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Factors Influencing the Adoption of Whole Farm Plans: A Wairarapa Case Study

**A thesis presented in partial fulfilment of the requirements
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Abstract

Hill country erosion is a serious environmental issue in New Zealand. After widespread damage from storms in 2004, Horizons Regional Council initiated the SLUI programme. This programme relies on whole farm plans (Whole Farm Business Plans) as the core tool to address erosion on hill country farms. Several regional councils in New Zealand, like Horizons, rely on whole farm plans and continue to seek ways to achieve a high level of voluntary adoption by farmers.

A single case study was used to examine the phenomena of adoption of whole farm plans. This research answered the question: What factors influence the adoption by farmers of whole farm plans, and why these factors are influential? A review of historical farm plans identified plans most similar to Horizons Whole Farm Business Plans. These were located in the Wairarapa and this formed the case area. Farmers from two catchments in the Wairarapa, and key informants were interviewed to identify factors influencing adoption of farm plans.

Findings from this study, in the main, support adoption diffusion literature for agricultural innovations. The specific mix of interrelated factors that influence the adoption of farm plans, and the reasons for their influence, were identified and described. Characteristics of this case included the widespread adoption of farm plans, and farmers' perceived farm plan implementation as secondary to the core farm business. Factors associated with the compatibility of the innovation to the core farm business and the credibility of the organisation delivering farm plans provided important influences on adoption of farm plans. The circumstances of the farmers and their farm did not strongly influence adoption in this study because farm plans are customised and take into account each individual's circumstances. For an innovation such as farm plans that is considered secondary to the core farm business, factors easing implementation were important. This was contributed to by the characteristics of the innovation and by the delivery and support from the organisation. Key people played a significant role in farmers' decisions to adopt a farm plan.

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Table of Contents

Abstract	I
Acknowledgements	III
List of Tables	VIII
List of Figures	VIII
List of Acronyms	IX
CHAPTER 1 INTRODUCTION	1
1.1 Thesis Introduction	1
1.2 Research background	1
1.3 Problem statement	3
1.4 Research question	4
1.5 Research objectives	4
1.6 Research approach	4
1.7 Thesis structure	5
CHAPTER 2 LITERATURE REVIEW	7
2.1 Introduction	7
2.2 Innovation adoption frameworks	8
2.3 Factors influencing the adoption of agriculture innovations	12
2.3.1 Factors related to the innovation	13
2.3.1.1 Relative advantage	15
2.3.1.2 Compatibility	15
2.3.1.3 Complexity	16
2.3.1.4 Observability	17
2.3.1.5 Trialability	17
2.3.1.6 Temporal characteristics	19
2.3.2 Factors related to extension	19
2.3.2.1 Communication	20
2.3.2.2 Organisational Strategies	24
2.3.3 Factors related to farmer and farm characteristics	28
2.3.3.1 Goals	29
2.3.3.2 Beliefs and values, attitudes and behaviour	30
2.3.3.3 Age, education and experience	32
2.3.3.4 Farm size, farm tenure, & financial security	33
2.3.3.5 Farmers links with information sources	34
2.4 The Innovation Decision Process	35
2.5 Summary	38
CHAPTER 3 METHODOLOGY	41
3.1 Introduction	41
3.2 Research design	41

3.3	Case selection.....	43
3.3.1	Criteria for case selection.....	45
3.4	Site Selection and Sampling Procedure	46
3.5	Data Collection.....	47
3.6	Data Analysis	48
3.7	Ethical considerations	49
3.8	Summary	50
CHAPTER 4	CASE DESCRIPTION	51
4.1	Introduction.....	51
4.2	Farm plans.....	52
4.2.1	Catchment Control Schemes	54
4.3	Wairarapa case description	55
4.3.1	History of soil conservation and farm plan development	57
4.4	The Whareama catchment description	60
4.4.1	Farm and farmer characteristics	61
4.4.2	Factors affecting erosion.....	62
4.4.3	Environmental issues	62
4.4.4	Whareama catchment scheme	63
4.5	The Whangaehu catchment description	64
4.5.1	Farmer characteristics	64
4.5.2	Factors affecting erosion.....	66
4.5.3	Environmental issues	67
4.6	Summary	67
CHAPTER 5	RESULTS.....	69
5.1	Introduction.....	69
5.2	Factors that influence the adoption of farm plans and farm plan works	70
5.3	The compatibility of farm plan works with the core farm business.....	72
5.3.1	Ease of implementation of farm plan works	75
5.3.2	Benefits and costs for the farmer of farm plan works	78
5.3.3	Degree to which the farm plan and farm plan works are developed to specifically suit each farmer and their farm circumstances	82
5.3.4	Proven reliability of farm plan works	83
5.4	Characteristics of farmers and their farm circumstances	85
5.5	Credibility of the organisation delivering farm plans	88
5.5.1.1	Credibility of field staff.....	89
5.5.1.2	Organisational commitment to farm plan delivery	90
5.5.1.3	Organisational support of field staff	91
5.5.1.4	Organisation's integrity.....	92
5.6	Summary	93
CHAPTER 6	DISCUSSION	95
6.1	Introduction.....	95
6.2	Classification of the case.....	95
6.3	Factors that influence the adoption of farm plans and farm plan works	98
6.3.1	Compatibility of the farm plan works with the core farm business	103
6.3.1.1	Ease of implementation of farm plan works	104

6.3.1.2	Benefit - cost analysis of farm plan works	107
6.3.1.3	The match between farm plan and farm plan works, farmer and farm circumstances	110
6.3.1.4	The proven reliability of farm plan works'	110
6.3.2	Characteristics of farmers and their farm circumstances	112
6.3.3	Credibility of the organisation delivering farm plans.....	114
6.4	Summary.....	117
CHAPTER 7 CONCLUSIONS.....		119
7.1	Introduction	119
7.2	Research findings summary	119
7.3	Conclusions	121
7.4	Implications for regional councils.	123
7.5	Assessment of research methodology	124
7.6	Further research	125
REFERENCES		127
APPENDICES.....		135
APPENDIX 1:	REPORT PREPARED FOR THE HORIZONS REGIONAL COUNCIL: HISTORICAL FARM PLAN DATA FOR HORIZONS REGION WHOLE FARM PLAN	137
APPENDIX 2:	TOPIC AREAS FOR INTERVIEWS IN CASE SELECTION.....	167
APPENDIX 3:	ETHICAL CONSIDERATIONS.....	171
	Introductory letter received by interviewees.	171

List of Tables

CHAPTER 2: LITERATURE REVIEW

Table 2.1: Categories used to organise factors that influence the adoption of innovations	11
Table 2.2: Comparison of stages in the Innovation Decision Process	35
Table 2.3: Factors that influence stages of the Innovation Decision Process (adapted from Rogers, 2003).....	36

CHAPTER 3: METHODOLOGY

Table 3.1 Relevant situations for different research strategies (Yin, 1994, p.6)	43
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CHAPTER 6: DISCUSSION

Table 6.1: Characteristics of the case	96
--	----

List of Figures

CHAPTER 2: LITERATURE REVIEW

Figure 2.1. Stages of the Innovation Decision Process (adapted from Rogers, 2003, p. 163).	9
Figure 2.2. A Model of Farm Context, Innovation Decision Process and Farmer Categorisation for Macrostructural Design (adapted from Duff et al., 1992, changes and additions italicised).....	10

CHAPTER 4: CASE DESCRIPTION

Figure 4.1. Erosion-prone Land Used for Drystock in the Wellington Region.	57
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CHAPTER 5: RESULTS

Figure 5.1. Categories of Factors That Influence the Adoption and Implementation of a Farm Plan.	69
Figure 5.2. Factors Contributing to the Compatibility of Farm Plan Works With the Core Farm Business	75
Figure 5.3. Factors Contributing to Characteristics of the Farmers and Their Farms	86
Figure 5.4. Factors Related to the Credibility of the Organisation delivering farm Plans	88

List of Maps

Map 1: Location of Whareama and Whangaehu Catchments and the districts
 comprised in the Greater Wellington Region 51

List of Acronyms

Acronym	Meaning
CCS	Catchment Control Scheme
CSS	Countryside Stewardship Scheme
ESS	English Stewardship Scheme
ESA	Environmentally Sensitive Areas
EU	European Union
GWRC	Greater Wellington Regional Council
IAFS	Integrated Arable Farming System
IPCC	International Panel on Climate Change
LMO	Land Management Officer
LRI	Land Resource Inventory
LUC	Land Use Capability
LWMP	Land and Water Management Plans
MAF	Ministry of Agriculture and Fisheries
OEFP	Ontario Environmental Farm Plan
SCRC	Soil Conservation and River Control
SLUI	Sustainable Land Use Initiative
WCB	Wairarapa Catchment Board
WFBP	Whole Farm Business Plans

Chapter 1

Introduction

1.1 Thesis Introduction

In this study the factors that influence the adoption by farmers of whole farm plans are investigated. Regional councils and farmers use farm plans to facilitate the mitigation of erosion on hill country farms in New Zealand. Farm plans have been used in New Zealand for a long period of time, with the first having been developed in the 1940s. In a review of historical farm plans those that are similar to what are used today were identified. This supported the further exploration of historical farm plan use in order to determine what factors influenced farmers' adoption of them. A case study approach was used based on two subcases from the Wairarapa, and a wide range of factors that influence adoption of farm plans by farmers in these subcases were identified, along with an understanding of why these factors are important.

In this first chapter, details on the background and purpose of this research are provided, and the environmental issues of erosion in New Zealand, together with whole farm plans that regional councils use with farmers to address erosion on hill country farms are introduced. Following this are the problem statement, research question, objectives, research approach and the thesis structure.

1.2 Research background

Hill country erosion is a serious environmental issue in New Zealand. The on and off farm costs of erosion are significant.

Annual costs associated with hill country erosion are estimated at \$100 to \$150 million, in loss of soil nutrients; lost production; damage to houses, fences, roads, phone and power lines; and damage to waterways. Under heavy rainfall, up to 10 percent of erosion-prone land under pasture can be lost (MAF, 2008, p. 2).

Under the Resource Management Act (RMA) 1991, regional councils and unitary authorities have responsibilities to manage environmental issues including hill country erosion. The purpose of the RMA is to "promote the sustainable management of natural and physical resources" (RMA, Section 1). Sustainable management includes, "Avoiding, remedying, or mitigating any adverse effects of activities on the

environment” (RMA, Section 1). The local body authorities in New Zealand that face risks from erosion include: Northland, Gisborne, Hawkes Bay, Horizons, Greater Wellington and Taranaki.

Several regional councils, including Horizons Regional Council,¹ rely on whole farm plans as the primary tool to address hill country erosion on farms. Although whole farm plans have been used by farmers in the Horizons region since the 1950s, the Sustainable Land Use Initiative (SLUI) established by Horizons Regional Council after the devastating 2004 storms and floods has provided greater impetus to the adoption and use of whole farm plans to address on-farm erosion in the region. The February 2004 events presented graphic examples of the consequences of severe hill country erosion, including extensive flooding, land degradation and infrastructure damage. The State of the Environment Report for the Manawatu-Wanganui Region (Ausseil, Barnett, Beveridge, Fung, Gilliard, Gordon, Janssen, McCarron, Roygard, Todd, & Zarour, 2005) stated: “Severe erosion has affected 29,000 ha of hill country following the February 2004 storm. A further 87,000 ha have suffered moderate erosion” (p. 11). The Ministry of Agriculture and Forestry (MAF) indicated that after the 2004 storm and a similar situation in the Bay of Plenty in 2005, “The government provided approximately \$198 million to compensate farmers for lost production, to rebuild roads and bridges, and for rates relief” (MAF, 2008, p.2).

The adoption and use by farmers of a form of whole farm plans (Whole Farm Business Plans) is at the core of the SLUI programme. Horizons Regional Council staff and registered consultants work with farmers to produce individually customised Whole Farm Business Plans (WFBP), and provide ongoing support to implement the recommendations in each plan. WFBPs are used to incorporate resource conservation and sediment management into farm business development. This information contributes to a step-by-step annual works programme to improve the environmental issues on each farm. The whole farm plan prototype has three sections (Agresearch, 2005):

¹ Horizons Regional Council was formerly the Manawatu Wanganui Regional Council

- **Farm description and resource assessment**

Descriptions include the farm business, paddocks, areas, production level and types, nutrient management, business structure and financial outline, water resources, natural heritage and infrastructure. Land Resource Inventory (LRI) and Land Use Capability (LUC) analyses are carried out, and then strengths and weaknesses of the farm system are described.

- **Five-year strategic plan**

The farm is divided into components that require work, and then a five-year schedule for work is drawn up. The plan includes goals, key performance indicators, how goals are to be realised and capital investment required.

- **Reporting**

In a monitoring programme the goals and objectives of the farm plan that are set out. Monitoring tools such as the Visual Soils Assessment and the Stream Monitoring Assessment contribute to measurement of the goals and objectives. It is unclear who will conduct these assessments, although in a final statement the support Horizons Regional Council plans to provide throughout the implementation process is identified.

Regional councils like Horizons continue to seek ways to achieve a high level of voluntary adoption of whole farm plans by farmers. Horizons Regional Council's aim is to have 1500 farmers with WFBPs operational by 2015. There is limited empirical research on what influences the adoption of farm plans in New Zealand, and there are only a few international examples on which to draw. The aim in this research was to gain insights into what factors influence farmers' adoption of whole farm plans and why, to inform the initiatives of councils such as Horizons Regional Council.

1.3 Problem statement

Hill country erosion is a serious environmental issue in New Zealand. Regional councils and unitary authorities are responsible for the management of natural and physical resources, which includes mitigation of erosion. Whole farm plans are the primary tool which regional councils, including Horizons Regional Council, rely on to work with farmers to address erosion on farms. Efforts to achieve high levels of adoption of whole farm plans by farmers would be enhanced by an understanding of why farmers have adopted whole farm plans in the past.

1.4 Research question

The main research question guiding this research is:

What factors influence the adoption by farmers of whole farm plans, and why these factors are influential?

1.5 Research objectives

In order to answer this research question, the following objectives are addressed:

- Identify farm plans that best match the Whole Farm Business Plans currently being implemented by Horizons Regional Council.
- Identify and describe factors that have influenced and are influencing adoption of farm plans by farmers.

1.6 Research approach

A case study was chosen to answer the research question. Two stages were used in the research approach. The first was preliminary research to select the case, then in the second stage, the factors that influenced the adoption of farm plans were identified.

In selecting the case in the first stage, historical farm plans were reviewed to find if there were any similar to the WFBPs. Identification of similar farm plans led to the selection of the case area in the Wairarapa. Further investigation using key informants assisted in the identification of farmers to be interviewed for the research. These farmers were located in two catchments, the Whareama and the Whangaehu in the Wairarapa, and formed the two subcases.

Interviews with farmers and key informants produced the primary data to investigate the phenomena of adoption of farm plans. Qualitative data analysis was employed to analyse the data and to develop the results, which were then discussed in relation to the literature reviewed.

1.7 Thesis structure

In this research a range of factors that have influenced the adoption of farm plans was investigated. In Chapter Two, adoption diffusion literature in which factors that could potentially influence the adoption of farm plans is reviewed. There is limited research specifically on adoption of farm plans, but there is a wide range of research on the adoption of innovations that address environmental issues on farms. In Chapter Three the methodology used for this research is explained. A case study approach was used to answer the research question and attain the objectives. The case description in Chapter Four includes a description of the two catchments and of the Greater Wellington Regional Council that support farm plan programmes in the Wairarapa. In Chapter Five the results are presented, and in Chapter Six, in the discussion, the results of this research are compared and contrasted with those in the literature reviewed, and the findings from this research are highlighted. Conclusions are drawn in Chapter Seven and inferences made as to the potential implications for Horizons Regional Council and other councils that could influence the adoption of whole farm plans.

Chapter 2

Literature Review

2.1 Introduction

The adoption of innovations that address environmental issues on farms, in particular farm plans, and the factors that influence this are the focus of this research. Literature relevant to this is reviewed in this chapter and has been drawn from agriculture, environmental management and general adoption and diffusion of innovation research. Unless otherwise stated the literature reviewed is based on a developed country rather than the developing country context.

This review is organised into four sections. Frameworks that have been developed to help understand the wide range of factors associated with the adoption of innovations are introduced in Section 2.2. Section 2.3 includes key factors that have been identified from the literature as influential in adoption of innovations, with particular focus on agricultural innovations that address environmental issues. These influential factors are divided into three groups: i) the innovation, ii) the *extension process*² and iii) the farmers and their farm characteristics. The extension process includes the ways to encourage and support the transfer of the innovation to the farmer, or end user. In Section 2.4 the Innovation Decision Process developed by Rogers (2003) is reviewed. Detail about this framework is provided because of the extensive citation it received in the extension literature, and it also helps to explain the progression an individual makes over time with regard to adoption of an innovation. In the final section (2.5) a summary is made of the findings from the literature and how the information is used to guide this research.

Some specific terms are consistently used throughout this review, including farmer, extension agent and factors. These terms have been selected for this review from a range of different terms, which are used in the literature to mean similar things. First, *adoption* and *diffusion* are explained to show how these terms are used this review. Adoption refers the uptake process of an innovation by an individual, and the

² As with any literature review, a number of terms emerge, which are used differently, to mean different things by different people. Such terms are italicised when they are first used and a definition is provided for this research.

aggregation of individuals' adoption can be used to describe diffusion. Diffusion is measured by the extent (spatially and temporally) to which an innovation has been utilised by a population (Mercer, 2004).

2.2 Innovation adoption frameworks

A variety of frameworks are presented in the literature to assist with the understanding of the adoption of innovations. The frameworks reviewed include the Innovation Decision Process (Rogers, 2003) and a macrostructural framework (Duff, Stonehouse, Blackburn & Hilts, 1992). Although not identified in the literature as frameworks, a number of authors create frameworks by categorising a wide range of factors (Guerin, 1999; Pannell, Marshall, Barr, Curtis, Vanclay, & Wilkinson, 2006; Smithers & Furman, 2003; Wejnert, 2002). Rogers' framework has been widely and extensively cited in the agricultural literature, although it has also been used in research in a range of other disciplines. It is concentrated on the individual's progression towards adoption of an innovation. The macrostructural framework includes a framework similar to that of Rogers, and adds factors that are external to the individual farmer and his/her farm system. Some frameworks use categories that include a wide range of factors, both internal and external to the farmer and farm system, which influence the adoption of an innovation (Guerin, 1999; Pannell et al., 2006; Smithers & Furman, 2003; Wejnert, 2002).

The Innovation Decision Process developed by Rogers (2003) is a general framework for any innovation. It is based on the stages an individual goes through when making decisions about an innovation. The framework starts with prior conditions, which are the established views of an individual. The stages then progress from knowledge to persuasion, decision, implementation and finally the confirmation stage. These are illustrated in Figure 2.1 and explained further in Section 2.4. Rogers (2003) also emphasises the importance of time and communication throughout the Innovation Decision Process. Rogers' (1983, 1995, 2003) work is cited extensively in research reviewing adoption of practices addressing environmental issues (Duff et al., 1992; Upadhyay, Young, Wang & Wandschneider, 2003). However, Rogers' framework has been criticised for being "prescriptive, static and deterministic" (Morris, Mills & Crawford, 2000, p. 243). Morris et al. (2000) recognised these limitations, but decided

it was appropriate to use the framework to analyse farmer participation in the Countryside Stewardship Scheme (CSS) and the Environmentally Sensitive Areas (ESA) scheme operating in the UK. They concluded that it was helpful to understanding farmers' participation, and provided guidelines to develop the schemes and encourage their adoption.

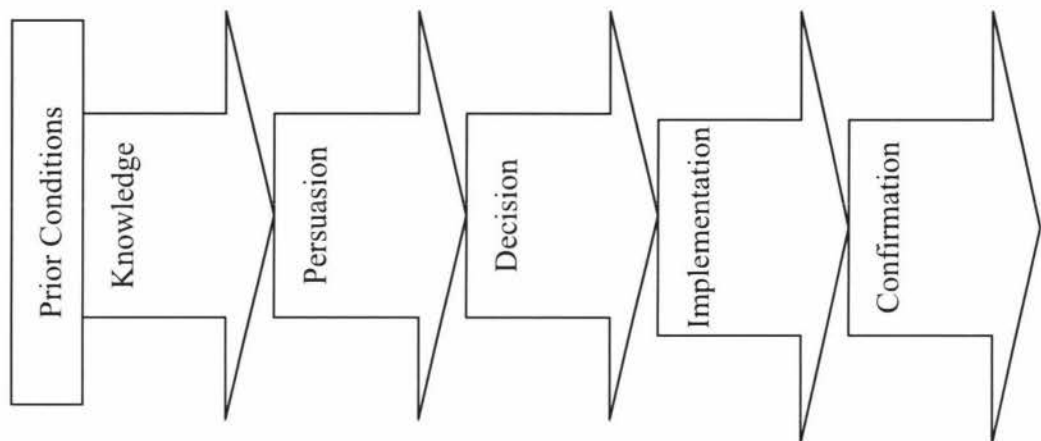


Figure 2.1. Stages of the Innovation Decision Process (adapted from Rogers, 2003, p. 163).

The macrostructural framework, developed by Duff et al. (1992), includes a consideration of a wide range of contextual factors that are likely to impact on the adoption of soil conservation practices. These factors are used to separate farmers into groups, so that policy can be better directed. It is expected that policy catering for different types of farmers will influence a wider audience, resulting in greater adoption of soil conservation practices. The framework is divided into stages that assist the development of policy. Data from each stage are used to develop the following stage (See Figure 2.2). The stages progress from identification of contextual factors that influence decisions to the farm unit decision making process, which are comparable to Rogers' (2003) Innovation Decision Process; to identification of the effort farmers are prepared to apply to soil conservation and the need for it on their farms; to classification of farmers according to their effort and need; and finally to policy development for those classified groups of farmers.

In the first stage the contextual factors used in Duff et al.'s (1992) framework are divided into two levels. The first level is the farm system that includes the individual farmer and farm. The farm system operates inside the second level, the regional

‘communication and transfer process’. Smithers and Furman (2003) analysed the Environmental Farm Plan Programme (OEFP). They divided factors influencing farmers’ participation into: ‘characteristics of the participant’, ‘characteristics of the farm site and operation’ and the ‘characteristics relating to the OEFP programme’. A review of general diffusion of innovation research, including global impacts for some types of innovations, resulted in the categories: “characteristics of the innovation”, “characteristics of the innovators” and the “environmental context” (Wejnert, 2002 p. 298). ‘Communication and transfer’ is clearly distinguished as a category only by Guerin (1999), whereas the other two authors incorporate the transfer characteristics within other categories. Pannell et al. (2006) reviewed literature on the adoption of conservation practices for rural landholders and categorised factors into three “broad sets of issues” (Pannell et al., 2006, p. 1408).

Table 2.1. Categories Used to Organise Factors That Influence the Adoption of Innovations.

Authors	Guerin (1999)	Smithers and Furman (2003)	Wejnert (2002)	Pannell et al. (2006)
Categories associated with the innovation	Innovation and its developers	Characteristics of the OEFP ¹ programme	Characteristics of the innovation	Characteristics of the practice
Categories associated with the user of the innovation and his/her circumstances	Land user	Characteristics of the participant Characteristics of the farm site and operation	Characteristics of the innovators Environmental context	Characteristics and circumstances of the landholder within his/her social environment
Categories associated to extension	Communication and transfer process			Process and learning and experience Stakeholders

¹Ontario Environmental Farm Plan Programme

Broad sets of issues, proposed by Pannell et al. (2006), are similar to the factors identified and categorised by other authors. Two broad sets of issues are “characteristics of the practice”, and “characteristics and circumstances of the landholder within their social environment” (Pannell et al., 2006, p. 1408). The third broad set of issues incorporates factors similar to those described by other authors’

categories associated to the farmer. It focuses on knowledge and learning, using a comparable structure to Rogers' (2003) Innovation Decision Process, and is titled, "the process of learning and experience" (Pannell et al., 2006, p.1408). Pannell et al. (2006) did not use the communication and transfer category that Guerin (1999) utilised. However, Pannell et al.'s (2006) discussion of stakeholders, such as extension agents, researchers and policy makers is similar, although not designated as one of the broad sets of issues.

In this review, three categories are used to organise the factors, identified in the literature, which influence the adoption of agricultural innovations. The categories used are; factors related to the innovation, factors related to extension, and factors related to the farmer and their farm characteristics.

2.3 Factors influencing the adoption of agriculture innovations

Factors that influence adoption of innovations are interlinked and complex (Wejnert, 2002). Each individual will have his or her own mix of factors, which influence his or her adoption of an innovation process (Wejnert, 2002). The mix of factors that influence an individual and a population, change over time, are different for different innovations and some factors are more influential than others. The level of influence a factor plays in the adoption process also changes over time (Wejnert, 2002).

Researchers from many disciplines have investigated a wide range of factors that influence the adoption of innovations. Pannell et al. (2006) suggest that virtually every quantifiable characteristic of the farm, and the farmer, has been statistically related to adoption of some innovation. Knowler and Bradshaw (2007) reviewed 31 separate empirical research articles on adoption of innovations that address environmental issues. Nearly 170 significant factors were identified, with few if any being consistently significant across all research. However, despite this extent of research, high levels of adoption of an agricultural innovation often do not occur (Marshall, 2004; Mercer, 2004). Understanding of why adoption levels for some innovations are low to moderate is still unclear (Pannell et al., 2006). A survey about adoption of sustainable farming methods with farmers in New Zealand hill country was criticised

for repeating what has already been done many times before, and farmers asked for practical help, not more talking (Bradshaw & Williams, 1998).

2.3.1 Factors related to the innovation

The literature does not establish a standard term for innovations that address environmental issues. In empirical research the innovation itself is referred to, such as new plant taxa (Wallace, 2006), or reduced tillage (Upadhyay et al., 2003). Reviews are often oriented to specific fields such as soil conservation farming methods (Duff et al., 1992), or agroforestry (Mercer, 2004). Knowler and Bradshaw specifically chose the term conservation agriculture, because it “provides a unifying label for a number of related soil management practices” (2007, p. 26). They suggested that the aggregation would make it easier for extension workers and policy makers to package soil conservation methods.

Innovations that address environmental issues are identified in the literature as having particular characteristics that may slow the rate of adoption. These characteristics include:

- Fewer observable impacts from the innovation after implementation, as compared to other innovations (Guerin, 1999; Marra, Pannell, & Abadi Ghadim, 2003), e.g. the impact of perennial crops used to address dryland salinisation are not easily observed.
- A time lag before benefits are evident (Barr & Cary, 2000; Duff et al., 1992; Mercer, 2004).
- Having low economic returns (Pannell, 1999).
- Knowledge intensive, rather than a simple input such as a new seed variety (Mercer, 2004).
- Having a long-term effect (Burton & Wilson, 2006; Pannell et al., 2006).
- Providing benefits to society, as well as to the individual property on which it is implemented (Guerin, 1999).
- Implemented before evidence of an unwanted event occurs. These are called *preventive innovations* (Rogers, 2003).

Duff et al. (1992) suggests potential candidates to adopt these types of innovations require greater encouragement as compared to innovations with easily observable, quick return benefits.

The definition of an innovation differs depending on whether a sociological or an economic approach is taken. These definitions also suggest different types of approaches to influence adoption of an innovation. The sociological definition states that an innovation is an idea, practice or object that an individual considers new (Rogers, 2003). An innovation may have been around for a long time, however the idea, practice or object is new to an individual when they first become aware of it. From that point of awareness an individual can then establish a view about the innovation (Mercer, 2004; Rogers, 2003). The sociological approach emphasises the important contributions to an individual's view. These contributions can be from social communication and information, also from an individual's interpretation of risks and impact on his or her social position (Upadhyay et al., 2003). The economic definition of an innovation is more objective: "technological factor of production with perceived and/or objective uncertainties about its impact on production" (Mercer, 2004, p. 312). Those taking the economic approach assume that individuals make decisions based on profit maximisation (Updhyay et al., 2003). They also accept that the individual perceives that the use of an innovation has uncertain impacts on production. These uncertainties are reduced over time with experience and modifications (Mercer, 2004).

The general description of diffusion of innovations by Rogers (2003) includes:

Most of the variance in the rate of adoption of innovations, from 49 to 87 percent, is explained by five attributes as perceived by the adopter: relative advantage, compatibility, complexity, trialability, observability (Rogers, 1995; cited in Rogers, 2003, p.221).

These five attributes are expanded upon in the following sections. An additional factor, temporal characteristics, is added to this review of innovations. The time taken to adopt an innovation is relevant to all innovations (Rogers, 2003), but is particularly applicable to innovations that address environmental issues, because this characteristic slows the rate of adoption (Barr & Cary, 2000; Duff et al., 1992).

2.3.1.1 Relative advantage

Relative advantage is an individual's perception of benefits and costs that can be influenced by incentives (Rogers, 2003) and context (Pannell et al., 2006). Rogers (2003) defined relative advantage as, "the degree to which an innovation is perceived as being better than the idea [or practice] it supersedes" (p. 229). This definition is focused on the individual's view of an innovation. Pannell et al. (2006) define relative advantage in a similar way to Rogers (2003). They emphasise farmers' perception of net benefits if they adopt an innovation, and identify many factors that can influence this perception. They include factors such as compatibility, complexity, costs and policies, which can all potentially influence the relative advantage of an innovation to the individual. Rogers (2003) identifies that incentives can increase relative advantage and are used to speed up the rate of adoption of an innovation. An individual's decision as to whether or not an innovation provides a relative advantage is dependent on his/her economic, social and environmental goals (Pannell et al., 2006).

Benefits and costs are similar to relative advantage, but the focus is on the innovation itself, not the individual's perception of it. The authors that describe benefits and costs incorporate a wider perspective to relative advantage. They include the benefits an innovation can provide to society, as well as to the individual (Knowler & Bradshaw, 2007; Wejnert 2002).

2.3.1.2 Compatibility

Rogers (2003) describes compatibility in relation to sociocultural values and beliefs, previously introduced ideas and the farmer's needs for the innovation. Wejnert (2002) has a similar explanation for compatibility. She identifies that an innovation must fit the existing system, which includes the socially accepted norms³ (similar to sociocultural values and beliefs) of the farmer and the farming community, and the existing practices (similar to previously introduced ideas) (Wejnert, 2002). Pannell et al. (2006) discuss the compatibility of an innovation as a relative advantage. This relates to how easily an innovation can be incorporated into the existing system, as Wejnert (2002) explains. For example, if a tree crop were introduced to a wheat

³ Social norms: When individual's values are aggregated they become social norms (Carey, Short, Morris, Hunt, Priscott, Davis, Finch, Curry, Little, & Winter, 2003). This is documented further in the section on beliefs, values, attitudes and behaviour.

farmer, the relative advantage would be moderate to low, due to the additional costs and skills required to incorporate it into the existing system (Pannell et al., 2006). Few researchers have looked at innovations over time; however Wilkinson's (1989) review of literature for his thesis identified that innovations change and can be superseded by better innovations over time, thus presumably, with improved compatibility. Innovations can also change to better suit location requirements. A more flexible innovation allows adaptation, consequently providing greater opportunities for adoption.

2.3.1.3 Complexity

"Complexity is the degree to which an innovation is perceived as difficult to understand and use" (Rogers, 2003, p. 16). A complex innovation can require greater levels of understanding, and it will take time to accumulate sufficient information about it, potentially from a wide range of sources. Sufficient information is when the perceived risk is acceptably understood, and a decision about the innovation can be made (Guerin, 1999; Vanclay & Lawrence, 1994; cited in Cary, Webb, & Barr, 2002; Pannell et al., 2006). Complexity can be the reason for having difficulty making accurate decisions regarding the adoption of an innovation (Pannell et al., 2006).

Innovations can sometimes be divided into parts. This is a way extension agents and farmers have reduced the complexity of innovations, and potentially increased the level of adoption (Wilkinson, 1989; de Buck, van Rijn, Roling, & Wossink, 2001). Some farmers have adopted parts of an innovation to increase their knowledge before they adopt the whole innovation (Feder & Umali, 1993). Farmers adopted parts of the Integrated Arable Farming System (IAFS)⁴, with few farmers adopting the whole system (de Buck et al., 2001). However, researchers have indicated that the IAFS must be implemented as a whole to get the full potential benefits. This partial adoption was explained as an example of farmers' lack of shift towards an environmental sustainability paradigm (de Buck et al., 2001). A more subjective analysis of Integrated Pest Management, which is a key part of the IAFS, suggested that partial

⁴ IAFS "IAFS comprise a multifunctional crop rotation that supports crop protection and nutrient management strategies.....In IAFS all these aspects of crop rotation, crop protection and nutrient management are deployed to integrate economical and ecological goals in farm management" (de Buck et al., 2001, p. 153).

adoption occurred because it was difficult to use and it required too much time for monitoring (Bodnaruk & Frank, 1997, cited in Cary et al., 2002).

2.3.1.4 Observability

Three aspects about observability were identified in the literature reviewed: the observability of benefits, the degree to which elements of an innovation can act as triggers to stimulate action, and the time lag before benefits are seen. The benefits from an innovation are not always easily seen. An innovation that has more easily observed benefits will have a higher level of adoption (Rogers, 2003), and vice versa. Observability is one way to gain information about an innovation. Therefore, less observable benefits from an innovation can mean less information and increased risks and uncertainty associated with the innovation's adoption (Pannell et al., 2006). Extension organisations use visual cues for environmental issues and visual outcomes of innovations to provide greater awareness and potentially stimulate uptake. Landcare⁵ Australia placed trials in farm paddocks bordering main roads to increase observability. They used well-flags to increase observability of the water level, and consequently help control irrigation use (Cary et al., 2002). Observability of benefits of an innovation can be delayed. Salinisation is an issue pertinent to Australia, where the lack of observability and the "long lags between cause and effect", are serious impediments to "accurate understanding of the impacts of the salinity-management tools" (Pannell et al., 2006, p. 1410), and hence adoption of these tools.

2.3.1.5 Trialability

Trials can offer farmers an opportunity to establish a more accurate perception of the risks and the degree of compatibility an innovation has with their existing system (Cary et al., 2002). Farmers can experiment with the innovation on a partial basis (Rogers, 2003), and learn and reduce uncertainty about the innovation (Pannell et al., 2006). This can contribute to a more accurate decision about adoption of the innovation (Pannell et al., 2006).

⁵ Landcare has many farmer groups throughout Australia that address land degradation and work towards farm sustainability. Many supportive individuals and organisations including government contribute to the groups.

Pannell et al. (2006, p. 1417) listed the following factors that influence farmers' interest and ability to use an innovation on a trial basis. All factors need consideration when implementing a trial.

