Nutrient Management Plans and their influence on the farm management practices of dairy farmers

A Thesis presented in partial fulfilment of the requirements for the degree of Masters of Environmental Management

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Abstract

Nutrient Management Plans (NMPs) are a relatively recent innovation in the New Zealand dairy industry, however due to their growing use in regional council policy, and initiatives such as the Dairying and Clean Streams Accord (2003), it is likely that NMPs will become mandatory for the diary industry in the near future. There is currently limited information on the use and benefits of NMPs in the New Zealand context, and how dairy farm management practices have been influenced by the introduction of NMPs.

The main objective of this research was to investigate how the introduction of an NMP has influenced the farm management practices of dairy farmers. This was achieved through the use of two case studies within the Waikato and Otago regions. These regions have contrasting approaches to nutrient management; The Waikato Regional Council has incorporated the use of NMPs in regional policy and has supported a number of community initiatives regarding nutrient management. In comparison, at the time of the research, the Otago Regional Council, while stating that they promoted the adoption of nutrient management practices, had no current policy requiring NMPs.

Results indicated that the degree of NMP uptake varied amongst farmers, depending on a variety of influences with regards to the farmer's own unique goals, circumstances and opinions. It was also found that while the reasons for NMP introduction varied amongst the farmers interviewed, the overall influences of NMPs on farm management practices were similar across both cases. The key influences of NMPs on farm management practices were; the increased precision and efficiency of fertiliser application, an increased appreciation and use of effluent as a nutrient source, and the identification and manipulation of other factors such as the effects of bought in feed and stock movement on nutrient flows on the farm.

There was a perceived lack of ongoing support and education for farmers regarding NMPs. This contributed to a general distrust amongst farmers of NMPs, in turn affecting their opinions, and uptake of NMPs. Furthermore NMPs were not being used to their full potential by the majority of farmers who participated in this research. The greater the involvement and support offered by the regional council and industry, the greater the trust and cooperation amongst the particular farmers with the relevant regional council and industry representatives.

Overall, while this research has found that NMPs do provide benefits to farmer's management practices, further support and ongoing education is required to ensure NMPs are accepted and used to their full potential by dairy farmers.

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Chapter 1 Introduction

1.1 Thesis Introduction

This study is an investigation of the influence of Nutrient Management Plans (NMPs) on the farm management practices of dairy farmers. NMPs are used to manage the nutrient inputs of farms while ensuring the farm's production and profits are optimised and adverse environmental impacts are minimised. Although existing literature (VanDyke, 1997) shows that internationally, NMPs have been in use for some time, NMPs are a relatively recent innovation in New Zealand. Evidence suggests that NMPs were introduced to the New Zealand dairy industry within the last decade (Ravensdown Senior Scientist, Interview, 2012). Over this time, there has been little literature or research undertaken on NMPs in the New Zealand context. A target was set, in conjunction with the Dairying and Clean Streams Accord (2003) for the New Zealand dairy industry, that all Fonterra supplying farmers would have an NMP in place by 2007. However in the 2010 / 2011 snapshot of progress for the Dairying and Clean Streams Accord (2003) only 46% of Fonterra farmers had an NMP in place (Fonterra, Local Government New Zealand, Ministry for the Environment, & Ministry of Agriculture and Forestry, 2011).

A case study approach was used incorporating two sub cases from the Waikato and Otago regions, identifying how NMPs have influenced farm management practices. In addition the farmer's views of NMPs, their purpose and their effectiveness, are described.

This first chapter will introduce background information regarding nutrient management in New Zealand and an NMP will be defined. The problem statement, the research questions and objectives will then be outlined, and the research approach and structure of the thesis are summarised.

1.2. Background

Over the past decade the growing concern regarding the preservation of New Zealand's 'clean green' image has led to increased public awareness of the agricultural industry and its effects on the surrounding natural environment. In particular, the dairy industry has been subjected to increasing pressure to reduce its environmental footprint (Ramilan, Scrimgeour, & Marsh, 2009). For example, a survey completed by Baskaren, Cullen, and Colombo (2010) in the

Canterbury region found that 85% of participants agreed that dairy farming was harmful to the environment (Robson & Edmeades, 2010). 'Dirty dairy', originally a term and campaign introduced by Fish and Game NZ, is a term that is often still used (and mis-used) by New Zealand media to describe the industry (Robson & Edmeades, 2010).

The dairy industry is the largest export earner in New Zealand earning in excess of NZ$10 billion and generating more than 26% of the country's merchandise exports annually (Dairy Companies Association of New Zealand, 2013). The industry has experienced considerable growth in recent times leading to increased intensification of on-farm production and use of inputs by farmers. This intensification has put a strain on the country's waterways as many lakes and streams are becoming degraded from the high levels of nutrient and sediment runoff associated with more intensive land use (Samarasinghe, Daigneault, Greenhalgh, & Sinclair, 2011). Within the dairy industry major concerns have centred on nitrogen and phosphorous from agricultural land contaminating the natural ground and surface waterways (Menneer, Ledgard, & Gillingham, 2004). If high concentrations of nitrate are found in drinking water it can be deemed to be detrimental to human health (Di & Cameron, 2004). Algal blooms and other undesirable biological growths may also occur in waterways where nutrient leaching from agricultural land has occurred.

The dairy industry reacted to the increasing public pressure by implementing a number of initiatives including the Dairying and Clean Streams Accord (2003). This has now been succeeded by the Sustainable Dairying: Water Accord. It was an agreement between Fonterra, Regional Councils and unitary authorities of New Zealand, the Ministry for the Environment and the Ministry of Agriculture and Forestry[1]. The purpose of the accord was to provide

…a statement of intent and framework for actions to promote sustainable dairy farming in New Zealand (Fonterra, Local Government New Zealand, Ministry for the Environment, & Ministry of Agriculture and Forestry, 2003 p. 2).

The Dairying and Clean Streams Accord (2003) stated that one of the six priorities for action was the effective management of nutrients to ensure minimal nutrient loss to ground and surface waters. The performance target for this priority was that 100% of dairy farmers would have a nutrient management system in place by 2007. However, as previously mentioned in the 2010 / 2011 snapshot of progress, only 46% of farmers had an NMP in place (Fonterra, et al., 2011).

Researchers have identified a number of possible reasons for the slower than targeted uptake of NMPs by dairy farmers in New Zealand. In a review of nutrient flow and management

[1] Now know as the Ministry for Primary Industries

practices, Monaghan, Hedley, Di, McDowell, Cameron, & Ledgard, (2007) suggested the monetary cost of NMP implementation, the complexity of the change of management practices, the compatibility with the current farm system, and a perceived uncertainty of the environmental benefits of NMPs as possible reason for non adoption. Edmeades et al. (2011) believe that NMPs will only be adopted and implemented by farmers if there is value in it for them, and the authors argue that the value needs to be primarily monetary. Clark, Caradus, Monaghan, Sharp, & Thorrold, (2007) state that farmers will most likely adopt NMPs that fit within their existing plans and values while Monaghan et al. (2007) see a need easily understood tools and information which outline the economic and environmental benefits of farm management practices such as NMPs for farmers.

1.3. Definition of a Nutrient Management Plan

Edmeades et al. (2011) argue that all previous attempts to develop NMPs in New Zealand have been *'ad hoc'*. At this stage, there is no formal classification or agreement on what an NMP should include and a number of different organisations within the NZ dairy industry have their own template or definition of what an NMP should be. These organisations include fertiliser companies, regional councils and DairyNZ[2].

DairyNZ state that while a nutrient budget highlights the inputs and output of nutrients to the farm system it does not provide recommendations on the management of these inputs and outputs to meet farm specific goals. Therefore in DairyNZ's opinion, a central intention of an NMP is to give context and purpose to nutrient budgets. A farmer's goals for production, economics and environmental impacts are seen as the key drivers of an NMP (DairyNZ, 2012).

The Code of Practice for Nutrient Management as developed by FertResearch (2007) defines an NMP as:

> A written plan that describes how the major plant nutrients (nitrogen, phosphorus, sulphur and potassium, and any others of importance to specialist crops) will be managed […] The nutrient management plan aims to optimise production and maximise profit value from nutrient inputs while avoiding or minimising adverse effects on the environment (FertResearch, 2007, p. 17).

[2] DairyNZ is the industry good organisation for New Zealand dairy farmers, funded by government investment and a milksolids levy. Its purpose is to enhance the profitability, sustainability and competitiveness of NZ dairy farmers (DairyNZ 2013).

1.4. Problem Statement

The New Zealand dairy industry and regional councils have responded to the public's negative perception of the industry and its environmental effects by establishing initiatives such as the 'Dairying and Clean Streams Accord' (2003) and incorporating the need for NMPs or similar farm management programs within regional council plans and policies. It is suggested that NMPs which have been implemented correctly, do have positive benefits, both economically and environmentally (Edmeades et al.,Edmeades, Robson, & Dewes, 2011; 2005; VanDyke, 1997) . Farming systems have been shown to be able to be profitable and have minimal environmental impacts (Smeaton, Cox, Kerr, & Dynes, 2011).

Despite existing research on the benefits of NMPs, and pending legislation for limits on nutrient use and losses, only 46% of Fonterra supplier farmers were recorded as having an NMP in place by the end of the 2010/2011 season. There is a need to increase the rate of adoption of NMPs and their associated practices by dairy farmers to meet the requirements of industry initiatives and regional council policy.

1.5. Research Question and Objectives

The aim of this research is to gather information on how the introduction of an NMP has influenced the farm management practices of dairy farm managers. The research will also identify how NMPs have contributed towards the farmers' goals, and will contribute toward the knowledge and understanding of NMPs in New Zealand. The research will help to improve the knowledge of dairy farmers and the industry as a whole, with regards to the implementation and benefits of NMPs.

1.6. Research Question

The research question that this research answers is:

How has the introduction of a Nutrient Management Plan influenced the farm management practices of dairy farmers, and what has shaped this influence?

1.7. Research Objectives

In order to answer the research question the following objectives were developed:

- Establish and describe how NMPs have contributed towards meeting dairy farmers environmental and production goals.
- Identify and outline common NMP implementation issues, and where possible indentify opportunities to improve NMP implementation.
- Establish why farmers have chosen to implement NMPs.

1.8. Thesis Structure

The purpose of this research is to examine NMPs and their influence on the management practices of dairy farmers. Chapter Two presents a review of the existing literature and research regarding NMPs. As there is little specific literature regarding NMPs in the New Zealand context, international literature has been drawn from, as well as literature regarding similar innovations in the agriculture sector. Chapter Three presents the methodology and outlines the case study approach before the case description chapter presents the key contextual information of the cases. The results are presented in Chapter Five. In Chapter Six the research is discussed, with the research findings compared to the literature, and key findings are presented. The conclusions are then drawn in Chapter Seven and implications of the research for the industry outlined. A review of the research methodology and suggestions for future research are then presented.

Chapter 2: Literature Review

2.1. Introduction

It is suggested that NMPs can be beneficial, both economically and environmentally for dairy farmers and the dairy industry as a whole (Monaghan et al. 2007; Shepard, 2005; VanDyke, 1997). The purpose of this chapter is to present the existing literature and research relevant to NMPs, in the context of the research question: how the introduction of a NMP has influenced the farm management practices of dairy farmers and what has shaped this influence?

Given that NMPs are a relatively new development in New Zealand there are only a few New Zealand examples that report the actual influence of NMPs and other nutrient management practices on dairy farm management. Therefore research from around the world regarding NMPs and innovation adoption practices is also reviewed in this section.

This review is split into three sections. The first section outlines studies and commentary on the benefits of NMPs for dairy farmers. The second section reviews the literature on NMPs, nutrient management and the adoption of new innovations in the New Zealand context, followed by a third section in which previous research and literature examines the factors influencing why farmers may or may not adopt new management practices. While much of the literature in this section does not deal with NMPs directly it does deal with similar management tools which are aimed at improving sustainability and reducing environmental impacts. Some of these management practices are included in NMPs, such as effluent management and fertiliser management. The final section is where the key findings of the literature will be summarised and connected to NMPs.

2.2. Benefits of NMPs

It has been suggested that the traditional focus of nutrient management was initially on optimising nutrient usage and increasing economic returns (Beegle, Carton, & Bailey, 2000). Over time, while the agronomic and economic focus has remained, various commentators have suggested that in recent years the environmental impact of nutrients and the use of nutrient management to mitigate these impacts have increasingly become more important (Beegle et al., 2000). Commentators and research suggest that correct implementation of an NMP will result in both economic and environmental benefits for the farm concerned (Monaghan et al. 2007; Shepard, 2005; VanDyke, 1997). This section of the review will present a number of studies

which have focused on the influence of NMPs and the beneficial outcomes resulting from their implementation.

One such study was undertaken by Shepard (2005) who surveyed 127 farmers in Wisconsin, USA in two catchments where NMPs had been extensively promoted. Of the farmers surveyed, 53% had NMPs. Results indicated that farmers who used NMPs did apply lower rates of nitrogen and phosphorus through fertiliser when compared with farmers who had not adopted NMPs. For example it was established that farmers with NMPs had an average application rate of Nitrogen (N) of 139kg per hectare compared to 188 kg per hectare for farmers with no NMP. However, the study also found that the implementation of a NMP did not guarantee the elimination of excess nutrient application. It found that 37% of farmers with NMPs still exceeded application levels. However, in comparison 62% of farmers with no NMP exceeded application levels (Shepard, 2005).

This is an American study therefore there is possibly some difference in regards to how NMPs are structured in America compared to New Zealand. It is also important to note that the study focused on nutrients to cornfields so cannot be directly compared to dairy farming in New Zealand. However, the research is evidence that when used by farmers, NMPs have been associated with reduced fertiliser usage.

An earlier study by VanDyke (1997) came to a similar conclusion to Shepard (2005). VanDyke's (1997) research was on nutrient management planning on Virginia livestock farms in the USA. The results agree that the use of NMPs can result in significant nutrient reduction while maintaining or increasing farm income. This research was based on four case study farms which had NMPs in place and had sufficient information available for the researcher to study the nutrient and economic performance of the farm before and after the NMP was implemented. The results of this study showed a reduced mean nitrogen loss of between 23% to 45% per acre and an increase of net farm income of between $395.00 and $7,249.00 per annum as a result of the improved nutrient management practices. The study also noted reductions of phosphorus losses by up to 66% (VanDyke, 1997) .

Unlike the research by Shepard (2005), which studied the influence of NMPs by comparing farms with an NMP to farms without an NMP, VanDyke (1997) adopted a before and after research approach, comparing results of farms before they had an NMP to results after they had implemented an NMP. Again this was not a New Zealand study, however unlike the research of Shepard (2005), it does focus on live stock farms which would suggest that NMPs have potentially both economic and environmental benefits for NZ dairy farmers.

Both pieces of research support the common theme that NMPs and their associated management practices can contribute to both economic and environmental benefits for farmers; however, as stressed by Shepard (2005) the implementation of an NMP does not guarantee that the application of excess nutrients will be eliminated. This is because nutrient loss from fertiliser application represents only a small portion of potential total nutrient loss. As stated by Di and Cameron (2004) numerous studies have shown that leaching from fertiliser and dairy shed effluent are relatively small compared to that from animal urine patches in paddocks. Other factors such as stocking rate and the uneven distribution of dung and urine on paddocks are major contributors to nutrient runoff. However, fertiliser is one of the biggest economic costs for dairy farmers and research Shepard (2005) and VanDyke (1997) has shown the use of an NMP can lead to less fertiliser usage and hence less cost.

In their attempt to define the requirements and definitions of an NMP, the comments of Edmeades et al. (2011) were in agreement with the findings of Shepard (2005) and VanDyke (1997), suggesting that NMPs can have both significant environmental and economic benefits to the dairy industry. Based on his own field experience advising New Zealand dairy farmers in nutrient management, Edmeades (2009) reported that farmers could typically make savings by applying less fertiliser and in some instances production gains were made as previously undiagnosed nutrient deficiencies were often identified and corrected.

Edmeades et al. (2011, p. 7) argue that 'using nutrients efficiently, as instructed by a well defined and designed NMP, is good for the bottom line and for the environment'. The authors go beyond the economic and environmental benefits and speculatively suggest other possible positive outcomes of NMPs including the public perception of the farmer as being a good steward to the land and the role of NMPs in achieving central and regional government policy goals. Edmeades et al. (2011) also argue that NMPs can possibly help in reinforcing New Zealand's clean green image.

A concern is also raised; that the situation that arose around the introduction of nutrient budgets must be avoided. Edmeades et al. (2011) state that nutrient budgets did not always engage the farmer and were just placed in the dairy shed for when the shed inspector arrived for the annual inspection. Another potential danger highlighted by the authors is that NMPs may be perceived by the farmers as creating more paper work for minimal benefit (Edmeades, et al., 2011).

A New Zealand specific example of the influence of NMP implementation on farm management practices is Project Rerewhakaaitu. Here 24 dairy farmers in the catchment of Lake Rerewhakaaitu implemented NMPs. The aim was for the NMPs to contribute towards the reduction of nutrient leaching and run-off to the catchment lake. *Inside Dairy* (2011) - a

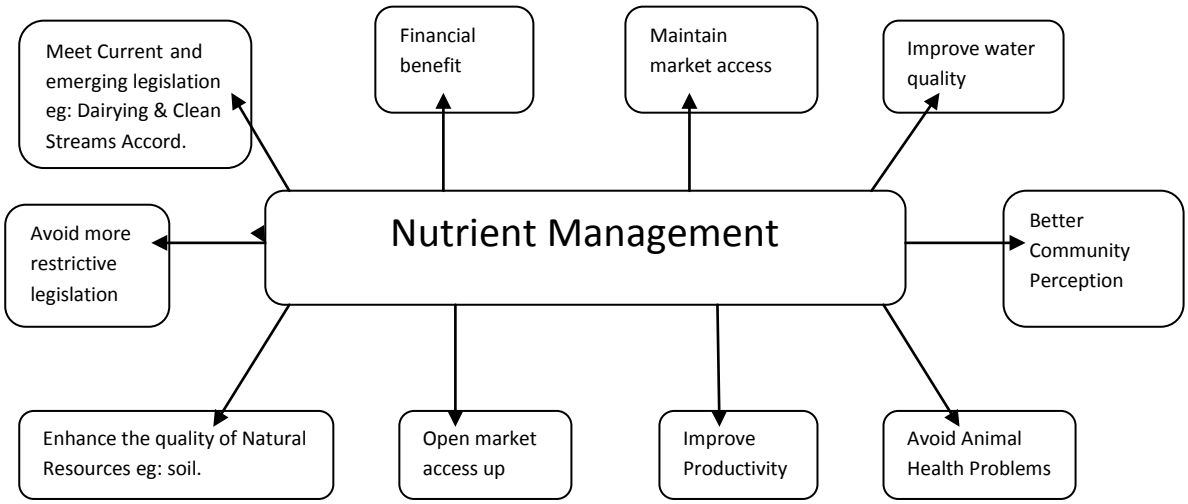
monthly magazine created by DairyNZ - stated that results showed that many of the participating farmers had reduced their fertiliser usage. By the end of the first year all farmers had begun to irrigate effluent back onto the farm instead of using oxidation ponds. By 2009 the majority of farmers were using Overseer nutrient budgets and were acting on the recommendations to reduce nutrient loss. With the support of the Bay of Plenty Regional Council the farmers had also developed a catchment plan for the Lake. Examples of changes and benefits resulting from farmer participation in the scheme included:

- Reduced nitrogen fertiliser use and feeding out of maize silage
- Increasing the size of effluent blocks
- Not applying nitrogen fertiliser in autumn or winter.
- Using soil tests to recognise that Olsen P levels were above the target, leading to a reduction in fertiliser application.
- Recognising which areas were low, medium or high risk areas for effluent application (*Inside Dairy*, 2011, p.11).

While evidence suggests that this project has been successful in reducing nutrients entering the catchment and lake, it has involved a high level of co-operation between the regional council, AgResearch and farmers. The majority of farmers in NZ are unlikely to have access to such a planned and executed scheme.

