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Manatū Ahu Matua

Farm-scale Modelling Report

Ruamahanga Whaitua Collaborative Modelling Project

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Prepared for the Ruamahanga Whaitua Committee and Greater Wellington Regional Council

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Glossary

Farm models	Technical descriptions of different farm systems. They follow a cascade from the general (such as farm types, as defined below) to the specific and from the beginning to the conclusion of the modelling process. The cascade flows from farm types to example farms, representative farms, and finally virtual farms.
Farm types	A range of twelve farm types were specified to be modelled in this study. The farm types were characterised based on their farming enterprise (e.g. dairying, livestock or cropping); their climate (e.g. high, moderate or low rainfall) their area (ha) and their typography (e.g. flat). These farm types were established initially by MPI and the Ruamahanga Whaitua to guide the selection of example farms to be surveyed for this project.
Example farms	These are real farming businesses operating within the Ruamahanga catchment that were surveyed by BakerAg. The farming systems and operational budgets include the actual information provided to BakerAg by farmers operating within the catchment. The example farms were highly dynamic and needed to be adjusted to create representative farms for further modelling.
Representative farms	The representative farms are farm-scale businesses in a long term equilibrium, and could include more than one enterprise with each enterprise producing a unique output for their own specialist markets. These farms were developed by modifying the example farms to run in the long-term version of Farmax and in Overseer. Both the underlying farming systems and the operational budgets have been modified beyond the information originally provided by BakerAg.
Farm enterprises	A farming business may include a number of enterprises that generate their own operational profit and loss (e.g. livestock, forestry and fishing). These are farm scale businesses in a long term equilibrium and that could include more than one enterprise with each enterprise producing a unique output for their own specialist markets. Farm enterprises provide viable and sustainable farming within the catchment by building on farming systems that manage resources productively and efficiently (especially natural resource use).
Farm systems	A farming system is a dynamic representation of inputs and outputs interlinking to support a farming business. They create estimates of profitability, animal production, nutrient uses and losses of nutrients, sediment and pathogens.
Virtual farms	These are farms created when the representative farms are used in Overseer with different soil, topography and climate conditions. The farming systems developed for the representative farms remain unchanged, however the operational budgets might change with changes in maintenance fertiliser policy. The virtual farms are not described in this report, but will be described in reports by Jacobs.
Whaitua	Whaitua means 'designated space'. Greater Wellington Regional Council (GWRC) is running the Whaitua process as part of managing the water resources of our region in a way that meets current needs and those of future generations.

1 Reader's Guide

This report has been prepared for three groups of people:

a) The main group are the Whaitua committee and fellow modelling collaborators on the Collaborative Modelling Project (CMP). This group of readers should be already familiar with the Ruamahanga Whaitua and the CMP. They may choose to go straight to the sections on the 'Farm Modelling Approach' and the 'Representative Farm Results' (Section 3). For more detail about each of the representative farms they can refer to Section 4 towards the back of this report, and Appendix C.

b) Another important group of readers are the stakeholders in the CMP. These readers may wish to refresh their knowledge about the Whaitua and the CMP by reading through Section 2. After that there is an outline of the 'Farm Modelling Approach' and a description of the example farms that were commissioned and how well they relate to the statistics that have been gathered about farming in the catchment. From there, Section 4 provides detail on the individual representative farm results.

c) A third group of potential readers of this report are the landowners in the Ruamahanga Catchment who might be affected by any policy changes. These readers might like to turn straight to the section on the representative farm models (Section 3). One or two of these models should be reasonably close to their farming system and at a catchment scale are likely to be used in the CMP to represent the behaviour of their farming system within the dynamics of natural resource management. Following these farms through the scenarios being developed by the Ruamahanga Whaitua will provide an indication of how such farms are likely to be affected in terms of their practical management and financial returns.

A list of the contributors to this work is included in Section 7. All the contributors are especially appreciative of the farmers that have made available their information for each of the model farms. The leadership and guidance of other Ministry for Primary Industries staff, especially Darran Austin, has been critical to achieving what we have been able to present here. John Bright (Aqualinc Research), Richard McDowell and Richard Muirhead (AgResearch) and Adam Daigneault (Landcare Research) have all assisted in developing this part of the project.

2 Introduction

2.1 THE WHAITUA PROCESS

The Whaitua process is part of Greater Wellington Regional Council's (GWRC) implementation of the National Policy Statement for Freshwater Management. GWRC has identified five Whaitua based around catchments that place different demands on land and water resources. Each Whaitua has a Whaitua committee established with membership including community, GWRC and representatives from iwi, and territorial authorities. The purpose of each Whaitua committee is to develop a Whaitua Implementation Plan (WIP) providing recommendations on priorities for the management and allocation of land and water resources in the Whaitua.

The first committee established in December 2013 was the Ruamahanga Whaitua Committee in the Wairarapa. The Ruamahanga Whaitua Committee includes representation from Te Upoko Taiao – the Natural Resource Committee of GWRC; Ngāti Kahungunu ki Wairarapa and Rangitāne ō Wairarapa; South Wairarapa District Council; Carterton District Council; Masterton District Council, and people from the community who have an interest in land and water management issues.

The committee makes use of supplied information and their understanding of community freshwater; agriculture; biodiversity; tangata whenua; recreation; urban and economic values to create a unique vision. This vision is the basis for setting objectives for land and water management in the catchment area. Ultimately the Natural Resources Plan for the Wellington Region will incorporate the regulatory and voluntary change recommendations of each WIP into Whaitua chapters containing policies, rules and educational strategies. These chapters will be read alongside the regional policies and regulations in the Plan that will control how resources are managed in the area.

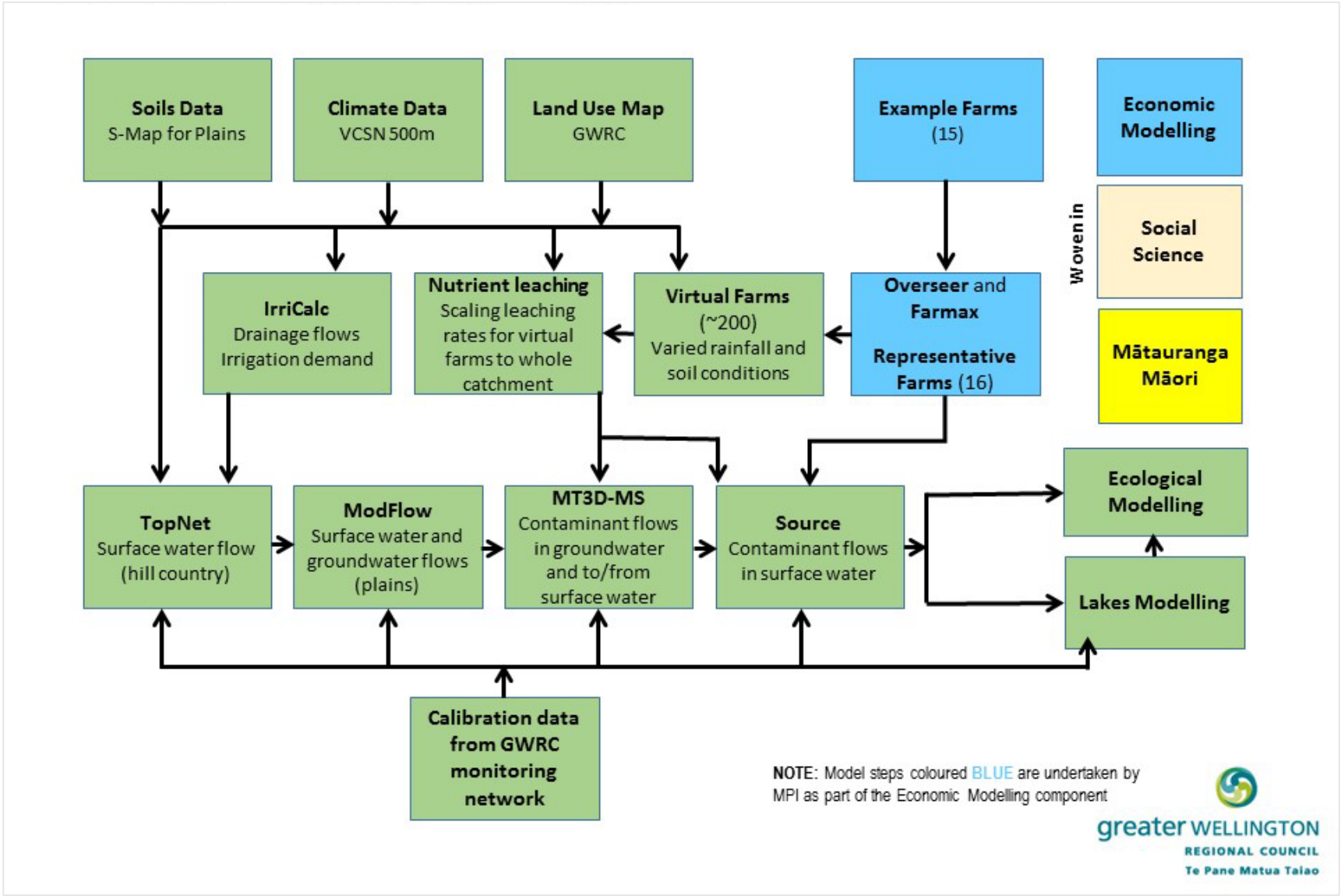
2.2 THE COLLABORATIVE MODELLING PROJECT (CMP)

The Collaborative Modelling Project (CMP) was established by GWRC to inform the work of the Ruamahanga Whaitua in four areas:

- Water quality and catchment targets and limits
- Groundwater and surface water flows and allocation
- Farm, catchment and regional economics
- Social and cultural values across the Ruamahanga

Different teams within the CMP are responsible for providing the Whaitua committee with research evidence to support their work in each of these areas. The evidence is provided in the form of presentations at committee meetings and summary and technical reports.
Figure 1 provides an overview of how technical parts of the CMP fit together. The work presented in this report is represented by "representative farms" in the figure. It is the initial report describing the representative farms, summarising their modelling results for the base-line farming systems (Overseer and Farmax), and describing their contribution towards the contaminant flows in surface water.

Figure 1 Ruamahanga Whaitua Collaborative Modelling Project (CMP) Architecture



3 Farm-scale Modelling Approach

The purpose of this component of the CMP is to provide the Ruamahanga Whaitua with a description of farming systems in the Wairarapa and to provide information to help develop an understanding of their base-line environmental impact on water allocation, water quality, sediment contamination and pathogen contamination. These aspects are analysed by other components of the CMP, based on the information available from farm-scale modelling.

Providing this information has required two farm system models to be developed for each farm. A farm enterprise model (Farmax) to describe how the farming inputs and outputs support the farming business and a nutrient model (Overseer Version 6.2.1 (2016)) that describes how nutrients from the farms flow into catchment waterways. The nutrient modelling provides estimates for nitrogen, phosphorus and potassium losses in surface runoff. It also estimates the potential leaching of those same elements into groundwater. A description of the contribution of possible on-farm mitigations is also described.

There were five steps in the methods involved in establishing the base-line farms for the catchment:

1. **Identifying the groups of farm types in the catchment that need to be modelled.**

   Example farm types were defined by MPI after a series of discussions to gather the input of the Ruamahanga Whaitua and stakeholders. They reflect the range of economically viable farming systems contained in the catchment. This means that for the purposes of catchment management, most farmers should be able to find at least one farm that represents their farming system. Some farming types (for example free range pig farming), existed in low numbers within the catchment. These farms were not modelled and instead industry experts can provide estimates of their likely catchment effects.

   This step is described further within Section 3.1 of this report.

2. **Collecting the farm system data for examples of the farm types specified in the first step.**

   Examples of the farm types were selected by farm consultants at BakerAg to match the specifications provided by MPI. With the assistance of the farm owners, the management and operational accounts for these farms were recorded for the 2013-14 year.

   The descriptions of these example farms were then checked by BakerAg to ensure that they were typical and suitable for selection as representative farms.

   This step is described further within Section 3.2 of this report.

3. **Establishing equilibrium farm models of the representative farms and determining that these were feasible in practice.**

   Each of the example farms was entered by Stantiall & Associates into the Farmax and Farmax Dairy software and modified to become an equilibrium farm system[1]. This required adjustments for:

   - Matching opening and closing livestock numbers

[1] Use of the "long term" versions of Farmax and of Overseer requires that the opening and closing states of the farms are equivalent. Therefore the state of the farm at the end of a year is also the state of the same farm at the beginning of the year. If they are not at equivalent states then the capital value of an enterprise is being driven either up or down, eventually becoming infeasible to operate within the modelled system.

- Stable replacement and culling numbers
- Equal opening and closing supplementary feed in storage
- Matching forage and regrassing areas
- Balanced and repeating cash crop rotations
- Maintenance fertiliser applications (phosphate, potassium and sulphur)

This step is described further in Section 3.3 of this report.

4. **Determining base-line nutrient budgets for each of the representative farms**

   Each equilibrium farm model was entered by Stantiall & Associates into the Overseer model version 6.2.1 (2016). The results provided a nutrient budget for each farm.

   The results for this step for each of the representative farms is summarised within this report in Section 4.

5. **Calculating base-line financial accounts for each of the representative farms**

   The example farm budgets were adjusted by Baker & Associates taking into account the changes required for them to become equilibrium farm models.

   The results for this step for each of the representative farms is summarised within this report in Section 4.

