Victoria Magazinovic

Nitrogen use on Central Otago Sheep and Beef Farms

Sustainable use for Future Profitability

Victoria Magazinovic
10-28-2016

Executive Summary

Central Otago is a region where farming is predominantly sheep and beef. The profitability of these farms varies, and in the last few years lamb prices have not helped this. Nitrogen use has the potential to help farmers improve production and profitability, but the use of it also varies a lot from farm to farm in the area.

The aim of this report is to explore the use of nitrogen on Central Otago sheep and beef farms in order to get an understanding of how farmers are using it, and how it could be used better. While using nitrogen can significantly boost productivity, it is important that this drives profitability as well.

Six Central Otago sheep and beef farmers were interviewed to get a good understanding of their systems, their use of nitrogen, and their profitability. These businesses have been compared and contrasted to build a picture of what good use of nitrogen in the future might look like for the area.

There were some similarities and differences between systems, but some major consistencies:

- All ran breeding ewes.
- All ran cattle but there was variation between what the cattle element was made up of – for some it was cows for some trade stock or grazing stock.
- All finished some or all of their own stock.
- All had an area of Lucerne within their system.
- All grew winter crops.
- All tried to cut all their own supplement for winter feed.

Farmers were also questioned around benchmarking, feed budgeting, and environmental regulation to build a picture of their motivation and execution of their goals.

From this, several recommendations have been made both for farmers and rural professionals:

1. Those in support roles (company reps, industry good organisations) need to identify 'triggers' for nitrogen use and be more proactive in their discussions around nitrogen to ensure that when farmers do decide to use it, that they have a good experience.
2. That current application rates for strategic use continue to be followed – the author is not suggesting that rates of nitrogen use should dramatically increase, but that farmers should be more prepared to utilise light to medium rates of nitrogen to help maximise their pasture production.

3. Rural Professionals need to help farmers in a more structured manner to execute plans to use nitrogen. This should allow them to more easily link their action (nitrogen application) with results, be it increased pasture growth or better ewe body condition score at weaning. This might be as simple as a straight forward pasture measurement exercise.
4. Farmers need to examine their systems more closely to ensure they are building resilience to adverse effects. For example, many could possibly benefit from building a higher trading or finishing component into their system rather than re-building ewe numbers – they need sound advice from Rural Professionals to do this given their tendency not to use formal feed budgeting.
5. In turn, advisors need to be more careful to explain and help farmers to understand the figures around their farming systems – be it pasture production or financial figures. As soon as they don't understand what they are looking at, the benefit of the exercise is lost (for example when benchmarking).
6. Farmers need to work at increasing the amount of measuring, monitoring and benchmarking that happens in their businesses. They are surely missing out on key triggers to make changes by not monitoring financial performance and pasture production closely.
7. Finally, farmers need to share what they do well. In particular, the farmers interviewed were all doing a great job of looking after the environment that they farm in. They need to be spreading the word, especially as they are largely doing this due to their own motivation, rather than due to regulation.

The farmers in this area face a set of challenging conditions. In order for their businesses to be future-proofed for future generations, they need to build businesses resilient to the many environmental and economic challenges they face. Using tools such as nitrogen is just one part of the puzzle, but one which the industry can provide significant help with in order to improve profitability.

Foreword

There were a number of main factors why I chose to undertake this project. The main one was a passion to see Central Otago sheep and beef farmers be successful in their businesses in order for our communities to continue to thrive. I have thoroughly enjoyed my time spent living in small communities and the people I have gotten to know through my job. I want them to prosper so that the small communities that rely on the sheep and beef industry have a sound future. Secondly while I deal with farmers and nitrogen on a day to day basis in my role as a Nutrient Specialist for Ballance Agri-Nutrients, I wanted to be able to take my 'Sales' hat off and examine the use of nitrogen with a broader view of people's businesses that 'sales reps' often aren't afforded. Through my role I have been able to see the impact which fertiliser use has on businesses production but often don't get to follow that right through to profitability. Finally, I want to see the wider sheep and beef industry in New Zealand to continue to be the backbone of our economy and make the best use possible of our large land area while maintaining it for future generations to enjoy.

Acknowledgements

I would like to thank Ballance Agri-Nutrients for their financial support of my participation in the Kellogg Programme, in particular John Elliott and Andrew Sanders for all their support (and patience!).

To all of the farmers who opened their homes and shared the nitty gritty details of their businesses with me, a huge thankyou. Everybody involved was so open with their information I was truly humbled by all of your help and enthusiasm.

All of my friends and fellow kelloggers who provided so much support while I completed this project deserve thanks as well. Some will likely be very pleased that I have finished!

Finally a huge thankyou to Desley Tucker and Anne Hindson for all they do for the Kellogg Programme, and Patrick Aldwell who kept me on track and put up with my many phone calls and email. You are a champion!

Authors Contact Details

Victoria Magazinovic

vmagazinovic@gmail.com

0275072576

Contents

1.0 Introduction

Sheep and beef farmers in New Zealand are coming under increasing pressure to run more profitable and resilient businesses, while the land they have traditionally relied on for finishing has been progressively converted to dairy and dairy grazing businesses. Huge parts of the country such as the Canterbury plains and Southland which were traditionally hubs for finishing the hundreds of thousands of lambs bred in the hills are now hugely intensified and occupied by dairy cows and high value cropping. This means that farms in areas like Central Otago are having to finish more of their own lambs, on land which has traditionally been less productive.

These farmers are under pressure to make decisions to remain profitable in order to future-proof their businesses for the next generation. Areas which have traditionally been run very extensively are now being developed, the stocking rate increased and hence the productivity of this country is lifting. Unfortunately lamb prices have not lifted alongside the increased productive capacity of the land. While beef prices have been lucrative, lamb prices have struggled in the past 3 years and while it is easy for farmers to blame low prices for low profitability, it is important that they focus on the factors inside the farm gate which they can control in order to maximise the profitability of their own businesses.

Across NZ nitrogen use on sheep and beef farms largely occurs in the cooler months of the year (autumn/winter/spring) in order to grow extra feed where growth rates are slower. However in the Central and Eastern Otago district, little to no growth occurs over the winter, meaning that autumn and winter N is not so widely used. Many farmers appear to expect the pastures to recover quickly enough in the spring to provide feed for lambing ewes, with temperature and moisture being the factors providing growth. This area can then quickly dry out as early as October/November, meaning that pasture growth rates slow again.

The aim of this project is to explore the use of nitrogen to help these farmers develop more resilient and profitable businesses. The climate extremes experienced in the Central Otago area mean that farming profits can vary hugely depending on how dry or otherwise one season is compared to the next. Nitrogen can be a useful tool to help maximise pasture growth at wetter times of the year. This report aims to explore how some farms use it well, as well as why others don't and how we can help them to use nitrogen as a tool to maximise profits.

1.1 Purpose of Research

There is a significant amount of research into the effects of nitrogen on pasture production, and it has been proven to be a useful tool to reduce seasonal variation in pasture production (Morton, Korte, Smith, Watt, & Smith, 1993). Much of the work done on the use of nitrogen on sheep and

beef farms has been done on farms all over New Zealand, but a lot of this centres around use of autumn or winter nitrogen to fill early spring feed deficits. Due to the climate in Central Otago optimal conditions for gaining economic nitrogen responses are often at different times to other parts of the country. For example soil and air temperature over winter mean that little to no growth is occurring over this time making applying winter N un-economic and applying early spring N difficult to time with set stocking.

The purpose of this research is to explore how Central Otago sheep and beef farmers use nitrogen, and how it could be better used to help them gain higher productivity and profitability. In turn it would be useful to determine if higher nitrogen use correlates with higher profitability in Central Otago, as it does in other parts of the country (Morton, Korte, Smith, Watt, & Smith, 1993).

2.0 Literature Review

2.1 The New Zealand Sheep and Beef Industry

Sheep and beef farming is a huge part of New Zealands Primary Industries, providing an export revenue for the 2015 year of over $9 Billion Dollars. The majority of this revenue in the 2015 year came from beef and veal, closely followed by lamb (Ministry for Primary Industries, 2016). In previous years lamb has provided a higher export revenue than beef, but in the last 5 years beef and lamb have always been the main earners for the Meat and Wool industry (Ministry for Primary Industries, 2016). Export revenue earnings for the sector for June 2016 are projected to hit $9.1 billion. Meanwhile, sheep breeding numbers are projected to slowly fall over the next 5 years (Ministry for Primary Industries, 2016).

Since the beginning of farming in NZ, the sheep and beef industry has occupied the largest farming area compared to all other industries (Beef & Lamb New Zealand, 2016). At the 2012 Agricultural Census, Sheep and Beef farms occupied 9,328,000ha made up of 25,113 farms (including small holdings) (Beef & Lamb New Zealand, 2016). This meant that at the 2012 Agricultural Census, sheep and beef farms made up 44% of all farmland in New Zealand. This has dropped significantly compared to the 69% of land use occupied by sheep and beef farming in New Zealand in 2002 (Ministry for Primary Industries, 2012). It was estimated that the area of Grassland used for dairy farming increased by about 6% from 2002 to 2009. While there is some discrepancy in numbers between reports, the area in dairy farming has certainly increased while the area used for sheep and beef farming has decreased (Ministry for Primary Industries, 2012).

It has been widely observed that the flatter land which was previously used for finishing lambs and calves, is the land which has now become attractive for dairy farming, and hence converted. This means that New Zealands pastoral hill country is now not only the main breeding ground for sheep and beef, but is increasingly relied on to finish stock for the red meat sector (Kerr, 2016).