The following table, presented by DairyNZ (2006) summarises the suggested benefits of adopting NMPs to improve nutrient management on dairy farms within New Zealand. It includes benefits reported within the reviewed literature as well as other additional benefits identified by DairyNZ. The benefits identified are both those that apply directly to the farmer, and benefits that apply to the dairy industry as a whole. They include financial and environmental benefits as well as the perception of the industry by the general public and others. It should be noted that while some of these benefits have been highlighted in research other are only predictions at this stage;

Figure 1: Potential benefits of NMPs:



(DairyNZ, 2006, p. 5)

The preceding literature suggests that NMPs are advantageous in a number of ways when they are implemented as part of the management practices of dairy farmers. There is however, limited literature reporting on what dairy farmers consider to be the benefits of NMPs, whether dairy farmers use NMPs, and how dairy farmers have achieved results through the use of an NMP. This Masters research will contribute to answering these questions.

2.3. New Zealand Literature

This section presents the literature that exists on NMPs, nutrient management and the adoption of new innovations in the New Zealand context, and adds to the NZ literature already referred to in this review.

Smeaton et al. (2011) undertook a New Zealand study in which they modelled the association between farm productivity and profit, N leaching and greenhouse gas emissions on sheep, beef, and dairy farms. Modelled scenarios included changes to stocking rates, fertiliser use, wintering of stock and the importing of feed. It was concluded that systems that are both environmentally beneficial and economically positive can potentially exist. Smeaton et al.'s (2011) research explores the issue that increased production and intensification of farms will lead to negative environmental impacts. In contrast to Smeaton et al. (2011), Edmeades et al. (2011) state that

currently there is a conflict between environmental compliance and farm productivity because in their view, agricultural intensification will generally have negative effects on nutrient loadings, whereby increased intensification generally leads to increased nutrient usage.

Ramilan et al.'s (2009) conclusions are similar to Edmeades et al.'s (2011), stating that New Zealand's increasing agricultural production has been accompanied by an increase in inputs such as fertiliser, which in turn has led to the degradation of the surrounding environment. Ramilan et al. (2009) argue that only recently have these negative externalities been recognised as part of farm performance analysis. There is now a growing amount of regional policy in New Zealand requiring farmers to adopt strategies to address the issue of nutrient management and its environmental impacts. These include the requirements of the Waikato Regional Council for dairy farmers to have NMPS when nitrogen fertiliser is applied at a rate over 60kg N/ha per year or when fertiliser is applied to an area that has had animal effluent applied to it within the last 12 months. However there is still debate as to whether policies to reduce nutrient runoff and improve our waterways can feasibly operate while still maintaining economic gains in agricultural productivity (Samarasinghe, et al., 2011).

The environmental impacts suggested by Smeaton et al. (2011) were similar to the findings of a four year study by Monaghan et al. (2007) which examined the link between water quality and farm practices and productivity in a catchment in Southland, New Zealand. The concentration of nutrients, sediment and faecal bacteria recorded regularly exceeded water quality guidelines. Based on a range of modelled scenarios the study concluded that the implementation of best management practices such as wintering pads, nitrification inhibitors and effluent application management could help reduce nutrient loss to waterways (Monaghan, et al., 2007).

While the research of Monaghan et al. (2007) was not a study on NMPs per se, it does incorporate a variety of mitigation strategies which are incorporated in NMPs such as effluent management and the reduction of inputs such as fertiliser. It suggests that such practices can have positive effects for farmers, both economically and environmentally. It should be noted that the data relating to actual mitigation strategies was based on modelling rather than actual field results.

A second study by Monaghan et al. (2007) discussed and reviewed recent research regarding nutrient flows and the farm management practices currently in place in New Zealand. They argued that due to the requirements of industry quality assurance schemes and regional councils, NMPs will become more than just a regulatory requirement and will eventually shape farmers' management strategies and lead to increased nutrient efficiency while meeting catchment specific environmental targets. It is suggested by Monaghan et al. (2007) that the development of nutrient management practices in recent times has seen an increased focus on

practices which minimise nutrient leakage from farm systems to the environment. As a result the authors view NMPs as a shift away from a small set of procedures designed to optimise fertiliser applications to a comprehensive whole farm approach which considers a wide range of issues to ensure both productivity and environmental goals are achieved (Monaghan et al., 2007) The main components of nutrient use efficiency are seen by the authors as:

- The magnitude of the nutrient inputs
- The inefficiencies in nutrient cycling, and
- The timing of the inputs and key management practices (Monaghan et al., 2007).

In conclusion, Monaghan et al. (2007) touch on a recurring theme highlighted throughout this review, believing that farmer education on the environment and nutrient management practices is important. They suggest that farmer education will need to be able to identify the on farm context and the implications of management practices on farm productivity and profitability. This is discussed by others (Edmeades et al., 2011; Bewsell & Kaine, 2005; Lamba, Filson & Adekunle, 2009) and will be elaborated on in the third section of this review.

Edmeades et al. (2011) state that NMPs are a new concept in New Zealand, and speculate that NMPs will likely become mandatory in the near future**.** NMPs are a recent development in New Zealand so farm managers are still developing an understanding of the value of NMPs (Scarsbrook, 2011). Monaghan et al. (2007) argue that this current lack of understanding creates uncertainty around the actual benefits of NMPs. And as Clark et al. (2007) suggest, farmers' values and attitudes affect their adoption of new innovations such as NMPs.

The majority of work regarding NMPs in New Zealand is based around commentary on the benefits and perceived best models of NMPs. One key purpose of this research is to gain the views of dairy farmers on NMPs, and to inform other interested parties within the industry regarding NMP implementation and benefits.

2.4. Factors influencing the uptake of NMPs by Farmers

This section will review the factors identified in the literature as influencing farmer engagement in the implementation of farm plans and tools such as NMPs. The factors influencing adoption of new innovation are highlighted as being complex and multifaceted (Pannell, Marshall, Barr, Curtis, Vanclay & Wilkinson, 2006) and the literature in this area is often contradictory. However, this literature is important in highlighting possible reasons for the slow uptake of NMPs by dairy farmers in New Zealand and identifying possible solutions.

Smeaton et al. (2011), in their research of farm productivity, nitrogen leaching and green house gas emissions, suggest that in their opinion there is a number of reasons why farmers may not adopt managerial systems which are both profitable and reduce environmental impacts. These reasons include the farmer's need to improve their managerial skills, a perceived increase in capital cost, and incompatibility with the individual farm. Edmeades et al. (2011) suggest that farmers will be motivated to adopt NMPs provided they can see value for their own farm. Furthermore, as stated by Dooley, Smeaton, & Ledgard (2005) to encourage farmers to adopt NMPs it is also important to understand what factors the actual farmer considers important when managing nutrient loss. This is a view that is supported by other research regarding the adoption of such innovation (Bewsell and Kaine, 2005; Lamba et al. 2009). Shepard (2005) argues for the need to focus on the manner in which NMPs are implemented and continuously used, and how support from external agencies such as regional councils and fertiliser companies needs to continue after plan implementation**.**

There have been no studies found that explore farmers' opinions of NMPs and how farmers view the introduction of NMPs in New Zealand. However, it is speculated in the literature that there are a number of barriers hindering the adoption of NMPs by dairy farmers, the majority of which revolve around some key issues:

- Farmers' distrust of and / or acceptance of new concepts or innovations (Smithers & Furman, 2003; Deugd, Roling, & Smaling, 1998).
- The question of whether or not reducing nutrient outputs will in turn reduce the profitability of the farm. Can an environmentally friendly farm also be profitable? (Smeaton et al., 2011; Edmeades et al, 2011).
- Will the NMP be able to individualise the characteristics and scenarios of particular farms and / or catchments and adapt accordingly? (Monaghan et al., 2007; Bewsell & Kaine, 2005).

The importance of support for farmers in their implementation of NMPs is argued by Shepard (2005) and Monaghan et al. (2007) as well as the need for NMPs to be tailored to the individual farm characteristics (Edmeades et al. 2011). It is argued that the challenge is providing readily discernible information on a range of management and mitigation practices, requiring the 'application of nutrient management tools, consideration of specific environmental targets and the alignment with the farmer's goals and farming systems' (Monaghan et al., 2007, p. 195). Farmers have identified the need for NMPs to be flexible in how they meet their own individual environmental targets (Monaghan et al., 2007). Edmeades et al. (2011) suggest that NMPs need to be sufficiently flexible to be able to be applied to individual farms but robust enough to cater for the requirements of the RMA (1991).

A New Zealand example of research regarding the adoption of environmental best practices by dairy farmers was undertaken by Bewsell & Kaine (2005). The researchers based their approach on the idea that the adoption of new practices would occur only if the new practice provided some benefit to the farmer. They also suggest that no consistent relationship can be expected between the adoption of new practices and the size of the farm, the farmer's income, and the farmer's education and experience (Bewsell & Kaine, 2005).

Results found that while the majority of farmers viewed the environment as important, they were not convinced that some of the promoted management practices were actually practical. The farmers in the research based their decisions on a systematic and pragmatic evaluation of their own personal context, and the commercial and practical realities of dairying (Bewsell & Kaine, 2005). Farmers who had adopted environmental best management practices were found to have done so to address their own specific needs rather than being influenced by sustainability or environmental considerations, which were seen by the farmers as a secondary concern. In concluding the authors stress the importance of linking new innovations to the individuality of a given farm, stating that it is critical to the successful adoption of best management practices by dairy farmers (Bewsell & Kaine, 2005). As evident in other literature (Monaghan et al., 2007; Edmeades et al., 2011) the idea that innovations need to be adaptable to the individual farm situation is a common theme.

Smithers & Furman (2003) looked into the factors which influenced the nature and varying levels of engagement amongst farmers in Environmental Farm Plans (EFPs) in Ontario Canada. The EFP programme involved an environmental appraisal and subsequent creation of a farm specific environmental action plan (Smithers & Furman, 2003). The issues of farmer confidence, confidentiality and trust in outside agencies are raised as an ongoing challenge for programme managers (Smithers & Furman, 2003). This issue of trust is a dominant theme in the literature, supported by the findings of others such as Deugd, et al. (1998) and Pannell et al. (2006).

A primary motivator for participation in the Ontario EFP programme was a concern by farmers for the quality of soil and water resources while to a lesser degree farm profitability and public perception were identified as motivators. Results also suggest that a history of environmental activism and motivation by an individual farmer provided a strong basis for participation in the EFP programme (Smithers & Furman. 2003).

Deugd et al. (1998) undertook a study on integrated nutrient management (INM) which is defined as the 'manipulation of nutrient stocks and flows, in order to arrive at a 'satisfactory' and 'sustainable' level of agricultural production' (Deugd et al., 1998, p 270). The paper is a commentary on existing literature and the success of integrated pest management. It reaches

conclusions that are similar to Smithers & Furman (2003), where education of farmers is identified as a key component for the adoption of new innovations by farmers. The key conclusions of Deugd et al. (1998) include the need for farmers to improve their soil management by improving their knowledge of farming systems. It is suggested that farmers and other stakeholders should work closely and learn off each other, and for institutional support to be available and encourage the learning. The authors agree that farmers require support and encouragement to implement such programmes, which is in accord with Smithers & Furman (2003). This could be applied to the NMP scenario whereby farmers require ongoing education and support to ensure they are able and willing to implement programmes such as NMPs in New Zealand.

Lamba et al. (2009) completed research which examined the factors that influenced the adoption of agricultural BMPs in southern Ontario, Canada through the use of in depth interviews. This study reached a number of similar conclusions to that of Bewsell & Kaine (2005) including the idea that BMPs need to be developed in a context specific manner due to the varying environmental conditions and situations of each farm. As with Smeaton et al. (2011) and Edmeades et al. (2011) results suggested that farm characteristics and the personal characteristics of the farmer themselves affected the adoption of BMPs. It was found that reasons for adoption of BMPs included farmers own goals and intention, compliance, government encouragement, and peer pressure. However in contrast to Bewsell & Kaine (2005) it was also noted that characteristics such as farm size and annual income did influence adoption of best management practices. Other reasons included whether or not the farmer was the land owner and the type of agricultural enterprise. It was also found that if a farmer was previously involved in an environmental organisation or programme they were more likely to adopt environmental best management practices. This is opinion is shared by Atari, Yiridoe, Smale, & Duinker (2009).

In conclusion, Lamba et al. (2009) suggested that to encourage adoption of BMPs farmers would require assistance, both financially and technically from representatives of the proposed BMP and government. Lamba et al. (2009) also agree with the suggestion of Pannell et al. (2006) and others, stressing the need for farmers to be able to trust agency representatives, stating it is a prerequisite for collaboration between farmers and agencies.

Another study completed within Canada investigated farmers' perspectives of the key factors that affected the adoption and implementation of the Nova Scotia Environmental Farm Plan (EFP) (Atari et al., 2009). In contrast to Bewsell & Kaine (2005) and in agreement with Lamba et al. (2009) results of the EFP study suggest that farmers' experience and income do also influence participation in the EFP. Atari et al. (2009) findings showed that the more

experienced farmers had less interest in conservation practices. Reasons included having implemented their own more traditional practices with environmental benefits.

Income was also seen as an influence as higher earning farmers were viewed as having more capacity to invest and recognised both the economic and environmental benefits of EFPs. It is also suggested that the cost of implementation of the EFP served as a disincentive for smaller scale operators. Atari et al. (2009) results did however support Bewsell & Kaine (2005) view that farmer's level of formal education was not a factor in adoption of such plans.

While the EFP was viewed by farmers in the Canadian study as being able to meet their environmental objectives, the voluntary nature of the program did not guarantee implementation (Atari et al., 2009). A substantial proportion of the Canadian farmers interviewed also highlighted a lack of awareness and knowledge about the programme supporting the importance placed by other authors (eg: Shepard, 2005; Monaghan et al., 2007) on farmer education in farmer adoption and use of innovations such as NMPs. Key reasons put forward by farmers as to why they chose to take part in the EFP programme include:

- 85% of respondents viewed the promotion of integrity and farm stewardship as the most important motivator;
- 66% highlighted the improvement of relations with non-farming communities as a major factor;
- 62% highlighted increasing compliance as a major factor (Atari et al. 2009, p. 1276).

The results of the same study were used again by Yiridoe et al. (2010) in their investigation of the determinants of participation by farmers in the EFP. In agreement with Deugd et al. (1998) the authors found that farmers' involvement in workshops and information sessions increased the chance that they would participate in the EFP programme.

Pannell et al. (2006) attempted to examine the adoption of rural innovations by reviewing and interpreting literature from a number of different disciplines, including economics, sociology and psychology. The goal was to provide guidance for research, extension and policy for conservation practices in agriculture. They concluded that adoption of innovations were broadly dependent on a range of personal, social, cultural and economic factors.

Based on their review Pannell et al. (2006) concluded that adoption was more likely to occur if land holders viewed the innovation as having a relative advantage over the existing method, and whether the innovation was easy to test and learn about. A key conclusion of the research was that adoption was often based on the farmer's own personal perceptions and expectations

of the innovation. Landholders were not likely to change their practices unless they saw the new innovation as being consistent with their own personal goals.

The importance of trust and credibility was also raised, and is highlighted in other research such as Smithers and Furman (2003) and Deugd et al. (1998). Pannell et al. (2006) state that as landholders had excessive amounts of information available to them, often of a conflicting nature, representatives of new innovations needed to focus on the innovation's and their own credibility, reliability and legitimacy. They argue that one way of achieving this is to encourage a participatory approach where representatives work with the farmers rather than against them (Pannell et al., 2006). Pannell et al. (2006) conclude that the developers of any new agricultural innovation should ensure that the innovation itself is adaptable, with the challenge being to find an innovation that has both economic and environmental benefits that are superior to the previous practice being replaced.

There are a lot of comments and suggestions as to why it is thought farmers have not adopted NMPs as quickly as planned, and speculation as to what will need to occur to increase the adoption rate of NMPs (Edmeades et al., 2011; Monaghan et al., 2007). However to date there is no research that has explored why farmers have, or have not adopted NMPs, nor how NMPs have been integrated into farmers management practices in NZ. It is this gap that this research will contribute to filling.

2.5. Summary

This literature review has presented existing information regarding NMPs. Due to the lack of New Zealand specific research the existing literature has been sourced from both the New Zealand context and internationally. The information can then be used to guide the research and in turn establish a theoretical framework. The key findings of the literature review are presented as follows:

- NMPs can potentially have significant economic and environmental benefits.
- Uptake of NMPs in New Zealand has been slower than anticipated.
- There is a lack of previous research into how farmers in New Zealand have incorporated NMPs and how NMPs have influenced the farmer's management practices
- A common theme stressed in the existing literature is the importance of the education and assistance of farmers to ensure the innovation is adopted and that the maximum potential of the new innovation is fulfilled.

- The views of farmers differ greatly regarding the reasons for the adoption of new innovations such as NMPs.
- The requirements of the individual farm and / or catchment need to be specifically addressed by such innovations.
- The factors influencing the adoption of new innovations by farmers are complex and multifaceted (Pannell et al., 2006).
- The following are examples of factors which have been identified in the research, with results in some cases conflicting with regards to their importance:
    - The benefits offered to the farmer through the new innovation
    - The innovations relative advantage over the existing method
    - The ability to link the new innovation to the farm context.
    - The credibility of the new innovation to the farmers.
    - Characteristics of the farm / farmer (e.g. farm size / farming type / farmer demographics)
    - The support offered to the farmer from other interested stakeholders.

In summary, some commentators predict that NMPs will become a mandatory requirement in New Zealand, and it has been shown that the implementation of an NMP can be beneficial to farmers. Despite the requirements of NMPs for all Fonterra suppliers, the uptake of the innovation in New Zealand has been slower than anticipated. Existing literature presents an abundance of often conflicting factors that may, or have been found to influence the effectiveness of new innovations such as NMPs, as well as the characteristics of both the farmers and the innovation which influence farmer's adoption of such innovations.

There are few New Zealand specific examples on NMPs and their impacts on farm management practices. This research will contribute to the existing literature by gaining the perspective of actual NMP users in New Zealand on the reasons why they have an NMP, and what they view as the benefits and disadvantages of NMPs. As well as the effects of NMPs on their management practices, farmers' views on the education and support available, the implementation process, and the issue of nutrient management will also be collated and investigated.

The existing literature has enabled the categorisation of the key factors influencing the adoption and effectiveness of innovations. These can be identified as the individual circumstances of the farm and farmer, the involvement of other stakeholders in the education and support offered with regards to the new innovation, and the actual benefits offered by the new innovation over existing methods. It is these three factors which broadly shaped the interview structure in turn guiding the data analysis, the results and discussion of the research.

Chapter 3 Methodology

3.1. Introduction

This chapter addresses the research approach which has been used to answer the research question previously identified. Through this approach the research objectives described in Chapter One were achieved. Firstly the research design used is described, followed by the case selection process. The data collection methods are then presented and the data analysis approach described. Finally the ethical considerations are also presented.

3.2. Research Design

For this research a comparison case study was undertaken on dairy farm managers in the Waikato and Otago regions, who have implemented NMPs as part of their farm management strategy. The case strategy was chosen to answer the research question, 'How has the introduction of a Nutrient Management Plan influenced the farm management practices of dairy farmers, and what has shaped this influence? '

When selecting a research design Yin (2009) identifies three key conditions which should be considered when selecting a research method:

1: The type of research question posed;

2: The extent of control that the investigator has over the actual behavioural events;

3: The degree of focus on contemporary or historical events.

While there is a large area of overlap between the various research methods, when considering a case study as a research method the answers to the above conditions are generally:

1: Form of research question: How? Why?

2: Does the investigator have control over actual behavioural events? No

3: Focus on contemporary events? Yes

(Yin, 2009**).**

Due to the high citation rate of Yin's work regarding case studies as a research method, his work will be used as a basis for the rationale of the research approach. Yin (2009) presents a

basic category of research questions as: who, what, when, how and why? In general ‘how’ and ‘why’ questions deal with operational links rather than frequencies or incidences. As they are more explanatory in nature they tend to favour case studies as the research method (Yin, 2009).

Yin (2009) states that case studies are preferred when the research involves contemporary events where behaviours cannot be manipulated, while they also provide two extra sources of evidence: direct observation of the events; and interviews with the people involved. Yin (2009) also states that a benefit of the case study approach is that it is able to deal with a variety of evidence including documents, artefacts, interviews and observations. Eisenhardt (1989) supports this view stating that case studies typically use a combination of methods such as archival exploration, interviews, questionnaires and observations.