3.1 FARM TYPES SELECTED FROM THE RUAMAHANGA CATCHMENT

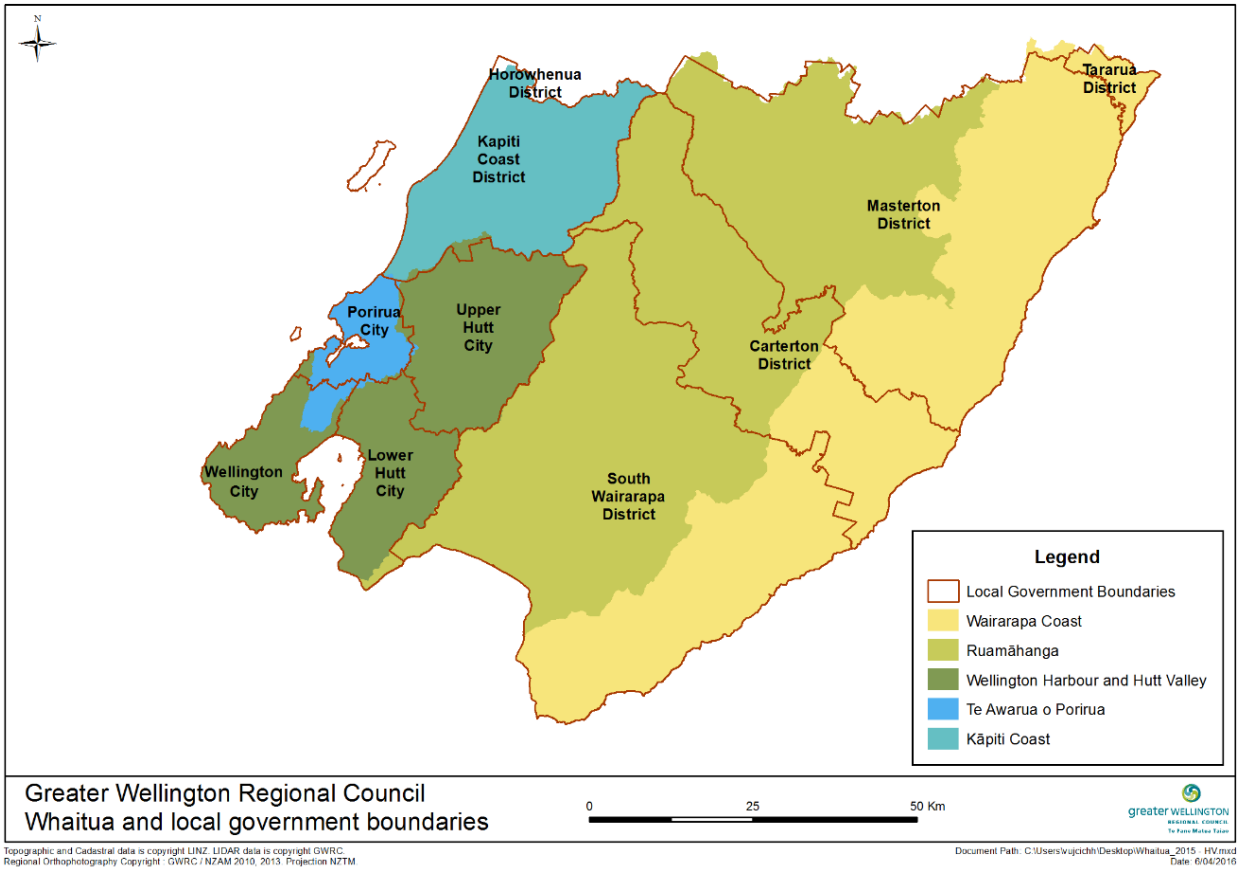
In January 2015 the Ministry for Primary Industries approached three farm and agricultural consultants working in the lower North Island to provide the information required to establish farm models for the Ruamahanga catchment[2].

There are three local government districts within the catchment and statistical information from the Ministry of Statistics and industry groups is available about the land uses in each of them. The boundaries of the three districts are shown in Figure 2.

The farm models were to be used by the Ruamahanga Whaitua to examine the benefits of their policy decisions on environmental and economic outcomes for the catchment[3]. For this task the farm models needed to fit the broad land use, soil and climatic zones to be found in the catchment[4]. The consultants were guided by descriptions of possible zones that had previously been described by Landcare Research as shown in Figure 3.

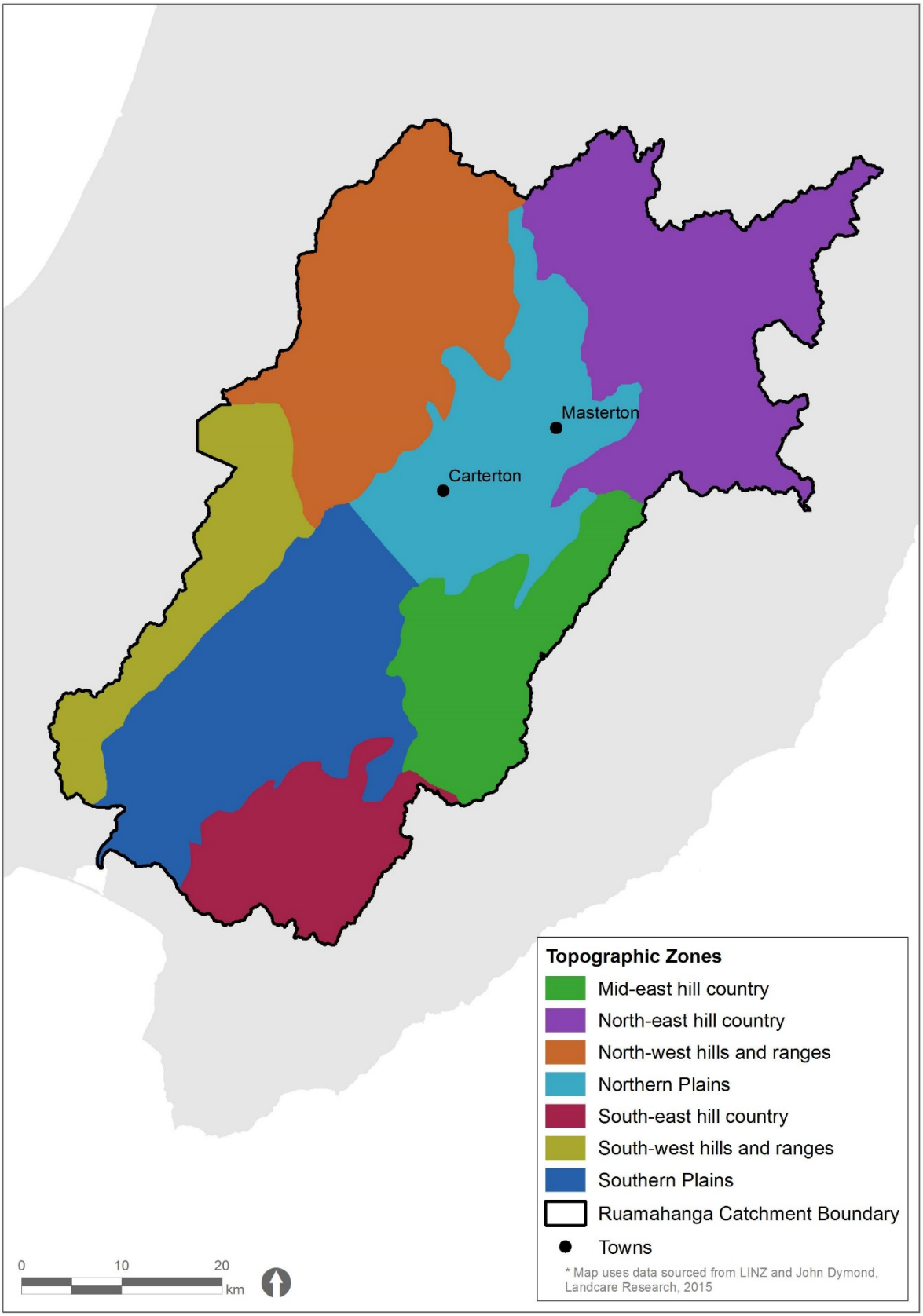
[2] Martin Boyle of BakerAg (Feilding), Terry Parminter of KapAg (Kapiti Coast) and John Stantiall of Stantiall and Partners (Feilding).
[3] Matt Dilly (MPI) pers. Comm. 09/02/2015
[4] Email by Matt Dilly, MPI, 09/02/2015

Figure 2 Wellington Regional Council Boundary and the boundaries of the nine District Councils it contains including the three Councils crossing the Ruamahanga catchment[5]



[5] Source: Greater Wellington Regional Council, 2016

Figure 3 Seven topographical subzones within the Ruamahanga catchment[6]



[6] Source: John Dymond pers comm. 01/04/2015

Approximately 3.4% of the nation's dairy cows are located in the Wairarapa[7]. Most of the dairy farms are on the northern and southern plains shown in Figure 3. The dairy farms in Carterton District have similar herd statistics to the North Island average; Masterton District and South Wairarapa farms have a slightly larger land area; but a similar stocking rate to the North Island average (Table 1).

The Beef + Lamb NZ Economic Service uses information from across the whole of the North Island's east coast in their economic forecasting. This information is not specific to the Ruamahanga Catchment, but it does include the catchment. The Wairarapa contains around 4.5% of New Zealand's sheep & beef farms over 400ha in area[8]. Table 2 presents the information held by Beef & Lamb about farms on the east coast by land class. Although land classes do not exactly match farming systems there will be a tendency for more intensive farming systems to be found on flatter land classes rather than on hill land or steep hill land.

A list of twelve livestock, arable and viticultural farm types was defined after collecting information and having discussions with staff at DairyNZ, Beef + Lamb NZ, and other stakeholder organisations. Four extra farm types were added to the original list by MPI to cover additional soil types for dairy, sheep and beef breeding farms and dairy support farms. Descriptions of these farm types are all listed in Table 3.

Table 3 shows the primary land use of each farm types as well as any minor land use. For each farm type there were targets of terrain, land area, soil order and rainfall. The second to last column of the table contains estimates of the prevalence of each of the farming types within the catchment, provided by MPI. These included estimated totals of 164 dairy farms and 465 sheep & beef farms. The final column of Table 3 contains the comments collected when the figure was circulated by MPI for feedback from industry groups. Some of the comments were technical (e.g. those about irrigation) and some of them relate to how well the identified farm types might be able to represent farming enterprises in the catchment.

[7] DairyNZ, 2015. New Zealand Dairy Statistics: 2014-15. Hamilton, New Zealand

[8] Beef + Lamb NZ, pers comm. 04/03/2015

Table 1 Wairarapa dairy statistics[9]

District	Dominant Topographical areas (from Figure 1)	Dairy Statistics								
		Dairy Farms	Total Number of Cows	Total Area for Dairying (ha)	Average Total Production per Farm (kg MS)	Average Area per Farm (ha)	Average Number of Cows per Farm	Average Stocking Rate (cows/ha)	Average Milk Solids per Unit Area (kgMS/ha)	Average Milk Solids per Cow (kgMS/cow)
Masterton	North east hill country and northern plains	18	8,700	3,000	192,000	165	480	2.9	1,200	400
Carterton	North-west hills and ranges, northern plains, mid-east hill country	56	21,300	7,800	140,000	139	380	2.7	1,000	370
South Wairarapa	South-west hills and ranges, southern plains, south east hill country	83	38,100	13,300	164,000	160	460	2.9	1,000	360
Total		157	68,100	24,100						
North Island Averages					120,360	120	340	2.8	990	360

Table 2 East coast (North Island) sheep and beef statistics for 2013-14[10]

Dominant Topographical	Proportion of flat land (%)	Effective Area (ha)	Sheep Number (total stock units)	Cattle Number (total stock units)	Stocking Rate (stock units/ha)	Prime Lambs Sold (number)
Intensive finishing	30-50	375	1,950	1,260	8.6	1360
Hill country	10	537	3,030	1,640	8.8	1346
Hard hill country	4	1,020	4,600	3,100	7.7	1,200

[9] LIC, 2014. New Zealand Dairy Statistics: 2013-14. DairyNZ and Livestock Improvement Corporation, Newstead, Hamilton.
[10] Beef & Lamb, Provisional statistics 2013-14 for All Classes East Coast, pers comm.

Table 3 Specifications of farm types to be used for the selection of example farms within the Ruamahanga catchment (original table developed by MPI and presented to stakeholders, 2015)

SYSTEMS TO MODEL IN HIGHER DETAIL BASED ON FARMER SURVEY									
Primary Land Use	#	Description	Terrain	Area (ha)	Dairy support	Soil Order	Rainfall	Minor Land uses	No. of farms	Comments
Dairy	1	Dry flat dairy	Flat	155	Off	1a brown 1b gley	1200	Forage	80	Will be irrigated with low rate applicators over 70% of property
Dairy	2	Irrigated flat dairy	Flat	250	Adjacent block	gley	1000	Forage	40	Pivot irrigator over 50% of property
Dairy	3	Dry dairy, high rainfall	Rolling	200	On farm/adjacent block	brown	1450	No forage	40	Might be less
Dairy	4	Organic farm	Flat	250	On farm/adjacent block	pallic	1200	No forage	4	NB. $1.05/kgMS premium
		Total number of dairy farms							164	
Primary Land Use	#	Description	Terrain	Area (ha)	Dairy support	Soil Order	Rainfall	Minor Land uses	No. of farms	Comments
Sheep and Beef	5	Summer dry, breeding/semi finishing	Rolling	800	Yes	brown	1200	Dairy support	10	Might be limited and slightly increasing dairy support across the different classes
Sheep and Beef	6	Summer wet breeding/semi finishing	Rolling	650	No	6a brown 6b pallic	1600	Dairy support	150	High amount of farms in this category - would have thought that would contain significant amount of the finishing as well. More likely to have dairy support here than summer dry.
Sheep and Beef	7	Flat drystock, beef finishing	Flat	300	No	pallic	1200		30	Specialist bull beef units
Sheep and Beef	8	Flat drystock, lamb finishing	Flat	450	No	8a gley 8b pallic	1200	Cropping	70	Irrigation for crop. Would potentially go for slightly smaller farm size here. Numbers a bit high. Farm size should be smaller.
Sheep and Beef	9	Steep hill summer dry, store lambs	Steep	1000	No	brown	1000	Forage	85	Probably limited amount of finishing with some limited crop areas as well
Sheep and Beef	10	Cropping, some beef finishing	Flat	300	No	gley	1000	Beef finishing	20	Irrigation
Sheep and Beef	11	Dairy support	Rolling	200	Yes	11a brown 11b pallic	1200	Sheep finishing	100	
									465	Total number of sheep&cattle farms (includes arable)
Primary Land Use	#	Description	Terrain	Area (ha)	Yield	Soil Order	Rainfall			Comments
Other	12	Viticulture	Flat	10		pallic				

The feedback by the industry groups to MPI about the farm types shown in Table 3 highlighted five items to be addressed during the selection of example farms.