This reduction in pastoral land available for sheep and beef farming has happened alongside a reduction in the total amount of sheep and beef stock run. Between 2005 and 2015, sheep stock numbers reduced by 26% while beef stock numbers reduced by 19% (Beef & Lamb New Zealand, 2016). Production in turn has also decreased, with beef production reduced by 7.5% and lamb production reduced by 8.1% between 2002 and 2009. However, the fact that meat production has reduced less than animal numbers indicates that production per animal has increased (Ministry for Primary Industries, 2012).

This suggests that sheep and beef farmers have become significantly more efficient in their ability to produce their end product. This is backed up by the fact that between the 2004/2005 year and the

2014/2015 year, lambing percentages, average lamb carcass weight, and lamb carcass weight per ewe all increased (see table 1) (Beef & Lamb New Zealand, 2016).

Table 1:

	04/05	14/15
Lambing Percentage	119%	127%
Average Lamb Weight (kg)	17.5	18.1
Lamb (kg/ewe)	16.4	19.5
Wool (kg/head)	5.5	5.2
Average Steer Wt (kg)	318	302
Milksolids (kg/cow)	308	377

(Beef & Lamb New Zealand, 2016)

It is important to note that the sources of this data are limited to information available which is classified quite broadly. Sheep and beef farms are becoming more dynamic and classes of land use are becoming blurred at times. For example many sheep and beef farms now have a portion of dairy grazing, making it difficult to know where to classify this dairy support activity. Due to this, it is difficult to determine specific measures which are more or less accurate at measuring intensification and productivity (Ministry for Primary Industries, 2012). The data available for analysis in this area tends to be very noisy, in particular as methods of collecting data and terms used change over time. Significant economic events or climate events such as droughts also need to be taken into consideration as they can have an impact on the 'noise' in the available data as well. The three main sources of information used to gather base statistics for this report are:

- Ministry for Primary Industries report: Pastoral Input Trends in New Zealand: A snapshot
- Ministry for Primary Industries: Situation and Outlook for Primary Industries 2016
- Beef and Lamb New Zealand: New Zealand Farm Facts Compendium 2016

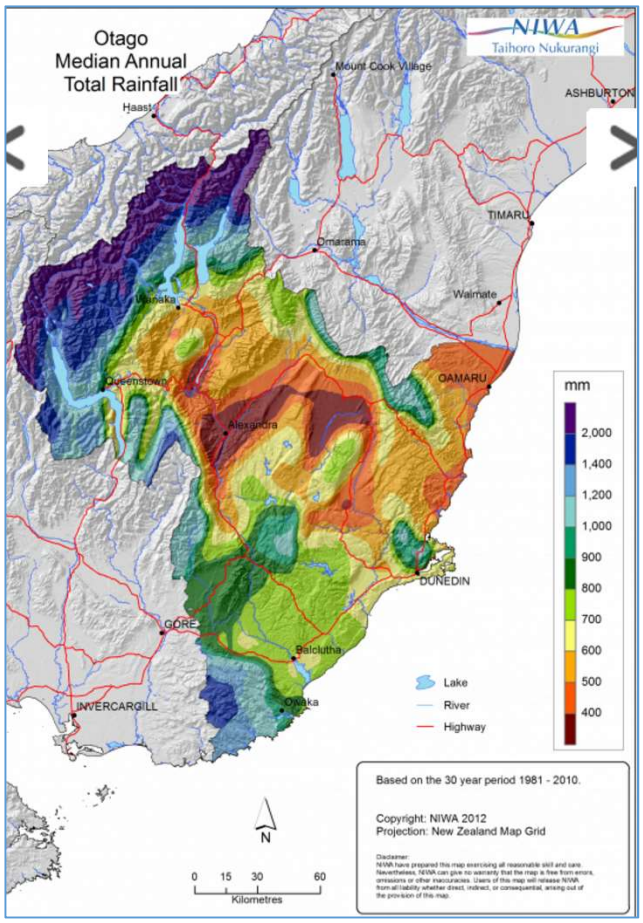
Sheep and beef farms in New Zealand are split into farm classes as detailed below:

Table 2:

Sheep and beef farm survey 2013-14 farm class			Estimated farms
1	South Island	High country	220
2	South Island	Hill country	850
3	North Island	Hard hill country	1,155
4	North Island	Hill country	4,020
5	North Island	Intensive finishing	1,490
6	South Island	Finishing breeding	2,657
7	South Island	Intensive finishing	1,306
8	South Island	Mixed finishing	592
Total all classes			**12,290**

2.2 Eastern Central Otago Sheep and Beef Farms

2.2.1 Classification of Area



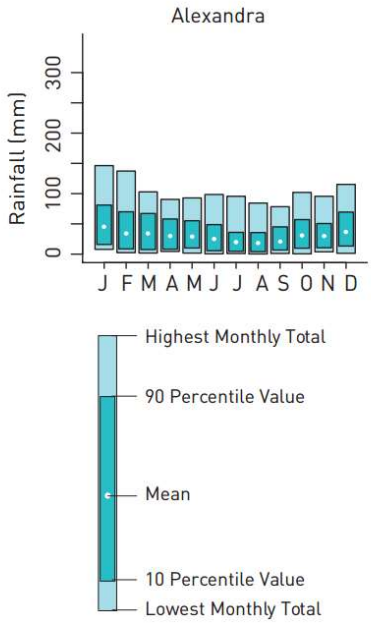
The area referred to as Central Otago in this report covers the area between Dunback, Middlemarch, the Maniototo, Ida Valley, Upper Manihericia and Alexandra areas. These areas have some variation in rainfall, as shown in the below map. While parts of the farms in this area may sit in the 700-800mm plus rainfall zones, it's important to note that these areas are generally high altitude cold country referred to as 'summer country' by many of those who farm it – meaning they will summer much of their breeding stock in this country as it is too cold to leave stock there in the winter. The majority of the engine room so to speak of these properties, is generally in rainfall zones of less than 600mm.

2.2.2 Climate of Eastern Central Otago

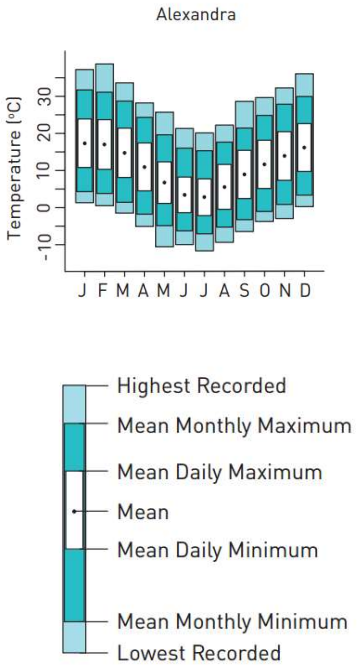
Table 3: Rainfall minimums, maximums and mean averages for Alexandra

Table 4: Temperature Maximums, minimums and mean averages for Alexandra

3:



4.



(Macara, 2015)

The below tables show the extremes between the coldest and highest temperatures experienced in the district. The areas of particular relevance to this report are Middlemarch, Ranfurly, Lauder and Alexandra, which are all within the studied area.

Table 5:

Table 16. Highest and lowest recorded air temperatures, average number of days per year where maximum air temperature exceeds 30°C and 25°C, and average number of days per year where the minimum air temperature falls below 0°C, for selected Otago locations from all available data.

Location	Highest recorded (°C)	Annual days max temp > 30°C	Annual days max temp > 25°C	Lowest recorded (°C)	Annual days min temp < 0°C
Alexandra	38.7	7	35	-11.7	86
Clyde	36.0	6	41	-9.8	93
Dunedin (Airport)	34.9	2	20	-8.8	66
Dunedin (Musselburgh)	35.7	0.6	7	-8.0	8
Lauder	35.0	3	33	-19.7	104
Middlemarch	36.0	4	33	-11.7	90
Nugget Point	33.0	0.1	3	-5.0	3
Oamaru (Airport)	37.7	0.9	11	-6.2	41
Queenstown	34.1	1	23	-12.2	47
Ranfurly	33.5	2	25	-25.6	118
Wanaka (Airport)	34.5	3	35	-8.6	73

(Macara, 2015)

Table 6:

Table 18. Frost occurrence and grass minimum temperatures at selected Otago locations.

Location		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alexandra	a	7.5	7.2	4.9	1.3	-1.9	-3.9	-4.6	-3.5	-1.2	1.2	3.7	6.6
	b	-4.3	-7.5	-7.8	-11.9	-13.9	-13.9	-14.4	-15.0	-11.9	-10.6	-7.8	-5.2
	c	1	1	4	11	19	25	27	24	17	11	5	1
	d	0	0	0.3	3	12	20	24	19	7	2	0.5	0
Dunedin (Musselburgh)	a	8.7	8.5	7.2	4.5	2.1	-0.1	-0.9	0.1	1.7	3.6	5.4	7.8
	b	-2.7	-2.6	-3.5	-5.5	-8.9	-10.1	-11.1	-9.0	-9.4	-6.5	-5.5	-2.8
	c	0.1	0.1	0.4	2	7	13	16	13	8	4	1	0.2
	d	0	0	0	0	0.4	2	3	2	0.3	0.1	0	0
Queenstown	a	6.3	6.2	4.4	1.9	-0.8	-3.1	-4.0	-2.9	-1.1	0.9	2.9	5.3
	b	-5.6	-4.4	-7.1	-8.7	-11.7	-12.6	-13.4	-12.6	-10.6	-8.0	-10.0	-6.0
	c	1	1	3	8	16	22	26	23	16	11	5	1
	d	0	0	0	0.1	4	13	16	10	2	0.1	0	0
Wanaka (Airport)	a	8.2	8.1	5.3	2.0	0.0	-2.4	-3.1	-2.2	0.0	1.9	3.9	6.7
	b	-5.0	-3.1	-3.8	-8.5	-11.0	-10.3	-10.7	-10.1	-10.2	-6.8	-5.5	-3.1
	c	0.3	1	2	7	13	20	22	20	13	8	4	1
	d	0	0	0.2	2	7	17	20	14	7	3	1	0.1

a: Mean daily grass minimum (°C)
b: Lowest grass minimum recorded (°C)
c: Mean number of ground frosts per month
d: Mean number of air frosts per month

(Macara, 2015)

Table 6 shows the high occurrence of frosts experienced in the Otago region (Alexandra being of particular relevance in this table. Table 7 below also shows soil temperatures over the year for the region. In this table Clyde and Ranfurly are of the most relevance, and show the soil temperature being well below the optimum levels for plant growth over the June-September period (McLaren & KC, 1996).