- Divisibility. The ability to implement the innovation on a small scale (Rogers, 2003).
- Observability. The ability to see the outcomes from a trial.
- Time lag. The time it takes to interpret the outcomes of the trial. A long time taken to interpret the outcomes may be interpreted as having insufficient benefits.
- Complexity. The degree to which a trial can be implemented without difficulties and the outcomes can be interpreted.
- Costs. The affordability of using finances, labour, time and land for a trial.
- Risk. Trials can be at risk of failure from a range of factors such as storm events and pests and disease, which may reflect on the risk associated to the innovation.
- Representation. A trial needs to convey information that is relative to what the innovation will provide in the long run.
- A trial's outcomes are more easily interpreted if there are similarities to existing practices.
- Spillover. The outcomes from the implementation of some innovations result in impacts on neighbouring properties. Farmers perceive that an increased water table on their own properties was an outcome of implementation of salinity control measures on their neighbours' properties. This perception reduced interest to trial the same salinity control measure.

According to the International Panel on Climate Change (IPCC) (2000), trials have proven to be the most effective way to encourage the use of an innovation. Even advice from highly respected sources is not as good as trials, when a farmer can make his or her own judgement about an innovation (Pannell, 1999).

Farmers interviewed about the Countryside Stewardship Scheme (CSS)⁶, in England, indicated that some options from the scheme did not encourage them to trial. These

⁶ The Countryside Stewardship Scheme and the Environmentally Sensitive Areas scheme are predecessors to a new scheme, the English Stewardship Scheme, introduced in 2005.

included the Field Margins option that required the whole farm to be committed and no stepwise option was available, and the Arable Field Margins option that required a ten-year commitment. Both situations did not encourage adoption (Morris et al. 2000).

2.3.1.6 Temporal characteristics

The length of time taken to work through the adoption process⁷ (Rogers, 2003) highlights the potential for a wide range of factors to influence the decision, particularly as circumstances change. Individuals change ideas and attitudes to an innovation as information and experience increase (Abadi Ghadim & Pannell, 1999; Feder & Umali, 1993; Wilkinson, 1989). Temporal issues may affect all stages of adoption. The first stage of adoption, the knowledge stage, the individual takes time to be aware the innovation exists. Gibbs et al. (1987, cited in Pannell et al., 2006) identified a wide variation in the time, often years, for farmers to acknowledge that an innovation exists, despite active initiatives to promote it. In the second stage, the persuasion stage, an individual may have very little understanding of an innovation when it is first introduced. There needs to be a process of collecting and interpreting information in order to reduce uncertainty, and increase potential acceptance for utilisation of the innovation in the existing system (Mercer, 2004; Pannell et al., 2006; Rogers, 2003). For the decision stage, each individual will have his/her own level of information that they require to make a decision on whether or not to adopt an innovation. Some may require very little information to accept the risks involved, in comparison to others who may require a lot (de Buck et al., 2001; Pannell et al., 2006). For the final confirmation stage, the time to see the benefits was a particularly important influence on adoption. Time to see the benefits can take three to six years for agroforestry (Mercer, 2004), and benefits from reversing land degradation was suggested to take more than 50 years to see (Cary et al., 2002).

2.3.2 Factors related to extension

Factors related to extension include the approaches to encourage, support, and inform a farmer about adopting an innovation. Pannell et al. (2006) define 'extension' as, "public and private sector activities relating to technology transfer, education, attitude

⁷ The adoption process is the process an individual goes through from awareness of the innovation through to its implementation, plus the confirmation required by an individual for ongoing use of the innovation. The most cited example of this process is described by Rogers (2003), and explained more fully in Section 2.3.

change, human resource development, and dissemination and collection of information” (p. 1408). Cary et al. (2002) refer to extension as a professional organisation delivering an innovation. This review divides factors related to extension into two categories: communication and organisational strategies. This is broader than that defined by Cary et al. (2002) and most literature reviewed was concentrated on only one or two types of extension.

2.3.2.1 Communication

For this review the communication category includes written, verbal and visual types of communication from peers and neighbours, opinion leaders and extension agents. Although the people described in these three categories could be used in organisational strategies, they are separated in this review due their personal link to the farmer.

Peers and neighbours

Peers and neighbours exert a strong influence on farmers’ decision making (Barenklau, 2005; Guerin, 1999; Marshall, 2004). Peers and neighbours were identified as the preferred sources of information for Australian farmers (Anderson, 1998; cited in Guerin, 1999), and for New Zealand farmers (Bradshaw & Williams, 1998). Some authors’ reviews of extension research stated that greater exposure to information and experimentation with an innovation increased farmers’ level of adoption of that innovation (Barenklau, 2005; Feder & Umali, 1993; Mercer, 2004). Based on this evidence, Barenklau (2005) and Mercer (2002) argue that the close proximity of neighbours provides many opportunities for farmers to observe and experience each other’s activity. Therefore, when one neighbour is experimenting with an innovation, the observing neighbours increase their information, which may speed up their adoption process. Barenklau (2005) indicated that there is little empirical research that measures the influence of peers and neighbours on adoption of innovations.

The literature reviewed did not identify peers and neighbours as having a strong influence on encouraging conservation activities. Australian policy makers assumed that peer group pressure would encourage conservation activities on farms (Marshall, 2004). However, encouraging peers into the Australian Landcare groups attracted only those farmers who were interested in being part of a group (Pannell et al., 2006). In his research Marshall (2004) specifically chose to examine the influence of peer pressure

to participate in Land and Water Management Plans (LWMP). His findings indicated that trust and community benefits were stronger influences than peer pressure on influencing the adoption of LWMPs.

Opinion Leaders

Opinion leaders have the potential to increase the level of adoption of innovations. Opinion leaders can be identified by the following characteristics. They are often central to *social networks*⁸, they generally conform to social norms, people informally seek information and advice from them (Rogers, 2003; Wejnert, 2002), and opinion leaders may not be aware of the role they play (Spence, 1994). Rogers (2003) defined opinion leadership as the “degree to which an individual is able to influence other individuals’ attitudes or overt behaviour informally in a desired way with relative frequency” (p. 27). Whereas Rogers (2003) differentiates between opinion leaders and *innovative farmers*, Guerin (1999) does not. Opinion leaders and innovative farmers influence others in different ways. Innovative farmers influence others by adopting the innovation early (Abadi Ghadim et al., 1996; cited in Pannell, 1999, Feder & Umali, 1993). Opinion leaders’ influence is more strongly associated with their information and advice they provide to others, although their own actions, one would suspect, would need to be consistent with their advice. Rogers (2003) suggests that extension agents can increase the rate of adoption of an innovation by identifying opinion leaders, and using their influence in the community.

Extension agents

An extension agent is a person who transfers an innovation to the farming community, with the intent of increasing the adoption of the innovation. Both extension agent and change agent are terms used in the literature to mean the same thing. However, change agent is a term used in relation to a broad range of sectors, whereas extension agent is restricted in its use to the rural agricultural sectors (Guerin, 1999; Rogers, 2003). Rogers’ (2003) definition of a change agent also recognises his/her affiliation to an organisation, “an individual who influences clients’ innovation-decisions in a direction deemed desirable by a change agency” (p. 27). The term extension agent is used in this review to convey both meanings.

⁸ Social networks are the interconnection of individuals and their communication (Wejnert, 2002; Rogers, 2003).

The credibility of an extension agent can significantly increase the level of adoption of an innovation (Feder & Umali, 1993; Guerin, 1999; Knowler & Bradshaw, 2007; Pannell et al., 2006; Rogers, 2003). Two key attributes, technical competence and the relationship with the farmer are important for an extension agent's credibility (Guerin, 1999; Lovejoy & Napier, 1986; Morris et al., 2000; Pannell et al., 2006; Rogers, 2003). Guerin (1999) suggests a range of attributes that could contribute to an extension agents technical competence, such as being well informed in land management and having a practical approach to the issues being addressed. Building a relationship could include a range of attributes in the extension agent including being honest and reliable (Guerin, 1999) and empathising with a farmer's circumstances (Guerin, 1999; Pannell et al., 2006).

Credibility with clients takes time to build (Pannell et al., 2006). Contact time between an extension agent and a client is positively related to successful adoption of innovations (Rogers, 2003). Time with the farming community allows the extension agent to understand the farming community (Morris, 2006), respond to issues that arise with ongoing use of an innovation (Guerin, 1999) and build trust (Pannell et al., 2006). Trust can lead to greater involvement by the extension agent in farmer's decision making processes, but without it the extension agent simply acts as an information source (Pannell et al., 2006).

Farmer goals and public environmental goals are different. This can place the extension agents in a difficult position to maintain their credibility with both the individual farmer and the public. Pannell et al. (2006) identified that extension agents in Australia have shifted over the last twenty years from supporting farmers' goals to promoting public goals. They suggested that this might create a complex interaction between the farmer and the extension agent. If an extension agent is paid from public funds, or at least partly paid by the government, s/he will be expected to contribute to public benefits, but at the same time to work with farmers to achieve their goals (Cary et al., 2002).

Two key roles of extension agents were highlighted in the literature reviewed: finding ways to address an individual's problems, and promoting the use of an innovation to contribute to improvements (Lovejoy & Napier, 1986; Rogers, 2003). In response to

research presented at an American soil conservation symposium, Lovejoy and Napier (1986) provided a range of proactive measures for extension agents to progress improvements to rural soil and water conservation. They suggest that extension agents must find ways for farmers to overcome the constraints that limit their adoption of innovations, and operate as sales people, actively promoting soil conservation. Rogers (2003) similarly suggests that extension agents might find ways to overcome these constraints. He emphasised the importance of extension agents' adjusting the innovation to suit a client's needs, not trying to change a client's needs to suit the innovation.

Extension agents' organisations contribute to the ability of agents to carry out their roles. Difficult application forms and insufficient information formatted for extension agents by the extension agents' organisation were both found to be limiting factors in the adoption of the CSS (Morris et al., 2000). Some American soil conservation organisations realised the extent of skills that were required to fulfil an extension agent's role. Lovejoy and Napier (1986) suggested these agencies needed to train extension agents, or employ new agents with social, managerial, marketing and technical skills.

Extension agents can use different types of communication to progress farmers' decisions regarding an innovation. Morris et al.'s (2000) survey of farmers found that different types of communication were more useful at different stages of farmers' decisions to adopt an innovation. Morris et al. (2000) used Rogers' (1995) Innovation Decision framework (Section 2.4), and allocated different types of communication to each stage of decision making identified in the framework. The analysis confirmed that communication types external to the farm and farmer, such as newspapers, magazines, radio and television, were useful at early stages of the innovation decision to raise awareness. More focussed information sources such as group meetings, workshops, observations and conferences, were useful once farmers' awareness was raised. In later stages of the innovation decision, when the farmer was prepared to evaluate the innovation, more one-to-one communication was found to be critical to lead the farmer through to implementation of the innovation. Specialist advice and support were required in the final implementation and confirmation stages of the innovation decision, after the innovation was accepted (Morris et al., 2000). Rogers

(2003), like Morris et al. (2000), identified different types of communication with an individual, depending on his/her stage in the innovation decision. Whereas Rogers (2003) concentrated on the extension agent fulfilling the different communication approaches, Morris et al. (2000) and Pannell et al. (2006), identified different sources to fulfil the communication requirements. Repetition of the same message from the extension agents as well as a range of other sources, that is, multiple deliverers, builds farmers' confidence in their decision to adopt an innovation (Pannell et al., 2006).

2.3.2.2 Organisational Strategies

Organisational strategies are activities to influence the uptake of an innovation, which are put in place by an organisation, such as national or local government. The organisational strategies identified for this review include partnerships, research and development, and policy and incentives.

Partnerships

The importance of collaboration of organisations to improve rural environmental issues was identified in some of the literature reviewed (Lovejoy & Napier, 1986; Morris et al., 2000; Smallshire, Robertson & Thompson, 2004). The collaboration of organisations such as MAFF and Rural Development Service (RDS) and English Nature in the UK, has been identified as a key to success of the ESA and CSS programmes (Evans et al., 2002; cited in Smallshire et al., 2004). Factors contributing to this successful collaboration include one organisation overseeing the process (UK Government's Department for Environment, Food and Rural Affairs, Defra, conservation management division), and other organisations contributing to a range of management options that are incorporated into the revised Environmental Stewardship (ES) schemes. Management options include developing how aspects of the scheme are carried out, developing and using indicators to help understand the progress of the scheme and supporting technical guidance. The outputs of this collaboration have led to more flexibility in the English Stewardship Scheme (ESS), which allows farmers to use their own abilities to reach environmental outcomes (Smallshire et al., 2004). Unlike the government-based origins of the ESS, the OEFP has its origins with a collaboration of farm organisations and commodity groups (Smithers & Furman, 2003). The OEFP is still farmer driven but now includes state run organisations for advice and financial support. The Ontario Soil and Crop Improvement Association

deliver the programme locally. The Ontario Ministry of Agriculture and Food and Rural Affairs provide technical expertise, and funding is provided by Agriculture and Agri-Food Canada (Ontario Ministry of Agriculture, 1998).

The involvement of farmers with local and national government to develop strategies addressing rural environmental issues was identified in the literature as a valuable contribution to adoption of activities that address environmental issues. In the OEFP, farmers have asked for government support and then directed the government's involvement (Smithers & Furman, 2003). The assumption from this is that farmers recognised that the government could make a valuable contribution to their OEFP initiative. Morris (2006) in his review of agri-environmental schemes in the UK identified the need for policy development to include the knowledge of farmers in order to achieve optimum environmental outcomes. The Australian government has also acknowledged the importance of collaborating with farmers to improve the level of practical applications in natural resource management. "The partnership between government and the community is critical to encouraging on-ground action to improve natural resource management at the farm, catchment and regional level" (Australian Government, 2007, National Landcare Programme, paragraph 3). In New Zealand, Rauniyar and Parker (1998) found that farmers wanted to be involved with resource management planning.

Research and development

Research and development have contributed to the development of innovations, and to the identification of ways to increase the level of adoption of the innovations - the latter is the focus of many studies that are reviewed for this chapter. One key factor that emerged as important for the development of an innovation was the involvement of both farmers and extension agents. A farmer's interest in the results can be increased, and an innovation that is more likely to be compatible to farmer needs, are two potential outcomes from research when a farmer and extension agent are involved (Guerin, 1999). Guerin (1999) argues that it is the role of the scientist to recognise the needs of the farmer, and suggests as a basis for further development, the scientist could evaluate existing innovations and the problems associated with them.

Research and development continue for some innovations after they are first initiated. Evaluations of the CSS have enabled changes to be made to programmes to make them more acceptable for farmers to apply (Smallshire et al., 2004). Farmers in the UK were not aware that their agricultural practices were contributing to the decline in bird populations. Substantial amounts of research added to understanding the reasons for bird populations' decline, which provided leverage for specific approaches to be added to the ESA schemes (Smallshire et al., 2004).

Policy and incentives

There are key links between policy, extension and innovations. Policy provides guidance for strategies. Extension agents can implement the strategies that may include the use of innovations. For this research, policies that address environmental issues could result in a strategy using farm plans.

Knowler and Bradshaw (2007, p.42) recommend a "targeted policy approach" for agriculture that addresses environmental issues. They recommend that targeted policies focus on subsidies and grants to specific localities, and most preferably to individuals and their farm operations. This conclusion emerged from a review of empirical studies regarding the adoption of innovations that address environmental issues from developing, developed, temperate and tropical locations. This targeted approach is similar to that recommended in Duff et al.'s (1992) conceptual macrostructural model that classified farmers into groups (Section 2.1). Knowler and Bradshaw's (2007) recommendation for a regional policy approach is to first identify if the adoption of an innovation provides a positive or negative net return to potential adopters. Once this is established there are three recommendations (Knowler & Bradshaw, 2007, p. 43):

- "Education and technical assistance, where conservation is profitable but the farmer is not aware of the technology or its profitability, or does not have the skills to implement it.
- Financial assistance, where conservation is not profitable to the individual farmer but would provide substantial public benefits.

- Regulation and taxes, where conservation behaviour is required of all farmers or for those participating in related income support programmes (e. g. A cross-compliance measure)".

Consistent with Knowler and Bradshaw's recommendation for education and technical assistance, other researchers identified valuable features to include in policy that is aimed at supporting the adoption of innovations that can improve environmental issues. A number of authors suggest that a policy should include flexibility, encouragement for learning, coping with change and strengthening ecological systems (Cary et al., 2002; Folke, Carpenter, Elmqvist, Gunderson, Hollong & Walker, 2002; Lovejoy & Napier, 1986; Mercer, 2004). In Duff et al.'s (1992) theoretical framework it was also identified that policy should provide choices, which may be similar to flexibility identified by the authors above. Duff et al. (1992) added that farmers should be able to make choices "to meet his or her responsibilities" (Duff et al., 1992, p. 405). This is interpreted to mean that the policy supports a range of practical applications, and the farmer will be able to choose from those applications that appropriately address the environmental issues pertinent to his or her property.

The literature highlights the importance of subsidies and incentives to promote the adoption of an innovation for which there are public benefits. Guerin (1999) argues that if there are off-site public-good effects from an innovation used on a farm, the government needs to provide incentives for adoption. Knowler and Bradshaw (2007) argue that the incentive needs to be financial if the adoption of the innovation provides little financial advantage, and used the following example to substantiate their argument. The off-site public benefits from the adoption of conservation tillage to limit soil erosion in the United States was estimated to be worth US\$90.3M- US\$288.8M.

Sometimes it is difficult to determine the contribution subsidies are making towards the adoption of an innovation. Explanations vary as to the influence subsidies exercise. Subsidies can help persuade farmers to change (Morris, 2006), but the degree of influence may be adjusted by many other factors. Knowler and Bradshaw (2007) reviewed 31 analyses, of which four positively and two insignificantly correlated subsidies to adoption of conservation programmes. Economic benefits from subsidies become a less significant influence on the level of adoption when the farmer perceives

risk, concerns and issues (Cary et al., 2002), or it impacts time available and lifestyle (Pannell et al., 2006).

In addition to the difficulties in determining the contribution from the use of subsidies, it is also difficult to identify the amount to give to farmers to encourage adoption. In a New Zealand review of farm plans, the researchers found that a small subsidy resulted in farmers taking more personal responsibility for addressing environmental issues on their farms. The extension agency then provided a supporting role rather than dictating what should be done (Blaschke & Ngapo, 2003). Carey, Short, Morris, Hunt, Priscott, Davis, Finch, Curry, Little, Winter, Parkin and Firbank (2003) identified the need for accountability of the money spent on agri-environmental schemes. Although accountability of the schemes was important, it was for reasons related to a positive public perception of the government spending, rather than being linked to farmers' adoption decisions. Only farms that meet the criteria outlined by the government will get funding through the ESA and CSS. This will help to ensure that the tax payers' money will be used by farmers for environmental and recreational benefits to the public and not for other purposes (Morris, 2004).

There was little information regarding regulations to influence adoption of innovations in the literature reviewed. Knowler and Bradshaw's (2007) suggestion for regulations and taxes relates to when all farmers have to be involved or are part of an income support programme. Burton and Wilson (2006) suggest (after producing a prescriptive review, supported by a survey of Bedfordshire (UK) farmers and other studies throughout Europe) that policy makers in the European Union (EU) should accept that farmers are still driven by maximising production and are sceptical about adoption of conservation measures; and this is the reason for most agri-environmental policy remaining voluntary and not regulatory in the EU.

2.3.3 Factors related to farmer and farm characteristics

There are many factors related to the farmer and his/her farm characteristics that can influence the adoption of an innovation. Factors identified in this section are taken from reviews of agricultural innovations, which have identified factors from a wide range of empirical literature (Cary et al., 2002; Guerin, 1999; Marshall, 2004; Smithers & Furman, 2003). The factors described are: goals; beliefs, values and attitudes; age

and education; farm size; farm tenure and financial security; and the degree to which farmers' link with information sources.

A farmer's level of adoption varies for each innovation, and over time. A wide range of factors has been analysed in an attempt to explain the variability of farmers' adoption of innovations (Knowler & Bradshaw, 2007). Farmers' levels of adoption can change over time between *partial adoption*, *full adoption*, *dis-adoption* or *re-adoption*⁹ (Cary et al., 2002). A farmer may partially adopt an innovation by applying only parts of it, or by using it only on a small part of the property, or by using other innovations for the same purpose (Upadhyay et al., 2003). Clearly, this depends on the divisibility of the innovation itself; whether it is the most beneficial approach is another matter. As discussed in the section on complexity, farmers partial adoption of the IAFS reduced the innovation's integrity (de Buck et al., 2001). For different innovations, a farmer will have different levels of adoption. For example, a farmer may be classified as innovative with respect to one innovation that s/he adopts before other farmers, but a laggard with regard to another innovation (Pannell et al., 2006).

2.3.3.1 Goals

Pannell et al. (2006) emphasise the centrality of goals to the farmer's process of adoption of conservation practices. The innovation must suit the farmer's goals and farm characteristics. Without these factors being satisfied, no amount of communication and education will make any difference. If a farmer cannot perceive that the innovation will benefit their goals, adoption will not occur (Pannell et al., 2006). Wallace (2006) implies that a farmer needs to be able to clearly articulate his/her goals and states, "explicit goals are an essential starting point to any decision process" (p. 1398). A clearly stated goal considered alongside *cultural values* stimulates discussion and is likely to include an assessment of the benefits, costs and risks for the specific farm environment (Wallace, 2006). There are two types of values, cultural and social (Wallace, 2006). Cultural values are stable; therefore they change little over generations by comparison to social values, which are more transient.

⁹ Partial adoption: only part of the innovation is implemented. Full adoption: the innovation is fully implemented. Dis-adoption: the innovation is implemented but then is stopped being used. Re-adoption: after dis-adoption the innovation is then implemented again.

Wallace argues that decisions associated with natural resource management are complex, so the use of cultural values rather than social values is more appropriate.

2.3.3.2 Beliefs and values, attitudes and behaviour

Farmers are most likely to adopt an innovation when it supports their strongly held values, beliefs and attitudes. A wheat farmer who strongly believes that wheat production is the right occupation for him or her is unlikely to adopt production practices alternative to wheat (Pannell et al., 2006). Sommers and Napier (1993) are widely cited for their comparison between Amish and non-Amish communities. The Amish community adopts sustainable practices because they align with their strongly held beliefs of protecting the soil and land. If innovations do not support established belief systems¹⁰, the cost from society's disapproval can be too high (Wejnert, 2002). It is unproductive and a waste of money to keep promoting and encouraging an innovation to an individual or a community, when the innovation conflicts with their beliefs. In relation to a population rather than individuals, "...belief system variables have been one of the strongest factors determining the adoption ceiling, i.e., the number of actual adoptions to the number of potential adopters" (Wejnert, 2002, p. 313).

A community can influence an individual's beliefs and behaviour related to an innovation. Farmers with beliefs, values and attitudes that support conservation practices can be shifted into action and adopt conservation innovations when there is endorsement from a community (Cary et al., 2002). Collectively, individual positive environmental values can lead to a "consensus for community action" (Cary et al., 2002, p. 34). Similar values within a group of individuals can become social norms. Over time these social norms become strengthened and the likelihood of behaviour responding to the social norm increases (Cary et al., 2002). However, when practices such as organic farming differ from social norms, encouraging adoption of these practices is very difficult. Organic farmers from Flevoland, The Netherlands, have been felt ostracised by conventional neighbours and colleagues, and their traditional social networks have been eroded. This is considered to have major consequences for encouraging others to adopt organic farming (de Buck et al., 2001).

¹⁰ Belief systems include "values, norms, language, religion, ideologies" (Wejnert, 2002, p. 312).

Farmers' attitudes towards production, financial rewards and environmental outcomes influence their willingness to adopt innovations that address conservation issues. Positive environmental attitudes are a confirming influence on farmers adopting conservation farming practices (Saltiel et al., cited in Wejnert, 2006; Smithers & Furman, 2003). However, a review of empirical research revealed either a positive or an insignificant relationship between a 'conservation attitude' and adoption of conservation agriculture (Knowler & Bradshaw, 2007). Some research indicated that farmers who were motivated by production oriented goals or financially oriented goals had low levels of adoption of conservation farming practices. Schmitzberger, Wrбка, Steurer, Aschenbrenner, Peterseil and Zechmeister (2005) classified farmers into the groups; production oriented, traditionally oriented and innovative business oriented. Whereas the latter two groups had a high potential for adopting conservation measures; production oriented farmers had a low level of adoption of conservation measures. Morris and Potter (1995) divided farmers into adopters and nonadopters of the UK ESA scheme. In the group of farmers that adopted the ESA scheme, some farmers were "strongly motivated by environmental commitment" (p.242), whereas others adopted the scheme for financial reasons. The group adopting the scheme for financial reasons were described as a lot less committed to conservation measures and the ESA scheme, and continued to implement the scheme on the condition that there was minimal disruption to the existing farm system (Morris & Potter, 1995).

An individual will have many attitudes of varying strength and direction associated with an innovation, and to the associated risk perceived, making a prediction of behaviour difficult (Cary et al., 2002). Contrary to the above authors who relate attitudes to behaviour, Cary et al. (2002) suggest that behaviour is unlikely to be predicted unless all attitudes of the individual are taken into account. First, farmers assess the risks associated with an innovation, then for each farmer, his/her personal attitudes to those risks vary (Guerin, 1999). For example, conventional and organic farmers surveyed in Flevoland, Netherlands about IAFS recognised similar risk factors (undesirable outcomes) to organic farming. What they did not agree on was what the acceptable level of risk was. The conventional farmers preferred to stay with what they knew. The organic farmers accepted lower yields and costs and high variability of each but higher prices for products, whereas the conventional farmers did not (de Buck et al., 2001).

2.3.3.3 Age, education and experience

Age and education are difficult to associate to generalisations about adoption of an innovation. Across research, results showed little consistency. Other factors influencing adoption can alter the influence of age and education. Education is often confused with experience and the reason for describing these two factors in this section.

There is little consistency among the studies exploring age as a factor influencing adoption of innovations (Guerin, 1999; Pannell et al., 2006; Rogers, 2003). For example, a reviewer of empirical research found suggestions that older farmers have little interest in conservation practices, because they are considering leaving their farms and moving to urban areas in the near future. They found also that older farmers were less aware of degradation to the land as compared to young farmers (Cary et al., 2002). However, another author's review of empirical research stated that older farmers are interested in conservation practices because of potentially increasing the resale price of their farms or because they were wanting to transfer their farms to the next generation (Pannell et al., 2006).

The level of an individual's education is not a clear indicator of his/her likely level of adoption of an innovation. Education is often confused with other associated factors such as experience (Pannell et al., 2006), farm size and wealth (Mercer, 2004). After a review of the empirical literature, Feder and Umali (1993) combined three factors, youth, wealth, and higher education, to identify a group of farmers that are more likely to adopt soil conservation innovations. Feder and Umali (1993) suggested that level of education influences farmers at different stages of their adoption process. Feder, Just, and Zilberman's (1985) review of adoption literature revealed that farmers with higher levels of formal education often adopted early, and more efficiently. An update of Feder et al.'s (1985) review by Feder and Umali (1993), further defined the influence of education as being important in the early stages of decision making towards adopting an innovation; however, other factors became dominant influences in later stages. Also counter to Feder et al.'s (1985) conclusion, farmers with higher education also can be less interested, and slow to adopt an innovation if it is complex (Pannell et al., 2006). More well-educated farmers can spend time to find out about an

innovation's limitations, by comparison with farmers with less education, who adopt more quickly without recognising the limitations. Training programmes relevant to the innovation are more likely than is general education to be influential on the level of adoption (Cary et al., 2002; Pannell et al., 2006).

Adoption is a learning process and over time a farmer may accumulate more information and knowledge about an innovation that are likely to improve decisions about that innovation (Pannell et al., 2006). These decisions may result in a range of adoption, from full adoption of an innovation to nonadoption. Experience with an innovation can allow farmers to make changes to that innovation. These modifications to an innovation allow greater compatibility with a farmer's specific circumstances (Rogers, 2003), and more efficient use of that innovation (Feder et al., 1985). Rogers (2003) identified research that suggests that modification to an innovation leads to faster rates of adoption and greater sustainability. If an innovation is modified too much the level of adoption becomes difficult to identify. Kelly et al. (2000; cited in Rogers, 2003) defined 'core elements' of an innovation as the features that make the innovation effective. This is interpreted to mean that original objectives of an innovation that address an issue are the important aspects to focus on when measuring the level of adoption or level of success. However, negative experience with an innovation can act as a barrier to further adoption as the risks are perceived as too high. Psychological literature describes this as 'learned helplessness' (Guerin, 1999) or 'innovation negativism' (Rogers, 2003).

2.3.3.4 Farm size, farm tenure, & financial security

Farm size, tenure and financial security often reflect the wealth of a farmer and the ability to take risks and the likelihood of adopting an innovation. However, it is important to recognise this is not consistent throughout all empirical studies. Farmers with larger farms are more likely to adopt innovations that address environmental issues (Cary et al., 2002). Knowler and Bradshaw's (2007) review of empirical studies identified examples of both positive and insignificant relationships between farmers with larger farms and adoption of conservation innovations. Farmers with larger farms also have been linked to having greater economies of scale, greater ability to take risks, higher socioeconomic status, and greater access to information. These factors may go

some way towards explaining why farmers with larger properties are more likely to adopt conservation agricultural innovations (Mercer, 2004).

Farmers with leased properties were associated with less adoption of innovations addressing environmental management (Guerin, 1999). Mercer's (2004) review of literature found that farmers with leased properties have less interest in adopting long-term investments, such as agroforestry. This was different from short-term investments, such as cropping, where farmers with leased properties were not clearly associated with positive or negative adoption. However, some authors who reviewed a wide range of literature found inconsistent results about the influence of tenure on adoption of innovations (Feder et al., 1985; Knowler & Bradshaw, 2007)

Economic variables can have a dominant influence on the adoption of rural and resource management innovations (Cary et al., 2002; Marra et al., 2003), particularly if they affect a farmer's perception of financial security. Economic variables may include the costs and financial benefits involved in implementing the innovation, and the farm's financial capacity. A greater sense of financial security has been correlated to a greater likelihood of adopting an innovation (Cary et al., 2002), but there are research examples that refute this (Knowler & Bradshaw, 2007).

2.3.3.5 Farmers links with information sources

The extent to which farmers link with others and how strong those links are can affect their adoption of innovation decisions (Pannell et al., 2006). Based on a review of empirical research, Pannell et al. (2006) itemised the characteristics of the links that farmers may have with others that influence adoption:

- Degree to which a farmer is involved with groups and organisations;
- Physical distance to other adopters;
- Physical distance to sources of information about the innovation;
- History of positive relationships with other farmers and extension agents;
- Divisions between different ethnic and cultural groups that cause significant barriers to flow of information between farmers; and
- Receptiveness to extension and promotions.

Participation in a social group establishes social acceptance and a common culture. When an innovation is offered, a social group is likely to be a key forum for discussion to understand the innovation. The interpretations made in the group will influence the willingness of individual group members to adopt (Stern et al., 1999; cited in Cary et al., 2002; Wejnert, 2002).

2.4 The Innovation Decision Process

Rogers (2003) has developed the Innovation Decision Process (See Figure 2.1, Section 2.2) as a general framework for all types of innovations. It is concentrated on the stages an individual may go through when making decisions about an innovation. Other authors have also used stages similar to those used by Rogers (2003) to help explain the adoption of farm related innovations (Barr & Cary, 2000; Pannell et al., 2006). Table 2.2 has the comparative stages for each author in the same rows. One author's wording for each stage is more explicit compared to that of another, nevertheless each stage is described below using Rogers' expressions. Figure 2.1 (Section 2.2) presents the sequence of stages. They could occur in any order; the decision stage, when the innovation is adopted, may be the first stage if an innovation is imposed on a society. Afterwards the knowledge and persuasion stages occur when the recipients learn about the innovation and are motivated to gather information about the innovation (Rogers, 2003).

Table 2.2. Comparison of Stages in the Innovation Decision Process.

Rogers (2003)	Pannell et al. (2006)	Barr & Cary (2000)
Prior conditions		
Knowledge	Awareness of the problem or opportunity	Anticipation of degradation
Persuasion	Nontrial evaluation	Seeking information, weighing the alternatives and risks
Decision	Trial evaluation	Making a decision,
Implementation	Adoption	Undertaking a trial,
Confirmation	Review and modification Nonadoption or dis-adoption	Making a change, Reaffirming the decision.

The Innovation Decision Process framework is described here because it helps to summarise the factors identified in previous sections. Few links have been made in the literature reviewed between the factors, yet many of the factors previously described influence each stage of the Innovation Decision Process. Table 2.3 lists the factors,

previously described, that relate to each stage of the Innovation Decision Process. Some factors are influential in more than one stage, such as attitude.

Table 2.3. Factors That Influence Stages of the Innovation Decision Process (adapted from Rogers, 2003).

Innovation Decision Process	Innovation	Extension	Farmer
Prior Conditions			Beliefs, values, attitudes & behaviour Education & experience Goals Farmer categorisation
Knowledge	Compatibility Complexity	Economic variables Extension All transfer factors	Attitude Goals Social communication
Persuasion	Relative advantage Compatibility Complexity Triability Observability	Neighbours & peers Opinion leaders	Attitude
Decision	Triability		
Implementation	Compatibility Complexity	Extension	
Confirmation		Extension	Social communication

The Innovation Decision Process developed by Rogers (2003) has five stages: knowledge, persuasion, decision, implementation and confirmation. It also accepts that the individual enters the decision making process with existing constraints and characteristics, called prior conditions.

Prior conditions relate to many of the factors, such as established beliefs, values and attitudes, associated with farmers and their goals. In order for the farmers to be receptive to the influential factors about an innovation, they must filter it through their established views of the world (Rogers, 2003).

The knowledge stage is about how the innovation is introduced to the farmer. There are three aspects to this introduction. The farmer becomes *aware* the innovation exists, aware of the *need* for it, and *recognises its potential* in his or her own situation. A

review of research based on statistical analysis, particularly associated with conservation tillage, found that awareness of soil erosion was either positively related or insignificantly related to adoption of soil conservation practices (Knowler & Bradshaw, 2007). However, according to Rogers' (2003) framework, there are several more stages to go through before adoption is considered. Even within this knowledge stage the farmer is required to recognise the need and potential for the innovation in his/her own circumstances. This initial stage may take a long time, particularly if the farmer has no interest in the type of innovation being offered or sees no need or relevance for it (Rogers, 2003). When the problem is unclear, such as when farm operations affect waterways off the farm, there is less awareness, therefore less interest in the innovation to address those problems (IPCC, 2000).