- The number of dry dairy, high rainfall farms (type 3) should be reduced.
- The summer wet sheep & beef breeding farm (type 6) is likely to have significant amounts of lambs and cattle being finished. These farms could also include dairy support grazing as an alternative enterprise.
- The beef finishing farm (type 7) includes specialist bull units.
- The lamb finishing farm (type 8) should include irrigation of the area used for cropping. It was considered that the size of this farm was too large and the number of farms being represented should be reduced.
- The dry store lamb farm was considered to have the potential to be growing some cash crops as well as livestock.

Further discussion on the number of farms and land uses to be found in the catchment can be found in Appendix A.

3.2 EXAMPLE FARM SELECTION

Example farms were identified by staff at BakerAg to match the farm types in Table 3. The staff particularly sought out farms with little advisory input. One of the dairy farms and five sheep and beef farms had had no previous known contact with BakerAg before this project (40% of total number of farms). Of the farms that had been in contact this was for the years after 2014 and so after the years that are the focus of this study.

All of the example farms that contributed towards this project with their farming system and business information are listed in Table 4. The names of the selected farms are different from the names used in Table 3 and reflect the dominant enterprise (e.g. dairy) and the defining characteristic (e.g. low rainfall), but they are listed in the same general order. Table 4 (example farms) also has some differences with the specifications for the commissioned farms, as shown in the last column. When compared with the industry feed-back listed at the end of the previous section, the following changes have been made:

- Dairy support has been removed from the sheep and beef breeding farms as suggested
- The specialist beef farm has a bull beef enterprise as suggested
- The lamb trading and finishing farms are smaller and one has irrigation as suggested
- The “sheep and beef and grazing farm” does not include any cash cropping enterprise despite the suggestion

There are eight sheep and beef farms in Table 4. Four of these farms have proportions of flat land that fit the definition of “intensive finishing farms” for Beef and Lamb as described in Table 2. One of the farms has only enough flat land to meet the “hill farm” criteria, and the other two farms have no flat land.

The example farm systems have been assigned varying levels of intensity, from low intensity (farming system I or 1) to high intensity (farming system V or 5), as shown in Table 4. These are based on industry normative descriptions of farming systems. As such the descriptions are unrelated to typography, locality, or profitability. Although they may be associated with each of these, the underlying structure and dynamics of the systems operate independently of these

contextual factors. The dairy industry has in place a scale of "The 5 production systems"[11]. These systems have been used to describe the range of dairy systems and their impact on economic returns and the environment[12]. The sheep and beef industry does not have a standardised scale of intensity. Instead the industry has commonly used a classification of farming system based on landform, e.g. hill country farms (Table 2).

The example dairy farms are generally farming system intensity IV. DairyNZ consider that dairy farms in the catchment will usually be system III, and that there are probably as many system II as system IV[13]. Beef + Lamb NZ confirmed that the distribution of farming systems types matches their expectations[14].

Each of the example farms is generally located within the catchment using a simple grid pattern and the farm location co-ordinates in Overseer (Figure 4 and grid references in Table 4). In the figure the dairy farms occupy the grid where there is a yellow hue, the sheep & beef farms where there is a brown hue, and the cropping and dairy support farms where there is a green hue. In some localities more than one example farm may be located. One of the dairy farms and one of the dairy support/arable farms are located to the west of Greytown. A dairy farm, a sheep & beef farm, and an arable/beef farm are located to the east of Carterton. Two of the sheep & beef farms are located around Gladstone; one dairy farm and one sheep & beef farm are located south of Mount Bruce. In the other identified locations only one of the farms is present.

The example farms are spread through all seven topographical subzones shown in Figure 3. However, there is no example dairy farm in the Southern Plain area although that is an area with a lot of dairy farms. There is also no example sheep and beef farm in the South eastern Hill Country although that is the dominant land use to be found there (Figure 4).

[11] Dairy NZ 2016 'The Five Production Systems', accessed January 2016, http:/www.dairynz.co.nz/farm/farm-systems/the-5-production-systems/

[12] Rowarth JS 2013. Dairy cows-economic production and environmental protection. In Dymond JR (ed). Economic services in New Zealand-conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand.
Shadbolt NM 2012. Competitive strategy analysis of NZ pastoral dairy farming systems. in International Journal of Agricultural Management, vol 1 issue 3, p19-27.

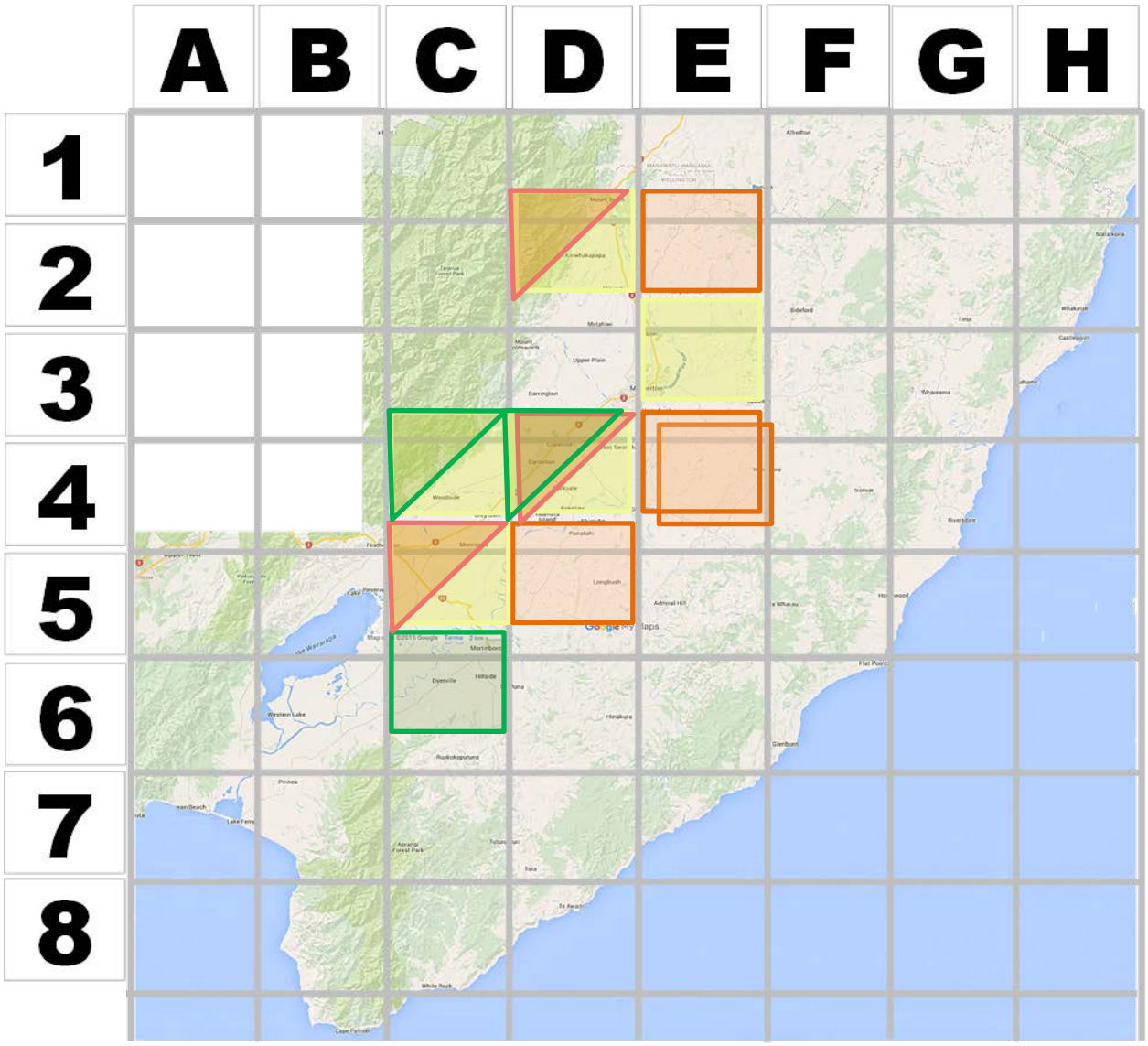
[13] Andrew Newman, Dairy NZ, pers. comm.

[14] Erica van Reenen, Beef + Lamb NZ, pers. comm.

Table 4 Description of example farms including farm system intensities and degree of fit with representative farms

Example Farms	Farm area (ha)	Annual rainfall (mm)	Dominant soil order	Flat land (%)	Map Ref (Figure 3)	Farming system intensity					Fit with Representative Farm Specifications (Figure 3)
						1	2	3	4	5	
Low rainfall, high production dairy *(Type 1)*	367	967	Pallic	100	C4				●		Larger than specification, but similar milking platform size to industry average
Low rainfall, moderate production (new type not included in Table 3)	171	1356	Gley	100	N/A				●		This farm type was added during modelling of representative farms to provide an indication of a low rainfall dairy farm with slightly lower production. It is based on the Type 1 low rainfall dairy farm, but with adjusted production.
Moderate rainfall dairy *(Type 1)*	301	1100	Pallic	100	D4				●		Larger than specification, but similar milking platform size to industry average
High rainfall dairy *(Type 3)*	204	1546	Brown	61	D2			●			Milking platform smaller than specification
Irrigated dairy *(Type 2)*	427	915	Gley	100	E3				●		Uses spraylines rather than centre pivot
Organic dairy *(Type 4)*	355	801	Recent	100	C5		●				Larger than specification, but similar milking platform size to industry average
Sheep and beef finishing, summer dry *(Type 5)*	585	825	Brown	30	E4			●			Smaller than specification, dairy support not included.
Sheep and beef breeding, summer wet *(Type 6)*	360	1340	Pallic	0	E2		●				Smaller than specification, dairy support not included
Sheep and beef finishing, summer wet *(Type 6)*	450	1491	Pallic	0	D2			●			Smaller than specification
Sheep and bulls *(Type 7)*	927	870	Pallic	65	D5			●			Smaller than specification
Irrigated sheep and beef trading *(Type 8)*	360	778	Gley	47	C5				●		Smaller than specification
Lamb and bull trading, 20% cropping *(Type 8)*	93	880	Pallic	100	D4				●		Smaller than specification
Sheep and beef breeding, summer dry *(Type 9)*	620	909	Brown	9	E4		●				Smaller than specification
Sheep and beef finishing 65% cropping *(Type 10)*	380	910	Pallic	36	D4			●			Larger than specification
Dairy support, 15% cropping, summer dry *(Type 11)*	284	970	Gley	100	C6				●		Larger than specification
Dairy support, 48% cropping, summer wet *(Type 11)*	315	1300	Gley	100	C4				●		Larger than specification

Figure 4 General location of example farms in the Ruamahanga catchment



Legend for Figure 4	
	General location of Dairy example farms
	General location of Sheep & Beef example farms
	General location of Cropping and Dairy Support example farms

3.3 REPRESENTATIVE FARMS

The representative farms were developed from the actual farm data provided by each of the example farms. Some changes were needed to adjust the example farm data in order to turn them into long term "equilibrium" farming systems that could be included in the catchment modelling [15]. At the end of the process the example farms had become representative farms with equal opening and closing numbers of livestock, balanced supplementary feed stocks and with maintenance applications of fertiliser applied.

In a farm system where livestock numbers are in equilibrium, the number of breeding animals at the end of the year is equal to the number of animals at the beginning of that same year. There will be a proportion of the breeding animals that die and some animals beyond their breeding years or with unacceptably low production will be culled and sold from the farms. The animals that have died or been sold are replaced by younger animals that have been kept for that purpose. All other young stock are surplus and are sold without entering the breeding herd or flock. It is unusual for livestock numbers for all livestock classes on commercial farms to be in equilibrium over a 12 month period. All the example farm livestock data had to be adjusted to create equilibrium livestock reconciliations.

Supplementary feed may be made within a farm or bought from other farms and fed to livestock later in the year. If supplementary feed is carried over between management periods on the representative farms then to create equilibrium conditions, the stock of feed at the end of a year will have to equal the stock of feed at the beginning of the year. For example a farm may make 100 tonnes of silage in the first year and feed it out in the following winter at the beginning of the next year. It is important for establishing that the farm is in equilibrium to adjust the actual numbers and ensure that the same amount of silage is again on hand at the end of the second year.