Table 7:

Table 17. Monthly and annual mean 9 a.m. earth temperatures (°C) at varying depths from the ground surface for selected Otago locations.

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Clyde													
10 cm	18.4	17.6	14.1	9.2	5.4	2.1	1.0	2.5	6.4	9.9	14.0	17.4	9.8
20 cm	20.2	19.8	16.1	10.9	6.6	3.1	1.7	3.5	7.5	11.4	15.6	18.9	11.3
30 cm	21.3	21.0	17.3	12.0	7.6	3.7	2.2	4.1	8.1	12.1	16.4	19.8	12.1
100 cm	18.9	19.4	17.7	14.3	10.6	7.0	4.5	5.1	7.8	10.8	14.3	17.2	12.3
Dunedin (Musselburgh)													
10 cm	15.7	15.3	13.3	10.4	7.7	5.3	4.2	5.2	7.5	9.9	12.4	14.5	10.1
20 cm	16.5	16.3	14.3	11.4	8.6	6.1	5.0	5.9	8.2	10.6	13.1	15.1	10.9
30 cm	17.6	17.1	14.9	11.8	8.5	6.3	5.0	6.0	8.7	11.3	14.0	15.9	11.4
50 cm	16.8	17.0	15.6	13.2	10.5	7.9	6.6	7.2	9.0	11.2	13.5	15.5	12.0
100 cm	15.8	16.3	15.5	13.7	11.5	9.3	7.8	7.8	9.0	10.7	12.7	14.4	12.0
Ranfurly													
10 cm	15.5	14.9	12.9	9.4	6.0	3.1	1.7	3.2	6.0	8.4	11.9	14.8	9.0
20 cm	16.3	16.1	14.2	10.7	7.3	4.1	2.5	4.0	6.6	9.1	12.3	15.2	9.9
50 cm	16.4	16.5	15.0	12.1	8.9	5.8	3.8	4.8	7.1	9.4	12.3	15.2	10.6
100 cm	15.2	15.8	15.0	13.1	10.6	7.8	5.7	5.7	7.1	8.9	11.2	13.6	10.8

(Macara, 2015)

2.2.3 Farm Systems

The extremes in climate in these systems, between low rainfall and low temperatures, means that high pasture growth rates can generally only be achieved in the shoulders of the season, Autumn and Spring. While irrigation can improve summer production, the high temperatures over this time mean evapotranspiration can exceed the amount of water that can be applied, meaning even under irrigation the climate limits pasture production compared to the temperate spring and autumn (Macara, 2015).

Farms in this area tend to vary their stocking policies and farm management depending on the amount of hill country they have in their system, as well as the amount of irrigation available and reliability of that irrigation. Farms with a large amount of hill country ('summer country' or 'run

blocks') tend to have a high proportion of breeding stock, and be largely store trade oriented breeding properties. Properties with less hill country and a higher portion of downlands tend to finish more stock themselves. This is similar to other parts of the country.

Many use Lucerne in their systems to provide lamb finishing or to cut for supplementary feeding over the winter. Almost all will use brassicas for wintering stock on, while many are now using fodder beet as a portion of their system. These properties rely on getting good winter crop yields and good lucerne yields to feed their stock over the winter, if their crops fail or they do not cut enough winter feed often their only alternative is to buy feed in, due to the very low growth rates experienced over the winter months. Generally they will try to have significantly more feed on hand than required over winter, to allow for snowfall events and summer dry.

Most of the farms surveyed for this project are class 6 farms: South Island Finishing-Breeding. These farms run 6-11 su/ha on dryland areas and 12 plus su/ha on irrigated areas. They often incorporate irrigation and cash cropping, and try to finish as much of their stock as possible (Beef and Lamb NZ, 2016). In this case, all of the farms surveyed had access to at least some irrigated country, although the reliability of the water and efficiency with which it is being used varied hugely.

There were also two Class 2 Farms surveyed for this project, classified as South Island Hill Country Farms. These farms are traditionally store stock producers who will carry between 2 and 7 stock units per ha. They generally have a significant portion of breeding cows (Beef and Lamb NZ, 2016).

2.2.4 Pasture Production

The biggest limiting factor on pasture production in the Central Otago region is climate, with cold soil temperatures restricting growth in the winter, and dry conditions restricting growth in the summer (Willis, 2014). Maximising growth rates at the shoulders of the season where temperature and moisture are not limiting is therefore key to pasture management on farms in this area.

Much work has already been done in this area, and it is well known that the following factors will lift pasture production:

- Correcting soil fertility to provide optimum Olsen P and pH levels
- Introduction of improved pasture.
- Introduction of legumes.
  (Kearney, Moot, & Pollock, 2010)
- Application of Nitrogen
- Application of water
  (Black & Murdoch, 2013)

Work done in 2003 at Lincoln showed that while unlimited water allowed cocksfoot pastures to produce 50% of their maximum yield, unlimited nitrogen supply allowed it to produce 72% of its potential yield (Mills, Moot, & McKenzie, 2006). This indicates that the combination of irrigation and nitrogen could produce over and above both of these yields, and also confirms the findings from previous research that nitrogen was the most limiting factor in cocksfoot pasture production over water (Peri, Moot, McNeil, Varella, & Lucas, 2002).

Pastures in the region are mainly made up of either ryegrass, cocksfoots or fescues as the dominant species, alongside a legume. Predominantly the legume will be white clover but sub clover and lucerne are also used in these mixes. Most farms which incorporate some hill area will have areas of native type pastures such as browntop and poa, as well as tussock area. Often this native and tussock area will be oversown with fertiliser and clover seed as finances allow.

2.2.5 Fertiliser

Fertiliser applications in the Central Otago region have tended to focus on phosphorus and sulphur (Fert Research, 2012). The amount spent on fertiliser varies a lot, mainly dependent on climate, cashflow, and the farmers policies and attitudes. Farmers tend to be happy to invest in fertiliser for cropping areas and heavily developed country such as that under irrigation, but fertiliser spend on dryland and hill country is often seen as discretionary spending despite the large portion of farms made up of this type of country (Jorneaux, Manning, & Roberts, 2013).

2.2.6 Nitrogen

It has been long acknowledged that the most limiting nutrient for growth in NZ pastures is Nitrogen. Large responses to nitrogen have been measured in a variety of crops and pastures both within NZ and internationally (McLaren & KC, 1996). Due to the production gains which could be achieved with nitrogen fertiliser, the use of nitrogen rose quickly from 1990 to 2004 across both dairy and sheep and beef farms (Ministry for Primary Industries, 2012). After 2004, two noteworthy things happened. Firstly, rising fertiliser prices across the board resulted in sheep and beef farmers reducing inputs. Secondly, in response to the significant rise in nitrogen application on sheep and beef farms since 1990, the Wise Use of Nitrogen programme was initiated in order to demonstrate how nitrogen could be used to improve profitability, while also minimising any possible harmful environmental effects (Lambert, Roberts, & Morton, 2007).

This programme involved 16 individual farms in a variety of locations throughout NZ, with rainfall ranging from 650-2200mm. This programme provides a useful background into best practice use of nitrogen on sheep and beef farms in NZ, and will be referred to frequently throughout this report.

In the Central Otago region, the use of nitrogen varies widely. In other parts of New Zealand it is more routinely used. In parts of the North Island nitrogen tends to be used in late autumn and winter – on the east coast of the North Island most nitrogen fertiliser is applied from May to July (Morton, Korte, Smith, Watt, & Smith, 1993) which is not realistic in the Central Otago region due to the low air and soil temperatures at this time (Macara, 2015).

2.2.7 Irrigation

The Central Otago Region has several irrigation schemes in place providing water to farmers. Schemes in the area studied are:

- Hawkdun Idaburn Irrigation Company Ltd – 3530ha irrigated – Open chanel
- Manuherikia Irrigation Co-Operative Society – 2300ha irrigated – Mainly open chanel
- Omakau Irrigation Company – 5842ha irrigated – Mainly Open Chanel
- Maniototo Irrigation Company – Mainly Open Chanel

There are also two proposed schemes currently going through feasibility studies at Waihemo/Shag River and Strath Taieri. These two proposed schemes are looking to increase reliability of existing water rights where farmers are presently consented to take water from rivers with low flow restrictions in place (Irrigation NZ, 2016).

All of the schemes in place in this area are currently mainly open chanel schemes. This means that they are less efficient users of water than if they were piped (The Ritso Society, 2007). Several of these schemes are currently undertaking feasibility studies around possible upgrades either by lifting dams (Hawkdun Idaburn, Strath Taieri, Waihemo/Shag River) or by piping an existing scheme (Manuherikia Irrigation Company) (Irrigation NZ, 2016). These changes could require farmers to sink significant investment into the schemes, which means the farmers involved in the respective schemes could have some big decisions to make in the future around investment in irrigation.