Persuasion in this process is distinct from the 'knowledge' stage because it is about creating an attitude towards the knowledge gained in stage one. The farmer seeks additional information and support through discussions (media, neighbours and peers, opinion leaders), analysis and reflection to reduce perceived risk about the new innovation before too much time, energy, cost and land are invested. A "*cue-to-action*" (Rogers, 2003, p. 176) can occur in the persuasion stage when something occurs for the farmer that triggers motivation to adopt the innovation.

The decision stage is when the farmer chooses either to adopt the innovation or reject it. Active rejection means that the innovation has been assessed but the decision is not to adopt, whereas passive rejection occurs by not considering the innovation in the first place. Adoption may be partial by establishing a small trial, or utilising just part of the innovation (Rogers, 2003).

Implementation is when an innovation is practically used. By contrast, the previous stages have been mental processes. Implementation can be an ongoing process where the farmer can modify the innovation to suit his or her own circumstances (Rogers, 2003). Rogers (2003) uses the term re-invention, whereas other authors refer to modifications. A number of authors have identified research that suggests that faster rates of adoption occur when an individual makes modifications to an innovation (Folke et al., 2002; Mercer, 2004; Rogers, 2003). Improved compatibility with the system into which it is being incorporated (Rogers, 2003), the information learnt, and

experimentation that occurs by each farmer (Folke et al., 2002; Mercer, 2004), have been linked to the faster rate of adoption after modifications. Rogers (2003) identified a number of reasons for modification of innovations. The most relevant to this review are modifications to simplify an innovation; modifications can occur when the innovation is a general package with a number of parts and different ways to use it. The innovation can be designed in this way to encourage modifications; pride can lead to cosmetic changes, to establish ownership of the innovation; and an extension agent may encourage changes to fit the circumstances of the user. Rogers (2003) acknowledges that some innovations will take time to implement and distinguishes the end of the implementation stage when the farmer accepts the innovation as a regular ongoing activity. Typically there are still questions and concerns about the innovation. The farmer continues to seek information and the extension agent can play an important role in supplying the expertise and advice needed.

The final confirmation stage emphasises the ongoing nature of the adoption process. Information and support seeking in the persuasion stage continues, although with a different perspective and emphasis because of increased experience and accumulated knowledge. If new information, another innovation, or lack of support for the innovation occurs, the innovation can be discontinued (Rogers, 2003). For example, for every two farmers who continued with conservation tillage in North East Victoria, Australia, one farmer discontinued. The dis-adoption was attributed to lack of ongoing support, and the need of farmers for an extension officer to respond to issues that emerged. Farmers had incorrectly concluded that their soil was unsuitable for conservation tillage after poor seedling emergence (Barr & Cary, 2000).

2.5 Summary

The objective in this literature review was to describe existing information that could be used to guide this research and establish the theoretical framework. The relevant theoretical and empirical points are listed below, with implications for how they could influence this research.

- The Innovation Decision Process, developed by Rogers (2003), is the most widely cited in the literature reviewed. This is limited by its focus on the individual,

therefore difficult to use to determine factors that influence the diffusion of an innovation across a population. However, it does describe stages in the Innovation Decision Process a population or an individual is at, which are likely to be helpful.

- The frameworks that categorise factors, which influence adoption (Guerin, 1999; Pannell et al., 2006; Smithers & Furman, 2003; Wejnert, 2002), provide some clarity to a wide range of diverse factors. This type of categorisation could help to organise and show links between factors and across categories.
- Understanding the mix of factors influencing the adoption of innovations is complex because the mix constantly changes. Each farmer can be at a different stage in the Innovation Decision Process for a range of innovations s/he is considering. Each farmer will have his/her own set of stages they are at for the innovation being considered. They will also have their own mix of factors, which change over time influencing their decisions. Despite this variability between farmers, and for each farmer over time, generalisations are made across a population on factors that influence the adoption of an innovation.
- Factors associated to environmental innovations have been identified as slowing the rate of adoption. Many of these factors are also relevant to farm plans and could slow their adoption.
- Five key factors associated to innovations are highlighted by Rogers (2003) as important influences on the rate of adoption, therefore expected to be influential on the rate of adoption of farm plans. These are relative advantage, compatibility, complexity, trialability and observability.
- Of the factors associated to the extension process in this review, opinion leaders, extension agents and incentives are described as potentially strong influences on adoption. Extension agent credibility was highlighted as an important attribute to build to influence adoption of an innovation from farmers. Although peers and neighbours, partnerships between farmers and the local and national government, research and development, policy and incentives could also present important influences on adoption of farm plans.
- Some factors associated to the farm and farmer were clearly linked to adoption of an innovation. It is important for farmers to perceive the innovation as supportive of their goals for adoption to occur. Similarly, if a farmers beliefs, values and attitude support the innovation adoption is more likely to occur. The influence of

age and education were less clear but the more experience a farmer had gathering information about the innovation, the more likely an appropriate decision can be made. Economic variables, including farm size and financial security can also be a strong influence on adoption.

The categorisation of factors into three areas - the innovation, the farmer and farm characteristics and the extension used to promote and support adoption of an innovation - has proven to be a valuable structure. It has assisted the organisation and understanding of the diversity of factors found in the literature, which influence the adoption of an innovation. The individual factors that can influence the adoption of innovations identified in the literature were used as the basis of enquiry for interviews in this research. The three categories then provided a structure to manage the diverse range of factors that emerge from the interviews. This same structure then guides the presentation of results and discussion.

Chapter 3

Methodology

3.1 Introduction

In this chapter the research approach used to answer the research question, and achieve the objectives identified in Chapter One is described. In section 3.2 the case study methodology used for this research is described. In Section 3.3 the case selection process is explained and the selected case is introduced. The subcases and key informants are then described in Section 3.4. In sections 3.5 and 3.6 the data collection and the data analysis techniques are described. The ethical considerations are included in the final section.

Two stages were used in the research approach: one to select the case and the second stage to investigate the case selected and answer the research question. In stage one a review of historical farm plans identified that farm plans similar to Whole Farm Business Plans (WFBP) were used in the Wairarapa. Wairarapa was selected as the case area to examine the phenomena of adoption of farm plans. Interviews with key informants helped to determine the two catchment areas in the Wairarapa where the interviews were carried out for the second stage of the research. Interviews with farmers from the two catchments contributed to two subcases and were expected to have different factors influencing adoption of farm plans. Qualitative analysis of the data collected determined the two subcases selected had similar results and were then combined in the results chapter.

3.2 Research design

A case study methodology was chosen to answer the research question, “What factors influence the adoption by farmers of whole farm plans, and why are these factors influential?”

The objectives to attain answers to the research question are:

- Identify farm plans that best match the Whole Farm Plans currently being implemented by Horizons Regional Council.
- Identify and describe factors influencing adoption of farm plans by farmers.

For the following reasons, a case study methodology is chosen as the research strategy. The research is being used to answer a 'what' and 'why' question, the researcher has no control over the data collection environment and the research is focussed on contemporary events. Context was identified in the literature to be an important influence on adoption of innovations (Pannell et al., 2006; Wejnert, 2002), therefore important to incorporate into the research strategy.

Three main criteria are identified by Yin (1994) to determine an appropriate research strategy. The first three columns in Table 3.1 itemise the three criteria against different research strategy. The criteria include the: type of research question, to what degree the researcher has control over the research subject, and the focus of the research on historical or contemporary events. Although Yin (1994) uses a range of questions, they are essentially three types, what, why and how. To answer a 'why' question, 'what' questions must also be answered. Blaikie (1993) describes that 'what' questions explore and describe phenomenon, 'why' questions aim to explain the phenomenon and 'how' questions explore practical outcomes. The 'what' and 'why' question for this study focused on a contemporary event, the adoption of farm plans, and hence all strategies identified by Yin (1994) except a case study are eliminated. In addition, a degree of control over the research subjects is not required for this study.

A number of researchers have identified the importance of context in relation to the adoption of an innovation (Pannell et al., 2006; Wejnert, 2002). The context in which factors influence the adoption of farm plans is a critical component of the research, and a case study is an approach in which this can be incorporated (Dey, 1993), in comparison to other methodologies like experiments and surveys, which isolate factors from the context (Table 3.1). A case study provides a means to differentiate the context from the factors being investigated by methods of data collection and analysis, without negating consideration of the case as a whole entity with all its interactions and complexities (Yin, 1994).

Table 3.1. Relevant Situations for Different Research Strategies (Adapted from Yin, 1994; Dey, 1993).

Strategy	Form of research question	Requires control over behavioural events?	Focuses on contemporary events?	Considers or isolates factors from the context
Experiment	How, why	Yes	Yes	Isolates
Survey	What	No	Yes	Isolates
Archival analysis	What	No	Yes/no	Isolates
History	How, why	No	No	Isolates
Case study	How, why	No	Yes	Considers

A case study can focus on a single case or multiple cases (Yin, 1994). The single case will reduce the potential number of variables compared with multiple-cases. Multiple cases would allow cross-case analysis and provide a broader range of phenomena (Yin, 2003). For this research two subcases were selected from within the case, because of potential differences that could provide greater detail in the results and a broader range of phenomena.

The United States General Accounting Office (1990) and Yin (1994) suggest increasing the number of cases analysed can result in less in-depth analysis than that provided by a single case. However, the depth of analysis would be more dependant the research approach and methodology. A significant limiting factor with single case selection is the appropriateness of the case to answer the research question (U.S. General Accounting Office, 1990). It is important to select the case with care, identifying particular criteria that are directed to answering the question.

3.3 Case selection

The aim in case selection is to find the richest source of data that will inform the research question (Flyvbjerg & Sampson, 2001). It is not necessarily the typical or the average case, but the one with a lot of information that is likely to reveal deeper explanations of the issues. A random sample rarely offers these deep insights, whereas carefully chosen cases selected for their validity to the research question have this potential (Flyvbjerg & Sampson, 2001). The consequence of this ‘purposeful’

approach to selection is that the results cannot be transferred to other populations, but the results are compared to literature (Patton, 1987).

The case selection formed the first stage of this research and addresses the first objective. The purpose of the case selection is to choose a sample that will provide theoretically important characteristics that inform the research question (Patton, 1987). Farm plans implemented historically in the Horizons region were reviewed to find examples similar to the WFBPs. The use of farm plans with similar content to WFBPs, are important attributes of the farm plans selected. In the literature both factors related to the innovation (Rogers, 2003) and context (Wejnert, 2002) are highlighted as influential regarding adoption. The review of historical farm plans in the Horizons region included an additional report to this research for Horizons Regional Council. This is included in Appendix 1. The purpose in the report was to formulate a categorisation system of criteria from historical farm plans that would be useful to the WFBPs being developed currently.

Investigation of historical farm plan documentation and information gained in interviews with key informants (Patton, 1987) assisted the identification of farm plans with a similar content to WFBPs. Key informants were selected with assistance from present staff at the central Palmerston North Horizons office. The five key informants interviewed each came from different areas now part of the Horizons region¹¹. Each key informant worked for Catchment Boards and or Horizons as field staff delivering and supporting farmers with farm plans and farm plan implementation. The data collection for this stage of the research was carried out during June and July of 2006.

Primary data for identification of farm plans were collected through semistructured interviews with the key informants using a list of general topics based on the content of the WFBPs, the literature reviewed and discussions with present Horizons staff (See Appendix 2). The historical farm plan documentation was identified and reviewed for the different Catchment Boards and Horizons Regional Council, with support from the key informants interviewed, the head archivist at the Horizons office and supplemented by discussions with staff from Horizons. The content of each document was detailed and referenced, with particular note of data similar to that contained in WFBPs.

¹¹ Horizons region refers to the area for which the Horizons Regional Council is responsible. This includes Rangitikei region, Wanganui region, Manawatu region, and part of the Wairarapa.

The content of Whole Farm Business Plans that is most similar to historical farm plans were identified as follows:

- Data that are consistent over time, that is data about soil, slope and rock type.
- Land Resource Inventory (LRI) (This contains the data that are consistent over time).
- Land Use Capability (LUC) (If this is completed to a high standard the information is useful for the development of ongoing farm plan reviews).
- Technically well done LRI and LUC. This is a difficult aspect to determine, however large LUC units for a farm map often means that national rather than farm level data have been used. Ongoing analysis of technically accurate data results in more accurate practical on farm applications and this will lead to greater potential success for farm conservation.
- Accurately drawn paddock maps (although these change as management change over the years, but they are useful to locate areas of the farm).

3.3.1 Criteria for case selection

As pointed out above, factors related to the innovation and the context are important to consider in selection of the case. The criterion from which the case is selected is based on farm plans having similar content to WFBPs, as listed above. In addition, as for WFBPs, the historical farm plans should have had the whole farm considered in their design, the purpose of the farm plans are similar, and over the time the farm plans have been available the content identified for WFBPs will have been used consistently for each farm plan produced. The context is also important therefore the farm plans selected should be produced for hill country farms with erosion-prone land, be primarily developed and delivered by a regional council or similar entity and adopted voluntarily by farmers.

Based on these criteria, the Wairarapa Catchment Board (WCB) farm plans were selected. The plans carried out in this area are thoroughly documented with LRI, LUC and aerial maps in almost every plan. After each revision of a farm plan, the aerial map was redone and the farm situation thoroughly reviewed. Part of what was the WCB area is now under the authority of Horizons Regional Council which is the reason for these historical farm plans being examined. Most of the WCB

administrative area is now under the authority of the Greater Wellington Regional Council (GWRC) and hence became the focus of this study.

Further discussions with a Land Management Officer (LMO) at the GWRC, identified characteristics of the GWRC and the farm plans they deliver, which confirm that they carry out a similar approach to Horizons Regional Council for their WFBPs. The GWRC staff develops the farm plan document, with some input from the farmer involved. Uptake of farm plans by farmers is voluntary. The GWRC develop farm plans with similar detail and consistency as were carried out historically. Farmer interests are central to the recommendations proposed in the farm plan. Farm plans primarily address hill country erosion and practical farm plan works for soil conservation have strong similarities to those recommended in WFBPs.

Further criteria that confirmed the location of the case as an appropriate selection are that farms in the Wairarapa have hill country on which erosion remains an issue. In addition, the Wairarapa is a relatively easy travelling distance for the researcher from the university.

3.4 Site Selection and Sampling Procedure

In this first stage of the research, after identifying the farm plans in the Wairarapa were most similar to WFBPs and fulfilled criteria for the case selection, the Wairarapa was selected as the case area. Interviews with two LMOs at the Wairarapa office of the GWRC helped to identify farmers to interview and provided data for the main research question.

The interviews with the two LMOs and four farmers identified by the LMOs highlighted the Whareama catchment as including a group of farmers with a high level of adoption of farm plans and a long history of use from having a catchment scheme in place since 1957. Two of the farmer interviewees resided in the Whareama Catchment and became part of the farmers in the subcase selected.

The selection of the Whareama catchment, as the first subcase, provided a basis for selection of the second subcase. The research was limited to two subcases because of the time constraints to carry out the interviews and analysis. With assistance from the LMO at the Wairarapa office of the GWRC, the Whangachu catchment was chosen.

The Whangaehu catchment was chosen to compare and contrast factors that influence adoption of farm plans with the Whareama catchment. The key difference between the catchments is that the Whareama has a catchment scheme, whereas the Whangaehu does not. The catchment scheme was assumed to stimulate a high level of implementation of farm plan works, compared to farmers who are not part of a catchment scheme. There is a high level of adoption of farm plans across the Wairarapa, but the level of implementation for each farm is less clear.

The identities of all farmers in each catchment were obtained from the LMOs, and those farmers were telephoned to request an interview. Three declined to be interviewed and five could not be contacted. Twelve out of fifteen farmers were interviewed in the Whareama subcase and nine out of eleven contacted were interviewed in the Whangaehu. The sampling of as many farmers as possible in the two subcases was aimed at obtaining a cross-section of farmers with varying views and levels of adoption of farm plans.

3.5 Data Collection

Data collection from one to one interviews with farmers within the two subcase areas were carried out between October 2006 and August 2007. In addition to these interviews data from those carried out with key informants in the subcase selection process were also used. The use of interviews is supported by Yin (1994), who states that they are one of the most important sources of information in a case study. All interviews had detailed notes taken and most were supported by tape recording. The interviews were semistructured and allowed opportunities for additional information to enter the discussion (Thomas, 2003). A checklist was formulated based on the literature reviewed and guided open questions. Additional types of questions were added to support data collected using the checklist items when an interviewee introduced a new idea that was relevant to the research question. The checklist items that were investigated included:

- Awareness of farm plan programmes.
- Description of farm plan programmes.
- The roles participants played in the farm plan programmes.
- The relationships between participants.

- Factors that historically and currently, on-farm and off-farm have influenced their use of farm plans.
- Goals and issues.
- Compatibility of farm plan works implementation with the present farming system.
- Farmer and farm characteristics.

Each interview took place at the interviewee's residence or place of work to ensure a relaxed atmosphere. The tapes were checked within a day of the interview to ensure that the data were recorded. Within a week the interviews were thoroughly reviewed, summarised and additional notes were taken, and some categorisation of information was carried out.

3.6 Data Analysis

Qualitative data analysis was used to determine factors that have influenced the adoption of farm plans in the two catchments from the data collected. Dey (1993) described a qualitative analysis process that includes describing, classifying and connecting the data to produce an account. Describing is identifying the concepts in the data and forming unambiguous statements that define and capture the meaning of the concept. One interview was chosen that provided a rich description of matters related to farm plan use. This was transcribed and used as a basis for analysis of other interviews. Some initial concepts were drawn from the transcription using the literature review as a guide for the type of concepts to look for. Often a concept was formed similar to that found in the literature but was reworded to better represent the data. Further interviews were transcribed continuing to identify the concepts identified in the first interview and adding new ones. Previous interviews were reviewed to see if the new concept occurred there too. A transcription was carried out for each interview but with progressively less detail included.

It was expected that the data from the Whareama and the Whangaehu catchments would be compared and contrasted. Each catchment was analysed separately using the describing stage of the analysis process, however there was very little difference in the concepts. For this reason the results were combined.

Classifying is placing the descriptions into groups and then connecting them (Dey 1993). Classifying was used to define the concepts drawn from the data in the describing stage. The words were carefully chosen to define the concepts, and terms used in the literature were considered. A term from the literature was used when it accurately reflected the data collected. The resulting definitions placed a boundary around the original concept and distinguished what was being referred to. An unambiguous accurate definition makes it easier to allocate data to the appropriate definition (Dey, 1993). For this research, in line with the research objectives, the definitions were called factors.

The factors were categorised and placed into a hierarchy to help determine the links and mechanisms that influence each. Each factor in the hierarchy was identified as contributing to the factors linked above it. Many links were identified between categorised factors, however it was important to reflect the data collected in the most informative way to answer the research question. The framework developed is such that the presentation of data in the results can be written up in a logical manner.

The connecting stage of the data analysis process requires the analyst to explain or determine cause and effect relationships between the categories (Dey, 1993). In this research explanatory relationships were used primarily to determine why something happens (Dey, 2003). For example, availability of subsidies influenced the level of uptake of farm plan works. Sometimes the explanations may support research in the literature and sometimes the literature does not have similar explanations. This is an iterative process so the describing, classifying and connecting steps in Dey's (1993) process were carried out a number of times until the categories and factors clearly represented the data and contributed to answering the research question.

3.7 Ethical considerations

A Low Risk Notification for ethical approval was submitted on June 2, 2006 to the Massey University Human Ethics Committee. A letter was received to acknowledge receipt of the notification and its entry onto the database and approval the research could go ahead.

Each interviewee was phoned to request his participation in an interview for this research. The purpose of the study and the objectives of the interview were briefly explained, and the amount of time the interview was expected to take. An open manner was put across by which recipients of the telephone call could feel free to decline. On arrival at the interviews a letter was presented that explained the research, provided contacts and outlined the interviewee's involvement and rights (See Appendix 3). This often stimulated questions that were generously responded to in order to ensure the participant was comfortable to begin the interview. The analyst emphasised the participant's freedom to decline any aspect of the interview. The participants remain anonymous in the presentation of the results, however as explained in the introductory letter, their association to the catchments could identify them.

3.8 Summary

A single case study was used to inform the research question. The case consisted of hill country farms vulnerable to erosion in the Wairarapa. Within the site is the phenomenon of adoption of farm plans. A primary reason for this case selection was because historical farm plans carried out in this region were most similar to Whole Farm Business Plans, and a similar approach continues in the region currently. Within this case, two subcases were selected: the Whareama catchment north of Tinui and the Whangaehu catchment. The Whareama catchment was expected to have a high level of adoption because of a long established catchment scheme, but the Whangaehu catchment has no scheme.

Data collection was undertaken using semistructured interviews in cognisance of ethical issues. For analysis of data collected an iterative process of describing, analysing and classifying, as described by Dey (1993) was used, from which was developed a framework of categories. Comparisons between the categories in the framework and the literature reviewed enabled conclusions to be drawn. Conclusions from the data analysis informed the research question, and contributed to implications for the Horizons region and possibilities for future research.

Chapter 4

Case Description

4.1 Introduction

Descriptions of the Wairarapa, the Whareama catchment and the Whangaehu catchment are presented in this chapter, along with a description of farm plans and catchment schemes. Each description illustrates characteristics that contribute to understanding the context within which farmers make decisions on the adoption of farm plans and farm plan works. Section 4.2 describes farm plans and catchment schemes. Sections 4.3 to 4.5 describe the Wairarapa and the two catchments respectively. First the locations of the Wairarapa and the two catchments are presented.

The Wairarapa is part of the Greater Wellington Region, and is located on the east side of the lower North Island of New Zealand. The two catchments are located at the northern end of the Wairarapa in the Masterton District (See Map 4.1).



Map 4.1. Location of Whareama and Whangaehu catchments and the Districts Comprised in the Greater Wellington Region.

Source: Adapted from Statistics New Zealand, (2008).

The Whangaehu catchment begins approximately after a fourteen kilometre drive north of Masterton, and follows the Whangaehu Valley Road. The Whangaehu River flows down the valley and joins the Ruamahanga River, one of the major rivers of the Wairarapa, just to the east of Masterton city. The Whareama catchment is further northeast of Masterton than the Whangaehu, and the farmers contacted for interviewing were in one part of the Whareama catchment, north of Tinui township. The Whareama River flows south and enters the Pacific Ocean north of Riversdale.

4.2 Farm plans

The specific objectives of farm plans vary but are all directed at achieving long-term sustainable land use. Farm plans are the primary tool for soil conservation and include measures to protect soils from erosion and degradation, retain soil productivity and reduce flood risks (GWRC, 2006). The Greater Wellington Regional Council (GWRC) offers conservation plans, sustainability plans, shelter plans and riparian management plans. Shelter plans and riparian management plans are focussed specifically on the objectives of shelter and riparian management in comparison to the whole farm in the conservation and sustainability plans. In this research the term farm plans refers to sustainability and conservation farm plans.

Farm plan works are the practical applications contained in farm plans, which farmers implement to address soil conservation issues. Farm plan works are selected for each farm plan after an analysis of the physical resources of the farm has been completed. There is a wide range of different types of farm plan works that can be selected. However, a similar range of farm plan works is utilised for all types of whole farm plans: sustainability plans, conservation plans, and the Whole Farm Business Plans (WFBP) used in the Horizons Region.

The sustainability plans are the most comprehensive plans offered to farmers, and are the most similar to WFBP. The level of detail included in the resource inventory is in both plans. Conservation plans are the most common farm plans used in the Wairarapa and contain a resource inventory, but without the same level of detail as sustainability plans.

The GWRC largely pay for the production of each farm plan document. Farmers pay for farm plan works implemented and are supported by subsidies offered by the GWRC. Conservation plans cost the GWRC \$2500 each with no cost to the farmer. The sustainability plans costs \$6000, of which the farmer incurs \$500. Subsidies for farm plan works range between 35 to 40% of the material costs.

The adoption of farm plans in the Wairarapa is high. Since the mid 1950s, the total number of farm plans developed in the Wairarapa is 500. An additional 40 farms that could potentially have a farm plan do not. In the Greater Wellington region the focus of farm plan development is in the Wairarapa, with only 25 farms outside Wairarapa being candidates for farm plans. Currently 293 farmers, out of the 500 with farm plans, are engaged in ongoing farm plan works implementation. Each year approximately 150 farms have farm plan works implemented. Although 293 farmers are engaged in ongoing farm plan works, in some years works implementation on farms is limited by the available resources that can be allocated by the GWRC and the farmer.

The development of a farm plan is based on the following stages:

- 1 A tour of the farm by the farmer and a LMO¹² to discuss what the environmental issues are on the farm.
- 2 An analysis of the physical characteristics of the farm by a LMO or some one contracted by the GWRC.
- 3 A review of the farm analysis by the farmer with the LMO to ensure its accuracy.
- 4 A five-year works programme on what to implement from the farm analysis is developed by the LMO in discussion with the farmer.
- 5 A LMO compiles the information into a written document, which is the farm plan.

A farm plan includes the following information:

- General description of the farm.
- Farm production outline.

¹² Land Management Officers (LMO) are staff from the Greater Wellington Regional Council who liaise with farmers with regard to soil conservation matters including farm plans.

- Forecasted estimates of production costs and benefits.
- Land Resource Inventory (LRI) (Water and Soils Division, MOWD, 1979)
- Land Use Capability (LUC) (Water and Soils Division, MOWD, 1979)
- Maps
- Works action plan that outlines the practical applications for the farm. These are planned for the next one-to-five years.

All farms considered for a farm plan are erodible hill country or steep land farms. Hill country refers to land with 21° to 25° slopes and steep land has 26° to 35° slopes. A farmer with a property with a high component of highly erodible land that includes Class 6, 7 and 8, would be recommended to have a farm plan. The sustainability plan is designed specifically for high risk erosion-prone land.

LMOs from the Horizons Regional Council and the GWRC indicated that the accuracy and efficiency of producing farm plans has improved and enabled more accurate recommendations by the LMO. The use of computers and particularly GIS programmes has contributed to these changes. Historically, farm plans were hand drawn on transparencies over photographs and took a great deal of time.

The objective of farm plan use in the Wairarapa is soil conservation. Additional activities on farms, not included in a farm plan, have also contributed to this objective. Better grazing and management has brought about stronger pastures that are more resistant to soil movement, therefore also contribute to the success of farm plan works. Possum eradication from the catchments has increased the level of success in establishment of trees. One farmer stated, *“In the seventies we ended up with 10% success rate; now you'll have a 20% death rate [of planted poles].”*

4.2.1 Catchment Control Schemes

The role of Catchment Control Schemes (CCS), administered by the GWRC, is described in this section. There are six Catchment Control Schemes administered by the Wairarapa office of the GWRC: Whakataki, Whareama, Homewood, Maungaraki, Awhea-Opouawa and Kaiwhata. The first CCS began in the Whareama catchment in 1957 and Kaiwhata was the last to begin, in 1981 (Cameron, 2007). The focus of

CCSs is on river management, which includes mitigation of flooding and soil erosion into the river. Farm plans for individual farmers in the catchment are an integral component of the CCS.

CCSs are set up when severe flood damage to local infrastructure such as roads, bridges and dwellings affects a community. The advantage of having a CCS, rather than just individual farm plans, is the additional support structures set up with the help of the GWRC. The initiation of a CCS occurs when a group, not an individual, contacts the GWRC for assistance. A Scheme Advisory Committee is set up and is usually an elected body, but for smaller schemes this may not be the case (Cameron, 2007). The members are usually rate payers in the community and at least one member from the GWRC usually attends meetings. The committee decide what works and maintenance of works are to be put in place, and the level of rates for the CCS.

Additional finance to support works in a CCS is available from rates specifically linked to the scheme, GWRC and the district councils. The rates set by the Scheme Advisory Committee are additional to the standard rates requested by the GWRC. The GWRC matches the amount provided by these additional rates from the community. Funding is also available from the district council when works support their areas of concern such as roading and bridges (Cameron, 2007). Additional financial incentives to farm plan works in an individual farm plan, are been given to farmers to implement farm plan works contained in a CCS.

4.3 Wairarapa case description

The organisation delivering farm plans to farmers in the Wairarapa is the GWRC. Information is often available for the Greater Wellington region and not Wairarapa on its own, although the hill country farms vulnerable to erosion, focussed on in this research, are predominantly situated in the Wairarapa. Information from the Wairarapa or the Greater Wellington region will be distinguished throughout this description.

The Wairarapa consists of three districts: Masterton, Carterton and South Wairarapa (See Map 4.1). The two catchments where interviews with farmers took place are located in the Masterton District. Agriculture is a significant contributor to the

Wairarapa with 23% employed in agriculture, forestry or fishing (Schrader, 2007). In 2002, 77% of sheep and cattle farms¹³ (853 farms) in the Greater Wellington region were located in Wairarapa (Statistics New Zealand, 2002).

Erosion is a significant feature of many hill country farms in the Wairarapa. The erosion in the area is a result of several factors including; “regional structure [the varying depths and type of layers of rock across the landscape], tectonism, lithology [bedrock and regolith properties, including depth of bedrock], soil properties, slope characteristics [angle, shape, aspect], vegetation cover and climatic conditions” (Noble, 1985, p.12). Geology for the Wairarapa is complex; the lithology includes sandstones, siltstones, mudstone and limestone that make up the majority of hill country and the erodible land (Noble, 1985). The GWRC recognise 140,000 hectares of erosion-prone land in the Greater Wellington region that need to be improved (GWRC, 2005). Planting woody vegetation with support from the GWRC is the most common strategy used by landowners in the region to manage the erosion. Woody vegetation has a deep root system and is expected to hold the soil “longer” than grass (GWRC, 2005, p.51).

The general climatic conditions for the Wairarapa include strong westerly winds that constantly dry out pastures and slow production. Summers are hot and dry and can exceed 32 degrees celcius. Droughts can occur most years (Noble, 1985). In winter, it is cold and wet and can drop to as low as minus nine degrees celcius, with snowfall on hill country above 450m a.s.l. The average rainfall for the eastern coastal hill country is 1000mm to 1400mm. The range of annual rainfall is 800mm in the Wairarapa Valley to 2000mm in the central ranges (Noble, 1985).

Cameron (2004) completed a survey on soil intactness in the Greater Wellington region, which included the extent of soil conservation measures and disturbed soil. This survey contributed to the Greater Wellington region, State of the Environment (SOE) report (GWRC, 2005). In the report, all land use in the Greater Wellington region was divided into seven categories. The drystock farming category is likely to

¹³ Number of farms is from the addition of farms designated ‘sheep beef cattle farming’, ‘sheep farming’, and ‘beef cattle farming’ for the districts in the Wellington region, not including the small part of the Tararua region that is largely under the authority of Horizons Regional Council. This is assumed to include the majority of farms that are candidates for farm plans.

include the majority of hill country farms referred to in this research. Drystock farming occupies 46.4% of land use in the Greater Wellington region (See Figure 4.1), most of which is situated in the Wairarapa. Twenty three percent of this land is classified as unstable in 2004, this means that the land has either eroded in the past two years or eroded prior to that and is revegetating. Of this unstable land (87,000 hectares), 43.7% (38,000 hectares) is open pasture and requires erosion management; 13.8% is in pasture with soil conservation plantings and the remaining 42.5% is pasture with native tree and scrub cover (Cameron, 2004) (See Figure 4.1).

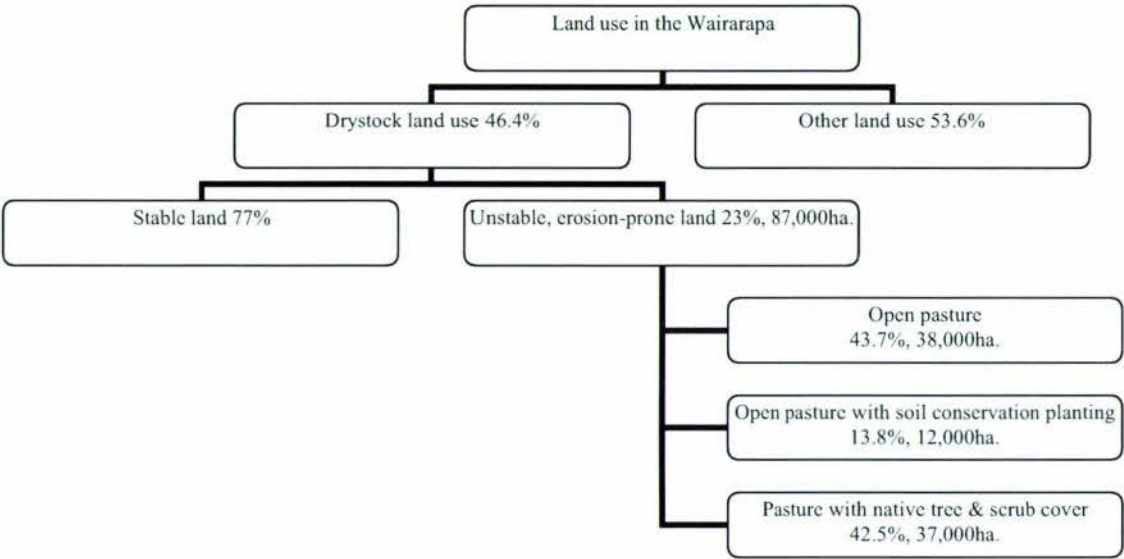


Figure 4.1. Erosion-prone Land Used for Drystock in the Wellington Region.
(Data from Cameron, 2004)

4.3.1 History of soil conservation and farm plan development

There has been a long history of farm plan use in the Wairarapa. The Wairarapa Catchment Board (WCB) followed by the GWRC has delivered farm plans in the Wairarapa for over 50 years. The two organisations, WCB and GWRC, are associated with two distinct eras in soil conservation in the Wairarapa and in New Zealand.

The first era of soil conservation is identified by the development of the Soil Conservation and River Control Act 1941 (SCRC) and the WCB. All the catchment boards in New Zealand were formed after the Act was passed into law (Newnham, 1948). It took ten years before farmers saw any impact associated with the Act at the

farm level. At this time the catchment boards enacted the SCRC Act under supervision and control of the SCRC Council (Hogg, 1972). The Act incorporated many approaches to address soil erosion, including analysis of erosion, research, education and assistance to farmers (SCRC Act, 1941, Section 11).

The government's SCRC Council, through the WCB, allocated substantial subsidies to farm plan works. From 1957 to 1968, the Whareama Catchment Control Scheme (CCS), of which farm plans were a substantial part, received 75% of the material costs from the government. This amount was reduced slightly after 1968 to 70% as the programme progressed (Brown, Copeland & Co. Ltd., 1985). The government and farmer shared costs from 1:1 and up to a 3:1 for farm plan works in a CCS. Prior to 1989 when catchment boards operated, farm plans and CCSs were a mechanism to receive funding from government.