In summary a case study is suitable when a ‘how’ or ‘why’ question is asked about a contemporary event of which the researcher has little if any control. The case study can then be used to accomplish a number of end results, including providing description, testing theory or generating theory (Eisenhardt, 1989).

With regards to the research question ‘How has the introduction of a Nutrient Management Plan influenced the farm management practices of dairy farmers?’ it is clearly stated that the questions asked are ‘how’ and ‘why’. The research topic is a contemporary event and the researcher has no control over the behavioural event concerned. Data was gathered primarily through interviews with farmers and key informants and will be supported by data gathered from existing documents and general enquiries made with the relevant institutes and individuals. It was therefore concluded that a case study approach was most suited for this research topic.

A key feature of a case study is that it does not represent a sample, rather its goal is to expand and generalise existing theories (Yin, 2009). Yin (2009) also argues that the researcher gains more depth and detail on the subject matter through the use of a case study.

Yin (2009) states that arguably the most common concern with case studies is the lack of rigor, whereby researchers have been inaccurate with their approach and not followed proper procedures or have allowed equivocal evidence to bias views and so affect the findings and conclusions. To add more substance to the research two case regions were studied. The Waikato and Otago regions were selected due to their regional variances in nutrient management policy and history of NMP adoption. These variances could then be compared with regard to how they have influenced the adoption and use of NMPs by dairy farmers. This research type is described as a comparison case study (Bouma, 2000, p. 98). The comparison study investigates the subject further by exploring it within similar types of entities. Yin (2009)

states that the case study approach can have multiple cases within itself and so can draw a single set of cross-case conclusions.

Eisenhardt (1989) states that case studies are a type of strategy which enables the researcher to understand the dynamics which reside within a single setting. Case studies can involve either a single case or as in the case of this research, multiple cases. Eisenhardt (1989) describes the tactic of selecting a pair of cases and listing the similarities and differences between them, thus forcing the researcher to look for subtle differences and similarities. This can lead to a more sophisticated understanding and the discovery of new categories and concepts which were not initially anticipated by the researcher. The 'myth' that case studies are limited by the researchers own preconceptions and bias is dispelled by the idea that 'attempts to reconcile evidence across cases, types of data, and different investigators, and between cases and literature increase the likelihood of creative reframing into a new theoretical vision' (Eisenhardt, 1989, p. 546).

To complete the case studies semi-structured interviews were used to gather data from the participants. This allowed the researcher to ensure key questions were asked and the general structure of the interview was maintained. It also encouraged the interviewee to speak openly allowing for additional information to be gathered. The interviewer could prompt for additional information and elaboration when required. Semi-structured interviews have been described as having a general interview structure that is set up by deciding before the interview what the main questions to be asked are, and also what the general theme of the interview will be (Drever, 1995). The actual structure takes shape during the interview and thus allows the interview subject some freedom in what is discussed and how much is said. This also allows the interviewer to prompt the subject for more information when required and so allows for a more in depth exploration of data. Drever (1995) states, that while this interview type is not suited for large scale research it is highly appropriate for case studies. Longhurst (2010) supports Drever's view and states that a semi-structured interview is undertaken in a conversational manner and allows all participants to explore issues which they feel are important. The informal manner of semi-structured interviews also allows for all participants to feel comfortable and relaxed. This is identified as a major consideration of this form of interview (Longhurst, 2010).

For this research a set of general questions were used to guide the interview however additional questions were often asked as the interviewer saw fit, to gain further information when required. Interviews were completed in a relaxed and conversational manner due to the informal nature of them, ensuring the interviewee was relaxed and forthcoming with information throughout.

The case study data was obtained through the use of on farm interviews. A sample of farmers with NMPs in place, were interviewed within each region. These regions were chosen as the Waikato Regional Council had already adopted NMPs under its regional policy in some capacity and had begun to actively promote the idea of nutrient management. In contrast the Otago Regional Council currently has no requirements for NMPs in its policy however a proposed water management policy change, which will set limits to nitrogen leaching, has just recently been moved into the public submission phase. The geographic characteristics and farm practices also varied between regions. The Waikato region was also chosen due its close geographic location to the researcher, while the researcher had a number of close contacts within the dairy industry in the Otago region.

Information was also gathered from key informants including DairyNZ and Ravensdown, as well as from the respective regional councils to gain their views regarding the development and use of NMPs in the NZ dairy industry. Information was also gathered from the relevant regional councils through e-mail correspondence while organisational documents such as regional policies and details regarding regional programmes were also acquired via the relevant websites and through e-mail communications.

3.3. Selection Criteria

The two key factors for selection of the research participants in the research were that the farmer must be involved in the management of a dairy farm and that an NMP must have been created for that particular farm. Published documentation and personal contacts from within the dairy industry confirmed that the use of NMPs was a nationwide initiative and so it was concluded that farmers with NMPs in place would be present within any regional jurisdiction throughout New Zealand. This was found to be true within the case study of this research.

When choosing the two regions to select for the case studies a number of factors were considered. Enquiries made within the industry with regional councils and fertiliser companies confirmed that due to privacy issues farmers personal details could not be passed on without the consent of the farmer themselves. For this reason the Otago region was selected as one of two case study areas as numerous personal contacts were available within the region's dairy farming community. This ensured access to dairy farmers was readily available. Further enquires made with the ORC also confirmed that the while the ORC supports and promotes the adoption of nutrient management practices, nutrient budgets or nutrient management are not currently in any implemented policy. However in March 2012 the ORC did notify a plan change (Proposed Plan Change 6A - Water Quality) which included limits for nitrogen leaching on farms based on Overseer results.

As the ORC could be viewed as a region in the infancy of nutrient management strategy development, it was decided that the second region chosen should represent an area which had already adopted some form of nutrient management planning and incorporated it into regional policy. This was the major influence in selecting the WRC as the second case study region. Other reasons included the close proximity of the Waikato region to the researcher as well as the differences in geography, climate and history of dairy farming in the region compared to the Otago region.

Under rule 3.9.4.11 on the regional plan, the WRC states that an NMP must be used when nitrogen fertiliser is applied at a rate greater than 60kg N/ha per year, and where fertiliser is applied to an area that has also had animal effluent applied to it in the preceding 12 months. Enquiries made with the WRC also confirmed that the WRC expect to see tighter management of nutrient loss from farms in the future (D.Harford, 2 July 2012, personal communication). The WRC has also instigated initiatives such as the Integrated Catchment Management project where the WRC has worked with farmers to help improve their agricultural practices to reduce fertiliser run off to the waterways of the region using tools such as education, incentives, enabling compliance and regulations (Hungerford, 2010).

Twelve farmers across the two regions of Waikato and Otago were interviewed. Farmers were identified within the Waikato region with the help of WRC staff. A representative from the council who had worked on the Integrated Catchment Management project contacted a number of the farmers whom they had worked with during the project and asked if they would allow their details to be passed on so they could be contacted and advised on what the research entailed. As these farmers were involved in the programme it was already known that they had an NMP in place. Of the farmers who were contacted, five approved, of which four were able to be contacted and were interviewed. One could not be contacted. A fifth interview was initiated by contacting another individual Waikato farmer whose details were acquired via personal contacts.

Within the Otago region personal contacts within the dairy industry were used to identify farmers who had NMPs in place. Farmers were again phoned and asked if they wished to participate. An attempt was made to contact 7 farmers, of which 6 agreed to be interviewed while one was unable to be contacted. One of the farm managers interviewed also organised a second interview with the farm owner which presented a different perspective to the subject for the same farm.

3.4. Data Collection

All farmers were contacted by phone and given an overview of the research, and then asked if they wished to participate. If the farmer was willing a time and date were then agreed upon for the onsite interview to take place. Data collection from all seven interviews within the Otago region took place in the Waitaki district from 23rd to 29th September 2012. All data collection from interviews within the Waikato region took place within the Little Waipa catchment during the months of October, November and December of 2012 with the fifth interview completed in January 2013.

All interviews took place at the farmer's own residence which assisted in ensuring the interviewee was relaxed. With the permission of the interviewee all interviews were digitally recorded on a device. The recording was checked on the same day of the interview taking place to ensure it had recorded correctly. The semi structured nature of the interview allowed the farmer to discuss their views in depth while allowing the interviewer to prompt for further information.

A semi-structured interview guide was formulated to guide the interview with key questions relating to important topics. Additional questions were asked or certain question excluded if the interviewer considered them irrelevant for the particular circumstance or if the farmer had already answered the question through the information given previously. The same question guide was used as a basis for all interviews with farmers across both sub cases to ensure consistency (Appendix 3). The key sections covered in the questionnaire were:

- Community feelings and trends associated with NMPs
- Implementation process of the farmer regarding their own NMP,
- Current situation for the farmer and their NMP regarding the NMPs influences on management practices, goals, time frames, changes etc.
- The farmer's impression and views of NMPs. What they saw for the future and what they would like to see changed.
- General farm details and overview.

Once completed the interviews were saved to a computer as well as being sent to a secondary computer for safe storage and ease of access. Data from the interviews was then reviewed and summarised.

3.5. Data Analysis

Data analysis for this research was based on a qualitative approach. Approximately half way through the interview process the most detailed and descriptive interview was selected to be fully transcribed. A full transcript was then analysed to identify key themes and concepts. This analysis then served as the basis for the analysis of the remaining interviews and enabled the identification of similar and new themes and concepts throughout the remaining interviews. All remaining interviews were then summarised with particular focus on the themes and concepts identified in the fully transcribed interview.

Once all interviews were individually summarised the results were merged and a summary was created for both the Otago and Waikato regions. An overall summary encompassing all interviews and both regions was completed also. This enabled the identification of key themes and concepts for each individual, each region and also the entire data set.

3.6. Ethical Considerations

A low risk notification for ethical approval was submitted on 31st July 2012, and a subsequent letter from the Massey University Human Ethics Committee was received on 10th August 2012 acknowledging approval subject to the following statement appearing on all public documents:

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 the research.

All interviewees were initially contacted via phone where the research was explained to them and they were asked if they were willing to participate. No pressure was put on the potential interviewees to accept and all were made aware of their right to decline.

All interviewees in the Otago region agreed upon an interview time within 48 hours of the phone call. Therefore in these circumstances it was at the interview that an information sheet was provided to the interviewee outlining the research, supplying contact details, explaining the interviewee's role, and reiterating their rights to decline any question asked of them. This information sheet also stated that all interviewees would remain anonymous. A consent form was also supplied where the interviewees signed to acknowledge that they agreed to participate in the research and were aware that they were being recorded and that any information supplied may be directly quoted and used in the research. The consent form also confirmed that the interviewees had read the information sheet. Before any interview began verbal acceptance was asked of all interviewees to confirm that they were happy for the interview to be recorded.

For interviews in the Waikato region, the time between the initial phone call and the interview date was often over a month in some cases. In this scenario the phone call was followed up by an e mail with further information regarding the research as well as the information sheet and consent form attached. Otherwise the process was the same as for the Otago region.

Individual participants remain anonymous throughout the presentation of result. As explained to interviewees previously, the only form of identification was with regards to their regional location.

3.7. Summary

To inform the research question the use of a case study research design incorporating two cases was used. Semi-structured interviews were used for data collection which assisted the interviewees to feel relaxed, while allowing the interviewer to direct the course of the interview, by for example prompting or asking new questions to gather additional information.

The research participants consisted of farmers within the Otago and Waikato regions that had an NMP implemented for their farm, either of their own accord or due to external motivation. The two regional cases were selected primarily due to their regional variances in approach to nutrient management. In comparison to the ORC, the WRC had already incorporated the need for NMPs within regional policy and had been actively promoting nutrient management strategies. The ORC however, was reviewing their water plan and had proposed the incorporation of set nitrogen limits based off the use of Overseer results. Other factors included the close proximity of the Waikato region to the researcher and the existence of personal contacts within the dairy community in the Otago region.

A qualitative approach was adopted for the data analysis where interviews were summarised and key themes and trends were identified for the individual, the relevant case and the overall data set. Comparisons and similarities were then indentified between the research data and reviewed literature enabling the formulation of conclusions. This in turn informed the research question and contributed to the limited amount of research regarding NMPs and their impact in the New Zealand dairy industry.

Chapter 4 Contextual Information to Cases

4.1. Introduction

Four farms chosen for this study were within the Waipa district, and one in the Hauraki district of the Waikato region. Six farms were in the Waitaki district of the Otago region. This section will outline the characteristics of these regions, with regards to the geographic make up of the area, the climate, policy requirements and some general characteristics of the farms and farmers interviewed. The following maps illustrate the regions covered by the respective Regional Councils with the approximate location of the farms involved in the research indicated:

Source: (Department of Internal Affairs, 2013)

Figure 2: Site of Farms in Waikato Figure 3: Site of Farms in Otago .

4.2. Geography and Climate

4.2.1. Waikato

The area covered by the WRC's jurisdiction is 25,000 square kilometres (Department of Internal Affairs, 2013) with the geographic boundaries being the Bombay Hills and Port Waikato to the north down to the Kaimai Ranges and Mount Ruapehu in the south, and from the Tasman Sea on the west coast to the Coromandel Peninsula to the east. The area has been cultivated for over 150 years with European settlers clearing forests and wetlands to establish farmland. As a result a number of key environmental issues have been identified by the Regional Council including:

- Erosion
- Fragmentation of rural land
- Cultivation
- Pugging and compaction
- Excessive drainage
- Loss of native habitats, and
- Nutrients in waterways (Waikato Regional Council, 2013)

In the regional council's publication titled '*The condition of rural water and soil in the Waikato region'* (2008) nitrogen and phosphorus were identified as the two main problem nutrients. With the numerous waterways and lakes in the region - including the Waikato River and Lake Taupo - and the amount of coastline encompassed within the regional boundaries, nutrient runoff into these waterways has been identified as a key issue (Waikato Regional Council, 2008).

The majority of interviews took place within the Little Waipa catchment to the west of Putaruru, close to the Waikato River. Unlike the braided river plains which characterise the Otago region, the landscape in this region would best be described as undulating or rolling hills. Many streams and steep sided culverts pass through the farms with one farmer stating that they had at least 30 culverts on their farm. Soil in this area is described as predominantly free-draining allophanic (volcanic ash) with some pumice. The soil has been described by farmers interviewed as Tirau Ash or Tirau Fine Sandy Loam, as it is referred to in their NMPs. In general the natural fertility of this allophanic soil type is low however the ability of the soil to retain phosphorus is high (Landcare Research, 2013). In general the climate in the region is characterised by humid summers and mild winters. The average regional rainfall is 1250mm which is seen as an adequate amount for agriculture, although there is the potential for droughts

during the summer months. These regional characteristics lend themselves to intensive and productive dairying systems.

4.2.2. Otago

The land area governed by the Otago Regional Council is 31,280 square kilometres (Department of Internal Affairs, 2013). The region stretches roughly from the Waitaki River in the north east, to the Catlins to the south east, up to Lake Wakitipu and Queenstown then north up the Southern Alps to Lake Ohau. It has not been until the last 10 or so years that the dairy industry has experienced significant growth. This growth has tended to be focused on the east coast from the northern area around Oamaru down south to Balclutha (Otago Regional Council, 2013).

Even though dairying is relatively new to the region, the ORC state that water quality results have shown that the industry is contributing to the degradation of Otago's waterways (Otago Regional Council, 2011). Generally the majority of the regions freshwater resources are in very good condition however the council has noted in its *Rural Water Quality Strategy 2011* (Otago Regional Council, 2011) that with the intensification of agriculture in parts of Otago the water quality has been significantly degraded.

The eastern coast of Otago, influenced by the South Pacific Ocean has a cloudy maritime climate with relatively moderate temperature changes through the seasons, while further inland is subjected to much colder winters and warmer summers. For the Oamaru region the average annual rainfall is 800mm with an average summer temperature of 20 degrees Celsius and a winter average of 8 degrees Celsius. Irrigation is therefore more prominent in this region (Otago Regional Council, 2013).

Five farms studied were situated on the river plain of the Waitaki River. This is very flat land. The major soil type is the Pukeuri soil, and is a Pallic type soil. These soils generally have slow permeability but depending on the geography the drainage is adequate however can be impeded on flatter areas. It has a moderate natural fertility (except for sulphur), and is susceptible to erosion (Landcare Research, 2013). All farmers interviewed use irrigation due to the low annual rainfall. While the two farmers further inland use spray as the main form of irrigation, the farms situated on the Waitaki plains use borderdyke irrigation. This has implication for the planning of fertiliser applications.

Also of note, is that the farmers on the plains have very few if any natural waterways running through their farms. One farmer indicated that they have no waterways on their farm at all, as they are situated by the coast.

4.3. Policy

4.3.1. Waikato

The WRC introduced its Regional Plan in 2007 and is due to review its plan again in 2015. The current rules that apply to farmer's management of nutrients are:

Rule 3.9.4.11: States that a Nutrient Management Plan must be used where nitrogen fertiliser is applied at a rate greater than 60 kg N/ha per year, and where fertiliser is applied to an area that has also had animal effluent applied to it in the preceding 12 months (Waikato Regional Council, 2007).

The requirements of an NMP under the plan are:

> A nutrient management plan must be prepared that, as a minimum records the following information for at least nitrogen (N) and phosphate (P) (in units of kg of N and P per hectare per year) :
>
> - Inputs from fertiliser.
> - Inputs from other sources such as manures, green crops and soil mineralization.
> - Outputs in product.
> - Results of soil testing for levels of **available** N and P.
> - Documentation of consideration given to climatic and soil conditions for the life of the crop to account for the effects of rainfall and irrigation on the potential for N and P leaching through the soil in to ground and surface water.
> - Practices that will be implemented to reduce nutrient and sediment losses from the property and to avoid, remedy or mitigate adverse effects on the environment.
>
> And: The nutrient management plan specified above must be developed based on the outputs of either Overseer (Agresearch) or any other nutrient management planning tool that meets the criteria...

(Waikato Regional Council, 2007)

The plan also states that the discharge of fertiliser is a permitted activity subject to conditions and that fertiliser must be applied in accordance with the NZ Fertiliser Manufacturers Association.

The plan does not go beyond what the requirements are for an NMP. However, the Waikato Regional Council does supply NMP guidelines on its website, including the steps to creating an NMP and pointers to help in choosing an appropriate farm advisor or company who are able to provide an NMP that meets the Council's expectations. The WRC does not however endorse any particular supplier.

The WRC has been actively promoting the idea of nutrient management. Examples of this include the council's involvement in Dairy Push[3] and the Integrated Catchment Management Plan (ICMP). Four of the five farmers interviewed were involved in the ICMP. This involvement has contributed towards the knowledge of those dairy farmers regarding nutrient management and a strong awareness of the environment amongst the majority of those farmers interviewed in the region.

The WRC has also advised that they expect to see tighter management of nutrient loss from farms in the future (D.Harford, 2 July 2012, personal communication). With the upcoming review o f the Regional Plan in 2015 it is expected that much tighter rules will be implemented with regards to nutrient discharge to the upper Waikato River (D.Harford, 2 July 2012, personal communication). Farmers in the Lake Taupo catchment are already operating under a Nitrogen nutrient cap and there much tighter controls around N leaching within that catchment.

In summary, the WRC has made NMPs mandatory in some instances as outlined in and limits have been set in particular catchments but in general there are no set criteria or limits to meet regarding nutrient leaching for the majority of dairy farmers in the region. It does look likely that this will change in time with much tighter nutrient management requirements predicted for the future.