2.2.8 Characteristics of high performing farmers

The Red Meat Profit Partnership has done a significant amount of research into identifying drivers and characteristics of high performance farmers (ANZ, 2014). The following key attributes were determined as being common to top performing farmers in the red meat sector:

- Vision and drive – well defined personal and business goals.
- Having the right skill set and team, including using specialist advice as required.
- Above average execution of key farm management practices
- Passion and confidence in the sector which drives investment and effort.

  (ANZ, 2014)

Other farmers are often keen to learn about the practices which top performers carry out, but can lack the support to implement these practices once they have learnt about them (Red Meat Profit Partnership, 2015).

3.0 Methodology

To undertake this research, six farmers were deliberately selected who had some similar features in their systems, but used nitrogen in varying ways. In order to get a broader understanding of what good use of nitrogen and profitable farming systems look like in the Central Otago area, it was important that there was some similarities and differences between the farmers. All had purchased nitrogen of some description through either Ballance or Ravensdown in the past three financial years.

Interview questions were written to provide a framework for a semi structured interview. In order to gather some hard data around stocking rate, profitability and level of nitrogen use, some structured questions were used. These were paired with some less structured questions in order to get a deeper understanding around the decision making processes of the farmers involved.

The structured questions requiring numerical answers were asked for a three year period – for the 2013/2014 Financial Year through to the 2015/2016 financial year. The area being surveyed can experience extreme dry, resulting in very variable figures from year to year. Of the three years surveyed, an extremely dry year and a comparatively wet year are included. This allows some figures to be averaged to make them more comparable.

All farmers were contacted by phone to gauge their initial interest in taking part, and this was followed up by an email providing a more structured brief as well as the questions which would be asked. This was done in order to give them time to collect some of the information required (for example the financial figures) as well as to give them an idea of the level of information required. All were advised that the amount of nitrogen they were using was not important, but rather their drivers for using or not using nitrogen in their farming system.

Interviews were conducted at the homes of the farmers, sometimes with husband and wife, and sometimes with one or the other depending on availability. These ranged in time from one hour to two and a half hours, and were digitally recorded.

Analysis of each interview was conducted. Firstly, a summary of the farming system and figures was drawn up, followed by the figures for each farm being compared against each other. Alongside the benchmarking of financial information, key information derived around the motivation of each farmer was summarised, so that common themes could be examined.

4.0 Findings and Discussion

4.1 Farm Description

All of the farms surveyed were sheep and beef farms. All had a portion of breeding ewes, with some finishing all of their lambs but all finishing at least some. Some also had some breeding cows while some ran only trade cattle. Some farms included a portion of dairy grazing. The total stocking rate run varied from approximately 6500su to 13000su. Most farms fit loosely into the Class 6 category of South Island Finishing-Breeding properties, with two more closely aligned as Class 2, South Island Hill Country farms.

The total size of properties ranged from approximately 1030ha to 2900ha. Effective areas are very difficult to work out for some of the properties involved. Some treated their properties as completely effective simply because it was too hard to estimate effective area due to rocks, faces, scrub and gullies within paddocks. For the sake of this report some assumptions have been made around effective area. The topography of properties also varied a lot. There were three properties which the farmers described as being flat to rolling, two which had an area of hill country alongside an area of flats, and two that were mainly hilly including some steeper hill country with a small portion of flatter cultivatable country.

All had a sub 700mm annual rainfall (based on Niwa 30 year averages in Overseer) the highest being 698mm and the lowest being 345mm annually. The average temperature annually also ranged slightly from 8 to 9.9 degrees Celsius. Actual year to year data varies a lot as discussed earlier in the report.

All of the farmers surveyed commented that one of the last two years had been challenging due to dry conditions, for some of these farmers both the 14/15 and 15/16 years presented the challenge of lower than average annual rainfall.

Of the farmers surveyed, three had invested significantly in irrigation development in the last three years. All of the farmers had undertaken some kind of development, be it expanding their area of improved pasture, irrigation development or investment into fencing, water schemes and fertiliser. This indicated their significant confidence in sector outlook going forward.

Every farm surveyed had an area of cropping included. Crops were mainly for winter feeding but there were some summer finishing crops included as well. All farms had a portion of lucerne included in their system, and all had access to some irrigation even if it was only a small amount of wild flood irrigation. The percentage of effective area irrigated varied from 2% to 30%. All were using a variety of pasture mixes, and those with spray irrigation were using different pasture species and mixes under irrigation to what they used on their dryland. All the farms surveyed cut their own

winter supplement on farm either as baleage or silage, and some have purchased further supplementary feed either as baleage or grain as required in dry years.

All of the farms involved were run by a husband and wife partnership, and were owner operated. Some had other family members who still had financial interest in the business. All owned the majority of their properties, while three of the six included some leased land in their total area.

4.2 Financial Performance

Farmers provided their Gross Farm Surplus and farm working expenses figures to allow us to calculate and analyse their economic farm surplus over the previous three years. It was expected that these figures would be relatively simple for farmers to provide, given that they all had a copy of their statement of financial performance provided to them by their accountant annually. It became apparent very early on that very few farmers involved in this survey were confident in the figures presented in their annual accounts and were not entirely confident navigating through the publications to find the figures requested for this survey. A lot of this was due to variation between language used by different accountants, banks and cash management programmes. Those who provided figures from their own budgets (for example Zero, figured, cash manager) tended to be comfortable finding their way around these figures, but were not entirely confident translating that to the figures provided by their accountant.

When asked how they benchmarked their financial performance, the majority of participants did not do any formal financial benchmarking other than to compare their own financial performance from year to year:

"Do we benchmark? No we don't, because we don't know where we are to be able to."

Three of the farmers surveyed commented that their accountant did provide some basic benchmarking in the form of putting out a report summarising the average and top 10% of farmers' financial performance for their area (ICL Farm survey), but found that it was difficult to compare their own businesses to the average because if their own way of accounting for different expenses didn't match up with the 'average' it made it less relevant. They also found it difficult to work out which category their farms should fit into with the huge variety between systems in the area. Some also wanted to know that they were comparing their businesses to other businesses who were undergoing development. They didn't want to be comparing their businesses to those who had comparatively low debt and were 'in cruise mode'.

Two farmers surveyed were participants in the Red Meat Profit Partnership programme, and one had been provided with some benchmarking through this. This was the only business which had

benchmarked formally. Even with the help of a consultant to do this, they made the comment that they weren't sure how some of the numbers had been formulated. They understood that there was probably a reason the consultant had altered the numbers from what they knew, but did not understand exactly what had been done which reduced some of the value of the benchmarking. Another participant had had his farm benchmarked through a trial he was involved in with a meat company, but this benchmarking had been nationwide which he again felt made it less relevant.

Despite this, most of the farmers interviewed still indicated an interest in being able to benchmark their financial performance, but the difficulties mentioned above were enough to have stopped them doing it previously. This indicates a willingness to learn about the practice, but that it was something they found difficult to execute – one of the points noted by the Red Meat Profit Partnership research discussed earlier.

Scanning and tailing percentages as well as number of ewes run were common figures that all of the farmers involved used to benchmark their own performance from year to year. All were wanting to beat their own performance from the previous year. None of the farmers mentioned any specific financial goals, other than that they wanted to improve their own performance year on year.

One farmer made the comment that:

"Previously we were wanting to increase number of ewes to improve performance but now we are changing to a kgs of lambs per ha focus – previously we were having lots of lambs born but then were unable to finish them."

This idea of producing more kgs of product or head of animals more efficiently was a common theme, but when farmers talked about producing more they didn't tend to link it directly to a higher financial performance. The common theme was constant improvement, all wanted to do better year on year, but some seemed uncertain about how best to judge and measure that.

Not understanding how their farm class compared to other farms was a common theme in all interviews. It was mentioned several times that people were uncertain how to categorise their farms, and then how comparable they would be to the other farms used in the farm survey data provided. One farmer also mentioned that it was hard to say wether the farms that were being used for comparison were developing and growing their businesses or not. Several farmers mentioned that the fact they were doing significant development made them uncertain how comparable benchmarking information was. Some had also 'hidden' capital expenditure amongst repairs and maintenance, making their figures on paper look significantly different to reality.

4.3 The million dollar question

As part of the survey participants were asked “if $1 million dollars was injected into your business tomorrow, what would you change in your system”. All participants mentioned further development in the answer to this question. For some this was development of native country, for some it was increasing the area they had in newer pastures or Lucerne, while for others it was further irrigation development to improve storage or water use efficiency. One wanted to expand by buying more land. Three participants mentioned debt reduction in their answer, but all of these then mentioned that this would allow them leverage to further develop in one area or another.

It became apparent that for all of the participants a cash injection like this would enable them to do something which they were aiming to do at some point anyway. One participant said that a cash injection like this would allow him to put another pivot on, completing the development which he has earmarked for a particular project. With some further questioning he mentioned this as already being ‘in the five year plan’.

4.4 Feed Budgeting

Participants were asked a series of questions about feed budgeting to determine their understanding of feed supply and demand and see how they related this to nitrogen use. None of the participants did formal feed budgeting such as in Farmax or Excel.

Three of the six did do a winter feed budget on paper. This was generally as simple as working out feed that they would have on hand at predicted crop yields, then working backwards with an allowance for different stock per head per day for however many days to ensure that all stock would be fully fed for the winter period. All had a target of how much pit silage or how many bales of baleage they would like to have on hand for winter. Most tried to be storing more feed than required each season, so that in the event of a particularly dry summer, or a snowfall event they would not be caught short. However after two dry years many of these stocks were run down with farmers hoping to get good yields this season and build stocks back up. Most had some grain stored on hand for adverse events like this as well, which might sit in a silo for a couple of years but was there if required.

