings that also lead the farm in a particular direction (e.g. the presence of a milking shed), increases the likelihood that the historical land use will continue.

132. There are a number of ways in which experience influences the likely decision choice of the farmer. First, experience increases perceived behavioural control (lowers the perceived risk) – which in turn leads to an increased likelihood that an individual will attempt to undertake a particular behaviour (see the Theory of Planned Behaviour – Ajzen, 1991). Second, the greater the experience the more skill and knowledge the farmer builds up in the activity. This build-up in knowledge and skill gives the farmer a competitive advantage and therefore has an economic value (Garforth et al., 2003). In addition, it provides farmers with social status within the community leading to the build-up of social capital that can also be converted to economic capital through the assistance of others (Burton et al., 2008). In addition, positive experiences that lead to farmers' obtaining social status contribute to the generation of self-esteem and self-identity (see Burton, 2004a) – making attitudes associated with experience more motivationally important than others (Coughenour, 1980) and therefore more likely to be used in decision-making.

133. As a result of the social and economic benefits that build up over a prolonged period of role performance, studies have suggested that the more experience farmers have with a particular type of farming, the less likely they are to change away from it (e.g. Siebert et al., 2006; Atari et al., 2009) and, conversely, the more experience they have with alternative forms of agriculture (or forestry – e.g. Scambler, 1989) the more likely they are to move away from conventional agriculture.

134. Experience in agriculture has been found to influence conservation behaviour. In particular, Atari et al. (2009) divided farming experience into three categories and conducted a test of association with years of experience in agriculture and conservation scheme participation. The authors found that farmers with a moderate level of experience were more likely to participate in the program than farmers with high levels of experience and, in contrast, those with low levels of experience were

less likely to participate in the scheme than those with moderate experience. While the authors claim these results suggest a relationship between experience and scheme participation, causality in the study was not explored adequately. In fact, Atari et al.'s (2009) findings appear more in keeping with what would be expected from a measure of the life-cycle of the farm, rather than the influence of experience in decreasing the likelihood of change (as discussed above). Brodt et al.'s (2005) finding that 'production maximisers' were likely to have more experience in agriculture than 'environmental stewards' (over 10 years' experience) also suggests that there is a relationship but, again, the analysis was not correlative and it does not exclude the possibility of a similar finding to that of Atari et al. (2009). Other studies that have regarded experience as a simple correlative relationship (i.e. not divided it into age groups based on stage of life-cycle) have found no difference between level of experience and engagement in conservation measures, i.e. "Farming experience (EXPER) and the size of the operation (AREA) do not affect the adoption of conservation practices." (Traore et al., 1998: 123)

135. Whereas the main impact on ABMs of a general education is to increase the likelihood of change, the impact of experience is to encourage the maintenance of the historical status quo. Thus, if ABMs are to account for experience, there should be a negative relationship between the length of time an activity is undertaken combined with the relative success of that activity (to neighbours), and the likelihood of change in land use. However, caution is advised if 'experience' is to be incorporated into the model as the 'life-cycle' of the farm may also be indicated by the years spent in farming or performing a particular behaviour. As a general rule, the life-cycle component should be of primary importance, with experience forming a secondary influence on decision-making (e.g. when an older farmer without a successor is seeking to wind the farm down, years of experience in intensive agriculture will not contribute as strongly to status quo decision-making as for a middle-aged farmer with a potential successor). If experience is used, it should be commodity specific (e.g. experience with dairy cattle) rather than generic (i.e. experience in agriculture).

4.6.7 Income from pluriactivity/non-agricultural diversification

136. Diversification refers to the adoption of income-earning activities outside the range of conventional crop and livestock enterprises associated with agriculture and involves a diversion of resources (land, labour and capital) which were previously committed to conventional farming activities (Ilbery, 1991). There are two key types of diversification (pluriactivity): on-farm agricultural and non-agricultural activities (self-employment) and off-farm activities, which are generally pursued in the labour market (de Vries, 1993). While both contribute to the total income of the farm, there is a difference between income derived by off-farm employment and on-farm diversification. First, in terms of the likelihood that households will engage in the two forms – whereas off-farm diversification is often in order to support the farm (to make ends meet), McNally (2001: 254) found that most on-farm diversifiers had higher than average net incomes. The author further found that farmers who were expecting relatively low profits in any one year are more likely to diversify and concludes that "although, in general, diversification activities do not contribute greatly to farm income, they might provide a buffer in years of relatively low returns for agricultural production. In this way, diversification is a strategy to spread risk."

137. Second, while on-farm diversification increases the resilience of the farm, off-farm income may (or may not) decrease the likelihood that the farm survives. The reason for this is that, while both add to profitability, if off-farm income becomes sufficiently larger than the income generated on the farm it exerts a pulling force on

any exit decision. Bragg & Dalton (2004: 3096) estimate for dairy farmers in the US that "When off-farm income begins to dominate on-farm income, the probability that the producer will exit increases by nearly 5 times." However, this should not be regarded as a simple relationship. Parker et al. (2007) observed (again in the US) that the percentage of income derived from off-farm sources increased as farm size increased. In a similar observation, de Vries (1993: 200) observes that some 'highly professional farmers' engage in off-farm activities primarily because of a "desire to participate in a variety of social contexts and to make themselves useful in political and administrative functions" which he terms *horizon enlarging pluriactivity*. In this case, the time spent generating off-farm income is not competing with time spent on the farm, but rather is part of a diversified (or entrepreneurial) business strategy where a manager or other family member is farming the land.

138. Bowler et al. (1996) suggest from their study into diversification in the UK that there are in fact two key groups of diversifiers – those where the income from the diversification constitutes less than 10% of the farm profits, and those where the diversification contributes over 60% of farm profits, with farmers who take on roles such as food processing and retailing tending to be in the higher group. Given that diversification takes time away from the farming role, it may be that 10% is a figure that can be easily sustained while continuing to farm full-time (e.g. through the spouse's labour) – whereas to make a serious attempt at the diversification enterprise requires a substantially higher commitment of farm resources. When considering diversification the MAS may be best off to model these as two distinct groups (see Chapter 6).

139. While in the past off-farm income in New Zealand has been of little concern, pluriactivity of farm households is becoming a more important issue. Le Heron & Roche (1999) indicate that even back in the early 1990s off-farm activity by farm household members was increasing (also see Johnsen, 2004; Smith et al., 2007). While the figure is likely to fluctuate considerably with market changes, a MAF survey of the 1992 – 1993 season showed that off-farm contributions to total disposable farm income amounted to 37% for dairying, 65% for sheep and beef farms, 69% for kiwifruit orchards and 90% for pipfruit orchards (LeHeron & Roche, 1999). Smith et al. (2007) observe for North Island hill farms that it is the smallest farms that are most reliant on off-farm income sources. The impact of off-farm income on the farm is likely to be greatest when commodity prices are low and the farmer is dependent on a single product (e.g. sheep). In this situation, off-farm income can contribute the bulk of the disposable farm income and thus effectively maintain the family on the farm. Recently concern has also been expressed that New Zealand farmers and agricultural industries need to think more about adding value to agricultural products rather than being simply suppliers of bulk agricultural produce (Campbell et al., in press). Thus, diversification also has the potential for adding value to the farm enterprise rather than simply acting as insurance against low prices.

140. There are several implications for taking diversification and pluriactivity into considerations into ABMs: when off-farm income is significantly greater than income generated on the farm, the likelihood that the farmer will exit farming is increased. Thus, ABMs could incorporate a trigger point based on the percentage of income derived from off-farm sources. On-farm diversification may be more likely for newer entrants to agriculture. Diversification of agricultural production may become more common, in response to increased drought (e.g. as is predicted for the east coast of the South Island – IPCC, 2001), as it adds resilience to the system.

4.6.8 Level of debt

141. As with many issues there is a connection between debt and the family structure (stage of life cycle, succession, farmer age) with debt being closely related to borrowing capital to ensure succession (Potter & Lobley, 1992). In addition, the succession of the farm itself can create debt issues where the farmer who assumes control is obliged to make arrangements to buy out siblings (Winkler, 1991; Svendsen, 2003). Meyer & Lobao (1997: 207) found that "Family operated commercial farms are less able to handle high debt loads and younger, more highly leveraged farm households were particularly vulnerable."

142. Debt can be simply incorporated into the income equation (e.g. Caskie et al., 2001) as it represents a flow of capital out of the farm accounts. Consequently, it has similar impacts on decision-making as income. It makes farmers more risk averse (Patrick et al., 1981: P245) and the fear of debt influences some farmers' decisions to engage in new land uses where large capital investments are required, for example, conversion to organic farming (Milestad & Hadatsch, 2003). Best management practices were found to be more likely to be adopted by farmers in the USA who had more capital (Baumgart-Getz et al., 2012). Essentially, where a farmer is debt loaded their risk averseness is likely to increase regardless of whether or not the farmer is 'naturally' risk averse by personality. In addition, it places constraints on the choices available to farmers. Winter (2000), for example, observes that debt was a key factor (as part of the farm business context) in determining 'radically different' responses of farms to policy and market signals. Further, Jay (2005), in a New Zealand context, found that debt was a key constraint to the adoption of sustainable farming practices.

143. A key difference, however, is that whereas a low income (without debt) may be compensated by the intrinsic gains farmers are making out of agriculture (lifestyle, social and cultural capital, etc.) debt can result in the farmer being forced out of agriculture against his or her will. It has been noted in the literature that bank managers are able to (and do) place pressure on farmers and, for indebted businesses, banks can be significant contributors to the decision-making process (Jack, 2006). Even where the farm is owned rather than rented, this can give what Bryant & Johnston (1993) describe as "an illusionary image of independence". While manageable debt may be a positive sign of investment in the business, the manageability of debt is often outside of the control of the farmer (ODT, 2009). What may appear manageable at one time can very rapidly become unmanageable when external economic drivers change.

4.7 Farm household

144. Research has identified many farm household characteristics that impact upon farm management decisions. For clarity these factors will be presented in a list format.

4.7.1 Succession

145. It has long been recognised that the successional process is simultaneously one of the central tenants for the continuation in agriculture (Ward and Lowe, 1994) and one of the key drivers of change in family farming (Potter and Lobley, 1992, 1996). Numerous papers have stressed the importance to farmers of "keeping the name on the land" (Bell and Newby 1974; Marsden et al., 1986; Bohnet et al., 2003; Burton, 2004; Evans, 2009) ensuring, above all else, that the farm retains its historical links with the farming family. It is argued here that life-cycle events are critical for the purposes of modelling because farmers' definitions of success in agriculture are generally "associated with life stage or generational differences in farming goals

and values" (Walter, 1997: 48) and the successional process defines "critical transitions when farm business restructuring, expansion and retrenchment is most likely to take place" (Potter and Lobley, 1996: 185: also see Ondersteijn et al., 2003). Potter and Lobley (1996: 185) refer to this as the "characteristic cycle of intensification and extensification" where farms appear to go through alternating growth and acquiescent cycles. Consequently, while tactical decisions such as variety of crop may be attributable to price fluctuations, many of the more important strategic decisions on the direction of the farm business are associated with successional issues (Lambert et al., 2007).

146. In order to account for the successional process in agent based models, it is important to identify stages in the farm family life-cycle and what they mean for farm development trajectories. A useful description of four successional stages was proposed by Hutson (1987) from a study in the UK : 1) Successor leaves full-time education to work under the supervision of the parents, 2) Successor and incumbent "have decided to make a go of it" and to expand or intensify production. New schemes or methods of production may be initiated at this point, 3) Successor begins to take responsibility for more of the farm, potentially operating a sector of the family business and 4) Father retires and the successor takes over full responsibility for farm management.

147. This classification reflects a younger successor gradually gaining more responsibility and bringing new influences onto the farm, while the older incumbent farmer gradually cedes responsibility and withdraws. However, even Hutson (1987, pp. 223) accepts this is not always the case as "The reality is that, under the pressures of expansion, goals can alter suddenly or unexpectedly as changes in external circumstances impinge at particular points in the internal cycle of family change." In addition, more recent studies suggest that preparations for succession begin even before the successor has decided to "make a go of it". Marsden et al. (1989), for example, suggest that the presence of a potential successor often changes the aspirations of the incumbent farmer, pushing the business towards a development pathway. Others have suggested that farmers begin socialising a likely successor (generally the oldest son) into agriculture and planning for succession almost from birth (Taylor et al., 1998; Fischer, 2007). Without this process, Fischer (2007) argues, it is less likely that succession will occur regardless of the commercial desirability of the farm as sons will develop alternative interests.

148. International research has documented interesting examples: in Ireland, older farmers without an identified successor were more likely to establish forestry than farmers with a successor (Collier et al., 2002). An analysis of British farms found that a move to more intensive practices was evident on farms with a recent successor or farms preparing for a successor to come into place. A move towards extensive practices was found on farms with no successor in place, even on farms that actively intensified their operations previously (Potter and Lobley, 1996). Farm households in Germany, the United Kingdom and Portugal were found to be more likely to leave some of their land idle if no successor was in place. Where a successor was identified, farmers in the United Kingdom and Portugal were likely to intensify farm production (Sottomayor et al., 2011). Similarly an examination of eight EU countries found that on-farm investment was higher on farms with an identified successor (Viaggi et al., 2011).

4.7.2 The role of the spouse and family in decision-making

149. The influence of the spouse on decision-making is a relatively under-researched topic after decades of focus on the, usually male, principal decision-maker (PDM) in agricultural research (Burton, 2004b). Thus, despite observations that the role of

other family members is important to acknowledge (Bryant & Johnston, 1993) the majority of bio-economical farm models fail to consider the input of other family members (Janssen & van Ittersum, 2007). The implications of this omission for tactical decision-making may be relatively minor. In a study by Bokemeier & Garkovitch (1987) the authors found that only 3% of women indicated they had greater decision-making power than their husbands on any issue. However, this varies across farms and contexts in two ways.

150. First, the influence of the spouse on strategic decision-making is generally greater than for everyday tactical decisions (on which AMBs are likely to focus). For example, Bokemeier & Garkovitch (1987) suggest that wives are likely to be participants in decisions if they involve substantial resources and financial issues, for example, selling or renting land, borrowing money, or buying equipment, and in terms of other decisions, the spouse's contribution is likely to reflect her sphere of responsibility (also Sawyer, 1973). Along these lines (although an old study), Wilkening (1958) found a relationship between the amount of debt owed by the farm and the participation of the wife in decision-making. The more in debt the farm became, the more likely the wife was to become involved in strategic decision-making.

151. Second, the involvement of the spouse in decision-making varies considerably across farms. One reason for this may be differences in the involvement of the wife in farm work. Sawyer (1973) suggests that the extent of the farm wife's decision-making is related to the level of work she participates in on the farm, and socio-economic characteristics of the farm, such as income and farm size. The smaller the farm the greater the role of the spouse. A further source of variation is in the decision-making area in which the spouse participates. Darques (1988) found that the areas where the male role was more dominant in decision-making were with regards to mechanisation, commercialisation, management and administration.

152. One area where the role of the spouse can be more important is in environmental decision-making. Some studies have suggested that women take a larger role in environmental decision-making than men and, in general, have a greater concern for the environment. For example, looking at farmers' involvement in Landcare in Australia, Curtis & de Lacey (1996) found that women scored significantly higher on a stewardship ethic scale than men. A second area where the wife often has a greater influence over decision-making is in terms of alternative farm enterprises (Halliday, 1989). For example, a number of researchers have noted that the farmer's wife is usually responsible for tourism ventures, in particular the establishment and running of accommodation based enterprises (Darques, 1988; Evans & Ilbery, 1992; Nilsson, 2002). It should also be noted that the wife's participation in off-farm pluriactivity is often restricted by the presence of children on the farm which Benjamin et al. (1996: 1584) suggest "always decreases the probability of off-farm work participation for the wife, regardless of the age of the children."

4.8 Farm structure

153. Research has identified many farm business structure characteristics that impact upon their management decisions. Land use change and adoption of environmental measures are more likely to be found on farms where these activities 'fit' the existing farm business.

4.8.1 Income

154. There are two main ways in which income influences decision-making. First, it acts as a direct constraint on decisions where capital is required, i.e. determining the list of possible alternatives for farm management. Battershill & Gilg (1996), for example, found that dependency on agriculture for income can also influence the decisions on use of land. In particular, the more dependent the farm is on agriculture for its income (relative to pluriactivity or diversification) the more constrained farmers are in terms of alternative non-agricultural land uses (Battershill & Gilg, 1996). In Europe investment flows into agriculture have been found to influence farmers' willingness to place land in non-productive (generally agri-environmental) land uses. As Whitby (2000) observes, some landscape and environmental features require expenditure for their maintenance. When farmers are trying to maintain other family goals (such as succession or standard of living) and farm incomes are low, investment in non-income generating activities is likely to be diminished.

155. Second, income goals determine the way in which the land is farmed[5], in particular the level of risk the farmer is willing (or required to) to take and the intensity with which the land is farmed. Farmers with higher incomes are in a better position to take risks (assuming they are not also debt laden) and are therefore more likely to try alternatives to conventional farming practices (Patrick et al., 1981), i.e. early adopters of new innovations often have larger farm incomes than non-adopters (Brown, 1981; Atari et al., 2009). In addition, farmers who intend to have higher levels of income in the future also exhibit lower levels of risk aversion (Patrick et al., 1981) as farmers need to take risks in order to increase their income. In general "the ways in which farmers attempt to accumulate capital can have a strong influence on the organisation of the farm business and land-use patterns" (Healy & Ilbery, 1990: 194). The need to maintain incomes has also been cited as a reason for farmers intensifying and capitalising the farm, moving towards more corporate, complex farm business organisations, technical arrangements, multi-unit enterprises and complex labour profiles employing a variety of types of labour (Marsden, 1991).

156. An interesting feature to note when modelling the impact of income on farm activity is its connectedness with income generated outside of agriculture, in particular as far as land values are concerned. Burton et al. (2005b, 2008) for example, in a study in the Cumbrian Uplands in the UK, found that despite being one of the most highly subsidised regions in the UK (with agri-environmental subsidies) the income generated by agriculture was not sufficient to make farmers competitive bidders for fell-farms in the region. Instead, income generated in nearby urban centres gave non-farmers a considerable advantage when it came to purchasing farms that were up for sale, leading to the break-up of the fell farming system. Where farms were brought by urban dwellers, the farmhouse and out-buildings were often developed as housing while the land was sold off to nearby farmers, thus speeding up the rate of farm size increase in the region. It is important for ABMs therefore to consider the impact of competing income levels from outside the agricultural community.

157. There are other implications for taking into account income into ABMs: farm businesses are subject to twice the income variation of non-farm businesses. Therefore, the need for income stability (rather than simply profitability) should be modelled as a critical factor driving land use decisions. When farmers are trying to maintain other family goals (such as succession or standard of living) and farm

[5] Note, the income goals are also associated with stage of the life-cycle and succession potential.

incomes are low, investment in non- or low-income generating activities is likely to be decrease. Farmers who are likely to take risks to generate income are not only those who have high incomes now (i.e. who are financially able to take risks) but also those who have high aspirations for future income generation. Finally, as land values become increasingly disassociated from their productive values, it is important that ABMs consider the role of capital generated externally to agriculture (i.e. the state of the national or local economy) on land use.

4.8.2 Farm size

158. Farm-size has been noted as having a critical role in influencing decision-making (Edwards-Jones, 2006; Defrancesco et al., 2008). As well as representing past strategic and entrepreneurial behaviour (Bergevoet et al., 2004), it also represents the farmer's future capacity for generating agricultural income from the farm and provides leverage for borrowing capital to expand or improve the farm. Increasing farm size is also a common means of developing the farm business (Evans, 2009). For example, where the implementation of new technologies for new land management practices is concerned, Lambert et al. (2007: 75) observe that the ability to spread fixed costs over more hectares makes conversion more likely on larger farms and "Thus, the scale of the farm operation is likely to be a major determinant in many farming practice decisions".[6] Larger farms are also less vulnerable to a range of economic and environmental conditions (Risby et al., 1999)[7] and, as a consequence, it has been suggested that increasing the farm size decreases risk aversion (Just, 2003).

159. Farm size is often associated with the life-cycle stage of the farming family and accordingly, features prominently in many typologies of farmers. For example, Jorgenson et al. (2007) suggests that system-oriented strategists tend to manage bigger farms, whereas those who rely on experience (experience based strategists) operate medium to low farm sizes. 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 (e.g. Burton, 1998) and, as a consequence, the manager takes a more system oriented approach rather than relying on intrinsic knowledge. Thus, not only does farm size influence the options available to farmers, but also the necessary personal characteristics of the manager. For example, 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).

160. The general pattern throughout the world is for increasing average farm sizes (e.g. Burton & Walford, 2005 – UK; Santelmann et al., 2004; Glebe, 2007 – US) as farming becomes more and more commercialised and the machinery required to manage farms as a commercial unit becomes increasingly large and expensive. Santelmann et al. (2004) from a study in Iowa in the US suggest that if the trends of the past 25 years continue, many owner operators in the region will cease to exist as large corporate farms operated by employees take over. Consequently it is

[6] Note, however, that the relationship between fixed costs and farm size is not always a simple linear one. Jack (2007: 924) in *Critical Perspectives on Accounting* observes that "the incremental costs of contract farming meant that fixed costs were stepped, at certain points, the additional costs of new machinery, say, required to take on another contract outweighed the financial benefits of all contracts."

[7] An example of this is drought resistance in New Zealand; Burton & Peoples (2008) found that larger farms (besides having more financial resources to cope with drought) were also generally spread over larger areas with variations in climate zones that could have important implications for farmers' stock management options.

important to understand how increasing farm size (in particular) influences decision-making across a range of behaviours.

161. In general, the literature suggests that farm size (and economies of scale in particular) facilitates farmers' ability to either extensify existing production, or to dedicate land to non-agricultural uses completely. In particular, farm size has been found by many to have a strong influence on farmers' entry into agri-environmental schemes in Europe (Potter et al., 1991; Skerratt, 1994; Young et al., 1995; Battershill & Gilg, 1996: Morris & Young, 1997; Wilson, 1997; Wilson & Hart, 2000; McNally, 2002) and on conservation engagement in general. For example, Parker et al. (2007) found in the US that conservation activity correlated positively with farm size which, they suggest, is consistent with the literature. Vanslembrouck et al. (2002) in Europe found through modelling that larger farm sizes had a significant impact on the model's ability to predict conservation activity. A similar finding has been made with respect to farming in New Zealand. Jay (2005) observed in her study that it was farmers on the smallest farms who were least likely to support bush remnants, while those on the largest farms were more likely. However, the relationship in this case was not a simple correlative one as farmers with medium to small farms were more likely to have bush remnants than those with medium to large farms. An interesting feature, as Jay notes, was that despite a lack of support for bush remnants the proportion of farmers on smaller farms with bush remnants (42%) was similar to the proportion of larger farms (44%) which, she suggests, indicates that small farms are financially capable of supporting bush remnants[8].

162. Jay's observation that the relationship is not a simple one may also explain observations in the literature that the results are not consistent (Morris & Young, 1997; Smithers & Furman, 2003; Defrancesco et al., 2008). Defrancesco et al. (2008) suggest that while some studies show a relationship between farm size and entry into conservation schemes, others find the opposite. For example, Midmore et al. (1999) found that very small farms in England showed the strongest support for conservation measures (40%), compared with only 25% of the largest farms. This is interesting in that, as the authors observe, while the strength of attitudes to conservation decreases as the farms get larger, participation increases with increasing farm size. In essence, the issue is that while farmers on smaller farms may have stronger environmental attitudes, they are also more limited in their ability to decrease the intensity of production on the land. Larger farmers may not have the same concern for conservation, but they have both better understanding of schemes and the financial ability to institute change. A further issue is that the exact details of the changes required may have a considerable impact on the results. For example, if a technology for improving conservation is affordable and effective for both large and small farms, farm size is unlikely to prove a barrier and farmers may adopt the technology regardless of their farm size (e.g. Traore et al., 1998).

163. Based on literature, there are several ways for implementing the importance of farm size in ABMs: In general, if ABMs are investigating conservation activities (either technologies or preservation of the natural environment) it is the larger farms which are more likely to engage. Larger farms (i.e. with more resources) are more likely to adopt new innovations. However, caution should be taken in cases where the benefits of the innovation decline with increasing farm size as adoption may peak

[8] Jay's (2005) findings are interesting as they suggest that greater understanding of the nature of the farm itself is important in order to model the impact of farm size. For example, were the larger farms on more rugged areas? Did the farmers on smaller farms have off-farm jobs and could thus afford to have remnant bush?

in the medium sized range. A minimum size of farm where the innovation can be adopted should be selected in the ABM, depending on the cost of implementing the innovation.

4.8.3 Tenure

164. Tenure can be a complex issue. Where farms are wholly owned, the ability of the farmer to make decisions is relatively unconstrained, whereas for farms that are rented, restrictions on certain types of land use can constrain the decision-making process. However, while landowners have more control over many decisions, debt can lead to the bank (or others) having a considerable influence over decision-making. As Marsden et al. (1989: 3) observed, while formal control of the business may remain with the farmer, "increasingly their management decisions and options are dependent upon external technical and economic factors largely controlled by external capitals." In effect, an 'owner occupied' farm can be owned to varying degrees by other organisations that are then able to influence decision-making on the farm.

165. As noted above, while debt is not traditionally seen as a factor in ownership (as most day-to-day decisions are still under the control of the farmer), as the debt level of farmers becomes higher farms are increasingly owned by the banks, and banks are increasingly in control of major investment decisions. To an extent, however, control of the land is dependent on the personal relationships between either the farmer and landlord or the farmer and bank manager, with social capital (trust) playing an important role in determining how constrained he/she is (Parker et al., 2007).

166. Areas where tenure has been shown to have an impact on decision-making include the investment in conservation practices (Salamon et al., 1997 – cited in Parker et al., 2007; Lambert et al., 2007), field afforestation (Selby & Petäjistö, 1995), an inclination towards stewardship of the land (Smithers & Furman, 2003), and preservation of the landscape (Potter & Lobley, 1992; Wilson, 1997; Kristensen et al., 2004). In all these cases greater control over the farm enables farmers to think more long-term and engage in activities not directly related to profit making (the main focus on rented land). Thus, as Jay (2005: 19) observes in the New Zealand context, ownership of land influences the balance between generating income and caring for the land as "owners have a greater commitment to the long-term health of the land than sharemilkers or employees, who depend on production for their income." As an example, the author observes how farms that are managed by sharemilkers are less likely to have bush and farms that are owned but have a manager installed are the least likely to have bush (note, however, there was no attempt to assess causality).

167. A further factor that should be noted is that land-ownership for many is more than simply a matter of securing resources, but it also has the important emotional component of the family farm, such that farmers can develop pride related to land ownership (Key, 2005) and a strong affinity (or 'sympathy') for their land (Kristensen, 2003). While this has no direct effect in facilitating decision-making, it may influence farmers' decision-making by reinforcing attitudes towards maintaining the farm, to avoid the loss of cultural and social capital associated with the loss of farm land (see Burton et al., 2008). This attachment to owned land could be incorporated into ABMs in several ways: farmers who have just taken over land do not share the same family connection to it and, therefore, change is more likely on owned land immediately following transfer; The longer land has been within a single family, the higher the level of attachment to it and therefore the less likely the farmer will be to sell the land; Tenure (whether the farm is owned or rented) is also likely to play an important role in determining any long term decisions made

on the farm, such as conservation of bush, afforestation, steward ship of land and preservation of landscape; Where land is owned, farmers have a longer-term outlook, and farm families who have owned land for an extended period (over generations) may develop a special attachment to the land (i.e. cultural value) which can result in decisions being made on the basis of non-economic capital. For example, ABMs could model that the longer land has been in the family, the less likely it is to be sold.

4.9 Social milieu

168. Research has identified many external social characteristics that impact upon farmers' management decisions, predominantly social and cultural capital (Bourdieu 1983, 1998). While economic income is clearly of primary concern, it should be remembered that farmers are also generating social capital (i.e. status and social networks) from their farms (e.g. Burton et al., 2008). In an attempt to redefine capital and propose a 'general science of the economy of practices', Bourdieu (1983) proposed the existence of capital in three fundamental forms: as economic capital (material property), social capital (networks of social connections and mutual obligations) and cultural capital (prestige). These forms of capital are seen as integrated, i.e. farmers with a high social status are likely to be more trusted and, critically, are more likely to receive economic (material) assistance from neighbouring farmers (e.g. if a farmer is good at managing pests, others will want to know him to gain his/her expertise and will exchange their own capital in order to gain this friendship and thereby knowledge).

4.9.1 Nearness to other farmers

169. As mentioned before, the influence of neighbours has been proven in studies where the TORA was implemented in its entirety (i.e. the subjective norm was correctly measured). Carr and Tait (1990: 228) concluded that "The most important sources of influence were those within the farming community itself or closely associated with it." Conventional Irish farmers were found to be more likely to convert to organic agriculture if they knew an existing organic farmer (Läpple, 2010). Participation in the AES in Italy was found to be influenced by a farmer's relationship with neighbouring farmers and those farmers' views on environmental schemes (Defrancesco et al., 2008). An examination of AES participation in nine European countries found participation of neighbouring farmers in the AES was also found to be an influence (Wilson and Hart, 2000).

4.9.2 Social pressure

170. Beedel and Rehman (1999) found that farmers who carried out hedge management in Bedfordshire were more likely to feel greater social pressure to manage their hedges than farmers who didn't manage their hedges. TpB was used in this analysis. Research examining adoption of best management practices with regard to diffuse pollution by graziers in the Burdekin Dry Tropics in Australia presented similar findings. Highly motivated graziers required greater support from industry for conservation practices. They were also strongly influenced by recognition of conservation among peers and the community (Greiner and Miller, 2008). There can be considerable variation in the dominant attitude towards land use changes. In Ireland afforestation was viewed very positively in Shillelagh, Co Wicklow which has a long tradition of forestry of Ireland. Whereas, in Newmarket in Co Cork, where there has been a considerable upsurge in afforestation, afforestation was negatively viewed as a source of social isolation (Ní Dhubháin et al., 2009).

4.9.3 Local availability of specialist services

171. While the availability of labour is clearly an important consideration for farmers when making decisions about land use and farm management, it is perhaps not as important as it may have once been. The increase in the use of contracting and labour saving technologies means that labour availability is only a serious restriction for larger businesses, those in parts of the country where labour is scarce, and those with critical periods during the year when labour is required. Nevertheless, the reliability of labour still comprises one of the key human associated risks for many farmers in New Zealand (Martin & McLeay, 1998). For example, MAF (2008) report on the dairy industry that

    "a continuing shortage of skilled labour, especially managers and herd managers. Finding staff, including relief milkers, is becoming more difficult, and the salary and wages of farm staff have continued to rise. Increasingly, overseas labour is being brought into the country".

172. An interesting characteristic of labour productivity is that it appears to be higher on smaller farms. Munroe (2001) suggests that this is to do with the type of labour on farms, with small farms using mostly family labour and larger farms needing hired labour. This result is not surprising given that family labour is often more motivated and experienced (and prone to self-exploitation, Marsden et al., 1989; Pritchard, 2006) than hired labour. On smaller farms without hired labour or successor(s) present it is likely that human capital reduces as the farmer ages due to age limiting the amount of physical labour possible (Kristensen et al., 2004).

173. International research has established links between the adoption of environmental practices and the availability of specialist skills. In Spain, there was an increase in afforestation in the Lugo province between 1993 and 1997 owing to EU afforestation schemes. It was found that 46% of afforestation occurred in the final year of scheme. This late upsurge was linked to the creation of 13 specialist contractors that applied for grants and established forestry stands for land owners that did not exist earlier in the scheme (Marey-Pérez, 2003). This example shows how the availability of expert skills and services in a locality can help in the adoption of innovative practices by farmers.

174. Given the importance of labour availability for the expansion of businesses, labour availability could be included as an external variable affecting change on farms in ABMs (variable on a regional and seasonal basis).

4.10 Characteristics of the innovation to be adopted

175. Rogers & Shoemaker (1971: 145) contend that for innovations to be easily adoptable they need to be 'compatible', where "Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of the receivers." This has important implications for the successful design, introduction and adoption of environmental practices. Rogers (1983: 225) observes that "A negative experience with one adoption can damn the adoption of future innovations. When one idea fails, potential adopters are conditioned to view all future innovations with apprehension." Thus 'risk aversion' is not a fixed characteristic of the agent, but is learnt. This may extend beyond the initial adopter as; if other farmers have observed the failure of an innovation it may decrease the likelihood of its adoption within the neighbouring area.

176. In Roger's framework five characteristics of the innovation were identified as being significant to an individual's likely adoption decision:

4.10.1 Relative advantage

177. An innovation must present an advantage over the superseded system for it to be adopted. As identified by Pannell et al (2006) and Greiner et al (2009) it must help a farmer to "achieve their goals, which may include economic, social and environmental goals." An example of a land use change was the rapid rise of afforestation among land holders in Ireland since the 1980's, which was incentivised. Evidence of this can be seen with the introduction of the first establishment grant in the Western Package Scheme in 1981. The mean annual area of private afforestation in the period 1981-1989 increased almost 12 fold in comparison with the period 1930-1979. The introduction of the EU Forest Premium Scheme in 1990 resulted in land holders receiving annual payments for 15/20 years post establishment. The mean annual area of afforestation increased over five fold in the period 1990-2005 in comparison with the period 1981-1989. Afforestation peaked in 1995 and this has been attributed to the introduction of the first AES in Ireland, thereby increasing the agricultural margins on more marginal land (Farrelly, 2006, Gillmor, 1998).

4.10.2 Compatibility

178. Rogers identified how an innovation must be compatible with existing practices in order for it to be adopted. Using afforestation in Ireland as an example once more, it has been found that afforestation would produce a higher return than the superseded system on many farms, yet its uptake has not been high (Breen, 2010, Frawley and Leavy, 2001). However, if a person identifies themselves as a farmer then becoming a forester might not be compatible their goals.

4.10.3 Complexity

179. The complexity of an innovation will have a bearing on whether it is adopted or not. In Europe, a reason commonly put forward by farmers for not joining AES schemes is the burden of the paper work attached to the scheme (Wilson and Hart, 2000). The technology adoption model was used to examine the uptake of new technologies by New Zealand dairy farmers. Dairy farmers who adopted a new technology not only placed a higher value on the perceived use of a technology, but also placed a higher value on the perceived ease of use of the technology than non-adopters (Flett et al., 2004).

4.10.4 Trialability

180. A key aspect that promotes the uptake of an innovation is the degree to which a new product can be tested before agreement. This is a key feature in software sales for instances where 30 days trials are common place.

4.10.5 Observability

181. Innovations that are readily observable are more likely to be adopted. Research by Carolan (2006) has identified that the epistemic barriers that exist between the highly visible aspects of productivist agriculture and the less visible aspects of more sustainable agriculture creates epistemic barriers. Non-participants have articulated that, if they were given more choice in what measures they were allowed to adopt, they would be more inclined to join AES (Wilson and Hart, 2000). Allowing farmers' choice in what measures they could potentially adopt, as opposed to setting out a fixed set of measures, may facilitate the development of a

more post-productivist ‘good farmer’ identity. This would allow farmers to display their farming skill in selecting the appropriate measures for their farm.

182. When an innovation is modelled as failing, ABMs should make the agent less willing to try new innovations in the future (i.e. failure of an innovation increases risk aversion for similar innovations). Further, it should decrease (to a lesser extent) the willingness of neighbouring farmers to adopt the innovation.

4.11 Conclusions from the Literature Review

183. This section has explored literature that will enable modellers to identify critical processes and characteristics that are likely to influence general decision-making and, for some of the common decision-making areas (e.g. whether to intensify production, institute environmental measures, and so on) the direction that the change is likely to take.

184. This review identified psychological constructs (e.g. attitudes, norms, self-identity, and morality) that may influence farmers’ behaviour. While the social relations, human capital, and farm structure provide the environment within which the decision-making can occur, the decision-making process itself is equally important for ensuring that the model produces accurate results. While there are numerous models of decision-making systems, the review looked at the most commonly used frameworks, i.e. those of the Theory of Reasoned Action and Theory of Planned Behaviour. The resulting discussion did not produce a system model of the decision-making processes in agriculture, but rather reviewed the components that may be incorporated into such a model as influencing the relationship between attitudes and behaviour.

185. As farm structures change within the model (such as an increase in farm size or income) farm decision-making changes as farmers are enabled or restricted in their choice. Numerous studies have looked at the impact of these changes on other parts of the system and the key relationships have been explored in this review. In addition, it has identified some issues that may be dealt with in ABMs. For example, the impact of multiple succession on farm size (dividing the largest farms) could potentially have a considerable impact on the rate of growth of farms by providing a mechanism for very large farms to split to produce new agents in the model. A further possibility is to look at the impact of forms of non-economic capital, i.e. the cultural and social capital generated from skilled farming performances and its influence on farmers’ willingness to change their enterprise and the level of assistance they receive from neighbours. Doing this could help move the model away from a simple econometric view of behaviour to a more utility based perspective.

186. If the impact of human capital is to be accurately modelled, it is important to ensure that the measures are specific to the behaviours under consideration. The ‘highest qualification’ or ‘years of experience’ are less important than what the experience or training is in. While this may seem axiomatic, many studies ignore this, leading to a variety of conclusions on the impact of human capital on farm decision-making and behaviours.

187. While socio-psychological models are interesting for exploring farmer decisions (and have been used widely) socio-psychological processes alone are not the sole contributors to the process. As was the case in the ‘behavioural approach’, to understand farmers’ behaviour requires not only the gathering of psychological constructs such as attitudes, values and goals, but also incorporating additional relevant data concerning the farm and farm managers, such as the farm structure, economic situation, successional status and so on. This combination of multiple

potential psychological drivers combined with multiple structural influences makes the determination of potential decisions in the model exceptionally complex. A way of reducing this complexity within the model is to develop taxonomic categories of farmer types that integrate both the structural and psychological dimensions to produce a more limited number of development trajectories that can be attributed to the farm/farmer agents. This review has therefore looked at the use of typologies in order to identify whether there are any farmer 'types' that reoccur throughout the farming literature. Despite the fact that the studies have emerged from a number of different countries and across a considerable time span, the result is surprisingly cohesive.

5. Survey and Sample Design

188. The design and work plan for this research was formalised at a workshop in Wellington on 5th March, 2013, that included representatives from AgResearch, Landcare Research, NZIER, MfE and MPI. The aim of the workshop was to confirm the scope of the study (policies, on-farm practices, farm systems) and agree on the survey instrument and methodology. The resulting survey was defined at the workshop but fine tuning of the wording and design continued over the next two weeks. We gratefully acknowledge that some of our questions regarding future strategic plans for the farming operation and some attitudinal questions were derived and/or adapted from the recent survey used by Wilkinson, Barr and Hollier (2011) to segment Victoria's farmers. A copy of the survey undertaken is provided as an appendix to this report.

189. Due to the very tight time constraints associated with the project, although we would have preferred to be much more rigorous, we were only able to conduct minimal pilot testing of the survey. Thus, in the Canterbury region the survey was piloted with two very senior farm system scientists, while in Waikato the survey was piloted with 7 farm systems scientists (two of whom also own their own small farms). If the pilots were not actually farmers, they were asked to think of a particular farmer that they knew well and respond to the questions as that farmer might (the range of farmer enterprises included dairy, sheep and beef, horticulture, pig, and goat farming). We acknowledge that more actual farmers would have been better, however, the pilots were very familiar with farm systems and they regularly work on a close basis with many individual farmers. After the Waikato pilots had completed the survey, they participated in a focus group to discuss at length the survey questionnaire on a question by question basis. As a consequence of this process, our nine pilot interviewees made numerous suggestions to improve both the flow of the questionnaire and individual questions, and in couple of cases, the question response sets. All pilots were satisfied with the reformulated survey design. Additional piloting also occurred once the survey was placed on the web to ensure the functionality of the web-based survey. However, the web-based piloting was conducted by members of the research team. A number of problems were also picked up at this stage and corrected before the finalised survey was opened for land user response.

190. The survey, titled 'Survey of Rural Decision Makers' was designed jointly by Landcare Research and AgResearch with input from the Ministry for the Environment, the Ministry of Primary Industries, Dairy NZ, the developers of the two ABMs for data were gathered, and others. It collects detailed data on farmer demographics, farm characteristics, succession plans, risk tolerance, profitability, information sources, objectives, farm management practices, farmer intentions, perceived behavioural control, norms, and environmental attitudes. It uses complex logic and skip patterns to facilitate efficient survey completion, which eliminate irrelevant questions (e.g., asking arable farmers where they winter off stock) but introduces important restrictions on the survey mode. Specifically, complex logic precludes surveying respondents via mail, leaving in-person interviews, telephone surveys, and Internet-based questionnaires as alternatives.

191. In-person interviews and telephone surveys yield higher survey response rates than Internet surveys (e.g., Balter et al., 2005; Couper, 2011; Manfreda et al., 2008; Shih and Fan, 2008), but incur significantly higher costs as they require trained enumerators to elicit responses. In contrast, Internet surveys eliminate a separate data entry process, which reduces both financial and time costs associated with data collection. Given the budget and time frame for this project, we deemed an Internet

survey to be the most appropriate data collection mode. UMR Research was contracted to conduct the survey on behalf of Landcare Research and AgResearch.

192. AssureQuality operates AgriBase, a commercial database of New Zealand's rural properties. Developed in 1993 to track properties susceptible to foot and mouth disease, AgriBase uses voluntary reporting to record detailed information on farms, vineyards, orchards, forests, and small holdings. Given our decision to survey farmers via the Internet, AgriBase's records of email addresses for a wide cross section of New Zealand farmers is of paramount importance.

193. The samples that AssureQuality provided were stratified by a few key variables. Initially we asked that some of AgriBase's farm types were removed from the analysis as we determined that they were outside the area of interest (Alpaca and/or Llama Breeding, Beekeeping and hives, Dogs, Emu bird farming, Fish, Marine fish farming, hatcheries, Flowers, Lifestyle block, Meat Slaughter Premises, Native Bush, Not farmed, Plant Nurseries, Ostrich bird farming, Saleyards, Tourism, Zoological gardens). For reference, the option of removing the 'Lifestyle block' farm type from the analysis was discussed at the workshop in Wellington. It was determined that they should be removed as the survey was not focusing on hobby farming. The list of farm types that were included in the analysis is below.

AgriBase Farm Types used in the sample creation

AgriBase Farm Types	Description
ARA	Arable cropping or seed production
BEF	Beef cattle farming
DAI	Dairy cattle farming
DEE	Deer farming
DRY	Dairy dry stock
FOR	Forestry
FRU	Fruit growing
GOA	Goat farming
GRA	Grazing other peoples stock
OAN	Other livestock (not covered by other types)
OPL	Other planted types (not covered by other types)
PIG	Pig farming
POU	Poultry farming
SHP	Sheep farming
SNB	Mixed Sheep and Beef farming
VEG	Vegetable growing
VIT	Viticulture, grape growing and wine

194. After receiving the email addresses from AssureQuality, the samples were cleaned and any duplicate email addresses (where a farmer owns multiple distinct farms and has the same email address listed for each) were removed. In addition, there were a number of email addresses that were found in two or more of the distinct regions. These email addresses were also removed from one of the regions prior to delivery to UMR Research.

195. After filtering out self-reported hobby farmers and lifestyle blocks and any duplicate email addresses, AgriBase holds email contact information for "key decision makers" on 2,830 properties in Canterbury, 1,274 properties in Southland,

and 1,723 properties in Waikato. Sixteen of these addresses were no longer being used by the owner, leaving 5,811 potential respondents.

196. All 5,811 individuals were invited to participate in the survey via email. Among them, 285 specifically requested to be unsubscribed from the survey. Several of these left comments indicating that they had already fielded many surveys on farm practices in recent months (Porter et al. 2004 review such "survey fatigue") while others reported that they had retired and/or were otherwise no longer engaged in farming. Thus, while the AgriBase database represents the best commercially available source of information for contacting farmers, some of its records are outdated.