Nutrient levels in soils change over time depending upon the soil types, the prevailing climatic and the amount of pasture or crop being grown. Farmers are also able to affect soil nutrient levels by their management. Amongst other things they can add fertiliser or organic material, they can remove nutrients in production or they can change their crop cultivation and harvesting practices. If the nutrients being removed from a property as product, leaching or runoff are being replaced by the equivalent amount as inputs then the farms are in equilibrium. Using the results provided by Overseer all the examples farms were adjusted until there were sufficient inputs to ensure that they were all in equilibrium.

When all the example farms had been through the adjustment process they became representative farms for the catchment.

[15] Use of the "long term" version of Farmax and of Overseer requires that the opening and closing states of the farms are equivalent. The state of the farms at the end of a year needed to be adjusted to match the state of the same farms at the beginning of the year.

4 Individual Representative Farm Results

Summary information from each of the representative farms has been included in the following pages (Sections 4.1 to 4.16). The summary picks out key performance indicators for each farm so that their economic returns can be compared with their environmental performance[16]. The indicators are explained below.

Production system
The summary of each farm begins with a system type described earlier in this report (Table 4) and in Appendix B.

Infrastructure
The section on infra-structure describes the area of the farm and the irrigation and effluent systems being used. This information provides some indication about the opportunities for expanding the scale of the farming businesses and addressing environmental risks. This information is common to both Farmax and Overseer.

Livestock
The section on livestock describes the size of the herds and flocks and the levels of production being achieved. In general farmers with low levels of productivity per animal unit over time will want this to increase. Farmers with relatively high levels of productivity per animal unit may want to increase the number of animal units being carried on the farm. The relationship between livestock class, animal numbers and animal performance has been derived from Farmax analyses.

Pasture and feed
The section on pasture and feed describes the feed inputs available to support the existing and future levels of livestock production. The estimated feed consumed and the amount of pasture production to provide for that has been estimated by Farmax. Overseer takes a similar approach to estimating the amount of feed being grown and its results have been included. Both Farmax and Overseer base their results on the area grazed rather than the total area, or even the effective area. The difference particularly shows on cropping farms where the grazed area is a lot less than the effective area.

Nutrients
The next section looks at nutrient losses as one measure of environmental impact, mostly with information about the loss of nitrate nitrogen. The amount of nitrogen leached varied from 9 kg N/ha/yr for a sheep & beef farm, to 47 kgN/ha/yr for a dairy farm, to 93 kgN/ha/yr for a dairy support and cropping farm.
The estimated phosphorus losses varied from 0.2 kgP/ha/yr for a flat sheep & beef farm to 5.5 kgP/ha/yr for a steep sheep & beef farm.

Operational Profit
The last section has a summary of the operating profit and losses to be expected from this farming system being operated under these conditions. For these figures the returns from 2013-14 year have been used with the price paid for milk solids adjusted downwards to $6/kg, reflecting the long term average. A premium for organic milk of $1.20/kgMS has been included.

[16] Parminter TG, 2015. Selecting farm practices and preparing land-use consents in the Manawatu-Wanganui Region. New Zealand Grassland Association, pp275-280.

To assist with determining the effects of making marginal changes to the farming business, the operational income and costs have been further divided into:

- **Farm overheads.** These figures are relatively fixed for farms and except for step changes are relatively inelastic with changes in land area or stocking rate. They include: wages, accident compensation levies, repairs and maintenance for buildings, administration, insurance, and rates.
- **Land operational.** These figures vary with marginal changes in land area, topography, and management. They include: fertiliser and lime (excluding nitrogen), regrassing, weed & pest, fuel, and plant and vehicle costs.
- **Livestock operational.** These costs vary with marginal changes in livestock numbers, livestock classes and stock management. They include: animal health, animal breeding, farm dairy, electricity, irrigation, grazing, supplementary feed, forage cropping, nitrogen fertiliser, and freight and cartage.
- **Cash cropping farms.** These have been computed differently from livestock farms in order to assist with livestock management decision making. Their income and costs have been included in the operational profit calculation. However the livestock operational cost does not include cropping costs and the marginal profit calculations do not include cropping costs.

4.1 DRY FLAT DAIRY (LOW RAINFALL AND HIGH PRODUCTION)

PRODUCTION SYSTEM		Dairy Type 4		
INFRASTRUCTURE				
Farm Area	367ha	Milking platform	171ha	
Feedpad	no	Effluent system and area	Sump and travelling irrigator	24 ha
		Irrigation system and area	Spray line (27%) and centre pivot (73%)	100 ha
HERD				
635 cows	160 replacements		Cows wintered off	yes
286,597 kgMS	1,680 kgMS/ha		455 kgMS/cow	
PASTURE AND FEED (Milking platform)				
Potential pasture (Farmax)		15,794 kgDM/ha/yr		
Actual estimated intake		13,692 kgDM/ha/yr	Pasture Utilisation	87 %
Pasture grown (Overseer)		19,800 kgDM/ha/yr		
Imported feed		302 tDM pasture equivalent		
Winter forage crop		0 ha		
Summer forage crop		0 ha		
Imported feed and grazing off as a percentage of the total		30 %		
Comparative stocking rate		82 kg liveweight per tonne dry matter on the milking platform		
NUTRIENTS				
Clover nitrogen		122 kg/ha	Other nitrogen	22 kg/ha
Imported nitrogen		94 kg/ha	Available nitrogen	238 kg/ha
Surplus nitrogen		173 kg/ha	Nitrogen conversion efficiency	27 %
Leached nitrogen		42 kg/ha	Phosphorus losses	1.0 kg/ha
OPERATIONAL PROFIT				
Farm fixed overheads		$259,484	Milk income	$1,720,253
Land operational costs		$227,687	Livestock income	$75,325
Livestock costs		$828,241	Other income	$339
Operational profit		$480,505	Marginal profit	
Per eff. hectare		$1,309	Per eff. hectare	$4,273
Per cow		$763	Per cow	$1,536
Farm Working Expenses		$4.59/kgMS		

4.2 DRY FLAT DAIRY (LOW RAINFALL AND MODERATE PRODUCTION)

PRODUCTION SYSTEM		Dairy Type 3		
INFRASTRUCTURE				
Farm Area	171 ha	Milking platform	171 ha	
Feedpad	no	Effluent system and area	Sump and travelling irrigator	24 ha
		Irrigation system and area	Spray line (27%) and centre pivot (73%)	100 ha
HERD				
430 cows	115 replacements		Cows wintered off	yes
150,590 kgMS	881 kgMS/ha		350 kg MS/cow	
PASTURE AND FEED (Milking platform)				
Potential pasture (Farmax)		15,089 kgDM/ha/yr		
Actual estimated intake		12,875 kgDM/ha/yr	Pasture Utilisation	85 %
Pasture grown (Overseer)		13,394 kgDM/ha/yr		
Imported feed		224 tDM pasture equivalent		
Winter forage crop		0 ha		
Summer forage crop		0 ha		
Imported feed and grazing off as a percentage of the total		17 %		
Comparative stocking rate		93 kg liveweight per tonne dry matter on the milking platform		
NUTRIENTS				
Clover nitrogen		109 kg/ha	Other nitrogen	36 kg/ha
Imported nitrogen		105 kg/ha	Available nitrogen	250 kg/ha
Surplus nitrogen		188 kg/ha	Nitrogen conversion efficiency	25 %
Leached nitrogen		34 kg/ha	Phosphorus losses	1.5 kg/ha
OPERATIONAL PROFIT				
Farm fixed overheads		$205,298	Milk income	$902,937
Land operational costs		$104,314	Livestock income	$57,121
Livestock costs		$245,931	Other income	$155,771
Operational profit		$560,286	Marginal profit	
	Per eff. hectare	$3,277	Per eff. hectare	$5,915
	Per cow	$1,390	Per cow	$2,159
	Farm Working Expenses	$3.69/kgMS		

4.3 DRY FLAT DAIRY (MODERATE RAINFALL)

PRODUCTION SYSTEM		Dairy Type 4		
INFRASTRUCTURE				
Farm Area	301 ha	Milking platform	185 ha	
Feedpad	no	Effluent system and area	Sump and travelling irrigator	80 ha
		Irrigation system and area	Rain gun (85%) and sprayline	60 ha
HERD				
629 cows	160 replacements		Cows wintered off	yes
228,105 kgMS	1,233 kgMS/ha		363 kg MS/cow	
PASTURE AND FEED (Milking platform)				
Potential pasture (Farmax)		13,623 kgDM/ha/yr		
Actual estimated intake		11,679 kgDM/ha/yr	Pasture Utilisation	86 %
Pasture grown (Overseer)		13,606 kgDM/ha/yr		
Imported feed		319 tDM pasture equivalent		
Winter forage crop		0 ha		
Summer forage crop		15 ha	Turnips	11 T/ha yield
Imported feed and grazing off as a percentage of the total		34 %		
Comparative stocking rate		88 kg liveweight per tonne dry matter on the milking platform		
NUTRIENTS				
Clover nitrogen		110 kg/ha	Other nitrogen	15 kg/ha
Imported nitrogen		87 kg/ha	Available nitrogen	212 kg/ha
Surplus nitrogen		146 kg/ha	Nitrogen conversion efficiency	31 %
Leached nitrogen		24 kg/ha	Phosphorus losses	1.2 kg/ha
OPERATIONAL PROFIT				
Farm fixed overheads		$322,809	Milk income	$1,371,988
Land operational costs		$160,877	Livestock income	$75,853
Livestock costs		$616,678	Other income	$775
Operational profit		$348,252	Marginal profit	
	Per eff. hectare	$1,157	Per eff. hectare	$4,278
	Per cow	$554	Per cow	$1,323
	Farm Working Expenses	$4.56/kgMS		

4.4 DRY FLAT DAIRY (HIGH RAINFALL)

PRODUCTION SYSTEM		Dairy Type 3		
INFRASTRUCTURE				
Farm Area	204 ha	Milking platform	125 ha	
Feedpad	no	Effluent system and area	Sump and travelling irrigator	20 ha
		Irrigation system and area	No	0 ha
HERD				
355 cows	65 replacements		Cows wintered off	yes
159,249 kgMS	1,274 kgMS/ha		449 kg MS/cow	
PASTURE AND FEED (Milking platform)				
Potential pasture (Farmax)		15,141 kgDM/ha/yr		
Actual estimated intake		13,388 kgDM/ha/yr	Pasture Utilisation	88 %
Pasture grown (Overseer)		17,000 kgDM/ha/yr		
Imported feed		120 tDM pasture equivalent		
Winter forage crop		5 ha	Kale	5 T/ha yield
Summer forage crop		7 ha	Turnips	8 T/ha yield
Imported feed and grazing off as a percentage of the total		21 %		
Comparative stocking rate		78 kg liveweight per tonne dry matter on the milking platform		
NUTRIENTS				
Clover nitrogen		100 kg/ha	Other nitrogen	18 kg/ha
Imported nitrogen		102 kg/ha	Available nitrogen	220 kg/ha
Surplus nitrogen		150 kg/ha	Nitrogen conversion efficiency	32 %
Leached nitrogen		47 kg/ha	Phosphorus losses	1.7 kg/ha
OPERATIONAL PROFIT				
Farm fixed overheads		$121,550	Milk income	$954,855
Land operational costs		$126,366	Livestock income	$38,485
Livestock costs		$253,298	Other income	$36
Operational profit		$492,162	Marginal profit	
	Per eff. hectare	$2,413	Per eff. hectare	$4,250
	Per cow	$1,406	Per cow	$2,115
	Farm Working Expenses	$3.15/kgMS		

4.5 IRRIGATED FLAT DAIRY

PRODUCTION SYSTEM		Dairy Type 3		
INFRASTRUCTURE				
Farm Area	426 ha	Milking platform	270 ha	
Feedpad	no	Effluent system and area	Sump and travelling irrigator	60 ha
		Irrigation system and area	Spraylines	135 ha
HERD				
840 cows	185 replacements		Cows wintered off	yes
295,000 kgMS	1,090 kgMS/ha		350 kg MS/cow	
PASTURE AND FEED (Milking platform)				
Potential pasture (Farmax)		14,081 kgDM/ha/yr		
Actual estimated intake		11,375 kgDM/ha/yr	Pasture Utilisation	81 %
Pasture grown (Overseer)		14,900 kgDM/ha/yr		
Imported feed		546 tDM pasture equivalent		
Winter forage crop		10 ha 10 ha	Oats Kale	5 T/ha yield 10 T/ha yield
Summer forage crop		21 ha	Turnips	10 T/ha yield
Imported feed and grazing off as a percentage of the total		28 %		
Comparative stocking rate		88 kg liveweight per tonne dry matter on the milking platform		
NUTRIENTS				
Clover nitrogen		97 kg/ha	Other nitrogen	41 kg/ha
Imported nitrogen		77 kg/ha	Available nitrogen	215 kg/ha
Surplus nitrogen		153 kg/ha	Nitrogen conversion efficiency	29 %
Leached nitrogen		24 kg/ha	Phosphorus losses	0.9 kg/ha
OPERATIONAL PROFIT				
Farm fixed overheads		$468,020	Milk income	$1,797,398
Land operational costs		$200,735	Livestock income	$87,400
Livestock costs		$583,141	Other income	$4,005
Operational profit		$636,907	Marginal profit	
Per eff. hectare		$1,492	Per eff. hectare	$3,953
Per cow		$758	Per cow	$1,554
Farm Working Expenses		$4.24/kgMS		