When asked to identify when their main feed pinch was, all farmers identified early spring as being a tight time of the year for feed. For some this was every year, for others it was only sometimes but they all mentioned it. Some also mentioned that the increasing use of fodder beet in their systems was allowing them to keep trading stock on crop for longer to allow more breathing space for set stocking ewes onto grass. In addition to the early spring period, other tight times of the year mentioned were just before weaning, due to lambs eating increased pasture as well as the

summer/autumn period if conditions were dry. This varied a little bit depending on the system, with those with higher finishing numbers being more likely to mention this autumn pinch as they were trying to finish stock and tup ewes at the same time. Because both the finishing stock and the ewes at tupping need quality feed, this was made even harder if the season was dry.

Target pasture covers at set stocking showed quite a split in practices. Three participants were aiming for covers between 1500kgDM/ha and 2000kgDM/ha, and the other three participants were targeting “whatever is there” or “no particular target”. Of the farmers who had particular set stocking targets in mind, all said that they don’t always hit the targets they had in mind, but more often than not they did. Of these three participants, one was using plate metering to measure covers. One was using cages to do pasture cuts and get a grasp of how different paddocks were performing. This participant made comment that they had been astounded at the difference between paddocks, with one new grass paddock they measured having growth rates ten times higher than what they thought was quite a good older paddock. Notably, these three participants also had the highest average EFS/SU across the three years surveyed, and two were the top two performers for EFS/Ha as well with the third dropping only slightly one a per hectare basis.

Of the farmers who did not have any particular targets for set stocking, all had some way of managing feed available to allow them to still feed stock the best they could. One mentioned that basically the more feed there was on hand the less they used break fences. Another noted that he simply varied stocking rates across paddocks depending on levels of feed available. One tended to alter the date stock started on crop depending on supply. While its likely they all used a combination of these management practices, they were all able to pick one practice they relied on to ensure they could feed stock adequately at set stocking. It should be noted that all of the farmers in this survey had lambing percentages which are average or above average for the same farm class for the area.

When asked for comments around decision making when using nitrogen in respect to feeding levels, participants mentioned the following key factors:

- Wanting to keep grass in front and essentially create surplus (3)
- Animal condition (2)
- Faster growth in shorter time (1)
- Climate/Environmental factor (2)
- Maintaining flexibility (1)

Those who had an element of trading stock also all mentioned the flexibility and buffer that this gave them somewhere during our interview even if it was not directly linked to feed budgeting. One participant described his system as:

"*Stocking policy is basically flexibility with trading, and not stocked to the hilt"*

And also mentioned that

"The hill is our buffer"

Three of the farms surveyed had an area of native or hill country which was generally used to carry breeding stock during times of the year where they weren't such a priority (for example ewes post weaning). One participant made comment that it was particularly difficult to predict growth rates on their native and even developed hill country, making feed budgeting difficult. Another noted that things could change very quickly in this country where the less developed pastures slowed down faster and then took longer to get going again coming out of a dry spell.

4.5 Environmental Regulation

A semi structured question around environmental regulation was asked at all interviews, to get an idea of whether this was a factor in farmers' decision making around use of nitrogen. The one strong theme in participants' answers was that they all without hesitation said in one way or another that looking after the environment was important to them. Several mentioned the importance of leaving things in a better state for the next generation. All felt that it was important that they farmed 'sustainably', and took a long term view of what this meant to them:

"It's important that we farm sustainably, as we are only a tenant here really"

"Everyone wants good water quality! The media just paints a bad picture and gives farmers a bad rap"

"Some of the regulations are a bit over the top, but there needs to be some there to stop the cowboys"

All of the participants linked environmental regulation to water quality or efficiency. Two mentioned that they felt the media were responsible for giving nitrogen a bad rap. Several had actively tried to enhance waterways on their properties by fencing and adopting stocking policies to minimise damage to waterways. One was involved in water quality monitoring for one of the streams running through their property. It is important to note that all of this has been done voluntarily, and none of the farmers interviewed had been forced by regulatory bodies to take any of the actions they had to improve the environment.

"We try to look after the water ways we have, we are just trying to do the right thing"

Two of the farmers noted that there seemed to be some confusion around definition of a water way. They were concerned that waterways which only existed due to flood irrigation would now be 'protected' as waterways, but would disappear as irrigation was changed from flood to spray to improve water use efficiency.

Several participants also made the connection that there were a few poor operators doing damage to waterways who gave the rest a bad name. They suggested that environmental regulation was required to ensure that people not farming to best practice were forced to improve their practices to meet the rest of the industry.

When asked what would stop them from using nitrogen, three participants mentioned that they would stop if Overseer or environmental regulation stopped them from doing so.

4.6 Nitrogen Use

4.6.1 Nitrogen use on Sheep and Beef Farms

All of the participants in this study had used nitrogen fertiliser at some point. Over the three years studied, use varied from an average of 1kgN/ha/yr to 15kgN/ha/yr. Most nitrogen was applied in the form of Di-Ammonium Phosphate (DAP) or Urea, with some also utilising Sulphate Of Ammonia (SOA). Several were utilising new technology available such as Agrotain coated urea to improve the efficiency of nitrogen use. All participants used nitrogen on cropped ground, but not all of them used it on grazed pasture area. Those who did use nitrogen on pasture tended to use it on newer pastures and developed areas rather than on undeveloped native areas. See the summary of average N use per ha over the years 2013-2015 below.

Table 8:

Farm	Av Effective Ha	Av N Use/ha
1	2912.5	9.6
2	1406.7	8.4
3	1788.0	1.0
4	2650.5	6.6
5	1000.0	15.7
6	1290.0	1.6

Nitrogen on pasture tended to be used mainly in the spring, between August and October. Some participants had also used nitrogen on pasture in the autumn to rebuild feed covers after a dry

period. All participants who used N on pasture noted that while there was usually a specific time of the year that they targeted to apply nitrogen, sometimes it wasn't possible due to climatic conditions. For example two had wanted to apply autumn nitrogen in the autumn of 15/16 however they wanted it to rain before they applied, and by the time it rained the ground temperature was too cold and they felt they couldn't justify applying. Another had been slightly put off using nitrogen after applying pre lambing when soil temperatures were too cold still and as a result felt he got little to no response. Climate was one of the major factors influencing participant's decisions to use or not use nitrogen. It was also one of the major factors influencing their timing of applications of nitrogen. For some this was mitigated by the availability of irrigation to ensure nitrogen was watered in on parts of their farm.

All but one participant used DAP based fertiliser to establish crops and new pastures. Typically rates varied from 100-250kg/ha of a DAP based product at drilling. Some participants also applied nitrogen as urea to crops post emergence at least once, sometimes twice. Some did not apply any post emergence nitrogen to crops, and some were selective about which crops got nitrogen and which ones didn't. The higher yielding crops such as fodder beet tended to have one or two applications of post emergence nitrogen while lower yielding crops such as turnips might not get any. This tended to have been routine on all of these farms for many years, and a couple of farmers commented that their understanding of how nitrogen improved yields on crops made it not a big step to start using nitrogen on pasture. Again, crops grown under irrigation tended to have higher nitrogen rates than those in dryland as the farmers were more confident that they would be able to provide moisture in order to get a good response to the product applied.

All the participants seemed to have a grasp on the importance of finding a balance between waiting for climatic conditions to allow pasture to respond well to nitrogen, and getting nitrogen applied early enough that it creates the valuable feed they are looking for. While some had experienced what happens when they got it wrong, they all had appreciation for how well it could work as well as the associated risks. One commented that his go to feed was probably grain rather than to apply nitrogen, because there was no risk of no response with grain – he got exactly what he paid for in terms of kgs of dry matter. However in an early spring feed pinch, driving around the farm with a grain buggy was a certain way to upset things in set stocked paddocks making him appreciate the advantages of nitrogen use as well.

4.6.2 Nitrogen use and Climate

The next table shows the difference in average rainfall and temperature across the 6 farms surveyed. This is based on NIWAs 30 year average information obtained from the Overseer Climate Tool:

Table 9:

Farm	Av Effective Ha	Av Rainfall	Av Temp	Av Irrigated Area	% Area Irrigated
1	2912.5	698	8	200.0	6.9
2	1406.7	587	8.9	293.3	20.9
3	1788.0	670	8.6	40.0	2.2
4	2650.5	516	9.9	160.0	6.0
5	1000.0	474	9	210.0	21.0
6	1290.0	345	9.2	379.3	29.4