4.3.2. Otago

The North Otago Irrigation Company (NOIC) requires all customers who receive irrigation to have some form of NMP in place. NOIC's agreement with the ORC includes the following conditions:

[3] A farmer driven initiative to improve the profitability of dairy farms in the South Waikato through improved management practices

3: The consent holder shall as part of the condition of supply of irrigation water to water user, in consultation with Te Runanga O Moeraki, require the water users to produce, maintain and implement an appropriate environmental farm plan which addresses as a minimum the following issues:

- Irrigation Management Policy
- Effluent Management Policy
- Fertiliser Management Policy
- Riparian Management Policy
- Soil Management Policy

(North Otago Irrigation Company Ltd, 2003)

The Otago Regional Council's Water Plan was made effective in January 2004. The council have advised that until recently the plan made no mention of nutrient budgets or NMPs. This is currently being reviewed. As of March 2013 the ORC were currently proposing a change to the Regional Plan: Water for Otago. This is the Proposed Plan Change 6A (Water Quality). The proposed change regarding nutrients is as follows:

12.C.1.3 The discharge of nitrogen from land to groundwater, is a **permitted** activity, providing:

(i) From 31 March 2019, calculated nitrogen leaching by the Council using OVERSEER® version 6.0, does not exceed:

(a) 10 kg N/ha year over any nitrogen sensitive zone identified in Maps I1-I6; and

(b) 30 kg N/ha year elsewhere in Otago; and

(ii) Upon request, the person with responsibility for the management of the land supplies the Council with all necessary annual input data to run OVERSEER® version 6.0.

(Otago Regional Council, 2012).

This proposed amendment was mentioned by all the farmers interviewed. All farmers interviewed will have to reduce to 30 kg N/ha year and one will have to reduce to 10 kg N/ha year if this plan amendment is passed. One farmer stated they were currently leaching 50-60 kg N/ha year while a second is also around 60 kg N/ha year. Both would have to reduce to 30kg N/ha year if the amendment is passed.

While NMPs are a requirement as part of the consent process for any farmer requiring irrigation from NOIC and as part of the supply agreement with Fonterra, there are no current requirements for NMPs as part of the ORC's regional policy. The proposed plan change 6A (Water Quality) would see limits applied to nitrogen leaching (based on Overseer) within the region, however, there is no actual requirement for an NMP proposed by the ORC. In contrast to the WRC, at this time the ORC has had minimal involvement in advertising or promotion of environmental best management practices such as NMPs.

4.4. Farm Details

The following table is a summary and comparison of the farms involved in the case study. At the time of the study all farmers believed they were on track to reach their goals with regard to the production of milk solids per cow. The table gives an overview of the farms with regard to the size of the farm ,the size of the herd and how intensive the farms are with regards to stocking rates and production.

Waikato	Seasons on Farm	Effective Farm Size (ha)	Herd Size (cows)	Production Goals (MS/Cow)	Stocking Rate (Cows/ha)	Number of Staff
Farm 1	20	124	370	370	2.98	3
Farm 2	20	185	475	421	2.57	3
Farm 3	14	184	501	359	2.72	4
Farm 4	31	100	305	393	3.05	2
Farm 5	3	92	206	350	2.24	1
Otago						
Farm 1	8	185	640	420	3.46	4
Farm 2	4	196	760	440	3.88	3
Farm 3	5	320	1250	490	3.91	6
Farm 4	10	300	1000	475	3.33	5
Farm 5	2	293	1500	480	5.12	16
Farm6	7	380	1200	350	3.16	5

Table 1: Farm Summary

Four of the five farmers interviewed in the Waikato region were involved in regional community programs such as the ICMP and Dairy Push which were both voluntary programs that focused on innovations which addressed topics such as nutrient management and the use of NMPs. The WRC was also actively pushing the idea of nutrient management and the use of NMPs and had incorporated the need for NMPs as part of the regional policy in particular circumstances.

In contrast there is no current regional policy set by the ORC requiring NMPs. However all farmers interviewed were aware that an NMP was required as part of the farmer's supply agreement with the irrigation supplier NOIC. In contrast, farmers in the Waikato region did not require any irrigation beyond the application of effluent. A major concern for farmers in the Otago region was the use of Overseer as a policy tool as part of the proposed water plan rule change (6A) by the ORC. In this proposal Overseer is to be used to set limits on nitrogen leaching throughout the region. All farmers interviewed would have to reduce their nitrogen leaching significantly as a result.

Farmers in the Otago case were shown to have larger farms and higher stocking rates, and ultimately larger production goals than those in the Waikato case, with one farmer having approximately 1500 cattle. As a result of the more intensive farming and corresponding use of fertiliser, those farmers in Otago that had not implemented an NMP of their own accord were supplied an NMP by their fertiliser company as part of the service. Key Informants advised that Ravensdown creates NMPs for the top 20% of their fertiliser customers across NZ whether requested by the farmer or not.

Characteristics of the farmers and their farms throughout both case studies varied greatly and some regional trends were evident. All farmers interviewed in the Otago case were between the ages of 30 to 40yrs old and all had young families. The number of seasons that the farmers had been on the particular farm varied from two to ten years with herd sizes being from 640 to 1500. Actual farm size reflected the herd size and varied from 185ha to 380ha with stocking rates of 3.46 to 5.12 cattle per hectare. The number of staff employed by the Otago farmers varied from three to sixteen.

In comparison farmers in the Waikato case study were generally of an older age with the youngest being in their late 30s and the oldest nearing retirement age. Seasons on the particular farm were recorded from three to 31 seasons and herd size was from 206 to 501. The actual farm sizes were also smaller than those in the Otago case and varied from 92hec to 185hec with stocking rates of between 2.24 to 3.05 cattle per hectare. The stocking rate amongst those farmers interviewed in the Waikato region was significantly less than those in the Otago case and so amongst these particular cases the farming practices in the Otago case were found to be more intensive than in the Waikato. The number of staff employed by the Waikato farmers varied from just themselves (one) to four.

Awareness of farmers regarding nutrient management in their respective regions varied greatly in both case studies and across the entire data set. Some farmers considered themselves very knowledgeable while others admitted to having little knowledge at all.

4.5. Summary

This chapter has presented a summary of the characteristics that have an effect on the farmers in the two cases of the case study. The regional variance with regards to policy, geography, climate, farm characteristics and subsequent farming conditions have been presented and compared. In doing so context is given to the data gathered during the research.

Chapter 5 Results

5.1. Introduction

This chapter presents the findings of the data from the research on NMPs and their influence on dairy farm management. The chapter is split into four sections; the first section presents the results from interviews with key informants within the dairy industry. Each region is then presented in a section, and the final section summarises and compares the results of the entire data set. Subsections are included and based off the key themes which have been identified in the research. These subsections will be as follows:

- The range of reasons for the introduction of NMPs to Dairy Farmers
- The degree of uptake and perception of NMPs by dairy farmers and reasons for this.
- The influence of NMPs on the management practices of dairy farmers.

Throughout this section the Otago farmers will be referred to as Farmer O1 – O6 and the Waikato farmers will be referred Farmer W1 – W5. For farm O2 both the farm owner and farm manager were interviewed so they will be referred to as O2a and O2b respectively.

5.2. Development and Promotion of NMPs in NZ

The initial development of NMPs began around 2005 (Ravensdown Senior Scientist, Interview, 2012) with a goal to help farmers decide what actions they need to take with regards to their nutrient budget. The intention of an NMP was to offer information regarding fertiliser advice, farm maintenance, environmental risk, and council requirements, while incorporating the farmer's goals. NMPs were also seen as a way to document all transactions and advice given between fertiliser representatives and farmers (Ravensdown Senior Scientist, Interview, 2012.

The fertiliser companies are assisted in the promotion of NMPs by DairyNZ, who see their role being to raise awareness of nutrient management tools through, for example, the use of discussion groups (DairyNZ, Environmental Developer, Interview, 2012). At the time of this research Ravensdown were in the process of developing a new NMP model and DairyNZ were involved in a project with the fertiliser industry to set up a certification system for advisers to ensure that NMP advisers were appropriately qualified. This process of certification was described by a Dairy NZ representative as a form of quality assurance (DairyNZ, Environmental Developer, Interview, 2012).

Personnel from Ravensdown and DairyNZ both stated that their main form of encouragement and advertising to farmers with regards to NMPs was through the use of newsletters and articles, with Ravensdown also using on farm visits by account managers to promote NMPs. At this stage there is very little continual support for farmers. DairyNZ advised that they currently offer little direct support to farmers regarding nutrient management, while Ravensdown were wary of telling farmers what to do, preferring to sell NMPs as 'this is what you should do' (Ravensdown Senior Scientist, Interview, 2012) with regards to nutrient management. This was described as 'voluntary compliance' and it was commented that this approach may change in the future (Ravensdown Senior Scientist, Interview, 2012.

NMPs were acknowledged by a Ravensdown senior scientist to be a sunk cost, as the plan may encourage reductions in fertiliser usage, and cost between $3,000 and $5,000 per plan (Ravensdown Senior Scientist, Interview, 2012). The DairyNZ Environmental Developer viewed the potential benefits of NMPs as improved sustainability and public perception. NMPs were seen as being economically sustainable, and environmentally friendly, as well as helping farmers to remain compliant and keep below any regional nutrient caps that may apply.

Both representatives from Ravensdown and DairyNZ recognised that fertiliser management had only a small impact on nutrient loss, and that the use of whole farm system management would be required to meet industry targets. They argue that this would require a range of professionals (eg: farm consultants and economists) to work alongside each other to develop whole farm plans. NMPs were viewed by both parties as being constantly evolving. They predicted that in the future there is likely to be a move to incorporate NMPs into a whole farm plan.

Both parties identified issues with farmers' understanding of NMPs and the actual need for NMPs. The DairyNZ personnel identifed DairyNZ research that found that there was great value for farmers when the fertiliser representative sat down and talked the farmer through the NMP (DairyNZ , Environmental Developer, Interview, 2012), however there is concern with the time available for representatives to do this, as well as being able to follow it up and supply ongoing support to the farmer (Ravensdown Senior Scientist, Interview, 2012). The Ravensdown scientist believed that farmers do not want to act too early with regard to nutrient management until pending regional regulation is known, and subsequent requirements of the farmers' are confirmed (Ravensdown Senior Scientist, Interview, 2012).

Ravensdown viewed their NMPs at the time of the research as too detailed and so were reviewing the structure of the NMP so that important information was not lost. This view was supported by the DairyNZ representative who saw the NMP as having too much information which made it hard for the farmers to find what they needed to get out of the NMP. This highlighted the conflict between satisfying the regulatory requirements of NMPs and what

information the farmers wanted to see. Ravensdown was also wary of the perception of the role of a fertiliser company giving fertiliser advice: 'the poacher and game keeper' (Ravensdown Senior Scientist, Interview, 2012).

NMPs were seen as 'rapidly evolving' (Ravensdown Senior Scientist, Interview, 2012), with the majority of Regional Councils currently in the process of rewriting their regional plans. It was predicted that many of the new regional plans will include specific restrictions around fertiliser use and the need for NMPs. Dairy NZ views the inconsistency between regions as an concern when it comes to the development of a suitable NMP template for the dairy industry (DairyNZ, Environmental Developer, Interview, 2012).

5.3. Otago Results

5.3.1. Reasons for the introduction of NMPs to Dairy Farmers

An NMP is now a requirement for all dairy farms that supply milk to Fonterra. That is 95% of dairy farmers in New Zealand (Fonterra, 2013). Results from the Otago region indicate that all farmers interviewed had had their NMPs created for their farm by a fertiliser company. Further to this, dairy industry key informants indicate that NMPs have been introduced to farmers through articles and newsletters, however the level of actual awareness amongst the Otago farming community is not known. As stated by a senior scientist at one of the two major fertiliser cooperatives in New Zealand; as they have over 30,000 shareholders, farm visits by company representatives are prioritised depending on such factors as the size of the farmer's business, as 80% of the fertiliser goes to 20% of the shareholders. The senior scientist stated that it is this 20% which will have NMPs developed for them whether they ask for it or not. All farmers interviewed in Otago were suppliers to Fonterra and have had an NMP supplied to them by one of the main fertiliser companies: Ravensdown and Ballance.

In the Otago region another major influence for the adoption of NMPs by dairy farmers is the requirement of NOIC[4], that all farmers who receive irrigation water from them have an environmental farm plan in place. This plan must include an effluent, fertiliser and soil management policy. All farmers interviewed were supplied irrigation by NOIC and therefore had an NMP in place to meet NOIC's requirements.

Of the six farms, farmer O4 had an NMP since 2010, farmers O3, O5 and O6 since 2008, farmer O2 since 2007, while farmer O1 stated that the NMP for their farm was introduced in 2002. However as key informants from within the dairy industry have advised that NMPs have

[4] - North Otago Irrigation Company

only been around since 2005, it seems likely that the plan that farmer O1 was referring to pre 2005, was a Nutrient Budget.

Three farmers (O1, O2, and O3) had NMPs because the fertiliser company had supplied it to them as a part of their service, and the farmers stated that the main motive for the introduction of the plan was because of the need to comply with the requirements of Fonterra. One farmer also included the requirements set by NOIC for an NMP.

Farmer O6 stated that their reasoning for getting an NMP was because the farm owners wanted one as part of their farm policy. This was because the farm was initially in poor shape when they took it over. As a result, soil tests were completed across the farm to identify the different areas which required additional nutrients. With the help of the fertiliser company, the farmer then created an NMP to focus on the areas of low fertility throughout the farm.

Farmer O3 stated that their farm was a conversion from sheep to dairy farming and so chose to get an NMP for similar reasons as Farmer O6. An NMP was used to identify the areas which required extra fertiliser and how much fertiliser was required for each of those areas. The farmer stated that they didn't want to waste any fertiliser – '…you don't put stuff on if it isn't needed!'(Farmer O3, 2012, Interview). The farmer was also aware of the requirements of NOIC. This farmer was aided by a fertiliser company when implementing the NMP. As stated by the farmer, 'we probably would have been forced to get there but have been doing it anyway' (Farmer O3, 2012, Interview).

Farmer O5 moved to the region in 2008 and it was then that they first became aware of NMPs. The farm owner was also on the board of directors of one of the major fertiliser companies. This farmer saw himself as a 'greeny at heart' (Farmer O5, 2012, Interview) and was aware of the potential of runoff. As such they wanted to 'get things right' (Farmer O5, 2012, Interview). Over time the farmer has become more knowledgeable about border dyke irrigation and the potential for nutrient runoff and has modified nutrient management practices accordingly.

5.3.2. Influences on the degree of uptake and opinions of NMPs by Dairy Farmers

This research indicates that while NMPs have influenced the management practices of dairy farmers, the actual degree of influence varies depending on the individual experiences and opinions of those interviewed. These are influenced by such factors as the implementation process, the support and education offered to the farmer, and the farmer's trust in the NMP as an effective nutrient management tool.

Results indicate that the Otago farmers were resigned to new management tools such as NMPs being introduced, with one farmer stating that '...we need to sort it out...the pollution of the waterways' (Farmer O5, 2012, Interview) and another stating that '...we need to be made aware of our environmental footprint as farmers'(Farmer O2a, 2012, Interview). Those interviewed saw NMPs as a start and the first step in a process of what was going to happen within the industry in the future. Three farmers commented on how they considered NMPs to be the beginning of an increased accountability for dairy farmers and their management practices, with one stating that NMPs were 'the first step in a process of what's going to happen over the next 20 years' (Farmer O2b, 2012, Interview).

When considering the success of their NMP and its influence on their farm management practices, five farmers considered the NMP to be successful. Reasons for this included an increased awareness of the farmer's own management practices and the influences of these on the environment - an example being nutrient runoff and its effect on the quality of neighbouring waterways. Farmers stated that they were now more informed and considered themselves to be more compliant. One farmer had used less fertiliser over the last few years while lifting production and maintaining approximately the same number of cows: 'NMPs are there to work, so why shouldn't you use them? You're silly if you don't' (Farmer O6, 2012, Interview).

Farmer O5 did state that they did not consider NMPs to be successful. This related to what the farmer perceived as a lack of education and support for farmers. While their own NMP had beneficial effects, the farmer considered the lack of education and support for farmers as a major flaw in the NMP model. They describe the NMP as a 'one hit wonder' (Farmer O5, 2012, Interview) where once it had been introduced and created there was no further follow up.

5.3.3. NMPs consideration of the unique characteristics of the individual farm:

Farmers interviewed in Otago were unaware of any specific farm goals - production or environmental - being specified within the NMP. Farmer O6 stated that the environmental side of the NMP needed to be pushed harder (Farmer O6, 2012, Interview). While results show that farmers were not aware of goals being specified within the NMP they also confirmed that in some instances NMPs have contributed towards the farmer's own goals in other ways. While three farmers stated that their NMP had not contributed towards any of their farm goals, the others commented that the NMP had made them more aware of their farm management practices and what the potential ramifications of these practices were on the environment.

All farmers were supplied NMPs by a fertiliser company and viewed fertiliser management as the main focus of the plan. In this regard NMPs were viewed as farm specific as they did provide a specific fertiliser plan for each individual farm.

However, farmers regarded Overseer – the nutrient budget program that NMPs are based on - and subsequently NMPs, as being unable to account for the individual characteristics of each farm due to the default settings within the programme. For example, it was commented that Overseer was unable to accept all the different soil types on their farm. Farmer O2b stated that they '...have concerns with Overseer as it is based on assumptions and very little science' (Farmer O62b, 2012, Interview) and questioned 'Is [an NMP] actually a reality of what's happening [with regards to nutrient management]?' (Farmer O2b, 2012, Interview).

While all six farms had NMPs in use, three of those interviewed highlighted the inability of the NMP to actually make farmers incorporate it into their management practices. Two raised the issue that NMPs would be just thrown on the dairy shed shelf for the shed inspection by Fonterra, but not ever read. Another stated that while the NMP was a guideline, it was not actually forcing the farmers to do anything. There was a general theme throughout the research that NMPs were often not being read by the farmers, with four farmers stating that they had not read the document thoroughly: '...I've never read it in depth'(Farmer O1, 2012, Interview), '...haven't read it from cover to cover, but I haven't needed to' (Farmer O5, 2012, Interview). Results suggest that these farmers used the NMP as a fertiliser plan only, with one stating that they were '...only aware of the actual fertiliser information in them, otherwise it's just a piece of paper on the shelf' (Farmer O4, 2012, Interview).

5.3.4. Support & Education

The importance of continued support and education of farmers regarding NMPs and nutrient management was a common theme throughout the research. Two farmers commented on a lack of understanding amongst farmers regarding nutrient management, stating that '...most farmers wouldn't know jack about [nutrient management]' (Farmer O2b, 2012, Interview), and that '...farmers are not aware of NMPs and what they stand for' (Farmer O5, 2012, Interview). Three of the farmers were not aware of any advertising or support within the dairy industry regarding NMPs. As previously mentioned, farmer O5 stated they did not consider NMPs to be successful because of the perceived lack of education and support for farmers. Farmer O5 gave an example when they attended a workshop hosted by the ORC: '...the [ORC] once asked us at a workshop: How many of you know how much you are leaching? Only me and one other farm er knew!' (Farmer O5, 2012, Interview). Key informants claimed that the use of NMPs was encouraged by the fertiliser company representatives and through articles in newsletters.

DairyNZ stated that apart from articles they did not actively push NMPs, relying instead on the fertiliser industry to do so. Three farmers commented that they were aware of their fertiliser company promoting NMPs. Other organisations advocating for NMPs included Fonterra, ORC, DairyNZ and NOIC. The fertiliser company representative was viewed as the main source of information and support, with all farmers interviewed stating that the knowledge and assistance of the fertiliser representative was good. However as stated by one farmer, the representatives ' …are not passionate activists…they know that people are going to just put it [NMP] on the shelf.' (Farmer O5, 2012, Interview). Farmer O3 stated that '...they [fertiliser representative] are limited by what they've got [available to them re: science and tools]' (Farmer O3, 2012, Interview).

Farmers also perceived a lack of information regarding NMPs. Some farmers did state that they knew it was out there but did not read up on it or paid little attention to it, with one commenting that it was probably in the mail '…but you just throw it out with everything else' (Farmer O1, 2012, Interview). Two also commented that while they thought there were workshops on the topic they had not been to any. Three farmers stated that they were not aware of any information regarding NMPs. As stated by one farmer '…the fertiliser companies and farmers are not pulling it [NMP] apart like they potentially could' (Farmer O2b, 2012, Interview). Meaning NMPs are not being utilised or used to their full potential. One farmer stated that there was '...a void of real information' (Farmer O2b, 2012, Interview). regarding NMPs and nutrient management while Farmer O5 (2012, Interview) stated that there was a missing link between what the ORC was telling farmers to do and what was happening as no one was actually telling farmers how to do it. In the farmers words it was '…like a boss who said this is your job, do it, I'll come back next year and if you're doing it wrong….' (Farmer O5, 2012, Interview).