4.6 ORGANIC DAIRY

PRODUCTION SYSTEM		Dairy Type 2		
INFRASTRUCTURE				
Farm Area	355 ha	Milking platform	210 ha	
Feedpad	no	Effluent system and area	Sump and travelling irrigator	27 ha
		Irrigation system and area	Central pivot (25%) and spraylines	159 ha
HERD				
567 cows	108 replacements		Cows wintered off	yes
213,462 kgMS	1,017 kgMS/ha		377 kg MS/cow	
PASTURE AND FEED (Milking platform)				
Potential pasture (Farmax)		11,082 kgDM/ha/yr	Milking platform	
Actual estimated intake		9,607 kgDM/ha/yr	Pasture Utilisation	87 %
Pasture grown (Overseer)		13,711 kgDM/ha/yr		
Imported feed		0 tDM pasture equivalent		
Winter forage crop		0 ha		
Summer forage crop		12 ha	Turnips	10 T/ha yield
Imported feed and grazing off as a percentage of the total		22 %		
Comparative stocking rate		96 kg liveweight per tonne dry matter on the milking platform		
NUTRIENTS				
Clover nitrogen		138 kg/ha	Other nitrogen	12 kg/ha
Imported nitrogen		0 kg/ha	Available nitrogen	150 kg/ha
Surplus nitrogen		78 kg/ha	Nitrogen conversion efficiency	48 %
Leached nitrogen		35 kg/ha	Phosphorus losses	0.8 kg/ha
OPERATIONAL PROFIT				
Farm fixed overheads		$364,015	Milk income	$1,536,791
Land operational costs		$210,751	Livestock income	$58,723
Livestock costs		$156,371	Other income	$103
Operational profit		$864,480	Marginal profit	
Per eff. hectare		$2,428	Per eff. hectare	$3,890
Per cow		$1,538	Per cow	$2,561
Farm Working Expenses		$3.42/kgMS		

4.7 SHEEP AND BEEF FINISHING, SUMMER DRY

PRODUCTION SYSTEM		Sheep & Beef Type 3			
INFRASTRUCTURE					
Farm area	620 ha	Effective area	585 ha	Irrigated area	0 ha
Flat land	27%	Winter stocking rate	11.4 stock units (su)/ha		
SHEEP					
Ewes wintered	2,990	Weaning ratio	121%	Wool	23,732 kg
Lambs to works	4,666	Lambs store/grazed	0		4.8 kg/sheep su wintered
CATTLE					
Breeding cows	69	R1yr finished	75	Cattle store/culled	25
Dairy cows grazed	0	Older cattle finished	269		
Proportion of stock units as cattle			26%		
Total product per hectare		279 kg	Feed conversion		25 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		7,887 kgDM/ha/yr	Effective area		
Actual estimated intake		6,821 kgDM/ha/yr	Pasture Utilisation		86 %
Pasture grown (Overseer)		9,635 kgDM/ha/yr	Feed imported		7.0 t DM pasture equiv.
Winter forage crop		10 ha	Kale	12 T/ha yield	
Summer forage crop		10 ha	Rape	12 T/ha yield	
CASH CROPS					
Nil					
NUTRIENTS					
Clover nitrogen		80 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		3 kg/ha	Available nitrogen		90 kg/ha
Surplus nitrogen		69 kg/ha	Nitrogen conversion efficiency		19 %
Leached nitrogen		9 kg/ha	Phosphorus losses		0.2 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$73,069	Sheep income		$425,863
Land operational costs		$80,367	Cattle income		$245,567
Livestock costs		$131,379	Other income		$7,094
Operational profit		$393,709	Marginal profit		
	Per eff. hectare	$673		Per eff. hectare	$1,022
	Per su	$59		Per su	$82

4.8 SHEEP AND BEEF BREEDING, SUMMER WET

PRODUCTION SYSTEM		Sheep & Beef Type 2			
INFRASTRUCTURE					
Farm area	380 ha	Effective area	360 ha	Irrigated area	0 ha
Flat land	0 %	Winter stocking rate	9.1 stock units (su)/ha		
SHEEP					
Ewes wintered	2,023	Weaning ratio	115 %	Wool	13,713 kg
Lambs to works	1,391	Lambs store/grazed	295		5.3 kg/sheep su wintered
CATTLE					
Breeding cows	110	R1yr finished	0	Cattle store/culled	97
Dairy cows grazed	0	Older cattle finished	4		
Proportion of stock units as cattle			22 %		
Net product per hectare		208 kg	Feed conversion		30 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		7,516 kgDM/ha/yr			
Actual estimated intake		5,581 kgDM/ha/yr	Pasture Utilisation		74 %
Pasture grown (Overseer)		9,134 kgDM/ha/yr	Feed imported		9.0 t DM pasture equiv.
Winter forage crop		9 ha	Plantain	7 T/ha yield	
Summer forage crop		10 ha	Rape	7 T/ha yield	
CASH CROPS					
Nil					
NUTRIENTS					
Clover nitrogen		59 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		36 kg/ha	Available nitrogen		102 kg/ha
Surplus nitrogen		84 kg/ha	Nitrogen conversion efficiency		14 %
Leached nitrogen		22 kg/ha	Phosphorus losses		2.7 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$42,373	Sheep income		$243,329
Land operational costs		$36,780	Cattle income		$57,621
Livestock costs		$64,134	Other income		$0
Operational profit		$157,663	Marginal profit		
	Per eff. hectare	$438		Per eff. hectare	$734
	Per su	$48		Per su	$72

4.9 SHEEP AND BEEF FINISHING, SUMMER WET

PRODUCTION SYSTEM		Sheep & Beef Type 3			
INFRASTRUCTURE					
Farm area	540 ha	Effective area	450 ha	Irrigated area	0 ha
Flat land	0 %	Winter stocking rate	8.2 stock units (su)/ha		
SHEEP					
Ewes wintered	1,800	Weaning ratio	140%	Wool	18,342 kg
Lambs to works	2,235	Lambs store/grazed	0		6.9 kg/sheep su wintered
CATTLE					
Breeding cows	103	R1yr finished	8	Cattle store/culled	139
Bull calves grazed	250	Older cattle finished	9		
Proportion of stock units as cattle			28 %		
Net product per hectare		237 kg	Feed conversion		25 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		7,231 kgDM/ha/yr			
Actual estimated intake		5,943 kgDM/ha/yr	Pasture Utilisation		82 %
Pasture grown (Overseer)		8,895 kgDM/ha/yr	Feed imported		0 tonnes DM
Winter forage crop		12 ha	Kale	10 T/ha yield	
Summer forage crop		12 ha	Turnips	5 T/ha yield	
CASH CROPS					
Nil					
NUTRIENTS					
Clover nitrogen		54 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		18 kg/ha	Available nitrogen		88 kg/ha
Surplus nitrogen		61 kg/ha	Nitrogen conversion efficiency		18 %
Leached nitrogen		17 kg/ha	Phosphorus losses		5.5 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$96,471	Sheep income		$288,339
Land operational costs		$116,143	Cattle income		$201,068
Livestock costs		$95,887	Other income		$18
Operational profit		$180,924	Marginal profit		
	Per eff. hectare	$402		Per eff. hectare	$830
	Per su	$49		Per su	$106

4.10 SHEEP AND BULL FINISHING

PRODUCTION SYSTEM		Sheep & Beef Type 3			
INFRASTRUCTURE					
Farm area	1,110 ha	Effective area	927 ha	Irrigated area and system	40 ha (K-line)
Flat land	65 %	Winter stocking rate	10.7 stock units (su)/ha		
SHEEP					
Ewes wintered	3,979	Weaning ratio	138%	Wool	30,570 kg
Lambs to works	3,453	Lambs store/grazed	0		4.8 kg/sheep su wintered
CATTLE					
Breeding cows	0	R1yr finished	0	Cattle store/culled	10
Dairy cows grazed	0	Older cattle finished	490		
Proportion of stock units as cattle			43 %		
Net product per hectare		266 kg	Feed conversion		25 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		7,800 kgDM/ha/yr			
Actual estimated intake		5,035 kgDM/ha/yr	Pasture Utilisation		65 %
Pasture grown (Overseer)		8,718 kgDM/ha/yr	Feed imported		22.0 t DM pasture equiv.
Winter forage crop		32 ha	Kale	12 T/ha yield	
Summer forage crop		32 ha	Rape	5 T/ha yield	
CASH CROPS					
Nil					
NUTRIENTS					
Clover nitrogen		56 kg/ha	Other nitrogen		3 kg/ha
Imported nitrogen		9 kg/ha	Available nitrogen		81 kg/ha
Surplus nitrogen		53 kg/ha	Nitrogen conversion efficiency		21 %
Leached nitrogen		8 kg/ha	Phosphorus losses		0.9 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$267,396	Sheep income		$586,987
Land operational costs		$191,319	Cattle income		$289,369
Livestock costs		$178,193	Other income		$65,772
Operational profit		$305,220	Marginal profit		
	Per eff. hectare	$329		Per eff. hectare	$810
	Per su	$31		Per su	$77

4.11 IRRIGATED SHEEP AND BEEF TRADING

PRODUCTION SYSTEM		Sheep & Beef Type 4			
INFRASTRUCTURE					
Farm area	370 ha	Effective area	360 ha	Irrigated area and system	84 ha (Pivot irrigator)
Flat land	70 %	Winter stocking rate	11.4 stock units (su)/ha		
SHEEP					
Ewes wintered	0	Weaning ratio	N/A	Wool	8,464 kg
Lambs to works	4,885	Lambs store/grazed	506		4.6 kg/sheep su wintered
CATTLE					
Breeding cows	48	R1yr finished	188	Cattle store/culled	60
Dairy cows grazed	0	Older cattle finished	211		
Proportion of stock units as cattle			10 %		
Net product per hectare		320 kg	Feed conversion		25 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		10,840 kgDM/ha/yr			
Actual estimated intake		8,197 kgDM/ha/yr	Pasture Utilisation		76 %
Pasture grown (Overseer)		10,494 kgDM/ha/yr	Feed imported		0 t DM
Winter forage crop		25 ha	Kale	8 T/ha yield	
Summer forage crop		30 ha 6 ha	Turnips Plantain	11 T/ha yield 7 T/ha yield	
CASH CROPS					
Nil					
NUTRIENTS					
Clover nitrogen		66 kg/ha	Other nitrogen		6 kg/ha
Imported nitrogen		44 kg/ha	Available nitrogen		119 kg/ha
Surplus nitrogen		98 kg/ha	Nitrogen conversion efficiency		16 %
Leached nitrogen		15 kg/ha	Phosphorus losses		0.9 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$52,236	Sheep income		$181,934
Land operational costs		$69,824	Cattle income		$133,883
Livestock costs		$107,306	Other income (contract grazing)		$9,630
Operational profit		$96,081	Marginal profit		
	Per eff. hectare	$267		Per eff. hectare	$710
	Per su	$23		Per su	$53

4.12 LAMB AND BULL TRADING, 20% CROPPING

PRODUCTION SYSTEM		Sheep & Beef Type 4			
INFRASTRUCTURE					
Farm area	93 ha	Effective area	93 ha	Irrigated area	0 ha
Flat land	100 %	Winter stocking rate	10.8 stock units (su)/ha		
SHEEP					
Ewes wintered	0	Sheep stock ratio	1,059 rsu	Wool	10,007 kg
Lambs to works	5,626	Lambs store/grazed	0		11.1 kg/sheep su wintered
CATTLE					
Breeding cows	0	R1yr finished	31	Cattle store/culled	0
Dairy cows grazed	0	Older cattle finished	0		
Proportion of stock units as cattle			10 %		
Net product per hectare		615 kg	Feed conversion		16 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		11,970 kgDM/ha/yr			
Actual estimated intake		9,874 kgDM/ha/yr	Pasture Utilisation		82 %
Pasture grown (Overseer)		15,334 kgDM/ha/yr	Feed imported		0 t DM
Summer forage crop		3.5 ha	Rape	5 T/ha yield	
CASH CROPS					
Summer		Spring barley 19 ha	6.7 t/ha		
NUTRIENTS					
Clover nitrogen		56 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		154 kg/ha	Available nitrogen		212 kg/ha
Surplus nitrogen		118 kg/ha	Nitrogen conversion efficiency		44 %
Leached nitrogen		20 kg/ha	Phosphorus losses		0.6 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$73,927	Sheep income		$121,554
Land operational costs		$45,209	Cattle income		$23,995
Livestock costs		$63,930	Cash crop income		$76,380
Cash crop costs		$62,100	Other income		$54,540
Operational profit		$31,303	Marginal profit (Livestock only)		
	Per eff. hectare	$337		Per eff. hectare	$1,665
				Per su	$136

4.13 SHEEP AND BEEF BREEDING, SUMMER DRY

PRODUCTION SYSTEM		Sheep & Beef Type 2			
INFRASTRUCTURE					
Farm area	680 ha	Effective area	620 ha	Irrigated area	0 ha
Flat land	9 %	Winter stocking rate	8.8 stock units (su)/ha		
SHEEP					
Ewes wintered	3,112	Weaning ratio	N/A	Wool	29,260 kg
Lambs to works	1,463	Lambs store/grazed	2,469		7.0 kg/sheep su wintered
CATTLE					
Breeding cows	98	R1yr finished	167	Cattle store/culled	73
Dairy cows grazed	0	Older cattle finished	128		
Proportion of stock units as cattle			23 %		
Net product per hectare		202 kg	Feed conversion		29 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		6,830 kgDM/ha/yr			
Actual estimated intake		5,834 kgDM/ha/yr	Pasture Utilisation		85 %
Pasture grown (Overseer)		8,650 kgDM/ha/yr	Feed imported		10.0 t DM pasture equiv.
Summer forage crop		15 ha	Turnips	4 T/ha yield	
CASH CROPS					
Nil					
NUTRIENTS					
Clover nitrogen		68 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		8 kg/ha	Available nitrogen		84 kg/ha
Surplus nitrogen		67 kg/ha	Nitrogen conversion efficiency		14 %
Leached nitrogen		8 kg/ha	Phosphorus losses		0.2 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$97,722	Sheep income		$419,277
Land operational costs		$97,460	Cattle income		$101,481
Livestock costs		$111,694	Other income		$0
Operational profit		$213,883	Marginal profit		
	Per eff. hectare	$345		Per eff. hectare	$683
	Per su	$39		Per su	$75