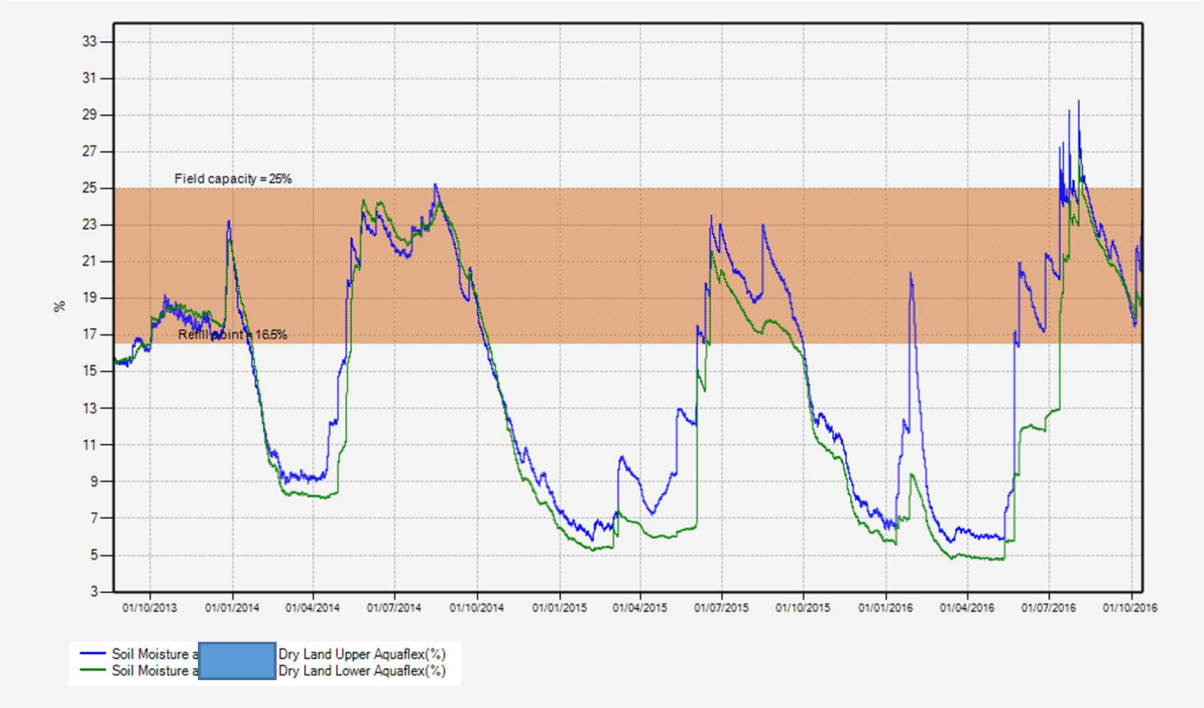
Tables 3 and 4 in the literature review section also show the wide variation which can occur in terms of the spread of rainfall and annual total amount of rainfall.

The low total amounts of rainfall and variation between seasons can make pasture growth rates vary widely over the season. One corporate farm located in the studied area provided the author with their feed budget in order to give an idea of growth rate variation over the season. They budgeted on growth rates varying from 0kgDM/ha/day over parts of the winter, through to growth rates over 60kgDM/ha/day at the peak of their growing season. Over the summer of 2015/2016 their actual pasture growth rates measured on improved dryland pasture were as low as 1kgDM/ha/day due to dry conditions, whereas in February 2016 after some rainfall was received actual measured pasture growth rates for the same area were up to 33kgDM/ha/day.

Nitrogen works as a growth multiplier. At times of the year where pasture growth rates are restricted due to lack of moisture or adequate temperature the response gained from using nitrogen is also limited. This means that in order to use nitrogen to maximise pasture production in the times of the year where pasture growth rates are high, farmers in this area need to make the decision to use nitrogen before moisture becomes a limiting factor. This can be as early as October/November as seen in the moisture readings below. Given how early moisture can become a limiting factor, the time where farmers want to be getting a response to nitrogen applications is when they have ewes set stocked and don't want trucks driving around paddocks applying nitrogen. However in order to

apply nitrogen outside of this set stocking period, but still have adequate soil moisture to get a good response, they need to make the decision to apply before set stocking. However they also need the soil temperature warm enough to get a response – which can be challenging in the late august/early September period.

Figure 2: Soil Moisture trends on dryland in Central Otago



None of the farmers interviewed were using formal feed budgeting for this time of the year. Several measured their pasture production. They tended to vary the rate which paddocks were set stocked at depending on the covers available at the time of set stocking, but this can change quickly when some paddocks vastly outperform others once growth kicks off in the spring. A common theme when survey participants talked about use of nitrogen in the spring was uncertainty around response under less than perfect conditions. Some who had quite a bit of history using it were quite comfortable to use it in the spring, but still recognised that the response could vary. Those who had used it and got less response than expected in the past seemed to have been slightly put off. An indicator of the caution by all farmers around nitrogen use at cooler times of the year was the fact that while all of those interviewed had used nitrogen on irrigated areas, they wouldn't necessarily use it on dryland areas at the same time. Some said this was because they didn't need the extra feed – they would only apply on dryland if they were short of feed. However even if they didn't need the extra feed and didn't apply on dryland, they would still apply nitrogen on their irrigated areas to use later for trading stock or cutting supplement.

4.6.3 Nitrogen use and Farm Systems

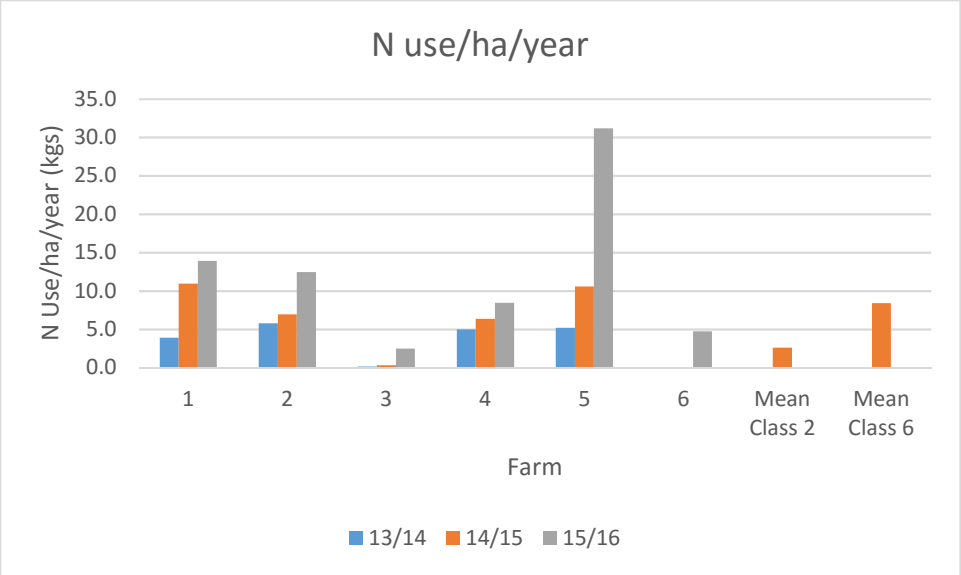
There were some similarities and some differences between the farm systems examined in this report. All the farms had a portion of breeding ewes, and some also had breeding cows. One had dairy cows and heifers grazed on contract. All had some irrigation, and all were trying to finish as many of their own lambs as possible. Half of the farms were also finishing some trading stock on top of finishing their own lambs and some also finished their own calves while some sold their calves store.

Several of the farms involved had dropped their breeding ewe and/or cow numbers in the previous three years due to dry conditions. Only two farms were looking to build these back up, while the others involved were looking to use their finishing and/or trading stock as their buffer for future adverse weather events. Several of the farms involved had already used nitrogen as another buffer in their system in order to maximise pasture production. Most commonly this was in the form of applying nitrogen either early in the spring to try and increase early season pasture production. It was also common for some farmers to apply nitrogen in the autumn to help pastures to recover from drought conditions.

The forms of nitrogen used on all farms were predominantly DAP based products (in particular for cropping) and urea based products. Some nitrogen in the form of SOA was being used on some farms. It is worth noting that the majority of the farms involved were using some of the newer nitrogen technology available such as agrotain coated urea or DAP with boron included in the granule for cropping.

Across all farms, nitrogen use had increased over the past three years as demonstrated in the below graph. Note data was unavailable for the average Class 2 and Class 6 farm in the 13/14 and 15/16 years.

Figure 3: Nitrogen use per ha per year



This increased use of nitrogen can be contributed to a mixture of increased cropping inputs and increased pasture inputs over the past three years. Farms three and six have gone from using no nitrogen at all to using some in a combination of cropping and pastoral use within the time frame studied.

4.6.4 Motivation to use Nitrogen

For some of the farmers surveyed their use or non-use of nitrogen was historic – one made comment that his father had never used nitrogen which was why he never had. One made comment that his father had always used nitrogen which had played a large part in why he had. For several of the other farmers surveyed, they had made a conscious decision to start using more nitrogen on pasture in the past five years. While most of those surveyed had used it on crops, the use of it on pasture had previously been extremely discretionary due to cost.

The highest users of nitrogen had been involved in trials or discussion groups where the use of nitrogen had been examined closely to observe the benefits of nitrogen use in terms of pasture production. One noted that he had been involved in a local discussion group who had set up their own trials for nitrogen response and concluded that the best responses were seen when nitrogen was not applied any later than march. He now will not apply any nitrogen later than this.

For the farmers involved who had increased their nitrogen use on pasture in recent years, there was generally a trigger that had prompted them to begin using it. One farmer had lost a large amount of new grass to porina and grass grub, which left him relying on a much smaller area for his spring feed. He had previously always used nitrogen on crops, so understood basically how it worked. This made taking the step to using nitrogen on pasture to fill his unexpected feed deficit an obvious choice in

his mind. Another stepped up use of nitrogen after purchasing a new property with superior irrigation allowed him more certainty around water application and hence around nitrogen response. This variable certainty of response was a factor which was common to all of the interviews conducted.

Several of the participants also made note of the fact that clover root weevil has hit central Otago in the past 3 seasons. When the impact this was having on pasture production was made apparent, they looked for strategies to make up for the shortfall in pasture production. Adding nitrogen to their system as fertiliser was an obvious choice, and one which was promoted by those advising farmers on how to deal with the clover root weevil.