197. Market research firms increase participation rates by sending out reminders after the initial invitation and by offering prize draws and other reward for completing surveys. We followed standard practice, sending two reminders after the initial invitation. In addition, we contributed $10 to a charity selected by the respondent for each survey completed; respondents were invited to choose among CanTeen, the Royal New Zealand Plunket Society, the Federated Farmers Adverse Events Trust, the New Zealand Fire Service, the New Zealand Red Cross, and the SPCA.

5.1 Response Rates

198. Some 784 surveys were initiated (Table 1). 536 were completed, representing a 68.4% yield on initiated surveys. This completion rate is commensurate with other Internet surveys undertaken by UMR Research, particularly given the complexity of our instrument (e.g., a recent Internet survey undertaken by UMR Research consisted of 15 questions total and had a completion rate of 79%).

Table 1: Sample, completion rates, and response rates by region

	Primary sample	Surveys begun	Surveys completed	Completion rate	Final response rate
Canterbury	2821	424	283	66.7%	10.0%
Southland	1272	189	136	72.0%	10.7%
Waikato	1718	171	117	68.4%	6.8%
Total	5811	784	536	68.4%	9.2%

199. The final sample comprises 283 farmers in Canterbury (10.0% of those contacted), 136 in Southland (10.7% of those contacted), and 117 in Waikato (6.8% of those contacted). The overall response rate was 9.2%, which UMR Research reports being similar to cold-calling medium- and large-sized businesses to respond to surveys, an appropriate comparison.

200. After eliminating a handful of completed surveys in which the respondent noted that they had retired and/or left farming, the final sample covers 528 farms across the three regions.

5.2 Survey Feedback

201. UMR Research who undertook the survey on our behalf raised several important points for the research team that will be taken into account for future research.

202. First, it is impossible to know how many of the 5,811 email invitations to participate in the survey were actually read by survey respondents. That being said, 285 recipients (4.9%) specifically requested that their names be removed from the survey mailing list, which is an unusually high rate in UMR Research's experience.

However, this abnormality may not be surprising given that email addresses in AgriBase are self-reported and are only updated as frequently as individuals in the database choose to do so. That is, some of the email addresses were entered a decade or more ago and some potential respondents are likely to have left farming in the intervening time, suggesting that the effective primary sample is somewhat smaller than the list of 5,811 email addresses.

203. A smaller effective primary sample also results in response rates appearing lower than they would otherwise. Specifically, the response rate is calculated by dividing the number of responses by the number of potential responses, which, as noted above, is likely overstated.

204. Next, UMR Research considered the $10 charitable donation to be effective in encouraging participation. They typically use prize draws to incentivize survey completion but believed that charitable donations were better suited to this audience, particularly because we included charities of particular relevance to rural residents, e.g., the Federated Farmers Adverse Events Trust.

205. Finally, UMR reports that the survey took 16 minutes to complete, on average. This duration is similar to other Internet surveys and is within the range of times that survey respondents were told to expect.

6. Descriptive Statistics

206. This section reports the results of the descriptive statistics gathered in the Survey of Rural Decision-makers.

6.1 Sample Description

6.1.1 Primary Enterprise

207. For our purposes, "primary enterprise" is defined as the activity that represents the largest land use on any given farm. Table 2 compares primary enterprise types reported in AgriBase to those reported in the survey by region. In both Canterbury and Waikato, dairy is substantially overrepresented while sheep and beef are substantially underrepresented. The comparatively small sample from Waikato contributes to these differences, as does the fact that dairy support is underrepresented for the region. However, the fact that the AgriBase database depends on voluntary reporting may also play a role: specifically, the infrequent nature of reporting in AgriBase implies that much of the dairy conversion, which has been especially pronounced in Canterbury and Waikato in recent years, may be reported with significant delay in that database. Indeed, the average record for farms in Canterbury and Waikato in AgriBase was entered in 2008.

Table 2. Distribution of primary enterprises by region

		Canterbury	Southland	Waikato
AgriBase	Sheep and beef	57.4%	64.9%	38.19%
	Dairy	9.1%	16.1%	37.40%
	Deer & Other Livestock	8.8%	8.4%	3.31%
	Hort & Viticulture	4.3%	0.4%	3.36%
	Arable	8.9%	0.8%	1.97%
	Forestry	3.9%	2.3%	2.67%
	Dairy Support	7.7%	7.2%	13.10%
Survey	Sheep and beef	48.2%	59.0%	19.8%
	Dairy	14.8%	16.4%	61.2%
	Deer & Other Livestock	4.7%	3.7%	2.6%
	Hort & Viticulture	3.6%	0.0%	6.0%
	Arable	12.2%	2.2%	2.6%
	Forestry	2.5%	2.2%	0.9%
	Dairy Support	9.7%	13.4%	3.5%

Source: Brown, Morgan, & Small (2013, p3)

6.1.2 Respondent Role on Farm and Farm Ownership

208. Figures 1 and 2 show that most farms are owned by individuals and/or family trusts and that most decision-makers are the owners themselves. Corporate ownership is unusual among the farms that were surveyed.

Figure 1. Farm role (all completed survey response)

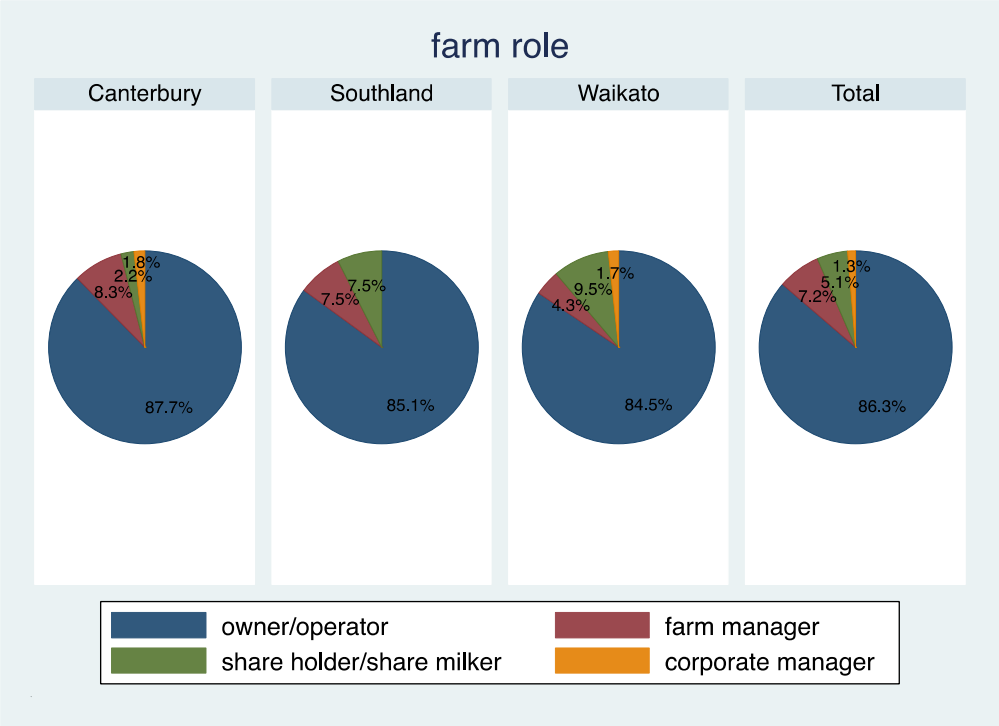
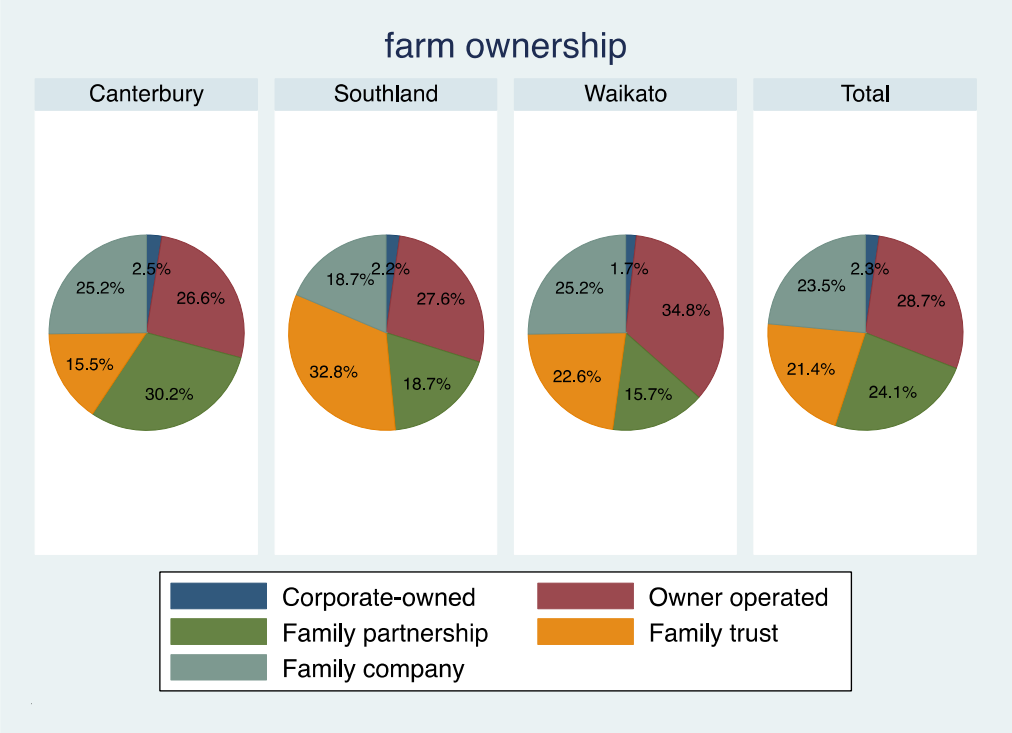


Figure 2. Farm ownership structure (all completed survey responses)



209. These findings are consistent with other studies of New Zealand farm ownership, particularly the dairy sector (e.g., Dooley, 2008; LIC, 2005; LIC and DairyNZ, 2012; Payne et al., 2007). Dooley and Payne et al. also identified other ownership and management structures in dairying, including equity partnerships, although these are the exception rather than the rule.

6.2 Demographics

6.2.1 Age

210. Figure 3 and Table 3 depict the age distribution of farmers by region. Survey respondents range in age from 24 to 80. Canterbury farmers are older, on average, than their counterparts from Southland and Waikato (statistically significant at the 10% level) while those from Southland are younger, on average, than their counterparts from Canterbury and Waikato (significant at the 5% level level). The mean and median age among survey respondents is 54.8. This is close to the average farmer age of 56, reported in a farmer survey by Fairweather et al. (2007). Baker (2008) reported the average age of New Zealand farmers as 58. However, Fairweather and Mulet-Marquis (2009) noted problems with the NZ farmer age data and reported that the 2006 New Zealand Census indicated that the average age for individuals self-reporting as farmers was considerably younger at 43.7 years.

Figure 3. Age of the decision maker (years)

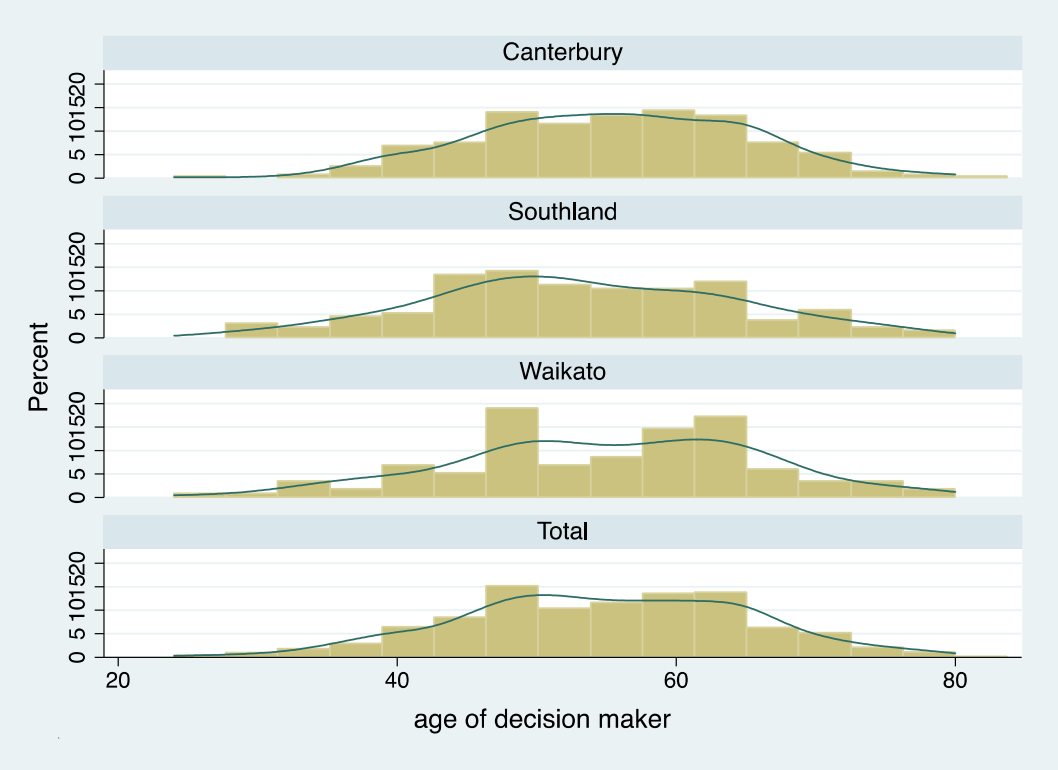


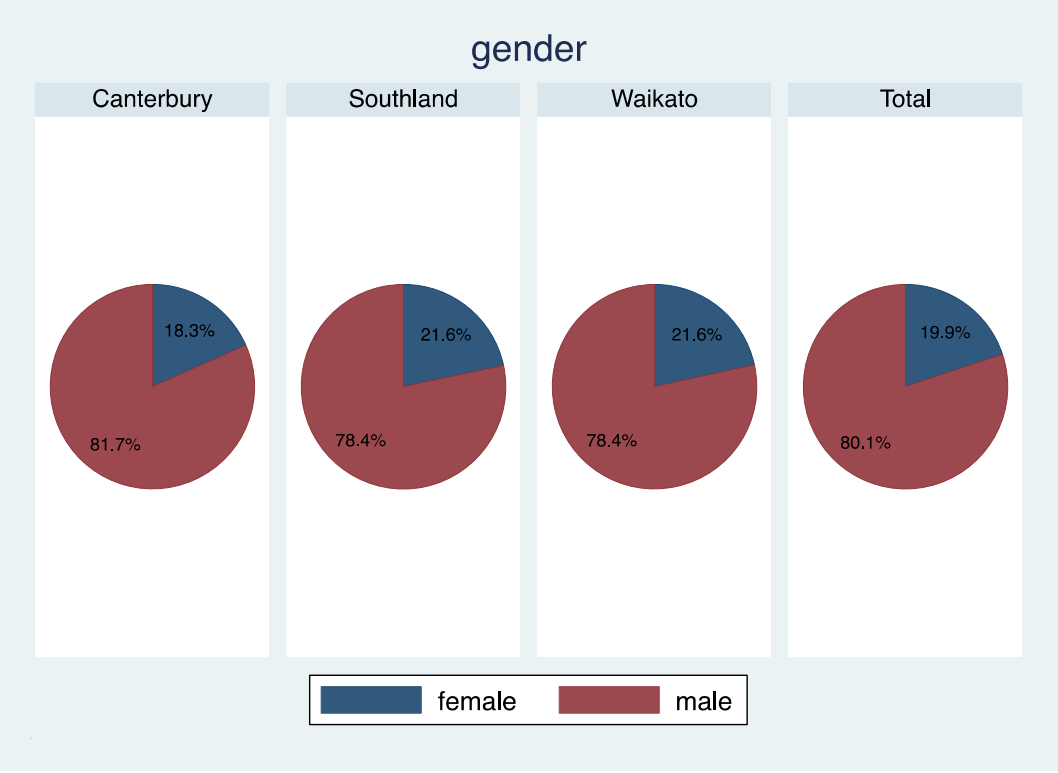
Table 3. Age of the decision-maker (years)

region	N	mean	sd	min	median	max
Canterbury	278	55.47	9.63	25	56	80
Southland	134	53.21	10.94	28	52	77
Waikato	116	54.95	10.93	24	55	79
Total	528	54.78	10.29	24	55	80

6.2.2 Gender of Decision-maker

211. One-fifth of decision-makers are female, with similar shares represented across regions (Figure 4). This figure is similar to the international literature, which indicates that 21% of women in the work force were employers. Even in highly developed countries such as the Netherlands, Norway, and Finland, less than one-third of employers are woman (United Nations, 2006). The New Zealand Census of Women's Participation in Governance and Professional Life (Human Rights Commission, 2004) claimed that although women comprised 47% of the national workforce, they are significantly under-represented in leadership and decision-making positions. The Census indicated that females represented 5.04% of directors of publically listed companies (NZX), 14.12% of legal partnerships, 15.82% of university professors and associate professors, 16.3% of directors of listed companies (NZAX), 29.1% of members of parliament, and 35.07% of directors of crown companies.

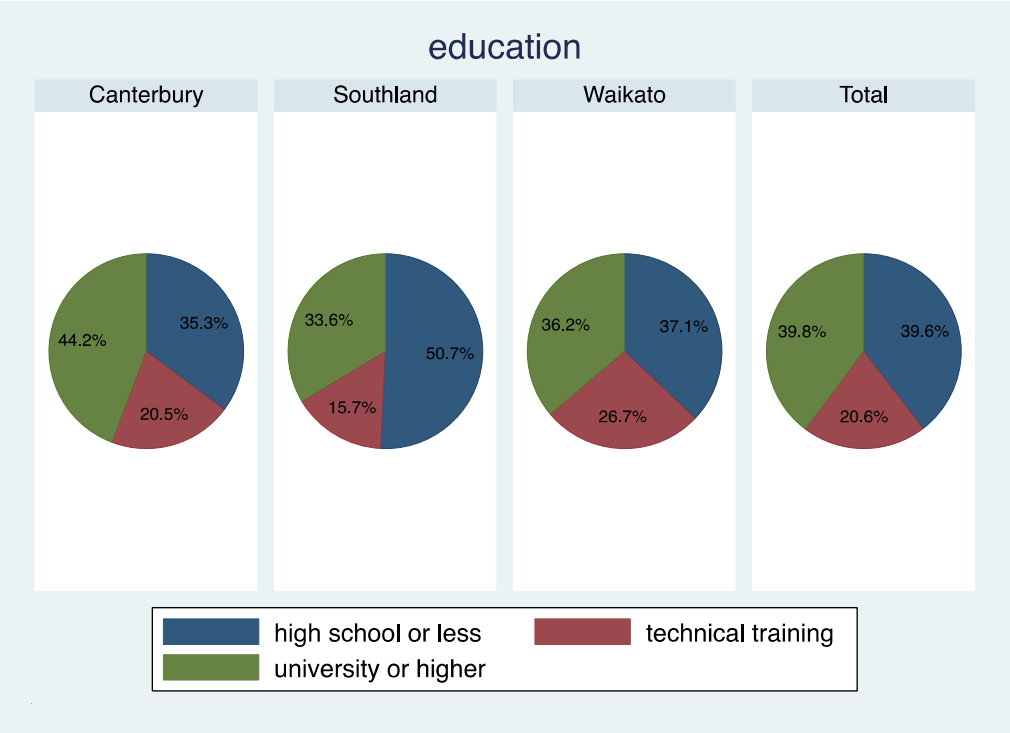
Figure 4. Gender of the decision-maker



6.2.3 Education of Decision-maker

212. Some 20% of farmers have completed technical education in farming and twice that number have completed university education. Farmers in Canterbury are the most highly educated (significant at the 10% level) while those in Southland are statistically more likely to have high school educations or less (significant at the 10% level). Statistics New Zealand (2001) reported that educational attainment in highly rural/remote areas differs substantially from the national average, with fewer adults having formal qualifications. Nationally, 34% of adults (specifically, 38% of males and 29% of females) in highly rural areas had no formal qualifications in 2001. Approximately 20% held a vocational qualification and a further 6% held a university degree. The respondents in our sample were substantially better educated than the average adult living in a highly rural location (see Figure 5).

Figure 5. Education of the decision-maker



6.2.4 Farming Experience

213. While a handful of rural decision-makers are new to the business, others have up to 66 years of farming experience (Figure 6 and Table 4).

Figure 6. Farming experience (years)

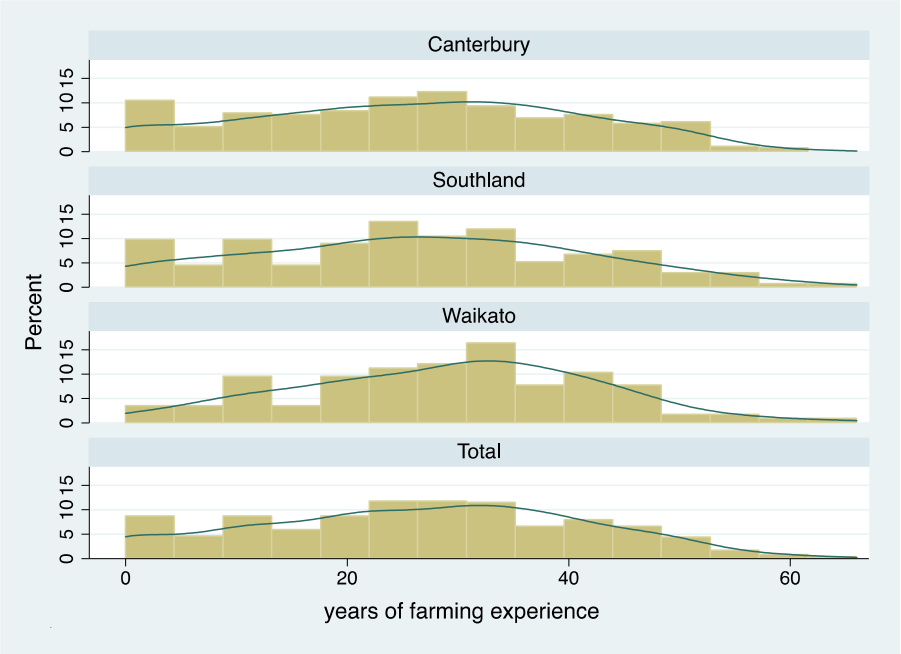


Table 4. Farming experience (years)

region	N	Mean	sd	min	median	max
Canterbury	278	25.78	15.08	0	25.5	60
Southland	134	26.24	15.26	0	26	62
Waikato	116	28.99	13.46	0	30	66
Total	528	26.6	14.81	0	28	66

214. The mean and median years of experience are 26.6 and 28 years, respectively, although respondents from Waikato have 10% more farming experience, on average, than other respondents (significant at the 10% level).

6.2.5 Number of Farms Worked On Prior to Current Farm

215. Respondents were asked to indicate how many farms they had worked on prior to their current farm. Figure 7 and Table 5 show that the vast majority had worked on more than one farm, that 25-29% had worked on three to four farms previously, and that 7-9% had worked on 10 or more farms. The mean number of farms worked on for the entire sample is 1.7; the median number is 1.

Figure 7. Number of farms worked on prior to this farm

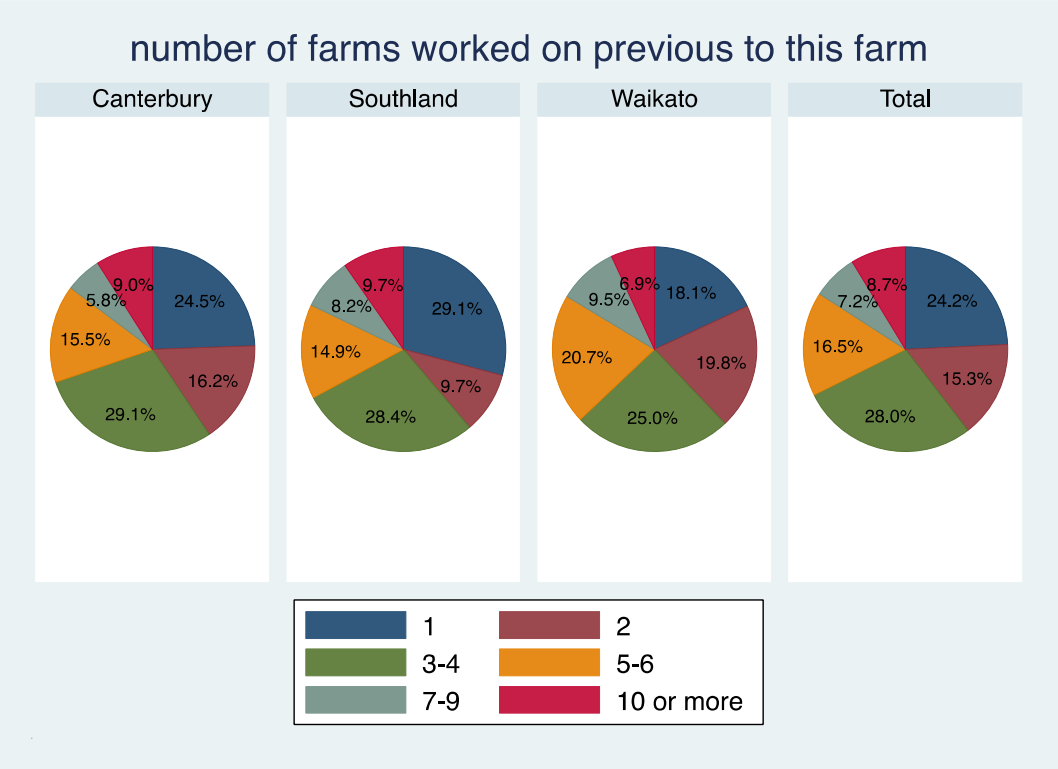


Table 5. Number of farms worked on prior to this farm

Region	N	mean	sd	min	median	max
Canterbury	278	1.8	1.3	0	2	6
Southland	134	1.6	1.2	0	1	5
Waikato	116	1.5	1.3	0	1	7
Total	528	1.7	1.3	0	1	7

6.2.6 Length of Time on Current Farm

216. Figure 8 and Table 6 report the length of time in years that respondents have been working on their current farm. The minimum time is one year while the maximum is 64 years. The mean for Canterbury is 23.4 years, for Southland is 22.4 years, and for Waikato is 21.2 years. The mean for the whole sample is 22.7 years while the median is 21 years.

Figure 8. Length of time on this farm (years)

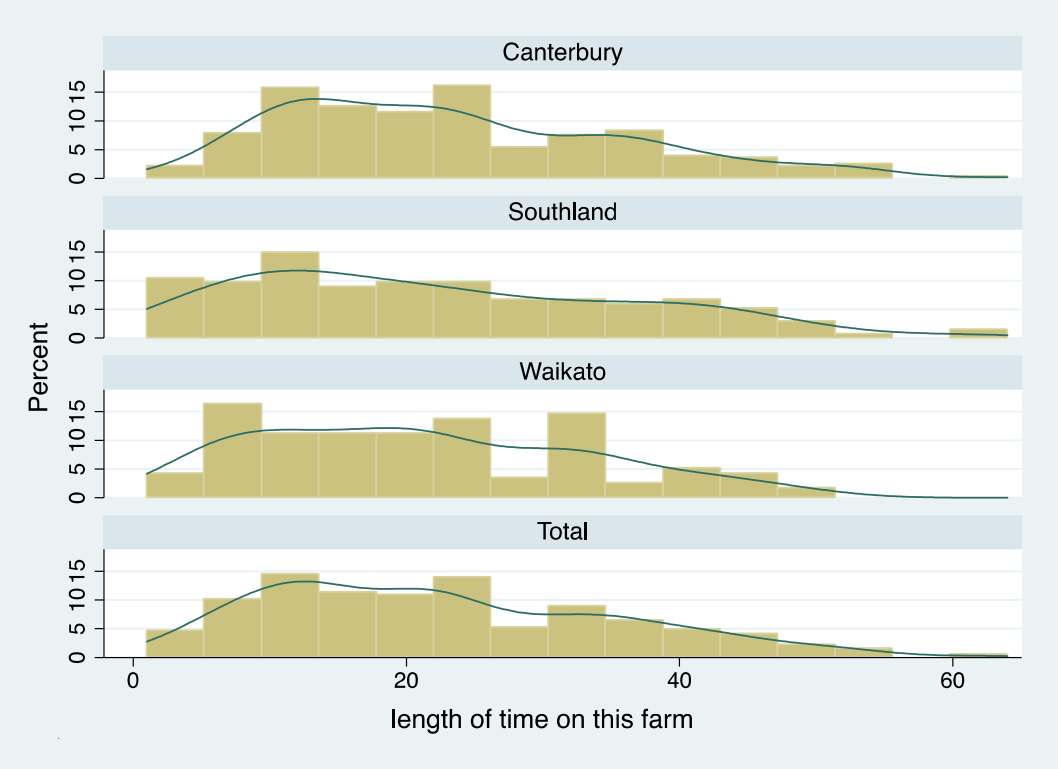


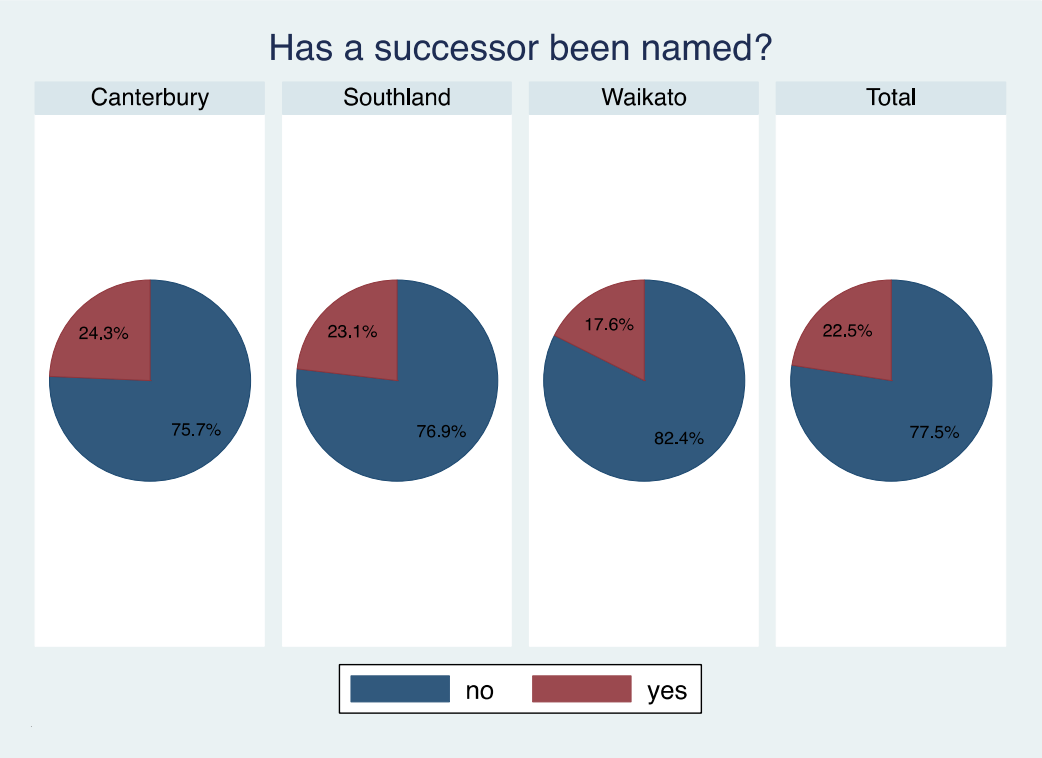
Table 6. Length of time on this farm (years)

Region	N	mean	sd	min	median	max
Canterbury	278	23.4	12.5	1	21.5	64
Southland	134	22.4	14.4	1	20.5	63
Waikato	116	21.2	12.0	2	20	49
Total	528	22.7	12.9	1	21	64

6.2.7 Successor

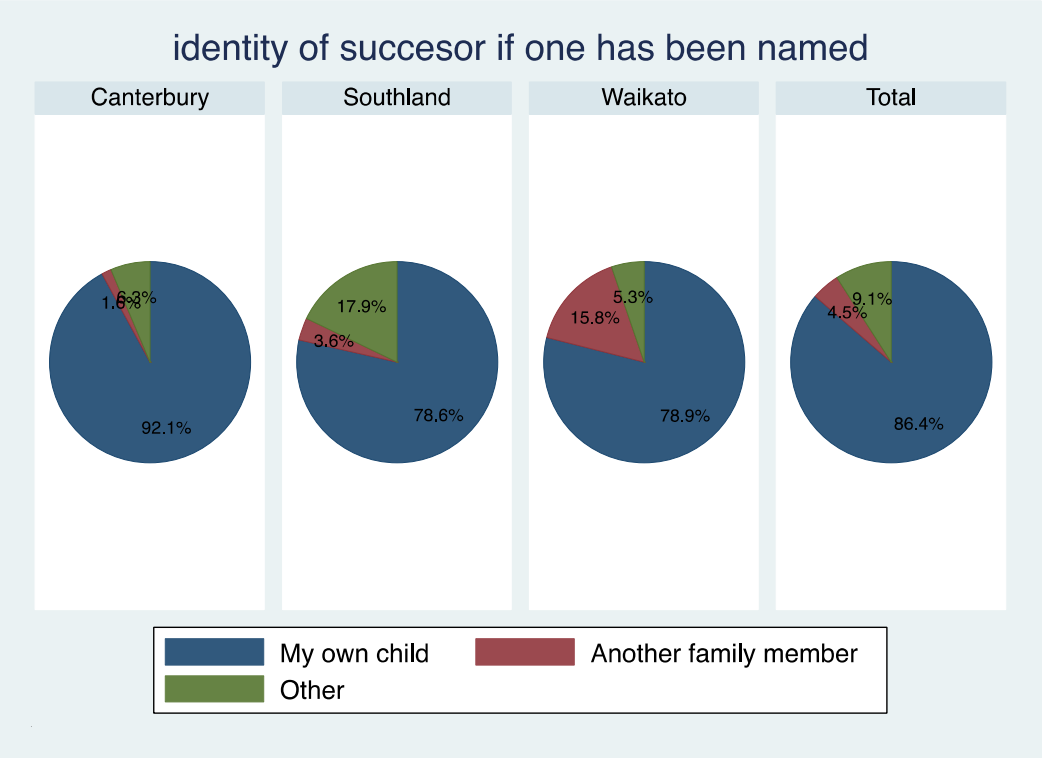
217. Across the three regions, between 17.6% (Waikato) and 24.3% (Canterbury) of respondents have already identified and named a successor to the farm (mean = 22.5%).These data are presented in Figure 9.

Figure 9. Successor



218. Respondents who had identified successors were asked whether the successor was their own child, another family member, or someone else. Across the three regions, between 78.6% (Southland) and 92.1% (Canterbury) of the identified successors were the respondents' own children, with a mean of 86.4% across all regions (see Figure 10).

Figure 10. Identity of successor if one has been named



6.3 Farm Characteristics

6.3.1 Farm Size

219. Table 7 presents descriptive statistics regarding the size of the respondents' current farm operations by region. The figure is measured in hectares and includes leased land. Although self-identified lifestyle blocks were excluded from the sample, farms with five or fewer hectares of land comprised 3% of the total sample. The largest farms represented in Southland and Waikato are 4,300 and 3,000 hectares, respectively. Eight farms in Canterbury are larger, all of them primarily dedicated to sheep and beef production. Canterbury farms are larger than Southland and Waikato farms, on average (significant at the 5% level), while Waikato farms are smaller, on average (also significant at the 5% level).

Table 7. Total size of farm (ha)

region	N	mean	sd	min	median	max
Canterbury	278	623.76	1845.65	2	245.5	22,000
Southland	134	434.75	628.22	3	256.5	4,300
Waikato	116	255.46	422.1	3	139.5	3,000
Total	528	494.87	1396.87	2	210	22,000

220. According to LINZ (2010), the average sizes of specialized beef cattle, specialized sheep, and mixed sheep and beef operations are 105 hectares, 443 hectares, and 679 hectares, respectively. The average sheep and beef operation in our survey is 492 hectares, which is well within the expected range based on New Zealand averages.

However, we do not distinguish among the specialized and mixed operations in our sample.

221. LINZ (2010) also reports that the average size of dairy farms is 172 hectares. The average size in our sample is 266 hectares, although a few very large dairy farms in Canterbury and Southland increase the average substantially. The median dairy farm in our sample is 200 hectares, which is 16% larger than the average reported by LINZ (2010).

222. Other farm sizes are also similar to those reported in LINZ (2010). For example, the mean deer operation in our sample is 208 hectares compared to 230 hectares reported by LINZ.

223. Table 8 shows the average amount of land leased by region. Canterbury farmers leased the most land with a mean of 225 ha and a maximum of 18,000 ha. Southland and Waikato farmers, in contrast, had rather small amounts of leased land, on average. In all three regions, the medium number of hectares leased was zero, meaning that most surveyed properties did not lease land.

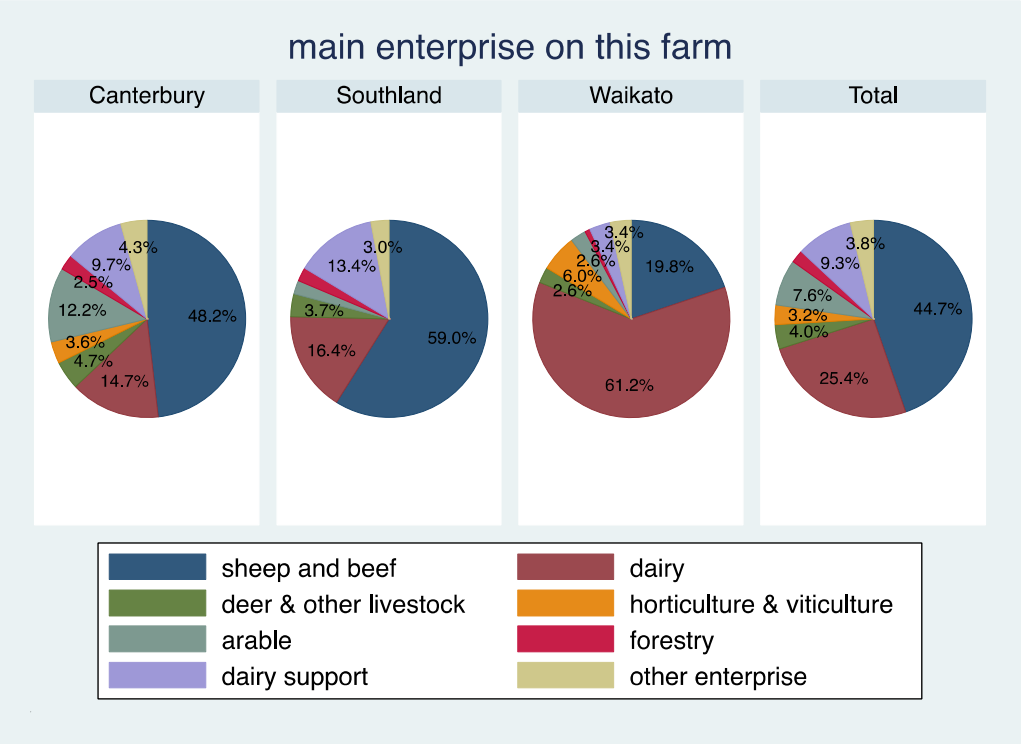
Table 8. Leased land (ha)

Region	N	mean	sd	min	median	max
Canterbury	278	225.14	1427.93	0	0	18,000
Southland	134	28.61	73.14	0	0	515
Waikato	116	18.13	56.3	0	0	400
Total	528	129.78	1041.11	0	0	18,000

6.3.2 Primary Enterprises

224. Figure 11 depicts the primary enterprises by region. Southland has the greatest proportion of sheep and beef (the main enterprise of 59% of surveyed farms in Southland) while Waikato has the greatest proportion of farms on which the main enterprise is dairying (61.2%).

Figure 11. Enterprise representing the greatest land use



225. Figure 12 indicates the percentage of farms that have multiple enterprises by region. Some 65.8% of surveyed farms in Canterbury have multiple enterprises while only 41.4% of sampled farms in Waikato have multiple enterprises. Table 9 shows the average number of enterprises per farm by region, which ranges from 1.5 in Waikato to 1.9 in Canterbury. Some farms have as many as five different enterprises.

Figure 12. Number of different enterprises on the farm

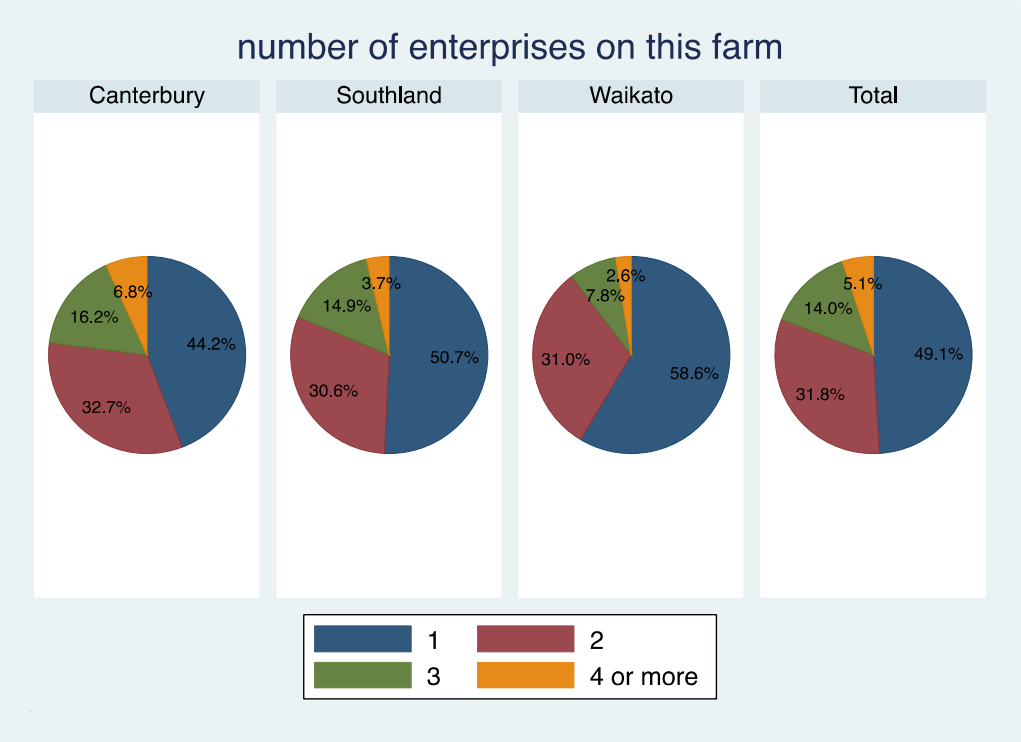


Table 9. Number of different enterprises on the farm

region	N	mean	sd	min	median	max
Canterbury	278	1.9	1.0	1	2	5
Southland	134	1.7	0.9	1	1	5
Waikato	116	1.5	0.8	1	1	4
Total	528	1.8	0.9	1	2	5

226. Table 10 shows the percentage of surveyed farms in each region that have each of the named enterprise types. Three quarters of Southland farms and 70.14% of Canterbury farms have sheep and beef as an enterprise while only 28.45% of the surveyed farms in Waikato have sheep and beef. In contrast, 65.52% of Waikato farms, 26.87% of Southland farms, and 19.06% of Canterbury farms operate a dairy enterprise. Some 29.86% of surveyed farms in Canterbury include an arable enterprise. Dairy support is also well represented in all three regions, ranging from 24.14% of farms in Waikato to 32.84% of farms in Southland.