There has been ongoing development and improvement of farm plans from when they were first offered in the 1940s. Only a few were developed at the beginning of the era when several years were spent developing an analysis process of the farm resources to incorporate into a farm plan programme (McCaskill, 1973). By 1961 Wallace-Ramsay outlined a comprehensive farm plan process that included Land Resource Inventory and Land Use Capability analysis, along with a five-year works programme that was carried out by the Otago Catchment Board (Wallace-Ramsay, 1961; cited in Manderson, 2003). Only some Boards chose to continue with this level of detail and from the detail observed in historical farm plans, it is assumed this is what the WCB followed. Others followed Knowles' (1962; cited in Manderson, 2003) recommendations to streamline the process in order to work towards the SCRC Council targets, which aimed to complete farm plans for every farm with erosion. This streamlined approach limited the detail presented, and eliminated the LRI that is the only factual information that can be used with confidence today. Current situation regarding farm plan use.

The second era of soil conservation includes the establishment of regional councils that replaced catchment boards, and the Resource Management Act (RMA) (1991), which replaced the SCRC Act (1941). Under the RMA, regional councils are responsible for the management of natural and physical resources for their respective regions. The

GWRC Regional Policy Statement includes objectives to address sustainable management for the region (GWRC, 2005). The two objectives in the Regional Policy Statement relevant to soil conservation are:

- 1 Land degradation is limited to that for which there is not a feasible remedy.
- 2 The soils in the Wellington region maintain those desirable physical, chemical, and biological characteristics, which enable them to retain their life supporting capacity and to sustain plant growth (GWRC, 2005, p. 42).

The GWRC can use a regulatory approach but prefers to be proactive and rely on voluntary compliance.

The GWRC have consistently committed funds over many years to soil conservation programmes, and continue to do so. Just prior to this second era, in 1987, the government completely withdrew subsidies and responsibility was transferred to the regional councils (Clough & Hicks, 1993). After 1989, the regional councils had a choice where to allocate funding and whether to maintain farm planning and CCSs, or not. Many regional councils chose to abolish farm plans and allocate funding to sustainable land management in different ways (Blaschke & Ngapo, 2003). The GWRC chose to continue farm planning and CCSs, similar to what was traditionally carried out. Funding from the GWRC is relatively small for soil conservation programmes as compared to other, much larger, projects utilising ratepayers' money in the region (GWRC, 2006). The GWRC have allocated funds for 2006 to 2009 to plant the following each year: 22,000 poles on 300 hectares, 150 hectares of conservation woodlots and four kilometres of shelterbelts (GWRC, 2006). This level of planting will take over a 100 years to plant the erosion-prone land in the Greater Wellington region (GWRC, 2006).

The GWRC support a wide range of activities that contribute to soil conservation. They provide farmers with access to trees for conservation planting and contractors to carry out farm plan works. In addition to farm plans and CCSs, funds are allocated to groundwater hydrology, flood warning systems, consents, environmental awards, the Streams Alive programme for riparian planting projects and soil conservation reserve forests (GWRC, 2006). They are also involved with research agencies looking at the

effect of nitrogen fertiliser on hill country farms, and coordinate the Ballance Farm Environmental Awards and associated field days. Information and advice are available for riparian planting outside project areas, and for supporting environmental community groups.

LMOs are the GWRC field staff who deliver farm plans to farmers. They have direct contact with farmers to support farm plan development and implementation. They also participate in a range of activities throughout the region, in addition to the official commitments of their work identified above, which contribute to promotion and support of farm plan activities. These include local discussion groups, Farm Forestry Association and Meat and Wool NZ Monitor farm events. The key roles, as described in an advertisement for a new LMO, include management of farm plans and communication with staff, farmers and other community members to implement environmental development programmes.

Four LMOs service the Wairarapa with the delivery of farm plans and support to implement farm plan works. Two LMOs have worked in this role for a long period of time and are recognised for their expertise in farm planning and soil conservation. Although the LMOs are allocated geographic areas of responsibility, a number of farmers choose to maintain their relationship with the two senior LMOs. As a result of this, three of the LMOs had responsibilities in the subcase areas examined in this research.

4.4 The Whareama catchment description

The Whareama catchment has had a lot of attention from the Wairarapa Catchment Board and GWRC over the last 50 years. In the Whareama Catchment, serious flooding and erosion caused by geological and climatic factors motivated the establishment of one of New Zealand's first Catchment Control Schemes in 1957 (Hicks, 1991). Over the history of the Whareama Catchment Scheme a range of reports were completed that describe the erosion, flooding, the Catchment Scheme and a detailed history of the area (Brown, Copeland & Co. Ltd., 1985; WCB, 1986; Hicks, 1991; Wood, 2000). These reports provide a lot more detail about the Whareama compared to the other subcase, the Whangaehu catchment.

4.4.1 Farm and farmer characteristics

The characteristics of the farmers interviewed in the Whareama catchment are varied:

Personal characteristics

- Farmers range in age from their early thirties to their late fifties.
- The farming families include children ranging in age from toddlers under five years to adults in their twenties and thirties.

Farm ownership

- Farmers have resided in the Whareama for both long and short periods of time. One family arrived in the 1850s with the newest arrival in 2002.
- All farms are owner operators, except one with a manager and associated trustees.
- All farms have sheep and beef.
- Farm size ranges between 510 and 1750 hectares.

Farm management

- All farms have men as the main decision makers. Some have active participation and support from direct and extended families.
- Farmers' level of interest in political and community issues and research varies.
- All farmers have a history of farming. Some were brought up on the Whareama farm others have worked elsewhere and/or been university trained and then returned to the Whareama.
- The present farmers have been responsible for the farm management of their Whareama properties for between two and 20 years, with many following generations of one to three farming families.

Farm plans and soil conservation on farms

- Forestry blocks are scattered throughout the area. They have often been initiated from farm plan programmes. The forestry blocks range in size from one hectare to approximately 30 hectares, with some farms totalling up to 400ha. of forestry.
- Some farms have well established tree planting over a significant percentage of the erodible land, while other farmers are just beginning the process of tree planting.
- The area of land planted in trees across each farm varies from a few areas of planted trees, through to nearly all areas of erosion-prone land across a farm with trees.
- All farms have had a farm plan developed.

- Out of twelve farmers interviewed, there were nine active farm plans (planned works were being implemented), and three inactive farm plans (a farm plan works action plan had not been reviewed for ongoing implementation of works) at the time of the interviews.
- All farmers with an active farm plan and one farmer with an inactive farm plan are planting trees regularly each year, although one farmer has only just had a farm plan developed and another has virtually completed planting requirements to fulfil his farm plan. One of the farmers with an inactive farm plan has also virtually completed the tree planting outlined in his farm plan.

4.4.2 Factors affecting erosion

Erosion in the catchment is affected by regional structure, lithology, soil, slope, tectonism, climate and vegetation (Noble, 1985). The predominantly hilly landscape of the Whareama catchment has sandstone, mudstone or argillite as the underlying rock types (WCB, 1986). The lithology of relatively hard sandstone and argillite form slopes of steep rugged hills and harder sandstone forms outcrops and jagged peaks. Slips, slumps, earth flows severe gullyng are common types of erosion in the catchment, which cut through the soft underlying rock. Tectonic fault line crushing causes severe gullyng and slumping in some areas (WCB, 1986). Farmers noted that this catchment has predominantly mudstone (fertile but very prone to erosion) on the east side and argillite (less fertile and less prone to erosion compared to mudstone) on the west of the valley. According to farmers, the climate for the Whareama is dry in summer and wet in winter, as described for the Wairarapa. Vegetation for the catchment includes some blocks of native trees, but most of the area is in pasture or exotic woody vegetation. The areas in pasture vulnerable to erosion are the key areas focussed on in the farm plans.

4.4.3 Environmental issues

Farmers have been constantly re-evaluating how to address environmental issues since the first European settlers moved to the Whareama and cleared the bush for farming in the 1850s (WCB, 1986). Crack willows, *Salix fragilis*, were planted by the first farmers in the region to manage eroding river banks and proved to be a mistake. The willows quickly established, choked the rivers and consequently increased flooding in the area (WCB, 1986). This was only one of the many issues early farmers had to

learn how to manage. Other issues included decreasing soil fertility, rabbit infestations and the resultant poor grass growth that accentuated soil loss, along with additional soil loss after dry summers and rain storms (WCB, 1986).

Floods occurred every two to three years as a result of the blocked river course and by 1947 they became an annual event. Flood waters entered houses, blocked access to the area and destroyed fencing. Thousands of sheep were lost in the 1936 flood and 1400 hectares of the most productive land were unusable due to the risk of flooding. The Masterton to Homewood Road could be closed for three months due to erosion and slips onto the roads. A major crisis occurred when three large floods inundated the valley in 1956 (WCB, 1986).

4.4.4 Whareama catchment scheme

In 1957, after the serious floods of the previous year, the CCS was formed for the Whareama. The Wairarapa Catchment Board's soil conservation division and the local population both supported the ongoing maintenance of the CCS. The Wairarapa Catchment Board had carried out a detailed investigation to formulate the structure of the scheme. There was unanimous support for the scheme proposal from a public meeting. Because of this public support, endorsement of the scheme occurred by the SCRC Council in 1957 (WCB, 1986). Massive cutting and poisoning of the willows began in 1957. By 1966 the Whareama was clear to Tinui and since then maintenance of the willow control has continued (WCB, 1986).

The Whareama Catchment Scheme continues to have a nominated committee of farmers that meet every year to decide how to set the levy amount and how it is best spent. Key areas that have been concentrated on since the scheme began include the headwater areas, works in farm plans that support the scheme, clearing willows and maintenance (GWRC, 2000). Farm plans were integral to addressing both flood relief and soil erosion. They provided, and continue to provide, a process by which issues concerning private property can be addressed. Therefore since the scheme began in 1957, many of the land owners in the Whareama catchment were contacted by the WCB to have a farm plan developed. Whereas today the GWRC do not make the first contact with a farmer, but wait for farmers to request support.

Floods are still common and an accepted constraint for many farm systems in the Whareama catchment, but after 50 years of the Whareama Catchment Scheme, floods are less of an issue than they were in the past. In the past flood waters spread across pastures and took days and sometimes weeks before they flowed back into the river channel, whereas today the flood waters are back in the channel in less than 24 hours. Floods are more prevalent lower down in the catchment, but there is less concern due to less houses and woolsheds being damaged. However, fence damage from floods in lowland areas is still significant and one farmer has chosen to place his fences on an embankment to avoid them being continually “wiped out” by flood waters.

4.5 The Whangaehu catchment description

There are not a lot of data specific to the Whangaehu catchment, therefore most of the following description is based on comments from farmers interviewed. The Whangaehu catchment has no catchment control scheme.

4.5.1 Farmer characteristics

Several of the farmers are the third or fourth generation farming land in the Whangaehu catchment. The earliest arrival of the present farmers’ families was in 1919 and the latest arrived in 1968. All farming families in the Whangaehu have been in the valley for at least 39 years. Of the nine farmers interviewed in the Whangaehu, four farmers interviewed are from two families. They each acquired his own farm in the Whangaehu catchment, either by buying another farm or dividing the original farm into smaller blocks.

Characteristics of the farmers in the Whangaehu catchment are also variable similar to the farmers in the Whareama catchment. They include:

Personal characteristics

- Farmers range in age from their thirties to early sixties.
- Children of all ages are part of the families. One farmer had his first child due, while others have preschoolers and school age children. One farmer had his son working alongside, and another shared work with his son who has his own farm nearby.

Farm ownership

- All families are long term residents, ranging from 39 to 88 years.
- All farmers are owner operators.
- All farms have sheep and beef, and one farm lower down the catchment has flat land that includes cropping, and producing supplements for dairying.
- Farm sizes range from 459 to 1600 hectares.

Farm management

- All farms have men as the main decision maker. Some have active participation and support from direct, and extended families.
- Farmers' level of interest in political and community issues, and research varies from a high level of interest and regular participation in farming groups, to no participation in groups and a wish to concentrate on farming their own farms.
- The younger farmers have worked elsewhere and/or been university trained, and then come back to the Whangaehu. Generations of farming families in the catchment range from one to four.
- The minimum time a farmer has had responsibility for managing a farm in the Whangaehu is 16 years.

Farm plans and soil conservation

- Of the nine farms, five have some *Pinus radiata* plantings; one property has 100 hectares, another 40 hectares, and the remaining three farmers stated they had a few small blocks.
- The amount of tree planting across the farms was unclear, but all farmers talked of significant areas of trees. If they were not regularly planting trees at the time of the interviews they had carried out regular planting of blocks in the past.
- All farms have areas of land planted in exotic trees with still more areas needing erosion management.
- Only one farm has never had a farm plan, but this farmer is still planting 100 poplar and willow poles every year.
- Out of nine farmers interviewed, there are six active farm plans, and two plans being reviewed at the time of the interviews.
- Only two farmers are not planting trees routinely each year and one of those is having a plan redeveloped.

Masterton city is a short distance from the Whangaehu catchment and impacts the valley in a number of ways. There has been no additional housing, but a lot of farms have been merged when farmers have bought neighbouring properties and then sold off houses they did not need. A number of people live in these houses with small one-or two-hectare lifestyle blocks. The people in the lifestyle blocks were not interviewed. There are no subdivisions in the Whangaehu, but the next valley across towards Masterton, up Black Rock Road, is *“full of subdivisions”*.

4.5.2 Factors affecting erosion

The factors that influence the level of erosion in the Wairarapa and the Whareama catchment are similar for the Whangaehu catchment. Farmers' descriptions of erosion primarily related to the lithology and slope for the area. The land is generally fertile, which is related to the main rock type in the area, mudstone. There is a little underlying sandstone. Several farmers described areas of their properties with sandstone that are extremely vulnerable to erosion, and *“just takes off”* in a really heavy downpour. No official soil surveys were identified for the Whangaehu and only a few isolated surveys have been carried out in the Wairarapa region (Fenwick & Tangelder, 1983). The climate described by farmers is similar to that identified for the region with a dry summer and wet winter. There were a few blocks of native vegetation but land is mainly in pasture and conservation trees planted.

All farmers in the Whangaehu catchment have farms with highly erodible land. Some properties higher in the valley have all steep erosion-prone land. Further down the valley land forms are more rolling. One property has rolling hills and many steep gullies. All farmers have slip and slump types of erosion and some have earthflows. One property has approximately 250 hectares of flat land that is used to grow supplementary feed for dairying. This is zoned flood plain where the Whangaehu River gets closer to its junction to the Ruamahanga River. All farms drain into the Whangaehu River, with some farms also having parts of the farm draining into neighbouring rivers: the Tauweru River in the Bideford Valley on the east side, and the Kaiparoro River on the west side.

4.5.3 Environmental issues

The Whangaehu River has been choked with crack willow like that described for the Whareama. Flooding covers paddocks, enters woolsheds, and damages fences and tracks. Each farmer was working independently to manage the crack willows along the river on their properties. Some farmers have removed all the willows along the river. One farmer has eight kilometres of the Whangaehu River that run through his property, and has just begun to clear the crack willow. The river immediately above this farm has been cleared of crack willow and the water now arrives a more quickly, resulting in frequent flooding. Last year, floods occurred three times with water covering low-lying paddocks. Other farmers did not describe this level of flood waters. The river has been cleared from the bottom of this farm all the way to the Ruamahanga River.

Another farm has part of his property zoned as flood plain. Here flooding is expected and farm management strategies accommodate it. Flood warning systems are in place and they usually allow farmers enough time to shift stock. However, some farmers still get caught out and lose stock. The Castlepoint road was closed several times in 2006 due to flooding.

4.6 Summary

The majority of erosion-prone land, and hence the candidates for farm plans in the Greater Wellington region are in the Wairarapa. Farm planning has been the primary tool for soil conservation in the region since the 1940s. There have been two distinct soil conservation eras. In the first era, farm plans were utilised by the Wairarapa Catchment Board to comply with the Soil Conservation River Controls Act 1941. In the second era, the Greater Wellington Regional Council took over the WCB, and they now have the responsibility to comply with the Resource Management Act 1991. The GWRC and their LMO deliver farm plans to farmers in the region, support them in carrying them out, and contribute to a wide range of additional activities that support soil conservation.

Characteristics of farmers within the two catchments vary. For example, some farmers have been brought up on their farm and continue farming after previous generations. Other farmers have only recently purchased farms. Farms in the two catchments range in size from small to large. Each farmer is at varying stages of farm plan implementation across their farms. Farmers range in age from their 30s to their 60s. One key factor differentiates the two catchments. The Whareama catchment has had a catchment scheme operating since 1957, whereas the Whangaehu has never had a catchment scheme.

Chapter 5

Results

5.1 Introduction

In this chapter the factors that influence farmers’ decisions to adopt and implement a farm plan and farm plan works are presented. Factors were identified from analysis of interviews with farmers in the Whareama and Whangaehu catchments and with key informants.

Three major categories are used to present the factors that emerged (See Figure 5.1): the compatibility of farm plan works with the core farm business, farm and farmer characteristics, and the credibility of the organisation delivering the farm plans. The first category is focused on the farm plan innovation, while the second includes characteristics of the farmer and his farm. The third and final category includes factors specifically associated with the organisation delivering the farm plans, and in this case study it refers to the GWRC. There are many interrelationships between the factors in each category, and across categories, which will be identified throughout the results. In the next section, the general factors that influence the adoption of farm plans and farm plan works are described, followed by the description of the first category of factors: the compatibility of farm plan works with the core farm business.

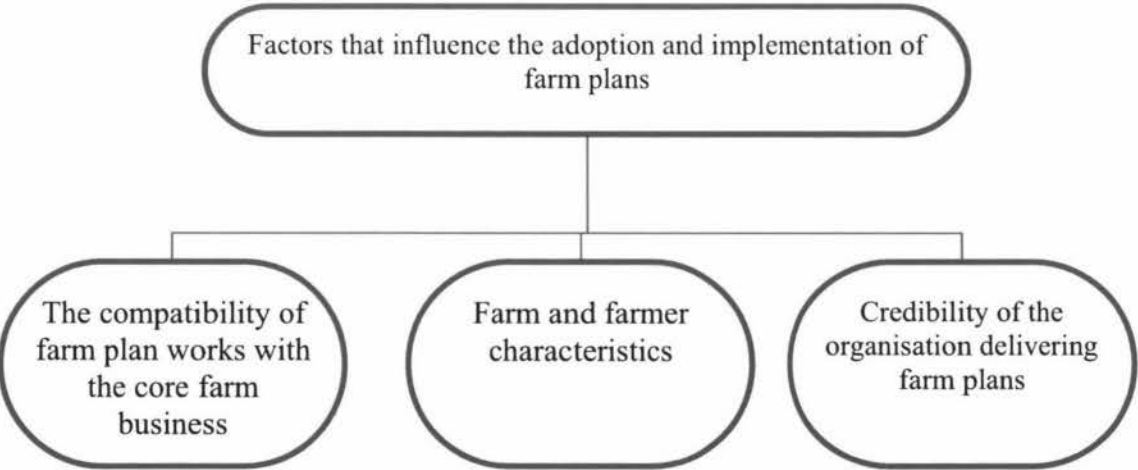


Figure 5.1. Categories of Factors That Influence the Adoption and Implementation of a Farm Plan.

Analyses of the data revealed similar results for the Whareama and the Whangaehu catchments. The use of farm plans and farm plan works by farmers varied across farms, but this variability was similar in both catchments. Even though only one catchment had a catchment scheme, the factors that emerged from the analysis were similar in both catchments. For this reason results from both catchments are combined.

5.2 Factors that influence the adoption of farm plans and farm plan works

The term adoption is used in this study as Rogers (2003) describes it with five stages. The five stages are part of the Innovation Decision Process (Rogers, 2003) and include: knowledge, persuasion, decision, implementation and confirmation. These terms are used recognising that all stages are ongoing, simultaneously. For example, if a farmer is in the confirmation stage of adoption, aspects of the previous stages still occur for the farmer, such as accumulating more knowledge about farm plan works.

The farmers' level of adoption of farm plans varied across those interviewed. Five different categories explain the level of adoption that existed amongst the farmers in the two catchments. These are distinguished by a combination of four aspects: whether a farmer has reached the implementation stage or not, the regularity of farm plan works implementation, the length of time a farmer and their family have operated the farm and implemented farm plan works, and the extent that farm plan works have been implemented across the farm.

The five categories of adoption are:

- 1 Farm plan is adopted and implementation of farm plan works nears completion. Two farmers interviewed said that they have virtually completed farm plan works implementation. Previous generations started regular implementation, and this has continued for more than fifty years. They are not planting at present, but have ongoing maintenance that includes replacing dead trees, attempting to plant some very difficult areas, renovating paddocks with mature trees, and pruning.
- 2 Farm plan is adopted with regular and irregular implementation of farm plan works. Fourteen of the farmers interviewed, the majority, are in this category and

have planted trees in most years. Two have planted sporadically over time, planting for several years then having a break for a number of years before planting again. The number of years that this group of farmers have carried out this level of planting was not stated. Some farms have had previous generations of the current family planting trees, and some farms are relatively newly purchased properties with little previous planting. The farmers identified many examples of installed farm plan works on their farms, and they did not specify a date that implementation would conclude. A couple of farmers suggested that their farm plan would not be completed within the time span they would be farming the property. The farmers in this category indicated a willingness to persevere with implementing the planned works.

- 3 Farm plan is adopted and implementation is in initial stages. Two farmers are just beginning their farm plan implementation. They have recently taken over management of the farm, have a farm plan and are committed to its completion.
- 4 Farm plan is developed but not adopted and some minimal implementation of typical farm plan works. Two farmers have had a farm plan developed for their farms, but rejected the proposal. One of these two farmers regularly plants trees on erodible land, the other does not but has carried out some activities in the past to address erosion, such as tree planting. The extent that farm plan works type of activities are completed for the management of erosion on these properties was unclear. However these farmers expressed much less urgency in the need to address erosion due to the fact that their farms have much lower levels of erosion on their properties compared to other properties in the catchments.
- 5 Farm plan is not developed but there is regular implementation of typical farm plan works. Only one farmer interviewed has never had a farm plan developed, yet plants trees regularly on erodible land. His family have operated the farm since the 1960s, previous generations have had a plan developed but the current owner has not had a review carried out and does not refer to previous plans. He foresees ongoing implementation into the future with no clear conclusion date, similar to farmers identified in category two.

These above categories highlight a high level of adoption of farm plan works and a high level of awareness. All farmers interviewed were aware of farm plan works and had considered what adoption would mean for their own circumstances. The wide

range of soil conservation and farm plan related information sources available in the Wairarapa, the amount of information, and the length of time that information has been available have all contributed to farmers' awareness of soil conservation and farm planning in the two catchments. Farmers interviewed described varying levels of involvement and interest in the sources of information. Some farmers used many sources of information and some used very few. Information, support and promotion of farm plans that farmers used, came from groups, organisations, events, neighbours, peers and written material.

Key individuals who promote and encourage the implementation of farm plans and tree planting are referred to as champions in these results. Some champions encouraged a large number of farmers across the region, whereas other champions affected a few farmers to whom they were close. Murray King from the GWRC district office and Jim Pottinger, a farmer, have promoted tree planting and farm plans across the region and are remembered for their passion for trees in the 1960s and 1970s. One farmer said that Murray King contacted all farmers in the Whangaehu catchment to encourage them to adopt a farm plan. Currently, two senior field staff from the district office are champions of soil conservation for farmers in the region. These two key identities are respected by farmers and well known for their knowledge and long history encouraging the use of farm plans. Parents, grandparents and previous employers have also inspired individual farmers to plant trees and sometimes to have a farm plan.

The first category of factors to be described is the compatibility of farm plan works with the core farm business.

5.3 The compatibility of farm plan works with the core farm business

There are a number of key components that make up a farm plan used by farmers in the Whareama and Whangaehu catchments. The farm plan is made up of the farm plan document and farm plan works action plan. The farm plan document includes the resource data for a farm and the farm plan works action plan. The farm plan works action plan includes the practical applications planned for the farm over one-to-five years. The extent of farm plan works, to be implemented within the action plan,

dictates whether a one year or a longer plan of farm plan works is developed. Some farmers' descriptions of farm plan works referred to culverts, debris dams and other engineering structures, but the dominant activity described was planting trees. This includes retired blocks, woodlots and spaced tree planting.

When farmers make decisions about farm plans they generally concentrate on the farm plan works, not the resource data found in the farm plan document. The farm plan document with the analysis of farm resources is used to select the farm plan works for the action plan. This analysis of farm resources may be referred to again for each review of the action plan, which may be carried out with field staff every one-to-five years. However, once farmers understand how to select farm plan works for specific conditions of their farm, there is little reference to the original document. For this reason, in this research it is important to separate the farm plan document from the farm plan works.

The farmers identified different uses for, and value in, the farm plan document. A few used the farm resource analysis as a general guide for allocating areas of the farm to different types of farm plan works. Some farmers found the resource data useful, but not for soil conservation purposes. For example, the newly revised plans that have more accurate paddock sizes were found useful for improving the accuracy of stock management and fertiliser application. A small number of farmers who have had a long relationship with the GWRC, although not valuing the resource data for themselves, acknowledged the farm plan documents' value for GWRC planning. They accepted the farm plan developed for them by the GWRC, even if they saw little value in it for themselves. Some farmers saw no value in the farm plan document and often did not know where to find it at the time of the interview. Of these farmers, many obtained a farm plan simply to get a subsidy. They intended implementing farm plan works and the subsidy assists the level of implementation.

Farm plan works are placed in a one-to-five year plan. The reviews of these action plans and the extent to which the field staff are involved vary for each farmer. The field staff are the primary developers of each farm plan document, with input from the farmer. After the initial development of the farm plan, the field staff member is involved to varying degrees with individual farmers. After the one-to-five year action

plan has been carried out, the farmer can choose to have a new set of farm plan farm plan works prepared for the subsequent one-to-five years. Although the GWRC uses a one-to-five year time frame for a farm plan works action plan, the review of the plan is voluntary. Farmers vary in the extent to which they follow the scheduled action plan. A few farmers are planting trees without a farm plan, and without involvement of the GWRC. For farmers who have adopted a farm plan, there are a number of reasons that change the one-to-five year time frame for a review of farm plan works. A farmer may choose to delay the review of a new action plan, or s/he may choose his/her own action plan without negotiation with the GWRC at the scheduled time. Damage on a farm from a storm event may demand the development of a different action plan sooner than the scheduled review.

Implementation of farm plan works takes a secondary priority to activities considered by farmers as core to the farm business. Activities included as farm plan works are not considered by many farmers interviewed to be essential to the operation of the farm business and hence to their farm business goals. Some farmers accepted a significant level of erosion: "The farm could have an awful lot more erosion before I go bankrupt." Further, some farmers made it clear that the criteria associated with being considered a good farmer do not include the implementation of farm plan works type activities.

If you could plant a blade of grass why plant a tree on it? That was pretty much my view too when I came here as a guy fresh out of school and that guy [another farmer in the catchment] had that view. This whole hill slope was eroding and at the end of the day they could force him into it technically, but practically it's the old carrot and the stick. ...He was a very good farmer too.

In consideration of the secondary nature of farm plan works in a farm business, it was important that the implementation of farm plan works could easily be incorporated around the core farm business. This ease of implementation is evident throughout the data supporting the four factors that emerged as the key contributions to compatibility of farm plan works with the core farm business. The four factors are: the ease of implementation of farm plan works, benefits and costs for the farmer of farm plan works, degree to which the farm plan and farm plan works are developed to

specifically suit each farm's circumstances, and the farm plan works' proven reliability (Figure 5.2).

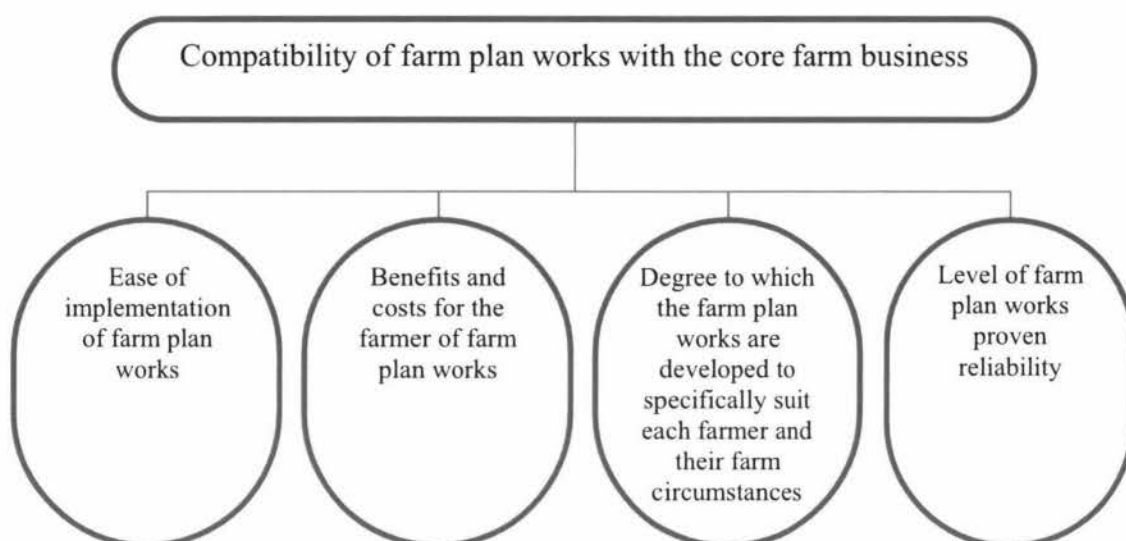


Figure 5.2. Factors Contributing to the Compatibility of Farm Plan Works With the Core Farm Business.

5.3.1 Ease of implementation of farm plan works

The ease with which farm plan works could be implemented emerged as a significant factor encouraging farmers' adoption of farm plan works. As stated above, farmers' priorities in the main are focussed on the farm business. Any situation that made the implementation of planned farm plan works more difficult tended to result in reducing the level of farm plan works implemented by some farmers in any one year. The factors that contribute to ease of implementation are those that minimise the additional effort and time required by a farmer to implement farm plan works over and above what s/he considers to be core farm business activities. Farmers identified a range of factors that make farm plan works easy to put in place, with minimal interruption to the core farm business operations, thus contributing to their compatibility. The ease of implementation of farm plan works is a function of the availability of inputs to carry out farm plan works, the availability of flexible approaches to practically implement farm plan works, and the availability of technical advice for decision making for farm plan works.

The availability of inputs necessary for completion of farm plan works impacted on the ease of implementation of farm plan works and hence the extent of farm plan works completed in any year. For both catchments studied the GWRC nursery was the main supplier of trees for tree planting works. The GWRC had in place an ordering and delivery system that worked well for farmers. However, shortages in supply of trees and lack of supply of certain varieties of trees from the GWRC in some years led to farmers curtailing the amount of planting they undertook in those years. One farmer wanted to plant a thousand trees, but was restricted to 450, due to lack of supply. Another farmer had to plant the varieties he could get, rather than the varieties that would best address the most erosion-prone sites he wanted to plant.

The flexibility farmers had with who could implement the farm plan works was an important factor contributing to the ease of implementation and consequently their level of implementation of farm plan works. Given that farm plan works are not the main priority in the farm business and farmers are generally busy, some farmers saw an advantage in having the flexibility to employ contractors to undertake the works. The contractors provided farmers with the opportunity to get farm plan works implemented when time was limited by weather conditions and other farm work that needed to be carried out. In 2007 the winter was very dry, and farmers interviewed later in July still had not planted their order of poles. Once August comes, other tasks to be completed on the farm would not allow the poles to be planted by the farmer. Contractors also assisted when farm plan works were difficult to implement. For some particular sites, helicopters can be used to drop poles on steep, difficult to access sites. Sometimes farmers simply chose to concentrate on other farm activities rather than farm plan works: "I pay someone to do it now I do not do it myself [district office does it]. ...we used to plant them by hand. I've done my apprenticeship." The flexibility to use contractors also played a part in ensuring implementation of farm works such as tree planting as indicated in the quotation below.

We used to do it ourselves. You get the poles, plant half of them then you have more work to do [on the farm] and they sit in the dam or creek for a bit. Now on contract they turn up and then they are all in the ground.

Further aspects of flexibility contributing to farm plan works' ease of implementation are timing and extent farm plan works are implemented. The farm plan works that

have limited flexibility as to when they can, or should, be implemented reduced farmers' ease of implementation because they were less able to fit the farm plan works around other farm activities. As stated above, this was sometimes addressed by the use of contractors. Likewise, the flexibility farmers have as to the extent of the farm plan works they implemented in any one year assisted their ability to complete implementation around other farm work priorities. For example, some farmers chose to plant 50 trees. This small number was quickly planted by the farmer and easily budgeted for with minimal impact on the core farm business. Farmers' and farm circumstances changed each year and farmers preferred farm plan works that could be implemented according to their, and their farms' changing circumstances, such as level of discretionary income, amount of time available, or soil moisture level. Personal interests such as family commitments and other business interests off the farm also took time, and had to be scheduled around farm business demands. The time and funds required for core farm business activities and personal interests sometimes impacted the level of farm plan works implemented in any one year.

Farmers' ability to adjust farm plan works that are proposed in the farm plan increases the compatibility of works with their own circumstances. The nature of farm plan works is they can be adapted to suit circumstances, and they often need to be adapted to get the optimum level of success. The farmers interviewed provided many examples of changes they have made to planned works to their farm system. These include: replanting different species, timing tree planting for greater moisture availability, increasing areas of tree planting, different planting patterns, using planting sites with the most appropriate characteristics for the tree, thinning out trees, and installing stopbanks.

The availability of technical advice contributed to a high level of uptake of farm plans and willingness to undertake farm plan works on farms by farmers. The level of technical support utilised by farmers in both catchments varied considerably, from little use of advisory services, through to full support. Full support could include field staff from the GWRC making decisions what farm plan works to implement each year and organising contractors to implement the chosen farm plan works. The main source of advice for farmers regarding farm plan works is the staff of the Wairarapa district office of the GWRC, which willingly responded to enquiries. They responded to

requests for advice and input, and also took a more proactive role defining specific details of farm plan works implementation on farms.

5.3.2 Benefits and costs for the farmer of farm plan works

A range of benefits and costs were identified that influence farmers' decisions regarding farm plan works. They include benefits and costs farmers perceive on-farm and off-farm, short-term and long-term. For the purposes of this study, financial benefits and costs that impact on decisions to implement farm plan works are presented separately from non-financial benefits and costs.