4.14 FINISHING BEEF, 65% CROPPING

PRODUCTION SYSTEM		Sheep & Beef Type 3			
INFRASTRUCTURE					
Farm area	380 ha	Effective area	151 ha	Irrigated area	0 ha
Flat land	36 %	Winter stocking rate	9.1 stock units (su)/ha		
SHEEP					
Ewes wintered	700	Weaning ratio	126 %	Wool	7299 kg
Lambs to works	7,537	Lambs store/grazed	0		3.9 kg/sheep su wintered
CATTLE					
Breeding cows	0	R1yr finished	0	Cattle store	0
Dairy cows	0	Older cattle finished	128		
Proportion of stock units as cattle			33 %		
Net product per hectare		317 kg	Feed conversion		26 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		10,427 kgDM/ha/yr			
Actual estimated intake		8,272 kgDM/ha/yr	Pasture Utilisation		79 %
Pasture grown (Overseer)		9,872 kgDM/ha/yr	Feed imported		0 t DM
Summer forage crop		18 ha 47 ha 8 ha	Grnfd barley Plantain Clover seed	6 T/ha yield 5 T/ha yield	
CASH CROPS					
Pac Choy Barley Peas Oats		10.2 ha 54.5 ha 30.6 ha 27.0 ha	9.0 T/ha 3.8 T/ha 3.0 T/ha 7.6 T/ha		
NUTRIENTS					
Clover nitrogen		36 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		77 kg/ha	Available nitrogen		122 kg/ha
Surplus nitrogen		56 kg/ha	Nitrogen conversion efficiency		51 %
Leached nitrogen		20 kg/ha	Phosphorus losses		0.5 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$195,107	Sheep income		$339,889
Land operational costs		$184,601	Cattle income		$70,066
Livestock costs		$82,983	Cash crop income		$500,612
Cash crop costs		$93,675	Other income		$5,341
Operational profit		$359,542	Marginal profit (Livestock only)		
	Per eff. hectare	$1,149		Per eff. hectare	$737
				Per su	$472

4.15 DAIRY SUPPORT, 15% CROPPING, SUMMER DRY

PRODUCTION SYSTEM		Sheep & Beef Type 4			
INFRASTRUCTURE					
Farm area	284 ha	Effective area	284 ha	Irrigated area	0 ha
Flat land	100 %	Winter stocking rate	10.7 stock units (su)/ha		
SHEEP					
Sheep wintered	0				
CATTLE					
Dairy cows grazed	274				
Proportion of stock units as cattle			100 %		
Net product per hectare		257 kg	Feed conversion		19 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		6,226 kgDM/ha/yr			
Actual estimated intake		4,875 kgDM/ha/yr	Pasture Utilisation		78 %
Pasture grown (Overseer)		7,909 kgDM/ha/yr			
Summer forage crop		10 ha	Rape	8.0 T/ha yield	
CASH CROPS					
Spring barley Autumn wheat Maize silage		23.5 ha 10 ha 10 ha	5.5 T/ha 7.0 T/ha 16.3 T/ha		
NUTRIENTS					
Clover nitrogen		66 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		0 kg/ha	Available nitrogen		68 kg/ha
Surplus nitrogen		19 kg/ha	Nitrogen conversion efficiency		73 %
Leached nitrogen		15 kg/ha	Phosphorus losses		0.3 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$28,494	Sheep income (grazing)		$73,560
Land operational costs		$65,053	Cattle income (grazing)		$181,379
Livestock costs		$102,453	Cash crop income		$69,060
Cash crop costs		$65,823	Other income (grazing & crop)		$34,895
Operational profit		$97,071	Marginal profit (livestock only)		
	Per eff. hectare	$537		Per eff. hectare	$791
				Per su	$73

4.16 DAIRY SUPPORT, 48% CROPPING, SUMMER WET

PRODUCTION SYSTEM		Sheep & Beef Type 4			
INFRASTRUCTURE					
Farm area	300 ha	Effective area	300 ha	Irrigated area	0 ha
Flat land	100 %	Winter stocking rate	11 stock units (su)/ha		
SHEEP					
Sheep wintered	0				
CATTLE					
Breeding cows	0	R1yr heifers	138		
Dairy cows	1,425	R2yr heifers	405		
Proportion of stock units as cattle			100 %		
Net product per hectare		263 kg	Feed conversion		25 kgDM/kg
PASTURE AND FEED					
Potential pasture (Farmax)		9,093 kgDM/ha/yr			
Actual estimated intake		6,519 kgDM/ha/yr	Pasture Utilisation		72 %
Pasture grown (Overseer)		8,219 kgDM/ha/yr	Feed imported		0 t DM
Winter forage crop		100 ha	Kale	8.5 T/ha yield	
CASH CROPS					
Summer		Spring barley 50 ha	5.0 T/ha	Income Costs Net	$116,458 $97,466 $18,992
NUTRIENTS					
Clover nitrogen		31 kg/ha	Other nitrogen		2 kg/ha
Imported nitrogen		69 kg/ha	Available nitrogen		102 kg/ha
Surplus nitrogen		76 kg/ha	Nitrogen conversion efficiency		25 %
Leached nitrogen		93 kg/ha	Phosphorus losses		1.0 kg/ha
OPERATIONAL PROFIT					
Farm fixed overheads		$65,444	Grazing income (dairy cattle)		$638,995
Land operational costs		$45,358			
Livestock costs		$290,782	Cash crop income		$85,000
Cash cropping costs		$90,000	Other income		$31,458
Operational profit		$263,869	Marginal profit (livestock only)		
	Per eff. hectare	$880		Per eff. hectare	$2,084
				Per su	$30

5 Modelling Results

The representative farms each provide information for use in the CMP to support the Whaitua Committee's decision making process. This includes the nutrient loss information shown in Table 5. In Table 5 the background information for each farm already described in Section 3.2 is followed by the leaching and subsoil losses, and then the runoff losses.

Table 5 Representative farm data for nutrient losses from the "root zone" (results from Overseer)

Representative Farm	Farm Background				Leaching and losses to root zone					Runoff to surface water	
	Effective Area (ha)	Relative Stocking Rate (RSU/ha)	Predominant Soil Type (soil order)	Annual Rainfall (mm/year)	Average annual drainage depth (mm)	Average annual nitrate leached (kgN/ha/yr)	Average annual N concentration in drainage water (ppm)	N lost in urine (kgN/ha/yr)	Annual phosphorus loss (kg P/ha/yr)	Average annual N loss in runoff (kgN/ha/yr)	Average annual P loss in runoff (kgP/ha/yr)
Low rainfall dairy, high production	367	37	Pallic	967	514*	42	7.7	37	1.0	0	0.6
Low rainfall dairy, high production	171	21	Gley	1,356	437*	34	3.3	13	1.5	0	0.9
Moderate rainfall dairy	301	28	Pallic	1,100	356*	24	5.1	19	1.2	0	0.9
High rainfall dairy	204	28	Brown	1,546	739	47	5.3^	31	1.7	1	1.3
Irrigated dairy	426	27	Gley	915	510*	24	4.3^	17	0.9	0	0.6
Organic dairy	355	22	Recent	801	409*	35	6.1	30	0.8	0	0.5
Summer wet sheep and beef finishing	450	11.7	Pallic	1,491	696	20	2.3^	11	5.5	1	5.4
Sheep and bulls	927	11.5	Pallic	870	282	9	3.0^	6	0.9	0	0.8
Irrigated sheep and beef trading	360	13.3	Gley	778	323	15	3.9^	8	0.9	0	0.8
Lamb and bull trading 20% cropping	93	17.3	Pallic	880	153	20	6.3^	6	0.6	0	0.3
Sheep and beef breeding, summer dry	620	11.1	Brown	909	279	8	2.7^	6	0.2	0	0.1
Sheep & beef finishing 65% cropping	313	19.3	Pallic	910	334	21	6.0	8	0.5	0	0.4
Low rainfall dairy support 15% cropping	284	10.2	Gley	970	284	15	3.2	7	0.3	0	0.2
High rainfall dairy support 48% cropping	300	19.6	Gley	1300	617	93	14.3	19	1.0	0	1.0

Notes accompanying Table 5:
* Includes the use of irrigation;
^ Applies to flat areas only where subsurface drainage occurs

Sources of results for leaching to groundwater (*source in italics*):

- Average Annual Drainage depth (mm), *from overseer block reports, other values*
- Average Annual N leached (kg N/ha/yr), *from farm report, nutrient budget*
- Average Annual N concentration in drainage water (ppm), *from farm report, nitrogen budget*
- Average Annual N lost via Urine (kg N/ha/yr), from farm report, *nutrient budget, leaching/loss, urine patches*
- Average Annual N lost via Runoff (kg N/ha/yr), from farm report, *nutrient budget, leaching/loss, other*
- Average Annual P leached (kg P/ha/yr), *from farm report, phosphorus budget*
- Average Annual P concentration in drainage water (ppm), *from farm report, leaching/losses, drainage*
- Average Annual P lost via Runoff (kg P/ha/yr), *from farm report, nutrient budget, leaching/loss, runoff*

6 Limitations of the study and further development

The economic modelling component of the CMP has been designed around real farms existing within the Ruamahanga Catchment and then modifying those farms so that they could be used to generalise across similar farms. Each farm has been analysed to ensure that they are equally viable as bio-physical models and as financial models. Each farming system contains a degree of internal variability between management areas that has been disguised by averaging the results for each farm.

The example farms were selected based on the specifications in the commissioning request that themselves were based on catchment statistics. The degree of fit between the example farms and the industry statistics is described here. Although in absolute terms there are some moderate differences in the results, in relative terms they are very similar. At catchment scale for policy scenarios that apportion relative nutrient loads between land uses the differences are likely to be small. The significance of these differences though to economic modelling is uncertain.

Other agricultural enterprises will be addressed by working with the industries themselves. Examples of typical and best practice results from the industries will be provided in consultation with the NZ Pork Industry Board, the Deer Industry New Zealand, Horticulture NZ and the New Zealand Forestry Association. The agricultural consultants will continue working with the CMP and the Whaitua Committee to ensure that the representative farms have a well described base-line for assessing the changes that may result when the mitigating practices are introduced.

7 Contributors to this report

We wish to recognise the following contributors to the work presented in this report:

SENIOR AUTHOR: Terry Parminter is managing director at KapAg and is working with farmers on systems management and with central and local government agencies and industry organisations on strategies for social and human behaviour change. Terry was the lead author of this report.

PROJECT MANAGER: Jess Grinter (Senior Policy Analyst, MPI) managed the farm-scale modelling team and was the key MPI contact for the CMP. Jess was a secondary author of this report.

TECHNICAL ADVISOR: Darran Austin (Principal Advisor, MPI) provided direction on the purpose and scope of the project.

FINANCIAL DATA COLLECTION: Martin Boyle, agricultural consultant with BakerAg provided oversight of farm data collection, analysis and farm systems modelling. We also acknowledge the hard work of Stefan Bryant and Ellie Avery of BakerAg, in providing technical modelling support.

SYSTEMS MODELLING: John Stantiall, agricultural consultant with Stantiall and Partners who provided Overseer and Farmax modelling services and experience in farming systems.

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Appendix A Comparison of industry land use statistics and regional statistics

The Ruamahanga Catchment is 358,993ha and the Ruamahanga Whaitua administers a slightly smaller 355,685ha. The extent of different land uses is illustrated in Figure 5 and the estimated areas of each land use are listed in Table 6. The specific numbers about land use provided by industry sources are that there are 157 dairy farms in the catchment in total farming over 24,100ha (Table 1). The estimates of land use areas reflecting the farm types (in Table 3) can be compared with these results.

The total area being represented by the farm types in Table 6 is 80% of the total catchment area. Information from Statistics NZ is summarised in Table 7. These results from Statistics NZ indicate that for the whole of the Wairarapa, the area of grazed and cropping land is less than 200,000 ha. That figure is much lower than the estimates in Table 6. The estimates in Table 6 use total farmed area whereas the figures in Table 7 are probably based on the effective area only. It is also probable that authors of this report have overestimated the number of commercial farms operating within the catchment. For example compare the number of dairy farms in Table 1 (157) with the number used in this study and shown in Table 6 (164).