Table 10. Farms with each enterprise type (percent)

region	sheep beef	dairy	deer	pigs, goats, poultry	horti-culture	viti-culture	arable	forest	dairy support	other
Canterbury	70.14%	19.06%	6.83%	7.91%	8.63%	3.96%	29.86%	8.99%	28.06%	3.82%
Southland	75.37%	26.87%	12.69%	2.24%	3.73%	0.00%	6.72%	9.70%	32.84%	0.80%
Waikato	28.45%	65.52%	3.45%	7.76%	6.90%	0.86%	6.03%	8.62%	24.14%	2.78%

Total	62.31%	31.25%	7.58%	6.44%	7.01%	2.27%	18.75%	9.09%	28.41%	2.83%

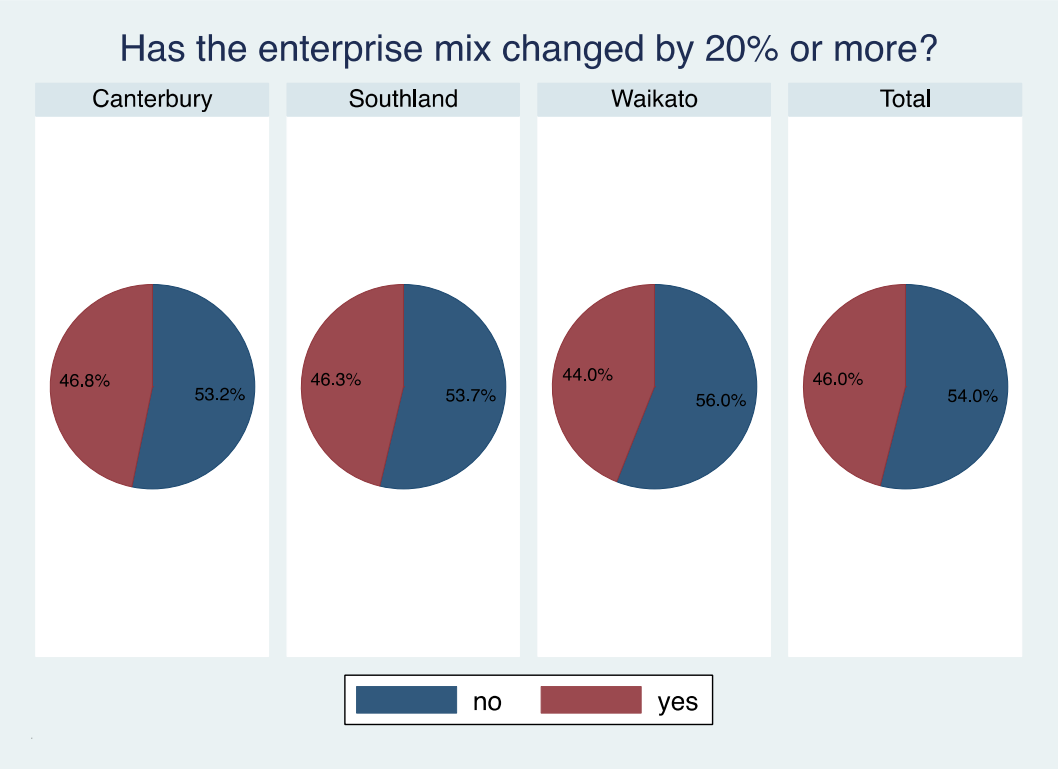
227. Table 11 shows the percentage of land and acreage allocated to each enterprise type in each region. Consistent with previous results, the share of land allocated to sheep and beef is highest in Canterbury and Southland while the share allocated to dairying is highest in Waikato. Comparatively little land on surveyed farms is allocated to pigs, goats, poultry, and other livestock, to horticulture, or to viticulture.

Table 11. Land allocated to each enterprise (ha)

Region	stats	sheep, beef	Dairy	deer	pigs, goats, poultry	horticulture	viticulture	arable	forestry
Canterbury	share	67.6%	18.0%	6.5%	4.7%	7.2%	4.0%	28.8%	9.0%
	mean	621	344	188	38	28	57	369	312
	sd	2,067	295	302	109	77	164	1,895	1,394
	min	1	38	8	1	1	1	4	1
	median	72	295	65	3	6	7	106	15
	max	20,000	1,500	1,000	400	350	550	17,000	7,000
Southland	share	74.6%	21.6%	11.9%	0.0%	2.2%	0.0%	6.7%	9.7%
	mean	339	256	253	.	31	.	162	49
	sd	604	190	584	.	39	.	270	57
	min	2	5	12	.	2	.	8	4
	median	138	200	75	.	15	.	17	28
	max	4,300	740	2,410	.	75	.	800	200
Waikato	share	28.4%	64.7%	3.4%	4.3%	6.9%	0.9%	3.4%	7.8%
	mean	216	219	120	18	79	3	12	19
	sd	480	288	187	22	191	.	2	11
	min	3	36	10	2	2	3	9	5
	median	40	155	35	3	10	3	13	15
	max	2,000	2,450	400	50	550	3	14	35
Total	share	60.8%	29.2%	7.2%	3.4%	5.9%	2.3%	17.6%	8.9%
	mean	492	266	208	32	41	53	334	183
	sd	1,630	279	430	93	113	157	1,760	1,017
	min	1	5	8	1	1	1	4	1
	median	100	200	65	3	8	5	82	20
	max	20,000	2,450	2,410	400	550	550	17,000	7,000

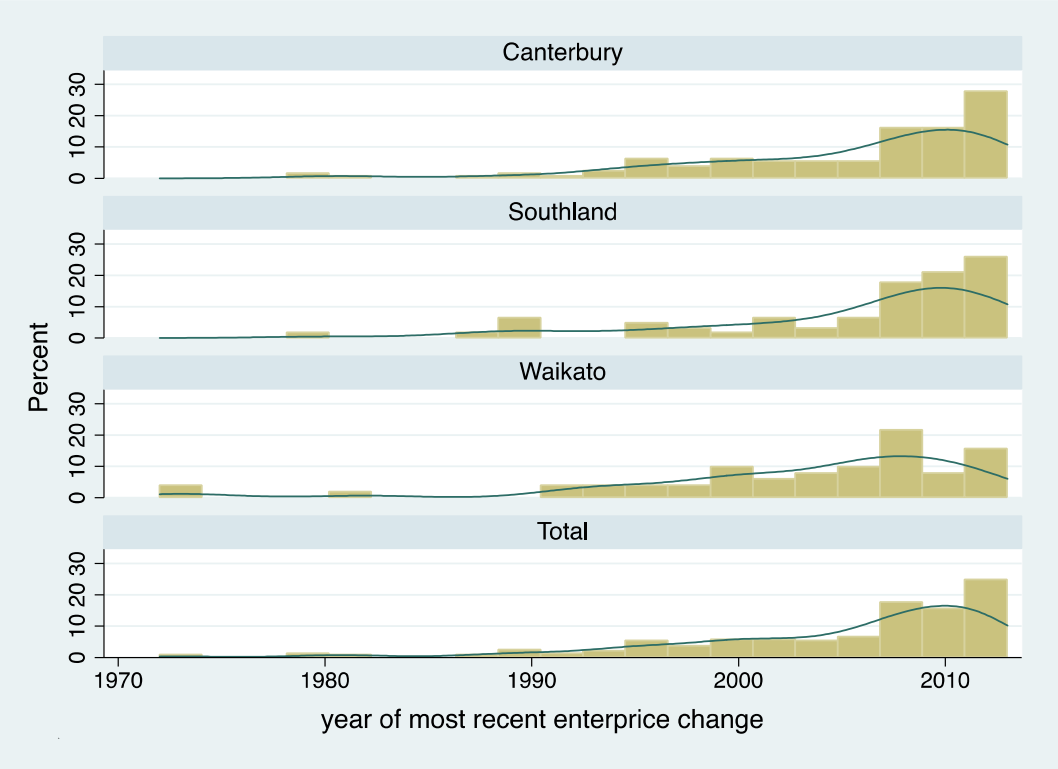
228. Figure 13 shows that 46.8% of Canterbury respondents, 46.3% of Southland respondents and 44.0% of Waikato respondents changed enterprise mixes by more than 20% during the time of their tenure on the farm.

Figure 13. Changes in the enterprise mix during tenure of farmer



229. Respondents who had made significant changes to the enterprise mix on their properties were subsequently asked in what year these changes were made. Results are shown in Figure 14 and Table 12. On average, Canterbury farmers changed enterprise mixes most recently, on average (statistically significant at the 5% level).

Figure 14. Most recent enterprise change among farms that experienced change (year)



Note: Enterprise change is defined as 20% or more of farmland being reallocated

Table 12. Most recent enterprise change among farms that experienced change (year)

region	N	mean	sd	min	median	max
Canterbury	130	2005	7	1980	2008	2013
Southland	62	2005	8	1980	2008	2013
Waikato	51	2003	9	1972	2005	2012
Total	243	2005	8	1972	2008	2013

6.3.3 Livestock and Dairy Support

230. Among properties that have livestock, Table 13 shows the average number by type across the three regions. Sheep enterprises in Canterbury have the smallest average number of sheep (1,905) but the greatest range with the highest maximum of 26,500. Waikato sheep enterprises have an average of 2,242 sheep with a maximum of 14,000 while Southland sheep enterprises have the highest average number of sheep at 2,586 but the smallest maximum of 12,500. Waikato farms have the highest average number of beef cattle (214) followed by Canterbury (188) and Southland (144). Canterbury dairy enterprises have the largest average number of cattle (1,375), followed by Southland (749) and Waikato (681). Southland and Waikato deer enterprises have similar average numbers of deer (868 and 803, respectively) while deer farms in Canterbury have half as many animals (441), on average. Pigs are primarily farmed in Canterbury, where the average pig enterprise has 9,246 head of stock. Waikato pig farms in the survey stock 1,251 animals, on average, and pig farming is absent in the surveyed farms in Southland. Goat

farming is primarily a hobby activity on the surveyed farms in Canterbury and Southland, although a handful of farms have larger goat herds in Waikato. Likewise, surveyed farms in Southland do not engage in poultry farming, and the average poultry farm in the Waikato has approximately three times as many birds as the average poultry farm in Canterbury.

Table 13. Head of livestock

region	stats	sheep	beef cattle	dairy cattle	deer	pigs	goats	comm poultry
Canterbury	mean	1,905	188	1,375	441	9,246	22	36,507
	sd	3,418	358	1,596	351	19,991	32	33,730
	min	2	1	6	49	2	1	6
	median	550	50	1,000	330	120	10	55,000
	max	26,500	2,823	8,725	1,430	45,000	70	72,000
Southland	mean	2,586	144	749	868	.	100	.
	sd	2,846	228	629	1,226	.	.	.
	min	6	1	19	30	.	100	.
	median	1,775	48	492	350	.	100	.
	max	12,500	1,250	2,240	3,900	.	100	.
Waikato	mean	2,242	214	681	803	1,251	410	103,670
	sd	4,324	349	1,104	1,199	1,766	410	89,774
	min	20	1	120	120	2	120	10
	median	135	52	460	246	1,251	410	155,000
	max	14,000	1,400	9,500	2,600	2,500	700	156,000
Total	mean	2,166	178	915	665	6,961	144	56,656
	sd	3,292	322	1,244	919	16,798	250	60,016
	min	2	1	6	30	2	1	6
	median	1,000	50	610	320	120	70	58,500
	max	26,500	2,823	9,500	3,900	45,000	700	156,000

231. The average stocking rate for dairy cattle in the three regions is presented in Figure 15 and Table 14. The average dairy cattle stocking rate across the three regions was 3.3 animals per hectare. Canterbury farms had the highest average stocking rate (3.7), followed by Southland (3.2) and then Waikato (3.1). Unfortunately, the survey questions did not separate out sheep from beef with regard to land quantity and therefore sheep stocking rates and beef cattle stocking rates cannot be calculated from the survey data.

Figure 15. Stocking rate of dairy cattle

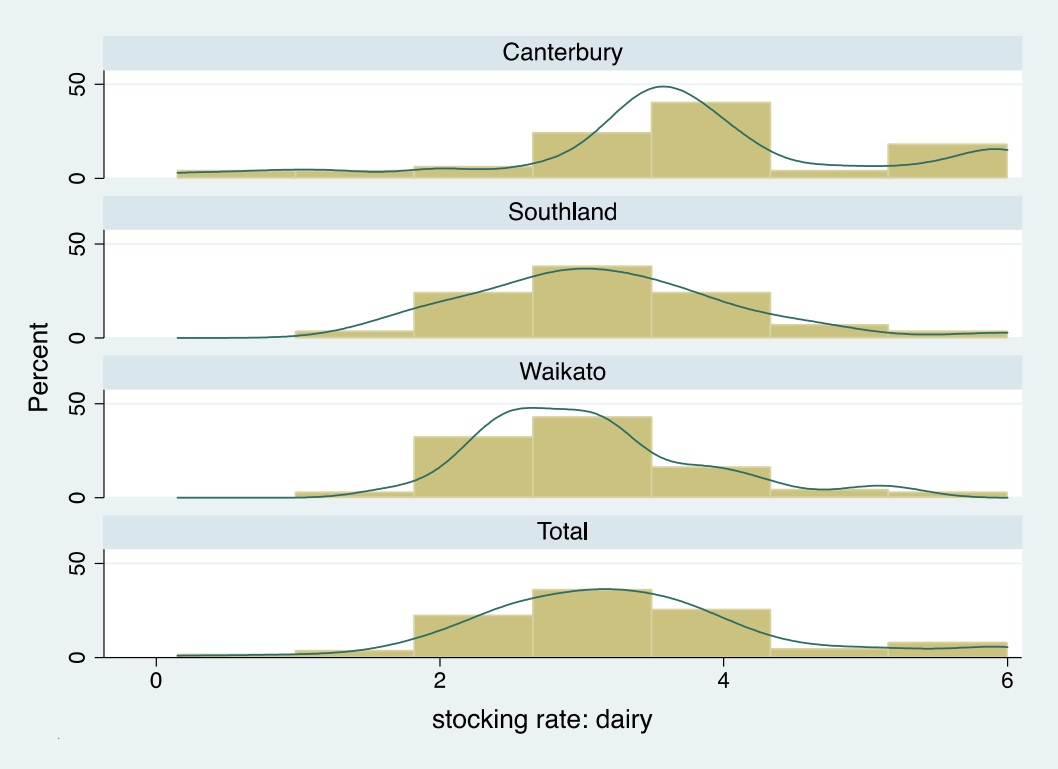


Table 14. Stocking rate of dairy cattle

region	N	mean	sd	min	median	max
Canterbury	50	3.7	1.3	0.2	3.7	6.0
Southland	29	3.2	0.9	1.8	3.0	6.0
Waikato	75	3.1	0.8	1.6	2.9	5.3
Total	154	3.3	1.1	0.2	3.2	6.0

232. Respondents with dairy enterprises were asked where they graze their young stock and where they winter their stock. Response options for these two questions included: on their own block, a runoff that is leased or owned, and elsewhere. Respondents could select more than one option, thus percentages do not necessarily sum to 100%. The results of these two questions are presented in Table 15.

233. Over 50% of Canterbury and Waikato respondents graze their young cattle elsewhere, with roughly one-third also using a runoff. In contrast, the majority of Southland respondents graze their young cattle on their own block or on a runoff. Waikato and Southland respondents predominantly winter stock on their own block (90.8% and 80.0%, respectively), albeit with some support from runoffs (27.6% and 45.7%, respectively). Canterbury dairy farmers are much more likely to winter their stock on a runoff or elsewhere than the other two regions (significant ant the 1% level).

Table 15. Grazing and wintering of livestock (percent)

	Where are young stock grazed?			Where are stock wintered?		
region	own block	owned or leased runoff	elsewhere	own block	owned or leased runoff	elsewhere
Canterbury	30.8%	30.8%	53.8%	38.5%	32.7%	42.3%
Southland	51.4%	45.7%	28.6%	80.0%	45.7%	25.7%
Waikato	28.9%	36.8%	52.6%	90.8%	27.6%	14.5%
Total	34.4%	36.8%	47.9%	71.8%	33.1%	25.8%

234. Respondents whose farming enterprise included dairy support were asked how many weeks they grazed heifers during the last year and approximately how many heifers were grazed. The results of these two questions are presented in Tables 16 and 17, respectively. Across the three regions, the mean number of weeks of dairy support provided was 42. Respondents in Canterbury offered an average of 40 weeks of dairy support while those in Waikato and Southland averaged 44 weeks of dairy support.

Table 16. Duration of dairy support among those who provide it (weeks per year)

region	N	mean	sd	min	median	max
Canterbury	63	40	18	4	52	52
Southland	31	44	16	10	52	52
Waikato	24	44	16	2	52	52
Total	118	42	17	2	52	52

Table 17. Number of dairy cattle supported

region	N	mean	sd	min	median	max
Canterbury	64	315	348	7	200	2,000
Southland	33	451	772	14	180	3,600
Waikato	27	224	381	15	120	2,000
Total	124	331	504	7	180	3,600

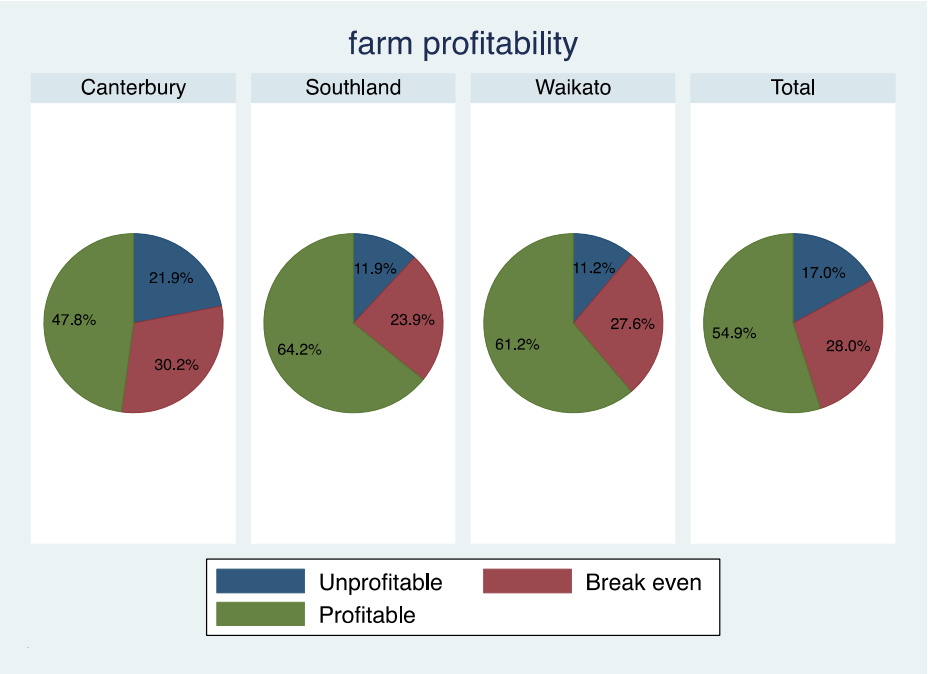
235. The mean number of heifers for which dairy support was provided was 451 in Southland, 315 in Canterbury and 224 in Waikato.

6.3.4 Farm Finances – Profitability and Non-farm Income sources

236. Figure 16 shows the self-reported profitability of all farming enterprises by region. Across all three regions, 54.9% of respondents reported that they were profitable in recent years, 28% reported that they had broken even, and 17% reported to be unprofitable. Respondents in Southland (64.2%) and Waikato (61.2%) reported a higher share of profitability than respondents in Canterbury (47.8%), significant at

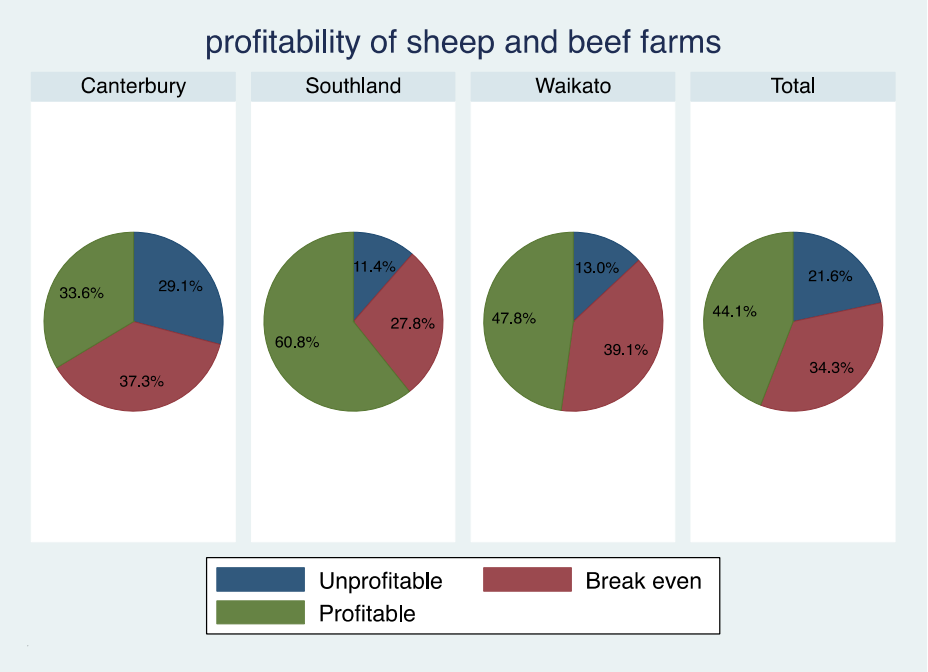
the 5% level. Canterbury respondents reported the highest percentage of unprofitable farms among the three regions surveyed.

Figure 16. Farm profitability



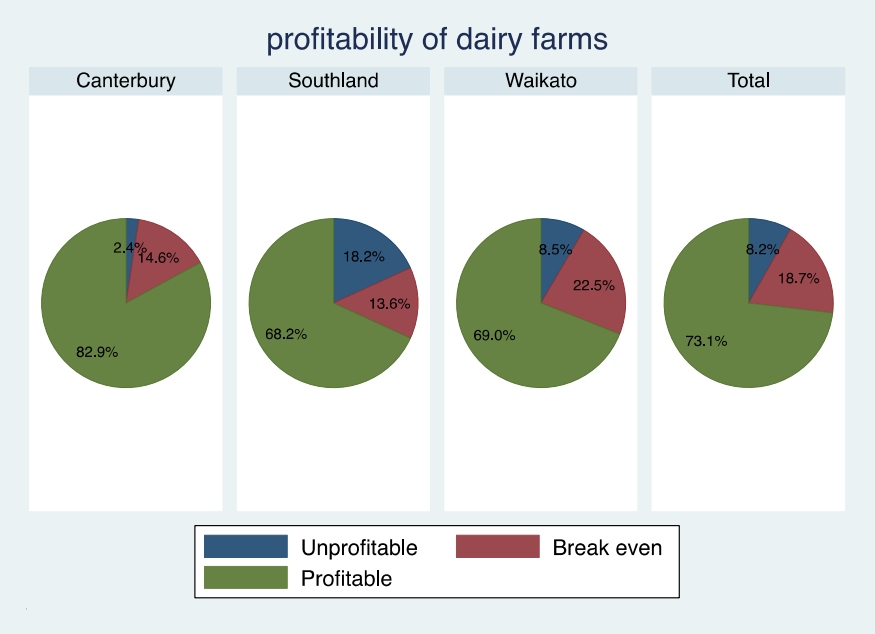
237. Figure 17 reports profitability of sheep and beef enterprises across the three regions. Southland has the highest percentage of profitable sheep and beef enterprises and the lowest percentage of unprofitable ones. Just under half of Waikato sheep and beef enterprises report being profitable and only one-third of Canterbury sheep and beef respondents report being profitable in recent years. Thirty percent of respondents in Canterbury report being unprofitable.

Figure 17. Profitability of sheep and beef farms



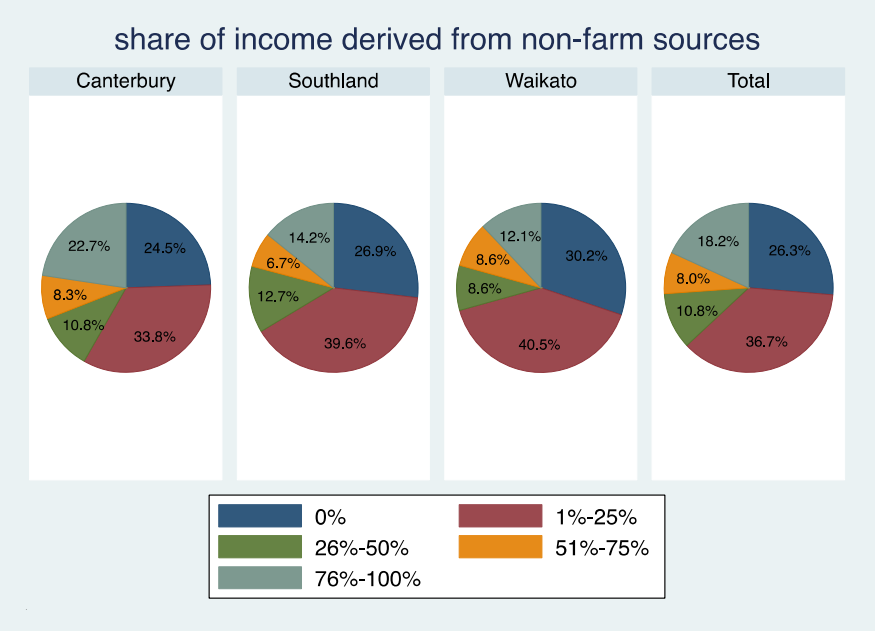
238. Respondents whose primary enterprise is dairy (Figure 18) report considerably higher percentages of profitability than those whose primary enterprise is sheep and beef in all three regions, with the highest percentage of profitable dairy enterprises being in Canterbury (82.9%). Southland and Waikato report similar percentages of dairy farms as being profitable (68.2%, 69.0% respectively), although Southland (at 18.2%) has more unprofitable dairy farms than Waikato.

Figure 18. Profitability of dairy farms



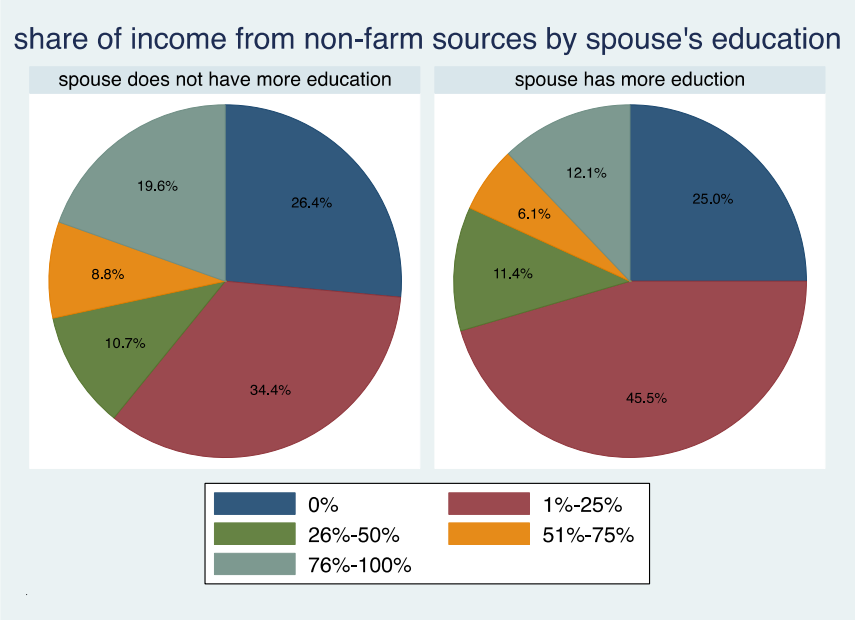
239. Figure 19 shows the share of farm income derived from non-farm sources across the three regions for all enterprise types. Canterbury respondents derive a greater proportion of household income from non-farm sources than Southland and Waikato (significant at the 1% level).

Figure 19. Share of income derived from non-farm sources



240. Figure 20 reports the share of income derived from non-farm sources according to whether the spouse has more education than the farmer. The data indicate that the percentage of non-farm income is greater when the spouse does not have higher educational qualifications than the farmer.

Figure 20. Share of income derived from non-farm sources according to whether the spouse has more education than the farmer



6.4 Farmer Characteristics

241. This section reports on the respondent characteristics. Topics include tolerance to risk, willingness to experiment and innovate, the degree of trust and importance placed on various information sources and networks, farming orientation (i.e., productivist or environmentalist), plans for the farm over the next five years, farmer adoption of and/or behavioural intentions towards various land management practices/behaviours related to improved environmental outcomes, perceived behavioural controls over the adoption of technologies to improve environmental outcomes, farmers' perceptions of the normative expectations of others (i.e., social norms) regarding managing their farm in an environmental sustainable way, the degree to which farmers perceive that their beliefs, attitudes, and values are similar to other farmers in their district, the degree to which they identify with other farmers in the district, and attitudes and values regarding water.

6.4.1 Risk Tolerance and Willingness to Experiment and Innovate

242. This subsection is concerned with respondent farmers' tolerance to risk (Figure 20, Table 18), their willingness to experiment with new ideas (Figure 21, Table 19), and their willingness to innovate and try new things (Figure 22, Table 20). All questions are asked on an 11-point scale from 0 to 10.

243. In terms of risk tolerance, 0 indicates low risk tolerance while 10 represents high risk tolerance. Canterbury respondents score a mean of 5.6, Waikato respondents score a mean of 5.4, and Southland respondents score a mean of 5.3. These scores are statistically indistinguishable from one another. Nevertheless, the distributions are quite flat and the scores dispersed across the full range.

Figure 20. Risk tolerance

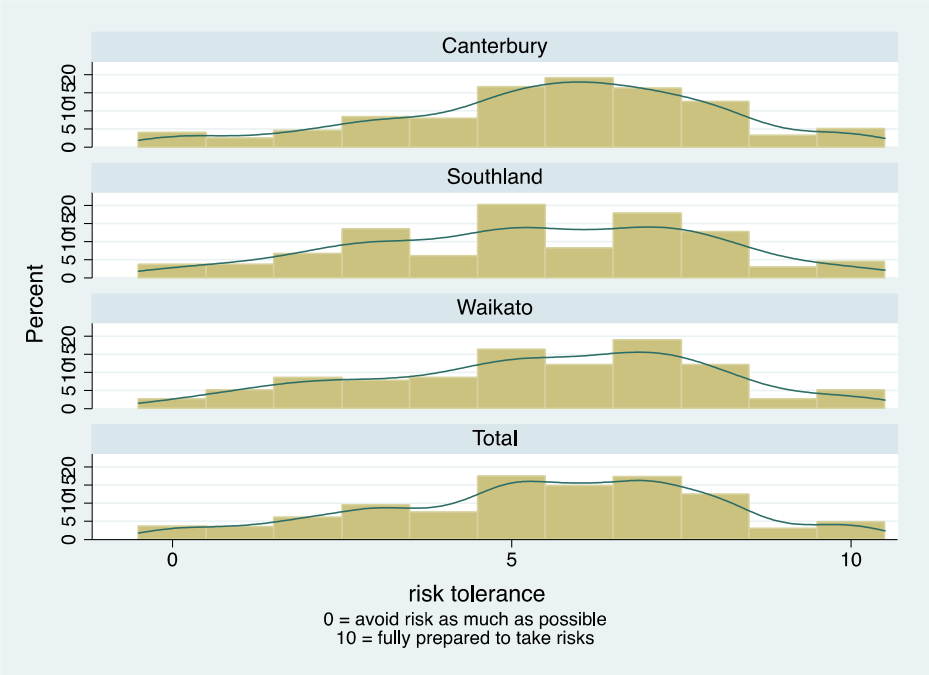


Table 18. Risk tolerance

region	N	mean	sd	min	median	max
Canterbury	278	5.6	2.4	0	6	10
Southland	134	5.3	2.5	0	5	10
Waikato	116	5.4	2.5	0	6	10
Total	528	5.5	2.4	0	6	10

244. For willingness to experiment, 0 indicates a greater willingness to experiment on the part of the respondent and 10 indicates a lower willingness to experiment. Canterbury respondents were the most willing to experiment with a mean score of 4.2 while Southland respondents were the least willing to experiment with a mean of 4.9 (significant at the 5% level). Again, the distribution is flat and the minimum and maximum scores extend across the full response range. The median score for all three regions is 5.

Figure 21. Willingness to experiment

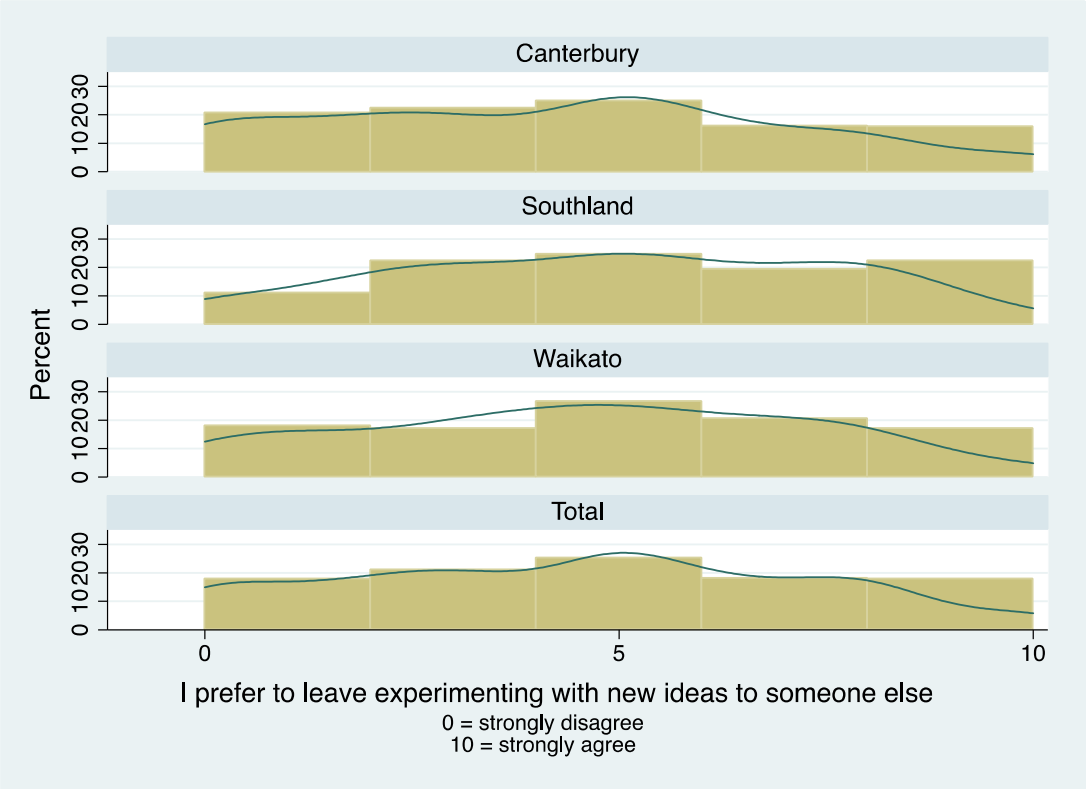


Table 19. Willingness to experiment

region	N	mean	sd	min	median	max
Canterbury	278	4.2	2.9	0	5	10
Southland	134	4.9	2.7	0	5	10
Waikato	116	4.6	2.7	0	5	10
Total	528	4.5	2.8	0	5	10

245. Willingness to innovate is also measured on an 11-point scale, with 0 indicating low willingness to innovate and 10 indicating high willingness to innovate. In contrast to the questions pertaining to risk tolerance and willingness to experiment, Southland respondents are somewhat more willing to adopt new practices (mean = 5.1) than Waikato respondents (mean = 4.8) and Canterbury respondents (mean = 4.5) (significant at the 10% level). Although Southland farmers are less risk tolerant and less inclined to experiment, this result suggests that they are quicker to adopt an established idea or practice than respondents in the other two regions. Adoption of new technologies after discussion or observation of others successfully using the technology is consistent with Roger's (2003) diffusion of innovation theory and Bandura's (1977) Social Learning Theory. Again, the distributions are flat, with a median score for all regions being 5 (the midpoint of the response scale).

Figure 22. Innovators

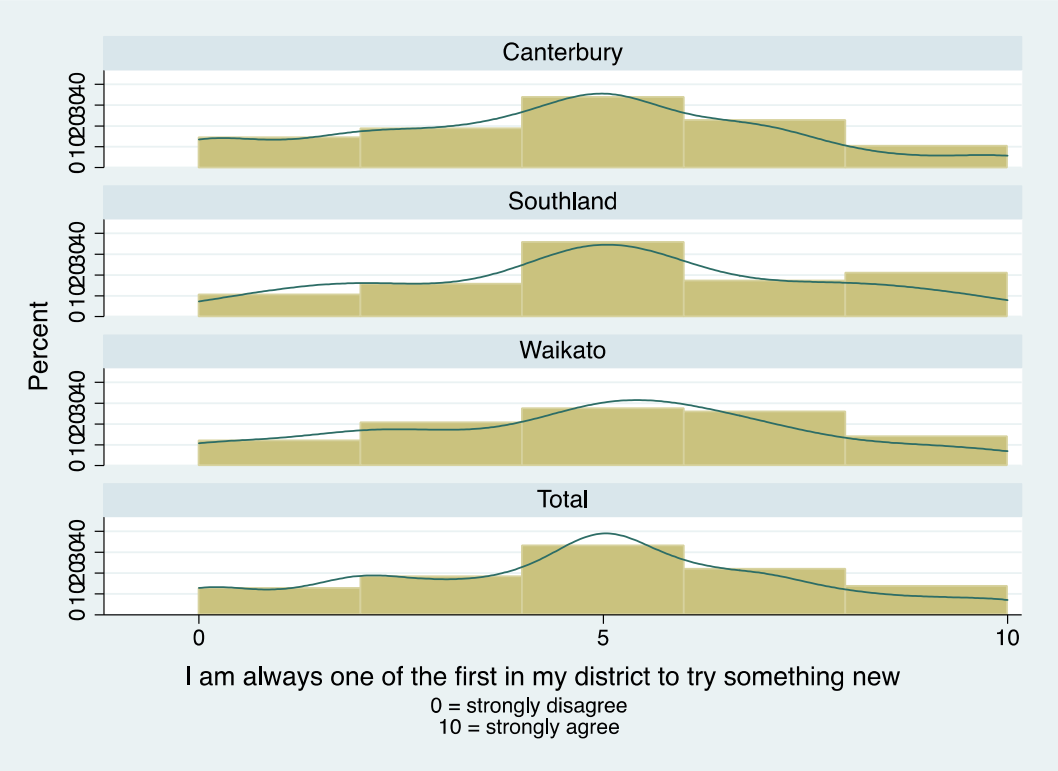


Table 20. Innovators

region	N	mean	sd	min	median	max
Canterbury	278	4.5	2.6	0	5	10
Southland	134	5.1	2.6	0	5	10
Waikato	116	4.8	2.7	0	5	10
Total	528	4.7	2.6	0	5	10

6.4.2 Trust in and Importance of Information Sources

246. Table 21 shows respondents' perceived trust in selected information sources in rank order by region. In all three regions, veterinarians are the most trusted source of information for respondents. A similar result was found by Fisher (2013), who reported that vets were the most trusted and influential information source on British farmers with regard to bovine tuberculosis. The second most trusted information source is accountants and financial advisors in Southland and Waikato, and other farmers and discussion groups in Canterbury. The third most trusted source is other farmers and farmer discussion groups in Southland and Waikato, and accountant and financial advisors in Canterbury. The least trusted source is regional councils, followed by television and radio and central government. Overall, scientists are ranked the eighth most trustworthy of the 15 selected sources.

Table 21. Perceived trustworthiness of information sources, in rank order

	Canterbury		Southland		Waikato		total	
Newspapers, general interest magazines	12	(5.18)	12	(4.82)	12	(4.83)	12	(5.01)
Television, radio	14	(4.26)	13	(4.28)	14	(4.26)	14	(4.27)
Internet	11	(5.33)	11	(5.19)	11	(5.14)	11	(5.25)
Organizations that broadly represent primary industries (e.g., Fed Farmers)	5	(6.43)	7	(6.11)	6	(6.34)	5	(6.33)
Industry groups (e.g., Beef & Lamb NZ, HortNZ, DairyNZ)	7	(6.31)	5	(6.16)	5	(6.48)	6	(6.31)
Cooperatives (e.g., Zespri, Fonterra)	10	(5.77)	10	(5.72)	4	(6.55)	10	(5.93)
Central government	13	(4.35)	15	(4.19)	13	(4.41)	13	(4.32)
Regional councils	15	(4.12)	14	(4.23)	15	(4.09)	15	(4.14)
Accountants and financial advisors	3	(6.88)	2	(6.68)	2	(6.78)	2	(6.81)
Farm consultants, extension officers, contractors	4	(6.49)	8	(6.10)	6	(6.34)	4	(6.36)
Farmers' forums, agricultural shows, field days	6	(6.36)	4	(6.19)	8	(6.12)	7	(6.27)
Other farmers, farmer discussion groups	2	(6.97)	3	(6.63)	3	(6.61)	3	(6.80)
Scientists	8	(6.24)	6	(6.13)	9	(5.94)	8	(6.14)
Veterinarians	1	(7.11)	1	(7.07)	1	(7.00)	1	(7.08)
Rural retailers and their technical representatives	9	(6.11)	9	(5.96)	10	(5.75)	9	(5.99)

Note: Trust is measured on an 11-point scale from 0 ("least trustworthy") to 10 ("most trustworthy"). Raw scores are shown in parentheses.

247. Table 22 shows the importance placed by respondents on information obtained from selected sources, in rank order by region. Similar to trust, the three most important sources of information are veterinarians, accountants and financial advisors, and other farmers and farmer discussion groups. The least important is TV and radio, followed by central government and then regional councils. Information from scientists is ranked as fifth most important.

Table 22. Perceived importance of information sources given their trustworthiness, in rank order

	Canterbury		Southland		Waikato		total	
Newspapers, general interest magazines	12	(4.83)	13	(4.72)	14	(4.44)	12	(4.72)
Television, radio	15	(3.83)	15	(4.18)	15	(3.83)	15	(3.92)
Internet	10	(4.96)	11	(4.86)	11	(4.94)	11	(4.93)
Organizations that broadly represent primary industries	8	(5.67)	9	(5.41)	10	(5.65)	9	(5.60)
Industry groups (e.g., Beef & Lamb NZ, HortNZ, DairyNZ)	9	(5.62)	6	(5.80)	6	(5.95)	8	(5.73)
Cooperatives (e.g., Zespri, Fonterra)	11	(4.95)	10	(5.16)	5	(6.22)	10	(5.28)
Central government	14	(4.18)	14	(4.28)	13	(4.56)	14	(4.29)
Regional councils	13	(4.28)	12	(4.73)	12	(4.66)	13	(4.48)
Accountants and financial advisors	1	(6.49)	4	(6.11)	1	(6.54)	2	(6.40)
Farm consultants, extension officers, contractors	4	(6.11)	3	(6.22)	4	(6.27)	4	(6.17)
Farmers' forums, agricultural shows,	5	(6.04)	8	(5.75)	8	(5.66)	6	(5.89)

field days								
Other farmers, farmer discussion groups	3	(6.34)	2	(6.32)	3	(6.28)	3	(6.32)
Scientists	6	(6.00)	5	(5.93)	8	(5.66)	5	(5.91)
Veterinarians	2	(6.35)	1	(6.51)	2	(6.47)	1	(6.42)
Rural retailers and their technical representatives	7	(5.72)	6	(5.80)	7	(5.75)	7	(5.74)

Note: Importance is measured on an 11-point scale from 0 ("least important") to 10 ("most important"). Raw scores are shown in parentheses.

6.4.3 Farmers' social networks

248. Two measures of the size of farmers' social networks are included in the survey. The first asks "With how many farmers did you discuss farm practices, farm systems change, or practices to improve environmental performance in the last 12 months?" The second asks "How many working farms have you visited in the last 12 months?" The results are depicted in Figure 24.

249. Only a small percentage of survey respondents have not spoken to any other farmers. Approximately two-thirds of all respondents in each region have spoken with 1 – 10 other farmers, while between 21.6% and 26.7% have spoken with 11 - 50 other farmers. A small percentage in each region has spoken with more than 51 other farmers (Figure 23).