The financial cost of farm plan works, along with expectations of levels of success, strongly influence farmers' decisions as to how much of the farm plan works they carried out each year. A high cost resulted in a lower level of implementation, and vice versa when the costs were lower. At the time of the interviews farmers described the cost to implement farm plan works as expensive, and this led some to limit implementation: "I'd love to plant more poplars but at twelve dollars a pop they're too expensive, we'll keep on with 50 to a 100 a year on this place." A high cost meant farmers stopped or limited the amount of farm plan works they undertook, particularly when the benefits from established farm plan works were lower than they had expected: "Haven't [planted trees] for four or five years.... I found we were getting a pretty ordinary success rate and they're bloody expensive." Evidence also showed that a low cost encouraged high levels of farm plan works implementation, however this was also limited when the benefits from the established works were lower than expected. This occurred when earlier farm plan works had large subsidies available but poorer quality trees. "They were only \$2 each [poles], I used to do miles and miles, but they did not have decent treesIt got a bit demoralising after a while and I just gave up."

The influence of subsidies definitely encouraged farmers' participation in the farm plan programme. In the past when the Catchment Board offered up to 75% subsidy that reduced the cost of trees to two dollars each for farm plan works, farmers planted a large number of trees. Today, when the subsidies are 30 to 45%, farmers still identified subsidies as a key motivation to be part of the farm plan programme offered by the GWRC. For a number of farmers with well established, regular implementation

of works, they indicated they would implement works with, or without, the assistance of the GWRC. However, even for these farmers the reason to participate in the farm plan programme is to get the subsidy. “The main benefit of the plan is the subsidy that comes with it.” For these farmers it was not clear to what extent the subsidies influenced the amount of works implemented.

Farmers choose the most financially rewarding farm plan works to implement, when they have a choice of suitable works for a site. Some farm plan works can provide direct farm income, such as pine production. Farmers used calculations of financial costs and returns to compare some options such as pine blocks versus poles and grass. During the early 1990s, the level of return from pines outweighed the returns from livestock, and the planting of many more pine blocks occurred as compared to today. Poor returns from farming livestock resulted in little interest in implementation of other types of farm plan works because of farmers’ low level of discretionary funds available for this work. The district office had staff with skills in forestry that allowed them to continue their farm plan work with farmers implementing pine blocks. A GWRC staff member interviewed stated, “In the nineties, when there was a lot of downturn in farming and returns in forestry were high, we saw opportunities to fill a void and fill our workload up.” Today returns from *P.radiata* are poor, and one farmer said that he could not afford to invest in pine trees even though he had a 40% subsidy approved. Only one farmer interviewed is planting a new *P.radiata* block not for financial return, but for protection against serious erosion. A few farmers suggested that interest by farmers in planting *P.radiata* blocks might be renewed if carbon credits offer favourable returns.

Farmers’ evaluations of on-farm non-financial benefits and costs from the implementation of farm plan works are impacted on by their perception of the problem. The problem in this case was the level of erosion and the impact it is having on farm production and infrastructure. Farmers’ evaluation of the problem was mostly carried out by observations. Farmers with less erosion showed less urgency and at the other end of the scale when serious damage occurred after a storm event, farmers were highly motivated to act (see section 5.4). However, farmers stated that the extent of erosion and the level of impact on production and infrastructure were difficult to

accurately assess. “It’s pretty hard to see any benefits [from farm plan works] in production, but I’m sure there are, and you’re not getting the wastage as far as a big dirty slip coming down and taking a whole pasture out.” A farm changes after a storm event because of soil loss and changes in pasture quality, which adds to the variability across a property and the difficulty in evaluating benefits and costs: “It was very hard to tell, even in those major flood events, just how much area was affected... Probably way down on production, but they are not open, open scars.”

The farmers’ assessment of long-term benefits from farm plan works influenced their decisions to implement them. Extensive erosion following a storm event often prompted an immediate response to implement farm plan works, but this decision is based on farmers’ perceptions of what benefits are likely to occur from that implementation. The benefits from farm plan works require a long-term view. This is because of the time lag before benefits are realised and the life span of the works. Farm plan works, such as tree planting, take six to ten years before they begin to manage soil erosion, and then they may continue in this role for over 50 years. Farmers expressed a range of concerns regarding the long-term impacts of farm plan works on the farm business, particularly poor results incurred from earlier installations such as the influence of poor pasture growth under established trees and debris from large overgrown trees: “Old man pines are just falling down and it’s just a nightmare”. More positively, farmers’ expectations from the implementation of farm plan works included a number of ways works would contribute to farm environmental sustainability. Some farmers felt having a sustainable farm would mean that they are more likely to be operating in accordance with policy changes related to sustainable farming practices and more likely to satisfy the demands of consumers, “I think the most important thing facing New Zealand agriculture in the future is going to be consumer perception, and I think what we are aiming for is to have a farm that is well perceived by the people who are buying our product.”

Farmers’ assessments of tangible long-term benefits and costs from farm plan works implementation included the impact on farm production and infrastructure. The impact of erosion causing loss of soil and therefore loss of grass for production, as well as loss of fences and tracks, was an important part of farmers’ decision making. The benefits from implementing farm plan works to mitigate the impact of erosion in the future

were important for them. The district office staff members frequently estimated, and placed in the farm plan document, the financial benefits expected from increased pasture production after farm plan works are established. However, only one farmer identified the use of this financial information as a key motivation to implement his farm plan.

Assessed intangible long-term benefits and costs also contribute to farmers' decisions to implement farm plan works. Intangible benefits and costs were more difficult to measure, compared to tangible benefits and costs. For example, some farmers were clearly passionate about trees: "I've been a farm forester for years and years. Quite keen on conservation." Some were clear about the contribution works can make to the aesthetic environment: "It's to my advantage to make the place look nice." Some farmers considered the impact of farm plan works on society. Many farmers interviewed commented on the importance of contributing to future generations and how farm plan works are part of that contribution.

Farmers' assessment of benefits for the catchment, in addition to benefits on their own farms from implementation of farm plan works, influenced their level of implementation. Damage to farms caused by flooding is a problem shared by most farmers in both catchments, and is particularly relevant to those with land alongside the river. The extent to which benefits accrue to individual farmers on the river is dependent on all farmers' implementing farm plan works along the river. In the Whareama catchment farmers were working together to achieve community benefits. One farmer in the Whareama did not experience the benefits from the combined action of farmers implementing farm plan works along the river. On his farm, he described the water rising twice as high and flooding more often with less rain compared to other farms. However, he expressed his willingness to support the implementation of farm plan works. By comparison, in the Whangaehu catchment, farmers are less united regarding action to address the problem. The reason for this difference between the two catchments may be due to the long-term existence of the catchment scheme in the Whareama, but this was not clearly ascertained. The farmers in the Whareama identified clear benefits from farm plan works implementation for their community, such as less damage to buildings after a flood. By comparison, farmers in the Whangaehu did not identify significant community benefits.

5.3.3 Degree to which the farm plan and farm plan works are developed to specifically suit each farmer and their farm circumstances

The compatibility of farm plan works with the core farm business is influenced by the degree to which the farm plan and farm plan works are developed to specifically suit each farm's circumstances. The farm plan and farm plan works are largely developed by field staff from the GWRC together with the farmers. Two key factors emerged as important to the compatibility of the planned works with the core farm business with the development of the farm plan: the level of involvement of the farmer in development of the farm plan works action plan, and the degree to which the farm plan is based on an understanding and analysis of the physical resource inventory.

The level of involvement of the farmer in the farm plan development influences the compatibility of the farm plan with the farm system for which it is designed. The degree of compatibility achieved from the farmer's involvement depends, in part, on the quality of communication between the field staff and the farmer. The capability of the field staff to carry out this role is also a key factor and is outlined further in Section 5.5. Some farmers expressed a strong desire to be involved in the process of the farm works plan development to ensure it is designed to suit their farms and their circumstances. Two farmers interviewed rejected the farm plan proposed by the GWRC, partly due to unrealistic costs for their personal circumstances.

The expenditure was something like fifty grand in five years [to implement the proposed farm plan works], you know and it was about ten grand a year, ... I just was not prepared to go even down the track and go with it. That was pretty much the last contact I had with [the field staff].

[A field staff member] sent this report back and he sort of overcooked it a bit and he had some astronomical amount of spending for the next five years budgeted.

The degree to which the farm plan is based on an understanding and analysis of the physical resource inventory influenced the compatibility of works selected for the farm. The appropriate selection of farm plan works for a farm's physical characteristics are critical to achieve the expected outcomes of soil stability and grass production. Many farmers praised the quality of the farm analysis and showed confidence in the proposed works. There are plenty of established works on farms that

contributed to ongoing confidence with proposed works. “Personally I’ve got a lot out of this plan and my planting, which is quite a big part of what I want to do”

5.3.4 Proven reliability of farm plan works

The proven reliability of farm plan works influences farmers’ choices to incorporate farm plan works into their farm systems. There is a long history of farm plan development in the Wairarapa that has allowed time for the farm plans and farm plan works reliability and compatibility to be established. Farm plan works have been shown to contribute to improvements in soil stability and be compatible with existing farm systems. If farm plan works were not compatible with a farm system and limited core business capabilities, implementation was reduced. This reliability has provided farmers with confidence to continue implementation of farm plan works. Two key factors emerged from the data that contributed to farmers perception of the appropriateness of the farm plan works that were selected: the level of successful establishment of farm plan works over many years, and the level of improvement over time of farm plan works.

Successful establishment of farm plan works over many years has encouraged farmers to continue implementation. However, farmers have also experienced poor success of farm plan works establishment, slowing their rate of farm plan implementation. Farmers in the two catchments identified many examples of successful long-term farm plan works that encouraged ongoing implementation. “Had one paddock in ‘77 that totally slipped away. That’s been planted 20 years now. It’s hardly moved, it’s quite amazing. ...I’m really pro planting.” “[The soil] was just spewing down the [hill the] whole time, ... now we are really seeing the benefits of those trees [ten years later].” Successful establishment referred to by the farmers meant that trees were continuing to grow and erosion was minimised in the area where the trees were planted. However, during the six to ten years it takes for trees to establish and begin holding the erosion-prone soil, the trees sometimes were damaged or died. Farmers also provided examples of setbacks to farm plan works, even after the first six to ten years. The setbacks included poor survival rates of trees due to poor varieties¹⁴, pine blocks

¹⁴ Poor varieties refer to trees that do not suit the physical conditions in which they are planted. Researchers have developed new varieties of trees to manage eroding sites. However, farmers interviewed have dealt with, and continue to deal with, the consequences of poor varieties they planted in the past that provided low levels of success. A range of new varieties can be used in

causing erosion due to their weight, severe erosion after a block of pines is harvested, repeated failures on severe sites, and poor pasture growth under long-term established poplar and willow. "It's just a mess, the grass underneath is not that good and there's sticks and rubbish and they're starting to split and it's really put me off that thick planting of poles." For most farmers interviewed, the level of success has been sufficient to encourage them to continue ongoing implementation, despite the setbacks they have experienced. Some specific sites on a farm may have been left due to low tree survivability, but over most parts of the farms that require erosion management, the farmers continue to implement farm plan works.

The level of improvement to farm plan works over the years is another key factor that adds to the farmers' impression of farm plan works reliability. Ongoing research and development have added to farm plan works improvements. Key contributions from research and development have added to the level of successful establishment of trees, and the level of compatibility of farm plan works with the existing farm system. Improved tree varieties, more effective planting practice, an efficiently well run nursery supplying poles, and audits to ensure that the work is done well with high success rates, have all contributed to the level of successful tree establishment in the Wairarapa. The GWRC staff interviewed indicated these improvements have led to 80 to 85% survival of trees planted throughout the region in 2005. The development of new varieties, which better suit the conditions of specific sites, provided a significant contribution to successful establishment of farm plan works.

All the trial poles; they've selected the best formed trees, those not prone to wind, a lot have had their head blown out, bad formed trees, and survivability ...I've been absolutely astounded with some of the Matsudana, one hybrid I've been planting them right on the top of the north west faces, ... I've got two paddocks called Windy and Gale and they're doing amazingly well.

Another example of research and development is the Dinex sleeve. This has also contributed to improved tree establishment, but its primary contribution is the greater compatibility tree planting can have with other farm operations. The Dinex sleeve has allowed cattle to be in the paddock as soon as the poles are planted, whereas prior to its

a wide range of sites across a farm. However, there is still a need for more varieties to be developed to suit the diversity of conditions across some farms.

use they had to be kept out of newly planted paddocks for up to three years to avoid damage.

Farmers have found some research and developments for farm plan works difficult and uneconomic to fit into the existing farming operations. Several farmers mentioned their awareness of the value of pruning. However, the difficulty farmers found with pruning highlights again the importance of the farm plan works being easy to incorporate. Farmers did not carry out pruning because of the expense, lack of availability of trained staff to carry out the task, and also some lack of awareness that pruning needed to be done.

It's all very well to say we'll keep them pruned, or keep them topped, but most farmers are running on absolutely minimum labour.....forestry gangs are having problems getting staff, let alone some hobo [contractor].

Most farmers did not use their trees for fodder, even though like pruning, they supported the idea. A few farmers explained why fodder trees are not suitable in their existing farm systems. One suggestion was that buying in more supplements was more cost effective compared to allocating land to fodder trees. Another farmer said when a farm is short of feed, it is May, and poplar and willow can not be used because they lose their leaves. A few farmers thought that cutting trees for fodder is dangerous. "It's incredibly dangerous cutting down willow branches because you've got to climb up the blessed tree with your chain-saw... and there'll be a death."

5.4 Characteristics of farmers and their farm circumstances

Key characteristics of the farmers and their farms emerged from the data as contributing to their adoption of farm plans and farm plan works. The farmers' view of farm plan works, their level of interest in environmental issues and tree planting, and their levels of discretionary time and funds all contributed to their decisions regarding the implementation of farm plan works. The stage of physical development of the farm business influenced the level of time and funds allocated to farm plan works, and the level of erosion on a farm influenced the degree of urgency farmers felt to implement farm plan works (Figure 5.3).

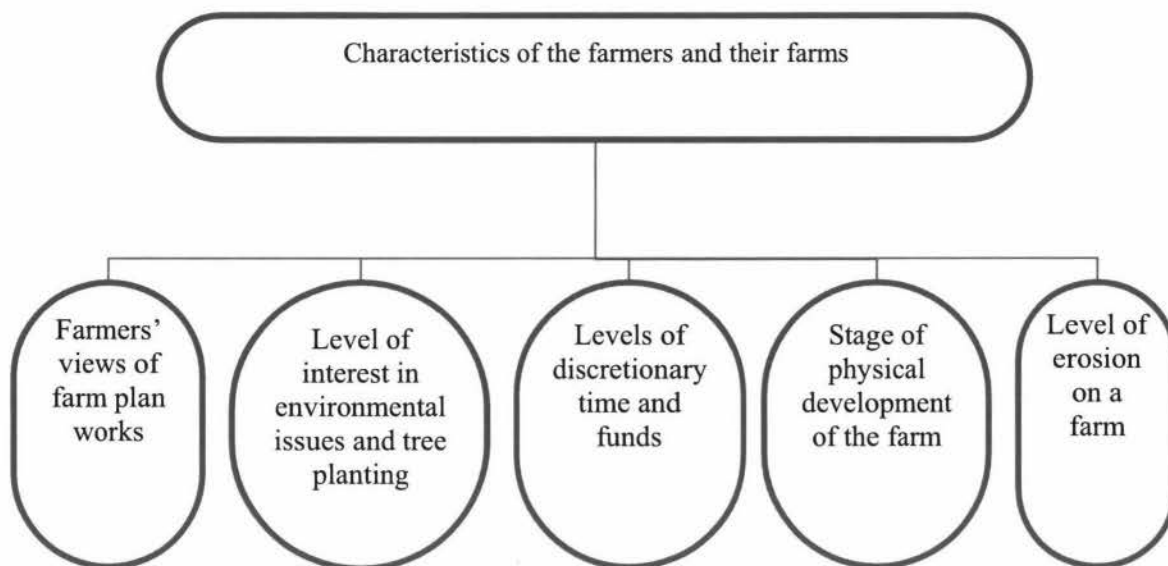


Figure 5.3. Factors Contributing to Characteristics of the Farmers and Their Farms.

Farmers' view of farm plans and farm plan works was shaped by a range of factors that consequently affected their decisions regarding adoption. Farmers had gained experience in a number of ways, but the experience farmers gained from implementation of farm plan works on their own farms was of particular significance. Information sources and champions, which helped to raise farmers' awareness, also contributed to their view of farm plans and works.

Farmers' motivation to implement farm plan works came from a strong interest in environmental issues. However, farmers with this type of motivation did not implement significantly more farm plan works compared to other farmers implementing works. Some farmers were distinctive by their passion for trees and enthusiasm to implement farm plan works to manage erosion. However, other factors moderated their ability to implement works. All farmers interviewed expressed their passion for farming and interest in maintaining their farm business. They described the value of tree planting on eroding land, which is different from a passion for trees and for the environment in general. A number of farmers showed little interest in having trees on their property, "Ideally I wouldn't have a pole on the property." However, they were aware of the importance of trees to support their farm business, and some of these farmers planted regularly.

The amount of farm plan works implemented by farmers in any year was linked to their level of discretionary funds and time. “We didn’t do much when we were all poor. From ‘85 onwards for about five years we didn’t do [any works implementation].” The level of discretionary income was influenced by the profitability of their farming business as a whole, which was linked to the stage of farm development and the relative profitability of farming itself, and the financial commitments they had with respect to family and their education. The time farmers had available for implementing farm works was influenced by the time required to undertake core farm business activities and this varied with different farming systems, stage of development of the farm, and their family and off-farm commitments.

The level of discretionary income of farmers farming less developed properties constrained their ability to implement farm plan works. Two farmers who had recently purchased run-down farms in the Whareama catchment wanted to implement farm plans but did not have adequate income to do so. “We’ve been wanting to plant ever since we got here, but we just couldn’t afford to do everything, and there was so much to do. It was just the last job on the list.”

The level of erosion on farms influenced farmers’ sense of urgency to carry out farm plan works. The level of erosion affecting farm production and infrastructure influenced farmers’ level of urgency to address it. A couple of farmers have nearly completed the implementation of their farm plan and expressed less urgency to implement ongoing works compared to other farmers that were interviewed. A farm’s natural susceptibility to erosion is affected by a number of factors, but the key differentiation between the farms in the case studied was the rock type (mudstone or argillite), and the slope. Farmers with an argillite rock type and/or shallower slopes had little erosion and felt little urgency to address it. “Because we’re predominantly a crushed argillite base erosion isn’t really an issue.” “To be honest our farm is not steep hill country and is reasonably semihard hill country and erosion wise ... it’s not a big issue.” Most farmers interviewed had farms with a mudstone base and described dramatic erosion damage, particularly after storm events.

There’s two slips out there, they’re big. They would have gone four or five hundred metres and two hectares in size, at least from the top of it. And they just would have gone, just boom! It looked like what you’d imagine an avalanche would be, the top of it gone, and a whole lot of pinnacles at the bottom of it.

The frequency and impact of erosion damage as a result of storm events influenced the level of adoption of farm plan works. Storm events occur regularly, and the resultant damage reminded farmers about the issue and the urgency to address it. “We’ve since realised, especially with these last two weather events, with all the slippage, that it’s [implementation of farm plan works] got to happen quicker than that.” The GWRC staff interviewed said they are contacted for more erosion management work after a storm event.

5.5 Credibility of the organisation delivering farm plans

The credibility of the organisation that delivers farm plans influences farmers’ level of adoption and ongoing implementation. In this case, the relationship between the GWRC and farmers was identified as critical for their role of delivery and implementation of farm plans and farm plan works. The credibility of both the GWRC and the credibility of its staff emerged as key factors influencing farmers’ relationships with them. Field staff are central to the GWRC’s involvement with each farm plan development and implementation. The credibility of field staff is defined by their technical competency, their ability to build a relationship with farmers and their ability to design an appropriate farm plan to each farmer’s circumstances. The credibility of the GWRC is enhanced by a range of factors. These factors include their commitment to farm plan delivery, their support of field staff and integrity as an organisation (Figure 5.4).

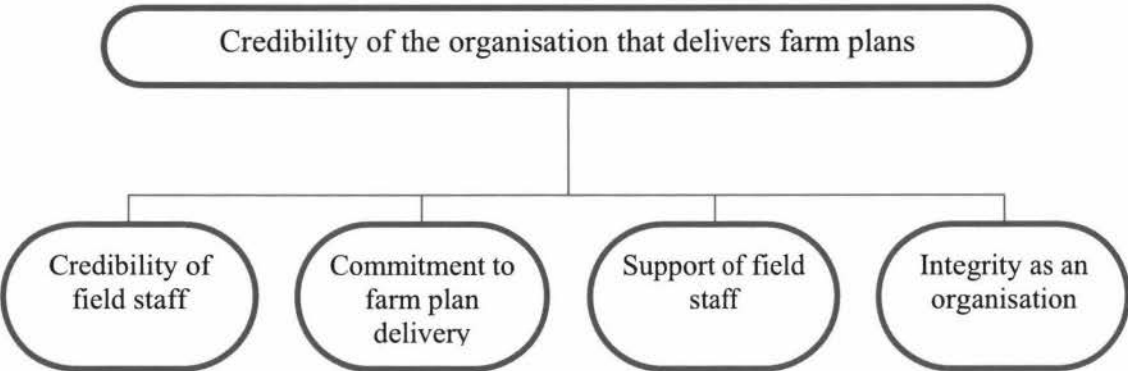


Figure 5.4. Factors Related to the Credibility of the Organisation delivering farm Plans.

The GWRC play an integral role with farm plans in the region. They can be involved with every aspect of a farm plan, from the initial design through to its implementation and ongoing maintenance. They are the main source of information about the farm plans, the main source of supply for trees for farm plan works, and the main source of supply for contractors who can implement farm plan works. If farmers want a farm plan developed, they have to liaise with the district office. However, other aspects of the farm plan can be carried out without the GWRCs involvement. However, for some aspects, such as sourcing trees, it is a lot more difficult and rarely carried out by the farmers interviewed. The GWRC is involved to varying degrees with different farmers, and its involvement changed over time as different factors impacted on the farm system.

5.5.1.1 Credibility of field staff

A key element of field staff's credibility as perceived by farmers is their technical competency. Technical competency contributed to field staff members' ability to build a relationship with the farmer and made farmers more willing to accept the occasional poor advice. One farmer, who had spent less time with field staff, got zero survival after reluctantly planting trees on a field staff member's advice in a dry period, resulting in loss of revenue. As a result he had little further contact with the field staff - whereas, some farmers with a longer relationship with field staff accepted what proved to be poor recommendations, and continued with their involvement with the GWRC and field staff. Technical competency, as perceived by the farmers and field staff, is a function of advice that is suitable to the farm system and results in successful farm plan works, and is particularly important in the early stages of developing the farm plan. When farmers accepted the advice as suitable to their farm systems and experienced success from recommendations, they continued to seek advice and maintain a relationship with the field staff. The technical competency of field staff was described as being adequate to being very well-informed. Farmers had a choice to what extent they communicated with the district office and field staff. Some chose to communicate on a regular basis and others chose to only communicate when they needed specific advice.

The capability of field staff to build a relationship with farmers contributed to both the credibility of field staff and the organisation delivering farm plans. The longer time a

field staff member had spent working with a farmer the more their relationship was enhanced. The ability of the staff to invest time with farmers was also indicative of the support given to them by the GWRC. Within a farm plan there can be a range of farm plan works that offer opportunities for the GWRC to be involved, and have contact, with a farmer. One farmer stressed how important it was to spend time with a new field staff member until the farmer felt confident about the field staff capabilities. The building of rapport between field staff and farmers was also shown to be an important part of their relationship. A new field staff member working at the GWRC showed how quickly this could be achieved. Farmers spoke of her with high regard even though she had worked for the GWRC for only a couple of years.

The ability of field staff to design an appropriate farm plan for each farmer's circumstances influenced the level of implementation of works by farmers. Two aspects contributed the field staff's ability: the field staff's skill in analysing a farm's resources, and the ability to reach an agreement with the farmer about what to implement.

5.5.1.2 Organisational commitment to farm plan delivery

The GWRC's commitment to achieving successful farm plan implementation influenced their credibility. The GWRC's commitment was shown by their long-term ongoing support of farm plans, they participated in a wide range of activities that endorsed the concept of farm plans, they followed up works with checks, audits and improvements and responded to errors they made. In 1989 when the GWRC replaced the Wairarapa Catchment Board, support for the farm plan programme was continued. The GWRC supported many soil conservation activities that assist farm plan and farm plan works development. The GWRC are involved with catchment control schemes and farm planning activities and are involved with discussion groups and monitor farms, the Ballance Farm Environment Awards, Streams Alive that focuses on riparian planting projects, management of soil conservation reserve forests, and they support a number of soil conservation research projects. Over the years, field staff have followed up farm plan works operations with checks, audits and advice to improve implemented works. A few farmers indicated that the follow-up visits carried out by the field staff were a valuable contribution towards the farm plan works, whereas a few other farmers did not see the follow-ups as necessary. A positive example of a follow-

up visit was when a field staff member, responsible for the completion of a tree milling contract, checked the creeks and got the forestry gang to return and tidy up. The willingness of the GWRC to accept and respond to errors they had made contributed to farmers' view of their commitment to farm plans, and added to the level of the organisation's credibility. One particular incident appeared to affect most farmers as they all commented on only 10% to 20% success from one batch of diseased poles. All farmers that contacted the GWRC had their trees replaced.

A consistent approach used by the GWRC for the farm plan programme over time also contributed to what is seen as its ongoing commitment to soil conservation. Farm plans used in the Wairarapa have been further developed over the time they have been available, but the core of a farm plan is fundamentally the same.

The level of responsiveness the GWRC had to farmers also contributed to their perceived commitment to successful farm plan delivery. The GWRC's involvement with the farming community contributed to their ability to respond to concerns that arose. One to one relationships between field staff and farmers allowed such responsiveness.

5.5.1.3 Organisational support of field staff

Further to the organisation's credibility, their support for field staff makes the integration of new staff into the farm plan programme relatively seamless. Farmers expressed the importance of efficient liaison with field staff with regards to farm plans.

It's no point if every year you have to show a new person [field staff] what you're doing and find out what they think. If they [GWRC] can ensure that there's a seamless transition, which is a trendy word, but that's what you want, so you don't have to go back to square one each time.

Some farmers have had three different field staff over the past few years. However, despite these changes, farmers did not comment about the disruption to farm plan implementation, or the loss of excessive time before informing the new staff member about their properties. The ease of transition was assisted by the comprehensive documentation of farm plan work carried out on each farm, and the access new staff had to staff with long-term experience and expertise in the field.

The level of support from the organisation is such that field staff members fulfil their role as experts in soil conservation, and ensure that farmers can depend on field staff for advice. The key source of expertise in the district office is with long-term employees who have built their knowledge and experience over time. These experts supported the new staff operating in the organisation.

5.5.1.4 Organisation's integrity

The appropriateness of the organisation's policy development for farmers reflects and contributes to their credibility with farmers. Some policy being developed at the time of the interviews did not encourage farmers to implement farm plan works. For example, one policy under development included making carbon credit payments available to farmers with land that is newly retired, but with no credit to farmers with existing retired land who consider they have worked hard for many years to make environmental changes on farms. A farmer with well established retired blocks threatened to get rid of them if the government was not going to pay him. Another policy under development aims to stop the cutting of all native species of trees on farms. This would seriously affect farmers, and affected a few farmers who are clearly taking measures to develop their farms with a great deal of consideration for the environment. One farmer with a lot of areas covered in manuka may not be able to utilise the land for other purposes, yet these could be productive areas. Although farmers' concerns about these policies did not affect their relationship with field staff, they did impact on their perceptions of the GWRC.

The extent of transparency in spending by the GWRC delivering farm plans influenced farmers' perceptions of the organisation's credibility. Farmers expressed their awareness of the GWRC's spending, and concerns regarding the allocation to different activities and the amount they spent. Farmers were aware of the costs they incurred for farm plan related matters and the allocation of money spent by the GWRC as a whole. They indicated the importance of getting value for the money spent by the GWRC, both for themselves and the community.

5.6 Summary

Many interlinked factors were identified in the case that influenced farmers' adoption of farm plans. Three major categories have been used to describe the factors and identify links between factors and across categories. The three categories are: compatibility of farm plans and farm plan works, characteristics of farmers and their farm circumstances and the credibility of the organisation.

There was a high level of awareness and adoption of farm plans and farm plan works across farmers interviewed. This was contributed to by the length of time farm plans have been available, the wide range of information sources contributing to soil conservation, and champions.

The compatibility of the farm plan is a function of the ease with which farmers can fit works around the core farm business. The flexibility of farm plan works, the availability of inputs and the ease of access to technical advice enabled works to be fitted around core farm business activities. Farmers evaluate a wide range of both financial and non financial benefits and costs to determine whether or not to adopt farm plan works. Field staff expertise to analyse the physical resources and their ability to communicate with farmers to ensure appropriate selection of farm plan works contribute to a customised farm plan. In addition, the proven reliability of farm plan works from farmers' perceptions of their success and improvements to the works over time encourage ongoing adoption.

Key characteristics of farmers and their farms influencing adoption of farm plans and farm plan works included: farmers' views of farm plan works contributed to by their own experience in implementing works, information sources and champions, limited discretionary time and funds, and the level of erosion on farms, particularly after increased damage from a storm event.

The GWRC's credibility was a major influence affecting the adoption of farm plans and farm plan works. The GWRC played an integral role in the delivery, support and

promotion of farm plans in the region. Their credibility is a function of field staff credibility, GWRC support of field staff, their commitment to farm plans, and their integrity as an organisation.

Chapter 6

Discussion

6.1 Introduction

In this chapter, the results of the research are discussed and explained relative to the literature on adoption diffusion, particularly regarding agricultural innovations that address environmental issues. The results, in the main support the literature that was reviewed, with no evidence that was contradictory. This discussion highlights the specific mix of factors that influenced the adoption and ongoing implementation of farm plans and farm plan works in the case area. The influential factors related to the innovation, farmer and farm circumstances, and the organisation delivering the farm plans. First the case is classified.

6.2 Classification of the case

In the classification of the case, characteristics of the innovation, the farm and farmers, and the organisation delivering the innovation are itemised. These characteristics are pertinent to this case and help to explain the findings in the following discussion. Each characteristic is listed in Table 6.1. The two subcases studied were found to have similar characteristics and for this reason are not differentiated.

The innovation in this case is farm plans. The primary focus of farm plans and farm plan works is to mitigate hill country erosion on a farm. To achieve this, physical resources of a farm are analysed by GWRC field staff and the results are documented in the farm plan. Field staff use these data, with support from the farmer, to select appropriate farm plan works. The result is a customised farm plan with works suited to the individual characteristics of the farm and circumstances of the farmer.

Farm plan works are widely diffused across the region, which also means a high level of awareness of farm plans and farm plan works by farmers across the region. On some farms, farm plan works have been implemented for the full 50 years that farm plans have been available in the region, and these farms include a few on which

implementation of works is almost complete. Most farmers with an existing farm plan foresee many years of works still to implement.

Table 6.1. Characteristics of the case.

Category	Characteristics
Innovation	Aim to mitigate hill country erosion
	Number of discrete parts
	High level of awareness of innovation across the region
	Widespread adoption of the innovation across the region
	Implementation of farm plan works across a farm is incremental and takes many years
	Secondary priority to core farm business activities
	Flexible (Duff et al; 1992 ; Smallshire et al., 2004)
	Uncertain, difficult to accurately calculate and low economic returns
	Implemented for the long-term (Mercer, 2004)
	Customised to each farm and farmer
	Time lag of 6 to 10 years before benefits are evident (Barr & Cary, 2000; Duff et al., 1992; Mercer, 2004)
	Requiring inputs
	Supported by incentives
	Impacts on-farm and off –farm (Guerin, 1999; Knowler & Bradshaw, 2007; Marshall, 2006)
Organisation delivering the innovation	Local government body
	Funded by landowner rates
	Organisation integral to the farm plan development
	Long-term commitment to delivering and promoting the innovation
	Field staff available for one-to-one consultation with farmers
	Organisation responds to farmers' demands for the innovation and support
	Recognised responsibilities in soil conservation in the region
Farmers and Farms	Recognised expertise in soil conservation among long term field staff
	Variable levels of implementation of farm plan works
	Highly erodible hill country farms with significant class 6,7 and 8 land
	Variable extent of erosion
	Wide range of farm sizes
	Family owned farm for one to four generations
	Ages 30 to 60 years
	Owner operators and one manager
	Variable levels of education and farming experience

Farm plan works implemented on a farm are in place for a long time, with uncertain, difficult to accurately calculate, low economic returns for farmers. Benefits from implemented works can take six to ten years before they are realised and a reduction in erosion is seen. The benefits from implementation of farm works are both on-farm and off-farm. The implementation of farm plan works by farmers has always been supported by subsidies offered by the GWRC, and prior to its formation in 1991, the

Wairarapa Catchment Board. The subsidies have ranged from 30% to 75% of the individual works over the 50 years that farm plans have been available in the region. The implementation of the farm plan works for a whole farm takes many years - a minimum of 15 years was suggested by one farmer, and it can take a lot longer.

The farm plan is made up of two parts: documentation of the physical analysis of the farm resources, and a plan of action to address the erosion for a one-to-five-year period. The plan of action can be reviewed, and a new one-to-five-year plan formulated as the farmer chooses to address further aspects of the physical analysis. The action plan contains discrete parts called farm plan works that can vary in the amount of work required to implement them. The discrete farm plan works provide farmers with a flexibility as to what is implemented each year and when. Additional flexibility is gained from bringing in contractors and making adjustments to the works to optimise implementation on a specific site. The main inputs required for implementation are trees such as poplar, willow and pine, which are generally bought from an external supplier. New varieties of these trees have been developed over the years to better suit different sites across a farm, particularly areas that are difficult to establish trees on, such as windy dry sites. Many other aspects of the farm plan document and farm plan works have been improved over the 50 years of implementation, including the accuracy and representation of the resource analysis, accuracy of maps, knowledge as to how best to prune the trees and innovations to protect young trees.

The GWRC is the organisation delivering farm plans to farmers in the Wairarapa on a voluntary basis. The GWRC is a local government body primarily funded through rates. They are an integral part of the farm plan development and implementation in the region. When a farmer chooses to adopt a farm plan s/he contacts the district office. A field staff is then made available to work one-on-one with the farmer to develop a farm plan. The field staff and district office staff are available to respond to the farmer's needs by providing advice and support and being a supplier of inputs, such as trees and contractors. The GWRC is also involved in promoting the uptake of farm plans and implementation of farm plan works by supporting and participating in extension events, providing funding, undertaking research to improve farm plan works, and supporting activities arranged by other organisations.