Often participants used nitrogen on pasture for a specific purpose, such as to boost covers before or after cutting supplement. This seemed to give them a more quantifiable outcome than using it on pasture for stock consumption. Several participants commented that it was difficult to see the pasture growth result gained from applying nitrogen for early spring grazing. They mentioned that what they applied in the early spring was really to get results at weaning time, however they couldn't be specific around this. This lines up with various trials conducted under the National Wise Use of Nitrogen project which suggested that some of the effects on animal performance were indirect such as improved ewe Body Condition Score (BCS) at weaning, and a heavier stocking rate/ha allowing more lambs weaned/ha rather than lambs being significantly heavier. One farmer made the point that even if nitrogen application didn't result in getting significantly more lambs for slaughter at weaning time, it would result in a better supply of feed at this time allowing them more options for feeding newly weaned lambs.

Several participants also mentioned animal condition when discussing their motivation to use or not use nitrogen. Those who had mentioned that keeping feed in front of them in the rotation was a driver tended to also link this to animal condition.

One participant made comment that

"Things need to be going well for us to use it"

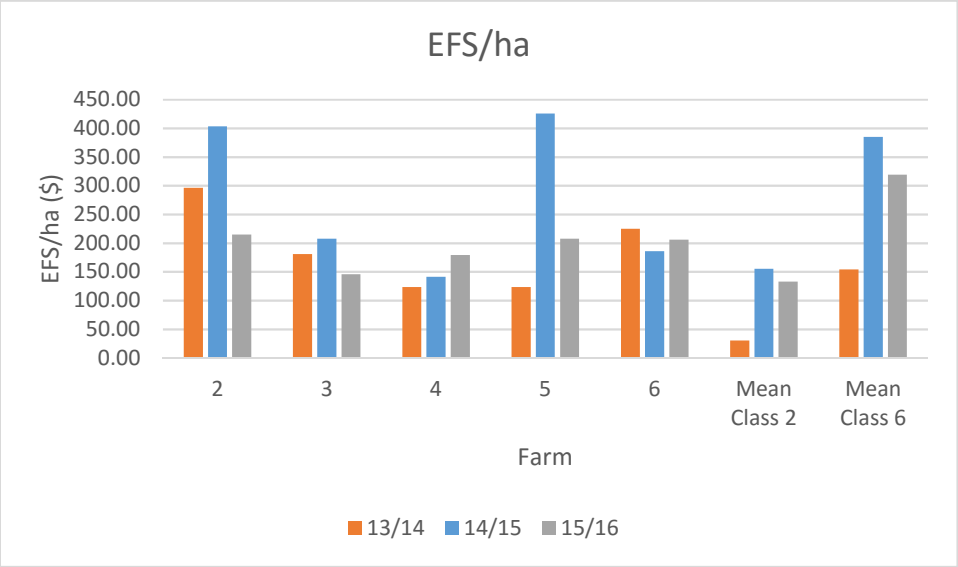
This was in terms of climatic conditions lining up to provide a good response, but also that financially things need to be looking good. Talk around cost was consistent throughout the interviews. All mentioned that if costs significantly jumped up, this would discourage them from using nitrogen. However they all also said that to use it they needed to be in a good space financially even if nitrogen prices were low.

4.6.5 Nitrogen Use and Profitability

Participants were asked to provide their Gross Farm Surplus, working expenses, standing charges and admin fees to allow the author to calculate an indicative Economic Farm Surplus per ha. Note this is not a true EFS because it does not include depreciation, rent or interest. These three variables were left out to try and reduce variation between the numbers produced.

The figures were broken down into a per effective hectare and a per stock unit figure to make them more comparable again. The same general trends showed up regardless of whether the per stock unit or per hectare figures were used.

These figures were examined year by year, as well as on average over the 3 years examined. The below graph shows the EFS/ha for each farm as well as for the average Class 2 and Class 6 farm for the examined years.



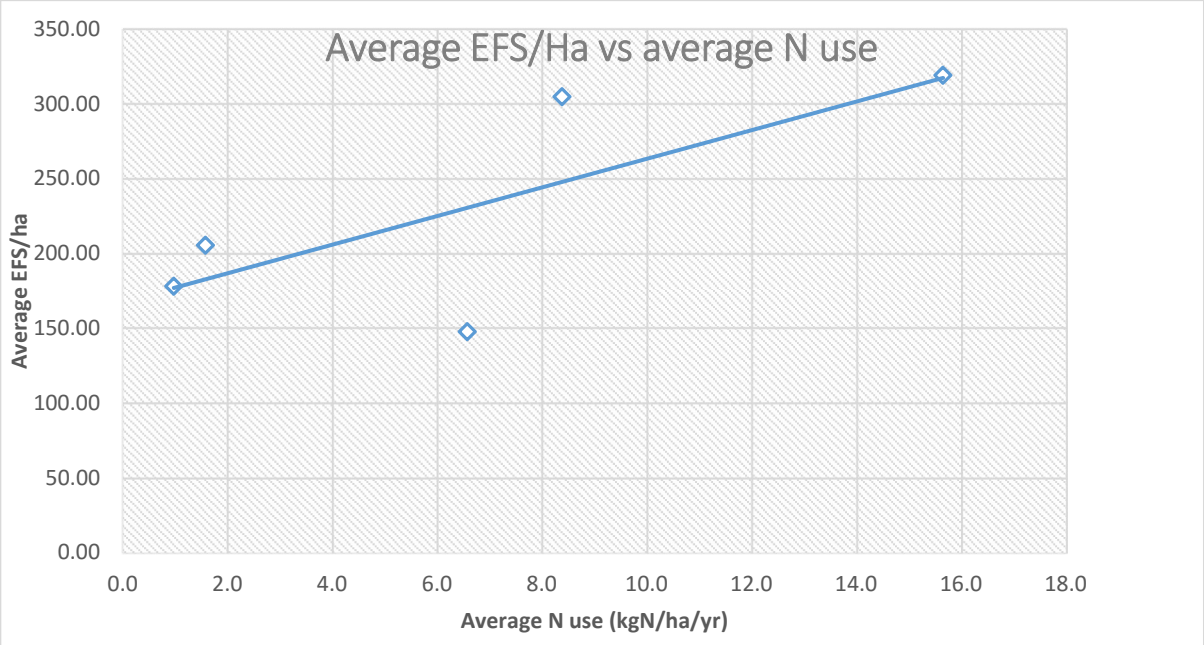
This shows quite a bit of variation in performance between years and between farms. The main outlier is farm 1 which aligns more closely as a Class 2 system. In the 2014/2015 year this farm had a significant area of failed crop which had to be re-drilled and so incurred significant extra working expenses from extra seed and fertiliser. On top of this, they also had an extremely dry year in the 14/15 and 15/16 years and their water on their small irrigated area is reasonably unreliable. For this reason this data has been left out of this table.

If average farm performance is examined over the three years, farm 5 has the highest average EFS. However this graph shows that this is mainly due to the 14/15 season being a particularly good one for them – when their figures are examined it shows that they had significantly lower working expenses this year than in previous years. This could indicate that less has been spent on a significant cost eg cutting out maintenance phosphorus fertiliser.

When comparing the surveyed farms to the Mean for Class 2 and Class 6 farms, it is difficult to decide which farms belong in which class, as pointed out by several farmers. When initially analysing this data, the author had picked that farms one and three would be the only ones which would fit the Class 2 category. However, all of these farms were difficult to class into either group. All had a portion of finishing and highly developed area which made them seem like they should be classified as Class 6 (finisher breeder). However, these farms are typically smaller than those examined in this report, and don't have the portion of hill or native country that a lot of these farms had. As the report progressed, it became apparent to the author that the only farms which truly fitted in the Class 6 category were farms two and five while the rest were better aligned as Class 2 with their larger areas of undeveloped or hill country. This alignment shows above, where generally the farms classified as Class 2 (farms one, two four and six) have performed better than the average Class 2 farm (bar our outlier, farm one).

On average, there did not seem to be a direct relationship between average N/ha/year and average EFS/ha/year as shown in the graph below:

Figure 4: Average EFS/ha vs Average Nitrogen Use



However, with the outlier is removed, there does look to be a very loose correlation between increasing Nitrogen use and Increased EFS. With the outlier removed, the two highest average EFS farms also have the two highest nitrogen use figures. While this is not statistically significant, it indicates that if nitrogen is used well, increased use of it could correlate with increased profitability.

One thing that was consistent was that the highest financial performers (averaged over three years) did have the highest numbers of trading stock, allowing them more flexibility. Having trading stock allowed a bigger buffer in their system for adverse weather events. These farmers all made note of having a 'buffer' class of stock and being able to prioritise different stock classes at different times of the year depending on climate and growth conditions.

4.6.6 Profitability, Benchmarking and Measuring

It was predicted that those farmers who benchmarked, measured and budgeted more would be those who made better use of nitrogen inputs and were more profitable. Of the 3 top performers, two had set targets around feeding levels which they aimed to meet at critical times of the year. One utilised financial benchmarking performed for them by their accountant, but doubted its accuracy. Another had benchmarking done for them through a group they were involved in but struggled to understand some of the figures which reduced its value. None of the farmers surveyed did formal feed budgeting, although of the top three financial performers one did do a winter feed budget on paper. The remaining two of the three were aware of how much supplement they needed to have on hand to get through a winter although this tended to be something they simply worked out in their heads.

Most of the farmers surveyed indicated that benchmarking was something they were interested in doing, but found difficult to do. The majority cited their main reason for this as not knowing how to classify their farm, or how comparable the numbers produced for benchmarking would be. Some were very open about their financial figures and said they had compared figures with friends but in this case the figures they had to compare against were limited.