250. Figure 24 shows the number of farms visited. Only a small proportion of respondents have not visited any other working farms. Between 14.2% and 17.2% of respondents in each region have visited 1-2 other farms while 25.0 - 36.7% have visited 3-5 farms.

Figure 23. Size of social network (other farmers)

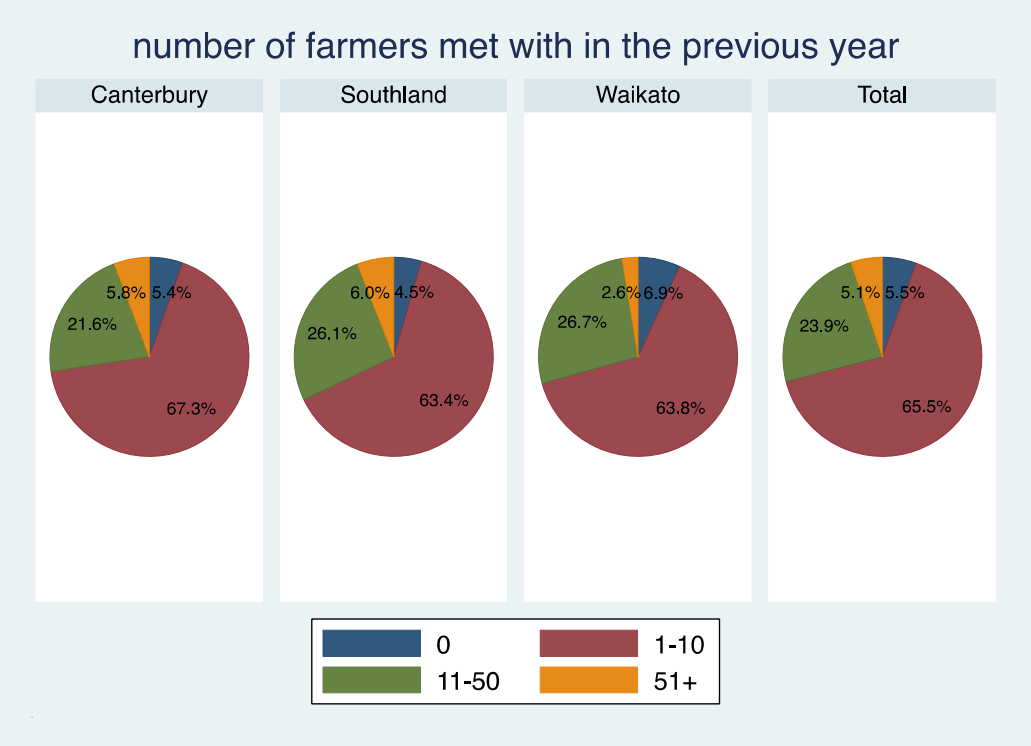
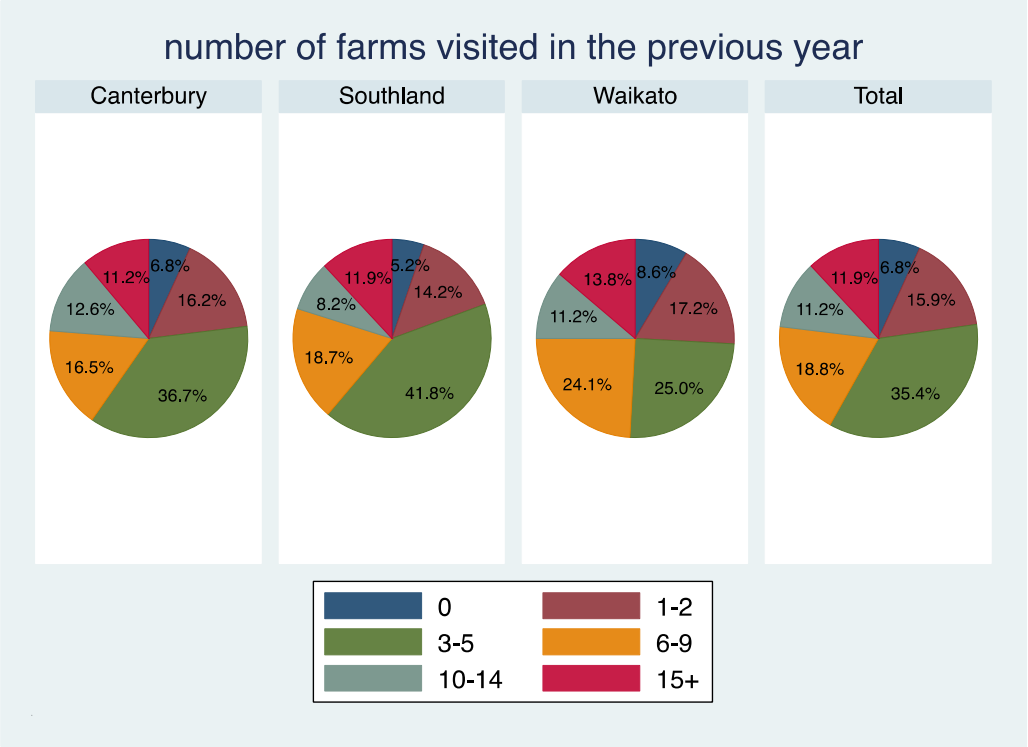
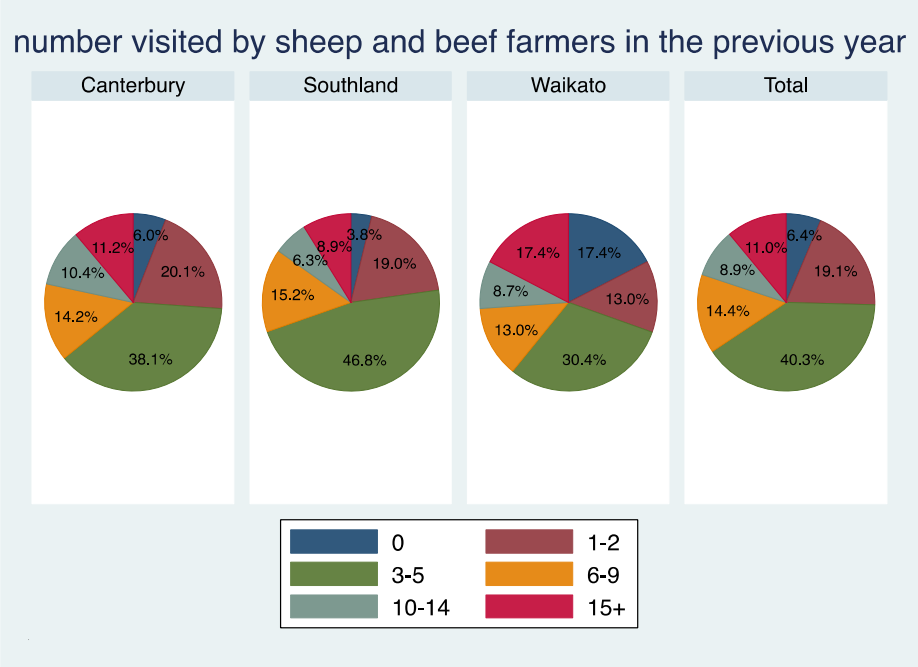


Figure 24. Size of social network (other farms)



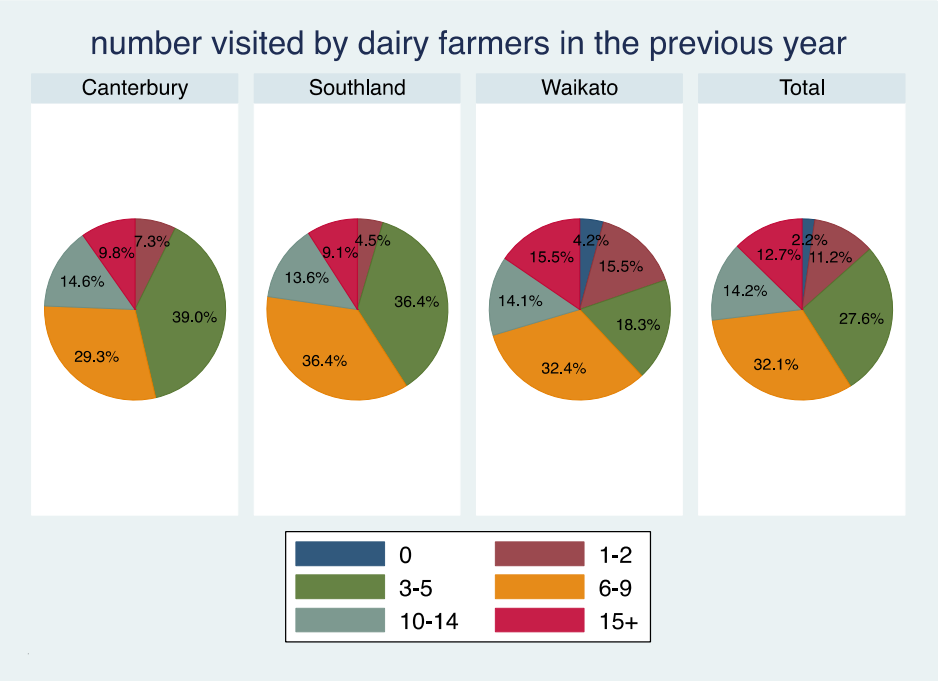
251. Figure 25 shows the size of sheep and beef farmer networks (in terms of other farms visited in the past year) by region.

Figure 25. Size of social network (other farms) among sheep and beef farmers



252. Figure 26 presents the same information for dairy farmers. By this measure, dairy farmers are considerably more connected than sheep and beef farmers in all three regions.

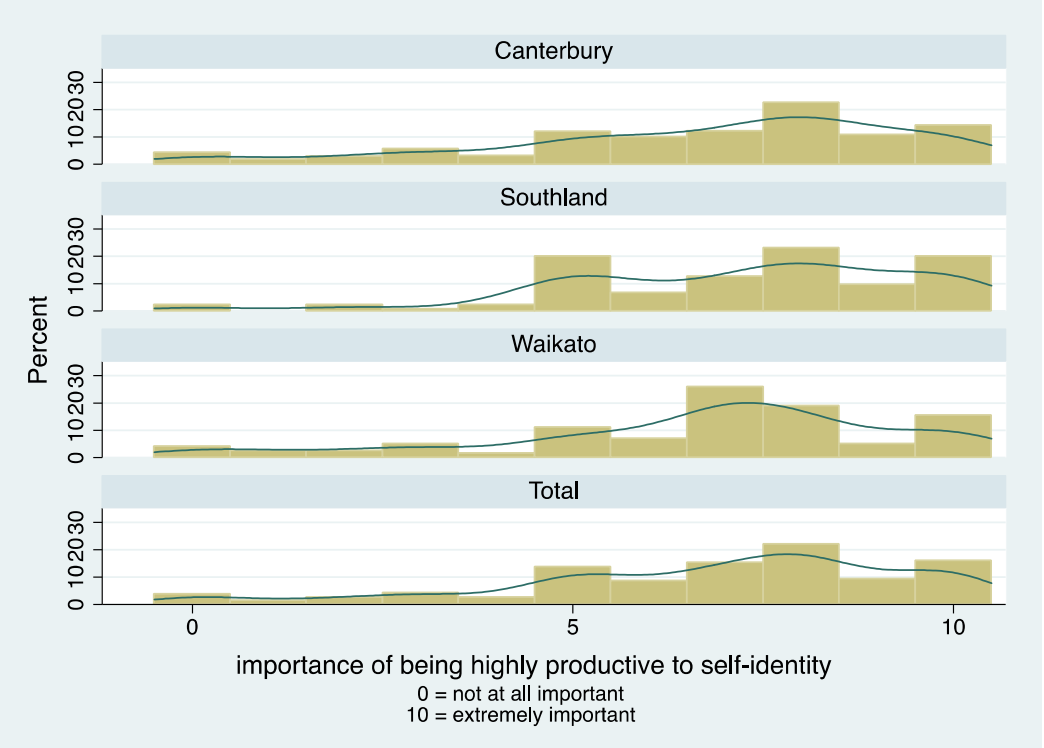
Figure 26. Size of social network (other farms) among dairy farmers



6.4.4 Farming orientation

253. Two questions were asked regarding farming orientation. The first focuses on the extent to which respondents self-identify with a productivist farming outlook (Figure 27 and Table 23) and the second focuses on the extent to which respondents self-identify with an environmentalist outlook (Figure 28 and Table 29).

Figure 27. Farming goals – productivity



254. The mean scores for productivist outlook for Waikato, Canterbury, and Southland are 6.6, 6.7 and 7.2, respectively. The median score for Canterbury and Waikato is 7 while for Southland it is 8. These figures suggest that Southland respondents have a slightly more productivist orientation than Waikato and Canterbury respondents, significant at the 5% level.

Table 23. Farming goals – productivity

region	N	mean	sd	min	median	max
Canterbury	278	6.7	2.7	0	7	10
Southland	134	7.2	2.3	0	8	10
Waikato	116	6.6	2.6	0	7	10
Total	528	6.8	2.6	0	7	10

255. For the environmentalist orientation question, the distribution across all three regions is skewed toward the high end of the scale. Across the three regions, the mean and median scores are 8.2 and 8.0, respectively.

Figure 28. Farming goals – environment

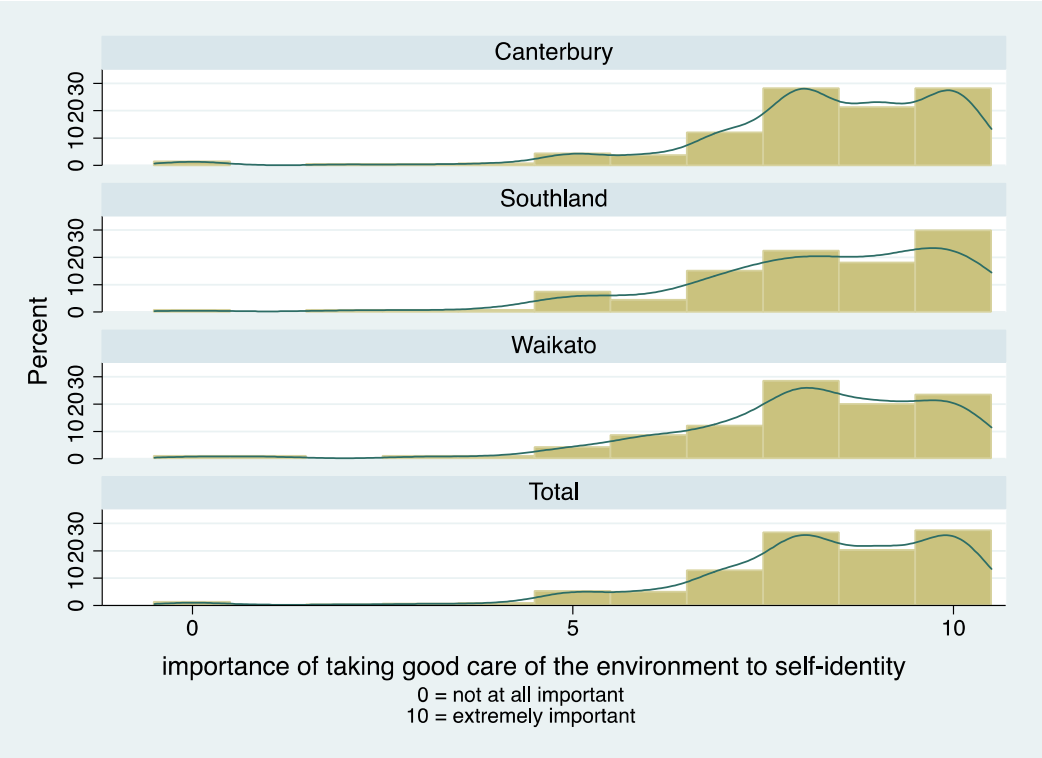


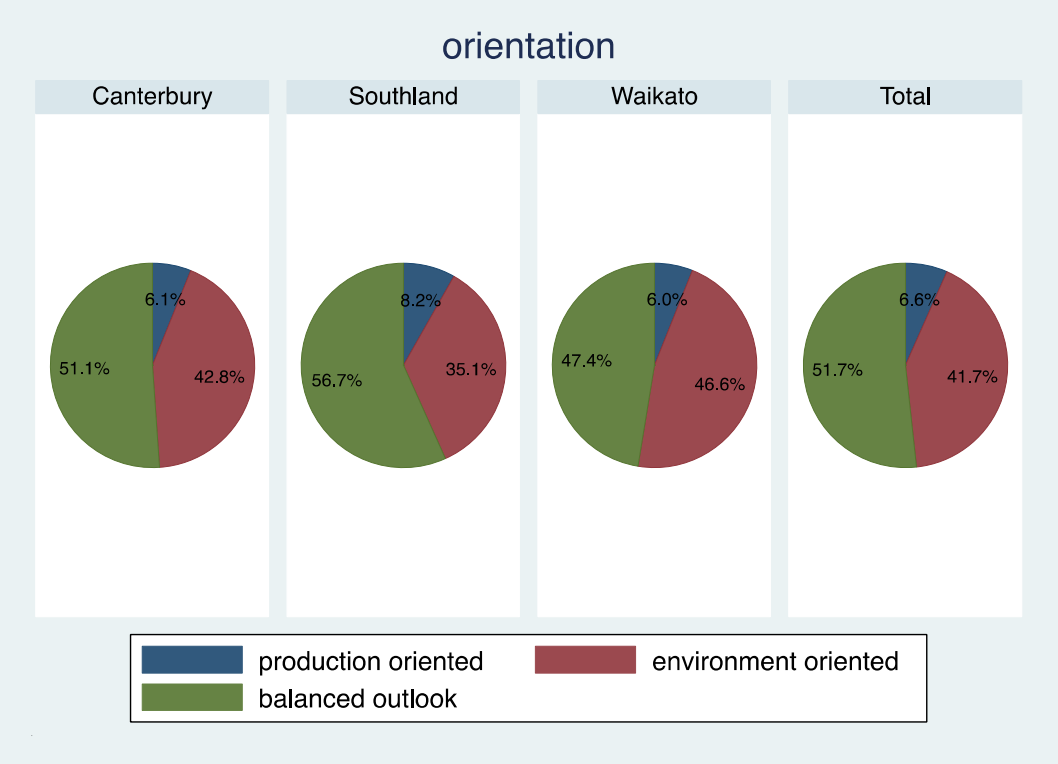
Table 24. Farming goals – environment

region	N	mean	sd	min	median	max
Canterbury	278	8.3	1.8	0	8	10
Southland	134	8.1	1.9	0	8	10
Waikato	116	8.0	1.8	0	8	10
Total	528	8.2	1.8	0	8	10

256. From the data obtained in the two orientation questions, a measure for orientation (i.e., productivity vs. environmental orientation) was constructed with three different categorical orientations: “production orientation”, “environmental orientation”, and “balanced orientation”. The orientation measure was constructed such that respondents who gave a score that is 2 or more points higher on the productivist question than on the environmentalist question are defined as being "production oriented", and vice-versa. Those assigning scores to the two questions within one point of each other are defined as having a "balanced outlook".

257. Figure 29 presents farming orientation by region. In all regions a balanced outlook predominates. Southland has the lowest percentage of respondents with an environmental orientation (significant at the 5% level). The share of respondents classified as productivist does not vary systematically across regions. Across all three regions, roughly half of respondents have a balanced outlook while production orientation does not exceed 8.2% in any region.

Figure 29. Orientation – productivity vs. environment



Note: Orientation is based on the scores given to the following two questions: A) How important is being a highly productive farmer to your sense of self-identity? B) How important is being a farmer who takes care of the environment to your sense of self-identity? Specifically, respondents who gave a score that is 2+ points higher on question A than on question B are defined as being "production oriented", and vice-versa. Those assigning scores to questions A and B within 1-point of each other are defined as having a "balanced outlook".

6.4.5 Respondents' Plans for Their Farms in the Next Five Years

258. Respondents were asked a set of six questions regarding their plans for their property in the next five years. Specifically, they were asked the likelihood that each of the following outcomes would happen in the next five years: a) part or all of the farm will be sold; b) part or all of the farm will be leased out or worked by a sharemilker; c) they will purchase, lease, or share farm additional land; d) the enterprise mix will be changed to reduce their workload; e) the enterprise mix will be changed to a more intensive enterprise; and f) the enterprise mix will be changed due to impending regulations. Questions a, b, and d reflect de-intensification, questions c and e reflect intensification, and question f is concerned with the possibility of future regulation impacting freedom to operate. The response scale for these six questions was an 11-point scale ranging from 0 ("extremely unlikely") to 10 "extremely likely". Previous research has found that farmers with an identified successor in place are more likely to intensify their operation, whereas farmers without a successor are more likely to move towards extensive practices (Potter and Lobley, 1996; Sottomayor et al., 2011)

259. Figure 30 and Table 25 show the reported likelihood of selling the farm in the next five years across the three regions. With a mean of 3.0 and a median of 1, the results indicate a low likelihood of respondents selling their farms. Differences across regions are not statistically significant.

Figure 30. Intention to sell the farm in the next 5 years

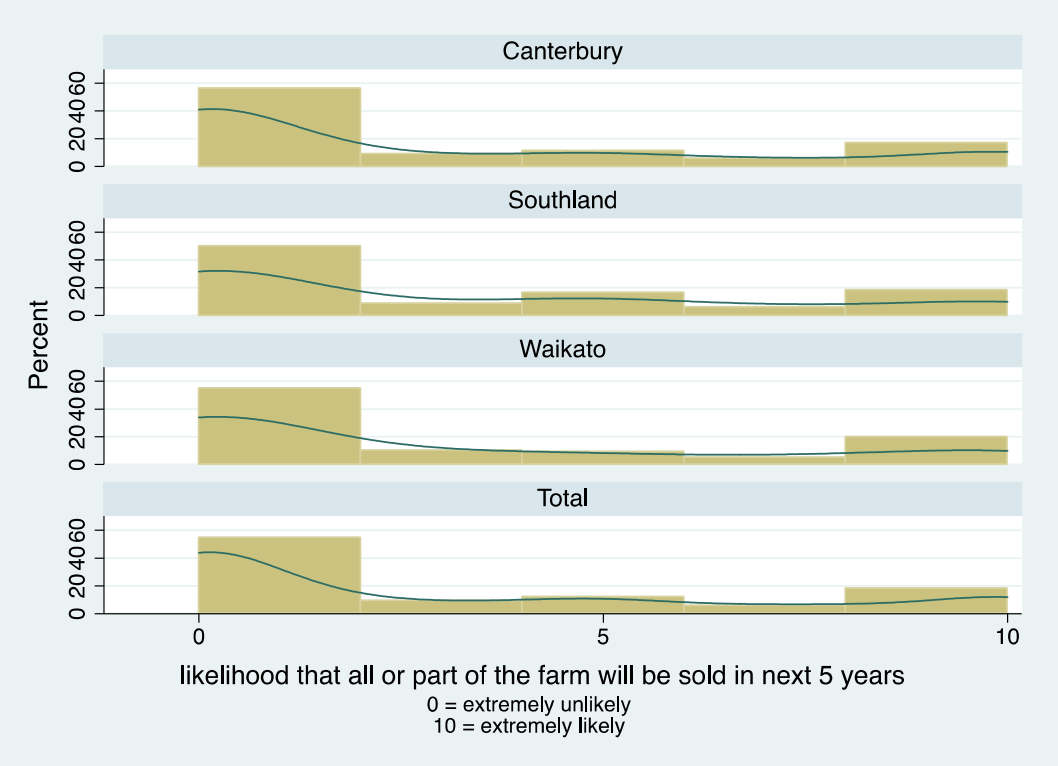


Table 25. Intention to sell the farm in the next 5 years

region	N	mean	sd	min	median	max
Canterbury	278	2.8	3.6	0	1	10
Southland	134	3.2	3.7	0	1.5	10
Waikato	116	3.0	3.7	0	1	10
Total	528	3.0	3.7	0	1	10

260. Figure 31 and Table 26 report respondents' intentions to lease land out in the next five years. As can be seen from the figure and table, respondents across all three regions are even less likely to lease out their land than they are to sell it. Differences across regions are not statistically significant.

Figure 31. Intention to lease land out in the next 5 years

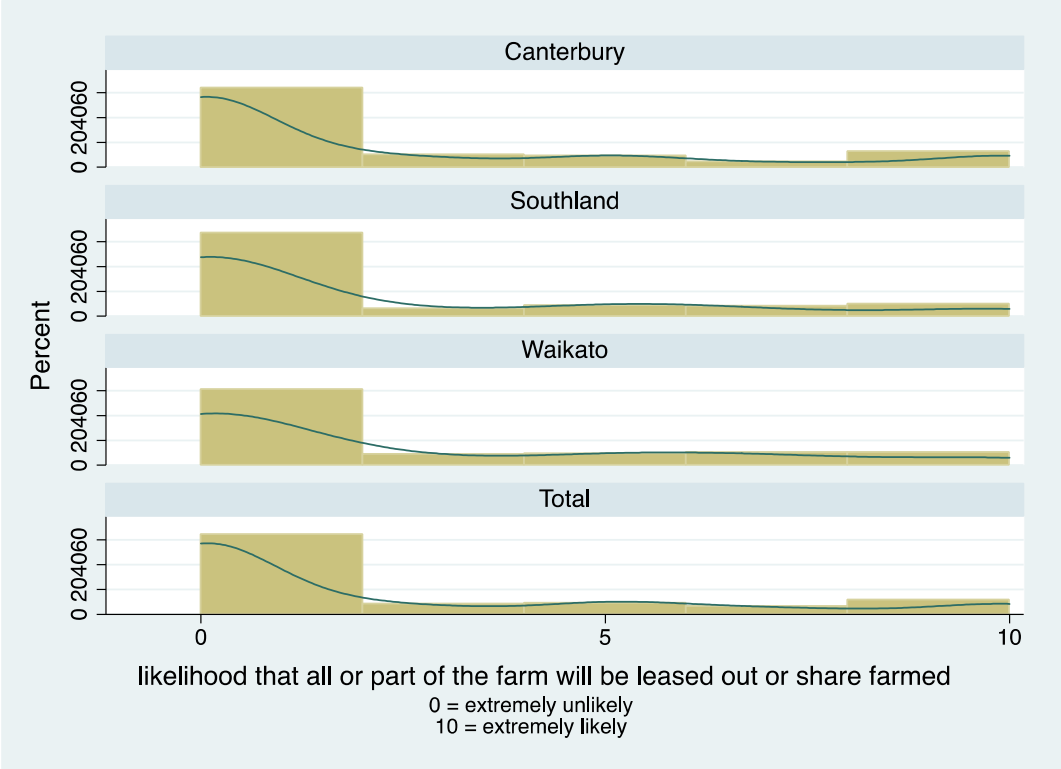


Table 26. Intention to lease land out in the next 5 years

region	N	mean	sd	min	median	max
Canterbury	278	2.2	3.4	0	0	10
Southland	134	2.1	3.2	0	0	10
Waikato	116	2.4	3.3	0	0	10
Total	528	2.2	3.3	0	0	10

261. Figure 32 and Table 27 show that relatively few respondents intend to farm additional land in the next five years. However, respondents are more likely to farm additional land than they are to either lease or sell land in all three regions (significant at the 5% level)

Figure 32. Intention to farm additional land in the next 5 years

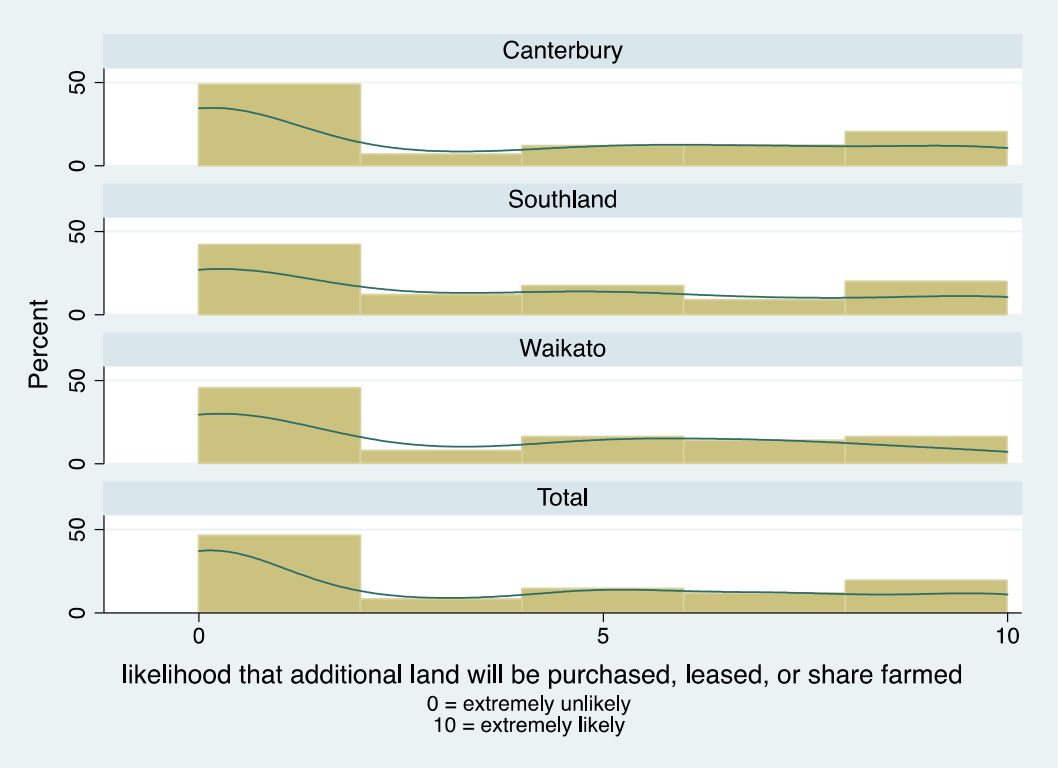


Table 27. Intention to farm additional land

region	N	mean	sd	min	median	max
Canterbury	278	3.5	3.7	0	2	10
Southland	134	3.7	3.7	0	3	10
Waikato	116	3.4	3.5	0	2	10
Total	528	3.5	3.7	0	2	10

262. Figure 33 and Table 28 show that relatively few respondents report a high likelihood of changing the enterprise mix in order to reduce workloads over the next five years. The median score for rural decision-makers in Waikato is 2 while that for decision-makers in Canterbury and Southland is 3.

Figure 33. Intention to change enterprise mix to reduce workload in the next 5 years

Table 28. Intention to change enterprise mix to reduce workload in the next 5 years

region	N	mean	sd	min	median	max
Canterbury	278	3.7	3.6	0	3	10
Southland	134	3.7	3.4	0	3	10
Waikato	116	3.5	3.5	0	2	10
Total	528	3.7	3.5	0	3	10

263. Figure 34 and Table 29 show that the majority of respondents do not intend to change their enterprise mix to intensify their farming operations in the next five years. With a mean of 3.6 and a median of 3, rural decision-makers in Canterbury are more likely to hold intentions to intensify their enterprise mix than decision-makers in either Southland (mean = 2.9, median = 2) or Waikato (mean = mean 2.3, median = 1), significant at the 1% level.

Figure 34. Intention to intensify enterprise mix in the next 5 years

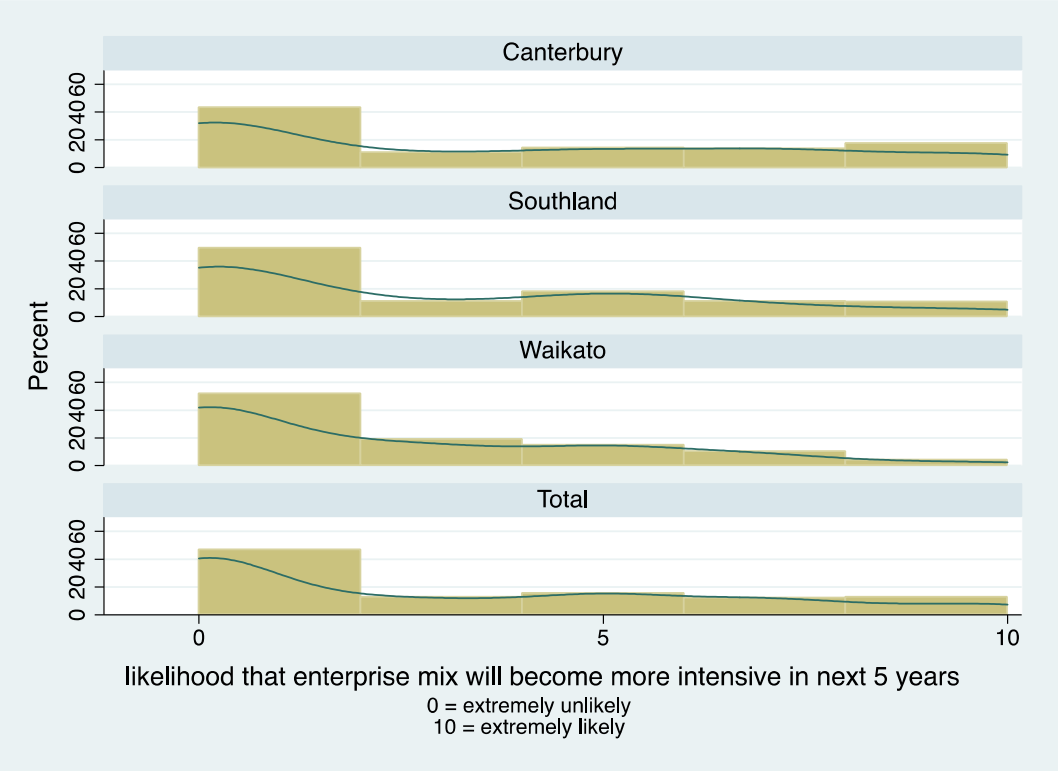


Table 29. Intention to intensify enterprise mix in the next 5 years

region	N	mean	sd	min	median	max
Canterbury	278	3.6	3.5	0	3	10
Southland	134	2.9	3.1	0	2	10
Waikato	116	2.3	2.8	0	1	10
Total	528	3.1	3.3	0	2	10

264. Respondents were also asked to estimate the likelihood that their enterprise mix would change due to impending regulations. Results are presented in Figure 35 and Table 30. These data indicate that the majority believe that they are unlikely to change their enterprise mix due to regulatory pressure in the next 5 years, with little difference across regions.

Figure 35. Expectation of changing enterprise mix due to regulations in the next 5 years

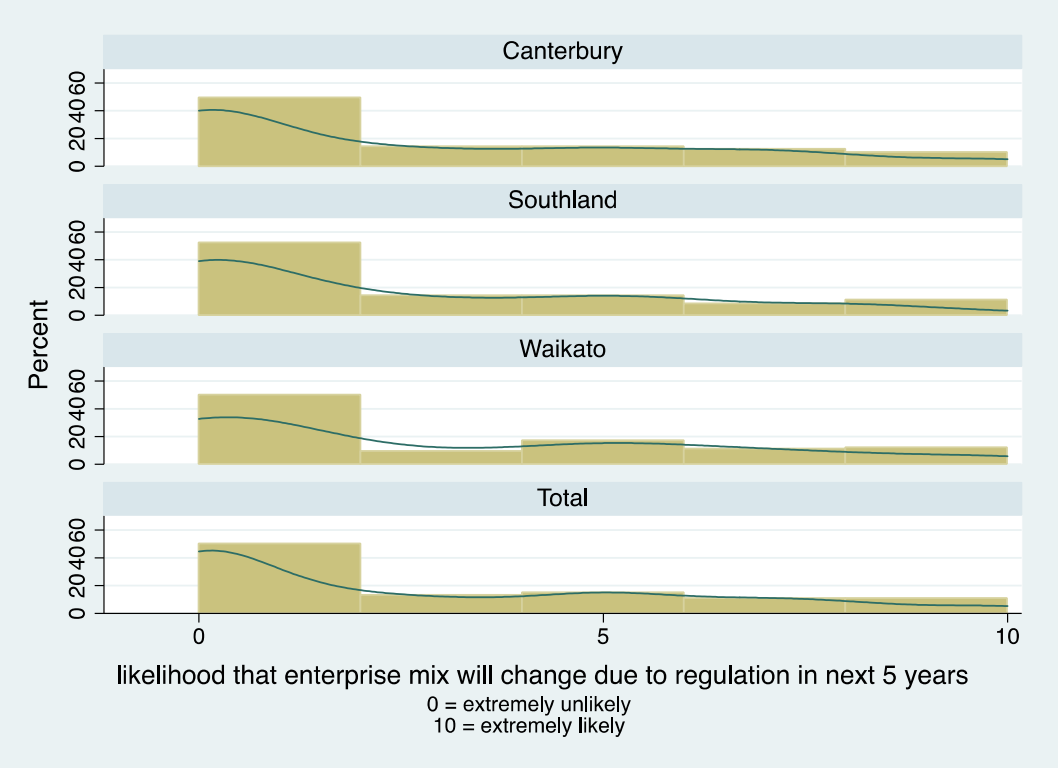


Table 30. Expectation of changing enterprise mix due to regulations in the next 5 years

region	N	mean	sd	min	median	max
Canterbury	278	2.8	3.2	0	2	10
Southland	134	2.6	3.0	0	1	10
Waikato	116	3.1	3.3	0	2	10
Total	528	2.8	3.1	0	2	10

6.4.6 Motivation for Farming - Tradition

265. This question asked the extent to which the respondent farmed due to family tradition. Answers were reported on an 11-point scale ranging from 0 ("strongly disagree") to 10 ("strongly agree"). Tradition was a stronger motivator in Southland (mean = 4.6, median = 5) than in either Canterbury or Waikato (both with a mean of 4.0 and a median of 3), significant at the 10% level. These results indicate that although tradition is not the primary motivation for farming for a majority of respondents, it is nonetheless an important motivator for some farmers.

Figure 36. Motivation for farming

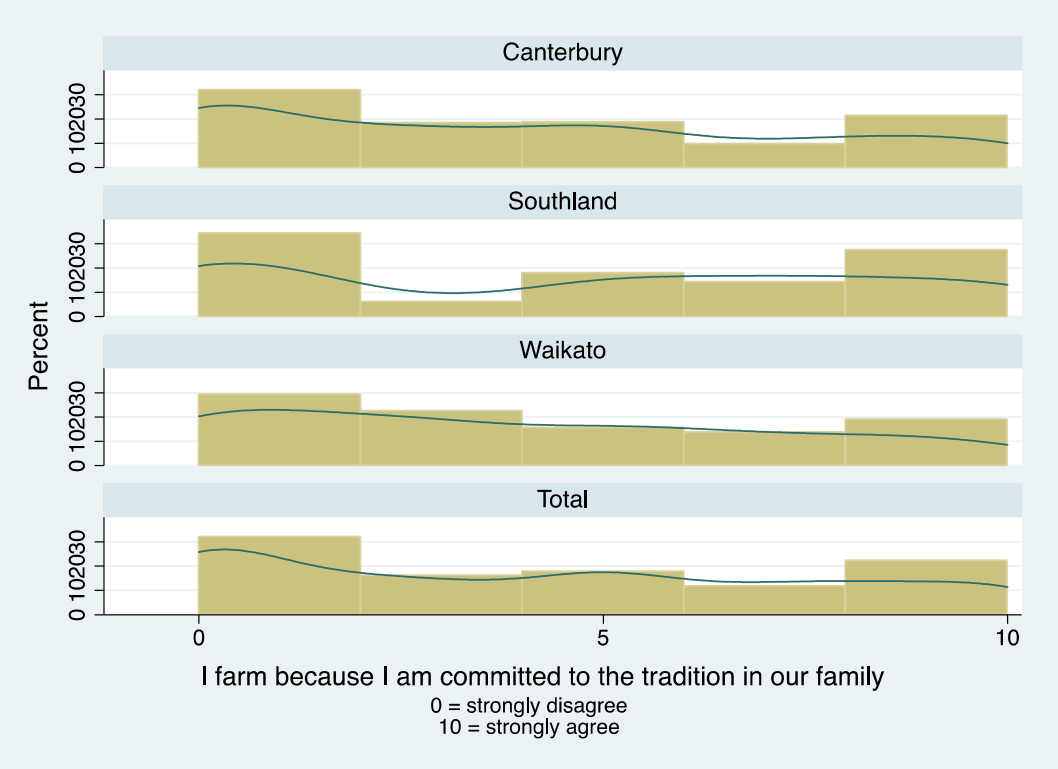


Table 31. Motivation for farming

region	N	mean	sd	min	median	max
Canterbury	278	4.0	3.4	0	3	10
Southland	134	4.6	3.7	0	5	10
Waikato	116	4.0	3.2	0	3	10
Total	528	4.1	3.4	0	4	10

6.4.7 Perceived Behavioural Control

266. Three questions were asked regarding respondents' perceived behavioural control over their ability to adopt technologies or management practices that improve environmental outcomes. The first question concerns whether or not respondents believe that they have the necessary skills and knowledge; the second question concerns whether respondents believe that they have adequate financial resources; and the third question seeks to ascertain whether other issues prevent respondents from adopting such practices or technologies. In all three questions, a score of 0 indicates "strongly disagree" while a score of 10 indicates "strongly agree".

267. Figure 37 and Table 32 show the results of the skills and knowledge question. Across all three regions, the mean score is 6.9 and the median is 7, indicating that the majority of respondents are confident that they have the necessary skills and knowledge to adopt improved environmental practices.

Figure 37. Skills and knowledge

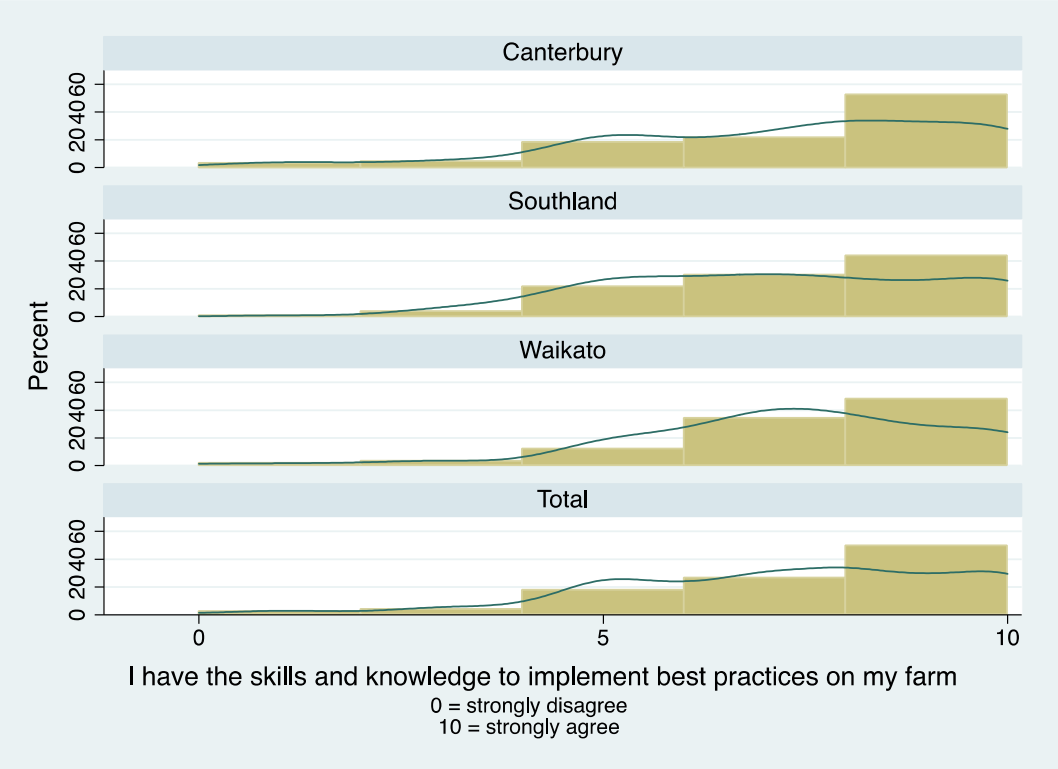


Table 32. Skills and knowledge

region	N	mean	sd	min	median	max
Canterbury	278	6.8	2.4	0	7	10
Southland	134	6.9	2.1	0	7	10
Waikato	116	7.0	2.0	0	7	10
Total	528	6.9	2.2	0	7	10

268. Similarly, the majority of respondents across all three regions are confident that their farming businesses are financially robust enough to enable them to implement best practices or adopt new technologies that improve environmental outcomes on their farm (mean = 7.2, median = 7).