Farmers interviewed did want to see more information on NMPs. Five farmers commented on a lack of relevant information and education. While all those interviewed stated that their fertiliser representative was very good and available to help, it was also noted, as mentioned earlier, that the NMP became a one hit wonder, whereby it was created and then no follow up was completed until the NMP was reviewed in two years time. Two farmers stated that perhaps annual audits of the NMPs would make farmers more aware and accepting of them.

Interviews found that NMPs were not a common topic of conversation within the community with no one aware of any other farmers' implementation successes or failures. Farmers could only present evidence from their own implementation of an NMP.

5.3.5. Implementation Process

The process of NMP implementation was viewed by five farmers interviewed as being easy. All farmers interviewed stating that the fertiliser representative did sit down and walk them through the plan. The sixth farmer found the plan itself to be difficult to understand. Farmers commented that the creation of the NMP was easy because the fertiliser company did everything for them, with farmer O2a (2012, Interview) stating that it would be more complex and costly if they had to get a private consultant in to do it. Another commented that consistency is created when the fertiliser company is the one who create the plan (Farmer O2b, 2012, Interview).

All farmers interviewed agreed that the requirements of the farmer themselves throughout the implementation process were to provide all information regarding the inputs and outputs of the farm and the completion of the soil tests. This was described as a 'whole farm scenario' (Farmer O2a, 2012, Interview) which included details relating to cow numbers, soil fertility, previous fertiliser usage, bought in feed, effluent area, stocking rates and climate details. Four farmers stated that there was no additional cost to them and that it was part of Ravensdown's service. Two farmers stated that they had to pay for the soil tests themselves.

5.3.6. Farmers concerns regarding NMPs

A number of issues regarding the implementation of NMPs were identified. The major concerns were related to the Overseer programme, the need for more information, and a fear that the process was going to get more complicated. One farmer was concerned with Overseer's inability to differentiate between the various farm types: 'Overseer can't differentiate as every farm is different...spray irrigation is a different scenario to Border dyke' (Farmer O1, 2012, Interview). In the farmer's opinion, the variances in farm type affect fertiliser management in different ways. Another farmer voiced concern with Overseer, stating that they '...have concerns with Overseer as it is based on assumptions and defaults...what is the average size of a cow?' (Farmer O2a, 2012, Interview). Another concern surrounding Overseer was how it was reliant on the inputs of the user whereby users could manipulate the details entered into the programme to change the nutrient budget to suit their needs.

Farmers perceived that there was a lack of science behind the model and as a result there was a lack of trust in the information created by the programme. As Overseer was dependent on the actual information supplied if mistakes were made when inputting the information then the output would also be wrong. As a result farmers stated that they could not rely on Overseer

with one stating that they '...wouldn't trust [NMPs] because of Overseer' (Farmer O2b, 2012, Interview).

Those farmers interviewed within the region tended to be quite knowledgeable on the Overseer programme due to the proposed Water Plan Change (6.A) which would set limits on nitrogen leaching based on the Overseer model. All farmers interviewed would have to reduce nitrogen leaching significantly if the plan was passed and as such the issue was very topical in the local media.

Farmer O3 was concerned with the lack of alternative tools available to farmers as those currently available were just based off soil tests. It was stated that more tools were required to manage and monitor all farm scenarios (Farmer O3, 2012, Interview).

Two farmers also raised a concern around how they thought the process of dairy farm management was only going to get more complicated in the future. One did state that the increased complexity would also bring increased precision, however, it was also stressed that in the case of Overseer, that there was a fine line between complexity and being able to maintain the understanding of farmers: '[Overseer] doesn't pick up what individual farmers do...but then it can become too complicated...there is a fine line because you need to maintain the understanding of it by keeping it as simple as possible' (Farmer O2a, 2012, Interview).

When asked, all farmers stated that they would recommend an NMP to others. Farmer O5 did stress that they would only recommend an NMP if it came with proper support and education to ensure the farmer understood why an NMP was required.

5.3.7. Influence of NMPs on the management practices of Dairy Farmers

When the Otago farmers were asked what they viewed as the purpose of their NMP and the role of NMPs within the dairy industry, the answers could be split into two key groups:

- Those who viewed an NMP as a compliance tool.
- Those who viewed an NMP as a tool to aid farm management.

Two farmers saw the NMP as a tool to increase compliance within the dairy industry. The remainder viewed an NMP as a tool to improve nutrient management by, for example; utilising nutrients more effectively and reducing leaching while improving production and reducing costs. One farmer saw an NMP as '…a tool that lets us better manage the nutrients that we are bringing onto the farm or putting on the farm' (Farmer O2a, 2012, Interview). A second stated that an NMP was there '…to help you minimise wastage [of fertiliser and nutrients] while still achieving a high level of performance' (Farmer O5, 2012, Interview).

All farmers interviewed in Otago stated that they had changed their management practices in some way as a result of having an NMP. Some commented that the NMP had made them more aware of their own farming practices with one stating that they had '…more of a picture of what's happening' (Farmer O3, 2012, Interview). Results identify a number of major changes resulting from the introduction of an NMP. These are illustrated in the following chart:

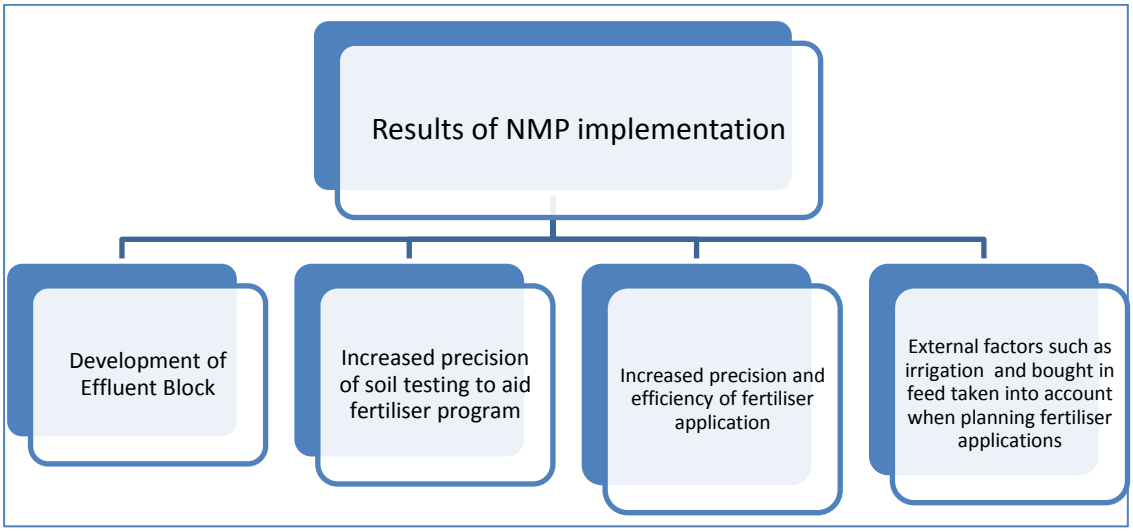


Figure 4: Results of NMP Implementation

Other changes include an awareness of the effects of the effluent block on animal health. Farmers interviewed identified that this is because the effluent blocks tend to be high in potassium which can cause metabolic issues (milk fever) in the cows during the calving season.

The following table is a summary of how each farmer had altered their practices due to the implementation of an NMP:

FARM	THE EFFECT OF NMPS ON MANAGEMENT PRACTICES:
O1	Soil test ever paddock to see which paddocks are deficient in what nutrients.
	Fertiliser application on the effluent block is 200kg/ha while the non-effluent block gets 450 kg/ha
O2	Effluent block was unbalanced and was causing animal health issues around calving. Have been finding ways to fix that.
	More cautious of how and when the effluent is applied. Effluent has been separated and injected into the irrigation system (spray irrigation)
	More focus on the application of fertiliser to increase the effectiveness of it. Urea is applied behind every grazing to ensure it gets taken up by the plant
	Realised the effect of bought in feed on nutrients. Has decreased the fertiliser bill by 35% while maintaining P & K levels.

	Has split farm into blocks, effluent / non effluent / stony / hill. Have different rates of phosphate going onto those areas depending of its availability and use
O3	Farmer believes they are now within the nutrient limits so the NMP has had little influence
	Has split dressing application according to the different farm blocks
O4	More aware of effluent area as it is high in nutrients. Fertiliser is not required on the effluent block.
	Have learnt that putting cows on particular paddocks at particular times is not good for the cow. The effluent block has high K which can cause metabolic issues
O5	NMP has helped maintain less than 200kgs of N
	More focus on the value of effluent. The farmer is now going to sample the effluent ponds separately to get a more precise measurement for future NMPs
	Has changed the rate and type of fertiliser application
O6	Have now allocated specific amounts of fertiliser on particular paddocks rather than a blanket application

Table 2: Effects of NMPs on farm management practices in the Otago Case

5.3.7.1. Consideration of Effluent

Four farmers highlighted the treatment and consideration of effluent and the effluent block as a major management change resulting from the implementation of an NMP. With Farmer O5 going as far as actually getting the effluent ponds tested to find the true nutrient value. Feedback from those farmers interviewed suggested that this was not common.

One farmer was now 'more cautious of how and when the effluent is applied. [Effluent] has been separated and injected into the irrigation system' (Farmer O2a, 2012, Interview). Farmer O4 was now more aware of the effluent and its nutrients and no longer applied fertiliser on the effluent block. They had learnt that putting cows on particular paddocks at particular times was not good for the cow. The effluent block was high in Potassium which can cause metabolic issues.

5.3.7.2. Soil Tests

A common trend identified in the interviews as a result of the growing complexity of nutrient management was the increasing use of detailed soil tests by all farmers. These soil tests were carried out in a variety of ways, as per the examples below identified by the farmers during the interviews:

- The use of a carbon ratio test to see how much farmers were increasing organic matter
- The use of farm maps to organise fertiliser application more efficiently.

- The identification of good and poor areas (re: nutrients) leading to individualised fertiliser application for the different parts of the farm.
- The use of annual soil tests of 6-8 paddocks, and a whole farm test every 3-4 years
- The use of whole farm soil testing of each individual paddock annually.

5.3.7.3. Fertiliser Application

Five farmers commented on how the NMP had helped them to manage actual fertiliser requirements and application.

One farmer was now more focused on the application of fertiliser to increase the effectiveness of it. Urea was applied behind every grazing to ensure it gets taken up by the plant. A second farmer had split the fertiliser dressing application according to the different farm blocks while a third now allocated specific amounts of fertiliser on particular paddocks rather than a blanket application.

5.3.7.4. Consideration of other factors such as irrigation and bought in feed

Farmers were now considering other external influences on their farm nutrient levels. One farmer '...didn't realise bought in feed had such a huge impact on nutrients' (Farmer O2a, 2012, Interview). As a result they had decreased the fertiliser bill by 35% while maintaining Phosphorus and Potassium levels.

Farmers also commented on having to be aware of irrigation when applying fertiliser. The timing of fertiliser application was considered when planning irrigation. This was particularly important in the Otago region due to the prevalent use of border dyke and spray irrigation. Irrigation also affected the spread of nutrients and so some farmers only applied fertiliser to the top third of the paddock and allowed the border dyke irrigation to carry it down over the remaining two thirds of the paddock.

5.3.8. Summary

Farmers in the Otago region were required to have an NMP as part of their supply agreements with NOIC and Fonterra. All farmers interviewed were assisted by their fertiliser supplier during the implementation of their NMP, with three farmers actively seeking out their NMP on their own accord.

The fertiliser representative was seen as the main source of information and support regarding NMPs. While all farmers rated the assistance of their fertiliser representative or farm consultant as good, some did comment on a lack of understanding amongst farmers regarding nutrient management. The majority of farmers commented on a lack of information and advertising regarding NMPs with three not aware of any advertising at all. Subsequently most farmers interviewed also wanted more information and support regarding their NMP.

A number of concerns were raised, including the idea that dairy farming was becoming increasingly complicated for farmers. The majority of farmers also raised concerns with regards to the Overseer model, and its perceived inability to accommodate the individual characteristics of a given farm. Another prominent issue raised was how farmers were not using the NMP to its full potential with many admitting that it was often left on the shelf or not read thoroughly if at all.

The majority of the farmers saw the need for NMPs and saw some value in them, with all farmers considering their NMP to be successful on some level and all stating that their NMP had influenced their farm management practices in some way. Common changes as a result of NMP implementation include the development and expansion of the effluent block, the increased precision of soil tests and of fertiliser applications, and an increased awareness of other factors on the farm nutrient inputs and outputs.

Three farmers stated that their NMP had made them more aware of their farm management practices and their environmental impacts. All farmers interviewed said that they would recommend an NMP to other famers.

5.4. Waikato results

Following on from the results of the Otago case, this section will now present the results of the Waikato case.

5.4.1. Reasons for the introduction of NMPs to Dairy Farmers

All farmers interviewed in the Waikato region were suppliers to Fonterra so were required to have an NMP in place under the Dairying and Clean Streams Accord (2003). Four farmers were also involved in a trial with the WRC[5] which involved - amongst other management tools - the use of NMPs to assess how dairy farmers could improve their managerial practices to work towards reducing nutrient leaching. The project was entitled the Integrated Catchment

[5] Waikato Regional Council

Management project (ICMP). Some farmers also mentioned being involved with other community schemes such as DairyPush which is a DairyNZ initiative in the Waikato Region. One of the goals of Dairy Push is to identify and put into effect farm management practices that will help to improve nitrogen efficiency and reduce leaching.

The WRC has policy in place (Rule 3.9.4.11) which states that an NMP must be used in certain circumstances. Two farmers also mentioned how the Fonterra Dairy Guide now has a 'pull out' section within it that must be completed and returned to Fonterra annually regarding the farmer's management of nutrients throughout the season. This is a new and compulsory requirement of the Fonterra dairy guide.

Development of the NMPs for all farmers interviewed was relatively recent with farmers W1 and W2 stating that they have had an NMP since 2006, W3 since 2008, and W4 and W5 since 2010. Farmer W2 implemented an NMP on their own accord. This farmer believed that the nutrient levels on the farm were not where they should have been. In his opinion Phosphorus levels were too high and Potassium levels were too low. The fertiliser representative was not changing his recommendations so the farmer decided to use an external consultant from an independent consultancy service for farmers. The consultant completed a farm visit, discussed the farmer's goals and used soil tests to establish what was required. As part of the consultancy process an NMP was created. While there was a cost involved in this service the farmer stated that it was '…a drop in the ocean compared to the overall cost…' (Farmer W2, 2012, Interview) representing less than 1% of the overall annual fertiliser costs.

The remaining farmers interviewed stated that external motivation was the reason for the introduction of their NMP. Two farmers, both involved in the ICMP, stated that the WRC was the key motivator behind their NMP implementation due to their involvement in the programme. Two others stated that the reason for NMP adoption was because it was compulsory and that it was supplied by their fertiliser supplier Ballance. One of these two farmers stated that they were also assisted by their farm consultant.

5.4.2. Influences on the degree of uptake and opinions of NMPs by Dairy Farmers

Waikato farmers' degree of implementation and views of NMPs were influenced by a number of factors such as the perceived support and education offered, and the process of NMP implementation. The Waikato farmers interviewed saw NMPs as a '...mixture of useful information and a nuisance...' (Farmer W1, 2012, Interview) due to the additional paper work, legislation and the increasing pressure to become more compliant.

Three of the farmers viewed their NMP as successful with one stating that the NMP had 'put numbers on [nutrient management]' (Farmer W3, 2012, Interview) so the farmer could ask themselves '...can I do this better, cheaper, or more efficiently?' (Farmer W3, 2012, Interview). Another stated that NMPs had given farmers the '...ability to manage resources more effectively to save costs' (Farmer W1, 2012, Interview). All three farmers were involved in the ICMP.

Farmer W5, while admitting that they had not used their NMP, thought that it would be successful if they had gone through it. They did stress that they did not know about some of the information in the plan so it would require some explanation, stating 'A lot of stuff [in the NMP] I don't know what it is anyway' (Farmer W5, 2012, Interview). This farmer was not involved in the ICMP.

Farmer W4 did not view the NMP as successful stating that it had no value to him and was '...a waste of time...' and there to '...make employment for local body people' (Farmer W5, 2012, Interview). This farmer's opinion was that as long as they were within the criteria which the WRC had set for nutrient leaching then they would not change their current practices. This farmer was involved in the ICMP

5.4.3. NMPs consideration of the unique characteristics of individual farms.

Only four of the farmers were queried on the contribution of their NMP towards their production and environmental goals as Farmer W4 had already stressed that they did not use their NMP and that it had not influenced their management practices in any way. This farmer's view was that they farmed '…responsibly, ethically and sensibly…' (Farmer W4, 2012, Interview).

Farmer W5 stated that they thought the NMP itself had not contributed towards any farm goals however, a number of practices they had put in place were similar to those that would be specified in their NMP: 'To a certain extent we have been running along the same lines [as the NMP]' (Farmer W5, 2012, Interview). In the last two seasons, the farmer had changed their effluent so that it was irrigated onto the land and were working towards getting the required nutrient levels across their farm.

Three farmers stated that their NMP had contributed towards their production goals for the respective farm. All farmers were involved in the ICMP. No farmer indentified any environmental goals that their NMP had contributed to.

One farmer saw their NMP as a major factor in their production goals. The NMP had made the farmer focus on issues such as pugging and the leaching of nutrients. They were now '...more

careful about when you put urea on for the best response and less chance of leaching' (Farmer W2, 2012, Interview). This had led to undisclosed financial gains for the farmer including significant savings made in their fertiliser costs. Farmer W3 saw the ICMP as having a far greater input on their goals; however, they did state that they had altered the way they managed their effluent block as a result of the NMP.

Three farmers commented that they had already been setting themselves environmental goals due to their involvement in other projects: 'The catchment management plan [ICMP] has had a far greater input on us' (Farmer W3, 2012, Interview).

Farmers also commented on how an NMP may just be discarded once completed and how NMPs were not read thoroughly by the users. Four farmers commented on this issue with one stating that at times the NMP does get '…chucked in the drawer and is whipped out when you go to put your fertiliser on' (Farmer W2, 2012, Interview), while another commented that they '…hardly ever look at it…' (Farmer W3, 2012, Interview), and when they do it is to review their situation to make sure they are still on track. Farmers interviewed in this region viewed the NMP as primarily a fertiliser plan stating that it was 'Good for fertiliser recommendations' (Farmer W2, 2012, Interview), and to '...cut fertiliser costs' (Farmer W1, 2012, Interview).

5.4.4. Support & Education

Two farmers wanted more education around nutrient management with both stating that they wanted to understand the details of how an NMP is created for a farm with one stating they have '...a need to understand what goes on behind the [NMP]' (Farmer W2, 2012, Interview). Two others commented on the need for further clarity on the subject of nutrient management with one stating that '…there is a lot of [information] and scaremongering, you don't know what's true and what's not' (Farmer W1, 2012, Interview). This view was supported by another farmer who stated that there was lots of information available but '…as usual different people have different opinions and it can get confusing' (Farmer W4, 2012, Interview).

Farmers indicated that while they were aware of advertising in the form of mail or newsletters regarding nutrient management, they tended to pay little attention to it. Two were not aware of any advertising at all while two more commented on the massive amount of mail that dairy farmers received, with one stating that they were aware of advertising but '…there is so much stuff that comes in…so in terms of what you pay attention to…' (Farmer W2, 2012, Interview).

When identifying the main source of support regarding NMPs, one farmer indentified the WRC as a source of information and support due to their involvement in the ICMP. Stating it was a

role of '…encouragement through the catchment plan to just think about what we [the farmer] are doing' (Farmer W3, 2012, Interview).

All other farmers viewed their farm consultant as the major source of support and information regarding nutrient management. Farm consultants were seen to make recommendations to reduce leaching and manage nutrients more effectively. One farmer stated that the '… fertiliser reps have been the most active. They have been good at keeping [NMPs] in front of us' (Farmer W3, 2012, Interview). Four farmers said that their farm consultant was very knowledgeable and helpful and readily available when required. All farmers mentioned that they could receive more support if they needed it.