Characteristics of the farmers who participated in this research and their farms, vary widely. The farmers ranged in age from the early thirties through to retirement age and their level of education varies from leaving school at fifteen to attaining a postgraduate level university qualification in agriculture. Farms ranged in size from 450 to 1750 hectares. They have been owned or managed from a short period of time of around five years through to a long period of time over four generations of family ownership. All the farms have Class 6, 7 and 8, erosion-prone hill country. The farmers interviewed have a high level of awareness of the farm plans and there is wide and ready access to information about farm plans and farm plan works.

6.3 Factors that influence the adoption of farm plans and farm plan works

Many different interlinked factors influence the adoption of innovations (Wejnert, 2002), including farm plans. The adoption of farm plans and farm plan works was the result of a complex interplay between factors within and across the three broad categories used. These categories relate to the innovation, the farm and farmer, and the extension organisation. Each farmer's adoption decisions were influenced by their individual unique circumstances (Wejnert, 2002), which in turn shaped their view of the innovation and the organisation delivering the innovation.

Three broad categories were found to be useful for describing the factors important in influencing farmers' decisions about farm plans. These categories are the compatibility of farm plan works with the core farm business, characteristics of farmers and their farm circumstances, and the credibility of the extension organisation delivering and promoting farm plans. At a general level these three categories are similar to those identified in the literature, that focus on the innovation, the farmers and farms, and the extent of the innovation (Guerin, 1999; Pannell et al., 2006; Smithers & Furman 2003; Wejnert, 2002). There are, however, some important differences that reflect the exact nature of the innovation and the level of awareness and initial adoption by farmers in the region and the significant role the extension organisation (GWRC) has played and continues to play, in the adoption of farm plans and ongoing implementation of farm works.

The importance of each of the three categories in the adoption of an innovation is not dealt with in the literature. Many of the factors influencing adoption that related to the circumstances of the farmers and their farms in the literature, did not emerge as strong influences on adoption of farm plans. This resulted in the category related to the farm and farmer having less influence on the adoption of farm plans compared to other two categories. The farm plan and the farm works action plan included within the plan are customised directly to the individual circumstances of each farmer and his/her farm. As a result, the innovation matches these circumstances, and individual circumstances therefore did not emerge as significant influences on adoption. The customised innovation design is particularly advantageous in ensuring farmers' willingness to adopt the innovation and continue to implement farm works over many years.

The organisation's credibility was the main focus for the category of factors related to the extension of the innovation. The GWRC is recognised as the entity primarily responsible for soil conservation in the region and is the dominant entity involved historically and currently in the extension of farm plans. For this reason, the credibility of the organisation emerged as an important influence on the adoption of farm plans.

In this research, as Rogers (2003) describes, information sources were important to support ongoing implementation of the innovation, not just its initial adoption. Most of the literature reviewed focussed on the role which information sources played in increasing farmers' understanding, and in reducing uncertainty about an innovation prior to its adoption (Cary, et al., 2002; Guerin, 1999; Mercer, 2002; Pannell et al., 2006; Rogers, 2003). Farmers' decisions to adopt an innovation can be influenced by a wide range of information sources (Morris et al., 2000; Pannell et al. 2006). Morris et al. (2000) identified that different information sources were important for different stages of farmers' adoption process. This was not specifically identified in this research, but farmers clearly stated that they used different information sources at different times.

Peers and neighbours are an important part of farmers' decision making (Barenklau, 2005; Bradshaw & Williams, 1998; Guerin, 1999; Marshall, 2004). Although they played a part in the decisions farmers made about farm plans in this research, the role of peers and neighbours was not any more important than other sources of information.

The extent of contact farmers have had with champions of the innovation has played a significant role in their adoption of the innovation. Champions include opinion leaders (Rogers, 2003), but whereas opinion leaders are defined as frequently influencing different people informally, champions have a broader definition. The term champion is used to characterise people who are enthusiastic about the innovation and the need for farmers to adopt it. Contrary to the definition of opinion leaders, champions may affect only a small number of people with whom they have a close relationship, such as family members. Some champions, such as field staff from the district office, affect a wide range of farmers and may operate with a more formal process, as extension agents do.

The five stages of the Innovation Decision Process developed by Rogers (2003) were useful to describe farmers' process of adoption of farm plans and farm plan works. Farmers in this case have a high level of awareness and a high level of adoption of farm plans and farm plan works. Awareness and adoption are the terms Pannell et al., (2006) used to identify the first and fourth stage of adoption, which Rogers (2003) refers to as the knowledge and implementation stages. All farmers interviewed were aware of farm plans because they have all had experience with the implementation of farm plan works, hence can be thought of as having completed one cycle of the Innovation Decision Process.

The way Rogers' (2003) framework applies to farm plan works in this case is that farmers can go through the Innovation Decision Process every year. Rogers recognises the iterative nature of the framework, but for this innovation, in this case, iteration is a significant characteristic of farmers' adoption process. As explained in the results chapter, in this research the term adoption refers to all five stages of the Innovation Decision Process. It was useful to refer to adoption in this way because farmers have already gone through the initial adoption and now experience the ongoing cycle of decision making regarding farm plan works each year. This also means that farm plans are not an innovation as defined by Rogers (2003). That is they are not 'new' to farmers in the case region. This case was more about the ongoing implementation, rather than the initial adoption, of an innovation.

Mercer's (2004) definition of an innovation also does not accurately describe farm plans. Farm plans are not a 'factor of production'. According to Upadhyay et al. (2003), Mercer's (2004) definition assumes that an individual makes decisions based on profit maximisation, whereas the economic benefits from farm plan works are uncertain and low for most farmers interviewed. Farm plans and farm plan works focus on erosion mitigation, not on maximising production.

Three key factors played an important role in raising awareness of farm plans in this case, and continue to be important as the Innovation Decision Process continues. The long period of time for which farm plans have been used in the region, and the availability of information from a wide range of sources are consistent with Pannell et al. (2006) and Rogers (2003) who identify these factors as important in the first stages of the Innovation Decision Process. The third key factor, significant efforts from a number of champions, is discussed earlier.

For an innovation where implementation is ongoing for a number of years, like farm plans and farm plan works, Rogers (2003) states that the end of the implementation stage, in the Innovation Decision Process, occurs when an innovation is regularly implemented. However, this is not an appropriate explanation for the end of the implementation of farm plan works because it is often not carried out regularly. Many farmers stopped implementation of farm plan works when other factors influenced their farm circumstances, such as low income or other personal or business interests, but then after a few years implementation resumed. This irregular implementation may reflect this innovation's focus on environmental issues and not on the farm business need for regular production and income.

The variable levels of adoption of farm plan works, including the irregular implementation discussed above, can be partly explained by the nature of the innovation. There can be many discrete farm plan works, each with varying amounts of work, within a farm plan action plan. The time taken, and the timing of implementation for each works, do not affect the integrity of the innovation. At different times a farmer may choose to stop or start implementing works. This does not mean that the farm plan is dis-adopted then re-adopted as Cary et al. (2002)

describe for other innovations. A farmer maintains adoption, but varies the number and size of works implemented.

Farmers' decisions regarding farm plans are largely focussed on the works. Like farm plans, some innovations have a number of parts (Cary et al., 2002; Smallshire et al., 2004), but the focus on one part of the innovation for adoption was not identified. The reason for this focus on works is that the physical analysis of farm resources is carried out to inform the selection of farm plan works in the action plan. Once farmers understand the reason for choosing specific works, the original farm analysis document becomes less important.

Farm plans can be identified as an environmental innovation. This general term can include a wide range of innovations, however factors have been linked to innovations identified as environmental that are useful to explain the adoption of farm plans. Six characteristics were linked to environmental innovations in the literature and are relevant to the adoption of farm plan works. First, Pannell (1999) identified that low economic returns often come from environmental innovations. This study revealed that economic returns are low for farm plan works, but also uncertain and difficult to accurately calculate. Two characteristics related to time are linked to farm plan works and to other environmental innovations. These include the length of time for which the innovations are in place (Burton & Wilson, 2003; Pannell et al., 2006), and the time lag before benefits are evident (Barr & Cary, 2000; Duff et al., 1992; Mercer, 2004). Fourth, environmental innovations have fewer observable impacts compared to other innovations (Guerin, 1999; Marra, Pannell, & Abahi Ghadim, 2003). This is accurate for farm plan works because the impacts are delayed for six to ten years. However, at this time the issue of erosion is visibly mitigated, whereas other environmental innovations such as tree planting to address salinity (Marshall, 2004), continue to have impacts, which are difficult to observe. The fifth characteristic, also relevant to farm plan works, is that environmental innovations provide benefits to society, as well as to the individual property on which they are implemented (Guerin, 1999). For the final characteristic linked to environmental innovations, Mercer (2004) described the need for a high level of knowledge to understand them. However, farmers in this study did not identify farm plans and farm plan works as difficult to understand. Farmers'

knowledge of their farms' natural resources and field staff providing information and advice are likely to have provided sufficient knowledge to understand them.

Observability and trialability, as defined by Rogers (2003), were not found to be important factors influencing adoption of farm plan works. The term observability found in the literature generally referred to observation of benefits gained after implementation of the innovation (Cary et al., 2002; Pannell et al., 2006; Rogers, 2003). Although observation of benefits takes place in this case, it is a consequence of the long time during which farm plan works have been available and used in the region. Therefore this is not consistent with Rogers' definition. Trialability as defined by Rogers, refers to evaluating an innovation on a partial basis. Similarly, divisibility refers to implementing an innovation on a small scale (Rogers, 2003). Although farm plan works could be considered as being implemented on a partial basis or a small scale, they are more accurately described as discrete parts. Cary et al. (2002) describes trials as opportunities for farmers to evaluate the risks and compatibility of an innovation. For a farm plan, the incremental implementation of the works is such that farmers continually evaluate the innovation. Although similar, a trial is to determine the initial adoption of the innovation, whereas works evaluation is partly to consider the ongoing implementation. Most of the factors Pannell et al. (2006) identified as important to consider when setting up a trial could support some farm plan works trial, such as its observability, complexity, cost, risk and being representative of the innovation - although the discrete farm plan works can be different from the next works, and are not necessarily a small scale version of the whole farm plan. The six to ten years it takes before benefits from the works are evident is a long time to wait before a decision to adopt the innovation is made. This factor also makes the process of implementing works not accurately termed a trial, but ongoing implementation.

Specific factors influencing the adoption of farm plans and farm plan works are now discussed in relation to the three broad categories. First, factors related to the innovation.

6.3.1 Compatibility of the farm plan works with the core farm business

The term compatibility, as used in this research is similar to the explanation of compatibility used by other authors. Consistent with Pannell et al.'s (2006) and

Wejnert's (2002) explanations, the results emphasised the importance for works to be easily incorporated into the farm system. By comparison, Rogers' (2003) definition, and Wejnert (2002) also described compatibility, focussing on how well the innovation suits the social circumstances of the farmer or social norms of a community. Although these social aspects were not significant in the results of this research, farmers interviewed accepted farm plans as an appropriate approach to address erosion on hill country. Farmers' goals were not directed at achieving farm plan implementation, but often supported the concepts of which farm plans were a part, such as environmental sustainability and leaving a farm for future generations.

An important clarification in this case, which is not articulated in the literature, is that farmers did not consider the innovation to be essential to the core farm business. This may reflect that farm plans and farm plan works are not directed at increasing production and profitability, but are directed at mitigating an environmental issue. Whatever the reason, completing farm works was secondary to other core farm business activities. The importance of the ease of implementation, discussed in the next section as a factor influencing farmers' adoption, also reflects the level of priority they place on the innovation. If the implementation of farm works was disruptive of other activities deemed to be core to the farm business and more important, then it was less likely that they would be implemented.

6.3.1.1 Ease of implementation of farm plan works

A key feature in this research was the link between ease of implementation and compatibility with the core farm business. Although this link is logical, it was not explicit in the literature that was reviewed. This finding is likely to reflect the level of priority farmers give to farm plan works. Production and development and protection of infrastructure were clearly stated as main priorities by a number of farmers. When farm plan works are easy to fit around the core farm business, they also contribute to the compatibility of the works. Pannell et al. (2006) linked complexity to relative advantage and trialability but not to compatibility.

The ease with which farm plan works can be implemented influences the level of adoption. Although farmers in this research did not highlight the complexity of the innovation as a factor influencing their use of farm plan works, there is a clear link

between ease-of-use and the concept of complexity as defined by Rogers (2006). Rogers defines complexity as, “the degree to which an innovation is perceived as difficult to understand and use” (p. 16). Like Rogers’ definition, farmers in this case did not express farm plans and works as difficult to understand or use - whereas Cary et al. (2002), Guerin (1999) and Pannell et al. (2006) only refer to complexity as an individual’s difficulty to understand the innovation. Farmers did not state farm plan works as difficult to understand, and in addition to understanding, the practical ease with which the works could be implemented was an important factor, which the farmers identified. However, the level of understanding and the analysis involved in the resource inventory for each farm are not without complexity.

Guerin (1999), Cary et al. (2002), and Pannell et al. (2006) state that information and understanding of an innovation reduce the perception that an innovation is complex. Farmers in this research are likely to understand farm plans and farm plan works from experience on their farms and support from the GWRC. Farmers with experience and knowledge of their own farms understand farm plans and thought it reflected their farms appropriately. Those farmers who had been on their farms for a short time only, did not consider the plan complex either. Field staff supported farmers by taking time to explain the farm plans so they understood them. Field staff often supported farmers to make decisions on which farm plan works to implement. In these ways the GWRC ensures that the innovation is not complex for farmers. Although other authors did not specify that a role of extension agents is to reduce complexity of the innovation, many authors recognised the need for extension agents to respond to issues or constraints that arise for the farmer (Guerin, 1999; Lovejoy & Napier, 1986; Rogers, 2003), and provide information and understanding (Morris et al. 2000, Rogers, 2003; Pannell et al., 2006).

Flexibility of practical implementation of farm plan works encouraged adoption, which is consistent with the literature (Duff et al; 1992; Smallshire et al., 2004). Farm plans comprise discrete parts called farm plan works, and in addition, the works have flexibility as to when, by whom and to what extent they are implemented, thus providing a range of choices. The description of flexibility in the literature is slightly different from, although similar to, what emerged in this case. Duff et al. (1992) and Smallshire et al. (2004) refer to providing more choices with different options or

components to an innovation. Although not explicitly stated by other authors the outcome of flexibility as described for farm plan works and in the literature is potentially the same: the choices allow the innovation to fit around the existing farm business, thus contributing to compatibility.

Farm plan works are also flexible with how they are implemented, which often contributes to their compatibility, increasing the level of success, and encouraging ongoing implementation. A number of authors refer to the ability of an individual to modify an innovation, or reinvent it (Rogers, 2003), which leads to faster rates of adoption (Folke et al., Mercer, 2004; 2002; Rogers, 2003). Individuals often modify an innovation to increase its compatibility with specific circumstances. Modifications to an innovation are also made to simplify it, to make cosmetic changes to it so farmers feel proud of what they have put in place, and to establish ownership of the innovation (Rogers, 2003), and to be more efficient with its use (Feder et al., 1985). Rogers also indicated that an innovation can be designed with parts to encourage individuals to modify it. Many of these reasons for modifying an innovation are integral to a farm plan - such as the flexibility of the farm plan, the number of discrete parts, and the ability to customise the design to each farm.

The availability of inputs to carry out farm plan works influences the level of implementation. Some innovations do not require inputs, but for innovations that do, the literature did not address availability of inputs as an issue. However, the authors covered in the literature review concentrated on adoption of innovations in developed countries. An example of research on adoption of soil conservation measures in Africa identified, "resource access (social networks, planting material, information)" (p. 354), as influential on successful adoption of innovations (German, Mowo, & Kingamkono, 2006). In this case, accessibility of inputs by farmers from supply agents was straightforward, but the suppliers did not have available the quantities which farmers wanted, which limited the amount of works dependent on trees which farmers were able to implement. This may provide another example that emphasises farm plan works as not core to the farm business. The GWRC makes trees easily available to farmers as a way to encourage implementation. If farm plan works were a core farm business activity, farmers are likely to work hard to access more trees, whereas farmers

accepted the limited availability and limited the level of implementation of tree planting.

Technical advice and support made an important contribution to individuals' decisions regarding farm plans and farm plan works. Farmers in this case could easily access field staff and technical advice. This factor supports a number of authors in the literature (Lovejoy & Napier, 1986; Morris et al., 2000; Rogers, 2003). The link between access to technical advice and compatibility of the innovation was not evident in the literature. Logically technical advice contributes to compatibility in relation to reducing complexity or any difficulty associated to an innovation.

6.3.1.2 Benefit - cost analysis of farm plan works

Boundaries to define benefits and costs are difficult to ascertain and were often used in the literature to include a wide spectrum of factors (Knowler & Bradshaw, 2007; Marshall, 2004; Wejnert, 2002). The range of benefits that emerged in this research includes farmers' perceptions of an innovation for themselves, and for the wider community, and reflects the approach Knowler and Bradshaw's (2007) and Wejnert's (2002) use of benefits and costs.

Farmers evaluated both financial costs and nonfinancial benefits and costs for their decisions of farm plans and farm plan works. This differentiation was not used in the literature and highlights an important characteristic of this case. Financial benefits from farm plan works were often not given high priority by farmers in their decision making. This may reflect the difficulty farmers had in accurately forecasting the financial benefits from farm works, partly because of the time lag before they can be evaluated. The variability of physical conditions across a farm also makes it hard to calculate accurately the impact of farm plan works on production. By comparison, financial costs of implementing works annually were of direct concern to farmers.

The time lag before benefits are evident from the implementation of farm plan works did not clearly influence ongoing implementation. However, the time lag before benefits are evident was linked to a number of environmental innovations (Barr & Cary, 2000; Duff et al., 1992; Mercer, 2004; Pannell et al., 2006), and were suggested to slow the rate of adoption (Duff et al, 1994). The length of time works have been

available has contributed to a body of knowledge on the costs of production of works that farmers can use to evaluate them. Examples of established works are available across the region that farmers observe. This may explain why the delayed benefits did not impact implementation of farm plan works in this study.

The financial cost to implement innovations is an important part of farmers' decision as to whether or not to adopt (Cary et al., 2002; Guerin, 1999; Marra et al., 2002). This research confirms the importance of these considerations. The financial cost of farm plan works, the level of subsidies assigned to works and the comparative cost of different works all contributed to decisions farmers made with regard to their implementation.

The level of subsidies sometimes encouraged adoption and implementation of farm plan works, but was not always sufficient to do so. This is similar to Knowler and Bradshaw's (2007) review of research that identified both examples where incentives increased adoption and also when they did not. However, as Cary et al. (2002) and Pannell et al. (2006) recognised, subsidies were only one of many considerations farmers included in their decisions that influenced levels of adoption. At different times the mix of factors influencing a farmer's implementation of works could override the benefits that subsidies provide.

A wide range of nonfinancial benefits and costs were identified in this research that farmers considered in their decisions about the adoption of an innovation, as Pannell et al. (2006) found. The farmers' evaluations of nonfinancial benefits and costs included an assessment of the extent of the problem as well as the assessment of the benefits, on-farm and off-farm, from implementing farm plan works.

This research supports authors (Barr & Cary, 2000; Knowler & Bradshaw, 2007; Pannell et al., 2006; Rogers, 2003) who describe individuals' perceptions of the extent of a problem as motivation to adopt an innovation that will address the problem. This was particularly apparent in this research when the impact and extent of erosion on-farm and off-farm are clearly visible to farmers. When the problem is not clear or obvious, there is less interest in addressing the problem (IPCC, 2000). For a number

of environmental issues the extent of the problem is more difficult to see, such as salinity (Marshall, 2004) and chemical pollution (de Buck et al., 2001).

Damage to farms after storm events acted like a 'cue-for-action', as described by Rogers (2003). The visible evidence of erosion on a farm is also a 'cue-for-action' but a storm event acted as a dramatic reminder to address the issue. After a storm event, when serious damage to productive land and infrastructure was clearly seen, farmers were often motivated to augment implementation of works. Rogers places 'cues-for-action' in the persuasion stage of the Innovation Decision Process, and the decision stage to implement the innovation follows.

The terms tangible and intangible were useful to organise the range of benefits and costs identified in this research. In this research tangible benefits and costs related to farm plan works' impact on production and infrastructure. Knowler and Bradshaw (2007) also linked aspects of production to benefits and costs. However, no reference was made to infrastructure. Intangible benefits and costs were more difficult to measure, such as aesthetic value of trees or the impact of erosion on the catchment. The terms intangible benefit or cost were not identified in the literature, however specific examples of intangible benefits and costs found in this research were identified by other authors such as Wejnert (2002).

Some farmers implemented farm plan works because they perceived benefits to the wider community. Marshall (2006) and Knowler and Bradshaw (2007) also stated this factor in their research. Guerin (1999) indicated that community benefits, as a factor influencing adoption, could be attributed to opinion leaders only. Farmers in this case perceived community benefits in two particular ways. The evidence of reduced flooding and less infrastructural damage after works implementation were clearly visible; also, farmers with land bordering the river realised that the consequence of erosion from their land had a wider impact down stream. Farmers' recognition of community benefits in Marshall's (2006) research was their perception of community viability and vitality expected from the adoption of LWMPs and the development of the regional irrigation scheme.

6.3.1.3 The match between farm plan and farm plan works, farmer and farm circumstances

Results from this research confirmed the importance of a match between the innovation and the individual's social and physical circumstances in influencing the level of adoption (Pannell et al., 2006; Rogers, 2003; Wejnert, 2002). However, the OEFPs (Smithers & Furman, 2003) constituted the only innovation outlined in the literature that was specifically designed to match the individual circumstances of 'adopters'. The OEFPs are very similar to the farm plans explored in this research. Farm plans are such that different works can be selected to match the farm circumstances that are identified in a physical resource inventory. The attributes of both farm plans and OEFPs that enable the match to specific circumstances are not only the number of parts to the innovation, but also the flexibility to vary the selection of parts to suit different circumstances.

The involvement of farmers in developing the farm plan, the quality of communication between field staff and farmers, and the understanding and analysis used for the physical resource inventory support the compatibility of the match between the innovation and the farm circumstances. Each attribute involves field staff, and Guerin (1999) and Pannell et al. (2006) identified two of the attributes as contributing to the credibility of an extension agent, but not the involvement of the farmer. Guerin (1999) and Pannell et al. (2006) stated that getting to know and understand farmers to develop a relationship was important, but they did not emphasise getting farmers involved. The importance of field staff credibility to carry out the development of each farm plan in this case is discussed in Section 6.5.1.

6.3.1.4 The proven reliability of farm plan works'

Proven reliability of farm plan works emerged as an important factor encouraging the ongoing use of works. Only Cary et al. (2002) mentioned reliability as being a factor influencing an innovation's adoption. The length of time farm plans have been used in the region has provided experiences and evidence for the reliability of the innovation to be assessed. The reason for reliability not being identified as a factor contributing to the level of adoption of an innovation is that, by definition, they are yet to be proven as reliable. A lot of adoption diffusion literature focus on the initial uptake.

The level of success which farmers experience from farm plan works implementation contributes to ongoing adoption. Success refers to whether the innovation works or not and whether or not farmers get the outcomes they expect from use of the innovation. The literature does not focus on whether or not the innovation works. There is an assumption that the innovation is a positive contribution for the individual who adopts it. For the English Stewardship programme, Kyntec (2003; cited in Smallshire et al., 2004) measured success across regions by the number of agreements with farmers (the initial document when a farmer agrees to implement particular components of the programme) and what components of the programme had been implemented. Measures of success that farmers identified in this case are specific to farm plan works and include: level of soil stability on farms, survivability of trees, and the amount of implemented works established and maintained across a farm. Although farmers experienced some significant setbacks in farm plan works implementation, overall farmers achieved sufficient success to continue implementation. It is likely that the widespread adoption of farm works by farmers in the region also contributed to farmers' perception of the success of the innovation.

As highlighted by Wilkinson (1989) and Smallshire et al. (2004), improvements made to innovations, as was the case for farm plan works, have contributed to enhancing their adoption. Much of the literature on adoption and diffusion does not mention this factor. However, innovations are not often analysed over a long period of time, therefore discussions in the literature is limited about changes to innovations over the long-term. A wide range of factors encouraging continued implementation might have counteracted the setbacks farmers experienced, including improvements and successful establishment of works.

Research and development have played significant roles in the improvement of farm plans and farm plan works, and encouraged the ongoing implementation of works. Ongoing research and development were not identified in the literature as factors encouraging the adoption of an innovation. Guerin (1999) identified the importance of farmers' involvement in research and development and the scientist's role in recognising problems associated with existing innovations. The field staffs' intimate involvement with farmers is likely to have ensured that research with which they were involved was relevant to farmers' needs, as Guerin (1999) describes. In the next

section characteristics of the farm and farmer that influenced adoption of farm plans and farm plan works are discussed.

6.3.2 Characteristics of farmers and their farm circumstances

Only a few characteristics of farmers and their farm circumstances emerged as strong influences on the adoption of farm plans and farm plan works. This is linked to the character of this innovation. Farm plans and works are specifically customised to each farmer's circumstances. Therefore, factors that are discussed in the literature - such as goals (Pannell et al., 2006; Wallace, 2006), attitude (Cary et al., 2002), beliefs (Wejnert, 2002), age (Guerin, 1999; Pannell et al., 2006; Rogers, 2003), education (Feder & Umali, 1993), farm size (Cary et al., 2002), tenure (Guerin, 1999) and financial security (Cary et al., 2002) are considered when works are selected for the farm plan. These factors did not emerge as factors significantly influencing the adoption of farm plans and works, because they are likely to have been recognised and accommodated within the plan.

Farmers' view of the innovation was a key characteristic influencing the adoption of farm plans and farm plan works. This view has been influenced by such things as personal experience with implementing works, contact with peers, neighbours and champions and different information sources. As discussed in Section 6.3, previous generations and employers were champions and played a significant role in influencing farmers' views of tree planting, farm plans and farm plan works. Peers, neighbours and information sources did not emerge as strongly influential, but farmers certainly used these sources as part of their decision making. Consistent with other research, farmers' experiences with the innovation influenced their level of adoption, both positively and negatively (Feder et al., 1985; Guerin, 1999; Pannell et al., 2006; Rogers, 2003).

Farmers' level of discretionary time and funds influenced the implementation of farm plan works. Although this is not explicitly stated in the literature, an individuals available time and funds logically will impact on decisions regarding an innovation particularly when they are considered secondary to the core business. The level of funds is relevant to the discussion in Section 6.3.2, regarding financial costs influencing adoption of farm plans and farm plan works. The discretionary time and

funds referred to in this case often were in reference to the short term annual decisions, whether to implement works or not. These circumstances include family demands, off farm businesses and interests, core farm business demands, and external factors such as market prices affecting farm income. The shortage of discretionary time and funds was particularly evident for farmers with less developed farms.

The stage of farm development was an important influence on farmers' decisions to adopt farm plan works. Some farmers developed their farms and established sufficient farm income before the implementation of farm plan works began. Stage of farm development was particularly relevant for farmers with less developed properties for whom, activities on the farm that ensured sufficient farm income had to take priority. Prioritisation of activities on a farm and stage of farm development were not identified in the literature reviewed. However, stage of farm development, similar to the above discussion of discretionary time and costs, highlights the following factors: farmers did not consider the innovation to be essential to the core farm business (Section 6.3), and the financial costs of farm plan works were an important part of farmers' decisions regarding implementation of farm plan works (Section 6.3.2).

Farmers' level of interest in environmental issues influenced their enthusiasm to adopt farm plans and farm plan works. This supports Knowler and Bradshaw's (2007) review, which highlighted some studies that linked a positive environmental attitude with adoption of environmental innovations. However, Knowler and Bradshaw reviewed other studies that found an insignificant relationship. Possible reasons for variable relationships between adoption of innovations and a positive environmental attitude were not elaborated on by Knowler and Bradshaw (2007). However the level of adoption by farmers in this case was moderated by other factors, such as financial cost. Farmers less motivated by environmental interests had similar levels of adoption to those with an interest.

For this research both extent of erosion and awareness of the erosion were factors influencing adoption. Farmers on farms with less erosion were also less likely to adopt farm plan works. This result supports Knowler and Bradshaw's (2007) review of empirical research that found that the level of soil erosion on farms encouraged adoption of soil conservation practices. However, Knowler and Bradshaw also

reviewed some studies that stated soil erosion itself was not a factor encouraging adoption of soil conservation practices. These studies suggested that the awareness of soil erosion, rather than the presence of the erosion, is a more critical factor.

The centrality of goals that Pannell et al. (2006) and Wallace (2006) highlighted for decisions to adopt an innovation was not supported in the results of this research. Farmers' stated general goals that did not specifically relate to farm plans, therefore did not stand out as a significant influence towards adoption of farm plans. However, the goals often did support the mitigation of erosion, such as farming for future generations or ensuring an ongoing productive farm unit. The reason for goals not standing out as a significant factor influencing adoption is due to the secondary priority of farm plan works. The higher priority of core farm business activities equally support the goals identified and are more likely to be linked to farmers achieving their goals.

6.3.3 Credibility of the organisation delivering farm plans

Credibility of the organisation and its staff delivering farm plans stood out as a major contribution to the level of adoption of farm plan works. The credibility of extension agents was highlighted in the literature reviewed (e.g. Guerin, 1999; Pannell et al., 2006), however, the credibility of the organisation for which the agents work, and the influence of this on adoption was not. There are a number of reasons for the credibility of the organisation being identified as significant to adoption. In this case, farmers accept that the organisation is responsible for soil conservation in the region. The influence on farmers from a wide range of soil conservation related activities carried out by the organisation and its field staff has continued over a long period of time. Field staff from the organisation play an important role delivering farm plans, and convey the organisation's responsibility in their expertise and dedication to achieve soil conservation on farms. In addition, the organisation provides a range of additional contributions to farm plan implementation. The GWRC is the main supplier of both specialised trees specifically developed for farm plan works, and contractors to carry out farm plan works; the GWRC also provides efficient systems to deliver supplies. All farmers interviewed use the GWRC's supply of trees and many utilise their contractors.

This research supports the literature that links credibility of an extension agent to increasing the level of adoption of an innovation (Feder & Umali, 1993; Guerin, 1999; Knowler & Bradshaw, 2007; Pannell et al., 2006; Rogers, 2003). Field staff credibility contributing to the organisation's credibility, in this case, includes three key factors: technical competency of field staff, the relationship built between field staff and the farmer and the field staff's ability to design an appropriate farm plan for a farmer's circumstances. The technical skills of field staff and their relationship with clients were two important factors contributing to extension agent credibility identified in the literature (Guerin, 1999; Lovejoy & Napier, 1986; Morris et al., 2000; Pannell et al., 2006; Rogers, 2003).

In this case technical competency of field staff and the relationship between field staff and farmer were closely linked. This confirms what Guerin (1999) and Pannell et al. (2006) explain in their papers. The technical competency of field staff contributed to their relationship with farmers, and farmers with a well established relationship with a field staff member were more accepting of occasional poor advice. This research has helped to clarify the importance of a range of attributes an extension agent requires to build his/her credibility.

A range of field staff attributes support their technical competency and the relationship they have with farmers, which consequently builds their credibility. Farmers in this case recognise the district office staff as experts in soil conservation. This supports Guerin (1999) who suggests that an extension agent should "be well informed on the latest developments in land management" and "have an overall knowledge of the environmental management and technology (p. 298)". This research emphasised the importance of farmers having the ability to use field staff as they needed, sometimes regularly and sometimes occasionally. Although somewhat different, Guerin (1999) identified extension agent accessibility, which is a contributing factor to this on-call, responsive approach that emerged in this research. The rapport built between field staff and farmer stood out as a key part of building credibility in this case, and supported by Guerin (1999) and Pannell et al., (2006).

The ability of field staff to design an appropriate farm plan to each farmer's circumstances influences the adoption of farm plans. This skill which field staff

require is not specifically referred to in the literature, due to its being a particular characteristic of this case. However, it is an outcome of the field staff technical competency and their relationship with the farmer. Field staff require technical expertise to design an appropriate farm plan and they require a relationship with farmers such that farm plan works are selected in the action plan to suit a farmer's circumstances and hence these two findings are consistent with those in the literature (Guerin, 1999; Pannell et al., 2006).

Time spent with a farmer was identified as an important component of field staff's ability to build credibility in this research, which agrees with Pannell et al. (2006). Rogers (2003) identified that contact time between an extension agent and a client affects successful adoption of an innovation. Farmers interviewed who had a longer relationship with field staff were more forgiving of poor advice. Pannell et al., (2006) did not identify this particular consequence from time spent with a farmer, but they did identify a number of extension agent attributes that are built over time that could support this finding; in particular was the building of trust.

As indicated above, factors related to the credibility of the organisation were important in this research, but were not noted in the literature as influential to adoption. The discussion above focussed on field staff credibility, however the organisations contribution supporting field staff is also important.

The organisation provide field staff with support to fulfil their role to deliver an innovation, in turn contributing their own credibility. The discussion above on field staff credibility explains the field staff members' role in soil conservation. However there was no reference in the literature about how the organisation can contribute to field staff credibility. The ease of transition for a farmer when new field staff were employed or new farm owners arrived on a property, and farm plan works implementation continued with minimal interruption, contributed to the GWRC's credibility. Documentation used by field staff in this case partly contributed to the ease with which new field staff could take over the liaison with farmers. Another factor in this case contributing to the ease of field staff transition was the support from long-term field staff, who had a high degree of technical competence and established rapport with farmers.

In this research, farmers' perceptions that appropriate policy is being developed by the organisation contributed to its credibility. This link between policy development and organisation credibility was not found in the literature, but likely reflected the GWRC's specific role as a policy implementation body for the region and that it is funded by rates. In support of Morris (2006), this research found that it is important to involve farmers in policy development to achieve optimal environmental outcomes.

Spending by the organisation delivering farm plans impacted on their credibility. In this case farmers expressed their awareness of the GWRC spending, and their desire for it to be cost effective. This may be a reflection of the GWRC being largely funded by rate payers including many farmers. Similarly, Carey et al. (2003) and Morris (2004) identified the need for transparent allocation of spending on the ESA and CSS. Carey et al. (2003) indicated the accountability of money spent by the government was principally for a positive public perception of the government spending. In England, the ESA and CSS schemes are allocated a large amount of agricultural spending from government. Strict criteria are used when farmers apply for funding, to ensure that the tax payer will get the environmental and recreational benefits (Morris, 2004).