Figure 38. Financial robustness

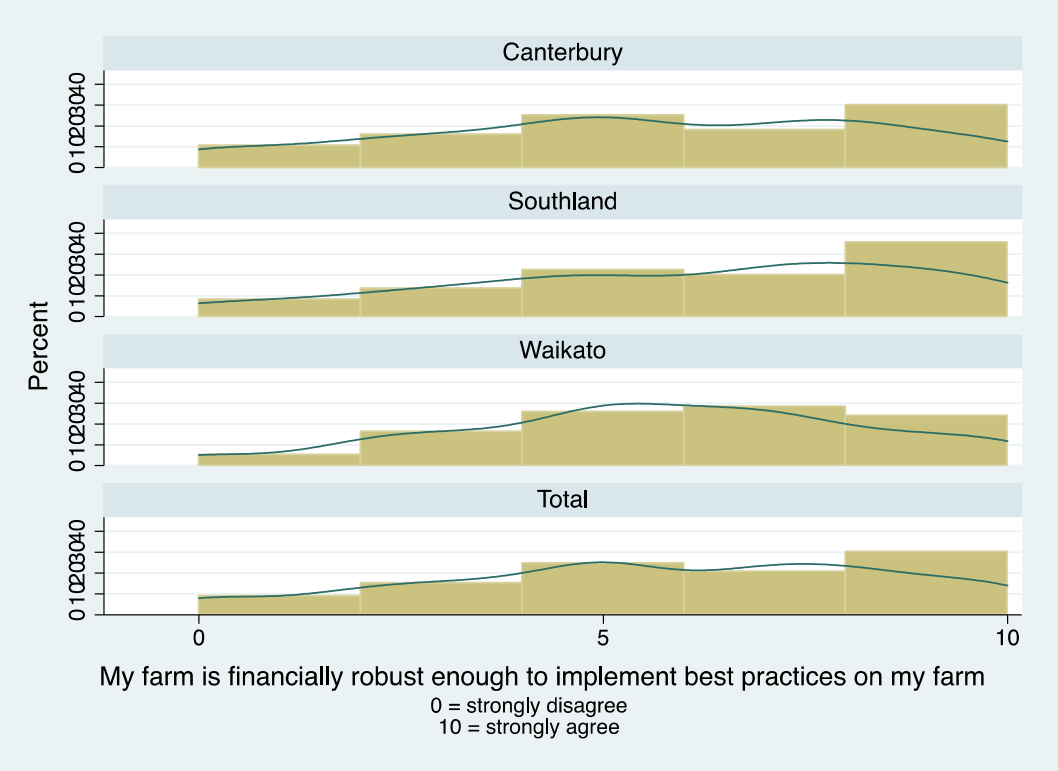


Table 33. Financial robustness

region	N	mean	sd	min	median	max
Canterbury	278	7.2	2.3	0	8	10
Southland	134	7.1	2.1	1	7	10
Waikato	116	7.3	2.0	0	7	10
Total	528	7.2	2.2	0	7	10

269. A slight majority of respondents agreed that that there were other issues that constrained them from implementing best practice or adopting new technologies that improve the environmental outcomes of their farm. These data are presented in Figure 39 and Table 34.

Figure 39. Other constraints

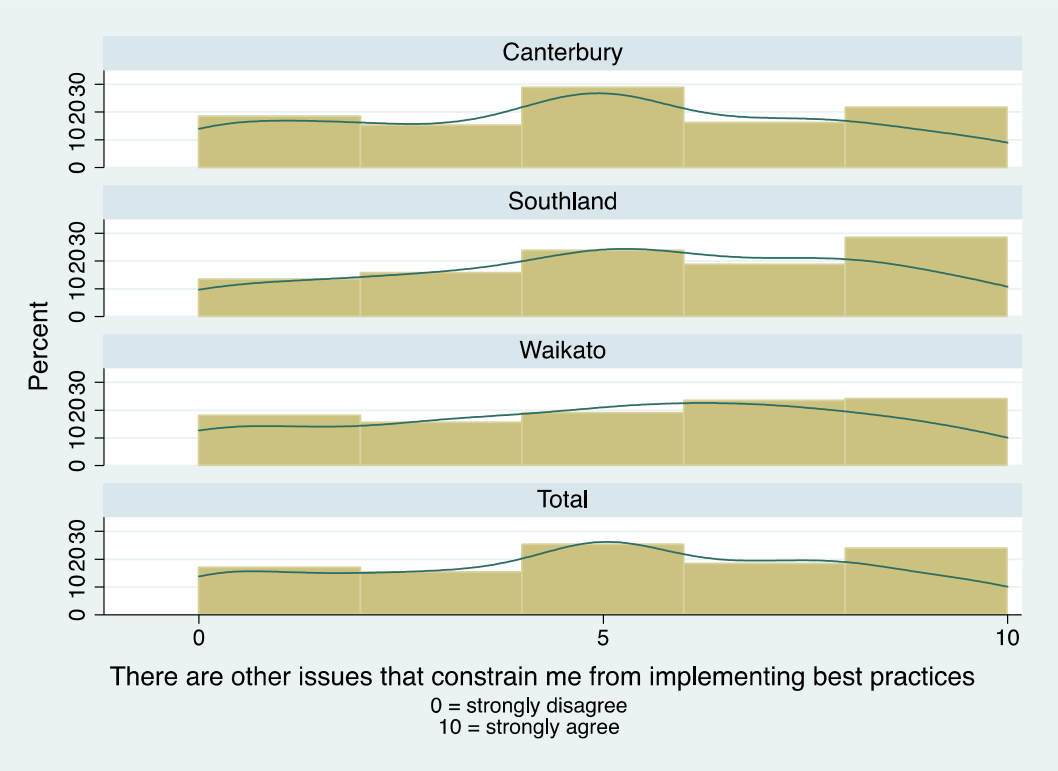


Table 34. Other constraints

region	N	mean	sd	min	median	max
Canterbury	278	5.5	2.9	0	5	10
Southland	134	6.0	2.9	0	7	10
Waikato	116	5.7	2.6	0	6	10
Total	528	5.6	2.8	0	6	10

270. Although the majority of respondents agree that they have the necessary skills and knowledge and that their farming business finances are robust enough to implement best practices or adopt new technologies to improve environmental outcomes, approximately half report that there are other constraints preventing them from doing so. Unfortunately, the survey did not collect data about the nature of these constraints; therefore, in future work, it will be important to capture this information in order to understand why farmers feel that they cannot implement best practice or adopt better environmental technologies.

6.4.8 Perceived Social Norms

271. The survey asked three questions about respondents' perceptions of social norms and public expectations regarding the environmental sustainability and integrity of their farming practice. The three questions focused on the extent to which three different groups in society believed to be influential on farmers' behaviour – the respondents' family members, other farmers in the district, and the New Zealand public – believe that they should manage the farm in an environmentally

sustainable manner. The 11-point scale ranged from 0 ("strongly disagree") to 10 ("strongly agree").

272. Figure 40 and Table 35 show that most respondents believe that their family members want them to farm in an environmentally sustainable manner. The means for Canterbury, Waikato, and Southland are 7.5, 7.6 and 7.7, respectively, and the median for all three regions is 8.

Figure 40. Expectations of family members

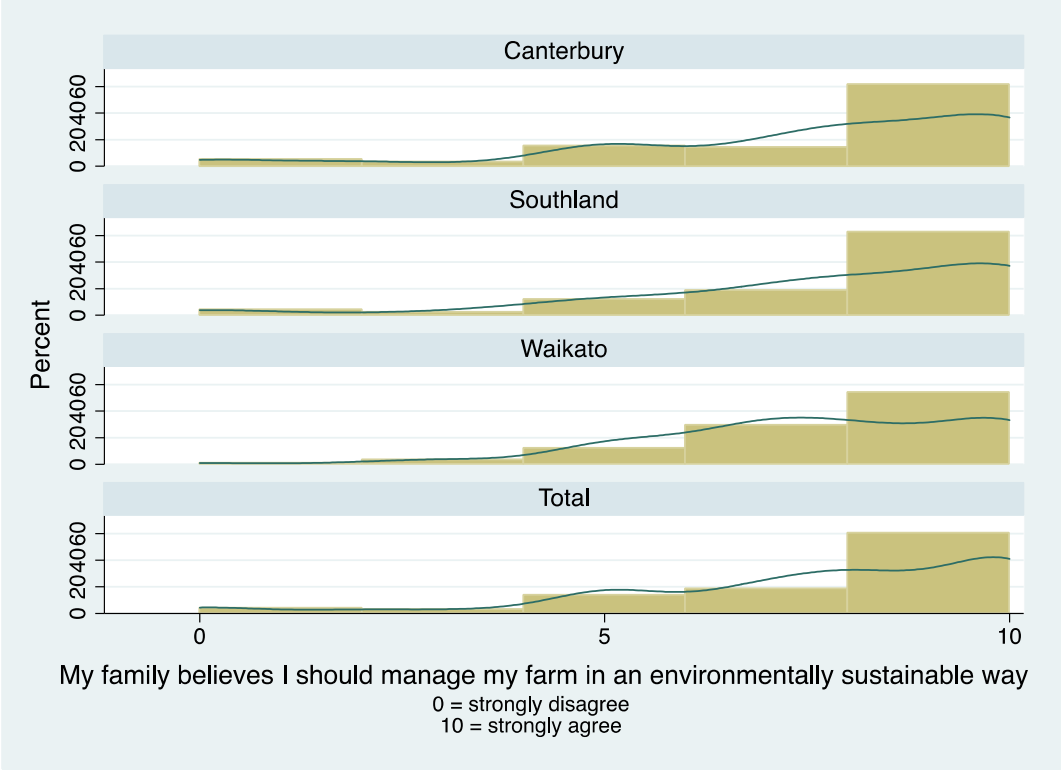


Table 35. Expectations of family members

region	N	mean	sd	min	median	max
Canterbury	278	7.5	2.7	0	8	10
Southland	134	7.7	2.5	0	8	10
Waikato	116	7.6	2.1	0	8	10
Total	528	7.5	2.5	0	8	10

273. Figure 41 and Table 36 show respondents' perception of the environmental expectations that other farmers have of them. The clear majority of respondents believe that the farming community expects them to farm in an environmentally sustainable manner. The means for Canterbury, Waikato and Southland are 7.4, 7.4, and 7.5, respectively, and the median for all three regions is 8.

Figure 41. Expectations of other farmers

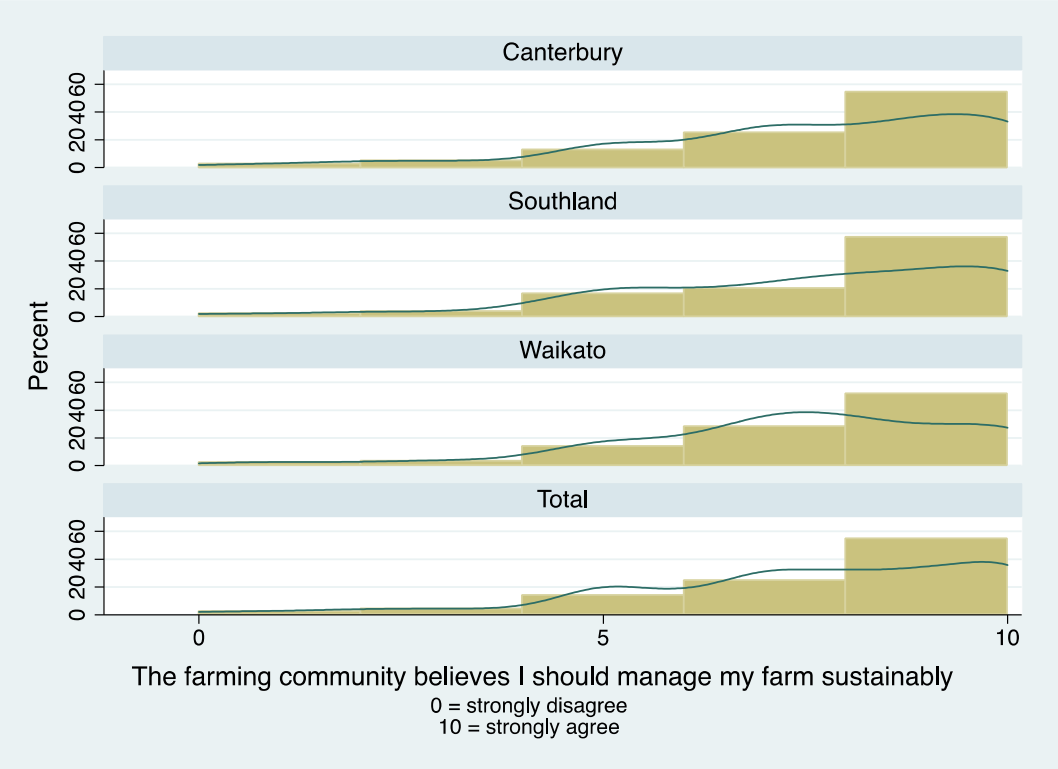


Table 36. Expectations of other farmers

region	N	mean	sd	min	median	max
Canterbury	278	7.4	2.3	0	8	10
Southland	134	7.5	2.3	0	8	10
Waikato	116	7.4	2.2	0	8	10
Total	528	7.4	2.3	0	8	10

274. There is a strong perception amongst respondents that the New Zealand public expects them to farm in an environmentally sustainable way. Indeed, respondents in all three regions believe that the social expectations for farming sustainably are stronger amongst the New Zealand public than among either their family members or the farming community (each significant at the 1% level), with means Canterbury, Waikato, and Southland of 7.9, 8.0, and 8.0, respectively. These data are presented in Figure 42 and Table 37.

Figure 42. Expectations of the New Zealand public

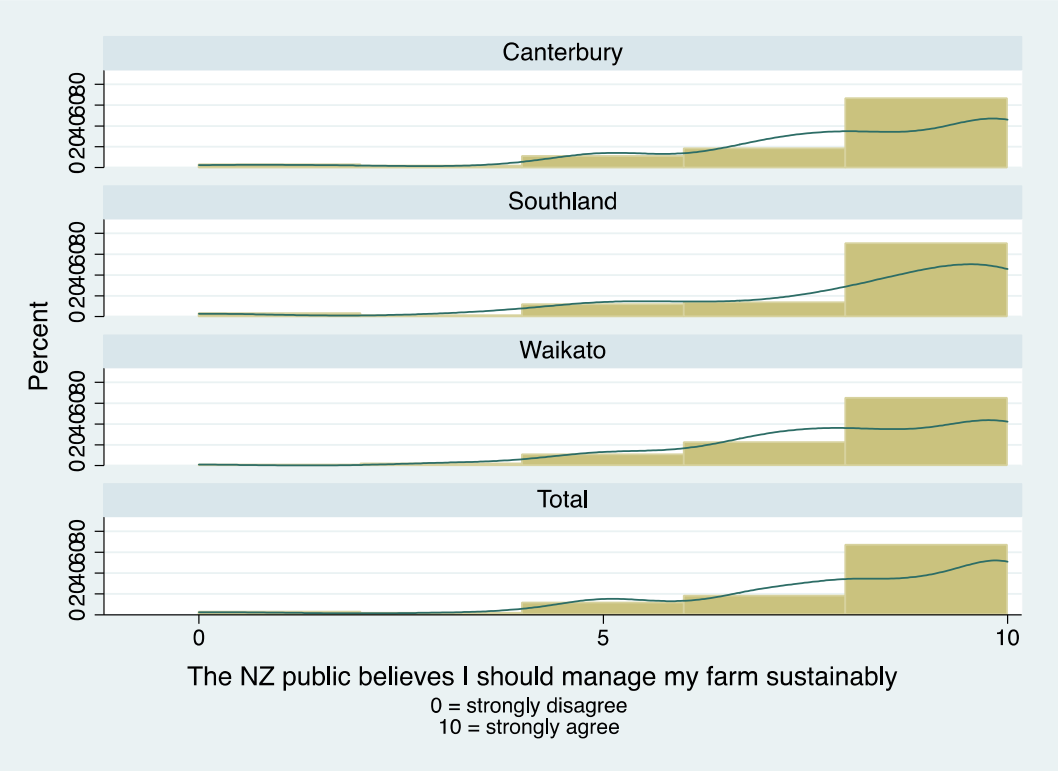


Table 37. Expectations of the New Zealand public

region	N	mean	sd	min	median	max
Canterbury	278	7.9	2.2	0	8	10
Southland	134	8.0	2.3	0	9	10
Waikato	116	8.0	2.0	0	8	10
Total	528	8.0	2.2	0	8	10

6.4.9 Degree of Identification with Values, Attitudes and Beliefs of Farming Community

275. The survey contained a single question which sought to determine how strongly respondents identified with their peers in the local farming community, i.e., the extent to which they believe that their beliefs, attitudes and values are similar to those of other farmers. A score of 0 indicates "strongly disagree" while a score of 10 indicates "strongly agree".

276. The results are presented in Figure 43 and Table 38. The majority of farmers in all three regions agree that they hold similar beliefs, attitudes, and values toward developing and managing their farms as other farmers in their local districts. Differences in the means across regions are not statistically significant.

Figure 43. Similarity of beliefs, attitudes, and values with other farmers

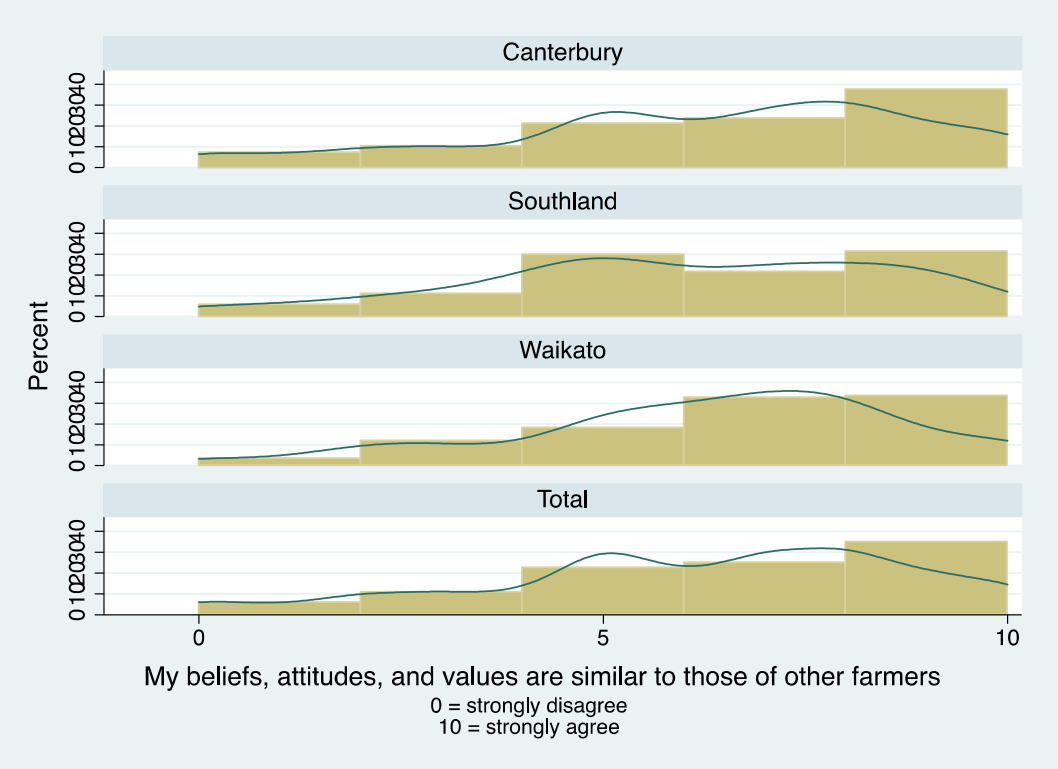


Table 38. Similarity of beliefs, attitudes, and values with other farmers

region	N	mean	sd	min	median	max
Canterbury	278	6.2	2.7	0	7	10
Southland	134	5.9	2.6	0	6	10
Waikato	116	6.3	2.4	0	7	10
Total	528	6.1	2.6	0	7	10

6.4.10 Attitudes toward Water Resources

277. Three questions were asked to gauge respondents' attitudes toward water resources. Specifically, respondents were asked about A) the importance of sustaining recreational use of waterways; B) the importance of sustaining the quality and purity of freshwater; and C) the importance of sustaining natural habitats for native fish and birds, including wetlands and native forests. A fourth question was asked about the importance of these water values to the respondents' own farming practices. We recognize the likelihood that responses to these questions will be influenced by socially desirable responding, i.e., that respondents may answer such questions in a fashion that reflects what they consider to be the most socially desirable response. As shown in the next section, however, we find systematic difference in responses across enterprise types, suggesting that the responses are at least somewhat valid. For all four questions, a score of 0 indicates "not at all important" while a score of 10 indicates "extremely important".

278. Figure 44 and Table 39 show respondents' attitudes toward the recreational use of water. The mean score is 7.8, indicating a high value placed on the recreational use of water. However, there are notable differences among the three regions: Southland residents place the highest value on the recreational use of water while Canterbury respondents place the lowest; this difference is significant at the 5% level.

Figure 44. Recreational uses of water

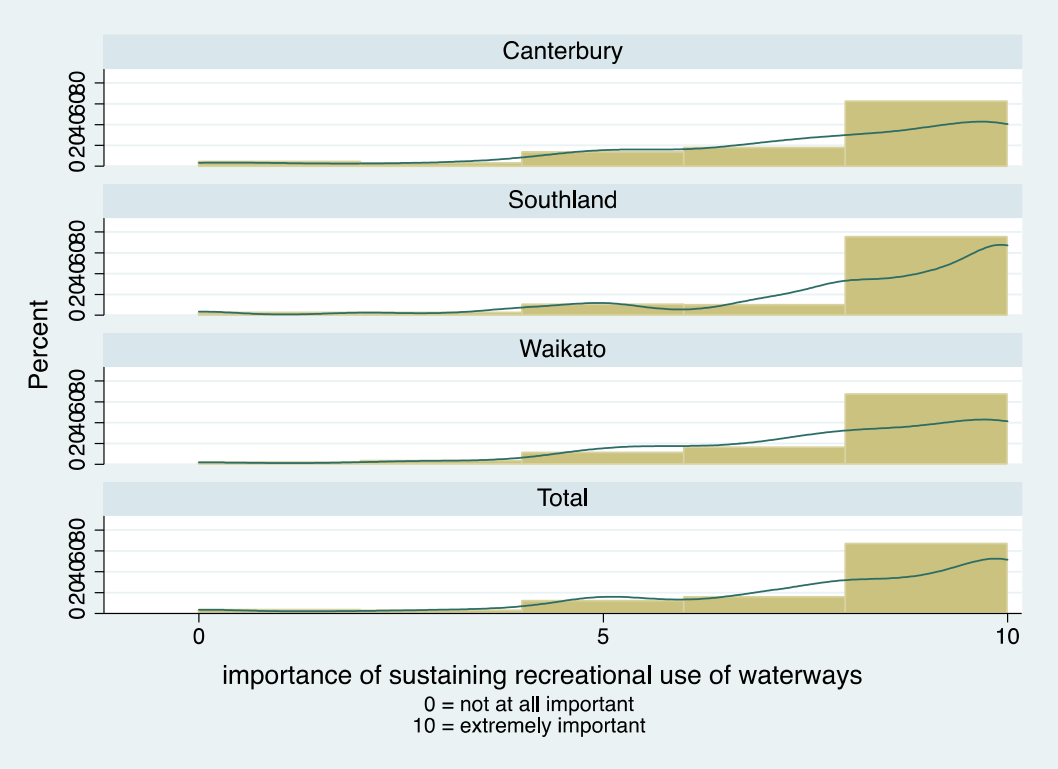


Table 39. Recreational uses of water

region	N	mean	sd	min	median	max
Canterbury	278	7.6	2.5	0	8	10
Southland	134	8.2	2.3	0	9	10
Waikato	116	7.9	2.2	0	8	10
Total	528	7.8	2.4	0	8	10

279. The purity and quality of freshwater are very important to the majority of respondents with an overall mean of 8.9 and a median of 9. These results are presented in Figure 45 and Table 40, although we hasten to point out that differences in the means across regions are not statistically significant.

Figure 45. Purity and quality of freshwater

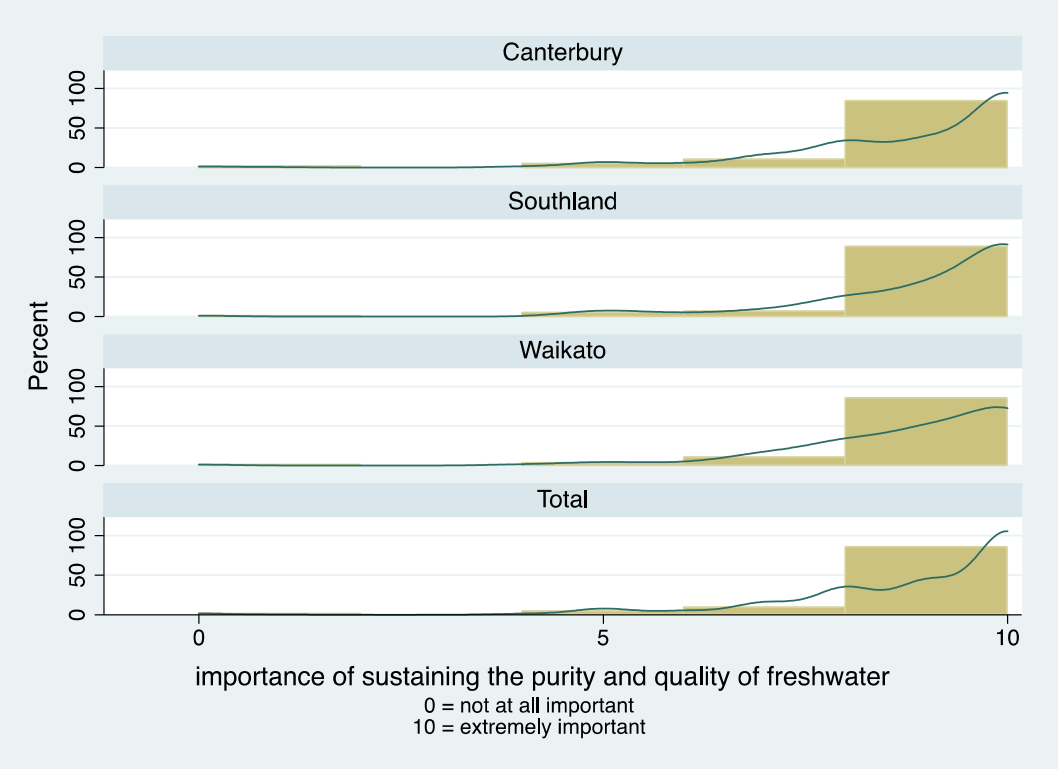


Table 40. Purity and quality of freshwater

region	N	mean	sd	min	median	max
Canterbury	278	8.8	1.7	0	9	10
Southland	134	9.0	1.5	0	10	10
Waikato	116	8.8	1.6	0	9	10
Total	528	8.9	1.6	0	9	10

280. The majority of respondents across the three regions also strongly value water for sustaining natural habitats for native fish and birds. Figure 46 and Table 41 show that the mean across the three regions is 8.4 and that the median is 9. Canterbury and Waikato respondents both had a mean of 8.3 and a median of 9, while Southland respondents had a mean of 8.7 and a median of 9, a difference that is statistically significant at the 5% level.

Figure 46. Natural habitats provided by freshwater

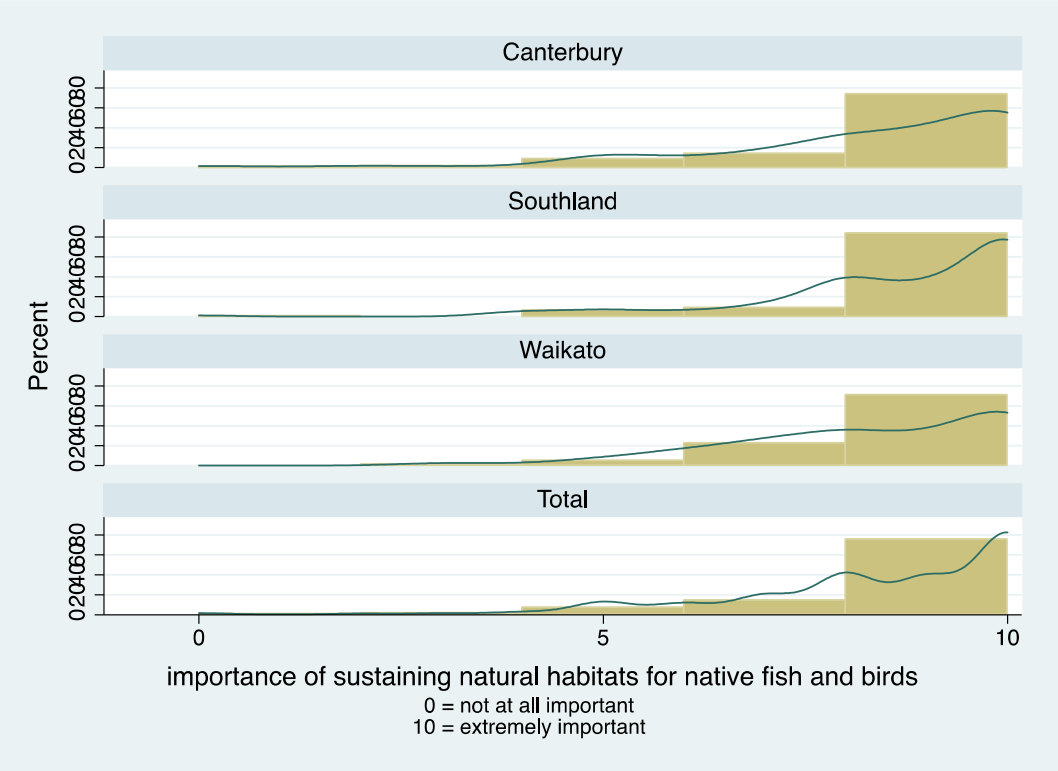


Table 41. Natural habitats provided by freshwater

region	N	mean	sd	min	median	max
Canterbury	278	8.3	2.0	0	9	10
Southland	134	8.7	1.7	0	9	10
Waikato	116	8.3	1.7	3	9	10
Total	528	8.4	1.9	0	9	10

281. While the majority of respondents from all three regions place considerable importance on these water values in their farming practice (Figure 47 and Table 42), Southland respondents (mean = 8.0, median = 8) also place greater importance on these water values in their farming practice than respondents from Waikato (mean = 7.7, median = 8) or Canterbury (mean = 7.5, median = 8), differences significant at the 10% level.

Figure 47. Importance of freshwater values to farming

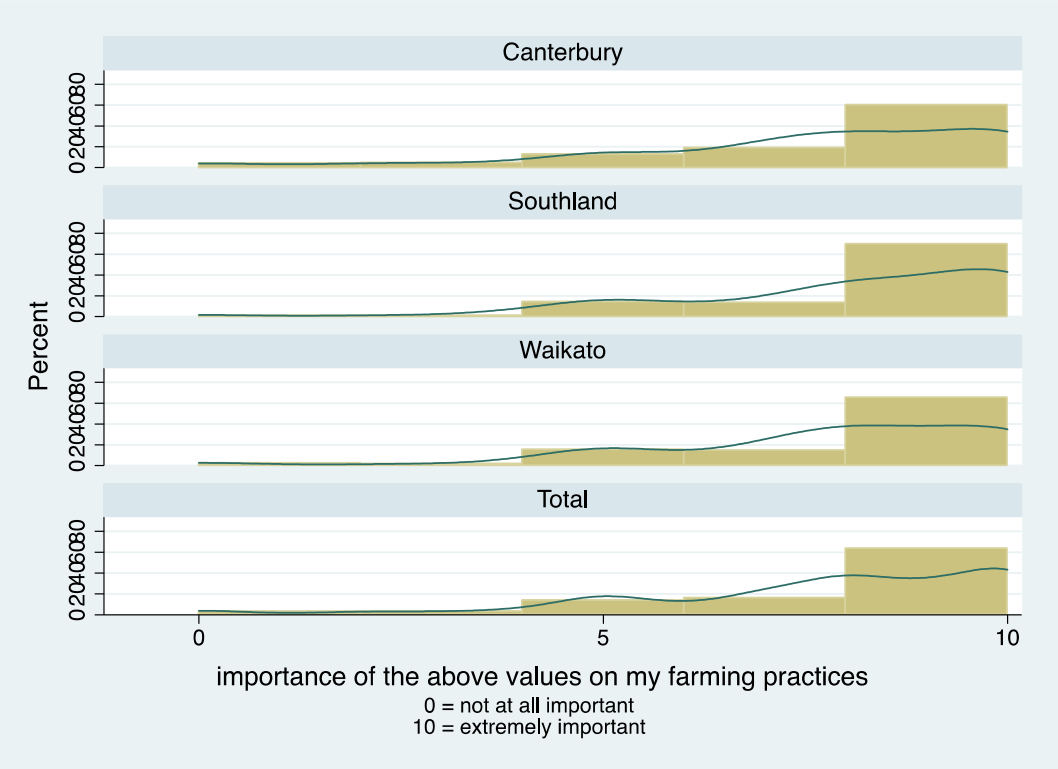


Table 41. Importance of freshwater values to farming

region	N	mean	sd	min	median	max
Canterbury	278	7.5	2.5	0	8	10
Southland	134	8.0	2.2	0	8	10
Waikato	116	7.7	2.3	0	8	10
Total	528	7.6	2.4	0	8	10

6.4.1 Farm Management Practices by Enterprise – Adoption of, or Behavioural Intention Towards Practice

282. The last three tables in this section consider rural decision-makers' behaviours in terms of adoption or behavioural intention to adopt specific farm management practices that have the potential to mitigate environmental impacts associated with farming. The response set available for each farming practice included: A) already doing it (i.e., have already adopted the practice/technology on their farm); B) intend to adopt the practice or technology; C) considering adopting the practice or technology but have not yet decided; D) have decided not to adopt the practice or technology; and E) the practice or technology is not applicable to my farming situation.

283. Results for Canterbury, Southland, and Waikato are presented in Tables 42, 43, and 44, respectively. Because not all practices are applicable to all enterprise types, the data are reported by primary enterprise.

284. Sheep and beef farmers in Canterbury have already adopted several of the environmental practices. For example, 25.4% have reduced their stocking rate, 35.1% have reduced N fertilizer (a further 6.7% intend to, while12.7% are considering it), 26.9% have a nutrient management plan (a further 16.4% intend to, while 13.4% are considering it), 23.1% have upgraded their irrigation system (a further 9.7% intend, while another 9.7% are considering it), 34.3% have fenced streams (a further 10.4% intend to, while 11.3% are considering it), 17.2% have planted riparian buffers (a further13.4% intend to, while 10.4% are considering it), and 32.8% have changed primary crops or rotation (a further 6.7% intend to, while11.9% are considering it).

285. Likewise, many dairy farmers in Canterbury have adopted environmental practices relevant to their farming operations. For example, 48.8% report that they have already reduced N fertilizer (a further 14.6% intend to, while 19.5% are considering it), 68.3% winter off stock, 31.7% have applied DCDs (a further 4.9% intend to, while14.6% are considering it – even though it had been declared illegal by the time of the survey), 80.5% employ a nutrient management plan (a further 9.8% intend to), 70.7% have upgraded their irrigation system (a further 7.3% intend to), 12.2% have constructed a feed pad (a further 4.9% intend to, while 24.4% are considering it), 80.5% have upgraded their effluent system (a further 9.8% intend to), 68.3% have fenced streams, 14.6% have constructed wetland or sediment traps (a further 12.2% intend to), 19.5% have planted forestry blocks, 29.3% have planted riparian buffers (a further 17.1% intend to), and 36.6% have changed primary crops and/or rotation (a further 9.8% intend to). Notable amongst Canterbury dairy respondents is the low proportion of respondents who have reduced stocking rates (7.3%) and who intend to (7.3%). Over half of Canterbury dairy farmers intend not to reduce stocking rates and a further 17.1% do not intend to reduce N fertilizer, while 31.7% do not intend to construct feed pads. In addition, 17.1% do not intend to construct wetlands or sediment traps. Forestry blocks will not be planted by 24.4% and 17.1% will not change primary crops and/or rotation.

286. Of the arable farming respondents in Canterbury, 20.6% have already reduced N fertilizer (14.7% intend to, while 23.5% are considering it). Some 17.6% currently have a nutrient management plan (26.5% intend to, while 23.5% are considering it), 47.1% have added or upgraded their irrigation system (a further 23.5% intend to). Streams have been fenced by 26.5% of Canterbury arable farming respondents (a further 5.9% intend to), 14.7% have planted forestry blocks (with a further 8.8% intending to, and 8.8% considering it), 23.5% have planted riparian buffers (a further 11.8% intend to, while 8.8% are considering it), and 52.9% have changed primary crops and/or rotation (a further 11.8% intend to, while 11.8% are considering it). Notably, 35.3% of Canterbury arable farmers do not intend to reduce N fertilizer.

Table 42. Management practices by enterprise – Canterbury

	variable	reduce stocking rates	reduce N fertilizer	winter off stock	apply DCDs	employ a nutrient mgmt plan	add or upgrade irrigation system	construct a feed pad	upgrade the effluent system	fence streams	construct wetlands and/or sediment traps	plant forestry blocks	plant riparian buffers	change primary crops and/or rotation
sheep	already doing	25.4%	35.1%	13.4%	3.7%	26.9%	23.1%	3.0%	5.2%	34.3%	14.9%	29.9%	17.2%	32.8%
& beef	intend to do	3.7%	6.7%	2.2%	6.7%	16.4%	9.7%	2.2%	0.0%	10.4%	8.2%	3.7%	13.4%	6.7%
N=134	considering	5.2%	12.7%	3.0%	3.0%	13.4%	9.7%	9.0%	1.5%	11.2%	9.0%	9.7%	10.4%	11.9%
	not going to do	29.9%	14.9%	11.9%	14.2%	14.2%	4.5%	13.4%	1.5%	9.7%	5.2%	14.2%	8.2%	5.2%
	N/A	35.8%	30.6%	69.4%	72.4%	29.1%	53.0%	72.4%	91.8%	34.3%	62.7%	42.5%	50.7%	43.3%
dairy	already doing	7.3%	48.8%	68.3%	31.7%	80.5%	70.7%	12.2%	80.5%	68.3%	14.6%	19.5%	29.3%	36.6%
N=41	intend to do	7.3%	14.6%	2.4%	4.9%	9.8%	7.3%	4.9%	9.8%	0.0%	12.2%	2.4%	17.1%	9.8%
	considering	19.5%	19.5%	4.9%	14.6%	7.3%	4.9%	24.4%	0.0%	0.0%	2.4%	0.0%	4.9%	4.9%
	not going to do	51.2%	17.1%	7.3%	19.5%	2.4%	0.0%	31.7%	4.9%	2.4%	17.1%	24.4%	4.9%	17.1%
	N/A	14.6%	0.0%	17.1%	29.3%	0.0%	17.1%	26.8%	4.9%	29.3%	53.7%	53.7%	43.9%	31.7%
arable	already doing	2.9%	20.6%	0.0%	0.0%	17.6%	47.1%	0.0%	2.9%	26.5%	5.9%	14.7%	23.5%	52.9%
N=34	intend to do	2.9%	14.7%	0.0%	2.9%	26.5%	23.5%	2.9%	0.0%	5.9%	5.9%	8.8%	11.8%	11.8%
	considering	11.8%	23.5%	8.8%	2.9%	23.5%	2.9%	8.8%	0.0%	2.9%	8.8%	8.8%	8.8%	11.8%
	not going to do	26.5%	35.3%	11.8%	14.7%	20.6%	0.0%	20.6%	5.9%	2.9%	14.7%	8.8%	5.9%	11.8%
	N/A	55.9%	5.9%	79.4%	79.4%	11.8%	26.5%	67.6%	91.2%	61.8%	64.7%	58.8%	50.0%	11.8%

Table 43. Management practices by enterprise – Southland

	variable	reduce stocking rates	reduce N fertilizer	winter off stock	apply DCDs	employ a nutrient mgmt plan	add or upgrade irrigation system	construct a feed pad	upgrade the effluent system	fence streams	construct wetlands and/or sediment traps	plant forestry blocks	plant riparian buffers	change primary crops and/or rotation
sheep	already doing	27.8%	27.8%	10.1%	1.3%	22.8%	3.8%	17.7%	3.8%	58.2%	16.5%	40.5%	27.8%	39.2%
& beef	intend to do	1.3%	6.3%	0.0%	0.0%	19.0%	2.5%	0.0%	1.3%	10.1%	7.6%	2.5%	16.5%	6.3%
N=79	considering	7.6%	7.6%	2.5%	5.1%	13.9%	2.5%	8.9%	1.3%	3.8%	8.9%	3.8%	8.9%	11.4%
	not going to do	35.4%	20.3%	19.0%	17.7%	13.9%	2.5%	17.7%	2.5%	16.5%	13.9%	11.4%	11.4%	16.5%
	N/A	27.8%	38.0%	68.4%	75.9%	30.4%	88.6%	55.7%	91.1%	11.4%	53.2%	41.8%	35.4%	26.6%
dairy	already doing	31.8%	31.8%	81.8%	4.5%	81.8%	36.4%	22.7%	72.7%	86.4%	31.8%	18.2%	36.4%	27.3%
N=22	intend to do	9.1%	22.7%	9.1%	9.1%	13.6%	4.5%	27.3%	22.7%	13.6%	9.1%	9.1%	36.4%	13.6%
	considering	0.0%	13.6%	0.0%	13.6%	0.0%	0.0%	13.6%	0.0%	0.0%	13.6%	0.0%	9.1%	18.2%
	not going to do	50.0%	31.8%	4.5%	31.8%	0.0%	9.1%	22.7%	4.5%	0.0%	18.2%	22.7%	0.0%	18.2%
	N/A	9.1%	0.0%	4.5%	40.9%	4.5%	50.0%	13.6%	0.0%	0.0%	27.3%	50.0%	18.2%	22.7%

287. Only data for sheep and beef and dairy are shown due to small sample sizes for the other enterprise types in Southland. Some sheep and beef farmers in Southland have also already adopted environmental practices; specifically, 27.8% have reduced stocking rates (a further 7.6% are considering it), 27.8% have reduced N fertilizer (a further 6.3% intend to, while 7.6% are considering it), 10.1% winter off stock, 22.8% already employ a nutrient management plan (a further 19% intend to, while 13.9% are considering it), 17.7% have constructed a feed pad (8.9% are considering it), 58.2% have fenced off streams (a further 10.1% intend to), 16.5% have constructed wetlands or sedimentary traps (a further 7.6% intend to, while 8.9% are considering it), 40.5% have planted forestry blocks, 27.8% have planted riparian buffers (a further 16.5% intend to, while 8.9% are considering it), and 39.2% have changed primary crops and/or rotation (a further 6.3% intend to, while 11.4% are considering it). Some 35.4% do not intend to reduce stocking rates, 20.3% do not intend to reduce N fertilizer, 19% do not intend to winter off, 17.7% do not intend to construct a feed pad, 16.5% do not intend to fence off streams, 13.9 do not intend to construct wetlands and/or sediment traps, 11.4% do not intend to plant forestry blocks, 11.4% do not intend to plant riparian buffers, and 16.5% do not intend to change primary crops and/or rotation.