While the majority of farmers were aware of information on nutrient management and were happy with the support offered, three commented on a lack of education that they had received around the NMPs themselves. One was concerned with the complexity of the plan and stated that they would like to 'get more individual details' (Farmer W2, 2012, Interview) about their own farm. A second stated that the NMP had not been sold to them and that there was a lot of information in the NMP that they did not understand. A third farmer wanted more education on NMPs stating that they would like to see '…more discussions on how one thing might affect another and how it all fits together' (Farmer W1, 2012, Interview). An example given was the farm plan created as a part of the ICMP, which gave a lot of options to reduce leaching, however some required a lot of work and understanding to complete.

NMPs and nutrient management were a relatively topical subject in the Waikato region with four farmers stating that they were aware of feelings within the community regarding NMPs and farmer W3 was aware of another farmer's success with the implementation of an NMP where a great deal of money was saved due to a planned approach to nutrient management. The same farmer stated that 'most of us are already keen on those sorts of savings and have already been looking into this for a fair while' (Farmer W3, 2012, Interview).

5.4.5. Implementation Process

Four farmers interviewed in the Waikato case study found the development and implementation process of their NMP easy, with two farmers emphasizing that the majority of the work was completed by the fertiliser representative so there was very little responsibility on the farmer themselves. Four farmers found the assistance of the consultant during the implementation stage as 'good' or 'very good' with one stating that the fertiliser representative made it 'uncomplicated.'

One farmer did not find the process easy. While they did rate the knowledge and support of their private consultant as ‘very good’ the farmer was concerned with the accuracies of the Overseer programme as ‘...it doesn’t take everything into account’ (Farmer W2, 2012, Interview).

As with the Otago region all farmers interviewed ion the Waikato stated that what was required from them during the implementation process was to provide details regarding all the inputs and outputs of the farm system. Three farmers stated they were also responsible for the organisation of soil tests, with one farmer mentioning that they had to be considerate of where the cows had been recently so that they did not influence the soil test results. Four farmers stated that soil tests were a cost with two also having to pay for their farm consultant’s time. Three farmers raised no concerns with the implementation process, stating that their fertiliser representative or farm consultant made the process very easy.

5.4.6. Farmers concerns regarding NMPs

A number of weaknesses were indentified with one farmer stating that he did not consider NMPs necessary, going on to state that they viewed the NMP as having ‘no relevance’ (Farmer W4, 2012, Interview) to their farm practices and that it was there to ‘…appease overseas customers and local government’ (Farmer W4, 2012, Interview). One farmer viewed the NMP as being too complex, a view elaborated on by a second farmer who stated that the NMP ‘...involved more time thinking about what needed to be done’ (Farmer W1, 2012, Interview).

Farmer W2 raised concern with the Overseer model and how it was not able to individualise and accommodate for the farmer’s individual situation. This farmer was concerned with the accuracies of the Overseer programme, stating that ‘Every time they do a new model [of Overseer] things change...’ (Farmer W2, 2012, Interview) and that Overseer didn’t take everything into account due to its default settings. However, Overseer was also seen as ‘...a compromise between complexity and accuracy...’ (Farmer W2, 2012, Interview) and overall the implementation process was ‘pretty complete’ (Farmer W2, 2012, Interview). It is important to note that this farmer had their NMP completed through a private farm consultant and as such their NMP had incorporated more personal and individualised information which took into account a broader range of factors.

Farmer W3 expressed similar concerns with Overseer’s user dependency and the ability for users to influence the outputs of the model. Farmer W2 stated that he ‘…sometimes thinks that not even the scientists quite know what’s going on’ (Farmer W2, 2012, Interview).

Three farmers raised concerns regarding the increasing compliance within the dairy industry with all three agreeing that there would be further regulation in the future. One farmer stated that '…we will see increased compliance in the future…I have seen increased compliance in every aspect of the industry in the last three to four years. It is unbelievable!' (Farmer W4, 2012, Interview).

Three farmers stated that they would recommend NMPs to other farmers with one stating '… it gets you best value for money' (Farmer W2, 2012, Interview). Two farmers said that they would not recommend an NMP. Farmer W4 stated this was because they saw it as a mandatory requirement anyway, while Farmer W3 stated that they were not keen to recommend anything to farmers these days. However this farmer did go on to say that if they were asked they would tell how they have saved money and how the NMP has benefited them.

5.4.7. Influence of NMPs on the management practices of Dairy Farmers

Four farmers saw strength in NMPs with one farmer stating that they saw strength in the way NMPs increased farmer knowledge. The same farmer commented on how the NMP helped with the management of fertiliser application and how the NMP was better for the environment. A second farmer believed the NMP was achieving its purpose and was achieving its goals for their farm by increasing clover growth and reducing costs. The remaining farmers saw the strengths of the NMP in its use as a monitoring tool. One stated that it put numbers on their inputs and outputs, and the other said that it kept them in line with what they should be doing with regards to nutrient management.

When farmers were asked to define what they believed the purpose of an NMP was, three viewed an NMP primarily as a compliance tool. Two of these three farmers also saw an NMP as a tool to help improve their fertiliser usage stating that it helped to '…put numbers around what we are putting into our business and what we are taking out…' (Farmer W3, 2012, Interview) and that it was '…getting the production without wasting money on fertiliser' (Farmer W2, 2012, Interview). The third farmer saw an NMP purely as a requirement for compliance and also stated that an NMP was about '…appeasing people in town and local bodies' (Farmer W4, 2012, Interview).

Two farmers viewed an NMP as a tool to increase the efficiency of nutrients, stating that it was used to get the farm running to its optimum performance and to make better use of the resources used. Two farmers also mentioned that NMPs were there to address environmental concerns stating that NMPs helped to reduce nutrient runoff to waterways and showed that farmers were being environmentally responsible.

One farmer stated that they had not changed their management practices at all and viewed the NMP as a 'valueless document' (Farmer W4, 2012, Interview). This farmer goes on to state that they use their fertiliser representative's recommendations instead. It should be noted that as the NMP is also created by the same fertiliser representative that the recommendations in the NMP are the same as the fertiliser representatives.

Farmer W5 stated that they did not really use their NMP, going on to say that to a certain extent they probably had been running along the same lines as the NMP anyway. Using the same soil tests as a basis to create their own fertiliser plan, this farmer said that they made sure to put on the right amount of nitrogen, urea and other fertilisers. Upon checking the NMP they saw that they were within the guidelines anyway. The farmer stated that they already had a knowledge of when and where to apply fertiliser and how to treat their effluent block. It should also be noted that this farmer did not trust their private farm consultant who was hired by the farm owner. They viewed the consultant as 'old school' with old ideas. While the NMP itself was created by Ballance it was introduced to the farmer by the private consultant so the farmer admitted to paying little attention to the recommendations at the time.

The three remaining farmers stated that they did use their NMP and that their management practices had changed as a result of the NMPs introduction. All three were involved in the ICMP. They saw the NMP as a way of managing their fertiliser in an efficient manner by increasing production while cutting costs and reducing leaching. The major changes identified from the introduction of NMPs are summarised in the following table for the three farmers that stated that the NMP had affected their management practices:

FARM	EFFECT OF NMP ON MANAGEMENT PRACTICES:
W1	Silage crops now grown on Effluent block.
	Extended Effluent area
	Balancing Potassium levels
W2	Fertiliser application on effluent block is treated differently. Only particular fertiliser is put on the effluent block to top other nutrients up. (K is at optimum levels)
	Have doubled the rate (of fertiliser) on the hillsides
	Specific application of fertiliser on the paddocks. The front of the paddocks (first 1/3) is where the cows tend to go as it is next to the race. So this front 1/3 doesn't require any fertiliser at all
	Has split farm into 5 blocks: Sheep / Dry Stock block, Effluent block, Steep block, Front block, and Back block. Different rates of fertiliser applied to each block
	Now aware that the soil types at the front of the farm are quite different to the back. Now know that the steeper paddocks need a lot more effluent applied.

W3	Farmer is now more conscious of minimising pasture damage and minimising runoff of soil into waterways.
	Have cut fertiliser applications way down

Table 3: Effects of NMPs on farm management practices in the Waikato Case

5.4.7.1. Fertiliser Application

One farmer stated the NMP had enabled them to highlight particular areas of the farm that required extra nutrients while avoiding any wastage and overloading of nutrients due to their improved management as a result of the NMP. Subsequently the farmer had managed to cut their fertiliser costs and improve their finances.

A second farmer commented on how the NMP had helped them to reduce their fertiliser costs while another commented on how they are now more conscious of minimising runoff and pasture damage.

Two farmers discussed how the NMP had helped them to manage the actual application of nutrients more effectively. This included splitting the farm into blocks, only applying fertiliser to particular parts of a paddock, and only applying particular types of fertiliser where required.

As stated by one farmer, they are now '...conscious of minimising pasture damage and minimising runoff of [nutrients] into waterways...and have cut fertiliser applications way down' (Farmer W3, 2012, Interview) as a result of NMP implementation.

5.4.7.2. Consideration of Effluent

Two farmers had made significant changes to the management of their effluent block. This included extending the effluent block area and having a specific fertiliser plan for the effluent block to ensure no unwanted nutrients were being applied. One farmer had also started using the effluent block to grow their silage.

For one farm, the effluent block had been expanded in 2012 and the rate of application was now varied depending on the particular season. For example in early spring the irrigator was sped up to reduce the application rate of effluent.

5.4.8. Summary

All Waikato farmers interviewed were Fonterra suppliers and were also aware of the regional policy requirement of the WRC. In general the farmers viewed the NMP as a mixture of useful information and another piece of compliance. Four of the farmers were also involved in the ICMP which was found to be relatively influential on their farm management practices also.

One farmer viewed the WRC as their main source of support with the others stating that their fertiliser representative was their main source of support. Farmers were found to be happy with the support offered by their fertiliser representative and considered the process of implementation as being relatively easy.

Farmers raised concerns regarding the support and education offered regarding NMPs, with two commenting that they were not aware of any advertising, and two others commenting that there was so much advertising that it was often ignored. Three farmers also commented on a lack of education regarding nutrient management. Issues were also raised with the Overseer program, and the issue of NMPs not being read thoroughly if at all. Farmers also raised concerns with the increasing compliance and subsequent additional requirements of dairy farmers, with many seeing even more complications and compliance in the future.

Four NMPs were created by Ballance with one other being created by a private farm consultant. The majority of the farmers saw strengths in the current NMP with three farmers considering their NMP to be successful and stating that their NMP had influenced their farm management practices. These changes included the expansion of the effluent block, the increased precision of fertiliser applications. The same three farmers also commented that the NMP had contributed towards their production goals however it should be noted that no environmental goals were specified. Some farmers did state that the ICMP was more influential with regards to environmental goals.

5.5. Combined Data

This section will combine and summarise the results of both case studies, identifying any common themes or differences between the cases.

5.5.1. Reasons for the introduction of NMPs to Dairy Farmers

Over both case studies all farmers involved supplied milk to Fonterra and were aware that part of their supply agreement with Fonterra was that an NMP must be in place on their farm.

However, farmers were also aware that there was no requirement for them to actually use that NMP as long as the NMP itself was physically present in the dairy shed for the annual shed inspection by Fonterra. Farmers in the Otago region were also required to have an NMP in place as part of the supply agreement with their irrigation supplier NOIC. Farmers in the Waikato region were required to have NMPs as part of the regional policy rule whereby an NMP was required in certain scenarios. Four of the Waikato farmers were also involved in the ICMP which the WRC was involved in and which promoted the use of a NMP as part of an environmental farm plan.

Nine farmers had their NMP created by their fertiliser company while one farmer in the Waikato region had a private farm consultant create their NMP. The major fertiliser company in the Otago region was Ravensdown who supplied five of the six farms, while Ballance was the fertiliser supplier for all farms in the Waikato region. Four farmers stated that they had instigated the development of their NMP of their own accord (three in Otago and one in Waikato) while the remaining seven farmers all stated that the NMP was introduced to them either through there fertiliser company or private farm consultant.

5.5.2. Influences on the degree of uptake and opinions of NMPs by Dairy Farmers

Results from the research suggest that the Otago farmers seemed more resigned to the use of new management tools such as NMPs, while the Waikato farmer's responses suggest that NMPs were viewed as a mixture of useful information and a nuisance due to the additional requirements on the farmer.

Farmers in the Otago area stated that their NMP had increased their environmental awareness and contributed towards better fertiliser application and compliance. Three Waikato farmers said that the NMP had contributed towards their production goals. Examples given were reducing fertiliser costs and improving farm finances and increasing the efficiency of fertiliser application. All farmers interviewed were unaware of any actual environmental goals being specified within their NMPs. Waikato farmers did state that the ICMP was more influential towards their farm goals, with three commenting that farmers in the region had already been setting environmental goals due to their involvement in the programme.

Five farmers stated that they were not aware of any advertising or support offered regarding NMPs in their region with two Otago farmers expanding on this and commenting on a lack of understanding amongst farmers regarding nutrient management. Two Waikato farmers did state that they were aware of NMP advertising being available but that it was often ignored due to the large amounts of information and advertising that they received in the mail. This was a

common theme throughout the interviews in both regions. For example in the Otago region while some were not aware of any information regarding NMPs, others stated that while they were aware of it they had not attended any workshops or actively read up on nutrient management. Ten farmers saw their fertiliser representative as the main source of information and support regarding NMPs with all farmers stating that they rated the assistance and knowledge of their fertiliser representative as 'good' or 'very good'. Other sources of information regarding NMP included the relevant regional council, Fonterra and DairyNZ.

The majority of farmers stated that there was a lack of relevant information and education for farmers around NMPs. Farmers in both regions expressed a desire for information around the need for NMPs and what goes on behind the development of the plan. A Waikato farmer stated that the NMPs were not getting 'sold to them' and as a result there was a lot of information in the NMP which they did not understand.

5.5.3. Implementation Process

Nine farmers found the implementation process of their NMP as being relatively easy, due mainly because of the involvement of the farmers' fertiliser representatives or private farm consultants. The majority of farmers stated that their fertiliser representative or consultant did most of the work for them and all farmers agreed that all that was required from themselves were to supply details on the inputs and outputs of the farm and the soil tests. Six farmers stated that the only cost was the soil tests, while the remaining farmers said there were no costs at all. It should be noted that as the interviews were with actual farm managers or share milkers there is a chance that the farm owners may have paid the costs for soil tests and the farm manager may just not be aware of the fact. One farmer in the Waikato region did state that they had to pay for their private farm consultant's time however this was viewed as a trivial cost when compared to the savings made in fertiliser usage as a result of the NMP.

Ten farmers saw strengths in their NMP with six farmers seeing value in the NMP as compliance or monitoring tool. Three farmers also stated that the NMP had helped to increase their awareness and knowledge regarding nutrient management and so in turn helped to improve their fertiliser management.

Two farmers within the group saw no weaknesses with their NMP. Five farmers raised concerns around the NMP not actually being used or not being read thoroughly by themselves and others, while one other stated that NMPs were not necessary. Five farmers did raise concerns around many farmers' lack of understanding and knowledge regarding nutrient management. Another common issue amongst the majority of farmers across both case studies was concerns over the Overseer program. Farmers commented on a perceived lack of science

behind Overseer and a lack of trust in Overseer due to its user dependency and because of its use of default settings and its inability to accommodate for the individual characteristics of each farm. Farmers in the Waikato region also raised concerns regarding the increased compliance requirements for dairy farmers. This was a common theme with most farmers in both case studies.

5.5.4. Influence on Management Practices

Both sets of farmers from the two regions agreed on the purpose of an NMP with the key reasons given in both regions being the use of an NMP as a compliance tool and as a tool to help farmers improve their farm management practices and fertiliser application. All farmers in the Otago region said they had altered their farm management practices as a result of their NMP, while three farmers in the Waikato region said that they had changed their farm management practices. Only two farmers stated that NMPs helped to reduce their impact on the environment and these farmers were both in the Waikato region and part of the ICMP. The influence of the NMP on farm management practices was similar in both regions with the major changes identified by all farmers in both regions as:

- Development and expansion of the effluent area
- Increased precision and efficiency of fertiliser application through:
    - Splitting the farm into blocks based on such characteristics as soil type and geography and then applying the fertiliser according to the individual nutrient requirements of each block.
    - Only applying fertiliser to particular parts of the paddock to account for irrigation or stock movement
- The consideration of other external factors (eg: irrigation and bought in feed) on farm nutrient levels.
- Farmers in the Otago region also stated that they had incorporated more precise soil tests.

Eight farmers viewed their NMP as being successful, with the one farmer in the Otago region who did not view the NMP as being successful stating the lack of education and support as their key reasoning. One of the two Waikato farmers who did not view their NMP as being successful stated that they required a better understanding of their NMP, while the second farmer stated that they saw no value in their NMP.

Those who did view their NMP as a success stated among other reasons that the NMP increased the farmer's awareness of their own management practices and the influence they had

on the environment, and how the NMP put numbers on what they did with fertiliser, allowing the farmer to make changes as required.

Nine farmers stated that they would recommend NMPs to other farmers.

Chapter 6 Discussion

6.1. Introduction

This chapter's purpose is to discuss the results of the research and where possible compare these results to the literature that exists regarding NMPs and their influence on farm management strategies. This will include the factors which have influenced why farmers have adopted the use of NMPs and the degree of uptake of NMPs by farmers. The support available to farmers and the knowledge of farmers regarding nutrient management will be discussed as well as the implementation process and an overview of the opinions of NMP users regarding NMPs. The chapter will be split into four sections: One section will discuss the drivers which contribute to the acceptance and use of NMPs by dairy farmers. This is followed by a section focusing on the support available to farmers and the subsequent awareness of dairy farmers regarding nutrient management and NMPs. The third section will examine the opinions and concerns raised by dairy farmers with regards to NMPs, before the final section discusses the influence of NMPs on the management practices of dairy farmers.

The purpose of this research is to examine how the introduction of a Nutrient Management Plan has influenced the farm management practices of dairy farmers. Overall the results of the research do support the views in the literature, highlighting the positive impacts on farm practices from NMP use, while stressing the importance of adequate support and awareness of nutrient management for dairy farmers. Results also identified that the effectiveness of NMPs and the farmer's perspective of NMPs were influenced by a broad spectrum of factors beyond just the NMP itself. Examples include the relevant regional council's approach, the personal circumstances of the dairy farmer, and the availability of continual support and education for the dairy farmer.

6.2. Drivers contributing to the acceptance and use of NMPs by dairy farmers:

The broader context within which dairy farmers operate has clearly impacted on farmer's awareness of, and use of NMPs, which are now a requirement for all New Zealand dairy farmers who supply Fonterra. While this has raised the awareness of NMPs amongst farmers, it has not necessarily led all farmers to change their management practices. Nutrient management, and in turn the use of NMPs has been promoted extensively within the Waikato case. The key factor regarding NMPs in the Waikato case was the proactive approach of the WRC who had already incorporated NMPs into their regional policy which was made effective in 2007. The

WRC had also played a role in the development of a number of community programs relating to nutrient management. Such programs include the ICMP and Dairy Push (which both began in 2006). Farmers had therefore been exposed to the idea of nutrient management for a number of years. As a result the majority of those farmers interviewed in the Waikato case were accepting of NMPs. They saw the WRC as a key supporter of NMPs, and had co-operated with the WRC, along with others including their fertiliser company representative to develop their NMP. Farmers predominately viewed the WRC's role as for example, one of '…encouragement […] to just think about what [the farmers] are doing' (Farmer W3, 2012, Interview). Previous research has suggested that this is an important aspect of the successful adoption of new innovations with the likes of Lamba et al. (2009) and Deugd et al. (1998) agreeing that the support and co-operation of the government and/or relevant institution is a key component of the implementation and acceptance of innovations such as NMPs, a point that is clearly supported by the findings of this research. The involvement of farmers in other community programs such as the ICMP also supports the outcome of previous research by the likes of Smithers & Furman (2003) and Lamba et al. (2009). They concluded that previous involvement in similar programs was a motivator for the adoption of new innovations which deal with the particular issue or topic.