5.0 Recommendations

There is no one size fits all answer when it comes to improving how Central Otago sheep and beef farmers utilise nitrogen on farm. There are varying levels of current use, and the farmers interviewed for this report had all increased their nitrogen use over the past three years. Utilising nitrogen well in the future will require some behavioural change and changes in pasture management which farmers will need to be coached through if they are to use nitrogen efficiently and profitably.

5.1 Triggers for using nitrogen

Those farmers involved in this study who had started to use nitrogen on pasture or increased amounts of nitrogen in the past three years often mentioned that they had been triggered to use nitrogen by an event. This could be a drought, invasion of a pest (clover root weevil) or similar. In order to ensure that these farmers see good benefit from their first use of nitrogen, it is important

that those involved in advising them anticipate some of these triggers. This will help them decide on a solution which works best for their business in good time, so that they are acting proactively rather than reactively. A good example of this is the clover root weevil example where those advising on how to combat the issue also provided sound advice around how to use nitrogen.

5.2 Levels of use

The use of nitrogen on sheep and beef farms in Central Otago appears to have increased in the past 3 years based on the farmers surveyed. The levels of nitrogen being applied on pasture and crops by the farmers surveyed were unlikely to cause any environmental issues and could be continued with into the future quite sustainably. The author is not advocating that nitrogen use should increase dramatically on pasture to the levels used in the dairy industry. Rather sheep and beef farmers should be prepared to use nitrogen at low to medium application rates (between 20 and 45kgN/ha at a time) strategically in order to maximise their pasture production and in turn their profitability going forward.

As discussed, nitrogen and irrigation together will provide higher pasture production levels on a cocksfoot based pasture than one or the other. Where available, farmers may benefit from concentrating nitrogen use little and often on these areas.

5.3 Implementation and execution

Once a farmer has decided to use nitrogen, it is important that their first experience is a good one. As most are not in a habit of measuring or monitoring, it is important that those around them help them to make the most of their nitrogen applications. This might be a role for a fertiliser company representative, consultant or seed merchant. It is important that farmers make the link between the nitrogen they apply, how to ensure the best results, what to do with the extra pasture or crop production. In turn they then need to link this to tangible results such as improved body condition score at weaning or a higher portion of lambs able to go to slaughter at weaning. It might be as simple as helping them to measure pasture covers at set stocking to give them an understanding of actually how much feed is on hand.

5.4 Having a Buffer

Those who had the best average financial performance had high levels of flexibility in their stock policy, generally in the form of trading stock. Using nitrogen was also mentioned as a way of being able to buffer feed levels. Having both of these two factors meant significantly more ‘buffering capacity’ when adverse events occur. Being able to sell trade stock as well as use nitrogen (either under irrigation or once rain occurs) gives the capacity to turn a farms feed position around very quickly in the event of a drought. Those who had maintained or reduced breeding ewe numbers in

favour of introducing a trading element (or a higher finishing element) tended to have more profitable businesses. While having a trading element is not the silver bullet, it is something which needs to be considered carefully by more farmers, with the help of advisors.

5.5 Measuring and Monitoring

In order to capture more profit from their farming systems, it is essential that farmers begin to measure monitor and benchmark more in order to set themselves targets. This would allow the passion and confidence that these farmers show to be implemented better and in ways which would be more profitable for their businesses, as discussed in this report. They are surely missing out on key triggers for change by not having benchmarks for their financial performance and pasture production.

5.6 The role of advisors

The farmers in this survey utilised a variety of advisors in their businesses. Some had utilised consultants well, or had been provided with consultants through industry good programmes. Some had found consultants not that useful, but relied more heavily on advice from other parties such as their seed and fertiliser advisors or their accountants and bankers. Most of the participants struggled with understanding some of the figures provided to them by accountants. There would be parts that they had a good grasp of, but some parts which they found harder to interpret.

Advisors to these farmers need to be able to help them to understand their figures in order for them to be more confident and able to set financial targets for themselves. Once they understand their own figures and business better they will be more likely to benchmark themselves against others, and will have a better understanding of how comparative benchmarking figures are.

5.7 Environmental Considerations

Farmers in the Central Otago area are generally already good custodians of the environment that they farm in. The work they are already doing to preserve the environment needs to be shared much more widely. Farmers in this area tend to be inclined to keep their heads down and not share their success stories, but it is vital that they start to ensure the wider public understands that farmers are mostly doing their best to look after the land and waterways. Regulation will happen and is important to ensure that the few low performers in this space up their game. However all of the farmers who were interviewed for this report should be proud of the work they do to look after their land and continue to undertake this work as a vital part of their business.

6.0 Conclusion

Nitrogen use on Central Otago Sheep and Beef farms varies widely. As dairy conversions and intensification push lamb and beef finishing out of the areas which would have been traditional

finishing country, sheep and beef farmers will have to adapt in order to capture more profit out of their systems. For many of those involved in this survey, this has meant finishing more of their own stock or introducing a trading or grazing component into their system.

In order to maximise production, feed grown also needs to be maximised, at the times of the year where the climate allows maximum growth rates. In the Central Otago area, winters can be extremely cold and summers extremely hot, meaning that farmers need to maximise their growth in the spring and autumn periods. They also need to look after pastures so that they continue to grow as long as possible into a drought or cold period, and recover as quickly as possible afterwards. Using strategic nitrogen allows them to maximise their yields at the times of the year where pasture growth is available and to recover quickly once they receive autumn rain or good spring soil temperatures.

While some farmers are already doing a good job of using nitrogen to maximise their profitability and production, some are less likely to use it due to uncertainty around nitrogen response and because they struggle to connect the initial cost with a return later in the season. In order to help these farmers to use nitrogen and to have a positive experience from doing so, it is essential that they have good advice. They need to understand how and when to use it to get maximum benefit for their system, and they need help to connect the initial cost with a longer term gain.

Using nitrogen on sheep and beef farms is certainly not a new concept, but in the Central Otago area it is one for which the uptake has been extremely variable despite the potential it has to improve profitability. While there is always going to be some farmers who do not use it to its full potential, if more farmers used nitrogen strategically to help improve their pasture production we could in turn see businesses which are more resilient to the extremes in climate that this area experiences. In the quickly changing environment for farming businesses, anything that improves the resilience of their business is surely worth looking at and implementing where possible.

7.0 References

ANZ. (2014). *The Secrets of Top-Perfoming Red Meat Farmers.* Auckland: ANZ.

Beef & Lamb New Zealand. (2016). Compendium of New Zealand Farm Facts. Wellington, New Zealand: Beef & Lamb New Zealand. Retrieved from www.beeflambnz.com.

Beef and Lamb NZ. (2016, September 27). *Farm Classes*. Retrieved from Beef and Lamb NZ: www.beeflambnz.com

Black, A., & Murdoch, H. (2013). Yield and water use of a ryegrass/white clover sward under different nitrogen and irrigation regimes. *Proceedings of the New Zealand Grassland Association 75* (pp. 157-164). Dunedin: New Zealand Grassland Association.

Fert Research. (2012). *Fertiliser Use on New Zealand Sheep and Beef Farms.* Wellington: New Zealand Fertiliser Manufacturers Research Association Inc.

Irrigation NZ. (2016, October 13). *Irrigation Scheme Info*. Retrieved from Irrigation New Zealand: irrigationnz.co.nz

Jorneaux, P., Manning, M., & Roberts, A. (2013). *Economics of Fertiliser Application on Hill Country.* Palmerston North: FLRC.

Kearney, J., Moot, D., & Pollock, K. (2010). On Farm Comparison of pasture production in relation to rainfall in Central Otago. *Proceedings of the New Zealand Grasslands Association* (pp. 121-126). Dunedin: New Zealand Grassland Association.

Kerr, G. (2016). Why a Hill Country Symposium? *Hill Country Symposium* (pp. 7-9). Rotorua: New Zealand Grassland Association.

Lambert, M., Roberts, A., & Morton, J. (2007). *Nitrogen use on Hill Country: Lessons from the national wise use of nitrogen focus farm project.* Feilding.

Macara, G. (2015). *The Climate and Weather of Otago.* Niwa Science and Technology Services.

McLaren, R., & KC, C. (1996). *Soil Science.* Melbourne: Oxford University Press.

Mills, A., DJ, M., & McKenzie, B. (2006). Cocksfoot pasture production in relation to environmental variables. *Proceedings of the New Zealand Grassland Association 68* (pp. 89-94). Christchurch: New Zealand Grassland Association.

Ministry for Primary Industries. (2012). *Pastoral Input Trends in NZ : A Snapshot.* Wellington: Ministry for Primary Industries.

Ministry for Primary Industries. (2016). *Situation and Outlook for Primary Industries 2016.* Wellington: Ministry for Primary Industries.

Morton, J., Korte, C., Smith, D., Watt, B., & Smith, R. (1993). Nitrogen use and farm performance on Wairarapa sheep and beef farms. *Proceedings of the New Zealand Grassland Association 55* (pp. 53-57). Dunedin: New Zealand Grassland Association.

Peri, P., Moot, D., McNeil, D., Varella, A., & Lucas, R. (2002). Modelling net photosynthetic rate of field-grown cocksfoot leaves under different nitrogen, water, and temperature regimes. *Grass and Forage Science 57* (pp. 61-67). Christchurch: Grass and Forage Science.

Red Meat Profit Partnership. (2015). *RMPP Research Summary Overview.* Wellington: Red Meat Profit Partnership.

The Ritso Society. (2007). *Comparison of piped and open channel distribution of irrigation water supplies.* Darfield: The Ritso Society.

Willis, B. (2014). Central Otago - Built on gold, growing on grass. *Proceedings of the New Zealand Grassland Association* (pp. 15-23). Alexandra: New Zealand Grassland Association.