288. Some dairy enterprise respondents from Southland had also adopted the environmental practices. For example, 31.8% have reduced their stocking rates (a further 9.1% intend to), 31.8% have reduced N fertilizer (a further 22.7% intend to, while 13.6% are considering it), 81.8% already winter off stock (a further 9.1% intend to), 81.8% already employ a nutrient management plan (a further 13.6% intend to), 36.4% have added or upgraded their irrigation systems (a further 4.5% intend to), 22.7% have already constructed a feed pad (a further 27.3% intend to do so, while 13.6% are considering it), 72.7% have upgraded their effluent system (a further 22.7% intend to), 86.4% have already fenced off streams (the rest of the Southland dairy respondents – a further 13.6% – intend to), 31.8% have constructed wetlands and/or sediment traps (a further 9.1% intend to, while 13.6% are considering it), 18.2% have planted forestry blocks (a further 9.1% intend to), 36.4% have planted riparian buffers (a further 36.4% intend to, while 9.1% are considering it), and 27.3% have changed crops and/or rotation (a further 13.6% intend to, while 18.2 % are considering it). Notably, 50% of Southland dairy respondents do not intend to reduce stocking rates, 31.8% do not intend to reduce N fertilizer, 31.8% do not intend to use DCDs, 22.7% do not intend to construct a feed pad, 18.2% do not intend to construct wetlands and/or sediment traps, 22.7% do not intend to plant forestry blocks, and 18.2% do not intend to change primary crops and/or rotation.

289. Some sheep and beef farmers in Waikato have already adopted environmental practices. Specifically, 39.1% have already reduced their stocking rates (a further 4.3% a considering it); 43.5% have already reduced N fertilizer (a further 4.3% intend to, while 4.3% are considering it), 34.8% currently employ a nutrient management plan (a further 8.7% intend to, while 4.3% are considering it), 47.8% have fenced off streams (a further 8.7% intend to, while 4.3% are considering it), 26.1% have constructed wetlands and/or sediment traps (a further 4.3% intend to, while 4.3% are considering it), 39.1% have planted forestry blocks (a further 4.3% are considering it), 39.1% have planted riparian buffers (a further 13% intent to, while 4.3% are considering it), and 17.4% have changed primary crops and/or rotation (a further 8.7% are considering it). Notably, 21.7% of Waikato sheep and beef respondents do not intend to reduce stocking rates, 17.4% do not intend to reduce N fertilizer, 13% do not intend to employ a nutrient management plan, 17.4% do not intend to construct wetlands and/or sediment traps, and 13% do not intend to change primary crops and/or rotation.

290. Some dairy enterprise respondents from Waikato have also already adopted environmental practices. For example, 22.5% have already reduced their stocking rates (a further 8.5% intend to, while 19.7% are considering it), 46.5% have already reduced N fertilizer (a further 11.3% intend to, while 14.1% are considering it), 29.6% already winter off stock (a further 9.9% intend to, while 9.9% are considering it), 88.7% currently employ a nutrient management plan (a further 5.6% intend to do so), and 21.1% have added or upgraded their irrigation systems (a further 11.3% intend to, while 8.5% are considering it). Of the Waikato dairy enterprise respondents, 83.1% have fenced off their streams (a further 7% intend to), 32.4% have constructed wetlands and/or sediment traps (a further 8.5% intend to, while 8.5% are considering it), 22.5% have planted forestry blocks (a further 1.4% intend to, and 5.6% are considering it), 38% have planted riparian buffers (11.3% intend to, while 16.9% are considering it) and, 29.6% have changed primary crops and/or rotation (a further 5.6% intend to, while 12.7% are considering it). Notably, 36.6% of Waikato dairy respondents do not intend to reduce stocking rates, 21.1% do not intend to reduce N fertilizer, 26.8% do not intend to winter off stock, 19.7% do not intend to construct feed pads, 25.4% do not intend to plant forestry blocks, 19.7% do not intend to plant riparian buffers, and 22.5% do not intend to change primary crops and/or rotation.

Table 44. Management practices by enterprise – Waikato

	variable	reduce stocking rates	reduce N fertilizer	winter off stock	apply DCDs	employ a nutrient mgmt plan	add or upgrade irrigation system	construct a feed pad	upgrade the effluent system	fence streams	construct wetlands and/or sediment traps	plant forestry blocks	plant riparian buffers	change primary crops and/or rotation
sheep	already doing	39.1%	43.5%	8.7%	4.3%	34.8%	0.0%	8.7%	8.7%	47.8%	26.1%	39.1%	39.1%	17.4%
& beef	intend to do	0.0%	4.3%	4.3%	0.0%	8.7%	0.0%	0.0%	0.0%	8.7%	4.3%	0.0%	13.0%	0.0%
N=23	considering	4.3%	4.3%	0.0%	4.3%	4.3%	0.0%	8.7%	0.0%	4.3%	4.3%	4.3%	4.3%	8.7%
	not going to do	21.7%	17.4%	13.0%	13.0%	13.0%	4.3%	8.7%	4.3%	4.3%	17.4%	8.7%	8.7%	13.0%
	N/A	34.8%	30.4%	73.9%	78.3%	39.1%	95.7%	73.9%	87.0%	34.8%	47.8%	47.8%	34.8%	60.9%
dairy	already doing	22.5%	46.5%	29.6%	8.5%	88.7%	21.1%	25.4%	47.9%	83.1%	32.4%	22.5%	38.0%	29.6%
N=71	intend to do	8.5%	11.3%	9.9%	4.2%	5.6%	11.3%	14.1%	35.2%	7.0%	8.5%	1.4%	11.3%	5.6%
	considering	19.7%	14.1%	9.9%	12.7%	1.4%	8.5%	16.9%	4.2%	1.4%	8.5%	5.6%	16.9%	12.7%
	not going to do	36.6%	21.1%	26.8%	36.6%	2.8%	9.9%	19.7%	9.9%	1.4%	11.3%	25.4%	19.7%	22.5%
	N/A	12.7%	7.0%	23.9%	38.0%	1.4%	49.3%	23.9%	2.8%	7.0%	39.4%	45.1%	14.1%	29.6%

7. Data Analysis

291. The primary purpose of the Survey of Rural Decision Makers is to inform agent-based models. Our literature review identified that the Theory of Planned Behaviour could provide relevant information for use in agent-based models. As is common with the Theory of Planned Behaviour (TPB), we used a modified version of the theory (e.g., Pike, 2008). Due to restrictions on the number of questions that could be reasonably included in the survey, only the four most proximal variables to behaviour were measured. The standard assessment of the TPB includes three questions to form a reliable index for each of the specific target behaviours. Given that we had 13 specific target behaviours or practices (i.e., reducing stocking rates, reducing N fertilizer, wintering off stock, etc.) this would have amounted to 156 (12x13) TPB questions. With over 100 other questions considered important for informing agent-based models already in the survey, it was not possible to take this approach to the TPB in this project.

292. Instead, we took a more generalised approach. The 13 behaviours/practices in which we were interested in predicting were oriented toward better environmental outcomes, particularly for freshwater resources. Therefore, for each of the proximal predictors (i.e., attitude to the behaviour, perceived behavioural control, and subjective norms) we used three questions to focus on the more general concept of "better environmental outcomes". Thus, for attitudes towards freshwater, we asked three questions designed to tap into respondents' attitudes/values towards water quality. For perceived behavioural control, we asked three questions regarding respondents' perceived ability to implement best practices or to adopt new technologies that improve environmental outcomes on their farms. For subjective norms, we asked three questions about respondents' perceptions of important others' expectations regarding managing their farms in an environmentally friendly and sustainable manner.

293. In most TPB research, the analysis stops at behavioural intentions, knowledge about actual behaviours is either inaccessible or the respondents are not currently engaging in the behaviour. Generally in TPB studies, behavioural intention is used as a proxy for behaviour such was used in Small, Parminter and Fisher (2005). In our case, we were aware that at least some of our respondents would have already adopted some of the behaviours/practices of interest. Thus, our 13 behavioural intention questions also had to capture whether or not respondents had already adopted the behaviour as well as their intention to adopt the behaviour or practice. In retrospect, it is unfortunate that the question we constructed to measure intentions was categorical, as an interval or ratio scale variable may have provided more nuanced data. Nonetheless, it is still possible to use the information we have to create a TPB model for the 13 environmental practices (see Table 8a & b).

294. Below, we identify the correlates of each significant component of the Theory of Planned Behaviour, namely, attitudes toward freshwater, perceived behavioural control, subjective norms, behavioural intentions, and behaviours, allowing the first three categories to inform intentions and all of these to inform behaviours, per Figure 1 in the literature review.

295. Given the richness of our data, we also assess the correlates of the size of farming networks, risk tolerance, and farmer outlook, all of which may potentially inform both intentions and behaviours.

7.1 Attitudes toward freshwater

296. Table 1 reports the perceived importance of different uses of freshwater resources, specifically of sustaining recreational use of waterways (column 1), of sustaining the purity and quality of freshwater (column 2), and of sustaining natural habitats for native fish and birds (column 3). The dependent variables are measured on an 11-point scale, ranging from 0 ("not at all important") to 10 ("extremely important"). The models are estimated using ordinary least squares and heteroskedasticity-robust standard errors are reported.

297. Dairy farmers are significantly less likely to believe that sustaining fresh water for all three purposes is important than other rural decision-makers. For example, they evaluate the importance of sustaining recreational use of waterways 1.04 points (11.8% of the mean) lower than arable farmers and other rural decision-makers, the importance of sustaining the purity and quality of freshwater 0.65 points (7.8% of the mean) lower than others, and the importance of sustaining natural habitats for native fish and birds 0.96 points (11.5% of the mean) lower than others, all significant at the 1% level. Sheep and beef farmers also evaluate the importance of freshwater lower than arable farmers and other rural decision-makers, with 0.69 points lower on the recreational use scale (significant at the 1% level) and 0.33 points lower on the natural habitats scale (significant at the 10% level); sheep and beef farmers' views on the importance of preserving the purity and quality of water quality do not differ (in a statistical sense) from arable farmers and other rural decision-makers.

298. Controlling for primary enterprise and other correlates, rural decision-makers in Southland and Waikato evaluate the importance of sustaining recreational uses of water 0.62 points (significant at the 5% level) and 0.51 points (significant at the 10% level) higher than rural decision makers in Canterbury, respectively. Decision-makers in Southland also rate the importance of sustaining natural habitats for native fish and birds significantly higher than do decision-makers in Canterbury.

299. Graduates of technical training programmes evaluate the importance of preserving the purity and quality of fresh water 0.35 points higher than those with high school education or less, significant at the 5% level. Similarly, they evaluate the importance of protecting natural habitats 0.54 points higher than those with high school education and less, also significant at the 5% level. Notably, however, those with university education do not hold significantly different views of fresh water than those with high school education. These data are consistent with the international literature. It has been found that more educated farmers place greater importance on the environment and conservation (Ondersteijn et al., 2003; Wilson, 1997; Vanslembrouck et al., 2002). However, the type of education received is important. Targeted extension was found to be effective, whereas, formal education was not (Baumgart-Gertz et al., 2012). This may perhaps explain why graduates of technical training programmes show greater concern for water quality than either those with high school education or less or university graduates.

300. Finally, older rural decision-makers are less likely to believe that sustaining natural habitats for native fish and birds is important, with each additional year reducing this score by 0.024 points. This effect is statistically significant at the 5% level. This is also consistent with previous empirical findings (Clinch, 1999; Wilson,1997; Vanslembrouck et al., 2002).

Table 1. Attitudes toward different uses of freshwater resources (11-point scale, ordinary least squares regression)

		(1)	(2)	(3)
VARIABLES	UNIT	recreational use	purity and quality	natural habitats
age	years	-0.0142	0.00144	-0.0241**
		(0.0107)	(0.00919)	(0.00989)
male	binary	0.112	-0.00368	-0.0249
		(0.263)	(0.164)	(0.204)
technical training	binary	0.286	0.347**	0.540**
		(0.289)	(0.176)	(0.221)
university	binary	-0.257	-0.0331	0.263
		(0.234)	(0.165)	(0.189)
log land (ha)	log hectares	-0.00192	0.0327	-0.0112
		(0.0672)	(0.0427)	(0.0547)
sheep and beef	binary	-0.690***	-0.0323	-0.325*
		(0.246)	(0.154)	(0.190)
dairy	binary	-1.042***	-0.646***	-0.959***
		(0.317)	(0.249)	(0.273)
Southland	binary	0.616**	0.202	0.470**
		(0.254)	(0.160)	(0.191)
Waikato	binary	0.507*	0.262	0.380
		(0.292)	(0.210)	(0.236)
Constant		8.889***	8.640***	9.741***
		(0.790)	(0.622)	(0.706)
Observations		528	528	528
R-squared		0.043	0.030	0.060

Heteroskedasticity-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7.2 Perceived behavioural control

301. Table 2 reports the correlates of two perceived behavioural controls, namely, the extent to which the rural decision-maker has the skills and knowledge to adopt best management practices (column 1) and whether the rural enterprise is financially robust enough to do so (column 2). The dependent variables are measured on an 11-point scale, ranging from 0 ("strongly disagree") to 10 ("strongly agree"). Again, the models are estimated using ordinary least squares and heteroskedasticity-robust standard errors are reported.

302. More educated farm decision-makers report having greater skills and knowledge for adopting best practices: those with technical training and university education score themselves 0.56 points (7.8% of the mean) and 0.50 points higher (7.0% of the mean) than those with high school education on this measure, respectively, ceteris paribus. Both effects are statistically significant at the 5% level. While age does not significantly affect perceived skills and knowledge for adopting best

practices, age positively impacts financial robustness, with each additional year of age raising scores by 0.04 points (significant at the 1% level).

303. Dairy farmers evaluate their financial robustness 0.77 points higher than arable farmers and other rural decision-makers, other factors held constant (significant at the 5% level). Similarly, decision-makers on larger parcels evaluate their financial robustness higher, with an increase in 10% of land size associated with 0.043 point higher scores on this measure, significant at the 1% level. Land size is also positively associated with skills and knowledge (also significant at the 1% level) but not with other constraints. Notably, region does not significantly affect the perceived behavioural controls of rural decision-makers.

Table 2. Perceived behavioural controls (PBCs) (11-point scale, ordinary least squares regression)

		(1)	(2)
VARIABLES	UNIT	skills and knowledge	financial robustness
age	years	0.00576	0.0408***
		(0.0112)	(0.0127)
male	binary	0.152	0.236
		(0.242)	(0.287)
technical training	binary	0.557**	-0.257
		(0.276)	(0.355)
university	binary	0.498**	0.164
		(0.213)	(0.261)
log land (ha)	log hectares	0.315***	0.426***
		(0.0626)	(0.0741)
sheep and beef	binary	-0.201	-0.0333
		(0.239)	(0.283)
dairy	binary	0.214	0.773**
		(0.281)	(0.372)
Southland	binary	-0.0586	0.472
		(0.222)	(0.294)
Waikato	binary	0.0812	-0.00328
		(0.272)	(0.334)
Constant		4.897***	0.774
		(0.789)	(0.901)
Observations		528	528
R-squared		0.076	0.102

*** p<0.01, ** p<0.05, * p<0.1

7.3 Subjective norms

304. Table 3 reports the correlates of three subjective norms, i.e., the perceived behavioural expectations of individuals who are important referents to the decision-

maker. Specifically, we consider the expectation that the rural decision-maker manages the farm in an environmentally friendly and sustainable manner by direct family members (column 1), the farming community (column 2), and the New Zealand public more generally (column 3). Subjective norms are measured on an 11-point scale from 0 ("strongly disagree") to 10 ("strongly agree"). The models are estimated using ordinary least squares and heteroskedasticity-robust standard errors are reported.

305. Controlling for age and gender, education, land size, and region, dairy farmers report higher expectations within the farming community (0.75 points, or 10.1% of the mean, significant at the 5% level) than arable farmers and other rural decision-makers. Interestingly, dairy farmers do not report higher expectations than others from family members or the New Zealand public. The expectations reported by sheep and beef farmers also do not differ from those of arable farmers and other rural decision-makers. Larger land owners do report higher expectations, with a 10% increase in land holdings associated with 0.02 point higher expectations among both other farmers and the New Zealand public. That these figures are dwarfed by the expectations reported by dairy farmers underscores the scale of the pressure placed upon dairy farmers by other farmers.

306. Older rural decision-makers report higher expectations from family members: while the point estimate is modest at 0.02 points (significant at the 10% level), this equates to a 1.1 point difference between the oldest and youngest survey respondents, all else held constant. University graduates also report highest expectations from family members than do those with high school education or less (significant at the 1% level).

Table 3. Subjective norms (11-point scale, ordinary least squares regression)

		(1)	(2)	(3)
VARIABLES	UNIT	family	farm community	NZ public
age	years	0.0198*	0.0140	-0.00479
		(0.0119)	(0.0120)	(0.0104)
male	binary	0.303	-0.0939	-0.112
		(0.275)	(0.252)	(0.257)
technical training	binary	0.379	0.245	-0.0341
		(0.322)	(0.276)	(0.264)
university	binary	0.813***	-0.162	-0.105
		(0.242)	(0.223)	(0.212)
log land (ha)	log hectares	0.0892	0.194***	0.224***
		(0.0757)	(0.0625)	(0.0604)
sheep and beef	binary	0.0379	0.109	-0.193
		(0.268)	(0.251)	(0.227)
dairy	binary	0.314	0.753**	0.0362
		(0.333)	(0.308)	(0.290)
Southland	binary	0.303	-0.00972	-0.0223
		(0.269)	(0.249)	(0.236)
Waikato	binary	0.0884	-0.323	0.0370
		(0.289)	(0.265)	(0.250)

Constant	5.183***	5.610***	7.323***
	(0.884)	(0.830)	(0.740)
Observations	528	528	528
R-squared	0.032	0.044	0.034

Heteroskedasticity-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7.4 Farming networks

307. The rich survey data allow us to explore the roles played by farming networks, risk perception, and personal outlooks in addition to the attitudes, perceived behavioural controls, and subjective norms already analysed. Network size and contact is an important variable in Roger's (2003) theory of innovation diffusion and adoption. The early adopter is a role model and opinion leader within a network. Being able to observe other farmers use an innovation enables a rural land manager to conduct a non-trial evaluation of the innovation (Pannel et al., 2006). Social Learning Theory (Bandura, 1977) postulates that learning may occur via information exchange between individuals with network links or even through simple observation and modelling of another's behaviour. Thus, knowing other farmers who have adopted a new practice or land use has been found to influence farmers viewpoints and decisions about practice adoption (Defrancesco et al., 2008; Lapple, 2010; Wilson and Hart, 2000). It is also important to note that data from the current survey show that other farmers are the third most trusted and important source of information for rural decision-makers after vets and accountants.

308. Correlates of the size of farming networks are reported in Table 4. Because farming networks were measured categorically in the survey, linear estimation methods (e.g., ordinary least squares) are inappropriate. We thus use probit models to evaluate the correlates of discussing farm practices with six or more farmers and visiting six or more farms during the past year. The results are qualitatively similar using both the simpler linear probability model and the more complex ordered probit model, so we choose to report the probit results given the relative simplicity of interpretation. Marginal effects and heteroskedasticity-robust standard errors are reported.

309. An additional year of age at the mean is associated with 0.78% lower likelihood of discussing farm practices with six or more farmers and 0.75% lower likelihood of visiting six or more farms during the previous year, ceteris paribus, both statistically significant at the 1% level.

310. Male decision-makers are 11.5% more likely to discuss farming practices with six or more farmers during the previous year than female decision-makers (significant at the 5% level) and 24.3% more likely to visit six or more farms (significant at the 1% level). Dairy farmers are 12.2% more likely to discuss farming practices with six or more farmers than arable farmers and other rural decision-makers but are not statistically more likely to visit more farms. Sheep and beef farmers are neither more nor less likely to have larger farming networks than arable farmers and other rural decision-makers.

311. Neither Southland farmers nor Waikato farmers have larger network sizes than Canterbury farmers. However, larger farmers do have significantly larger networks. For example, a 10% increase in farm size is associated with a 0.8% increase in the likelihood that the decision-maker discusses farm practices with six or more

farmers and a 0.7% increase in the likelihood that he or she visits six or more farms, both significant at the 1% level. The effect of education on network size is not statistically distinguishable from zero.

Table 4. Size of farming networks (binary, maximum likelihood estimation)

		(1)	(2)
VARIABLES	UNIT	discusses with 6+ farmers	visits 6+ farms
age	years	-0.00783***	-0.00748***
		(0.00238)	(0.00231)
male	binary	0.115**	0.243***
		(0.0585)	(0.0503)
technical training	binary	0.0512	0.0907
		(0.0628)	(0.0652)
university	binary	0.0757	0.0665
		(0.0513)	(0.0511)
log land (ha)	log hectares	0.0771***	0.0743***
		(0.0156)	(0.0152)
sheep and beef	binary	0.00749	-0.0815
		(0.0540)	(0.0545)
dairy	binary	0.122*	0.0882
		(0.0681)	(0.0688)
Southland	binary	-0.0739	-0.0310
		(0.0566)	(0.0553)
Waikato	binary	-0.0557	0.0574
		(0.0637)	(0.0632)
Observations		528	528
R-squared		0.143	0.024

Marginal effects reported

Heteroskedasticity-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7.5 Risk tolerance

312. Table 5 reports the correlates of risk tolerance. Specifically, the survey asked "Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? On a scale of 0 to 10, where 0 means “don’t like to take risks” and 10 means “fully prepared to take risks”, how do you see yourself?" Dohmen et al (2005) demonstrate that this question correlates highly with empirical evidence on a wide range of risky behaviours, including smoking, traffic offenses, investment behaviour, willingness to migrate, and willingness to be self-employed. Importantly, it applies equally well to the agricultural sector (Roe 2011). This model is estimated using ordinary least squares and heteroskedasticity-robust standard errors are reported.

313. Men score themselves 0.88 points (16.0% of the mean) higher on the risk-tolerance scale than women, *ceteris paribus*, significant at the 1% level. Higher male risk tolerance is in line with the international literature on risk perception (Slovic, 1999). University graduates evaluate themselves as being 0.41 points more risk tolerant than those with high school and less education (significant at the 10% level). Larger land owners also see themselves as being more risk tolerant, with a 10% increase in land holdings associated with a 0.03 point increase in risk tolerance, significant at the 1% level.

314. In contrast, sheep and beef farmers see themselves as being 0.61 points less risk tolerant than arable farmers and other rural decision-makers, statistically significant at the 5% level. Older farmers also see themselves as more risk avoidant, with each additional year lowering risk tolerance by 0.03 points (significant at the 1% level). Again, this relatively small point estimates equates to a 1.87 point difference in risk tolerance between the oldest and youngest survey respondents, all else held equal. Respondents with technical educations and those primarily engaged in dairying are neither more nor less risk tolerant than their counterparts, and there are no systematic differences in risk profiles across regions. Interestingly, Australian research has shown that risk tolerant Graziers are more likely to adopt best management conservation practices (Greiner and Gregg, 2011).

Table 5. Risk tolerance (11-point scale, ordinary least squares regression)

		(1)
VARIABLES	UNIT	risk tolerance
age	years	-0.0334***
		(0.0107)
male	binary	0.876***
		(0.253)
technical training	binary	0.416
		(0.306)
university	binary	0.412*
		(0.223)
log land (ha)	log hectares	0.313***
		(0.0616)
sheep and beef	binary	-0.609**
		(0.248)
dairy	binary	-0.177
		(0.280)
Southland	binary	-0.322
		(0.252)
Waikato	binary	-0.201
		(0.275)
Constant		5.232***
		(0.760)
Observations		528
R-squared		0.143

Heteroskedasticity-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7.6 Farmer outlook

315. Table 6 identifies the correlates of farmer outlook, i.e., the extent to which respondents agree that being highly productive (column 1) and taking good care of the environment (column 2) are central to their self-identity as rural decision-makers, measured on an 11-point scale from 0 ("not at all important") to 10 ("extremely important"). The relationship is estimated via ordinary least squares and heteroskedasticity-robust standard errors are reported in parentheses. Note that these outlooks are often complementary rather than substitutes, with a simple correlation of 0.31. Thus, rural decision-makers who consider high productivity to be important for their self-identity are more likely to consider environmental care to be important for their self-identity as well. This finding concurs with research in the Netherlands which showed that higher educated farmers were able to intensify their production without adverse environmental consequences, and that farmers who achieved better financial performance were also better environmental managers (Ondersteijn et al., 2003).

316. Age and education are both negative determinants of productivist outlooks. For example, one additional year of age is predicted to lower the score on the "productivism outlook" scale by 0.036 points (0.5% of the mean), *ceteris paribus*, statistically significant at the 1% level. Similarly, rural decision-makers who have completed technical training or university have scores that are 0.70 points lower on the "productivism outlook" scale, significant at the 5% level. In contrast, land holdings are positively correlated with productivist outlooks, albeit weakly: land holdings increasing by 10% are associated with 0.043 point higher scores on the "production outlook" scale (statistically significant at the 1% level). Land is the only statistically significant correlate of having an environmental outlook, suggesting that characteristics other than age, gender, education, primary enterprise and region shape this outlook.

Table 6. Farmer outlook (11-point scale, ordinary least squares regression)

		(1)	(2)
VARIABLES	UNIT	production outlook	environment outlook
age	years	-0.0358***	0.00669
		(0.0108)	(0.00968)
male	binary	0.192	0.0483
		(0.265)	(0.224)
technical training	binary	-0.730**	0.279
		(0.303)	(0.216)
university	binary	-0.700***	-0.230
		(0.234)	(0.185)
log land (ha)	log hectares	0.433***	0.123**
		(0.0762)	(0.0556)
sheep and beef	binary	-0.159	-0.0170
		(0.263)	(0.188)
dairy	binary	0.0482	-0.233
		(0.328)	(0.223)
Southland	binary	0.210	-0.163

		(0.249)	(0.190)
Waikato	binary	-0.0229	-0.134
		(0.302)	(0.207)
Constant		6.873***	7.338***
		(0.831)	(0.703)
Observations		528	528
R-squared		0.143	0.024

Heteroskedasticity-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

317. Thus, demographics such as age, gender, and education have a modest impact on attitudes, personal behavioural controls, and subjective norms but a strong impact on network size, risk tolerance, and outlook. Although the magnitude is small, land size has a positive correlation with personal behavioural controls, subjective norms, network size, risk tolerance, and outlook. Sheep and beef farmers consider themselves to be more risk averse than other farmers while dairy farmers consider recreation in freshwater, the purity and quality of freshwater, and natural habitats for native species to be somewhat less important than other farmers. Dairy farmers also have somewhat larger networks and financial robustness but do not otherwise systematically differ from other farmers. Finally, rural decision-makers in Southland and Waikato consider the recreational use of freshwater and the natural habitats provided by freshwater to be somewhat more important than rural decision-makers in Canterbury.

7.7 Farm management plans for the next five years

318. Table 7 shows the correlates of six specific farming management plans for the next five years, namely, the plans to sell all or part of the farm (column 1), to lease all or part of the farm out (column 2), to buy or lease additional land (column 3), to change the enterprise mix to reduce the work load (column 4), to farm more intensively by changing the enterprise mix (column 5), and to change the enterprise mix due to new regulations (column 6). These outcomes are measured on 11-point scales ranging from 0 ("extremely unlikely") to 11 ("extremely likely") and the model is estimated via ordinary least squares with heteroskedasticity-robust standard errors reported in parentheses. Note that TPB data was not collected with regard to this set of six potential future farm management plans. Note also that these particular farm management options are only very weakly and indirectly related to the 13 specific farm management practices/technologies designed to reduce the environmental impacts of farming and, in particular, enhance water quality.

319. *Ceteris paribus*, older rural decision-makers are significantly more likely to plan to sell land or lease land out, with each year of age increasing the self-reported value by 0.072 points (2.4% of the mean) and 0.061 points (2.7% of the mean), respectively, each significant at the 1% level. Older decision-makers are also much less likely to buy or lease new land, a finding that is consistent with life-cycle models of farmer behaviour (Burton, in press).

Table 7. Farm management plans (11-point scale, ordinary least squares regression)

		(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	UNIT	sell land	lease land out	buy or lease land	change mix to reduce work	change mix to intensify	change mix due to regs
age	years	0.0717***	0.0614***	-0.103***	0.0208	-0.0243*	0.00898
		(0.0155)	(0.0136)	(0.0142)	(0.0163)	(0.0145)	(0.0138)
male	binary	-0.0374	0.0117	0.931***	0.406	0.791**	0.137
		(0.409)	(0.365)	(0.338)	(0.376)	(0.337)	(0.331)
technical training	binary	0.138	0.0797	0.194	0.419	1.118***	0.152
		(0.445)	(0.372)	(0.366)	(0.434)	(0.412)	(0.386)
university	binary	0.150	0.565*	0.0549	0.0567	0.120	-0.519*
		(0.356)	(0.338)	(0.326)	(0.349)	(0.306)	(0.295)
log land (ha)	log hectares	-0.281***	0.0695	0.607***	0.230**	0.446***	0.421***
		(0.103)	(0.0867)	(0.0906)	(0.0958)	(0.0900)	(0.0855)
sheep and beef	binary	-0.00353	0.0586	-0.344	-0.250	-0.616*	-1.232***
		(0.386)	(0.326)	(0.332)	(0.378)	(0.343)	(0.324)
dairy	binary	-0.0396	1.445***	0.403	-0.713	-0.586	-0.371
		(0.475)	(0.458)	(0.440)	(0.476)	(0.423)	(0.408)
Southland	binary	0.694*	0.0285	-0.185	0.0373	-0.748**	-0.287
		(0.392)	(0.349)	(0.348)	(0.378)	(0.336)	(0.317)
Waikato	binary	0.115	-0.373	-0.216	0.0397	-1.086***	0.111
		(0.466)	(0.412)	(0.379)	(0.443)	(0.365)	(0.375)
Constant		0.198	-2.035*	5.464***	1.229	2.167**	0.977
		(1.253)	(1.056)	(1.090)	(1.146)	(1.056)	(0.974)
Observations		528	528	528	528	528	528
R-squared		0.069	0.057	0.223	0.020	0.109	0.084

Heteroskedasticity-robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

320. Dairy farmers are especially inclined to lease land out in the next five years, with scores 1.45 points (64.7% of the mean) higher than arable farmers and other rural decision-makers. Decision-makers who are university educated are also more likely to have intentions of leasing out land, significant at the 10% level. In contrast, male decision-makers report 0.93 point (26.4% of the mean) higher intentions to purchase or lease additional land than female decision-makers (significant at the 1% level) but men and women do not differ in expectations regarding selling or leasing out land. Holding all else equal, farm size is highly and positively correlated with the intention to buy or lease new land and negatively correlated with the intention to sell land, suggesting that large farms will grow larger.

321. Sheep and beef farmers are neither more nor less likely than arable farmers and other rural decision-makers to plan to change farm size. Region of residence has only a moderate impact on these plans, with decision-makers in Southland scoring themselves 0.69 points higher in terms of planning to sell land (significant at the 10% level).

322. Sheep and beef farmers report 1.23 point (39.4% of the mean) lower intentions to change the enterprise mix due to impending regulations than arable farmers and other rural decision-makers (significant at the 1% level) and 0.62 point (19.7% of the mean) lower intentions to intensify (significant at the 10% level). Dairy farmers are not statistically more likely to change the enterprise than arable farmers and other rural decision-makers. Holding all else equal, rural decision-makers in Southland and Waikato are 0.75 points (24.0% of the mean) less likely and 1.09 (34.8% of the mean) points less likely than decision-makers in Canterbury to plan to intensify the enterprise mix, respectively. Both effects are statistically significant at the 5% level or higher.

323. *Ceteris paribus*, rural decision-makers with technical training report significantly higher levels of planning to intensify (significant at the 1% level) while those with university educations report lower intent to change enterprise mixes due to impending regulations (significant at the 10% level). Larger land owners report greater intent to change enterprise mixes, whether by reducing intensity (significant at the 1% level), increasing intensity (significant at the 1% level), or changing the mix due to impending regulations (significant at the 5% level). Age is negatively associated with planning to intensify (significant at the 10% level). Finally, males are more likely to report planning to intensify (significant at the 5% level).

7.8 Behaviours

324. Per the Theory of Planned Behaviour, attitudes towards behaviours, perceived behavioural controls, subjective norms, and behavioural intentions influence behaviours. Hence, we include all of the above in estimating whether rural decision-makers have adopted 13 specific management practices, which are reported in Table 8, panels A and B.

325. Attitudes toward freshwater use, perceived behavioural controls, and subjective norms are indicated by several individual variables from the survey, as indicated above. As is standard in TPB research, several items (usually three) designed to elicit reliable information about a single construct (such as attitude to freshwater use) are converted into an index based on the unweighted averages of the items. In the current study, 11-point indices were constructed for the predictor variables attitude towards freshwater use, perceived behavioural control, and subjective norm. Thus, for example, the new variable "water index" is the average perceived importance of sustaining recreational use of waterways, of sustaining the purity and quality of freshwater, and of sustaining natural habitats for native fish and birds for each respondent, and PBC index and norms index are defined analogously.

326. Cronbach's alpha statistic is widely used to indicate the degree to which a set of disparate items measures a single, unidimensional latent construct. We thus test the internal validity of these three indices, finding the following:

$\alpha_{water} = 0.8$
$\alpha_{PBCs} = 0.5$
$\alpha_{norms} = 0.7$

327. Bowling (2002) notes that alpha statistics of 0.5 and greater are sufficient to establish internal consistency while Tavakol and Dennick (2011) argue that alpha statistics should be below 0.9, so these indices are used in all subsequent analysis.

328. Given the richness of the data, we also assess the size of farming networks, risk tolerance, and farmer outlook in evaluating farming intentions and behaviours.

329. Because behaviours were measured categorically ("already adopted", "intending to adopt", "considering adopting but still undecided", "do not intend to adopt", and "does not apply") in the survey, linear estimation methods (e.g., ordinary least squares) are inappropriate. Ordered logit models handle such data well but are unwieldy to present succinctly and difficult to interpret. Hence, we employ probit models to evaluate the correlates of either having adopted or intending to adopt specific management practices relative to either deciding not to adopt or remaining undecided. Note that respondents who replied that the management practice was not applicable are excluded from the sample used to estimate each model and that sample sizes vary accordingly. Marginal effects and heteroskedasticity-robust standard errors are reported.

330. The six measures of future farm management plans; planning to sell land, to lease land out, to buy or lease land, to change the enterprise mix to reduce the workload, to intensify, and to change the enterprise mix due to regulations) were tested and found to have little measurable impact on farm management practices. *Ceteris paribus*, a 1-point increase in the intention to buy or lease land is associated with 4.3% increase in the probability that the farmer has already (or intends to) wintered off stock at the mean (significant at the 1% level) and a 1.8% decrease in the probability that the farmer does/intends to reduce stocking rates at the mean (significant at the 5% level). Similarly, a 1-point increase in the intention to change the enterprise mix to reduce the workload is associated with 1.6% increase in the probability that the farmer has already/intends to reduce stocking rates at the mean (significant at the 10% level). Finally, a 1-point increase in the intention to change the enterprise mix to increase the intensity of the farming enterprise corresponds to 2.6% greater likelihood that the farmer has already/intends to apply DCDs (significant at the 5% level).

331. Attitudes toward freshwater have a robust correlation with farmer behaviours, positively associated with reducing stocking rates, reducing N fertilizer, applying DCDs, employing a nutrient management plan, upgrading the effluent system, constructing wetlands and sediment traps, planting forestry blocks, and planting riparian buffers (all significant at the 5% level or greater). Perceived behavioural controls are positively correlated with reducing N fertilizer (significant at the 10% level), fencing streams (significant at the 1% level), and constructing wetlands and sediment traps (significant at the 1% level). It is not correlated with other management practices. Subjective norm is positively correlated with employing a nutrient management plan (significant at the 5% level), and with fencing streams (significant at the 5% level). Subjective norm is not correlated with other management practices. A meta-analysis of 185 TPB studies also found that subjective norm is a less powerful predictor than attitude to the behaviour or perceived behavioural control (Armitage and Conner, 2001)

332. Controlling for other variables, decision-makers with large social networks are 11.2% more likely to have already or to intend to employ nutrient management plans, significant at the 1% level. They are also 16.3% more likely to winter off stock and 10.1% more likely to add or upgrade irrigation systems, both significant at the 10% level.

333. Production-oriented decision-makers are 23.9% more likely to winter off stock (significant at the 1% level) but 18.9% less likely to add or upgrade irrigation systems (significant at the 10% level) than decision-makers who are not classified as being strongly production oriented. They are also 10.4% less likely to fence streams, *ceteris paribus*. Risk tolerance is not strongly associated with farmer behaviour, although a 1-point increase in risk tolerance corresponds to a 4.6% predicted increase in the probability that farmers either have or intend to construct a feed pad.

334. Not surprisingly, primary enterprise strongly affects the decision to adopt specific management practices. Sheep and beef farmers are 17.1% more likely to reduce stocking rates than arable farmers and other rural decision-makers, 23.9% less likely to add or upgrade irrigation systems, 19.2% less likely to upgrade effluent systems, 6.0% less likely to fence streams, and 14.6% less likely to plant riparian buffers, *ceteris paribus*, all significant at the 10% level or higher. Dairy farmers are 42.9% more likely to winter off stock, 23.4% more likely to employ a nutrient management plan, 14.3% more likely to upgrade effluent systems, and 14.4% more likely to fence streams, all significant at the 10% level or higher. They are also 17.6% less likely to construct wetlands or sediment traps than arable farmers and other rural decision-makers (significant at the 10% level) and 26.1% less likely to plant forestry blocks (significant at the 5% level).

335. In addition, management practices vary strongly by region, even controlling for primary enterprise type. For example, rural decision-makers in Southland and Waikato are 21-24% less likely to apply DCDs and are 29-34% less likely to construct feed pads than those in Canterbury, *ceteris paribus*. Relative to farmers in Canterbury, farmers in Southland are also significantly more likely to fence streams and to plant forest blocks while farmers in Waikato are more likely to construct wetlands or sediment traps and to employ nutrient management plans. At the same time, Waikato farmers are less likely to winter off stock, to add or upgrade irrigation systems, and to change primary crops and/or rotation. Each of these effects is statistically significant at the 5% level or above.

336. Finally, demographics and land characteristics are significantly correlated with farm management practices, even after controlling for enterprise, region, intentions, attitudes, perceived behavioural controls, subjective norms, network size, risk tolerance, and outlook. For example, more educated farmers are 10-17% less likely to reduce N fertilizer than those with high school education (significant at the 10% level or higher). Older decision-makers are significantly more likely to winter off stock, to apply DCDs, and plant forestry blocks, while male decision-makers are significantly less likely to reduce stocking rates, to winter off stock, to apply DCDs, and to employ a nutrient management plan. Land size is negatively correlated with reduced stocking rates and with fencing streams, but not with other management options.

Table 8A . Behaviours (binary, maximum likelihood estimation)

		(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	UNIT	reduce stocking rates	reduce N fertiliser	winter off stock	apply DCDs	employ nutrient mgmt plan	add / upgrade irrigation system
Age	years	-0.00009	-0.00131	0.0127***	0.0103**	-0.00275	0.00150
		(0.00303)	(0.00302)	(0.00463)	(0.00421)	(0.00248)	(0.00332)
Male	binary	-0.125*	-0.0571	-0.300***	-0.254**	-0.0785*	0.0699
		(0.0727)	(0.0656)	(0.0710)	(0.109)	(0.0461)	(0.0786)
technical training	binary	-0.126*	-0.165**	0.0609	-0.0202	-0.173**	-0.00237
		(0.0736)	(0.0777)	(0.100)	(0.0905)	(0.0788)	(0.0775)
university	binary	-0.0525	-0.102*	-0.0471	-0.0136	-0.0639	-0.0756
		(0.0630)	(0.0581)	(0.0911)	(0.0823)	(0.0459)	(0.0620)
log land (ha)	log ha.s	-0.0775***	-0.0108	-0.00913	0.0283	0.0169	0.0202
		(0.0217)	(0.0201)	(0.0319)	(0.0313)	(0.0148)	(0.0193)
sheep and beef	binary	0.171**	0.0944	0.0350	-0.0384	-0.0722	-0.239***
		(0.0753)	(0.0634)	(0.119)	(0.0948)	(0.0484)	(0.0797)
Dairy	binary	0.0324	0.0858	0.429***	0.0696	0.234***	0.0443
		(0.0936)	(0.0746)	(0.121)	(0.103)	(0.0429)	(0.0768)
Southland	binary	0.0407	-0.0350	-0.0158	-0.235***	0.0588	-0.183
		(0.0689)	(0.0646)	(0.0896)	(0.0641)	(0.0425)	(0.113)
Waikato	binary	0.100	0.0520	-0.371***	-0.211***	0.0963**	-0.373***
		(0.0816)	(0.0691)	(0.110)	(0.0738)	(0.0468)	(0.110)
water index	index	0.0538**	0.0476***	0.0327	0.0601**	0.0338***	-0.0289
		(0.0210)	(0.0175)	(0.0249)	(0.0273)	(0.0127)	(0.0187)
PBC index	index	-0.00843	0.0282*	0.00419	-0.00190	0.00862	-0.000962

		(0.0161)	(0.0147)	(0.0212)	(0.0233)	(0.0111)	(0.0162)
norms index	index	0.00648	0.00949	0.0241	0.0126	0.0258**	0.00375
		(0.0184)	(0.0163)	(0.0254)	(0.0284)	(0.0122)	(0.0187)
big network	binary	0.0705	-0.0604	0.163*	0.0986	0.112***	0.101*
		(0.0599)	(0.0563)	(0.0838)	(0.0735)	(0.0428)	(0.0581)
risk tolerance	scale	0.00345	0.0119	0.0247	0.00203	0.000728	0.0175
		(0.0128)	(0.0123)	(0.0163)	(0.0186)	(0.00888)	(0.0128)
product. oriented	binary	0.0317	-0.0827	0.239***	0.0914	-0.0956	-0.189*
		(0.0808)	(0.0780)	(0.0867)	(0.120)	(0.0728)	(0.0989)
int. to sell land	scale	0.00110	-0.00372	0.00974	-0.0174	0.00351	-0.00110
		(0.00829)	(0.00767)	(0.0121)	(0.0131)	(0.00603)	(0.00778)
int. to lease land out	scale	0.00523	-1.14e-05	0.00932	0.0137	0.00552	-0.00401
		(0.00902)	(0.00828)	(0.0113)	(0.0128)	(0.00696)	(0.00807)
int. buy/lease land	scale	-0.0180**	0.00334	0.0433***	0.0169	-0.00228	-0.0116
		(0.00859)	(0.00832)	(0.0119)	(0.0115)	(0.00630)	(0.00866)
int. reduce work	scale	0.0161*	0.00181	0.0133	-0.00919	-0.00452	-0.0110
		(0.00879)	(0.00797)	(0.0119)	(0.0115)	(0.00636)	(0.00828)
int. incr. intensity	scale	0.00459	0.00569	-0.00299	0.0264**	0.00104	0.00244
		(0.0102)	(0.00922)	(0.0131)	(0.0131)	(0.00747)	(0.00893)
Int. change b/c regs	scale	0.00214	0.00417	-0.0134	0.00195	-0.00282	-0.00706
		(0.00948)	(0.00885)	(0.0137)	(0.0126)	(0.00664)	(0.00928)
Observations		352	402	212	188	415	240

Marginal effects reported

Heteroskedasticity-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8B. Behaviours (continued) (binary, maximum likelihood estimation)

		(7)	(8)	(9)	(10)	(11)	(12)	(13)
VARIABLES	UNIT	construct feed pad	upgrade effluent system	fence streams	construct wetlands / sediment traps	plant forestry blocks	plant riparian buffers	change primary crops and/or rotation
Age	years	0.00401	0.00263	-0.000253	-0.00464	0.00628*	0.00465	0.00321
		(0.00392)	(0.00251)	(0.00176)	(0.00375)	(0.00331)	(0.00315)	(0.00308)
Male	binary	0.0184	0.0934	-0.0234	-0.0300	0.0232	-0.0741	-0.0999
		(0.0945)	(0.0714)	(0.0361)	(0.0835)	(0.0780)	(0.0669)	(0.0690)
technical training	binary	0.0191	0.0645	0.0239	0.156*	0.0247	0.0633	-0.0286
		(0.102)	(0.0444)	(0.0386)	(0.0823)	(0.0846)	(0.0690)	(0.0771)
university	binary	-0.129*	0.0656	0.0366	0.0654	0.0900	0.170***	-0.0437
		(0.0755)	(0.0425)	(0.0298)	(0.0737)	(0.0685)	(0.0577)	(0.0615)
log land (ha)	log ha.s	-0.0237	-0.0133	-0.0201**	0.000607	0.00770	0.0343	-0.0169
		(0.0306)	(0.0164)	(0.0102)	(0.0261)	(0.0220)	(0.0212)	(0.0207)
sheep and beef	binary	-0.0107	-0.192*	-0.0600*	-0.126	-0.123	-0.146**	-0.0463
		(0.0997)	(0.138)	(0.0368)	(0.0844)	(0.0768)	(0.0726)	(0.0672)
Dairy	binary	0.170	0.143*	0.144***	-0.176*	-0.261**	-0.0399	-0.0402
		(0.109)	(0.0940)	(0.0351)	(0.0967)	(0.103)	(0.0884)	(0.0862)
Southland	binary	0.344***	0.0419	0.0766***	0.0658	0.135**	0.0843	-0.00262
		(0.0843)	(0.0405)	(0.0255)	(0.0761)	(0.0685)	(0.0622)	(0.0665)
Waikato	binary	0.285***	-0.0822	0.0356	0.202***	0.0553	-0.0726	-0.218***
		(0.0978)	(0.0555)	(0.0368)	(0.0756)	(0.0864)	(0.0777)	(0.0830)
water index	index	0.0354	0.0329**	0.0139	0.0766***	0.0513**	0.0671***	0.0301

		(0.0248)	(0.0146)	(0.00905)	(0.0271)	(0.0229)	(0.0209)	(0.0187)
PBC index	index	-0.0278	-0.00173	0.0244***	0.0661***	-0.0160	0.0114	0.00704
		(0.0193)	(0.0152)	(0.00793)	(0.0189)	(0.0169)	(0.0151)	(0.0144)
norms index	index	0.0204	-0.0115	0.0182**	-0.00109	-0.00337	0.00243	0.0231
		(0.0275)	(0.0142)	(0.00804)	(0.0248)	(0.0221)	(0.0191)	(0.0175)
big network	binary	-0.0462	0.0798	0.0355	0.0243	-0.00713	0.0411	0.0476
		(0.0789)	(0.0561)	(0.0332)	(0.0705)	(0.0703)	(0.0595)	(0.0583)
risk tolerance	scale	0.0463***	-0.00560	0.00784	0.00452	-0.00635	0.00772	0.0174
		(0.0164)	(0.0105)	(0.00651)	(0.0141)	(0.0134)	(0.0120)	(0.0119)
product. oriented	binary	-0.0806	-0.0522	-0.104*	-0.123	-0.0571	-0.142	-0.0337
		(0.0882)	(0.0679)	(0.0620)	(0.108)	(0.109)	(0.0966)	(0.0852)
int. to sell land	scale	-0.000228	-0.00140	-0.00009	0.00154	-0.00664	0.00980	0.00749
		(0.0116)	(0.00585)	(0.00424)	(0.0101)	(0.00978)	(0.00836)	(0.00807)
int. to lease land out	scale	0.00193	-0.00295	-0.000530	0.00156	-0.00311	0.00219	-0.00404
		(0.0109)	(0.00654)	(0.00468)	(0.0107)	(0.0106)	(0.00850)	(0.00862)
int. buy/lease land	scale	0.00240	0.00546	0.00246	-0.00109	-0.00235	0.00373	-0.00608
		(0.0113)	(0.00708)	(0.00447)	(0.0107)	(0.0103)	(0.00858)	(0.00844)
int. reduce work	scale	0.0273**	-0.00690	-0.00501	-0.00557	-0.00505	-0.0113	0.00173
		(0.0110)	(0.00597)	(0.00449)	(0.0112)	(0.0100)	(0.00851)	(0.00855)
int. incr. intensity	scale	-0.00545	0.00457	0.00669	0.0119	0.00294	0.00889	0.0123
		(0.0128)	(0.00768)	(0.00463)	(0.0114)	(0.0110)	(0.00916)	(0.00889)
Int. change b/c regs	scale	-0.0124	0.00210	0.000650	-0.00510	-0.00537	-0.00449	0.00415
		(0.0121)	(0.00684)	(0.00531)	(0.0103)	(0.0108)	(0.00927)	(0.00882)
Observations		225	179	376	250	279	313	346

Marginal effects reported

Heteroskedasticity-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

8. Implications

337. Based on the literature review there are some specific recommendations that could be taken into account for future agent-based models of rural decision makers and their behaviours. These aspects will be incorporated (where appropriate) within the future development timelines for the two ABMs.