In comparison to the Waikato region, nutrient management and the subsequent use of NMPs had not been actively promoted by the Otago region's regional council. However the Otago case farmers were instead exposed to NMPs and supported through the fertiliser companies and the requirements of NOIC instead. A number of the Otago farmers interviewed had chosen to implement their NMP before being approached by an external agency to do so. Reasons for this included the need to improve the nutrient levels of the farm, a farm being a conversion from sheep to dairy farming, and as a requirement stipulated by the farm owners. Also of note is that all three of these farmers had their NMPs introduced when they first began to manage the particular farm. This was despite the current lack of Regional Council policy and perceived lack of advertising regarding nutrient management, as well as the lack of involvement in and/or knowledge of any community initiatives regarding nutrient management in the region. It should be noted that in all cases it was the fertiliser company representative who was responsible for the generation of all NMPs in the Otago case.

There is no evidence of the age or experience of farmers' influencing the acceptance of an NMP or the farm management practices associated with an NMP. This may reflect the small number of farmers involved in the research, but it may also support NZ researchers Bewsell & Kaine (2005) who suggested that farmer experience should not be expected to influence the adoption of environmental best management practices.

The reasons which influence the adoption of new management practices on dairy farms, in line with NMPs, are highlighted in this research as being varied and multifaceted. This supports the findings of other researchers of agricultural innovations such as Pannell et al. (2006) who state that the reasons for the adoption of new management practices as complex and multifaceted. This research highlights the need for trust with respect to both the innovation and the organisation promoting it. Similarly, Smithers & Furman (2003), state that farmers must have trust and confidence in an innovation if it is to be successfully implemented and utilised to its full potential. Interestingly, while the farmers in the Waikato region seem to be more cooperative, and the role of the WRC has been more pro active in comparison to the Otago case, the findings of this research suggest that the actual effects on management practices are very similar across both cases.

6.3. Support and Awareness

This research has highlighted the important role that intermediaries have played in shaping how farmers viewed and adopted the use of NMPs, and changed their farm management practices accordingly. The actual NMP introduction phase was viewed positively by the majority of farmers across both cases. Farmers stated that they were happy with the introduction and development process of their NMP, citing their personal trust of their fertiliser representative (who in most cases assisted in the development of their NMP), the knowledge of their fertiliser representative or farm consultant, and the ease of the actual process as key reasons for this. The farmers trust in their fertiliser company and representative supports a key finding in the literature where a number of authors (Smithers & Furman, 2003; Deugd et al., 1998; Pannell et al., 2006) have identified the need for the development of trust in outside agencies as important to ensure innovations are accepted by farmers. Farmers within the Waikato case also showed a general trust in their regional council due to its promotion of and involvement in nutrient management schemes.

However, there was a perceived lack of ongoing support for farmers after the initial NMP introduction phase, with the results of this research suggesting that the farmers involved wanted more ongoing support. Despite their involvement in initiatives such as the ICMP, the majority of Waikato farmers interviewed stated that either they were not aware of any ongoing advertising regarding nutrient management or that they paid little attention to the advertising available. This is partly due to what some farmers saw as an overabundance of information and the conflicting views of those that supplied the information. While in comparison to the Otago region, there seems to be more support and education available to the Waikato farmers, there

still is room for improvement as the majority of farmers interviewed stated that they would like to see more support and more information on NMPs, their purpose and how best to use them.

This research highlights the need for adequate and continual support for farmers to ensure NMPs are implemented appropriately. A number of farmers in the study identified a lack of understanding and ongoing support regarding nutrient management and NMPs. However, many also admitted to not attending any workshops or being involved in any initiatives regarding nutrient management. While the existence of workshops on the topic in both regions was confirmed, feedback from the Otago farmers in particular indicated that they were either not aware of any advertising or were not paying attention to it or actively reading up on the topic of nutrient management. The need for relevant support of farmers to aid in the uptake and integration of innovations such as NMPs is also stressed in the existing literature (Lamba et al., 2009). The literature stresses that the continual support and education of farmers regarding nutrient management should be developed and maintained to ensure NMPs are used to their full potential by farmers (Shepard, 2005; Monaghan et al., 2007).

It is suggested by the results of the research that there may be a link between the involvement of local government and the degree of NMP uptake by, and knowledge of farmers. NMPs were more topical in the Waikato region, with the research results indicating that this may be due to the more proactive approach of the WRC and the farmers' involvement in community programs on the subject. This finding is again in agreement with the conclusion reached in much of the literature (Shepard, 2005; Monaghan et al., 2007; Edmeades et al., 2011) that farmers required the support of others, such as local government, to ensure NMPs were used effectively and would contribute towards the farmers own specific goals.

Across both cases there was a perceived lack of continual advertising and support offered to farmers regarding nutrient management and NMPs. The majority of farmers across both cases commented on a lack of relevant information and ongoing education for farmers regarding NMPs. Farmers from both cases also expressed a desire for information and facts around the need for NMPs and how they are developed. Others commented on a need for regional facts and goals and a want for a more in depth session regarding the NMP when it is first introduced or when it is reviewed. While the majority of the Waikato case farmers had been involved in initiatives on the topic of nutrient management, they still desired further support, and information on the topic. This supports previous literature that suggests ongoing education and support are key contributors to the successful implementation of new innovations. Shepard (2005), Monaghan et al. (2007), and Lamba et al. (2009) all agree that the relevant authority need to continually follow up provide information and support to farmers while Deugd et al.

(1998) states that farmers need to work closely with the other stakeholders and that support is required to encourage the learning of the new innovation.

This research has shown that support to farmers is a key aspect of the use and acceptance of NMPs in New Zealand, an issue that was highlighted in both cases, despite the varying levels of support farmers had received. In some cases farmers were ignoring their NMP completely or - as was the case for most farmers interviewed - not reading the plan thoroughly, and so not utilising the NMP to its' full potential. As the existing literature concludes, farmers need to have support available to them not only during the introduction phase, but also post introduction. Findings suggest that farmers feel that they are not receiving what they consider enough support after the NMP had been introduced.

6.4. Farmers opinions / concerns regarding NMPs

Farmer's trust in the ability of an NMP to account for the individual characteristics of their farm and their current farm management practices was highlighted as a concern in this research. Across both cases there was a lack of trust amongst farmers with regards to the Overseer model, which was the basis of the NMP. Farmers from both the Otago and Waikato cases showed a distrust of the Overseer model as a reliable basis of the nutrient management tool. This in turn negatively affected the farmers' views of the NMP and whether in their opinion, it was advantageous to use. This is in alignment with previous literature which stresses the importance of any new innovation to be able to accommodate the unique characteristics of any given farm and the farmer's own personal business goals. Bewsell & Kaine (2005) and Lamba et al. (2009) agree that any innovation needs to be developed in a context specific manner to account for the varying environmental conditions and unique situations of each farm. If the NMP is seen as being imprecise the farmers' trust in the innovation is diminished. Therefore Farmers would require additional training on the Overseer programme and its capabilities to increase their knowledge and subsequent trust of the programme. This should ultimately allay these concerns.

It has been shown in this research that the farmers interviewed did not use the NMP to its full potential. Many of the farmers interviewed identified a lack of real understanding regarding nutrient management and NMPs. As a result NMPs were often not utilised nor used as effectively as possible. The literature suggests that because the farmers had not voluntarily adopted their NMP that the use of the plan may possibly be diminished, with Atari et al. (2009) stating that the voluntary nature of a program did not guarantee implementation. While the majority of farmers did state that they used their NMP to some degree, it was also stressed by many that the plan was not referred to very often and was not read thoroughly. This may be due

to a number of factors including what the farmers perceived as the generic nature of the NMP and what they viewed as the inability of Overseer to take into account the individual and unique characteristics of any particular farm. While the farmers were aware that they were required to have an NMP, there was no requirement for them to actually use it beyond the requirement specified by Fonterra that the NMP had to be available for the annual dairy shed inspection. This research supports previous literature that concluded that compliance and Government encouragement are important in encouraging the adoption of new innovations as highlighted by Lamba et al. (2009) and Atari et al. (2009).

Farmers viewed NMPs as another part of the increasing compliance required of all dairy farmers, with concerns raised regarding the increased compliance required of all dairy farmers in New Zealand. While many were resigned to the changes others had become very guarded and concerned with the perception of dairy farming by the general urban population. Farmers in the Waikato were aware of the WRC and its requirements regarding nutrient management and expected further changes and requirements of them in the future. Farmers in the Otago region were aware that currently there were no restrictions on them however they were also aware of the ORCs proposed water plan change (6.A) which would set restriction on nutrient leaching based on the Overseer program. This proposed water plan change seems to have influenced the Otago farmer's views regarding Overseer and subsequently NMPs.

These findings support those of existing literature (Atari, et al., 2009) that suggest that the farmers own views and circumstances, which are formed as a consequence of their personal experiences, do affect their adoption of an innovation such as an NMP. This in turn may affect the actual benefits which farmers gain through their use of NMPs. The influence of NMPs on the management practices of dairy farmers seems to be often restricted by the farmer's prejudices towards the innovation.

6.5. Influence of NMPs in the management practices of dairy farmers.

A key contribution of this research to the existing literature has been the gathering of actual dairy farmer's opinions regarding NMPs and the influence of NMPs on the farmer's management practices. NMPs were seen to provide beneficial results for the farmers interviewed, with farmers agreeing that their NMP had influenced their farm management practices in a positive way. The Otago farmers identified a broader range of influences of NMPs on their management practices which revolved around improved fertiliser application, a greater consideration for effluent, and the consideration of other factor on farm nutrient flow. Similarly to the Otago case, the key influences of the NMP on Waikato farmers revolved

around the management of the effluent, and a more precise and efficient management of fertiliser.

This research has provided empirical evidence that supports the existing commentaries and opinions regarding the potential benefits of NMPs. The majority of farmers interviewed saw strengths in their NMP with the two major strengths cited being:

- The NMPs use as a compliance and monitoring tool, and
- The NMPs ability to increase the farmer's awareness and knowledge of nutrient management, leading to improved fertiliser management.

A number of influences have been highlighted in the literature regarding NMPs and their affect on farm management practices. These influences have been identified either through actual studies of NMP implementation or as predicted benefits highlighted in commentaries on NMPs and their possible effects on dairy farming and agriculture as a whole in New Zealand. Studies by Shepard (2005) and VanDyke (1997) concluded that farmers who applied NMPs as part of their whole farm management strategy were able to significantly reduce the amount of nitrogen and phosphorous applied as well as maintaining or increasing farm income. Edmeades et al. (2011) argue that NMPs have both economic and environmental benefits. Other potential benefits identified in the literature include an improved public perception of the diary industry, and increased compliance.

The research undertaken in the two case studies suggests that the dairy farmer's perceived benefits of NMPs are fewer than what is proposed in the literature (Shepard, 2005; VanDyke, 1997; Edmeades et al., 2011). This may be due to the relatively recent introduction of NMPs in New Zealand, the perceived generic nature of NMPs in their current form by dairy farmers, and the level of understanding and familiarity of NMPs by dairy farmers.

Across the two case studies farmers agreed on the primary purpose of an NMP either as a tool to aid compliance – with regards to regional council policy and industry initiatives - or as a tool to help farmers improve their farm management practices and fertiliser application. While farmers were aware of the environment their primary concern regarding the benefits of NMPs revolved around the NMPs impact on improving the farm's production and financial position. This is also commented on in the literature. Previous research such as Bewsell & Kaine (2005) and Pannell et al. (2006) has suggested that a primary motivator for the adoption of any new innovation is its perceived benefits for the farmer and their business. However this may also relate to how NMPs have been promoted to farmers.

The findings of this research have contributed to the existing literature by also highlighting how NMPs are influencing farm management practices irrespective of who is promoting the NMP. In the case of this research the entities promoting NMPs were a Regional Council and the fertiliser companies, whose respective goals and reasons for being are very different. Most farmers agreed that NMPs had influenced their farm management practices and viewed their NMP as being successful. Reasons given for the success of NMPs included the perception that the NMP increased the farmers' awareness of their own management practices, and how the NMP allowed the farmers' to monitor their fertiliser application efficiently and accurately, and to make any changes as required. Positive results of NMP implementation mentioned in the existing literature include financial and environmental benefits, the ability to increase compliance and meet any current or emerging compliance, improved public perception of the industry, and the avoidance of animal health issues. To varying degrees all of the above benefits were also mentioned by the farmers within the case studies.

The major changes identified by farmers were similar between both case studies, being:

1: The development and expansion of the farmer's effluent block

2: Increased precision and efficiency of the fertilizer application.

3: Taking into account of other factors such as stock movement, irrigation and bought in feed, which can influence the overall farm nutrient inputs and outputs.

4: More precise use of, and reliance on, soil tests.

6.5.1. The development and expansion of the farmer's effluent block

Increased consideration of the value of effluent as a nutrient source was highlighted as a major change by many farmers across both case studies with six farmers identifying it as a change to their management practices as a result of NMP implementation, and others identifying the expansion of the effluent area as a potential change in the future. All farmers had separated the effluent and managed the effluent block separately from the rest of the farm with regards to fertiliser applications. Farmers were also becoming increasingly aware of the potential of effluent as an alternative source of nutrients. By increasing the size of the effluent block farmers were in turn able to reduce their fertiliser application and so reduce their fertiliser costs.

Some farmers had found that no additional nutrients were required for the effluent block so no longer applied fertiliser to that particular area while others had calculated that the nutrients of

the effluent block were often unbalanced. Farmers were also altering the rate and timing of effluent application as required, to account for such factors as seasonal weather variations and irrigation events.

This outcome is in agreement with much of the literature which suggests that's the management and consideration of effluent as a nutrient source can have both economic and environmental benefits (Monaghan et al., 2007). Both this research and the existing literature agree that effluent management can be identified as an influence on farm management practices as a result of NMP implementation. Existing literature has also identified the management of effluent as a 'best management practice' for farmers (Bewsell & Kaine, 2005), so the fact that the majority of farmers across both regions have identified this as a result of NMP implementation can be seen as a success with regards to the influence of NMPs on farm management practices.

6.5.2. Increased precision and efficiency of the fertiliser application

A key finding of this research is the increased precision and efficiency of fertiliser management as a result of the introduction of an NMP. The use of their NMP had allowed farmers to move away from the traditional practice of bulk fertiliser applications and to work towards a more precise application accounting for the various soil types and geography of the land as well as seasonal weather variations.

The use of NMPs and the more precise application of fertiliser had lead to farmers splitting their farms into a number of different blocks characterised by differences in soil nutrients and geography. Farmers were also becoming more aware of when to apply fertiliser to increase its effectiveness. Taking into account seasonal variations and recent rain events or irrigation to ensure nutrient uptake by the soil and plants were maximised.

This research supports the opinions and findings of much of the existing literature, which suggests that improved fertiliser management is a major benefit of NMP implementation (Shepard. 2005; VanDyke. 1997). Improved fertiliser management is also viewed by Bewsell & Kaine (2005) as a 'best management practice' which can result in both production and environmental benefits. Both the findings of this research and the exiting literature suggest that fertiliser management is a major influence on farm management practices as a result of the introduction of an NMP.

6.5.3. Consideration of other factors that can influence farm nutrient flows.

With the help of an NMP a number of farmers across both case studies had managed to identify other factors which influence nutrient efficiency and leaching, including the effects of bought in feed and stock movements, both within the paddock, and across the farm. This is a finding of the research which seems to have had little attention in the existing literature. This research suggests that farmers are increasingly becoming more aware of the multitude of factors which may affect nutrient flow, or act as an alternative nutrient source. This finding represents a contribution of this research to the field of literature on the subject of NMPs. It also represents another influence of NMP implementation on farm management practices.

Farmers also commented on the effects of nutrient levels on animal health. This is in agreement with the existing literature (Edmeades et al. 2011) which has suggested that NMP implementation could help to avoid animal health problems.

6.5.4. Soil Tests

This research suggests that farmers are becoming more reliant on the use of soil test as a result of NMP implementation. All farmers interviewed commented on the use of soil tests. Many farmers were making use of farm maps to organise the soil tests and fertiliser application by identifying the good and poor areas of the farm and individualising the fertiliser application for those areas. Farmers were using annual soil tests, which were either completed on a particular paddock representing a particular farm block, or in some cases soil tests were completed for every paddock throughout the farm. One farmer was also beginning to adopt the use of a carbon ratio test to see how much they were increasing their organic matter. The use of soil test has had minimal attention in the existing literature, and is an example of how farmers seem to be becoming more precise and efficient with the management of their on-farm nutrients as a result of the introduction of an NMP.

6.6. Summary

This discussion has shown that the results of the research provides empirical evidence to support the views in the literature concluding that NMPs can have positive impacts on farm practices while stressing the importance of adequate continual support and education for farmers on the topic of nutrient management. The results have also found that the effectiveness of NMPs and the farmer's perspective on NMPs were influenced by a broad spectrum of factors beyond just the NMP itself. Examples include regional policy, the role of the relevant

regional authority, the unique situation of the farmer, and the availability of support and education.

NMPs were found to have influenced the majority of farmers' management practices and so in turn had led to positive impacts, both in terms of production, and financially. However, there were mixed responses regarding the contribution of NMPs towards the farmers' personal goals which possibly can relate to the role of the regional authority in the promotion of nutrient management in the region.

The importance of adequate and continual support and an increased awareness of farmers regarding nutrient management is a key component of the success of NMPs. There is a concern across both cases that farmers were not getting enough support and wanted more education and relevant information on the issue. This had a flow on effect where it was found that NMPs were not referred to or used to their full potential as a result. Therefore it is likely that farmers would require additional training on the Overseer programme and its capabilities to increase their knowledge and subsequent trust of the programme, and NMPs as an effective nutrient management tool.

Chapter 7 Conclusions

7.1. Introduction

The aim of this research was to examine the influence that NMPs have on the farm management practices of dairy farmers, and provide an insight for local authorities and the dairy industry to aid in their efforts in promoting the use of NMPs. This was achieved by investigating the research question 'How has the introduction of a Nutrient Management Plan influenced the farm management practices of dairy farmers, and what has shaped this influence?

A case study approach incorporating two cases in the Otago and Waikato regions was used to identify why and how dairy farmers had incorporated NMPs into their farm management practices. The research identified what the farmers viewed as the major strengths and weaknesses of NMPs and how the NMPs had influenced the management practices of those farmers. A key reason for the selection of the two cases was the regional authorities contrasting approach to nutrient management and the different characteristics of dairy farming between the two regions.

In this chapter the key findings of the research will be summarised and conclusions drawn. The implications for local authorities and the dairy industry (incorporating both the organisations involved and actual dairy farmers) will then be outlined. This will be followed by an assessment of the research methodology and a description of possible future research that could expand on the findings of this case study.

7.2. Research findings summary

Overall the findings of this research align with the conclusions and propositions of the existing literature (including both commentaries and research), from within New Zealand and internationally. These relate to the possible benefits of NMPs and the factors that influence the adoption of, and successful implementation (initial and ongoing) of innovations such as NMPs. A mixture of factors relating to the parties involved, including the circumstances of the individual farmers, the role of the regional authority, and the NMP itself have influenced the adoption and use of NMPs by dairy farmers. A point also identified within the literature reviewed (Edmeades, et al., 2011; Monaghan, et al., 2007; Smithers & Furman, 2003). When incorporated into farm management practices NMPs have been found to be beneficial, however, concerns have been raised with regards to the ongoing support and education of

farmers regarding nutrient management. This is required to ensure NMPs are used to their full potential and their benefits are capitalised upon by the dairy industry.

Because the likes of Fonterra require farmers to have NMPs, a range of organisations within the industry are promoting and supporting changes to nutrient management practices by dairy farmers. As a result these farmers, to varying degrees, have changed their farm management practices. These changes vary from farm to farm, but include financial and production benefits, as well as environmental benefits. This is due to the farmer's increased awareness of the on farm nutrients, and subsequent fertiliser and nutrient management changes.

Farmers adoption of and subsequent opinions of NMPs were influenced by a number of specific factors. These factors relate to the farmer's own personal circumstances, the characteristics of the farm itself, regional policy requirements regarding nutrient management, and the role of the regional authority and others in the industry in promoting NMPs and supporting and educating farmers on the topic of nutrient management.