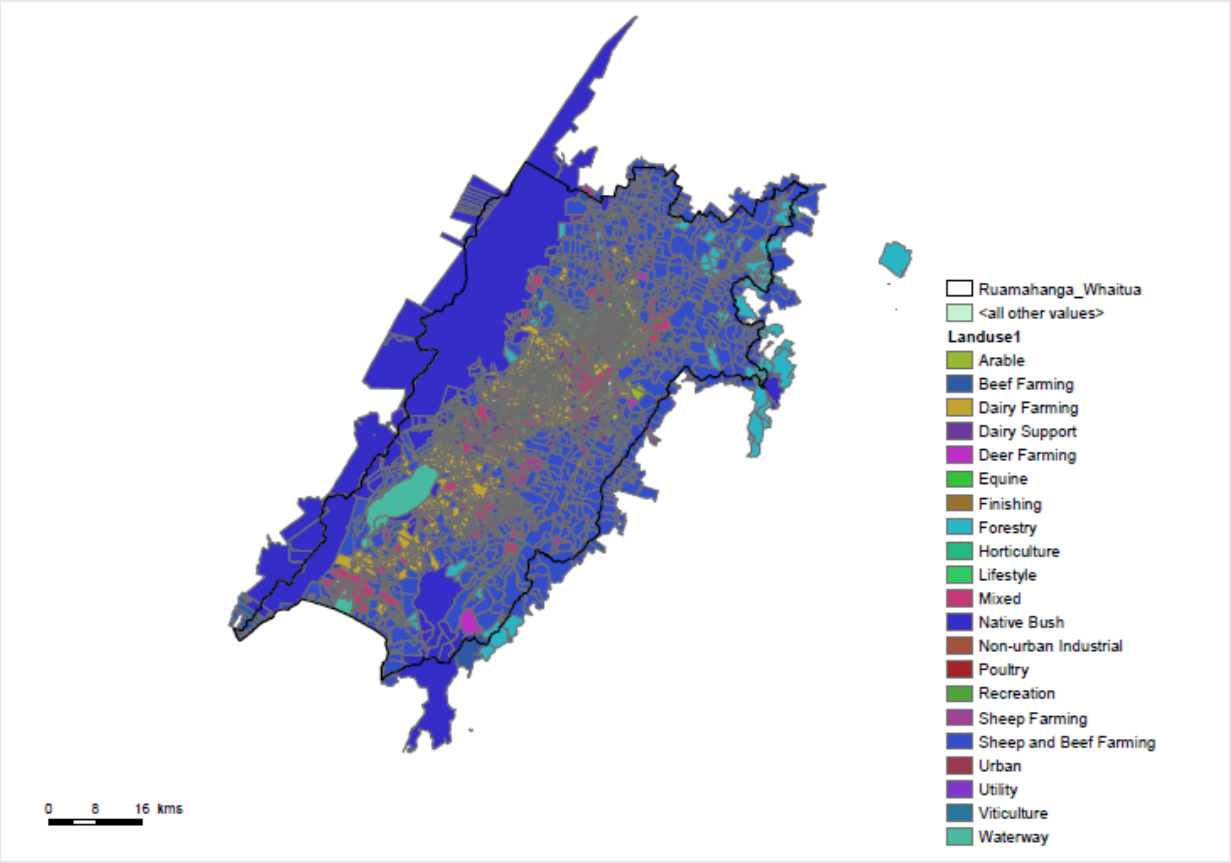
Table 6 Land use within the Ruamahanga catchment estimated from this study's results

Land Use	Estimated numbers of farms	Catchment area represented by farms types (ha)	
		(% of subtotal)	(ha)
Dairy	164	11	31,400
Dairy support	100	7	20,000
Sheep & Beef	315	77	222,000
Beef	30	5	9,000
Cropping	20	-	6,000
Other agriculture		-	
Total of agricultural landuses	629	100	288400

Table 7 Land use statistics for the Wairarapa (2011-2012; Source: Statistics NZ)

Territorial Authority	Grassland (ha)	Other Grazing Land (ha)	Crops (ha)	Horticulture (ha)	Exotic Forestry (ha)
Masterton District Council	31,430	-	2,100	-	33,950
Carterton District Council	57,430	230	2,300	220	10,680
South Wairarapa District Council	97,420	-	3,740	-	7,640
Total	186,280	230	8,140	220	52,270

Figure 5 Land use in the Ruamahanga catchment (estimates provided by GWRC, 2016)



Appendix B Farming Intensity Measures

The dairy industry introduced a farm system characterisation around a five point scale of management intensity in 2006 [17]. The scale has been used by a number of authors to examine the "key production and financial targets" for each type of system. When they have done so, it has become apparent that although each of the systems can be managed to achieve high levels of profitability, the skills required by farmers are different for each type of system [18]. The same intensity scale has been used to examine the benefits and costs of introducing practice changes on farms to reduce nitrate leaching [19]. In most cases the systems have been considered to contain structural differences in how resources are used and productivity improved. These structural differences have strategic strengths and weaknesses. An exception to this approach is a paper by Bruce Greig (2012) where he considered that all the systems could be evaluated along a single production function.

In this report the author has used the DairyNZ scale to define farming system intensity incorporating structural changes and production dependencies. The same approach has been used to scale intensity in the sheep and beef sector [20]. Both these scales are shown in Table 11.

All the dairy systems are particular to the dairy platform or effective milking area. They assume that all young stock are grazed off the dairy platform. The amount of imported feed is determined from supplementary feed brought onto the dairy platform and the time that the dry cows spend off the dairy platform.

The sheep and beef systems have increasing proportions of animals being finished for processing and reducing proportions of breeding stock as intensity increases. As the relative numbers of high growth rate animals are being farmed over summer, an increase in the proportion of feed may be required from cropping and imported feed.

Table 8 System types for the dairy and sheep and beef industries

System Type	Dairy Industry[21]	Sheep and Beef Industry
I	All grass self-contained, with all the livestock on the dairy platform. There are no feed imported onto the dairy platform and no supplement is fed to the herd except any supplement already harvested off the effective milking area. The cows are grazed on the effective milking area through the whole year.	A sheep enterprise that is breeding its own replacements (wethers and females) and where the main output is wool. The cattle enterprise may not exist, or be self-replacing breeding cows producing weaner calves, or be store cattle between 12-40 months of age. There is generally no bought in feed, and no forage cropping (except for pasture renewal).
II	Supplements used to protect pastures through summer dry or winter wet conditions.	A sheep enterprise with breeding ewes selling the majority of lambs store (less than 15 months of age). A cattle enterprise of breeding cows selling some calves and possibly some cattle at less than 30 months of age. At least 55% of the stock units wintered are sheep.

[17] Hedley P and Kolver E, Glassy C, Thorrold B, van Bysterveldt A, Roche J and Macdonald K, 2006. *Achieving high performance from a range of farm systems*. Proceedings of the 4th Dairy3 Conference, p147-168.
[18] Hedley P and Kolver E, 2006. *Achieving high performance from a range of farm systems in Southland*. Presented at South Island Dairy Event.
Shadbolt N, 2012. Competitive strategy analysis of NZ pastoral dairy farming systems. *International Journal of Agricultural Management*.
[19] Macdonald T, Rowarth J, Scrimgeour F, 2015. 'Measuring the comparative cost of environmental compliance and mitigation options for Waikato dairy farm systems'. In: *Moving farm systems to improved attenuation*. (Eds L.D. Currie and L.L Burkitt). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 28. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.
[20] Beef + Lamb NZ, pers comm.
[21] http://www.dairynz.co.nz/farm/farm-systems/the-5-production-systems/
Hedley P and Kolver E, Glassy C, Thorrold B, van Bysterveldt A, Roche J and Macdonald K, 2006. Achieving high performance from a range of farm systems. Proceedings of the 4th Dairy3 Conference, 147-168.

System Type	Dairy Industry[21]	Sheep and Beef Industry
		Forage cropping may be used specifically to winter breeding animals and up to 10% of cattle supplement may be imported.
III	Supplements used (in addition to II) to extend the lactation later into autumn without losing cow condition.	A sheep enterprise with breeding ewes producing lambs for replacements and finishing. Hoggets may be mated and/or additional lambs bought-in and finished. No breeding cows but bought-in cattle are kept at least 9 months and finished at less than 30 months of age. Forage cropping may be used specifically to finish lambs and up to 10% of cattle supplement may be imported.
IV	Supplements used (in addition to III) to lengthen the whole lactation. Cows must be in the top 25% of breeding worth to make the best use of supplements.	No breeding ewes but lambs are bought and finished on the property. No breeding cows but cattle bought and finished on the property at less than 30 months of age. Forage crops and imported supplement used for finishing animals in summer and autumn.
V	Supplementary feed is used throughout the whole year. Feed composition will be important at high supplementary feed levels.	No breeding stock and beef finishing at less than 18 months of age. Supplement may be used throughout the year.

Appendix C Nutrient Budgets and Summaries from the Representative Farms

This appendix contains output tables from the Overseer files specific to each of the representative farms described in Section 4 of the main report. For each farm there is a nutrient budget with the inputs and outputs of the main soil nutrients. The main agricultural nutrient of potential concern to waterway health is nitrogen leaching from livestock farming systems. In the first column under "nutrients removed – to water" the estimated loss of nitrogen from the soil profile is shown.

A table showing the nitrogen budget is presented for each farm; these tables illustrate the distribution of the overall farm loss across the various farm blocks. The range of results mainly reflects differences in soil type, and differences in livestock class and management. These tables show the calculated nitrogen concentrations in water flows below the soil profile. High concentration results are particularly important for those blocks that have subsurface drainage systems connected into nearby water bodies. A concentration over 11ppm is at a level that can be toxic to humans[22].

C.1 Dry flat dairy (low rainfall and high production)

Nutrient budget for low rainfall, high production dairy farm.

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	94	23	10	51	51	0	0
Rain/clover N fixation	124	0	2	4	2	4	17
Irrigation	6	0	4	6	21	5	21
Supplements imported	14	3	4	1	1	1	0
Nutrients removed							
As products	65	11	15	4	16	1	4
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	72	0	0	0	0	0	0
To water	42	1	20	54	84	5	20
Change in internal pools							
Plant material	0	0	0	0	0	0	0
Organic pool	60	12	3	4	1	0	0
Inorganic mineral	0	7	-34	0	-3	-5	-6
Inorganic soil pool	0	-5	16	0	-23	9	20

[22] World Health Organisation 2011. *Guidelines for Drinking-water Quality*, 4th Edition, p398

Nitrogen budget for low rainfall, high production dairy farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Effluent (Non-irrigated)	2585	108	**29.1**	494	427
Gley (Non-irrigated)	1321	28	8.5	199	94
Brown (Irrigated)	2944	109	**11.8**	253	126
Pallic (Irrigated)	5183	71	7.7	261	126
Support Block (Dryland)	3037	15	4.3	146	78
Other farm sources	352				
Whole farm	15423	42			
Less N removed in wetlands	0				
Farm output	15423	42			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Phosphorus budget for low rainfall, high production dairy farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Effluent (Non-irrigated)	35	1.5	Medium	n/a	Extreme
Gley (Non-irrigated)	21	0.4	Low	Low	n/a
Brown (Irrigated)	15	0.5	Low	Low	n/a
Pallic (Irrigated)	100	1.4	Medium	Medium	n/a
Support Block (Dryland)	55	0.3	Low	Low	n/a
Other farm sources	128				
Whole farm	354	1			

Nitrogen summary for low rainfall, high production dairy farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		122
Fertiliser N	kg N/ha/yr		94
Other N added	kg N/ha/yr		22
Indices			
Average N loss to water	kg N/ha/yr	24-42	42
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		29.9
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	123-191	173
N conversion efficiency	%	27-35	27

C.2 Dry flat dairy (low rainfall and moderate production)

Nutrient budget for low rainfall and moderate production dairy farm

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	105	24	14	25	37	0	0
Rain/clover N fixation	111	0	3	5	4	8	36
Irrigation	3	0	2	3	11	3	12
Supplements imported	31	4	27	3	6	2	2
Nutrients removed							
As products	63	11	14	4	15	1	4
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	120	0	0	0	0	0	0
To water	34	1.5	16	28	77	9	32
Change in internal pools							
Plant material	-19	-2	-19	1	-1	-1	-1
Organic pool	8	3	0	3	0	0	0
Inorganic mineral	0	9	-20	0	-3	-4	-5
Inorganic soil pool	45	4	53	0	-30	11	19

Nitrogen budget for low rainfall and moderate production dairy farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Irrigated Block ##	805	34	2.4	311	182
Effluent ##	844	62	7.3	488	375
Non Irrigated ##	2006	19	3.0	205	113
Turnips	431	29	4.4	242	20
Kale	1330	121	**18.7**	235	34
Other farm sources	322				
Whole farm	5738	34			
Less N removed in wetlands	0				
Farm output	5738	34			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for low rainfall and moderate production dairy farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Irrigated Block ##	48	2	High	High *	n/a
Effluent ##	43	3.2	Medium	Low	Extreme
Non Irrigated ##	69	0.6	Low	Low	n/a
Turnips	17	1.1	n/a	n/a	n/a
Kale	16	1.5	n/a	n/a	n/a
Other farm sources	58				
Whole farm	251	1.5			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for low rainfall and moderate production dairy farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		109
Fertiliser N	kg N/ha/yr		105
Other N added	kg N/ha/yr		36
Indices			
Average N loss to water	kg N/ha/yr	24-42	34
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		66.6
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	123-191	188
N conversion efficiency	%	27-35	25

C.3 Dry flat dairy (moderate rainfall)

Nutrient budget for moderate rainfall dairy farm

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	87	28	0	39	57	0	0
Rain/clover N fixation	112	0	2	4	2	4	15
Irrigation	3	0	2	3	10	2	10
Supplements imported	10	2	11	1	2	1	1
Nutrients removed							
As products	65	12	15	4	16	1	4
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	55	0	0	0	0	0	0
To water	24	1.2	23	37	54	4	19
Change in internal pools							
Plant material	-3	0	-5	1	0	0	0
Organic pool	58	12	6	5	1	1	0
Inorganic mineral	0	5	-35	0	-3	-5	-6
Inorganic soil pool	12	1	11	0	3	7	9