338. While the survey undertaken was successful, in the process of undertaking a detailed survey on rural decision makers, there have been a number of conclusions about the way the survey was built and conducted that have been documented. These aspects will, in the future, contribute to better survey questions as well as more appropriate ways in which the researchers can apply the survey to increase the response rate from the sample.

339. Even so, the survey responses received from the survey form a valuable dataset that will continue to improve over time based on the ability of getting additional survey responses. Increasing the sample size will increase the statistical precision of our estimates which in turn will improve our confidence in the results.

340. While each response explained in the descriptive statistics is an implication in itself, a few key points should be mentioned.

341. Waikato rural decision makers have 10% more farming experience, on average, than respondents from Canterbury and Southland. The vast majority had worked on more than one farm in their career. Only 22.5% of respondents had selected a successor. If one was identified it was usually one of their own children. Waikato farms are predominantly Dairy which differs to the other two regions where sheep and beef is the main enterprise on the farm

342. Canterbury farms are larger than Southland and Waikato farms, on average. Most respondents do not lease land for their farming operation. Over half of the respondents stated that they are undertaking more than one enterprise on their farm. Over their time on the farm, 46% of respondents had changed the hectares associated with their enterprises by more than 20%. Canterbury rural decision makers changed enterprise mixes most recently. Decision makers in Canterbury were more educated than their counterparts in the other two regions.

343. Respondents in Southland (64.2%) and Waikato (61.2%) reported a higher share of farm profitability than respondents in Canterbury (47.8%). While 66.4% of Canterbury Sheep and Beef farmers responded that they were breaking even or unprofitable, only 17.1% of Dairy farmers feel the same way. Respondents in Southland are also statistically younger and less educated on average than the other two regions.

344. In all three regions, veterinarians are the most trusted and important source of information for respondents. Overall, other farmers are the third most trusted and important source of information for rural decision-makers after vets and accountants. The least three trusted and important source of information where Central government, Television and Radio, and Regional Councils.

345. The sizes of rural decision makers' social networks are similar between regions. Only 5.5% of farmers surveyed did not discuss farming with any other farmers. A similar figure was found (6.8%) did not visit any other working farms over the previous 12 months. Dairy farmers are considerably more connected through their peer networks other farmers in all three regions.

346. While Southland respondents have a slightly more productivist orientation, they also acknowledge the importance of sustaining natural habitats for native fish and

birds than Waikato and Canterbury respondents. Rural decision-makers in Canterbury are more likely to hold intentions to intensify their enterprise mix than decision makers in either Southland or Waikato. The majority of respondents believe that they are unlikely to change their enterprise mix due to regulatory pressure in the next 5 years.

347. Tradition is a stronger motivator in Southland than in either Canterbury or Waikato. These results indicate that although tradition is not the primary motivation for farming for a majority of respondents, it is nonetheless an important motivator for some rural decision makers.

348. While most respondents believe that their family members and the farming community want them to farm in an environmentally sustainable manner, respondents in all three regions believe that the social expectation for farming sustainably is significantly stronger amongst the New Zealand public.

349. Questions around the update of farm management practices by enterprise provided a significant range of revealed preferences by rural decision makers in relation to the lack of willingness to adopt a management practice. Conversely the amount of respondents who have already adopted the practice is also telling.

350. These questions also highlighted a number of ways in which a rural decision maker might respond to the introduction of limit setting policies. Restriction on the number of dairy or beef cattle, or sheep would be resisted by all decision makers. Based on the level of implementation, their intention to implement, or consideration of reducing in N on the farm, more focused policies around N limits is expected to have greater acknowledgement and adoption. In addition dairy farmers in each of the three regions are more responsive to this management practice. Consequently you could assume dairy farmers would also be more responsive than Sheep and Beef or Arable farmers to other future N based polices in the future. Responses to the questions around their attitudes towards water resources highlight that more environmentally focused policies around the quality of freshwater resources might be understood and accepted. However as noted in the descriptive analysis respondents may answer such questions in a fashion that reflects what they consider to be the most socially desirable response.

351. Thirty-two different hypotheses pertaining to attitudes, perceived behavioural controls, social norms, network size, risk tolerance, outlook, farming intentions, and the uptake of 13 specific farm management practices were specified and tested.

352. Enterprise type, Region, Age and Education all play a role in rural decision makers' views on the importance of preserving the purity and quality of water. Education, Enterprise type and Farm Size all play a role in shaping their views on their perceived behavioural control.

353. Dairy farmers report higher expectations within the farming community than arable farmers and other rural decision-makers. Interestingly, dairy farmers do not report higher expectations than others from family members or the New Zealand public.

354. The size of a farmer’s social networks is related to the age of the decision makers, their gender, their enterprise type and their farm size. For example, dairy farmers are 12.2% more likely to discuss farming practices with six or more farmers than arable farmers and other rural decision-makers, but are not statistically more likely to visit more farms.

355. Gender, Education level, Farm Size, aspects of Enterprise type, and Age all play a role in the level of tolerance for risk by rural decision makers. For example, men score themselves 16.0% higher on the risk-tolerance scale than women.

356. In conclusion, land use by itself is not a sufficient predictor of behaviour. Aspects that do shape the behaviour of decision makers is demographics (e.g., age and gender), land characteristics (e.g., size), location, attitudes, the level of personal control they believe they have over their farm, the social expectations on them as a farmer, and the size of their social network. Conversely, a decision makers' tolerance of risk is not a sufficient predictor of behaviour.

357. This report contains a significant amount of information about the behaviour of rural decision makers' in Canterbury, Southland and Waikato. The dataset is extremely valuable and is presented here in an easy to digest form. The implications of this research fall in line with the various sections and the original aims of the research project.

358. All aspects of this report and the survey dataset will contribute to the development of more robust ABM's that can explore rural decision makers' behaviour and their responses to social, economic and policy changes. This will enable Landcare Research, AgResearch and other interested parties to develop a better understanding of how rural decision makers respond to policies setting limits on the use of freshwater resources.

9. Limitations of the research

359. Robinson, et al. (2007) identified at least 5 methods for which ABMs of land use can be informed, each offering advantages, disadvantages and complementing each other. These are: sample surveys, participant observation, field and laboratory experiments, companion modelling and GIS and remote sensed spatial data. We selected to use surveys to collect data to inform ABMs, as empirical data collection by surveys is guided a priori by theory and therefore we could develop questions and design the survey to target specific decision makers and situations, in this case, to address MfE requirements. Surveys are also an appropriate method to provide information on the distributions of characteristics, beliefs and preferences within a population of agents and estimate behavioural models based on economic theory. However, we should stress that there is no perfect single data collection method that can inform all aspects of a complex ABM of land use change (Robinson, et.al. 2007). We also recognise that understanding the complexity of land use change dynamics requires a multitude of disciplines complementing each other.

360. It is extremely difficult to design perfect survey questions and, as noted in the report, some of the question in our survey may be able to be improved. We have also noted that, due to project time constraints, our survey piloting was less rigorous than we would have liked. However, the current successful implementation of the survey indicates that it is generally acceptable, and may also be considered as a "large pilot" study (N=528) for the planned future implementation of the survey in additional regions of New Zealand. We note there are always a number of different issues to consider regarding survey questions and survey design, these may sometimes conflict, and it is often necessary to compromise on some issues. Before future implementation of the survey, it would be appropriate to review the questions with respect to the survey responses and the currently collected data.

361. In psychometric research, the dominant practice is to use multiple items to assess unidimensional psychological constructs. The reason for this is that multiple items increase the reliability of the measure and measurement reliability places an upper limit on the construct and predictive validity of the measure (Nunnally & Bernstein, 1994). In the current research, three psychological constructs required for the TpB are measured using multiple items. Although the reliabilities of these three measures are adequate for research purposes, as documented in the report, higher co-efficient alphas would improve the upper limit of the measures' construct and predictive validities. There are some exceptions to this general rule, for example, as documented in the report, the single question item used to measure "risk tolerance" has been validated in previous literature – i.e., reliability may also be assessed by using the test-retest method rather than coefficient alpha applied to multiple items in a single test. However, due to space restrictions in the survey, there are also a number of single items used to measure other psychological constructs, which do not have question items validated in prior literature. This means that, from our data, there is no way to measure the reliability of these items. This presents an unknown limitation on the precision and validity of these items (however, note that determining validity precisely is not theoretically possible and there are no generally accepted indices of construct validity e.g., Smith, 2005a). Some evidence for the validity of these items may be gained by examining the nomological network of related constructs in which they are embedded (Cronbach & Meehl, 1955; Smith, 2005b).

362. As documented in the report, it was not logistically possible to implement a full TpB questionnaire for all 13 specific behaviours/practices that we were interested in. Thus, we chose to implement a more generalised version of the theory,

considering general attitudes to water quality and management and towards the environment. However, Ajzen and Fishbein (2005) note that general attitudes are better at predicting aggregated behaviour, from a single behaviour domain, than they are at predicting a specific behaviour (conceptually, this is related to the reliability and validity issues discussed above). This may place a limitation on the predictive ability of our data with respect to the uptake of specific technologies or practices. However, our 13 behaviours or practices are drawn from a single behaviour domain. Thus, they are suitable for aggregation, and hence meet with the theoretical requirements of the principles of aggregation and compatibility as outlined by Ajzen and Fishbein. However, it is important to note that there is considerable theoretical debate about prediction of specific behaviours from general attitudes. For example, Fazio's Mode theory (1990) suggests that there are circumstances under which general attitudes are good predictors of specific behaviours. The application of the TpB in the current study is very similar to a study by Small, Parminter and Fisher (2005), in which general attitudes were found to be highly predictive of specific attitudes to an object and also (at a slightly lower level) strongly predictive of intention to perform a specific behaviour.

363. The modest sample size poses two potential problems for this analysis. First, if our sample systematically differs from the population, then our estimates will be subject to sample selection bias. However, this is difficult given to assess given the dearth of up-to-date information on basic farm characteristics and farmer demographics in New Zealand. Nevertheless, we have shown that farmer age and farm size across various enterprises are consistent with those reported in AgriBase. On the other hand, dairy farmers are over-represented vis-à-vis AgriBase. A higher incidence of dairy farming is not unsurprising given the high levels of dairy conversion in the sampled regions and the fact that the average AgriBase record was entered five years ago, and we would argue that this is consistent with the changing face of rural enterprise in New Zealand.

364. The second potential problem associated with modest sample sizes pertains to the standard errors in our estimates. Specifically, standard errors are negatively correlated with sample size, raising the bar for statistical significance in our estimates. This doesn't appear to have been a pronounced problem given that the number of statistically significant variables, but a larger sample size would nevertheless improve the precision of the point estimates

10. Future Work

366. Based on the success of the survey in these three regions, Landcare Research is conducting a similar survey across the other 13 regions to provide national data. This will increase the overall sample size, which will increase the statistical precision of our estimates. This will also allow us to test the farmer behaviour and outlook attributes across more regions and land use types. Within these new surveys, we aim to capture additional information in order to understand why farmers feel that they cannot implement best practice or adopt better environmental technologies.

367. It is expected that both Landcare Research and AgResearch will be implementing and incorporating the information and statistics found in this report in the two existing agent-based models for testing within the three regions. It is expected that the recommendations outlined in the literature review will also be incorporated where appropriate.

368. Finally, we believe that the data collected in the survey is extremely rich, and we hope to further explore this dataset to improve our understanding of how rural decision makers differ in their responses to policy. In addition, further analysis of the dataset would improve the agent-based models that are being developed by incorporating additional behavioural aspects.

11. References

ACOSTA-MICHLIK, L. & ESPALDON, V. (2008) Assessing vulnerability of selected farming communities in the Philippines based on a behavioural model of agent's adaptation to global environmental change. *Global Environmental Change,* 18**,** 554-563.

AHITUV, A.; KIMHI, A. (2002): Off-farm work and capital accumulation decisions of farmers over the life-cycle: the role of heterogeneity and state dependence. *Journal of Development Economics* 68: 329 – 353.

AJZEN, I. (1991) The theory of planned behavior. *Organizational behavior and human decision processes,* 50**,** 179-211.

AJZEN, I. (2001): Nature and operation of attitudes. *Annual Review of Psychology* 52: 27-58.

AJZEN, I. (2006) Theory of Planned Behaviour. Retrieved on 5/3/13 from http://people.umass.edu/aizen/tpb.diag.html#null-link,

AJZEN, I.; BROWN, T.; CARVAHAL, F. (2004): Explaining the discrepancy between intentions and actions: The case of hypothetical bias in contingent valuation. *Personality and Social Psychology Bulletin*, 30, 1108-1121.

AJZEN, I.; DRIVER, B. (1992): Application of the theory of planned behaviour to leisure choice. *Journal of Leisure Research* 24, 207–224.

AJZEN, I. & FISHBEIN, M. (1980) *Understanding attitudes and predicting social behavior*, Prentice-Hall.

ALTMAN, D.; ZACCARO, D.; LEVINE, D.; AUSTIN, D.; WOODELL, C.; BAILEY, B.; SLIGH, M.; COHN, G.; DUNN. J. (1998): Predictors of crop diversification: a survey of tobacco farmers in North Carolina (USA): *Tobbaco Control* 7 (4): 376-382.

ARMITAGE, C. J. & CONNER, M. (1999) The theory of planned behaviour: Assessment of predictive validity and 'perceived control. *British Journal of Social Psychology,* 38**,** 35-54.

ARMITAGE, C. J. & CONNER, M. (2001) Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology,* 40**,** 471-499.

ATARI, D.; YIRIDOE, E.; SMALE, S.; DIUNKER, P. (2009): What motivates farmers to participate in the Nova Scotia environmental farm plan program? Evidence and environmental policy implications. *Journal of Environmental Management* 90: 1269–1279

AUBRY, C.; PAILLAT, J-M; GUERRIN, F. (2006): A conceptual representation of animal waste management at the farm scale: The case of the Reunion Island. *Agricultural Systems* 88: 294–315.

AUSTIN, E.J.; DEARY, I.J.; GIBSON, G.J.; MCGREGOR, M.J.; DENT, J.B. (1996): Attitudes and values of Scottish farmers: "Yeoman" and "Entrepreneur" as factors, not distinct types. *Rural Sociology* 61 (3): 464-474.

BAKER, J. 2011. Your Last Fencepost: Succession and Retirement Planning for New Zealand Farmers. London:Longacre Press.

BAKKER, M. M. & VAN DOORN, A. M. (2009) Farmer-specific relationships between land use change and landscape factors: Introducing agents in empirical land use modelling. *Land Use Policy,* 26**,** 809-817.

BALTER KA, BALTER O, FONDELL E, LAGERROS YT. 2005. Web-based and mailed questionnaires: A comparison of response rates and compliance. Epidemiology 16(4): 577-579

BANDURA, A. (1977) *Social learning theory*, Prentice Hall.

BAUMGART-GETZ, A., PROKOPY, L. S. & FLORESS, K. (2012) Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management,* 96**,** 17-25.

BATTERSHILL, M.; GILG, A.W. (1996): Traditional farming and agro-environment policy in Southwest England: back to the future? *Geoforum,* Vol. 27 (2): 133-147.

BATTERSHILL, M.; GILG, A. (1997): Socio-economic constraints and environmentally friendly farming in the Southwest of England. *Journal of Rural Studies* 13, 213–228.
BEEDELL, J. & REHMAN, T. (1999) Explaining farmers' conservation behaviour: Why do farmers behave the way they do? *Journal of Environmental Management*, 57**,** 165-176.
BEEDELL, J., REHMAN, T. (2000): Using social-psychology models to understand farmers' conservation behaviour. *Journal of Rural Studies* 16, 117–127.
BELL, C.; NEWBY, H. (1974): Capitalist farmers in the British class structure. *Sociologia Ruralis* 14: 86-107.
BENENSON, I. & TORRENS, P. (2004) Geosimulation: automata-based modelling of urban phenomena, Hoboken, NJ, John Wiley & Sons.
BENJAMIN, C.; CORSI, A.; GUYOMARD, H. (1996): Modelling labour decisions of French agricultural households. *Applied Economics* 28: 1577-1589
BERGEVOET, R.; ONDERSTEIJN, C.; SAATKAMP, H.; VAN WOERKUM, C.; HUIRNE, R. (2004): Entrepreneurial behaviour of dutch dairy farmers under a milk quota system: goals, objectives and attitudes. *Agricultural Systems* 80: 1–21
BEWSELL, D., & BROWN, M. (2009) Promoting the use of tools to assess the impact of management practices on dairy farms in New Zealand. *Conference paper presented at APEN Conference*, Perth, Australia, 2009.
BIDDLE, B.J. (1979): Role Theory: Expectations, Identities and Behaviours. Academic Press, London.
BOHNET, I., POTTER, C. AND E. SIMMONS., (2003). Landscape change in the multi-functional countryside: a biographical analysis of farmer decision-making in the English high weald. *Landscape Research* 28 (4), 349 – 364.
BOKEMEIER, J.; GARKOVITCH, L. (1987): Assessing the influence of farm women's self-identity on task allocation and decision making. *Rural Sociology*, Vol. 52 (1): 13-36.
BOURDIEU, P. (1983): Ökonomisches Kapital, kulturelles Kapital, soziales Kapital. In: Kreckel, R. (Ed.): Soziale Ungleichheiten. Soziale Welt. Sonderband 2. (Otto Schartz & Co, Göttingen). pp. 183-198
BOURDIEU, P. (1998): Practical Reason. (Stanford University Press, Stanford)
BOWLER, I.; CLARK, G.; CROCKETT, A.; ILBERY, B.; SHAW, A. (1996): The development of alternative farm enterprises: A study of family labour farms in the Northern Pennines of England. *Journal of Rural Studies* 2 (3): 285-295.
BOWLING A. (2002) Research Methods in Health: Investigating Health and Health Services. 2nd ed. Buckingham: Open University Press.
BRAGG, L.; DALTON, T. (2004): Factors Affecting the Decision to Exit Dairy Farming: A Two-Stage Regression Analysis. *Journal of Dairy Science* 87: 3092-3098.
BREEN, J. C., D.; RYAN, M.;WALLACE, M.; (2010) Can't See the Wood for the Trees: The Returns to Farm Forestry in Ireland. *Working Paper Series.* Rural Economy Research Centre, Teagasc.
BRODT, S.; KLONSKY, K.; TOURTE, L. (2006): Farmer goals and management styles: implications for advancing biologically based agriculture. *Agricultural Systems* 89: 90–105.
BROWN, D. G., PAGE, S. E., RIOLO, R., ZELLNER, M. & RAND, W. (2005) Path dependence and the validation of agent-based spatial models of land use. International Journal of Geographical Information Science, 19, 153-174.
BROWN, M. (1981): Behavioural approaches to the geographic study of innovation diffusion: problems and prospects. In K.R. Cox and R.G. Golledge (eds.), Behavioural Problems in Geography Revisited. New York, Methuen: 123-144.
BRYANT, C.R.; JOHNSTON, T.R. (1993): Agriculture in the City's Countryside. London, Belhaven Press.
BURKE, P.J.; REITZES, D.C. (1981): The link between identity and role performance. *Social Psychology Quarterly* 44 (2): 83-92.

BURTON, R. (1998) The role of farmer self-identity in agricultural decision making in the Marston Vale Community Forest. Unpublished PhD Thesis (Leicester: DeMontfort University)

BURTON, R. (In Press) Accounting for family life-cycle stage in farmer typologies for agent-based land use modeling: a social science perspective. *Agricultural Systems*.

BURTON, R. J. (2004a) Reconceptualising the 'behavioural approach' in agricultural studies: a socio-psychological perspective. *Journal of Rural studies,* 20**,** 359-371.

BURTON, R. J. F. (2004b) Seeing Through the 'Good Farmer's' Eyes: Towards Developing an Understanding of the Social Symbolic Value of 'Productivist' Behaviour. *Sociologia Ruralis,* 44**,** 195-215.

BURTON, R., MANSFIELD, L., SCHWARZ, G., BROWN, K., CONVERY I. (2005b). Social Capital in Hill Farming: Report for the International Centre for the Uplands, Macaulay Institute, Aberdeen.

BURTON, R.J.F.; PEOPLES, S. (2008): Learning from past adaptation to extreme climate events: a case study of drought. Part C: Adaptation of New Zealand farmers to drought events. Report for MAF, Agresearch, New Zealand.

BURTON, R.; WALFORD, N. (2005) Multiple succession on family farms in the South East of England: a counterbalance to agricultural concentration? *Journal of Rural Studies* 21(3): 335-347.

BURTON, R.; WILSON, G. (2006): Injecting social psychology theory into conceptualisations of agricultural agency: towards a 'post-productivist' farmer self-identity. *Journal of Rural Studies* 22 (1): 95-115.

BURTON, R.J.F., SCHWARZ, G., BROWN, K.M., CONVERY, I.T., MANSFIELD, L. (2008): The future of hefted upland commons in areas of high public goods provision: Learning from the Lake District experience. In: A. Bonn, K. Hubacek, J. Stewart & T. Allott (Eds) Drivers of Change in Upland Environments. London, Routledge.

CARLSON, R. O. (1965) ADOPTION OF EDUCATIONAL INNOVATIONS.

CAROLAN, M. S. (2006) Do You See What I See? Examining the Epistemic Barriers to Sustainable Agriculture. *Rural Sociology,* 71**,** 232-260.

CARR, S. (1988): Conservation on Farms: Conflicting Attitudes, Social Pressures and Behaviour. PhD Thesis. The Open University, Milton Keynes.

CARR, S.; TAIT, J. (1990): Farmers' attitudes to conservation. Built Environment 16 (3): 218-231.

CARR, S.; TAIT, J. (1991): Differences in the attitudes of farmers and conservationists and their implications. *Journal of Environmental Management* 32: 281-294.

CASKIE, P., DAVIS, J., WALLACE, M. (2001) Targeting disadvantage in agriculture. *Journal of Rural Studies*, 17, 471–479

CHAPLIN, H.; DAVIDOVA, S.; GORTON, M. (2004): Agricultural adjustment and the diversification of farm households and corporate farms in Central Europe. *Journal of Rural Studies* 20: 61–77.

CHARNG, H.W.; PILIVIN, J.A.; CALLERO, P.L. (1988): Role identity and reasoned action in the prediction of repeated behaviour, *Social Psychology Quarterly* 51 (4): 303-317.

CIOFFI, C.; GOTTS, N. (2003): Comparative analysis of agent-based social simulations: GeoSim and FEARLUS models. Paper prepared for the "Model-2-Model" Workshop on Comparing Multi-Agent Based Simulation Models, Marseilles, France, March 31st-April 1st,2003.

CLINCH, J. P. (1999) Economics of Irish forestry. IN COFORD (Ed. Dublin, Ireland.

COLLIER, M. (1998): Researching cultural identity. In: Tanno, D., Gonzalez, A. (Eds.), Communication and Identity Across Cultures. Sage, London, pp. 122–147.

COLLIER, P., DORGAN, J., BELL, P. & COFORD (2002) *Factors influencing farmer participation in forestry*, COFORD.

CONNOLLY, L., KINSELLA, A., QUINLAN, G. & MORAN, B. (2006) National Farm Survey 2006. *Rural Economy Research Centre (RERC), Teagasc*.

CORRALIZA, J.; BERENGUER, J. (2000): Environmental values, beliefs and actions: A Situational Approach. *Environment and Behaviour* 32 (6): 832-848.
COUGHENOUR, C.M. (1980): Farmers, location, and the differentiation of crops from livestock farming. *Rural Sociology*, Vol. 45 (4): 569-590.
COUGHENOUR, C.M. (1995): The social construction of commitment and satisfaction with farm and non-farm work. *Social Science Research*, Vol. 24: 367-389.
COUPER, MP. 2011. The future of modes of data collection. Public Opinion Quarterly 75(5 SPEC): 889-908.
CRABTREE, B., CHALMERS, N. & BARRON, N.-J. (1998) Information for Policy Design: Modelling Participation in a Farm Woodland Incentive Scheme. *Journal of Agricultural Economics*, 49**,** 306-320.
CRONBACH, L. J., & MEEHL, P. E. (1955). Construct validity in psychological tests. Psychological Bulletin, 52(4), 281-302.
CROWLEY, C., WALSH, J. A. & MEREDITH, D. (2008) *Irish farming at the millennium: a census atlas*, NIRSA.
CURTIS, A.; DE LACY, T. (1996): Landcare in Australia: does it make a difference? *Australian Journal of Environmental Management* 46 (2) pp. 119–137.
DAMIANOS, D.; SKURAS, D. (1996): Farm Business and the Development of Alternative Farm Enterprises: an Empirical Analysis in Greece. *Journal of Rural Studies*, Vol. 12, No. 3, pp. 273-283.
DARQUES, M. (1988): The division of labour and decision-making in farming couples: power and negotiation. *Sociologia Ruralis*, Vol. 28 (4): 271-291.
DASKALOPOULOU, I.; PETROU, A. (2002): Utilising a farm typology to identify potential adopters of alternative farming activities in Greek agriculture. *Journal of Rural Studies* 18: 95–103.
DEBONO, K.; OMOTO, A. (1993): Individual differences in predicting behavioural intentions from attitude and subjective norm. *Journal of Social Psychology* 133, 825–831.
DEFRANCESCO, E., GATTO, P., RUNGE, F. & TRESTINI, S. (2008) Factors Affecting Farmers' Participation in Agri-environmental Measures: A Northern Italian Perspective. *Journal of Agricultural Economics*, 59**,** 114-131.
DE VRIES, W.M. (1993): Farming with other gainful activities in the Netherlands. *Sociologia Ruralis*, Vol. 33 (2): 190-202.
DESCHAMPS, J-C.; DEVOS, T. (1998): Regarding the relationship between social identity and personal identity. In: Worchel, S., Morales, J., P!aez, D., Deschamps, J.-C. (Eds.), Social Identity. Sage, London, pp. 1–12.
DOHMEN, T, FALK A, HUFFMAN D, SUNDE U, SCHUPP J, WAGNER W. (2005) "Individual Risk Attitudes: New Evidence From a Large, Representative, Experimentally-Validated Survey." IZA Discussion Paper No. 1730.
DOOLEY AE. 2008. The changing nature of dairying: Ownership, management and succession. Paper presented at the 2008 NZARES Conference, August 28-29, 2008, Nelson, New Zealand.
DUPRAZ, P., HENRY DE FRAHAN, B., VERMERSCH, D. AND DELVAUX, L. (2000). Production debiens publics par des ménages: une application à l'offre environnementale des agriculteurs, Revue d'Economie Politique, 110 (2), 267-291.
EAGLY, A.; CHAIKEN, S. (1992): The Psychology of Attitudes. Harcourt Brace Janovich, San Diego.
EDWARDS-JONES, G. (2006) Modelling farmer decision-making: concepts, progress and challenges. *Animal Science*, 82**,** 783-790.
EEC (1985): Information concerning of standard gross margins (SGMs) for the various agricultural enterprises and coefficients established pursuant to Commission Decision 85/377/EEC of 7 June 1985 establishing a Community typology for agricultural holdings. Official Journal of the European Communities, 37(C335), 1–145.

ERRINGTON, A. (1986): The delegation of decisions on the farm. Agricultural Systems, Vol. 19: 299-317.
EVANS, N. (2009): Adjustment strategies revisited: Agricultural change in the Welsh Marches. Journal of Rural Studies 25: 217–230.
EVANS, N.J.; ILBERY, B.W. (1993): The pluriactivity, part-time farming, and farm diversification debate. Environment and Planning A, Vol. 25 (7): Pages 945-959
EVANS, T., MUNROE, D. & PARKER, D. (2005) Modeling Land-Use/Land-Cover Change: Exploring the Dynamics of Human-Environment Relationships. IN MORAN, E. & OSTROM, E. (Eds.) Seeing the Forest and the Trees: Human-Environment Interactions in Forest Ecosystems. Cambridge, Mass, MIT Press.
FAIRWEATHER, J, HUNT, L, COOK A, ROSIN, C, CAMPBELL, H. 2007. New Zealand farmer and grower attitude and opinion survey: Analysis by sector and management system. ARGOS Research Report 07/08. University of Otago.
FAIRWEATHER, J.; KLONSKY, K. (2007): Response to Vanclay et al. on Farming Styles: Q Methodology for Identifying Styles and its Relevance to Extension. Sociologia Ruralis 49 (2): 189-198.
FAIRWEATHER, J, MULET-MARQUIS, S. 2009. Changes in the age of New Zealand farmers: Problems for the future. New Zealand Geographer (65): 118-125 doi: 10.1111/j.1745-7939.2009.01154.x
FALCONER, K. (2000): Farm-level constraints on agri-environmental scheme participation: a transactional perspective. Journal of Rural Studies, Vol. 16: P379-394.
FARRELLY, N. (2006) A Review of Afforestation and Potential Volume Output from Private forests in Ireland Forestry development Unit, Athenry, Co. Galway.,Teagasc.
FAZIO, R.H. (1990): Multiple processes by which attitudes guide behaviour: The mode model as an integrative framework. Advances in Experimental Social Psychology 23: 75-109.
FAZY, I.; FAZY, J.; SALISBURY, J.; LINDENMAYER, D.; DOVERS, S. (2006): The nature and role of experiential knowledge for environmental conservation. Environmental Conservation 33 (1): 1–10.
FERBER, J. (1999) Multi-agent systems : an introduction to distributed artificial intelligence, Harlow, Addison-Wesley.
FIELDING, K. S., TERRY, D. J., MASSER, B. M. & HOGG, M. A. (2008) Integrating social identity theory and the theory of planned behaviour to explain decisions to engage in sustainable agricultural practices. *British Journal of Social Psychology*, 47**,** 23-48.
FISCHER, H. (2007): Succession on Scottish family farms: socialisation processes and the construction of farmer identities. Unpublished PhD Thesis. University of Aberdeen, Aberdeen.
FISHBEIN, M. & AJZEN, I. (1975) *Belief, attitude, intention and behavior: An introduction to theory and research*.
FISHER, R. (2013) 'A gentleman's handshake': The role of social capital and trust in transforming information into usable knowledge. *Journal of Rural studies*, 31**,** 13-22.
FLINN, W.L.; JOHNSON, D.E. (1974): Agrarianism amongst Wisconsin farmers. Rural Sociology, Vol. 39: 187-204.
FLETT, R., ALPASS, F., HUMPHRIES, S., MASSEY, C., MORRISS, S. & LONG, N. (2004) The technology acceptance model and use of technology in New Zealand dairy farming. *Agricultural Systems*, 80**,** 199-211.
FOUNTAS, S.; WULFSOHN, D.; BLACKMORE, B.; JACOBSEN, H.; PEDERSEN, S. (2006): A model of decision-making and information flows for information-intensive agriculture Agricultural Systems 87: 192–210.
FRIEDKIN, N. (2001): Norm formation in social influence networks. Social Networks 23: 167–189
FRAWLEY, J. P. & LEAVY, A. (2001) Farm forestry : land availability, take-up rates and economics. IN TEAGASC (Ed. Dublin, Ireland, Teagasc.

GARFORTH C., ANGELL, B., ARCHERC, J., GREEN, K. (2003): Fragmentation or creative diversity? Options in the provision of land management advisory services. Land Use Policy 20: 323–333

GASSON, R. (1973): Goals and values of farmers. Journal of Agricultural Economics, Vol. 24: 521-537.

GASSON, R. (1974): Socio-economic status and orientation to work: the case of farmers. Sociologia Ruralis, Vol. 14: 127-141.

GASSON, R.; HILL, P. (1990): An Economic Evaluation of the Farm Woodland Scheme, Department of Agricultural Economics, Wye College, Farm Business Unit Occasional Paper No. 17.

GILLMOR, D. A. (1998) Trends and spatial patterns in private afforestation in the Republic of Ireland *IRISH FORESTRY JOURNAL OF THE SOCIETY OF IRISH FORESTERS* 55**,** 10-25.

GINTIS, H. 2000. Beyond Homo economicus: Evidence from experimental economics, Ecological Economics, Volume 35, Issue 3, December 2000, Pages 311–322

GLEBE, T. (2007): The Environmental Impact of European Farming: How Legitimate Are Agri-Environmental Payments? Review of Agricultural Economics 29 (1): 87–102

GOLDSTEIN, B.; EICHHORN, R.L. (1961): The changing Protestant work ethic: rural patterns in health, work, and leisure. American Sociologial Review, Vol. 26: 557-565.

GRANT, W.; MACNAMARA, A. (1996): The relationship between bankers and farmers: an analysis of Britain and Ireland. Journal of Rural Studies, Vol. 12 (4): Pages 427-437.

GREINER, R. & GREGG, D. (2011) Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. *Land Use Policy,* 28**,** 257-265.

GREINER, R. & MILLER, O. (2008) Reducing diffuse water pollution by tailoring incentives to region specific requirements: empirical study for the Burdekin River basin (Australia). *Environmental economics and investment assessment II. WIT, Ashurst***,** 31-42.

GREINER, R., PATTERSON, L. & MILLER, O. (2009) Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems,* 99**,** 86-104.

HALES, S. (1985): The rediscovery of self in social psychology: theoretical and methodological implications. Journal for the Theory of Social Behaviour. Vol. 15 (3): 227-242.

HALLIDAY, J.E. (1989): Attitudes towards farm diversification: Results from a survey of Devon farmers. Journal of Agricultural Economics. Vol. 40: 93-100.

HANNAN, D. E. & COMMINS, P. (1993) Factors affecting land availability for forestry. IN INSTITUTE, T. E. A. S. R. (Ed. Dublin, Ireland, The Economic and Social Research Institute.

HEALEY, M.J.; ILBERY, B.W. (1990): Location and Change: Perspectives on Economic Geography. Oxford, Oxford University Press.

HENNESSY, T., ANNE KINSELLA, A., MORAN, B. & QUINLAN, G. (2011) National Farm Survey 2011. *Rural Economy Research Centre (RERC), Teagasc*.

HENNESSY, T. & O'BRIEN, M. (2007) Is off-farm income driving on-farm investment? *Rural Economy and Development Programme, Teagasc Working Papers*.

HIGGINS, C.B.R.; SEABROOK, M.F. (1986): The self concept as a factor influencing flexibility in farming practice. Agricultural Manpower 12: 14-25.

HOGG, M.A.; ABRAMS, D. (1988): Social Identifications: A Social Psychology of Intergroup Relations and Group Processes. Routledge, London.

HOWDEN, P., VANCLAY, F. (2000): Mythologization of farming styles in Australian broadacre cropping. Rural Sociology 65 (2), 295-310.

HOWLEY, P., HYNES, S. & O DONOGHUE, C. (2012) Explaining the non-economic behaviour of farm foresters: The effect of productivist and lifestyle motivations. *Rural Economy & Development Programme.* Athenry, Galway, Rural Economy & Development Programme, Teagasc.

HUMAN RIGHTS COMMISSION AND THE NEW ZEALAND CENTRE FOR WOMEN AND LEADERSHIP. 2004. New Zealand Census of Women's Participation in Governance and Professional Life. Retrieved on 21 May 2013 from: http://www.neon.org.nz/documents/womensCensus/HRC-Womens-Census2004.pdf

HUTSON, J. (1987): Fathers and sons: Family farms, family businesses and the farming industry. Sociology, Vol. 21 (2): Pages 215-229.

HYNES, S. & GARVEY, E. (2009) Modelling Farmers' Participation in an Agri-environmental Scheme using Panel Data: An Application to the Rural Environment Protection Scheme in Ireland. *Journal of Agricultural Economics*, 60**,** 546-562.

ILBERY, B. (1981): Dorset agriculture: a classification of regional types. Transactions of the Institute of British Geographers 6: 214-27.

IPCC (2001): Climate Change 2001: Impacts, Adaptation, and Vulnerability. http://www.grida.no/climate/ipcc_tar/wg2/477.htm

JACK, L., (2007). Accounting, post-productivism and corporate power in UK food and agriculture. Critical Perspectives on Accounting 18 (8), 905-931.

JAGER, W. & JANSSEN, M. (2003) The need for and development of behaviourally realistic agents. Lecture Notes in Artificial Intelligence (Subseries of Lecture Notes in Computer Science).

JANSSEN, S.; VAN ITTERSUM, M. (2007): Assessing farm innovations and responses to policies: A review of bio-economic farm models. Agricultural Systems 94: 622–636

JAY, M. (2005) Remnants of the Waikato: Native forest survival in a production landscape. New Zealand Geographer. 61: 14–28

JOHNSEN, S. (2004): The redefinition of family farming: agricultural restructuring and farm adjustment in Waihemo, New Zealand. Journal of Rural Studies 20, 419–432

JOHNSTON, R.J. (1991): A Question of Place: Exploring the Practice of Human Geography, Blackwell, London.

JØRGENSEN, M.; JØRGENSEN, U.; CLAUSEN, C. (2007): The Social Shaping Approach to Technology Foresight, Futures 41 (2): 80-86.

JUST, R. (2003): Risk research in agricultural economics: opportunities and challenges for the next twenty-five years. Agricultural Systems 75: 123–159

KAHNEMAN, D. (2003). Maps of bounded rationality: Psychology for behavioural economics. American Economic Review, 93, 1449-1475.

KELLY, C.E.; ILBERY, B.W. (1995): Defining and examining rural diversification: A framework for analysis. Tijdschrift voor Economische en Sociale Geografie, Vol. 85 (2): Pages 177-185.

KERRIDGE, K.W., (1978): Value orientations and farmer behaviour—an exploratory study. Quarterly Review of Agricultural Economics 31 (1): 61–72.

KESSLER, C.A. (2006): Decisive key-factors influencing farm households' soil and water conservation investments. Applied Geography 26: 40–60

KEY, N. (2005): How much do farmers value their independence? Agricultural Economics 33: 117–126

KLOSTERMAN, R. E. & PETTIT, C. (2005) An update on Planning Support Systems. Environment & Planning B: Planning & Design, 32, 477–484.

KRISTENSEN, S.P. (2003): Multivariate analysis of landscape changes and farm characteristics in a study area in central Jutland, Denmark. Ecological Modelling 168: 303-318

KRISTENSEN, L.S.; THENAIL, C.; KRISTENSEN, S.P. (2004): Landscape changes in agrarian landscapes in the 1990s: the interaction between farmers and the farmed landscape. A case study from Jutland, Denmark. Journal of Environmental Management 71 (2004) 231–244.

LAMBERT, D.; SULLIVAN, P.; CLAASSEN, R.; FOREMAN, L. (2007): Profiles of US farm households adopting conservation-compatible practices. Land Use Policy 24: 72–88.

LANKESTER, A., VALENTINE, P. & COTTRELL, A. (2009) 'The sweeter country': social dimensions to riparian management in the Burdekin rangelands, Queensland. *Australasian Journal of Environmental Management*, 16**,** 94-102.

LAPPLE, D. (2010), Adoption and Abandonment of Organic Farming: An Empirical Investigation of the Irish Drystock Sector. Journal of Agricultural Economics, 61: 697–714. doi: 10.1111/j.1477-9552.2010.00260.x

LE HERON, R.; ROCHE, M. (1999): Rapid Reregulation, Agricultural Restructuring, and the Reimaging of Agriculture in New Zealand. Rural Sociology 64 (2): 203-218.