This research suggest that even with support farmers are unlikely to read and implement their NMP to its' full potential. This suggests the need for the industry to ensure farmers are adequately educated on the purpose and benefits of NMPs and that the appropriate ongoing support is offered to them during the introduction stage and throughout the life span of the NMP. This would help to encourage farmers to incorporate NMPs to their full potential and so reap the full range of benefits offered.

A lack of understanding and uncertainty with the science and basis for the recommendations included in the NMP, led to reluctance and lack of confidence from the farmers interviewed. As stated throughout the literature (Dooley, et al., 2005; Monaghan, et al., 2007; Pannell et al., 2006) it is vital that any innovation is capable of accommodating the characteristics of any individual farm while accounting for the farmers own personal and business needs. This leads to the issue of trust, whereby farmers need to be able to trust any new innovation if they are to adopt it as part of their management practices. This research suggests that dairy farmers will require additional training on the Overseer programme and its capabilities to increase their knowledge and subsequent trust of Overseer, as well as to increase their knowledge of nutrient management and the advantages of NMPs.

In spite of some farmers reticence and lack of in depth knowledge of their NMP, all farmers interviewed had altered their farm management in consideration of their nutrient management. The farmers viewed the purpose of an NMP as either a tool to aid compliance or as a tool to help the farmer improve their farm management practices, and fertiliser application and efficiency. This was reflected in how they used their NMPs and how the NMP shaped their

management practices. While there were a variety of changes identified, the main influences identified in both regions' cases were the development and expansion of the effluent block, the increased precision and efficiency of fertiliser applications, the increased precision of soil testing, and the recognition of other factors that influence fertiliser management practices. This shows that farmers are using NMPs to change their management practices. Many of these changes were highlighted in the literature (Edmeades, 2009; Shepard, 2005) as major goals of an NMP. Results also show economic and production benefits to the farmers as a result of the NMP. This research suggests that when implemented correctly NMPs can be effective and beneficial to farmers.

The support afforded to farmers by organisations like regional councils or fertiliser companies has been found to be important in encouraging and supporting farmer's acceptance and use of NMPs. A point that is likewise emphasised in the NZ and international literature (Monaghan et al., 2007; Shepard, 2005). It is suggested in the research that farmers who have had a longer involvement with NMPs and more interaction with an environmental agency have in turn more awareness of the environmental aspects of NMPs. This was reflected in the Waikato case study, where due to the more proactive approach of the WRC regarding nutrient management, and the involvement of the majority of the Waikato farmers in community initiatives such as the ICMP, the farmers were found to be generally more knowledgeable with regards to nutrient management and more accepting of NMPs,

Farmers expressed concern with the lack of support offered to them post introduction. Previous literature (Lamba, Filson, & Adekunle, 2009; Monaghan, et al., 2007; Shepard, 2005) indentifies the need for support to be ongoing and for the relevant industry representatives to work closely with farmers to ensure NMPs are beneficial for the farmer and the industry over the long term. While this may be due to the fact that NMPs are still a relatively recent concept in New Zealand it identifies the need for those in the industry to ensure that farmers are supplied with continual supported and education regarding nutrient management.

Farmers saw strengths in NMPs as a compliance, and monitoring tool, and in the NMPs ability to increase the farmers' awareness and knowledge regarding nutrient management. However a number of concerns were also raised. The key issues were regarding how the NMP was not being referenced, the lack of understanding amongst farmers relating to nutrient management, the lack of trust in Overseer and concern with regards to the increasing compliance throughout the dairy industry. While this research suggests that many dairy farmers see NMPs as a useful management tool, the weaknesses identified need to be addressed to ensure farmers can trust and use NMPs to their true potential. At present these weaknesses are likely to be restricting the use of NMPs as a management tool by dairy farmers.

7.3. Conclusions

NMPs can be beneficial when incorporated into the management practices of dairy farmers. However, at present, in some regions there is little requirement for the farmers to actually use their NMP. A number of interrelated factors influence the adoption and subsequent use of NMPs by dairy farmers in their farm management practices.

Throughout the research it was found that NMPs were of benefit to those farmers that had adopted them. The key benefits of NMPs identified revolved around the expansion and development of the effluent block and the increased precision and efficiency of fertiliser applications. Both of these benefits were also highlighted in the literature (Monaghan, et al., 2007; Shepard, 2005). Farmers interviewed were now also found to be accounting for other factors such as stock movements and bought in feed when calculating their nutrient requirements and were managing their farm in a more efficient and precise manner leading to positive results with regards to their production and financial situations. A number of farmers had substantially reduced their fertiliser application and financial costs while maintaining or enhancing production levels. In agreement with the literature (Shepard, 2005; VanDyke, 1997) this research has shown that NMPs can clearly have benefits for dairy farmers.

This research also suggests that NMPs are not being used as effectively as possible due to a number of factors, but primarily due to the perceived lack of support and education for farmers once the NMP is put in place, and a lack of trust in the plan. Existing literature comments that wide spread acceptance and subsequent adoption of NMPs can be achieved if farmers are supplied with the adequate support and knowledge regarding nutrient management and the advantages of an NMP, on a continuous basis (Edmeades et al., 2011; Monaghan et al., 2007; Shepard, 2005).

The continual support and education for farmers regarding nutrient management is likely to be a key component to the development of NMPs and their ability to be incorporated into the farmers' management practices. The role of regional authorities and others in the industry is very important in this respect. This research suggests that farmers require support throughout the entire NMP process. This is a view supported in the literature (Deugd, et al., 1998; Shepard, 2005). Industry representatives may need to work closely with farmers to ensure that the farmers' needs are met as well as ensuring that the farmer continues to refer to and develop their NMP accordingly. Results of this research suggest that the farmers may lose interest in the NMP if they are not supported post implementation.

Both the existing literature (Bewsell & Kaine, 2005) and the results of this research suggest that to increase the acceptance of NMPs the innovation needs to be able to incorporate the unique features and goals of each farm. It seems likely that this would help to increase the trust of farmers in the plan as this research suggests that farmers want to be able to use the NMP to help achieve their own management goals.

This research suggests that information needs to be supplied to farmers around the need for NMPs, their benefits and their place within the particular region. Results suggest that if farmers are made aware of the environmental situation of the region and the goals set to address any issues they will be more co-operative and encouraged to adopt new innovation that deal with the issues. Information also needs to be supplied around the benefits of NMPs to the financial and production goals of farmers. As presented in the literature (Bewsell & Kaine, 2005; Monaghan, et al., 2007), farmers may be more concerned with how the NMP benefits their own production goals and whether it is advantageous when compared to existing farm management methods.

Farmers trust in the new innovation and those who support it is also highlighted in the research as a key component of adoption. Farmers concerns regarding the generic nature of the Overseer and the use of Overseer as a regulation tool by the ORC seems to have affected the trust of farmers in NMPs. In comparison farmers have said that they do trust their fertiliser representative and rate their assistance as very good; as a result farmers tend to perceive the NMP in a more positive light.

This research is in agreement with the literature (Dooley, et al., 2005; Edmeades, et al., 2011), suggesting that if any new innovation is to be accepted, the farmers must see how that innovation benefits themselves' and how it fits into their own farm management goals and scenarios. It has now been proven that NMPs can have a positive impact on farm management practices and can contribute towards both the productivity and economic situation of a farm. This information should be passed on to farmers by those in the dairy industry who want to promote the use of NMPs. Support from the industry should be continuous throughout the whole process to increase the trust of farmers in NMPs, and also contribute towards the farmers' knowledge regarding nutrient management. Farmers should be encouraged to continuously use and refer to their NMP to ensure they reap the full benefits of the plan. In turn they may be able to see how the NMP can benefit both themselves, and the greater region.

7.4. Implications for the Industry

It has been shown by this research that NMPs in their current form can be beneficial to farmers primarily through fertiliser and effluent management. It also stresses the importance of the role of those in the industry who wish to promote NMPs. Regional authorities and others such as the fertiliser companies, DairyNZ, and Fonterra have an important role to play in the promotion of NMPs and the encouragement of farmers to adopt such innovations. As this research shows, it is also likely that the opinions of the actual farmers will in turn educate the other interested parties in the dairy industry also. This section will present the implications of this research for the industry and present conclusions with regards to how those concerned within industry can best carry out their role.

This research has found that while NMPs were not being utilised to their full potential they were still beneficial for farmers who had incorporated NMPs to some degree as part of their farm management practices. This is important for those interested parties in the industry who can use this information as an example of how NMPs can be beneficial. However this information alone will not guarantee the adoption of NMPs by farmers. This research has highlighted that irrespective of the level of farmer awareness and experience with NMPs, ongoing support - both face to face and at the broader level - from a trusted organisation is important. This research suggest that when farmers view the NMP as lacking in follow up or support, they are less likely to implement the plan in full.

The acceptance and use of an NMP is influenced by the wider sectors' commitment and support for NMPs, as well as the one on one support offered to farmers. The majority of the farmers interviewed were happy with the implementation process of the NMP and appreciated the support and knowledge supplied by those who assist them during the implementation stage. It seems likely that the focus needs to be on the development of the support and education offered to the farmers post implementation, an issue raised in the literature also (Shepard, 2005). This may help ensure that NMPs are referred to more often by farmers, and should help to increase the likelihood of the innovation being used to its full potential.

Certainty and confidence in the technology is also of importance and this is linked to the science on which the NMP is based. It seems likely that farmers need to have trust in the tools and the innovation to ensure the adoption and use of NMPs, which are directed at reducing the impacts of farming practices on the environment. This is a view that is also supported in the existing literature (Deugd, et al., 1998; Smithers & Furman, 2003). The majority of farmers

interviewed expressed a general lack of trust in NMPs. While this issue needs to be addressed it should also be stressed that there is a fine line between the complexity of the program and the understanding of the user. While this research has found that farmers are generally happy with the service provided by those who assisted in the NMP introduction, it should be ensured that representatives of the innovation are knowledgeable and adequately qualified to give the appropriate advice regarding nutrient management and so increase the trust of farmers in the new innovation.

It is also suggested in this research, and again supported in the literature(Edmeades, et al., 2011) that NMPs have more relevance and value to farmers if they are tailored to the individual farm scenario and so are able to accommodate the individual characteristics and goals of any given farm. While the individual characteristics of a given farm need to be considered, as previously stated, issues with the program becoming too complex also need to be avoided. Results from the research suggest that currently farmers tend to view their NMP as more of a fertiliser tool in the main, particularly when the plan is provided by a fertiliser company.

The WRC is known to be relatively proactive regarding the promotion of NMPs and nutrient management in comparison to other NZ regional councils. While this did not guarantee that farmers would implement and use their NMPs it has contributed to the subject of nutrient management being more topical in the region compared to the Otago case. This is an example of how those in the industry can use a proactive approach to advertise and push the subject of nutrient management effectively. While some farmers in the case admitted to not referring to their NMP the research suggest that the reasons for this are tied more to the individual's own personal characteristics and circumstances, as well as the lack of any support post introduction. As previously advised, the research and existing literature suggest that these are all issues that need to be addressed to ensure that the introduction of NMPs is successful.

7.5. Research Methodology Assessment

The case study approach and use of two cases was appropriate for this research and to address the research question. By using the case study approach the research was able to incorporate the unique contextual elements of each case which influenced the varying opinions and factors influencing farmers' views and subsequent usage of NMPs.

Due to the personal contacts within the Otago region, all interviews within that case were completed within a week. In comparison, a number of delays were encountered during the interview process for the Waikato case. The researcher was initially assuming that all Waikato interviews would be completed within a month however the four interviews for this region

were carried out over five months from October 2012 to January 2013. The researcher failed to take into account the fact that this was a busy time of year for the farmers and so a number of the farmers were hard to get hold of and required a number of follow up e mails and phone calls before they could commit to a time for the interview to take place. Due to the time restraints this also resulted in fewer interviews taking place in the region. For future research, the timing of the data collection needs to be considered more thoroughly, in regards to both the amount of time allowed for the data collection and the time of year that the data collection is to occur.

The small number of farmers interviewed within each catchment allowed for a more in depth analysis of the cases. The use of two cases also presented regional variations with regard to the data gathered and the end results and conclusions. This meant the results could be compared between regions and identified additional trends, factors and variations influencing the end result. If additional time was available an additional region or an increased number of interviewees could be incorporated to provide potentially more variations and trends in the data.

The use of semi-structured interviews was successful as it enabled the researcher to prompt for additional information and allowed for additional information to be gained as a result of the conversational manner of the interview. The interviewees were also much more relaxed and while they were often hesitant to begin with they were often talking freely by the end of the interview.

The qualitative data analysis process was appropriate for this research. A full transcription of all data was not required in this instance. The identification of key factors and themes was completed for each individual, each sub case and the entire case study. This enabled key trends and variances to be indentified between individuals within the sub cases, and across the entire data set. The supervisors also offered continual advice by helping to identify the key trends and variations to focus on.

7.6. Further Research

This research highlighted the influence of NMPs and the key factors influencing farmers' adoption of NMPs. The variations between regions and the conclusions of the existing literature suggest that a similar study in other regions within New Zealand may identify a different set of factors influencing NMP adoption and the influence of NMPs on farm management practices. This research could adopt a similar approach using a number of cases or instead focus on one particular region.

Further research needs to continue with regards to the continuous improvement of NMPs. This could for example focus on the NMPs ability to incorporate the individual characteristics of any specific farm or the effectiveness of an NMP as a compliance tool to meet regional or national requirements regarding nutrient leaching.

In conclusion this research has provided valuable information regarding the effectiveness of NMPs and their influences on farm management practices. It is particularly valuable as it has gathered data of the actual NMP user, evidence that to date has not been collected in the New Zealand context. The research has also identified the key factors influencing the adoption of NMPs by farmers and their major concerns and requirements which should be acknowledged and addressed to help increase the adoption of NMPs and ensure NMPs are utilised to their full potential in the future.

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Appendices

Appendix 1: Participant Consent Form

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

Nutrient management plans & how they are being integrated into the farm management practices of dairy farmers

PARTICIPANT CONSENT FORM - INDIVIDUAL

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree/do not agree to the interview being sound recorded.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: _____ **Date:** _____

Full Name - printed _____

Te Kunenga ki Pūrehuroa

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Appendix 2: Information Sheet

MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

Nutrient management plans & how they are being integrated into the farm management practices of dairy farmers

INFORMATION SHEET

Introduction
The purpose of this research is to examine how dairy farmers have integrated nutrient management plans into their farm management practices. This will be achieved through the use of interviews with dairy farmers within the Waikato and Otago regions and industry representatives.

This research will be undertaken by Gavin Neal, and will be used to contribute towards a thesis for a Master of Environmental Management at Massey University.

Project Description and Invitation

The project entails the completion of an interview with dairy industry' representatives and farmers involved with nutrient management plans in the Waikato and Otago regions. The information gathered from the interviews will contribute towards the study of how dairy farmers have integrated nutrient management plans into their farm management practices.
I am inviting you, either as a dairy farmer with a nutrient management plan in place or a dairy industry representative to take part in the study.

Participant Identification and Recruitment
Dairy farmer participants with a nutrient management plan in the Otago Region were identified through personal contacts within the industry and region. Waikato dairy farmer participants were identified with the assistance of the Waikato Regional Council and contacted by phone and / or email. Approximately 6 farmers in each region will be interviewed as part of the research. Industry representatives were contacted through inquiries made with the relevant parties, such as DairyNZ and Ravensdown. The research supervisors also assisted with gaining the cooperation of the industry representatives.

Project Procedures
Participation for farmers will involve a farm visit by Gavin Neal and interview. With the agreement of the participant the interview will be digitally recorded to enable later analysis. Participation for industry representatives will involve a pre-arranged meeting and interview. Once again if agreement is gained the interview will be recorded. The interviews will take no more than 1 1/2 hours.

Data Management
The data gathered from the interview will be recorded on a device during the interview and transcribed by Gavin Neal and then analysed. Farmers' personal details will be kept confidential. No copies of the actual recordings will be made. Results of the interviews will be combined and summarized for each region. Direct quotes from interviews may be used within the thesis but the confidentiality of the participant stating the quote will be maintained. The completed thesis results will be publically accessible. The actual interview recordings will be destroyed upon completion of the research.

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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 recorder to be turned off at any time during the interview.

Compulsory Statements

LOW RISK NOTIFICATIONS

"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(s), please contact Professor John O'Neill, Director, Research Ethics, telephone 06 350 5249, email humanethics@massey.ac.nz".

Please feel free to contact any of the above if you have any queries regarding the research

Yours sincerely

Gavin Neal

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Appendix 3: Interview Schedule for Farmers

INTERVIEW SCHEDULE – DAIRY FARM MANAGER INTERVIEW

Introduction , IceBreakers – Weather / Calving Season / the Drive Down etc / Do they have any big plans for the upcoming season etc

- Introduce myself and the research. Ask if they have question or concerns. Request their permission to record the interview.

Intro

- What (if any) are the feelings in the community regarding NMPs? Positives / negatives?
- Are NMPS being advertised / pushed by the industry / local govt.
- Any known success stories / any known failures?
- Any common trends that you've heard

Implementation

- So when did you first implement your NMP? (how many seasons in operation)
- Why did you choose to implement an NMP? (was it external pressure / self motivation)
  - If self-imposed – where did you get the info / help from etc
  - If external – by who? – Who developed your NMP?
  - What was the process involved?
  - What was your (the farmers) role in the implementation process?
  - Were there any costs involved for you in the development and implementation of your NMP? **(tread carefully with this Question)**
  - Was the Implementation process of your NMP Easy? (why / why not) Who helped?
    If viewed as not easy – ask what the major implementation issues were.
    What would you like to see improved
    What were the strengths of the implementation?

  - If you were assisted, how did you rate the assistance of the consultant?

Current Situation / Review

- What, in you view is the purpose of NMPs?
- Do you actually use your NMP? Why / why not – *if not then skip to 'Impressions of NMPS?'*
- How has the NMP influenced your management practices?
- What is your current situation and where do you hope to get to? Are you on track?

- What are your time frames? Are any changes / transitions staged or managed (ie: In Achievable Increments)
- Has the NMP contributed toward you achieving you environmental, production goals? Why / why not
- Would you consider it to be 'successful' in achieving its purpose?

Impressions of NMPS?

- What do you see as the strengths of NMPs?
- Weaknesses?
- Are NMPs easy to understand ?
- Any continued support from other parties post implementation? Is it enough? What would you like ?
- Do you receive continual info / education regarding NMPs. Is it enough, what would you like to see?
- What role has your regional authority played? Other parties within the industry?
- What changes would you personally like to see regarding NMPs in the future?
- Would you recommend NMPs to other farmers? Why / Why not.
- Are you aware of any opposition towards NMPs?
- Awareness of regional policy / restrictions, requirements of dairy farmers (eg – CSA)

General Farm Overview

- Hectares / Size
- No. of Cows /
- Number of Seasons working on that particular farm / in that region
- Number of Staff?
- Production Goals?

Appendix 4: Interview Schedule for Key Informants

INTERVIEW SCHEDULE - KEY INFORMANTS:

Introduce myself and the research. DO they have any questions or concerns? Request their permission to record the interview;

- What is your company's role with regards to the implementation and / or development of NMPs in the NZ Dairy Farming Industry?
- What resources and/or expertise do you supply to this area?
- How have you encouraged / advertised the benefits and implementation of NMPS to Dairy Farmers?
- After the NMP is initially implemented, what follow up / support is offered to the farmer?
- What does your organisation gain as a result of the implementation of NMPs? How do they benefit you?
- What do you see as the objectives / goals of NMPs? **(specific answer)**
- History of NMPs in NZ?
- What do you see for the future?
- What in your opinion are the major obstacles with regards to the implementation of NMPs by Dairy Farmers?
- What (if any) feedback, have you had from farmers re: The success / failure of NMPS? Any obvious trends?
- Your views of the Disadvantages / Advantages of the current NMPs in NZ
- Have you come across any major opposition from groups or individuals? Who / what / why?
- What, if any, are the industry targets re: NMP implementation
- How do you see regional / central govt. policy changing to adopt the use of NMPs?
- Any regional variances?
- Do you have any other contacts who you think would add value to the research?