6.4 Summary

In this chapter of this research the results largely confirm what is found in the literature. What was described is a specific mix of factors influencing the adoption of farm plans and farm plan works in the case area. There is a high level of awareness and adoption of farm plans across the region that influenced characteristics of this case. Farmers were not at the initial stage of adoption but mostly in consideration of ongoing implementation.

Factors related to the compatibility of farm plans and farm plan works with the core farm business and to the credibility of the organisation delivering farm plans, were highlighted as influential on farmers' adoption of farm plans and farm plan works. Factors related to farmer characteristics and farm circumstances were also significant influencing the adoption of farm plans and farm plan works, but were diminished as a result of the innovation being customised specifically to these characteristics and circumstances.

Farm plans and farm plan works are similar to innovations categorised in the literature as environmental innovations. In addition to the characteristics linked to environmental innovations, not identified in the literature, farm plans and works have been identified in this research as a secondary priority to the core farm business.

Chapter 7

Conclusions

7.1 Introduction

The aim in this research was to provide insights that would inform local body authorities like Horizons Regional Council in their efforts to encourage farmer adoption of whole farm plans. The researcher achieved this aim by investigating the research question. “What factors influence the adoption by farmers of whole farm plans, and why are these factors influential?” A case study including two subcases was employed to identify and describe factors influencing the adoption of farm plans by farmers. The site for the case study, the Wairarapa, was selected because farm plans adopted by farmers in this region matched most closely the Whole Farm Business Plans currently being promoted and adopted within the region administered by the Horizons Regional Council.

The case investigated in this study can be characterised as an example of a farm plan programme which has achieved widespread adoption of farm plans by farmers over a long period of time. The factors explored in this research are those which are influential in the ongoing implementation of farm plans rather than the initial adoption by farmers.

In this chapter, key research findings are summarised and conclusions to the study are drawn. The practical implementations of these findings for organisations like Horizons Regional Council who are seeking to achieve wide spread adoption of farm plans are outlined. Finally, the research methodology is assessed, and further research that can build on the findings of this research is described.

7.2 Research findings summary

The findings from this research are, in the main, consistent with those in the adoption diffusion literature. As for other agricultural innovations a specific mix of interlinked factors related to the innovation, the organisation delivering the innovation and the farmer’s circumstances and farm characteristics influenced the adoption of farm plans.

The specific mix of factors and the reasons why these factors are influential reflect the unique characteristics of the case studied.

The compatibility of farm plan works with the core farm business was one of the main factors identified as relevant to the adoption of innovation in this research. The characteristics of the farmers and their farms were important, and the credibility of the organisation was the key factor related to the organisation delivering the farm plans. Distinctive to this research was that many factors identified in the literature, which related to the farms' and farmers' circumstances did not strongly influence adoption in this study because farm plans are customised and take into account each individual's circumstances.

The compatibility of an innovation is an attribute identified in the literature as influential in farmers' adoption decisions. In this research it was the compatibility of farm plan works with the core farm business that was important. This was because farmers, in the main, viewed the implementation of farm plan works as secondary to the core farm business. The specific aspects of farm plans that contributed to their compatibility highlighted in this research are similar to those reported in the literature for other innovations. These included the ease of implementation of farm works, the flexibility with which farm works could be implemented, and the benefits and costs associated with farm plan works for farmers. The proven reliability of farm plan works was a further factor influencing adoption that was not mentioned in the literature. In this research this factor emerged because farm plans have been used for a long time by farmers in the region and the body of experience in implementing farm plan works within the region and the improvements made to the farm works have provided a basis for assessing their reliability.

Credibility of the organisation delivering farm plans was another significant factor in this case influencing adoption. The literature highlights the importance of extension agent credibility but in this research farmers' assessment of the organisation's credibility was also a factor important to the adoption of farm plans. This focus on the organisation is likely to be because in this research the regional council, the body delivering and supporting the implementation of the innovation, is a local government

organisation funded by rate payers, including those farmers who have adopted the innovation and who were interviewed in this research.

The circumstances of the farmers and the characteristics of their farms that were identified as being influential to farmers' adoption of farm plans are consistent with those in the literature. In this research however, as highlighted earlier, there were a limited number of factors that emerged as being important. These factors were farmers' opinions of farm plans, the level of soil erosion present on farmers' farms, and the amount of discretionary time and money they have available.

The significant role individuals can play in influencing the adoption by farmers of an innovation was confirmed in this research. Whereas the literature refers to opinion leaders, in this research the term champions was used to capture the idea of not just opinion leaders but also those individuals who were significant in influencing an individual farmer's, or a group of farmers', opinion/s about farm plan works and soil conservation. In this research these included grandparents and parents of farmers as well as past employers and field staff.

Farm plans have attributes similar to those associated to innovations that address environmental issues. These attributes are the low economic returns from implementing farm plans, the long time frame needed to implement farm plans, the time lag before benefits are evident, and the impacts on and off farm from farm plan works implementation. Different from what is shown in the literature, farm plans were not identified as complex or difficult to understand. This is attributed to by the level of experience which farmers have had with farm plans and the support provided by the organisation delivering farm plans. In addition to these attributes that are identified in the literature, an important attribute of farm plans in this research is the implementation is secondary to the core farm business.

7.3 Conclusions

An organisation can play an important role in farmers' voluntary adoption of an innovation. This role is emphasised when the innovation is considered by farmers to be secondary to the farm business. Wide spread adoption can be achieved through the

long-term efforts of an organisation that supports the implementation of the innovation through financial incentives, by providing ready access to essential inputs and technical information related to the innovation.

For an organisation that is integral to the delivery and implementation of an innovation by farmers, the credibility of that organisation with farmers will impact on farmers' decisions about the innovation. The credibility of an organisation is linked to the level of credibility of its field staff, but it can also be influenced by the actions and policies of the organisation as a whole.

The potential impact of farmers' circumstances and farm characteristics on the adoption of an innovation is reduced when the innovation is customised to farm characteristics and it is designed to accommodate farmers' circumstances. In addition, an innovation that can provide farmers with choices as to when, to what extent and by who it is implemented can also contribute to its adoption.

Key people can play a significant role in influencing farmers to adopt farm plans. These people are around the farmers supporting and contributing to their decision making. They include opinion leaders, peers, previous generations, employers, and field staff at the organisation delivering the farm plans.

Farmers' consideration of benefits and costs relating to the adoption of an innovation over the longer term is an element of farmers' adoption decisions for farm plans. This can include an assessment of short-term and long-term financial and nonfinancial benefits and costs. In addition to these considerations farmers can also include assessment of on-farm and off-farm benefits and costs.

A mix of interlinked factors that are similar to those that influence the adoption of agricultural innovations influences the adoption of an innovation that addresses an environmental issue on farms. These factors relate to the innovation itself, the circumstances of each individual farmer and his/her farm's characteristics and the organisation delivering and supporting the implementation of the innovation. In addition, the factors that influence the initial adoption of an innovation by farmers are also influential in the ongoing implementation of an innovation over time.

For an innovation that is considered by farmers to be secondary to their farm business, the compatibility of the innovation with the farm business will influence their decision as to whether or not to adopt. The key factors that contribute to the compatibility of the innovation include the ease of implementation, the degree to which the innovation is customised to suit the farmer's circumstances, the farmer's evaluation of benefits and costs, and the proven reliability of the innovation over time.

7.4 Implications for regional councils.

In this research the important role of a regional council in the promotion and support of farm plans, and encouraging farmers' voluntary adoption was highlighted. In this section a number of implications from the findings and conclusions for ways regional councils can carry out this role are provided.

As found in this case, it is likely that farmers consider the adoption of farm plans as secondary to their core farm business. The importance of this for regional councils is to make farm plan implementation compatible with the core farm business. A number of ways to achieve this were highlighted in the case studied. Importantly, field staff worked with farmers to develop a farm plan that is customised to each farm's and farmer's circumstances. The implementation of farm plan works was made as easy as possible by a number of means. The Greater Wellington Regional Council made inputs, such as trees and contractors to carry out the work, easily accessible. Technical advice regarding farm plans and works was also easy to access and subsidies were available to support implementation of farm plan works. In addition to what the regional council could offer, the farm plan itself provided farmers with a number of choices that eased implementation. They have choices concerning when, and to what extent the farm plan works are carried out.

Farmers focussed more on the farm plan works and their implementation rather than the farms' physical analysis in the initial farm plan documentation. The implication of this evidence highlights where the focus of the regional council also can be directed. This initial documentation provided value in understanding the farm's physical

resources for farmers new to their farm, but once this was understood, their focus was directed to the farm plan works.

Regional council credibility with farmers is important for farm plan adoption. The factors that contribute to this credibility include the credibility of field staff and factors contributing the credibility as an organisation. Some key factors that emerged in this study that contributed to the Greater Wellington Regional Council's credibility included the technical expertise of field staff and their relationship with the farmer. Credibility was built over the long term from the Regional Councils commitment and consistent support from supply of resources, improving the farm plan and contributions to a wide range of information sources. Policy decisions and spending that supported soil conservation on farms also contributed to credibility of the Regional Council.

Some key opportunities emerged in this research that could play an important role in the level of adoption of farm plans. Key people who promoted and encouraged farm plans and soil conservation activities were shown to have influenced farmers' adoption. These included field staff, previous generations and employers. Identification and support by these individuals could encourage other farmers. Storm events were cues-for-action for farmers. Additional support to farmers to implement works after a storm could prove valuable in raising the level of ongoing implementation. Financial returns are important to farmers, but many farm plan works provided uncertain, low returns that were not easily calculated. Farm plan works that provide clearly calculated higher levels of returns compared to the current land use, offer key terms of reference for promotion by a regional council.

7.5 Assessment of research methodology

The case study strategy used for this research was appropriate to address the research question. The context of the study is incorporated into a case study, rather than isolating the subject from its context. For this research the context was influential on the findings and helped to explain why factors were influential. The wide range of factors that influenced this case could be considered in a case study, as there is no control on the behaviour of the research subjects.

Key informants were straight-forward to contact, but farmers had varying commitments throughout the year that needed prior consideration. Interviews with farmers were spread out over a year from October 2006 to August 2007. The first telephone calls made by the researcher often failed to make contact with farmers. Therefore the majority of interviews took place the following winter when farmers were more readily available. In future, the researcher needs to take into consideration timing of interviews in the research design. In the research preparation, each stage needs to be timed around various constraints such as farmer availability.

The small number of farmers in each catchment area allowed the researcher to approach all farmers and avoid potential bias in farmer selection. Similar factors emerged from the two catchments chosen, although some differences were expected. The small number of farmers may have contributed to the limited variations, therefore if more time had been available, an additional catchment could have added to the richness of the data and provided more opportunities to identify potential variations.

The use of semistructured interviews by the researcher meant that the interview could be undertaken in a relaxed manner, which appeared to enhance the interviewees willingness to participate, and answer questions openly. The approach provided opportunities for a wide range of information to be gathered during the interview and importantly also led to the inclusion of new topics for questioning in the interviews. A more structured interview approach would not have provided this opportunity.

The qualitative data analysis process was rigorous. The concepts required unambiguous definitions and clear links between them that captured the complexity of the data collected. The iterative process involved continual checking for the appropriateness of the framework. This process was supported by the supervisors of this thesis who demanded clarity, continual reference to the data collected, and highlighted different characteristics from the data not identified by the researcher.

7.6 Further research

This research highlighted key factors particular to this case. The strong influence of contextual factors also identified in adoption diffusion literature, suggests that a case

study in a different region could provide a different set of specific factors influencing adoption. The variations on this case could be a different regional council and level of awareness of the innovation amongst farmers, such as a different region in which a different approach has been employed for the promotion and support of farm plans, or a region in which the level of uptake and awareness of the innovation by farmers is not widespread.

Key characteristics of farm plans influencing adoption that would be worth further investigation, due to the limited examples found in the literature, were identified in this research. Farm plans in this case had been operative over a long period of time and some useful terms of reference were used in this research. The term adoption in this research referred to all stages of Rogers (2003) Innovation Decision Process. Proven reliability was used to describe factors influencing adoption of farm plan works. It would be advantageous for researchers to investigate factors supporting adoption of innovations that are operative over a long period of time, including proven reliability and the five stages of adoption. Another characteristic of farm plans that was not identified in other research but further investigation of which should prove to be beneficial, is factors influencing innovations that are considered secondary or not essential to the core business of farmers.

Practical research supporting the ongoing improvement of farm plan works is also needed. This could include opportunities to increase tree survival, and ease of ongoing management to encourage continued implementation.

To conclude this thesis, this research has provided valuable insights into the adoption of farm plans. Important factors such as the role of the organisation delivering the farm plans and the particular nature of the farm plan design, that takes into account farm circumstances and farmer characteristics, can contribute to farmers' uptake of farm plans and contribute to the mitigation of erosion on farms.

References

- Abadi Ghadim A. K. & Pannell D. J. (1999). A conceptual framework of adoption of an agricultural innovation. *Agricultural Economics*, 21, 145–154.
- AgResearch Ltd. (2005). Kinross Farming Partnership, Whole Farm Plan. Retrieved 20 May, 2006, from http://www.nzarm.org.nz/KinrossWholeFarmPlan_A4_200dpi_secure.pdf.
- Ausseil, O., Barnett, H., Beveridge, A., Fung, L., Gilliard, B., Gordon, F., Janssen, H., McCarron, C., Roygard, J., Todd, M. & Zarour, M. (2005). *State of the Environment Report of the Manawatu-Wanganui Region*. Palmerston North: Horizons Regional Council.
- Australian Government, Agriculture, Forestry and Fisheries. (2007). *National Landcare Programme*. Retrieved 17 May, 2007 from <http://www.daffa.gov.au/natural-resources/landcare/national-landcare-programme>
- Baerenklau, K. A. (2005). Toward an understanding of technology adoption: Risk, learning, and neighborhood effects. *Land Economics*, 81(1), 1-19.
- Barr, N., & Cary, J. (2000). *Influencing improved natural resource management of farms - a guide to understanding factors influencing the adoption of sustainable resource practices*. ACT: Bureau of Rural Sciences.
- Blaschke, P., & Ngapo, N. (2003). *Review of New Zealand environmental farm plans*. New Zealand: Ministry for the Environment.
- Bradshaw, K., & Williams, P. (1998). *Information and communication needs to assist the adoption of sustainable land management practices in North Island Hill*

Country - An initial scoping exercise as part of the Best Management Practices for Eroding Hill Country Programme. MAF Technical Paper 99/5.

Brown, Copeland & Co. Ltd. (1985). *The Economics of the Whareama Catchment Control Scheme.* Wellington: Wellington Regional Council.

Burton, R. J. F., & Wilson, G. A. (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.

Cameron, D. (2004). *Soil Intactness Monitoring.* Retrieved 27 September, 2007 from www.gw.govt.nz/council-reports/pdfs

Cameron, D. (2007). *Catchment Control Schemes-Annual Review.* Report 07.564 Greater Wellington Regional Council. Retrieved 17 July, 2008 from www.gw.govt.nz/council-reports/pdfs

Carey, P. D., Short, C., Morris, C., Hunt, J., Priscott, A., Davis, M., Finch, C., Curry, N., Little, W., Winter, M., Parkin, A., & Firbank, L. G. (2003). The multi-disciplinary evaluation of a national agri-environment scheme. *Journal of Environmental Management*, 69(1), 71-91.

Cary, J. W., Webb, T. J., & Barr, N. F. (2002). *Understanding landholder's capacity to change to sustainable practices. Insights about practice adoption and social capacity for change.* Canberra: Bureau of Rural Sciences.

Chapman, K. (2007, December 11). SLUI venture in full swing. *Manawatu Standard*, p. 12.

Clough, P. & Hicks, D. (1993). *Soil conservation and the Resource Management Act.* MAF Technical Paper 93/2.

de Buck, A. J., van Rijn, I., Roling, N. G., & Wossink, G. A. A. (2001). Farmers' reasons for changing or not changing to more sustainable practices: an

- exploratory study of arable farming in the Netherlands. *Journal of Agricultural Education and Extension*, 7(3), 153-166.
- Dey, I. (1993). *Qualitative Data Analysis, A user friendly guide for social scientists*. London: Routledge.
- Duff, S. N., Stonehouse, D. P., Blackburn, D. J., & Hilts, S. G. (1992). A Framework for Targeting Soil Conservation Policy. *Journal of Rural Studies*, 8(4), 399-410.
- Feder, G., Just, R. E., & Zilberman, D. (1985). Adoption of Agricultural innovations in developing countries: A survey. *Economic development and cultural change*, 31, 225-298.
- Feder, G., & Umali, D. L. (1993). The Adoption of Agricultural Innovations - a Review. *Technological Forecasting and Social Change*, 43(3-4), 215-239.
- Fenwick, J. E. & Tangelder, C. A. (1983). *Directory of New Zealand. Soil Survey Maps*. Distance Education Service Publication Number 3. Lincoln College Press.
- Flyvbjerg, B., & Sampson, T. B. S. (2001). *Making Social Science Matter - why social inquiry fails and how it can succeed again*. Cambridge University Press.
- Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Hollong, C. S., & Walker, B. (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. *Ambio*, 31(5), 437-440.
- German, L., Mowo, J., & Kingamkono, M. (2006). A methodology for tracking the "fate" of technological interventions in agriculture. *Agriculture and Human Values*, 23(3), 353-369.
- Greater Wellington Regional Council. (2000). *Whareama Catchment Scheme five year review – May 2000*. Wellington: Greater Wellington Regional Council.

- Greater Wellington Regional Council (2005). *Measuring up the state of the environment report for the Wellington region 2005*. Retrieved May 28, 2007 from <http://www.gw.govt.nz>
- Greater Wellington Regional Council (2006). *A sustainable region-detailed information. Greater Wellington Regional Council's ten-year plan 2006-16, incorporating the 2006/07 annual plan*. Retrieved May 25, 2007 from <http://www.gw.govt.nz>
- Guerin, T. F. (1999). An Australian perspective on the constraints to the transfer and adoption of innovations in land management. *Environmental Conservation*, 26(4), 289-304.
- Hicks, D. L. (1991). *Effect of soil conservation tree plantings on damage sustained by the Whareama catchment during the storm of 8-11 April 1991*. DSIR Land Resources Contract Report No.91/106.
- Hogg, J. T. (1972). A review of soil conservation in New Zealand. *Tussock Grasslands and Mountain Lands. Institute Review*, 25, 50-61.
- International Panel on Climate Change. (2000). *Methodological and technological issues in technology transfer*. Retrieved 20 February, 2006 from (http://www.grida.no/climate/IPCC/tectran/IPCC_SRTT.pdf)
- Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: a review and synthesis of recent research. *Food Policy*, 32, 25-48.
- Lovejoy, S. B., & Napier, T. L. (1986). Conserving soil: Sociological insights. *Journal of Soil and Water Conservation*, 41, 304-308.
- Manderson, A. K. (2003). *Farming from the ground up: the use of land resource information as a basis for planning farm sustainability in New Zealand*. Unpublished PhD, Massey University, Palmerston North.

- Marra, M., Pannell, D. J., & Abadi Ghadim, A. (2003). The economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve? *Agricultural Systems*, 75(2-3), 215-234.
- Marshall, G. R. (2004). Farmers cooperating in the commons? A study of collective action in salinity management. *Ecological Economics*, 51(3-4), 271-286.
- McCaskill, L.W. (1973). *Hold this Land. A History of Soil Conservation in New Zealand*. Wellington: A.H. & A. W. Reed Ltd.
- Mercer, D. E. (2004). Adoption of agroforestry innovations in the tropics: A review. *Agroforestry Systems*, 61(1), 311-328.
- Ministry of Agriculture and Fisheries (2008). *About the SLM Hill Country Erosion Fund*. 5pp. MAF Retrieved 19 June, 2008, from <http://www.maf.govt.nz/mafnet/rural-nz/slm-hill-erosion-programme>
- Morris, C. (2004). Networks of agri-environmental policy implementation: a case study of England's Countryside Stewardship Scheme. *Land Use Policy*, 21(2), 177-191.
- Morris, C. (2006). Negotiating the boundary between state-led and farmer approaches to knowing nature: An analysis of UK agri-environment schemes. *Geoforum*, 37(1), 113-127.
- Morris, C. & Potter, C. (1995). Recruiting the new conservationists: Farmers' adoption of agri-environmental schemes in the U.K. *Journal of Rural Studies*, 11(1), 51-63.
- Morris, J., Mills, J., & Crawford, I. M. (2000). Promoting farmer uptake of agri-environment schemes: the Countryside Stewardship Arable Options Scheme. *Land Use Policy*, 17(3), 241-254.

- Newnham, W. L. (1948). Soil conservation in New Zealand. Policy and progress. *New Zealand Science Review*, 6(3), 47-54.
- Noble, K. E. (1985). *Land use capability classification of the Southern Hawke's Bay-Wairarapa region: a bulletin to accompany New Zealand Land Resource Inventory worksheets*. Wellington: Ministry of Works and Development.
- Ontario Ministry of Agriculture, Food and Rural Affairs. (1998). *Canada-Ontario Environmental Farm Plan*. Retrieved May 17, 2007 from www.omafra.gov.on.ca/english/environment/OEFP/OEFP.htm
- Pannell, D. J. (1999). Economics, extension and the adoption of land conservation innovations in agriculture. *International Journal of Social Economics*, 26(7/8/9), 999-1012.
- Pannell, D. J., Marshall, G. R., Barr, N. F., 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.
- Patton, M. (1987). *How to use qualitative methods in evaluation*. Sage Publications, California, United States of America.
- Rauniyar, G. P., & Parker, W. J. (1998). *Constraints to farm level adoption of new sustainable technologies and management practices in New Zealand pastoral agriculture*. Retrieved June 5, 2004 from <http://www.maf.govt.nz/mafnet>
- Rogers, E. M. (1983). *Diffusion of Innovations* (3rd ed.). New York: Free Press.
- Rogers, E. M. (1995). *Diffusion of Innovations* (4th ed.). New York: Free Press.
- Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press.

- Schmitzberger, I., Wrбка, T., Steurer, B., Aschenbrenner, G., Peterseil, J., & Zechmeister, H. (2005). How farming styles influence biodiversity maintenance in Austrian agricultural landscapes. *Agriculture Ecosystems & Environment*, 108(3), 274-290.
- Schrader, B. (2007). *Wairarapa, TeAra – the encyclopedia of New Zealand*, updated 6 November, 2007. Retrieved August 5, 2008 from <http://www.TeAra.govt.nz/places/wairarapa/wairarapa/en>
- Smallshire, D., Robertson, P., & Thompson, P. (2004). Policy into practice: the development and delivery of agri-environment schemes and supporting advice in England. *Ibis*, 146(Suppl.2), 250-258.
- Smithers, J., & Furman, M. (2003). Environmental farm planning in Ontario: exploring participation and the endurance of change. *Land Use Policy*, 20(4), 343-356.
- Sommers D. G. & Napier T. L. (1993). Comparison of Amish and non-Amish farmers: a diffusion/farm-structure perspective. *Rural Sociology*, 58,130-45.
- Spence, W. R. (1994). *Innovation: the communication of change in ideas, practices and products* (1st ed.). London: Chapman & Hall.
- Statistics New Zealand (2002). *Farms by farm type (ANZSIC) and territorial authority: 30 June, 2002*. Retrieved September 24, 2007 from <http://www.stats.govt.nz>
- Statistics New Zealand (2006). *Territorial authority by sex and age group for the census usually resident population count: 2006 census*. Retrieved September 24, 2007 from <http://www.stats.govt.nz>
- Statistics New Zealand (2008). *Boundary Map of Wellington*. Retrieved August 5, 2008 from <http://www.stats.govt.nz>
- Thomas, R. M. (2003). *Blending Qualitative and Quantitative Research Methods in Theses and Dissertations*. Thousand Oaks, California: Corwin Press, INC. A SAGE Publications Company.

- United States Government Accounting Office (1990). *Case study evaluations*. Retrieved May 25, 2006 from www.gao.gov/special.pubs/pe1019.pdf
- Upadhyay, B. M., Young, D. L., Wang, H. H., & Wandschneider, P. (2003). How do farmers who adopt multiple conservation practices differ from their neighbors? *American Journal of Alternative Agriculture*, 18(1), 27-36.
- Vanclay, F. (1999). Green or gone: Health, ecology, plagues, greed and our future. *Journal of Sociology*, 35(1), 117-119.
- Wairarapa Catchment Board (1986). *The Whareama Story*. Wellington: National Water and Soil Conservation Authority.
- Wallace, K. J. (2006). A decision framework for natural resource management: a case study using plant introductions. *Australian Journal of Experimental Agriculture*, 46, 1397-1405.
- Water and Soil Division, Ministry of Works and Development. (1979) *Our Land Resources- a bulletin to accompany New Zealand Land Resource Inventory Worksheets*. Wellington: Ministry of Works and Development.
- Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. *Annual Review of Sociology*, 28, 297-326.
- Wilkinson, R. L. (1989). *Stepwise adoption of a complex agricultural technology*. MAgrSc thesis. University of Melbourne, Melbourne.
- Wood, R. J. (2000). *Wairarapa Catchment Scheme five year review*, Masterton: Greater Wellington Regional Council.
- Yin, R. K. (1994). *Case Study Research, design and methods* (2nd ed.): Sage Publications.

Appendices

**Appendix 1: Report prepared for the Horizons Regional Council: Historical
Farm Plan Data for Horizons Region Whole Farm Plans**

Appendix 2: Topic areas for interviews in case selection

**Appendix 3: Ethical considerations
Introductory letter received by interviewees**

Appendix 1: Report prepared for the Horizons Regional Council: Historical Farm Plan Data for Horizons Region Whole Farm Plan

Historical Farm Plan Data for Horizons Region Whole Farm Plans

Report on historical farm plans from the Horizons region, for entry into a database to support Whole Farm Plans being developed as part of the Sustainable Land Use Initiative (SLUI).

Attn: Grant Cooper

Horizons Regional Council

From: Sian Cass

Institute of Natural Resources (INR)

Massey University

Date: August 1, 2006

Contents

Part One.....2

Introduction.....2

Objectives.....3

Method.....3

Results.....3

Part Two.....6

Data Entry Procedure.....6

Appendix One.....13

Examples of data entry for historical farm plans

Examples of data entry for catchment schemes

Appendix Two.....16

Soil Conservation and River Control Council Soil and Water Conservation Plan format (1969).

Part One: Introduction

Farm plans have been generated for over 50 years in the Horizons region and have potential to provide information that can be useful for the development of Whole Farm Plans. Whole Farm Plans, in this report, specifically refer to the format used for farm planning in the Sustainable Land Use Initiative being implemented by Horizons Regional Council. The first prototype was completed in 2005 and can be viewed at <http://www.nzarm.org.nz/KinrossWholeFarmPlan>. In 1989, Manawatu Catchment Board, Rangitikei/Wanganui Catchment Board and part of the Wairarapa Catchment Board was amalgamated to form the Horizons Regional Council. All farm plans completed by these organisations prior to Whole Farm Plans are referred to as historical farm plans in this report.

The objectives and methods used for this study and how to identify what types of data will be useful are outlined below. The results section summarises the content of historical farm plans and explains the database categories for collating useful historical farm plan information. Part Two provides a step-by-step procedure for searching for and categorising information in each historical farm plan and for recording it in the database.

Historical farm plan documents produced in the Horizons region often do not include the original data, but rather, they tend to focus on the work required by the farmer to make improvements. Typically the reasons for those improvements are summarised in a brief introduction. Historical farm plans for large farms and/or farms with significant environmental issues are more likely to contain detail of the analysis carried out. Catchment schemes documentations have maintained the land resource analyses that contributed to the associated individual farm plans. Two types of farm plans were produced: farm plans that analysed the whole farm and prioritised and identified issues that could be addressed over a five year period, and plans that just focussed on one part of the farm to address isolated issues over a one to three year period. These plans will be referred to as farm plans and issue-based plans respectively. Land Resource Inventory (LRI) and Land Use Capability (LUC) analyses were used to examine the farm to inform the development of the farm plan.

Objectives

The purpose of this report is to categorise information from historical farm plans that is likely to be useful for the development of Whole Farm Plans. The report outlines an efficient procedure to find the most relevant data from the historical farm plans and enter these into a database. Whole Farm Plan developers will be able to efficiently find and utilise information that has been completed for the farm they are planning for.

Method

Previous Catchment Board and Horizons staff were interviewed to ascertain what the historical farm plans contained and where they could be located. Examination of the historical farm plan contents confirmed and clarified the range and type of information. Discussions with present staff refined what would be useful for the Whole Farm Plans.

Results

The majority of historical farm plans are held at Horizons, Palmerston North office. The archives contain all the Catchment Board plans and the library has all the Horizons Regional Council historical farm plans. Farm plans that are in operation currently are in different Horizon depots and the Wairarapa Catchment Board farm plan maps are located in the Dannevirke depot. Copies of farm plans are found in the Marton depot and may provide maps that are missing in the Palmerston North archives. Catchment Schemes are filed as separate documents and located in various places in the Palmerston North archives and library. Catchment Scheme names, e.g. Makopua, can identify and locate them through the library database.

The most useful data from historical farm plans for Whole Farm Plan development are data collected from a farm that are consistent over time, for example, data about the soil, slope and rock type. This information, along with erosion and vegetation, is found in the Land Resource Inventory (LRI) and is of primary interest for the Whole Farm Plans. Land Use Capability (LUC) is an interpretation of the Land Resource Inventory and separates land into eight classes from Class I flat productive arable land to Class 8

land with severe productive limitations. It is difficult to know retrospectively why a particular land Class has been designated without the Land Resource Inventory information, and therefore LUC is not valuable on its own. The inclusion of rock type is an advantage as it helps to understand the reasons for the designation of a Land Use Capability class. The LRI and LUC must relate to specific locations and this is most clearly represented on a farm map. Paddock maps are helpful to locate areas on the farm but may change with different management that often occurs with new ownership. Categories chosen for the database will focus on land resource information.

The Soil Conservation and River Control Council (SCRCC) was responsible for the allocation of grants for farm development during the Catchment Board era. They requested that farm plans be presented to them in a specified format. The format, developed in 1969, is in Appendix Two, and variations of this can be seen in the historical farm plans. For a specific farm plan, LRI and LUC information was expected to be included. Mapping of the LRI was also expected to be done but not necessarily submitted to the SCRCC (see the description of section 1.05 in Appendix Two). Grants were allocated after works proposed in the farm plans were completed. Claims were submitted each year after the farm plan was developed.

The Manawatu Catchment Board historical farm plans rarely include LRI and LUC information. Sometimes LUC information is included on a map but it is likely to have come directly from national scaled mapping that is inappropriate for the farm level. A practical works programme based on re-fencing for improved land use was the focus of farm plans in this catchment.

The Rangitikei/Wanganui Catchment Board included LRI and LUC information for large farms and/or those with serious issues that required attention. Smaller farms still had an LRI completed but it was not included in the documentation. Soil surveys were carried out on farms prior to the 1970s, but after this period national soil maps were used to identify the soil types on a farm.

The Wairarapa Catchment Board historical farm plans include both LRI and LUC information that is often supported by an aerial map. Soil and rock type descriptions are often detailed.

Horizons Regional Council has largely maintained the historical Catchment Board method for farm planning but there are a few examples of different approaches having been taken. Some farmers were encouraged to do their own farm analyses. Land Management Units (units of the farm allocated according to management) have been allocated to large farms instead of LUC or LRI. Many plans are issue based.

Catchment schemes and community schemes are mostly in the Rangitikei/Wanganui catchment. The individual farm plans were still completed in accordance to the standard format but had the scheme objectives incorporated. Often little reference is made in the farm plan documentation except acknowledging the different grant allocations in the financial statement. The catchment scheme documents often have detailed descriptions of soils, geology and LUC, including relevant maps.

In summary historical farm plans have been developed using LRI and LUC analyses except in the Manawatu Catchment Board. Often the detail of the LRI and LUC analyses are not included in the farm plan documentation. Soil surveys were rare at the farm scale after the 1970s. The focus of the historical farm plan documentation is usually on the work that needed to be done by the farmer. Larger farms and those with serious issues to address may include the LRI and LUC information in more detail. Catchment Scheme documents have greater land resource detail and are worth sourcing if a farm has been involved.

Part Two: Data Entry Procedure

The following are instructions for someone to enter information into the historical farm plan database. It describes how to identify information in the historical farm plans and what abbreviations to enter into the database. Examples of entries are presented in Appendix One, which is Excel worksheets submitted with this report. The descriptions below simplify the data entry process but still offer the reference point necessary to decide whether to access an historical farm plan. All farm plans can be found at Horizons Palmerston North head office, except Wairarapa Catchment Board maps and additional information which are held at the Dannevirke office.

Specific formatting has been chosen to enable the Excel worksheets to be transferred to a database programme if necessary and information can be found easily. Minimising the amount of data in each cell and using more columns to achieve this. Abbreviations that are distinguished from other entries allow searches for specific information, eg. 01 can be distinguished from 1983, whereas, '1' could not be.

There are two worksheets: one for farm plans and the second for catchment schemes. The data entry is divided into four categories: Searches, Farm Changes (or Dates for catchment schemes), Maps and Description. Each has three to five sub categories. Catchment scheme entries are elaborated in the final section of Part Two.

Searches:

This category provides a range of options to locate the historical farm plans in the archives and library. Farm plans are identified on this database by the owner's name, the farm name and the road location. Sometimes there is more than one farm plan document for the same property, particularly those from the Rangitikei/Wanganui Catchment Board. The reference number is necessary to locate the farm plan in the library for Horizons farm plans only. The Catchment Board farm plans are filed in alphabetical order of the farm owner.

If there is no data for a subcategory, the space should be left blank in the worksheet.

1 Farmer

Enter the name of the present owner. This is found on the front of the farm plan file or in the introductory statement.

2 Farm Name

Name the farm, if there is one; otherwise leave blank.

3 Location

Enter the name of the road on which the farm is located and the general area, e.g. Wanganui.

4 Reference

Enter a reference number for Horizons farm plans. These are ordered numerically in the archives. For the other farm plans, enter the abbreviation of the Catchment. Manawatu Catchment Board (MCB), Rangitikei/Wanganui Catchment Board (RWCBC) and Wairarapa Catchment Board (WCB).

Farm Changes:

Farm changes include the year that farm plans and issue-based plans were developed, and the year of farm ownership changes. The years entered into these subcategories indicate when significant changes are likely to have occurred on the property. For example a new owner often brings different management practices and changes paddock fence lines. See the first entry in Appendix One for Farm Changes - H. Miller's property had a farm plan done in 1963 and again in 1970; the 1970 farm plan was done after H. Miller bought the property from JM Collins in 1969.