LEWIS, T. (1998): Evolution of farm management information systems. Computers and Electronics in Agriculture, Vol. 19: Pages 233-248.

LAND INFORMATION NEW ZEALAND (2010) "Average New Zealand Farm Size by Farm Type". Accessed on 22 June 2013 from: http://www.linz.govt.nz/sites/default/files/docs/overseas-investment/average-farm-sizes-by-farm-type.pdf

LIVESTOCK IMPROVEMENT CORPORATION. 2005. Dairy Statistics 2004/2005. Hamilton:Livestock Improvement Corporation.

LIVESTOCK IMPROVEMENT CORPORATION and DairyNZ. 2012. New Zealand Dairy Statistics 2011-12. DairyNZ. Retrieved on 21 May 2013 from: http://www.dairynz.co.nz/Publications/NZDairyStats/2011-12/files/assets/basic-html/page46.html

LOBLEY, M.; POTTER, C. (2004): Agricultural change and restructuring: recent evidence from a survey of agricultural households in England. Journal of Rural Studies 20: 499–510.

MACMYNOWSKI, D.P.,(2007). Pausing at the brink of interdisciplinarity: power and knowledge at the meeting of social and biophysical science. Ecology and Society 12 (1), 20.

MAF (2008): Pastoral Monitoring Report. MAF, Wellington, New Zealand.

MANFREDA KL, BOSNJAK M, BERZELAK J, HAAS I, VEHOVAR V. 2008. Web surveys versus other survey modes. A meta-analysis comparing response rates. International Journal of Market Research 50(1): 79-104.

MAREY-PÉREZ, M. (2003) Tenencia de la tierra en Galicia: modelo para la caracterización de los propietarios forestales. Ph. D. Thesis. Digital edition (CD), Servicio de Publicaciones de la Universidad de Santiago de Compostela, Santiago de Compostela, Spain.

MARSDEN, T. (1991): Theoretical issues in the continuity of petty commodity production. In S. Whatmore, P. Lowe, and T. Marsden (eds.), Rural Enterprise: Shifting Perspectives on Small-scale Production. David Fulton, London: 12-34.

MARSDEN, T.; WHATMORE, S.; MUNTON, R.; LITTLE, J. (1986): The restructuring process and economic centrality in capitalist agriculture. Journal of Rural Studies 2 (4): 271-280.

MARSDEN, T.; MUNTON, R.; WHATMORE, S.; LITTLE, J. (1989): Strategies for coping in capitalist agriculture: an examination of the responses of farm families in British agriculture. Geoforum, Vol. 20 (1): 1-14.

MARTIN, S.; MCLEAY, F. (1998): The diversity of farmers' risk management strategies in a deregulated New Zealand Environment. Journal of Agricultural Economics. Vol. 49 (2): Pages 218-233.

MATHER, A.S. (1992): Land Use. Longman Group, Harlow.

MATHER, A.S.; THOMSON, K.J. (1995): The effects of afforestation on agriculture in Scotland. Journal of Rural Studies 11 (2): 187-202.

MATTHEWS, R.B., GILBERT, N.G., ROACH, A., POLHILL, G., GOTTS, N.M., (2007). Agent-based land-use models: a review of applications. Landscape Ecology 22, 1447–1459.

MCNALLY, S. (2001): Farm diversification in England and Wales: what can we learn from the farm business survey? Journal of Rural Studies 17 – 247-257

MCNALLY, S. (2002): Are `Other Gainful Activities' on farms good for the environment? Journal of Environmental Management 66: 57-65.
METTEPENNINGEN, E., VANDERMEULEN, V., DELAET, K., VAN HUYLENBROECK, G. & WAILES, E. J. (2013) Investigating the influence of the institutional organisation of agri-environmental schemes on scheme adoption. *Land Use Policy*, 33**,** 20-30.
MEYER, K.; LOBAO, L. (1997): Farm couples and crisis politics: The importance of household, spouse, and gender in responding to economic decline. Journal of Marriage and the Family, Vol. 59: Pages 204-218.
MIDMORE, P.; SHERWOOD. A.; ROUGHLEY, G. (1999): Greening LFA Payments: The Environmental Dimension of Agricultural Support in Disadvantaged Areas of the United Kingdom (2nd International Conference of the LSIRD Network Livestock Production in the LFA 3 – 5 December 1998, Ireland).
MILESTAD, R.; HADATSCH. S. (2003): Organic farming and social-ecological resilience: the alpine valleys of Sölktäler, Austria. Conservation Ecology 8(1): 3. [online] URL: http://www.consecol.org/vol8/iss1/art3/
MORAN, W., BLUNDEN, G., GREENWOOD, J., (1993): The role of family farming in agrarian change. Progress in Human Geography 17, 22–42.
MORRIS, C. (2006) Negotiating the boundary between state-led and farmer approaches to knowing nature: An analysis of UK agri-environment schemes. Geoforum 37 pp. 113–127
MORRIS, C., EVANS, N. (2004). Agricultural turns, geographical turns: retrospect and prospect. Journal of Rural Studies 20 (1), 95-111.
MORRIS, C.; YOUNG, C. (1997): Towards environmentally beneficial farming? An evaluation of the Countryside Stewardship Scheme. Geography 82 (4): 305-316.
MUNROE, D. (2001): Economic Efficiency in Polish Peasant Farming: An International Perspective. Regional Studies, 35 (5): 461- 471.
NAVEH, Z., (2005). Epilogue: Toward a transdisciplinary science of ecological and cultural landscape restoration. Restoration Ecology 13 (1) 228–234.
NÍ DHUBHÁIN, Á., FLÉCHARD, M.-C., MOLONEY, R. & O'CONNOR, D. (2009) Stakeholders' perceptions of forestry in rural areas—Two case studies in Ireland. *Land Use Policy*, 26**,** 695-703.
NÍ DHUBHÁIN, Á. G., J.J.; O ' REILLY, G., (1994) Farmers attitudes towards forestry: cross cultural differences. *LLASS Working Paper No. 8.* University College Dublin.
NILSSON, P.A. (2002): Staying on farms: An Ideological Background. Annals of Tourism Research 29 (1): 7-24.
NUTHALL, P. (2006): Determining the important management skill competencies. The case of family farm business in New Zealand. Agricultural Systems 88: 429–450
NUNNALLY, J. C. and I. BERNSTEIN (1994). Psychometric theory. New York, McGraw-Hill.
O'BRIAN, M. (2005): Studying Individual and Family Development: Linking Theory and Research. Journal of Marriage and Family 67: 880–890
O'LEARY, T.; MCCORMACK, A.; CLINCH, J. (2000): Afforestation in Ireland - regional differences in attitude. Land Use Policy 17: 39-48
O'ROURKE, E., KRAMM, N. & CHISHOLM, N. (2012) The influence of farming styles on the management of the Iveragh uplands, southwest Ireland. *Land Use Policy*, 29**,** 805-816.
O'SULLIVAN, D. (2008): Geographical information science: agent-based models. Progress in Human Geography 32; 541-550.
ODT (2009): Is Debt Doing for Dairy Farmers? http://www.odt.co.nz/news/business/ 59078/is-debt-doing-dairy-farmers (2nd June, 2009).
OECD (2009) The role of Agriculture and Farm Household Diversification in the Rural Economy of New Zealand. New Zealand.
ONDERSTEIJN, C. J. M., GIESEN, G. W. J. & HUIRNE, R. B. M. (2003) Identification of farmer characteristics and farm strategies explaining changes in environmental

management and environmental and economic performance of dairy farms. *Agricultural Systems,* 78**,** 31-55.

OSTROM, E. 1997. A Behavioural Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association. The American Political Science Review. Vol. 92, No. 1 (Mar., 1998), pp. 1-22

PAGE, S. E. (2008) Agent-Based Models. IN DURLAUF, S. & BLUME, L. (Eds.) The New Palgrave Dictionary of Economics. 2nd Edition ed., Palgrave Macmillan.

PANNELL DJ, MARSHALL GR, BARR N, CURTIS A, VANCLAY F, WILKINSON R (2006) Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture 46, 1407–1424.

PARKER, D. C., MANSON, S. M., JANSSEN, M. A., HOFFMANN, M. J. & DEADMAN, P. (2003) Multi-agent systems for the simulation of land-use and land-cover change: A review. Annals of the Association of American Geographers, 93, 314-337.

PARKER, J.S.; MOORE, R.; WEAVER, M. (2007): Land Tenure as a Variable in Community Based Watershed Projects: Some Lessons from the Sugar Creek Watershed, Wayne and Holmes Counties, Ohio. Society & Natural Resources, 20: 9, 815 — 833

PATRICK, G.F.; BLAKE, B.F.; WHITAKER, S.H. (1981): Magnitude estimation: an application to farmers' risk-income preferences. Western Journal of Agricultural Economics 6 (2): 239-248.

PAYNE, T, SHADBOLT, N, DOOLEY, E, SMEATON, D, GARDNER, J. 2007. Dairy farm ownership and management structures: Focus group research . Proceedings of the 16th International Farm Management Congress, Vol 1, 15-20 July, 2007, University College Cork, Ireland.

PFEIFER, C.; JONGENEEL, R.; SONNEVELDA, M.; STOORVOGEL, J. (2009): Landscape properties as drivers for farm diversification: A Dutch case study. Land Use Policy 26: 1106–1115.

PIKE, T. (2008) Understanding Behaviours in a Farming Context: Bringing theoretical and applied evidence together from across Defra and highlighting policy relevance and implications for future research. Defra.

POLYANI, K. (1944/2001). The Great Transformation, Beacon Press.

PORTER, SR., WHITCOMB, ME., WEITZER, WH. 2004. Multiple surveys of students and survey fatigue. New Directions for Institutional Research (121): 63-73.

POTEETE, A. R., JANNSSEN, M. A. & OSTROM, E. 2010. Working together: collective action, the commons and multiple methods in practice. Princeton University Press. NY.

POTTER, C., BARR, C., LOBLEY, M., (1996). Environmental Change in Britain's Countryside: An Analysis of Recent Patterns and Socio-Economic Processes Based on the Countryside Survey, 1990. Journal of Environmental Management 48, 169–186.

POTTER, C.; BURNHAM, P.; EDWARDS, A.; GASSON, R.; GREEN, B. (1991): The Diversion of Land. Conservation in a Period of Farming Contraction. London, Routledge.

POTTER, C.; LOBLEY, M. (1992): The conservation status and potential of elderly farmers: results from a survey in England and Wales. Journal of Rural Studies, Vol. 8 (2): 133-143.

POTTER, C. & LOBLEY, M. (1996) The farm family life cycle, succession paths and environmental change in Britain's countryside. *Journal of Agricultural Economics,* 47**,** 172-190.

PRITCHARD, B., BURCH, D., LAWRENCE, G. (2007). Neither 'family' nor 'corporate' farming: Australian tomato growers as farm family entrepreneurs. Journal of Rural Studies 23, 75–87.

RISBY, J.; KANDLIKAR, M.; DOWLATABADI, H.; GRAETZ, D. (1999): scale, context, and decision making in agricultural adaptation to climate variability and change. Mitigation and Adaptation Strategies for Global Change 4: 137–165, 1999.

ROBERTS, D.; PHIMISTER, E.; GILBERT, A. (2002): Pluriactivity and farm incomes in Scotland: Longitudinal analysis using the farm accounts survey. Final report for the Scottish Executive Environmental and Rural Affairs Department, Macaulay Institute, Aberdeen.

ROBINSON, D.T., BROWN, D.G., PARKER D.C., SCHREINEMACHERS, P., JANSSEN, M.A., HUIGEN, M., WITTMER, H., GOTTS, N., PROMBUROM, P., IRWIN, E., BERGER, T., GATZWEILER, F., BARNAUD, C. (2007) Comparison of empirical methods for building agent-based models in land use science. Journal of Land Use Science. 2, 1, 31–55.

ROE, BE. (2011) "The Risk Attitudes of US Farmers: Comparisons to the General Population and Business Owners." 2011 annual meeting of the Agricultural and Applied Economics Association. July 24-26, Pittsburgh, Pennsylvania.

ROGERS, E.M. (1983): Diffusion of innovations (3rd ed.). The free Press, New York.

ROGERS, E.M.; SHOEMAKER, F.F. (1971): Communication of innovations: a cross cultural approach (2nd ed). The Free Press, New York.

ROUGOOR, C.W.; TRIP, G.; HUIRNE, R., RENKEMA, J. (1988): How to define and study farmers' management capacity: theory and use in agricultural economics. Agricultural Economics, Vol 18: P261-272.

ROUNSEVELL, M.D.A., ROBINSON, D.T. and MURRAY-RUST, D. (2012) From actors to agents in socio-ecological systems models. Philosophical Transactions of the Royal Society B: Biological Sciences, 367, 1586, 259-269; doi:10.1098/rstb.2011.0187 1471-2970

SACHS, R.E. (1973): The farmer: an entrepreneur personality? Sociologia Ruralis, Vol. 13: 194-211.

SALAMON, S.; FARNSWORTH, R.; BULLOCK, D.; YUSUF, R. (1997). Family factors affecting adoption of sustainable farming systems. J. Soil Water Conserv. 52 (2): 265–271.

SALTIEL, J.; BAUDER, J.; PALAKOVICH, S. (1994): Adoption of Sustainable Agricultural Practices: Diffusion, Farm Structure, and Profitability. Rural Sociology, 59 (2): 333-349.

SANTELMANN, M.; WHITE, D.; FREEMARK, K.; NASSAUER, J.; EILERS, J.; VACHÉ, K.; DANIELSON, B.; CORRY, R.; CLARK, M.; POLASKY, S.; CRUSE, R.; SIFNEOS, J.; RUSTIGIAN, H.; COINER, C.; WU, J.; DEBINSKI, D. (2004):Assessing alternative futures for agriculture in Iowa, U.S.A. Landscape Ecology 19: 357–374.

SCAMBLER, A. (1989): Farmers' attitudes towards forestry. Scottish Geographical Magazine 105 (1): 47-49.

SCHMIT, C. & ROUNSEVELL, M. (2006) Are agricultural land use patterns influenced by farmer imitation? *Agriculture, Ecosystems & Environment*, 115**,** 113-127.

SCHULTZ, P.; TABANICO, J. (2007): Self, Identity, and the Natural Environment: Exploring Implicit Connections With Nature. Journal of Applied Social Psychology 37 (6): 1219–1247.

SEABROOK, M.F.; HIGGINS, C.B. (1988): The role of the farmer's self concept in determining farmer behaviour. Agricultural Administration and Extension 30: 99-108.

SELBY, J.; PETÄJISTÖ, L. (1995): Attitudinal aspects of the resistance to field afforestation in Finland. Sociologia Ruralis 35 (1): 67-92.

SEN, A. K. (1977). Rational Fools: A Critique of the Behavioural Foundations of Economic Theory, Philosophy and Public Affairs Vol 6, (4) 317-344.

SHIH, TH.; FAN, XT. 2008. Comparing response rates from web and mail surveys: A meta-analysis. Field Methods 20 (3): 249-271.

SHUCKSMITH, M. (1993): Farm Household behaviour and the transition to post-productivism. Journal of Agricultural Economics, Vol. 44 (3): 466-478.

SIEBERT, R.; TOOGOOD, M. AND KNIERIM, A. (2007): Factors Affecting European Farmers' Participation in Biodiversity Policies. Sociologia Ruralis 46 (4): 318-340.

SIMON, H.A. (1957): Models of Man; Social and Rational. Wiley, New York.
SKERRATT, S. J. (1994). Itemized payment systems within a scheme—the case of Breadalbane. In Incentives for Countryside Management: The Case of Environmentally Sensitive Areas (M. Whitby, ed.). Wallingford: CAB International, pp. 105–134.
SLOVIC, P. (1999): "Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield." Risk Analysis 19(4): 689-701.
SMAJGL, A., BROWN, D.G., VALBUENA, D., HUIGEN, M.G.A., (2011): Empirical characterisation of agent behaviours in socio-ecological systems. Environmental Modelling & Software, 26, 7, 837-844.
SMALL, B. H., PARMINTER, T. G., & FISHER, M. W. (2005): Understanding public responses to genetic engineering through exploring intentions to purchase a hypothetical functional food derived from genetically modified dairy cattle. *New Zealand Journal of Agricultural Research* 48: 391-400.
SMITH, G. T. (2005a). On the complexity of quantifying construct validity. Psychological Assessment, 17(4), 413-414. doi: 10.1037/1040-3590.17.4.413
SMITH, G. T. (2005b). On construct validity: Issues of method and measurement. Psychological Assessment, 17(4), 396-408. doi: 10.1037/1040-3590.17.4.396.
SMITH, W.; MONTGOMERY, H.; RHODES, T. (2007): North Island hill country farmers' management response to issues of sustainability. New Zealand Geographer 63: 30–42
SMITHERS, J.; FURMAN, M. (2003): Environmental farm planning in Ontario: exploring participation and the endurance of change. Land Use Policy 20: 343–356
SOTTOMAYOR, M., TRANTER, R. & COSTA, L. (2011) Likelihood of Succession and Farmers' Attitudes towards their Future Behaviour: Evidence from a Survey in Germany, the United Kingdom and Portugal. *International Journal of Sociology of Agriculture and Food*, 18**,** 121-133.
STATISTICS NEW ZEALAND (2001). Highly rural/remote areas: Work, knowledge and skills (2001 census). Retrieved on 20/5/13 from: http://www.stats.govt.nz/browse_for_stats/ people_and_communities/Geographic-areas/urban-rural-profile/highly-rural-remote-areas/work-knowledge-skills.aspx
STRYKER, S. (1994): Identity theory: Its development, research base, and prospects. In N.K. Denzin (ed.), Studies in Symbolic Interactionism 16. JAI Press, London : 7-20.
SVENDSEN, S. (2003): Generationsskifte i fremtidens landbrug (Intergenerational succession of large farms in the future). Rapport nr. 164. Fødevareøkonomisk Institut, København.
TAIT, E.J. (1983): Pest control decision making on brassica crops. Advances in Applied Biology 8: 121-188.
TAJFEL, H. & TURNER, J. C. (1979) An integrative theory of intergroup conflict. *The social psychology of intergroup relations*, 33**,** 47.
TAVAKOL M, DENNICK R. (2011). "Making Sense of Cronbach's Alpha." International Journal of Medical Education. 2: 53-55.
TAYLOR, J.E.; NORRIS, J.E.; HOWARD, W.H. (1998): Succession patterns of farmer and successor in Canadian farm families. Rural Sociology, Vol. 63 (4): Pages 553-573.
TAYLOR, N. & MCCLINTOCK, W. (2004). Some characteristics of multiple job holding by New Zealand farm men and women. *New Zealand Agricultural and Resource Economics Society 2004.* Blenheim.
TERRY, D. J. & HOGG, M. A. (1996). Group Norms and the Attitude-Behavior Relationship: A Role for Group Identification. *Personality and Social Psychology Bulletin*, 22**,** 776-793.
TERRY, D.; HOGG, M.; WHITE, K. (1999): The theory of planned behaviour : Self-identity, social identity and group norms. British Journal of Social Psychology (1999), 38, 225-244.

THENAIL, C. (2002): Relationships between farm characteristics and the variation of the density of hedgerows at the level of a micro-region of bocage landscape. Study case in Brittany, France. Agricultural Systems 71: 207–230

TRAORÉ, N.; LANDRY, R.; AMARA. N. (1998): On-farm Adoption of Conservation Practices: The Role of Farm and Farmer Characteristics, Perceptions, and Health Hazards Land Economics, Vol. 74(1): 114—27

TRIANDIS, H. C. (1977) *Interpersonal behavior*, Brooks/Cole Pub. Co.

TURNER, J. C., HOGG, M. A., OAKES, P. J., REICHER, S. D. & WETHERELL, M. S. (1987) *Rediscovering the social group: A self-categorization theory*, Basil Blackwell.

TVERSKY, A. and D. KAHNEMAN (1991). "Loss aversion in riskless choice: A reference-dependent model." Quarterly Journal of Economics, 106, 1039-1061.

UNITED NATIONS. (2006) The millennium development goals report, 2005. New York: United Nations Publications.

VALBUENA, D.; VERBURG, P.; BREGT, A. (2008): A method to define a typology for agent-based analysis in regional land-use research. Agriculture, Ecosystems and Environment 128: 27–36.

VANCLAY, F.; HOWDEN, P.; MESITI, L.; GLYDE, S. (2006): The Social and Intellectual Construction of Farming Styles: Testing Dutch Ideas in Australian Agriculture. Sociologia Ruralis 46 (1): 61-82.

VAN DER PLOEG, J.D. (1993): Rural sociology and the new agrarian question. Sociologia Ruralis, Vol. 33 (2): 240-260.

VANSLEMBROUCK, I., VAN HUYLENBROECK, G. & VERBEKE, W. (2002) Determinants of the Willingness of Belgian Farmers to Participate in Agri-environmental Measures. *Journal of Agricultural Economics*, 53**,** 489-511.

VIAGGI, D., F. BARTOLINI, M. RAGGI, L. SARDONINI, F. SAMMETH and S. GOMEZ y PALOMA (2011), "Farm-household investment behavior and the CAP decoupling: Methodological issues in assessing policy impacts", Journal of Policy Modeling, Vol. 33, No. 1, pp. 127–45.

VILLA., M. (1999): Born to be farmers? Changing expectations in Norwegian Farmers' Life Courses. Sociologia Ruralis 39 (3): 328-342.

WALFORD, N. (2002); Agricultural adjustment: adoption of and adaptation to policy reform measures by large-scale commercial farmers. Land Use Policy 19 (2002) 243–255.

WALFORD, N. (2003) Productivism is allegedly dead, long live productivism. Evidence of continued productivist attitudes and decision-making in South-East England. Journal of Rural Studies, 19(4), pp. 491-502. ISSN (print) 0743-0167

WALTER, G. (1997): Images of success: how Illinois farmers define the successful farmer. Rural Sociology 62 (1): 48-68.

WARD, N.; LOWE, P. (1994): Shifting values in agriculture: the farm family and pollution regulation. Journal of Rural Studies, Vol. 10 (2): 173-184.

WHATMORE, S.; MUNTON, R.; LITTLE, J.; MARSDEN, T. (1987): Towards a typology of farm businesses in contemporary British agriculture. Sociologia Ruralis 27 (1): 21-37.

WHITBY, M. (2000): Reflections on the Costs and Benefits of Agri-Environment Schemes, Landscape Research 25: 365–374.

WICKER, A. W. (1969) Attitudes versus Actions: The Relationship of Verbal and Overt Behavioural Responses to Attitude Objects. *Journal of Social Issues*, 25**,** 41-78.

WILKENING, E.A. (1958): Joint decision making in farm families as a function of status and role. American Sociologial Review, Vol. 23: Pages 187-192.

WILKINSON, R; BARR, N; HOLLIER, C (2011) Segmenting Victoria's farmers. Farm Services Victoria, Department of Primary Industries, Victoria

WILSON, G.A. (1996): Farmer environmental attitudes and ESA participation. Geoforum, Vol. 27 (2): 115-131.

WILSON, G. A. (1997) Factors Influencing Farmer Participation in the Environmentally Sensitive Areas Scheme. *Journal of Environmental Management,* 50**,** 67-93.

WILSON, G.A. (2001): From productivism to post-productivism … and back again? Exploring the (un)changed natural and mental landscapes of European agriculture. Transactions of the institute of British Geographers, Vole 26 (1): Page 77-102.

WILSON, G. A. & HART, K. (2000) Financial imperative or conservation concern? EU farmers' motivations for participation in voluntary agri-environmental schemes. *Environment and Planning A,* 32**,** 2161-2186.

WILSON, G.A.; HART, K. (2001): Farmer participation in agri-environmental schemes: towards conservation-oriented thinking? Sociologia Ruralis 41 (2): 254-274.

WILSON, P., HARPER, N. & DARLING, R. (2013) Explaining variation in farm and farm business performance in respect to farmer behavioural segmentation analysis: Implications for land use policies. *Land Use Policy,* 30**,** 147-156.

WINKLER, W. (1991): Agricultural inheritance law in Western-Europe. Berichte uber Landwirtschaft 69 (4): 517-542.

WINTER, M. (2000): Strong policy or weak policy? The environmental impact of the 1992 reforms to the CAP arable regime in Great Britain. Journal of Rural Studies 16: 47-59.

WOLPERT, J. (1964): The decision process in spatial context. Annals of the Association of American Geographers 54: 557–558.

YOUNG, C.; MORRIS, C.; ANDREWS, C. (1995): Agriculture in the UK: towards an understanding of the role of 'farming culture'. Greener Management International 12: 63-80.

12. Appendices

12.1 Paper copy of rural landowner survey

If you are not the primary decision maker about the day-to-day operations of this farming operation, please forward the survey to that person.

This survey is designed to collect information to understand how farming operations and farming households operate their businesses across New Zealand. There are questions about what type of farm you run, the enterprises involved, and your future plans. Our aim is to gather information to determine how a range of farm types are operated. The data will be used to help develop economic models of the farming sector as a whole. This means that any answers you provide will be averaged across other farms with similar characteristics. These averages may be included in reports, but the reports will not include personal information that would enable someone to trace your answers back to this particular farm. Therefore, your privacy and the confidentiality of your responses is guaranteed.

The project and this survey have passed an ethical review board assessment.

We would be very grateful if you would participate in the survey. However, you are under no obligation to participate. As a token of our appreciation for completing the survey, we will donate $10 for each of the first 600 completed surveys that we receive to a range of charities. You will be given an opportunity to indicate where you would like your donation to be made at the end of the survey, selecting from the following charities: CanTeen, Plunket Society, Federated Farmers Adverse Events Trust, NZ Fire Service, Red Cross, and SPCA.

We estimate that the survey will take approximately 15 – 20 minutes.

Thank you for your help.

Details of the farmer and his or her family

1. Which of the following best describes your farm ownership structure?

□ corporate-owned	□ owner operated **>>3**	□ family partnership **>>3**	□ family trust **>>3**	□ family company **>>3**	□ other (describe: _____) **>>3**

2. In what year did this farm become a corporate farm? _____

3. Which of the following best describes your role on the farm…?

□ owner/operator	□ farm manager	□ share holder or share milker	□ other (describe: _____)

4. What is your age now? _____

5. What is your sex?

□ male	□ female

6. What is the highest level of education that you have you completed so far?

□ some secondary school	□ secondary school	□ technical training	□ university	□ post-graduate study

7. Approximately how many hours per week do you spend on farm work and farm management? _____

8. For how many years of your adult life have you made your living as a farmer? _____

9. On how many farms have you worked during your career?

□ 1	□ 2	□ 3-4	□ 5-6	□ 7-9	□ 10 or more

10. *Before starting work on this farm*, what types of farms did you work on, if any? Tick all that apply.

□ Sheep/beef
□ Dairy
□ Deer
□ Pigs, goats, commercial poultry, other commercial livestock
□ Horticulture
□ Viticulture
□ Arable
□ Forestry
□ Dairy support

□ Other (specify: _____)
□ None

11. What is your marital status?

□ married/ partner	□ single **>>15**	□ divorced **>>15**	□ widowed **>>15**

12. What is your spouse's age now? _____

13. What is the highest level of education that your spouse has completed so far?

□ some secondary school	□ secondary school	□ technical training	□ university	□ post-graduate study	□ uncertain

14. Approximately how many hours per week does your spouse spend on farm work and farm management? _____

If question 1 = corporate-owned, skip to question 25

15. Has a successor to this farm been identified?

□ yes	□ not yet **>>25**	□ no **>>25**	□ don't know/NA **>>25**

16. Which of the following best describes the successor?

□ my own child	□ another family member	□ someone who works on this farm but is not a family member	□ other

17. In what year did (or will) the successor become involved in key decision-making on the farm? _____

18. What is the successor's age now (enter approximate age if unknown)? _____

19. What is the sex of the successor?

□ male	□ female

20. What is the highest level of education that the successor has completed so far?

□ some secondary school	□ secondary school	□ technical training	□ university	□ post-graduate study	□ uncertain

21. In what year did the successor begin working on this farm? _____

□ Tick if the successor has not worked on this farm. **>>23**

22. Approximately how many hours per week does the successor currently spend working on and managing this farm? _____

23. *Before starting work on this farm*, what types of farms did the successor work on, if any? Tick all that apply.

□ Sheep/beef
□ Dairy cows
□ Deer
□ Pigs, goats (dairy, meat or fibre), commercial poultry, other commercial livestock
□ Horticulture
□ Viticulture
□ Arable
□ Forestry
□ Dairy support
□ Other (specify: _____)
□ None
□ Uncertain

24. In what year do you anticipate the successor making most of the important decisions on the farm? _____

We would now like to ask some questions specifically about this farming operation. If you have multiple farming operations, please answer these questions as if there was a single, large farm.

25. How large, in hectares, is the total size of this farming operation? _____

26. Among this, how many hectares are leased? Enter 0 if none. _____

27. How many distinct, geographically separate blocks comprise this farming operation? _____

If Question 27 = 1 then skip to question 29

28. Approximately how far away is the farthest part of your farming operation from your home, in km? _____ km

29. In what year did you begin working on this farming operation? _____

If question 1 = corporate-owned, skip to question 32

30. Did you start this farm yourself or take it over from someone else?

□ started myself **>> 32**	□ took it over

31. In what year did the previous farmer pass responsibility for most of the important decisions on the farm to you? _____

32. Which of the following activities were undertaken **for commercial purposes** on this farm **in the last year**? Tick all that apply.

□ Sheep/beef
□ Dairy cows
□ Deer
□ Pigs, goats (dairy, meat or fibre), commercial poultry, other commercial livestock
□ Horticulture

□ Viticulture
□ Arable
□ Forestry
□ Dairy support
□ Other (specify: _____)

If question 32 ≠ sheep/beef, skip to question 37

33. How many hectares of this farming operation are primarily used for sheep and beef? _____

34. In what year did the number of hectares used for sheep and beef change by 20% or more (if multiple times, report most recent)? _____
□ Does not apply or not during my time on this farm

35. How many head of sheep are currently on the farm? _____

36. How many head of beef cattle are currently on the farm? _____

If question 32 ≠ dairy cows, skip to question 42

37. How many hectares of this farming operation are primarily used for dairy (only count dairy platform, do not include dairy support)? _____

38. In what year did the number of hectares used for dairy change by 20% or more (if multiple times, report most recent)? _____
□ Does not apply or not during my time on this farm

39. How many head of dairy cattle are currently on the farm? _____

40. Are your young stock grazed on your own block, on a runoff that you own or lease, or elsewhere? Tick all that apply.

□ own block	□ runoff that is owned or lease	□ elsewhere

41. Where do you winter your stock? Tick all that apply.

□ own block	□ runoff that is owned or lease	□ elsewhere

If question 32 ≠ deer, skip to question 45

42. How many hectares of this farming operation are primarily used for deer? _____

43. In what year did the number of hectares used for deer change by 20% or more (if multiple times, report most recent)? _____
□ Does not apply or not during my time on this farm

44. How many head of deer are currently on the farm? _____

If question 32 ≠ pigs, goats, commercial poultry, other commercial livestock, skip to question 50

45. How many hectares of this farming operation are primarily used for pigs, goats, commercial poultry, and other commercial livestock? _____

46. In what year did the number of hectares used for pigs, goats, commercial poultry, and other livestock change by 20% or more (if multiple times, report most recent)?
_____
□ Does not apply or not during my time on this farm

47. How many pigs raised for commercial purposes are currently on the farm? _____

48. How many goats raised for commercial purposes are currently on the farm? _____

49. Approximately how many commercial poultry birds are currently on the farm? _____

If question 32 ≠ horticulture, skip to question 52

50. How many hectares of this farming operation are primarily used for fruits and vegetables? _____

51. In what year did the number of hectares used for horticulture change by 20% or more (if multiple times, report most recent)? _____
□ Does not apply or not during my time on this farm

If question 32 ≠ viticulture, skip to question 54

52. How many hectares of this farming operation are primarily used for growing grapes? _____

53. In what year did the number of hectares used for viticulture change by 20% or more (if multiple times, report most recent)? _____
□ Does not apply or not during my time on this farm

If question 32 ≠ arable, skip to question 56

54. How many hectares of this farming operation are primarily used for growing arable crops? _____

55. In what year did the number of hectares used for arable crops change by 20% or more (if multiple times, report most recent)? _____
□ Does not apply or not during my time on this farm

If question 32 ≠ forestry, skip to question 58

56. How many hectares of this farming operation is planted in forestry? _____

57. In what year did the number of hectares planted in forestry last change by 20% or more (if multiple times, report most recent)? _____

If question 32 ≠ dairy support, skip to question 60

58. For how many weeks did you graze heifers on this farm in the last year? _____

59. Approximately, how many heifers did you graze in the last year? _____

We would now like to ask you about some other aspects of farming, including risk and profitability.

60. Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? On a scale of 0 to 10, where 0 means "don't like to take risks" and 10 means "fully prepared to take risks", how do you see yourself?

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

61. In general, how profitable has this farming enterprise been in recent years?

□ unprofitable	□ break even	□ profitable

62. In general, what share of your household's income comes from non-farm sources?

□ 0%	□ 1%-25%	□ 26%-50%	□ 51%-75%	□ 76%-100%

63. What is the debt-equity ratio of this farming operation? _____

□ Tick if unknown

64. How important is being **a highly productive farmer** to your sense of self-identity, i.e., your sense of who you are? On a scale of 0 to 10, where 0 means "not at all important" and 10 means "extremely important", how do you see yourself?

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

65. How important is being **a farmer who takes good care of the environment** to your sense of self-identity, i.e., your sense of who you are? On a scale of 0 to 10, where 0 means "not at all important" and 10 means "extremely important", how do you see yourself?

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

Next, we'd like to ask you some questions about sources of information that may be important for your farming operation.

How **trustworthy** do you consider the following sources of information for making decisions related to farm practices, farm system change, and practices to improve environmental performance? Please indicate your answer on a scale of 0 to 10, where 0 means "not at all trustworthy" and 10 means "extremely trustworthy".

66. Newspapers and general interest magazines.
67. Television and radio.
68. The Internet.
69. Organisations that broadly represent primary industries such as Federated Farmers.
70. Industry groups such as Beef & lamb NZ, HortNZ, DairyNZ and WineNZ.
71. Cooperatives such as Zespri and Fonterra.
72. Central government.
73. Regional councils.
74. Accountants and financial advisors.
75. Farm consultants, extension officers, and contractors.
76. Farmers' forums, agricultural shows, and field days.
77. Other farmers and farmer discussion groups.
78. Scientists.
79. Vets.
80. Rural retailers and their technical representatives (e.g., seed companies, fertiliser companies).

Response frame:

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

Given the level of trustworthiness, how **important** are the following sources of information for making decisions related to farm practices, farm system change, and practices to improve environmental performance? Please indicate your answer on a scale of 0 to 10, where 0 means "not at all important" and 10 means "extremely important".

81. Newspapers and general interest magazines.
82. Television and radio.
83. The Internet.

84. Organisations that broadly represent primary industries such as Federated Farmers.
85. Industry groups such as Beef & lamb NZ, HortNZ, DairyNZ and WineNZ.
86. Cooperatives such as Zespri and Fonterra.
87. Central government.
88. Regional councils.
89. Accountants and financial advisors.
90. Farm consultants, extension officers, and contractors.
91. Farmers' forums, agricultural shows, and field days.
92. Other farmers and farmer discussion groups.
93. Scientists.
94. Vets.
95. Rural retailers and their technical representatives (e.g., seed companies, fertiliser companies).

Response frame:

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

96. With how many other farmers did you discuss farm practises, farm systems change, or practices to improve environmental performance in the last 12 months?

□ none	□ 1-5	□ 6-10	□ 11-20	□ 21-50	□ 51-100	□ more than 100

97. How many working farms have you visited in the last 12 months?

□ none	□ 1-2	□ 3-5	□ 6-9	□ 10-14	□ 15-19	□ 20-29	□ more than 30

***Next we would like to ask you about your experience with various farming technologies and practices*.**

Please describe your experience with the following technologies and practices on this farm.

98. reducing stocking rates
99. reducing N fertiliser

100. wintering off stock
101. applying DCDs
102. employing a nutrient management plan
103. adding or upgrading the irrigation system
104. constructing a feed pad
105. upgrading the effluent system
106. fencing streams
107. constructing wetlands and/or sedimentation traps
108. planting forestry blocks
109. planting riparian buffers
110. changing primary crops and/or rotation

Response frame:

□ I have already adopted or implemented this technology or practice on my farm	□ I intend to adopt or implement this technology or practice within the next 10 years	□ I am considering adopting or implementing this technology or practice, but have not yet made a decision	□ I do not intend to adopt or implement this technology or practice on my farm unless it is specified by regulation	□ Does not apply to my farming operation

Next, we would like to ask you about how you think the farm will change in coming years.

How likely do you think the following is to happen in the next 5 years? On a scale of 0 to 10, where 0 means “extremely unlikely” and 10 means “extremely likely”, please estimate this likelihood.

111. part or all of the farm will be sold
112. part or all of the farm will be leased out or worked by a share farmer
113. you will purchase, lease, or share farm additional land
114. the enterprise mix will be changed to reduce your farm workload
115. the enterprise mix will be changed to more intensive enterprises

116.the enterprise mix will be changed due to impending regulations

Response frame:

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

Next, we would like to ask whether you agree or disagree with the following statements.

How much do you agree with the following statement? Please indicate your answer on a scale of 0 to 10, where 0 means "strongly disagree" and 10 means "strongly agree".

117.I prefer to leave experimenting with new ideas to someone else.
118. I am always one of the first in the district to try something new.
119.I farm because I am committed to the tradition in our family.
120.When I see new practices and technologies being successfully used by other farmers, then I am also likely to adopt the new practice or technology.
121. I have the necessary knowledge and skill to implement best practices or adopt new technologies that improve environmental outcomes on my farm.
122.My farming business is financially robust enough to enable me to implement best practices or adopt new technologies that improve environment outcomes on my farm.
123.There are other issues that constrain me from implementing best practices or adopting new technologies that improve environmental outcomes on my farm.
124.Most of my immediate family believe that I should manage my farm in an environmentally friendly and sustainable manner.
125.Members of the farming community believe that it is important to farm in an environmentally friendly and sustainable manner.
126.The New Zealand public expect me to manage my farm in an environmentally friendly and sustainable manner.
127.My beliefs, attitudes, and values toward developing my farm and my farming management practices are very similar to those of other farmers in my local district.

Response frame:

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

Finally, we would like to ask a few questions about your values regarding fresh water and how they relate to your farming goals.

To what extent are the following values personally important to you? Please indicate your answer on a scale of 0 to 10, where 0 means "not at all important" and 10 means "extremely important".

128. Sustaining recreational use of waterways.
129. Sustaining the purity and quality of freshwater.
130. Sustaining natural habitats for native fish and birds, including wetlands and native forests.
131. How important an influence have the above values been on your farming practice?

Response frame:

□ 0	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6	□ 7	□ 8	□ 9	□ 10

Thank you very much for your time. This is the end of the survey. As a token of our appreciation, we will make a $10 charitable contribution for each of the first 600 responses that we receive.

Please indicate your choice of charities from the following list.

□ CanTeen	□ Plunket Society	□ Federated Farmers Adverse Events Trust	□ NZ Fire Service	□ Red Cross	□ SPCA

If you have any queries regarding this research, please contact us at UMR ADDRESS

12.2 Connecting literature review findings to survey questions

This appendix provides two tables which list the theories and constructs identified in the literature review and identifies the survey questions that attempt to ascertain the appropriate information for use in Agent Based Models. Table 1 identifies theories and constructs from sociological and behavioural theories and Table 2 identifies theories and constructs sourced from the review of farmer surveys.

Table 1. Theories and variables sourced from sociological and behavioural research and corresponding survey questions

Sociological and behavioural theories		
Theory	**Construct/variable**	**Survey qu #**
Theory of reasoned action/ Theory of planned behaviour	Behaviour	98-110,
	Intention	98-110, 111-116
	Attitude to behaviour	64,65,117,118,128-131
	Subjective norm	124,125,126
	Perceived behavioural control	121,122,123
Diffusion of Innovations	Innovators	60,117,118
	Early adopters	60,117,118
	Early majority	117,118
	Late majority	117,118
	Laggards	117,118
Social learning theory	Network links (strong/weak)	96,97
	Modelling/imitation	120
	Information medium	66-80, 81-95,96,97
Social identity theory/ Self-categorisation theory	Group norms – productivism, post-productivism, environmentalism	64,65,124,125,126,127,128,129,130,131
	High/low group identifiers	64,65,127
Farming sector	Dairy	10,23,32
	Sheep & beef	10,23,32
	Horticulture	10,23,32
	Others	10,23,32
	External income (farmer/spouse)	62
Farming attribute	Farm size	25,26,27,33,34,37,38,42,43,45.46,50,51,52,53, 54,55,56,57,
	Family structure	11,12,15,16,17,18,19,20
	Land quality	-
	Farming intensity	7,14,22,33,40,41,58,59
	Farming continuity	8,9
	Extent of semi-natural vegetation	-
Production process	Age	4,12,18
	Education	6,13,20
	Property size	25,26,27
	Distance from residence	28
	# of animals	35,36,39,44,47,48,49,59
Farm family life-cycle stage	Birth & socialisation	15,16,17,21,24,29,30,31

	/takeover of farm	
	Full-time on farm/consolidation	17,21,24,29,30,31,111-116
	Business expansion	111-116
	Transition of responsibilities	17,21,24
	Takeover of farm/Retirement	17,21,24

Table 2. Categories and variables sourced from review of farmer surveys and corresponding survey questions (categorisation based on Edwards-Jones, 2006)

Farmer survey findings		
Categorisation	**Construct/variable**	**Survey qu #**
Farmer characteristics	Education	6,13,20
	Age	4,12,18
	Behavioural beliefs	64,65
	Attitude	64,65, 128-131
	Risk	60,117,118
	Experience	8,9,10,23,29,30,31,38,43,46,51,53,55, 57,98-110,117,118,119,120,131
	Income from pluriactivity/non-agricultural diversification	62
	Level of debt	61,63,
Farm household	Succession	15,16,17,18,19,20,21,22,23,24
	Off-farm income	62
	The role of spouse and family in decision making	3,5,11,12,13,14
Farm structure	Income	61
	Farm size	25,26,27
	Tenure	1,
Social milieu	Nearness to other farmers	96,97
	Social pressure	124-126
	Local availability of specialist services	-
Characteristics of the innovation (Rogers, 2003)	Relative advantage	These factors are not farmer behaviours – but rather are the attributes of an innovation/technology/policy which may influence their adoption by farmers
	Compatibility	
	Complexity	
	Trialability	
	Observability	

Notes

A few variables/constructs mentioned in the literature review have no corresponding questions in the survey. These are:

1. Social milieu→local availability of specialist services,
2. Farming attribute→extent of semi-natural vegetation, land quality.

Farmer segmentations developed for ABMs – what is their applicability to the NZ situation?

1. Defra farmer segmentation (Pike, 2008)
    a. Custodians
    b. Lifestyle choice
    c. Pragmatists
    d. Modern farming family
    e. Challenged enterprises
2. Acosta-Michlik & Espaldon (2008) farmer segmentation
    a. Traditional
    b. Subsistence
    c. Diversified
    d. Commercial

Innovation/technology/policy characteristics

Characteristics of an innovation, new technology or new policy are also an important factor in farmers' decision-making processes regarding adoption or changing behaviour. Therefore, for any ABM to model farmer decision-making and behaviour, with respect to any particular innovation etc., these characteristics of the innovation should be represented in the ABM. Non-inclusion of the innovations characteristics will decrease the validity of the modelling process. However, these characteristics cannot be determined from a farmer survey but rather will be inherent in the innovation, technology or policy or the manner in which they are introduced and extended to farmers.

1. Characteristics of innovation/technology/policy (Rogers, 2003)
    a. Relative advantage
    b. Compatibility
    c. Complexity
    d. Trialability
    e. Observability