5 Farm plans

Enter the year a farm plan was initially drawn up. This first plan is often the most comprehensive, but not always, particularly if it was put together before 1970. Add the year of a farm plan review if it has additional LRI or LUC information.

5a Reviews

Add the years when the farm plan was reviewed, excluding any years listed in column '5'. The reviews either make reference to the first farm plans LRI and LUC or repeat it

but do not add to this information. The reviews are expected to be no less than five years apart except when a change of ownership occurs; sometimes extensions of two years occur. A code occurs on the outside of some farm plans as follows:

Year of farm plan/number of farm plans done in the area for the year/number of revisions; 85/310/2.

Manawatu and Wairarapa files include all the grant applications. It is not necessary to record these.

6 Issue-based plans

Issue-based plans only focus on isolated areas and particular issues on the farm. These are usually one to three year plans. These can be identified by the number of years the plans are designed for or by only one area of the farm being discussed or mapped.

Enter the year or years they were drawn up.

7 Ownership changes

The owner of the farm identified in column '1' is the owner when the last farm plan or farm plan review was done. The owner's name is on each historical farm plan and grant submission in the farm plan file. Enter the year when the first change of name occurs. Leave blank if there are no additional owners to the one entered in column '1'.

Maps:

Maps may be works programme maps, LRI maps, LUC maps, paddock maps or other maps. All drawn maps are taken from aerial photos but the aerial photos are often not included in the farm plan. The maps are valuable to relate the written descriptions to the actual farm landscape and sometimes have information not elaborated further in the farm plan descriptions. If maps are present enter the following:

Scale. Convert '20 chain to 1 inch' to 1:14000 and '10 chain to 1 inch' to 1:7000.

Quality of information –low.

Use quality of information only for the LUC map and only allocate 'low' if the quality is obviously poor. This can be best explained by looking at examples, see Appendix One to find a map example with low entered and compare to another LUC map listed. The most obvious measure of quality of information is the detail of the LUC map. A farm is divided into land Classes to identify limitations for production. The farm may

contain one or more of the eight Classes, with each Class potentially spread in pockets throughout the farm. If the farm has only been divided into a few different areas for a large property, it is likely the national mapping system has been used without converting it to the farm scale. Without an aerial photo to relate this to, it is difficult to judge accurately, but if it obviously has few areas allocated to different LUC classifications, enter 'low'.

Aerial Photos Add **AZ** if the map is aerial photo.

'Not With Plan' should be written if maps are not in the farm plan and there are indications in the descriptions or a pocket at the back that suggest maps were done. A copy may be found at another Horizons depot.

If there obviously was no map done for the farm, just leave the categories blank. Do not include a map entry if it is very difficult to read, some maps have faded badly.

8 Maps Year

Enter the year the maps are completed. This should be on the map.

9 Works

A works map identifies where and what farm improvements have been recommended. Enter the data as outlined above: scale, AZ if applicable, OR Not With Plan OR blank if there is no works map.

10 LRI

A Land Resource Inventory Map will be identified as such; if not, the following type of

symbols on a map are LRI data, e.g. $\frac{Lo - D - A + B}{0 - P1p2}$, which refers to

$$\frac{rock - soil - slope}{erosion - vegetation}$$

Enter the data about the map as outlined above: scale, AZ if applicable, OR Not With Plan OR blank if there is no LRI map.

11 LUC

A Land Use Capability map may be combined with the LRI map. Enter into the database as if they were separate maps. The map symbols used for LUC lists Class, limitation and a unit that relates to the lands potential use e.g. VIe3, means Class 6,

erosion limitation and similar potential to all other Vle land areas with a unit 3. Enter the data about the map as outlined above: scale, AZ if applicable, OR Not With Plan OR blank if there is no LUC map.

12 Paddock

Paddocks can be the only information identified on a map or they can be part of the Works, LRI, LUC or any other map. Enter the data about the paddock map if it occurs in any way as outlined above: scale, AZ if applicable, OR Not With Plan OR blank if there is no paddock map.

13 Other

Other maps may be in a farm plan but less common than the four subcategories above. Enter the name of the map type, e.g. aerial photo, nutrient and fertiliser, production, erosion, etc. Aerial photos can be part of the Works, LRI or LUC or any other map, but only enter aerial if they are not part of another map.

Description:

Descriptions about soil, LUC, other detailed information sections and catchment schemes are identified in this category. Numbers 01 and 04 are used to summarise the soil and LUC information from the historical farm plans e.g. from Appendix One, H. Millers property has been allocated 01 for soil because the official soil type names are listed but includes no direct information about the soil, and 03 for LUC because LUC information is present but it does not include rock type. Note that some descriptions are included to inform the farmer but are not relevant to the farm, e.g. Description of LUC classes or typical soils for the area.

14 Soils

Soil information provides fundamental resource information from which to make decisions. Some maps have soils information but few have an accurate soil survey included. Often the national soil mapping information is referenced to the farm soil. The following two sources of information are considered the best summary of what is present in the farm plans, with consideration of the comments above:

01 Soil Name - These will have been referenced from national soil bulletins.

- 02 Plus Soil Information - The soil information includes the name and usually location, fertiliser response and erosion susceptibility, but only record '02' if there added reference to soil structure, texture, consistency or anything directly about the soil itself.

15 LUC

Enter '03' to indicate the LUC classes have been allocated to the farm landscape and at least a brief description of the limitations for each class is provided. The historical farm plans that were examined all showed an LUC description with each class. Enter '04' if rock type is specifically acknowledged with each LUC class description. Rock type is a useful reference to understand why the LUC was chosen and is particularly useful when no LRI is available.

- 03 Class and the limitations identified.

- 04 Plus Rock type identified. This assumes '03' information is included

16 Other

Enter the name of other types of information that have been documented thoroughly in the farm plan. These may include erosion, production or paddock descriptions.

17 Catchment Scheme

The following Catchment Schemes have been identified: Makopua, Mangapipi, Matarawa, Porewa, Marshalls Gully, Mangatutu, Waituna, Magaone, Owahanga, Pohangina-Oroua and Mangateweka.

The following Community Schemes have been identified: Kai Iwi, Maxwell and FoxTangi (Foxton and Tangimoana). For each catchment or community scheme, farm plans for the majority of farms in the scheme's area had been done. More catchment schemes may be identified when the farm files are examined.

Identify if a farm is part of a catchment scheme by checking the financial statement. Different grants were allocated if the farm was part of a catchment scheme. Enter the name of the Catchment scheme (see the entry for D & P Humphries in Appendix 1 to see this farm was part of the Owahanga Catchment Scheme).

Locate the catchment scheme document by searching the Horizons library database and enter the catchment scheme description in the separate Excel worksheet using the following guidelines (see Appendix One for the separate Catchment Scheme worksheet).

The Catchment Scheme worksheet includes the catchment scheme name, its location in the district and location of the files, the year the scheme was developed, map descriptions and descriptions like those for farm plans and a list of participating farms.

Searches

1. Catchment Scheme Name. Enter the name of the catchment scheme.
2. Location. Enter a road or area to identify the location of the catchment.
3. Catchment Board or Horizons. Enter the name of the Catchment Board or Horizons who were responsible for the scheme.
4. Reference. Enter where the file for the catchment scheme can be located. It will be with the farm plan files or as an original document, an engineering file or a published document in the library. Enter farm file, original, engineering or published respectively.

Date

5. Year. Enter the year the catchment scheme was developed.

Maps

Enter the same types of notation used for the farm plan maps.

Description

Enter the same types of notation used for the farm plan descriptions except for the final column called farms.

Farms. List the names of the farms that are part of the catchment scheme, even when the number of farm is extensive.

Appendix One

Examples of data entry for historical farm plans

Examples of data entry for catchment schemes

Appendix one contains a printed example of entries in the proposed database. There are two worksheets: the first has entries for farm plans, the second has entries for catchment schemes. The Excel file is available on floppy disc, which is included with this report.

Searches				Farm Changes				Maps: scale, LUC low quality, AZ=aerial photo						Description			
Farmer 1	Farm Name 2	Location 3	Reference 4	Farm Plan 5	Reviews 5a	Issue-based Plans 6	Ownership Change 7	Maps Year 8	Works 9	LRI 10	LUC 11	Paddock 12	Other 13	Soil 1=soil name 2=+soil info 14	LUC 3=limitations 4=+rock type 15	Other 16	Catchment Scheme 17
H Miller	Porewa Farm Ltd	Pohangina Valley East Road	MCB	1963			JM Collins										
LD Percy	Pukerangi	Dews Rd Pahiatua	MCB	1970			H Miller 1969 LD Percy 1974	1970	1 7000		1 14000 low	AZ		01	03		
DM Wickham	Pukeakeake Waitatapia Station Ltd	Parikino, Wanganui Dalrymple Rd Bulls	RWCB	1978													
WG Redmayne	Tunnel Hill Ltd	Turakina Beach Rd Sherwood Coast Rd	RWCB	1987				1974	1 7000						03		
R Anderson	Sherwood		WCB	1984				1984	no scale	1 8000	1 8000			01	03		
				1985				1985	no scale	1 10000	1 10000			02	03	erosion erosion production	
				1985				1985	1 10000 AZ		1 10000	1 10000 AZ		02	03		
							MP Olson 1971 MM & SB Grant 1982	1971						01	04		
MM & SB Grant D & P Humphries D & N Hammond I & J Woodhouse	Bannockburn Wairakau & Bushy Range Onepuke Land Company Rakanui	Pahiatua Rd Owahanga Valley Rd Brandon Hall Rd Route 52	WCB	1976 1982 1988				1976 1982 1988 AZ	1 8000		1 14000	1 10000 AZ		02	03	paddock	Owahanga
				1972				1975	1 8000		5 597222222			02	04	paddock	Owahanga
			39			1999		1999			no scale			02	04	plant pests	
			17			1998								02	03	pole planting	

Searches				Date		Maps: scale, LUC low quality, AZ=aerial photo					Description			
Catchment Scheme Name 1	Location 2	Catchment Board or Horizons 3	Reference 4	Year 5	Reviews 5a	Maps Year 6	Works 7	LRI 8	LUC 9	Other 10	Soil 1=soil name 2=+soil info. 11	LUC 3=limitations 4=+rock type 12	Other 13	Farms 14
Makopua Valley Catchment Control Scheme	Makopua Rd	RWCB	farm file	1986		1986	1:16000		1:16000		02	03		Donavan, Carkeek, Gregory, Hammond Newcombe, Vennel,
Mangapipi Catchment Control Scheme	Rewa	RWCB	farm file	1984		1984	1:10000				02		geology erosion	Frecklington, Nolan, Thomasen, Coleman, Jones, Nolan, Frecklington, Jacks, Wollans
Mangatutu Catchment Control Scheme	Rewa	RWCB	farm file engineering	1963 1974	1983	1974	1:12000				02	03	erosion geology climate	
Pohangina-Oroua Scheme	Ridge Rd	MCB	originals published	1951	1980	1980			1:12000	rock type	02	04	vegetation farming	List available for 1951 only

Appendix Two

Soil Conservation and River Control Council Soil and Water Conservation Plan format (1969).

Appendix Two contains parts of the following document that is relevant to this report.

Ministry of Works, 1969, Soil Conservation and Rivers Control Council Revised Format for Soil and Water Conservation Plans, National Water and Soil Conservation Organisation, Wellington, New Zealand.

Source: Horizons Regional Council Palmerston North office archives.

Title of archive: Soil Conservation. Farm Plan Policy, 1963-1985.

SUMMARY (North Island Example)

1. PHYSICAL DESCRIPTION OF PROPERTY

1.01 Location - Access:

Tinui Valley Road, nine miles from Tinui township.
Railhead - Masterton. Located in Whareama catchment.

1.02 Area - Tenure:

1,302 acres freehold.

1.03 Climate - Geology/Soils - Topography - Vegetation:

Dry summers with desiccating N.W. winds, 40-45 inches rainfall with high intensity storms from the S.E. a feature. Moderately steep and steep mudstone and sandstone hills rising to 1,100 ft with limited area of alluvial flat. Soils mainly silt loams, Atua 29H, Kumeroa 29 fH and Taihape 114a. Vegetation originally native forest which at time of settlement was modified to scrub and fern. Today 2/3 of property is in improved pasture (ryegrass, dogstail) with good proportion of white, sub, and suckling clover, with pastures tending to revert on sandstone country.

1.04 Erosion (Present, Potential):

Overall assessment moderate comprising slipping and earthcreep on 400 acres of mudstone, with intermittent large slumps, and elsewhere general slope instability caused by active degrading of tributary streams. Limited areas of alluvial flat subjected to flooding and burial with detritus.

1.05 Land Use Capability Classes:

III - 104 acres (8%)	V - 606 acres (48%)
IV - 192 acres (16%)	VI - 302 acres (24%)
	VII - 48 acres (4%)

2. CONSERVATION PROGRAMME AND WORK SECTION

2.01 Problems:

This soil and water conservation plan will combat moderate slip, creep and slump erosion on hillsides, arrest downgrade occurring at present, and alleviate flooding and deposition of detritus on alluvial flats. As part of the Whareama Catchment Control scheme, the Board's priority rating for soil conservation work on this property is high. The plan will enable a system of management to be introduced that will ensure the property is producing to the maximum consistent with the known erosion hazards.

-2-

2.02 Proposed Programme:

This consists of construction of debris dams and stream planting for gully control, open planting for combating slip and creep erosion on hillsides, and contour works or graded banks for regulation of surface runoff on easier sloping areas.

First Five Year Programme - Subsidisable Items

<u>Type of Work</u>	<u>Cost</u> (including 10% soil con fee)	<u>Rate</u>	<u>Subsidy</u>
Debris dams (8 at \$50)	\$ 440	2:1	\$ 294
Stream planting (200 chs at \$2.50)	550	1:1	275
Open planting (3,000 trees at 60c)	1,980	1:1	990
Contour works (200 acres at \$2)	440	1:1	220
	<hr/>		<hr/>
	\$3,410		\$1,779
	<hr/>		<hr/>

First Year Programme

Job No. 1, 4 basket debris dams at \$50	\$220	2:1	\$146
Job No. 2 stream planting (80 chs at \$2.50)	220	1:1	110
Job No. 3 contour works (50 acres at \$2)	110	1:1	55
	<hr/>		<hr/>
	\$550		\$311
	<hr/>		<hr/>

(Owners unsubsidised contribution to the five year programme in this case is \$3,000 worth of fencing for improved management.)

At the completion of the first five year programme it is considered that a further three year programme of gully control and open planting will be required.

2.03 Management Patterns - Present Future:

The traditional set stocking of sheep and cattle in excessive numbers which in part caused the present erosion problems, and which was also a result of the property being subdivided off an extensive sheep

-3-

station of the early period - is being progressively replaced by a mob stocking management coupled with subdivision fencing and increased fertilizer application. Cattle are to be restricted particularly on the mudstone areas, to enable open planting to proceed. In the future complete grazing control through mob stocking will minimize the erosion hazard.

Stock Numbers

	<u>1969/70</u>		<u>1974/75</u>
Total Sheep	1,550 (w ewes)	Total Sheep	2,300 (y ewes)
Total Cattle	120 (x cows)	Total Cattle	160 (z cows)

The property has a moderate problem of opossums, which requires control to safeguard open and stream planting.

2.04 Specifications:

For all works proposed on this property these are certified as being within established district limits.

2.05 Economics:

Satisfactory.

2.06 Legal Agreement:

Will be operative provided Council approval is granted and subject to owner's acceptance of any terms of approval.

2.07 Plan prepared by:

Survey and

Planning

Additional acknowledgements (as appropriate) e.g.

Soils information (Soil Bureau)

Seed, fertilizer,)	Agriculture
financial analysis)	Lands & Survey
and/or economic)	State Advances
report, and farm)	Farm Improvement
development)		Club

Certified for
Approval Chief Soil
Conservator

-1-

1. PHYSICAL DESCRIPTION SECTION

(Concise account on each of the following)

- 1.01 Location and access
- 1.02 Area and tenure - legal description
- 1.03 Climate - geology/soils - topography - vegetation
- 1.04 Erosion - present and/or potential

This requires a concise account in descriptive form which must be based on the following criteria, as is laid down in the Land Use Capability Handbook.

Accelerated Erosion

This is erosion which has been initiated or intensified by some action of man, either by his management of the land or the effect of the animals he has introduced. During land inventory mapping sheet (Ch), wind (W), and scree creep (Sc) erosion is recorded on an areal basis. Slip (Sl), slump (Su), flow (F), rill (R), gully (G), tunnel gully (T), streambank (Eb), and deposition (D) is recorded on the basis of seriousness i.e. a combination of depth, frequency, potential and economic effect.

(In respective districts, standards will be set for these latter categories of erosion by consultation among District Soil Conservators, Officers in Charge of North and South Island L.U.C. survey parties, and Chief Soil Conservators of Catchment Authorities. The standards will be based on reference to standard selected sites, influenced by parent material and rock type, personal judgment, physical loss of land, time and cost of repair.)

The Degree of Erosion.

Will be represented by:

- (a) the percentage of the area that is bare ground exposed to erosion;
- (b) the percentage of the soil profile lost;
- (c) the severity or seriousness of types such as gully, streambank erosion, or deposition.

-2-

Bare ground is defined as that portion devoid of vegetative cover. The end point in the process of depletion (usage not in the sense of loss or decline in fertility from any cause) of vegetation is bare ground, and therefore an index of the extent of depletion is the percentage bare ground. Frequently, as can happen in the brown grey earths of Central Otago for instance, there is little or no erosion in terms of percentage of profile lost, yet the extent of depletion of the vegetation can be considerable.

As soil conservation seeks to put a protective cover over all areas where this is possible, depletion can be conveniently mapped together with erosion, since there is a greater risk of erosion while the soil is bare. It can be used as the basis for recording types of erosion that remove large areas of the surface soil such as sheet and wind erosion. On areas of deposition that are slowly being revegetated, the percentage of bare ground still to be covered should be recorded. Land which is under cultivation preparatory to sowing down is not shown as depleted ground, although direct erosion occurring on these areas such as wind or rill erosion, should be recorded.

The percentage of the soil profile lost is usually important as it affects the prospects of revegetation as well as erodibility. On some soils, however, a cover can be quickly restored on the subsoil, and in many areas, there may have been some soil loss in the past, although the ground is now completely covered. It is desirable to record the percentage of soil lost, especially on sheet and wind eroded areas.

On steep stream facings, with skeletal soils neither of the above criteria properly applies, although the areal basis has some application. However, several factors are usually involved, and this erosion status is best described according to its general severity or seriousness. Each type of erosion must be recorded on a 1-5 scale of intensity:

(a) Areal (sheet, wind and scree creep)

<u>Degree of erosion</u>	<u>Symbol</u>	<u>Estimated % of bare ground or area eroding</u>
None	0	No significant erosion
Slight	1	1-10%
Moderate	2	11-20%
Severe	3	21-40%
Very severe	4	41-60%
Extreme	5	> 60%

-3-

- (b) Seriousness (slip, slump, flow, gully, tunnel
gully, rill, streambank and deposition)

<u>Degree of erosion</u>	<u>Symbol</u>	
None	0	Applied as already
Slight	1	described with
Moderate	2	reference to stan-
Severe	3	dard selected sites,
Very severe	4	influenced by
Extreme	5	parent material and
		time of recovery,
		personal judgment,
		physical loss of
		land, cost of
		repair, etc.

The percentage of soil loss, especially on sheet
and wind eroded areas is shown:

<u>Soil Loss</u>	<u>Symbol</u>
None	0
1-25% topsoil loss	1
25-75% topsoil loss	2
75% topsoil to 25% subsoil loss	3
25-75% subsoil loss	4
> 75% subsoil loss	5

Where the latter symbols are used they should be placed
after the areal symbols with a bar, e.g., 3/2 = loss in terms
of area, loss in depth of profile. More detail on gully
erosion, deposition, or the mass movement types may be shown
if required, in inventory mapping.

Natural or geological erosion (n) should be recorded and
discussed, where it occurs at high rates.

1.05 Land use capability unit descriptions and recommen- dations for each.

At present each Catchment Authority varies in its
use of capability units. Where, as yet, staff are
not adept in their use, then land inventory plans
must be included in soil and water conservation
plans submitted to the Soil Conservation and Rivers
Control Council. However, where land use capa-
bility units are being used by Authorities, they
must be laid out in the following way, and include
all factors of the inventory in written form together
with the recommendations for future use of each unit,
and the conservation measures proposed. It is
absolutely essential that all unit descriptions con-
tain a description of the types and severity of
erosion, or indications of the erosion potential,
together with the proposed management.

-4-

In all cases, land inventory mapping must be carried out, for record purposes, whether forwarded to Council or retained by each Authority. Land use capability classes, subclasses and units must be to the standards laid down in the L.U.C. handbook, and this classification must precede any design of soil and water conservation plans.

e.g., Typical Land Use Capability Unit Descriptions
(South Island)

A. Land Suitable for Arable Use

Class III - Moderate Limitations

IIIe 1 - Flat to gently undulating Craigieburn silt loams which have been enhanced by addition of volcanic material to the profile, as wash from slopes above. Deep, and of medium fertility, the main limitations are moderate wind erosion under cultivation and a less favourable climate. Shelter belts are necessary. These areas should be developed for intensive grazing before any other.

Class IV - Severe Limitations

IVe 1 - Flat to gently undulating Craigieburn soils which are leached, generally not as deep, less fertile, and with a coarser texture than IIIe 1 soils. Limitations are similar to those for IIIe 1 soils, but with more severe effect. Suitable for semi-intensive grazing after cultivation.

B. Land Not Suitable for Arable Use

Class VI - Moderate Limitations

VIe 3 - Severely eroded steep sunny face of Tekoa Hill and Hurunui Steepland soils. Cover is dominantly Fescue tussock with manuka or matagouri scrub or fern. Eventually as time and money permit they should be included in the top-dressing and seeding programme, but for the present require spelling particularly in the flowering to seed-set period.

-5-

Vis 1 - Flat to gently undulating stony Tasman soils on low terraces and riverbed areas, too shallow for cultivation. Cover is Fescue and silver tussock, with matagouri west of the Kakapo outlet, and broom together with briar manuka and gorse east of it. Bouldery phases and wet hollows are common. Wind erosion is typically slight to moderate. Soils have medium fertility and in a few places improvement could be achieved by surface sowing.

Class VII - Severe Limitations

VIIe 6 - Steep high altitude areas above 4,000 ft on Bealey and Kaikoura Steepland soils. Erosion varies from slight to fairly severe sheet scree and wind, under a cover of fescue, snow and blue tussock, carpet grass and alpine scrub. This unit represents the high altitude basins which, following development of lower hill country should be phased out of grazing use.

VIIe 8 - Steep Bealey, Tekoa and Hurunui Steepland soils under beech forest which although placed in class VII, would be neither desirable nor economic to develop from a conservation point of view. Their use should be as catchment protection areas.

Class VIII - Protection Land

VIIIe 1 - High altitude areas (above 4,500 ft) with severe to extreme erosion, much of it natural. There is a high proportion of scree and bare rock, and generally a sparse vegetation of sub-alpine and alpine species. These areas are unsuitable for grazing use, and require to be destocked and retired.

e.g., Typical Land Use Capability Unit Descriptions (North Island)

A. Land Suitable for Arable Use

Class II - Slight Limitations

IIw 1 - Flat to gently undulating Bideford silt loam of medium natural fertility under good pasture with a good response to phosphate and fair response

-6-

to lime. The risk of erosion is slight, being limited to occasional overflow from the adjacent stream and from flooding brought about by surface runoff from surrounding hill slopes. The major limitation to intensive pastoral use is seasonal wetness because of seepage from surrounding hills, the effect of which is intensified by a heavy subsoil. Provision of tile drainage and graded diversions to suitable outfalls would minimise this limitation.

Class III - Moderate Limitations

IIIe 1 - An easy rolling phase of Atua hill soils of medium natural fertility under good pasture. Although the use is predominantly pastoral these units are fairly well suited to cropping, and the main hazard to their use in a rotation is a moderate risk of sheet and rill erosion under cultivation, and a risk of slumping where these slopes merge with steeper gully sides, or in localised wetter areas. Soil conservation measures necessary to control surface runoff are graded banks and diversions to fully utilise these areas as well as mole and tile drains in small areas of deeper seated seepage.

IIIw 1 - A small area of recent soils occurring along the present narrow floodplain of the major stream draining the property. Soils have variable texture and depth, although all are poorly drained and are subjected to overflow and deposition of silts when surface runoff occurs from surrounding slopes. Where drained and protected with small stopbanks the soils support excellent pasture, although this is not always practicable. Seasonal wetness is the main limitation but slight stream bank erosion occurs also which can be countered by protective planting.

Class IV - Severe Limitations

IVe 1 - A rolling phase of Atua hill soils under good pasture which has a fairly severe risk of rill, sheet and gully erosion under cultivation. Cultivation should be restricted to the occasional root or greenfeed crop in a fairly long rotation, and where topography of past erosion pattern allows, contour furrows should be installed to avoid concentrating water near gully heads.

-7-

IVe 2 - Strongly rolling Atua hill soils under good introduced pasture occurring in ridgetop situations with a severe risk of sheet, rill and gully erosion under cultivation. Measures which should safeguard these soils are an absolute minimum of cultivation, installation of contour furrows where topography allows, and the inclusion of drought resistant species when pastures are renewed. Pastures on these sites are subjected to desiccating winds in late spring and summer which cause them to dry off and lose their soil protection value.

IVe 6 - As for IVe 2, except that the vegetation is broadleaf podocarp forest. The area should be cleared and sown to pasture, in which case the limitations and erosion hazards of IVe 2 apply.

B. Land Not Suitable for Arable Use

Class VII - Severe Limitations

VIIe 4 - Steep Atua hill soils at present under poor, dominantly native pastures, with scrub and fern on shady slopes and in gullies. The unit is poorly fenced and has occurring on it severe, slip, slump, sheet and gully erosion. There are several conservation measures necessary, the first being subdivision fencing, with live fencing where suitable in sheltered situations, spaced planting on hillsides, and establishment of protective blocks of close planting in conjunction with drop structures at selected points. Management of stock should aim at increasing pasture density and height, with seasonal grazing by cattle initially until pastures and stability are improved.

1.06 Photographs of property showing representative soil and water conservation problems, proposed measures, and capability units.

2. CONSERVATION PROGRAMME AND WORK SECTION

(Concise account of each of the following.)

2.01 Soil and water conservation problems. (The problems, the proposed works and the way these will control the problems should be precisely described.)

-8-

2.02 Proposed soil and water conservation programme.

Required here, is a full outline of the programme by years, so written that it is oriented for the farmer's and the authorities benefit, i.e., for the authority it encompasses on-cost, soil con fee, farmers share, non-subsidisable items, and in particular each job is given a number which relates to the plan on which is shown the annual programmes. For the farmer it is suggested that there be two figures only, i.e., total cost, and cost to the farmer expressed as a percentage.

In this section also, should be highlighted the presentation of any special case on the basis of higher than normal subsidy rates, or eligibility in terms of the particular section/s S.C.1968/16 circular. In general this should take the form of applying for normal rates of subsidy, plus a grant to make up the difference. Where eligibility is in question, the important factor which Council seeks, is a precise statement of the present erosion, or erosion potential, and in what way the work proposed effects control of that erosion.

2.03 Management patterns (present and future)

A concise paragraph is required which clearly indicates to the farmer his management obligations in adhering to the soil and water conservation programme which he himself has helped to design. The reasons, in conservation terms, why certain management changes are required should be clear, as should what the erosion control is expected to achieve. For the Council it will be necessary to clearly indicate how the management adjustments are related to the mitigation of erosion, and to the particular works for which subsidy assistance is requested. Where works such as conservation fencing indirectly bring about erosion control, a clear statement is necessary about the type of management which conservation fences allow to control erosion and the farmers obligations in this respect. Whereas, for the farmer, blocks or paddocks are best named on the plan of the property as he knows them, the specific jobs on each block or paddock must be numbered in order for the Council, and the past and present management patterns related to block or paddock names (e.g. Job No. 6, Scrubby Block).

Where the plan incorporates retirement of class VIII land, then provision for equivalent grazing may be calculated on twice the stock units displaced from the class VIII areas.

-9-

N.B. The present carrying capacity of the area to be retired (on a physical basis) must also be estimated to ensure that the stock unit figure, used as the basis for calculation is a realistic one. Final retirement from grazing should await provision of alternative grazing for stock displaced. Proper steps must be taken to ensure that the farmer cannot graze the retired area as of right.

Where the plan incorporates spelling of class VII land for a significant period of years, to be followed ultimately by carefully controlled grazing, then provision for equivalent grazing must be calculated on actual stock units displaced, once again assessed in physical terms through land use capability units to ensure that this figure is a realistic and reasonable one. The practice of requesting upgrading of subsidy rates for OSTD which do not match the specific severity of erosion is no longer accepted in general.

Applications for cattleproofing must be related to a statement of cattle targets, in terms of the Council instruction and formula.

2.04 Specifications and unit costs of subsidised items

Detailed account of these will of course be necessary in the farmer's copy of the soil and water conservation plan. However, the aim is, as soon as is possible, for each Authority to formulate "master" sheets of technical specification limits (upper and lower) but not monetary, for each type of subsidisable conservation work. This will enable both the Authority and the Council to, in effect, have certified to them by the Chief Soil Conservator of each Authority that (a) either the specifications lies within approved limits, or (b) for special reasons the specification requires to be outside the approved limits, in which case it must be quoted in full and be supported by an explanatory statement. Initially such master sheets will require Council's approval.

2.05 Financial analysis and economic reports

Economic reports and financial analysis are required for all conservation programmes exceeding a total of \$10,000 or in every case where there are indications that the economics of the plan may be unfavourable.

Details of requirements will be the subject of a separate circular. These are designed to keep the farmers personal information confidential and analysis to a minimum, but yet ensure that the

-10-

farmer will not be financially embarrassed and the work can be justified to Council as in the National interest.

Briefly the requirements are:

- (a) A Statement by the Authorities' Soil Conservator that the "cash" position has been examined and is satisfactory. This would normally follow a "cash flow" type of analysis, but not necessarily carried out by Authorities Staff (e.g. Agriculture Department, State Advances, Lands Dept.etc)
- (b) A case to justify the plan in the National interest. For plans involving more than \$100,000 total cost in the five year period a full cost-benefit analysis is necessary. For lesser amounts the analysis should be related to the estimated cost and complexity of the proposal. This can range from simple statements of benefits in as quantitative terms as possible (acres to be controlled, potential, stock increases, etc.) against total costs involved; to an analysis giving the net return on the additional money involved (included non subsidized expenditure) or a full cost benefit analysis in appropriate cases.

Note:

- (i) For all programmes (including those below \$10,000) a clear concise statement in as quantitative terms as possible of what the proposal is expected to achieve is required.
- (ii) It is expected that although the actual programmes decided upon will be given in the proposals there would have been an examination of possible alternative programmes in relevant cases by partial budgets, gross margins, or pre and post development budgets as appropriate.

2.06 Legal Agreement

While this should be included in the farmer's copy of the plan, for Council purposes a certification that such an agreement will be operative, following approval by Council and subject to owners acceptance of any terms of approval is all that is required. This is to be included in the summary.

-11-

2.07 Plan prepared by

Survey and

Planning

With acknowledgments (as appropriate) e.g.

Soils information Soil Bureau

Seed and fertilizers,	}.....	Dept of Agric.
Financial analyses and/or		Lands & Survey
economic report,		State Advances
Run of farm		Farm Improvement
development	}.	Club

Certified for

Approval Chief Soil
Conservator3. STANDARD FORMS FOR AMENDMENTS TO ANNUAL PROGRAMMES

Although catchment authorities now have greater delegated authority (section 13.013 of SU 1968/19circular) for amendments to annual programmes, copies of these are still required for Council and District records, i.e. two copies, one for Council and one for district.

Samples of the standard form are enclosed which catchment authorities are to use for preparing their own stocks of the form.

Each standard form should be accompanied by a foil or plan print on which is shown the amendments - except where amendments are in monetary terms only, with no actual conservation works differences.

4. FOIL PRINTS OF 1968/69 PLAN SHOWING ANNUAL PROGRAMME AMENDMENTS

These are to be included with standard form as in 3 above for Council and District records. Two copies will be required.

Appendix 2: Topic areas for interviews in case selection

Topic areas for semi-structured interviews with key informants to select the historical farm plans most similar to Whole Farm Plans in the case selection.

- The roles carried out by the informant in their work place, and their location.
- The content of the farm plans and the programme they went through to develop a farm plan and work with the farmers.
- Changes that occurred over time.
- Concerns and issues they addressed such as motivation of farmers, farmer goals, economics, use of the physical analysis process.
- Types of farms.
- Information carried over from one farm plan to the next review.
- Changes that made a farm plan redundant such as storm events and land use.
- Impact of the person who prepares the plan.
- Perspectives on the approach used and value of the plans.

Appendix 3: Ethical considerations

Introductory letter received by interviewees.



Massey University
COLLEGE OF SCIENCES

Perspectives of Whole Farm Planning INFORMATION SHEET

Researcher Introduction

Researcher: Sian Cass
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This research project contributes to a Masters of Applied Science in Environmental Management. The purpose of the research is to describe different perspectives on the usefulness of whole farm plans on hill country farms.

Participant Recruitment

Two catchments in the Wairarapa have been chosen for this research. One catchment has a long history of involvement with a Catchment Scheme the other catchment does not. An attempt to contact every farm in each catchment will be made to ask for a member of the farm to participate in an interview with the researcher. Contact details for each farm will be requested from the Greater Wellington Regional Council and members of the catchment itself.

Project Procedures

The interviews will be taped. These tapes are for the use of the researcher only. Information from the interviews will be utilised in the final research document. Participants will not be identified but the catchment location will be and therefore some associations could be made. If a quote is chosen to be included it will be sent to the owner to ensure the intent of the statement is correctly portrayed. The tapes will be stored for 7 years in a secure location at Massey University after which they will be destroyed in accordance with requirements. A summary of the final project is available to participants on request.

Participant involvement

Participants will be involved in a semi-structured interview. Each interview is expected to take approximately one hour.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- *decline to answer any particular question;*

- *withdraw from the study (specify timeframe);*
- *ask any questions about the study at any time during participation;*
- *provide information on the understanding that your name will not be used unless you give permission to the researcher;*
- *be given access to a summary of the project findings when it is concluded.*
- *ask for the audio tape to be turned off at any time during the interview.*

Project Contacts

The participants are welcome to contact the researcher and supervisors with any concerns or questions about the research.

Ethical Approval

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, email humanethics@massey.ac.nz".