Nitrogen budget for moderate rainfall dairy farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
MP Effluent ##	1913	26	5.6	200	122
MP Non-Irrigated ##	604	15	3.4	175	105
MP Irrigated - Gun ##	1866	41	4.7	228	158
MP Irrigated - Pods ##	385	42	4.7	248	190
Runoff	1581	14	5.5	205	83
Turnips	607	40	9.0	214	35
Other farm sources	417				
Whole farm	7372	24			
Less N removed in wetlands	0				
Farm output	7372	24			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for moderate rainfall dairy farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
MP Effluent ##	70	1	Medium	Low	Medium
MP Non-Irrigated ##	20	0.5	Low	Low	n/a
MP Irrigated - Gun ##	122	2.7	High	High *	Medium
MP Irrigated - Pods ##	25	2.7	High	High *	Medium
Runoff	20	0.2	Low	Low	n/a
Turnips	22	1.5	n/a	n/a	n/a
Other farm sources	82				
Whole farm	361	1.2			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for moderate rainfall dairy farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		110
Fertiliser N	kg N/ha/yr		87
Other N added	kg N/ha/yr		15
Indices			
Average N loss to water	kg N/ha/yr	24-42	24
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		18.4
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	123-191	146
N conversion efficiency	%	27-35	31

C.4 Dry flat dairy (high rainfall)

Nutrient budget for high rainfall dairy farm

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	102	31	22	44	63	5	0
Rain/clover N fixation	102	0	2	5	3	7	30
Irrigation	0	0	0	0	0	0	0
Supplements imported	16	3	11	2	1	1	1
Nutrients removed							
As products	71	13	14	5	21	1	4
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	52	0	0	0	0	0	0
To water	47	1.7	16	42	59	14	42
Change in internal pools							
Plant material	-8	-1	-7	0	-1	-1	0
Organic pool	42	7	1	4	0	0	0
Inorganic mineral	0	12	-31	0	-3	-5	-5
Inorganic soil pool	17	0	42	0	-9	3	-10

Nitrogen budget for high rainfall dairy farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Milking Platform ##	4658	48	6.2	202	117
MP Effluent ##	1514	81	10.3	427	358
Runoff Rolling ##	720	15	1.8	118	117
Runoff Gullies	386	15	N/A	41	36
Turnips	936	134	**14.0**	289	44
Kale	981	196	**20.6**	299	44
Other farm sources	360				
Whole farm	9556	47			
Less N removed in wetlands	0				
Farm output	9556	47			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for high rainfall dairy farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Milking Platform ##	128	1.3	Medium	Medium	n/a
MP Effluent ##	40	2.1	High	Medium	Extreme
Runoff Rolling ##	65	1.3	Medium	High *	n/a
Runoff Gullies	28	1.1	Medium	n/a	n/a
Turnips	4	0.6	n/a	n/a	n/a
Kale	3	0.6	n/a	n/a	n/a
Other farm sources	70				
Whole farm	338	1.7			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for high rainfall dairy farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		100
Fertiliser N	kg N/ha/yr		102
Other N added	kg N/ha/yr		18
Indices			
Average N loss to water	kg N/ha/yr	24-42	47
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		7
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	123-191	150
N conversion efficiency	%	27-35	32

C.5 Irrigated flat dairy

Nutrient budget for irrigated dairy farm

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	77	24	4	45	22	0	0
Rain/clover N fixation	99	0	2	4	2	4	18
Irrigation	6	0	4	6	22	5	22
Supplements imported	33	4	30	3	6	2	2
Nutrients removed							
As products	62	11	12	4	17	1	4
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	72	0	0	0	0	0	0
To water	24	0.9	10	50	63	6	20
Change in internal pools							
Plant material	-7	0	-12	1	-1	-1	-1
Organic pool	41	8	1	3	0	0	0
Inorganic mineral	0	7	-19	0	-3	-4	-5
Inorganic soil pool	22	0	46	0	-25	10	24

Nitrogen budget for irrigated dairy farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Effluent Unirrigated ##	947	35	10.3	328	204
Effluent Irrigated ##	1923	71	7.8	339	204
MP Irrigated ##	1821	19	2.1	238	110
MP Unirrigated ##	1732	18	6.0	222	110
Trees	2	2	N/A		
Runoff ##	1348	10	2.9	100	46
Turnips	365	17	5.6	216	41
Kale	857	86	**27.4**	228	44
Oats	991	99	**30.6**	230	44
Other farm sources	278				
Whole farm	10263	24			
Less N removed in wetlands	0				
Farm output	10263	24			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for irrigated dairy farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Effluent Unirrigated ##	14	0.5	Low	Low	Medium
Effluent Irrigated ##	46	1.7	Medium	Medium *	Medium
MP Irrigated ##	110	1.2	Medium	Medium	n/a
MP Unirrigated ##	27	0.3	Low	Low	n/a
Trees	0	0.1	n/a	n/a	n/a
Runoff ##	42	0.3	Low	Low	n/a
Turnips	13	0.6	n/a	n/a	n/a
Kale	11	1.1	n/a	n/a	n/a
Oats	7	0.7	n/a	n/a	n/a
Other farm sources	108				
Whole farm	378	0.9			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for irrigated dairy farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		97
Fertiliser N	kg N/ha/yr		77
Other N added	kg N/ha/yr		41
Indices			
Average N loss to water	kg N/ha/yr	24-42	24
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		38.8
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	123-191	153
N conversion efficiency	%	27-35	29

C.6 Organic dairy

Nutrient budget for organic dairy farm

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	0	24	17	72	12	0	0
Rain/clover N fixation	140	0	2	3	2	3	12
Irrigation	10	0	6	10	38	9	38
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	72	15	12	6	25	1	4
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	47	0	0	0	0	0	0
To water	35	0.8	10	78	80	5	16
Change in internal pools							
Plant material	-1	0	-3	0	0	0	0
Organic pool	-8	11	1	2	1	0	0
Inorganic mineral	0	3	-25	0	-4	-12	-14
Inorganic soil pool	5	-5	31	0	-51	18	45

Nitrogen budget for organic dairy farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Effluent Block ##	2135	85	**11.6**	281	185
Irrigated Pallic ##	1355	36	4.9	140	0
Irrigated Recent ##	6345	57	7.8	134	0
Non-Irrigated Recent ##	403	17	7.3	105	0
Runoff	1757	12	5.0	44	0
Turnips	164	14	6.0	165	0
Other farm sources	143				
Whole farm	12302	35			
Less N removed in wetlands	0				
Farm output	12302	35			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for organic dairy farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Effluent Block ##	28	1.1	Medium	Low	Medium
Irrigated Pallic ##	44	1.2	Medium	Medium	n/a
Irrigated Recent ##	100	0.9	Medium	Low	n/a
Non-Irrigated Recent ##	2	0.1	Low	Low	n/a
Runoff	14	0.1	Low	Low	n/a
Turnips	2	0.2	n/a	n/a	n/a
Other farm sources	85				
Whole farm	275	0.8			

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for organic dairy farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		138
Fertiliser N	kg N/ha/yr		0
Other N added	kg N/ha/yr		12
Indices			
Average N loss to water	kg N/ha/yr	24-42	35
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		9.2
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	123-191	78
N conversion efficiency	%	27-35	48

C.7 Sheep and beef finishing, summer dry

Nutrient budget for sheep & beef finishing farm, summer dry

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	3	16	2	20	35	0	0
Rain/clover N fixation	82	0	2	4	2	5	20
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	17	3	1	2	5	0	1
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	22	0	0	0	0	0	0
To water	9	0.2	4	20	16	2	3
Change in internal pools							
Plant material	1	0	-2	1	0	0	0
Organic pool	32	4	0	1	0	0	0
Inorganic mineral	0	6	-22	0	-2	-3	-4
Inorganic soil pool	5	3	23	0	18	6	20

Nitrogen budget for sheep & beef finishing farm, summer dry

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Flats ##	1192	9	3.3	75	0
Easy Hills	1806	7	N/A	74	0
Steep Hills	1327	7	N/A	73	0
Rape	835	83	**33.0**	352	81
Kale	556	56	**22.0**	282	81
Unproductive	105	3	N/A		
Other farm sources	65				
Whole farm	5886	9			
Less N removed in wetlands	0				
Farm output	5886	9			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for sheep & beef finishing farm, summer dry

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Flats ##	3	0	Low	Low	n/a
Easy Hills	42	0.2	Low	Low	n/a
Steep Hills	23	0.1	Low	Low	n/a
Rape	1	0.1	n/a	n/a	n/a
Kale	1	0.1	n/a	n/a	n/a
Unproductive	4	0.1	n/a	n/a	n/a
Other farm sources	43				
Whole farm	117	0.2			

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for sheep & beef finishing farm, summer dry

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		80
Fertiliser N	kg N/ha/yr		3
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	9
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		1.8
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	69
N conversion efficiency	%	15-25	19

C.8 Sheep and beef breeding, summer wet

Nutrient budget for sheep & beef breeding farm, summer wet

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	36	26	0	36	54	0	0
Rain/clover N fixation	61	0	2	4	3	6	24
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	13	2	1	2	4	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	28	0	0	0	0	0	0
To water	22	2.6	17	37	56	11	35
Change in internal pools							
Plant material	3	0	-2	1	0	0	0
Organic pool	28	7	0	2	0	0	0
Inorganic mineral	0	6	-24	0	-3	-4	-5
Inorganic soil pool	3	8	11	0	0	0	-6

Nitrogen budget for sheep & beef breeding farm, summer wet

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Rolling ##	2640	17	N/A	98	49
Steep	2376	13	N/A	87	30
Rape	2422	242	**33.0**	257	36
Plantain	804	89	**11.6**	266	28
Unproductive	60	3	N/A		
Other farm sources	110				
Whole farm	8412	22			
Less N removed in wetlands	0				
Farm output	8412	22			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for sheep & beef breeding farm, summer wet

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Rolling ##	158	1	Medium	Medium	n/a
Steep	787	4.1	Extreme	High *	n/a
Rape	5	0.5	n/a	n/a	n/a
Plantain	3	0.3	n/a	n/a	n/a
Unproductive	2	0.1	n/a	n/a	n/a
Other farm sources	30				
Whole farm	984	2.6			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for sheep & beef breeding farm, summer wet

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		62
Fertiliser N	kg N/ha/yr		38
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	23
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		8.9
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	89
N conversion efficiency	%	15-25	14

C.9 Sheep and beef finishing, summer wet

Nutrient budget for sheep & beef finishing farm, summer wet

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	18	25	1	30	58	0	0
Rain/clover N fixation	56	0	2	4	3	6	22
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	13	2	1	2	4	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	30	0	0	0	0	0	0
To water	17	4.6	12	33	43	16	44
Change in internal pools							
Plant material	-2	0	-2	0	-2	0	0
Organic pool	15	9	0	0	0	0	0
Inorganic mineral	0	3	-21	0	-3	-5	-5
Inorganic soil pool	1	7	13	0	18	-5	-17

Nitrogen budget for sheep & beef finishing farm, summer wet

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Rolling	4884	13	1.7	78	23
Steep	583	12	N/A	62	0
Crop 1	3232	269	**30.3**	329	39
Unproductive	270	3	N/A		
Other farm sources	144				
Whole farm	9113	17			
Less N removed in wetlands	0				
Farm output	9113	17			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Phosphorus budget for sheep & beef finishing farm, summer wet

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Rolling	1961	5.1	Extreme	Extreme *	n/a
Steep	427	8.5	Extreme	Extreme *	n/a
Crop 1	36	3	n/a	n/a	n/a
Unproductive	9	0.1	n/a	n/a	n/a
Other farm sources	33				
Whole farm	2465	4.6			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Nitrogen summary for sheep & beef finishing farm, summer wet

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		54
Fertiliser N	kg N/ha/yr		18
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	17
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		12.5
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	61
N conversion efficiency	%	15-25	18

C.10 Sheep and bull finishing

Nutrient budget for sheep & bulls farm

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	9	25	0	27	48	0	0
Rain/clover N fixation	58	0	2	3	2	3	12
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	9	1	0	1	2	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements	5	1	4	0	1	0	0
To atmospheric	25	0	0	0	0	0	0
To water	8	0.7	5	29	28	2	7
Change in internal pools							
Plant material	-4	0	-3	0	-4	0	0
Organic pool	17	8	0	0	0	0	0
Inorganic mineral	0	4	-11	0	-3	-4	-5
Inorganic soil pool	7	11	7	0	26	5	9

Nitrogen budget for sheep & bulls farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Flats	4170	8	2.7	74	15
Flats irrigated	345	9	2.8	100	55
Rolling	1849	8	3.0	64	0
Steep Hill	728	7	N/A	65	0
Crop 1	857	27	9.2	270	0
Unproductive	549	3	N/A		
Other farm sources	113				
Whole farm	8612	8			
Less N removed in wetlands	0				
Farm output	8612	8			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Phosphorus budget for sheep & bulls farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Flats	153	0.3	Low	Low	n/a
Flats irrigated	19	0.5	Low	Low	n/a
Rolling	314	1.4	Medium	High *	n/a
Steep Hill	226	2.3	High	Extreme *	n/a
Crop 1	16	0.5	n/a	n/a	n/a
Unproductive	18	0.1	n/a	n/a	n/a
Other farm sources	66				
Whole farm	812	0.7			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Nitrogen summary for sheep & bulls farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		56
Fertiliser N	kg N/ha/yr		9
Other N added	kg N/ha/yr		3
Indices			
Average N loss to water	kg N/ha/yr	5-20	8
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		7.5
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	53
N conversion efficiency	%	15-25	21

C.11 Irrigated sheep and beef trading

Nutrient budget for irrigated sheep & beef trading farm

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	44	29	0	55	64	0	0
Rain/clover N fixation	68	0	2	4	2	5	20
Irrigation	4	0	3	4	15	3	15
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	13	2	1	2	5	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements	5	1	4	0	1	0	0
To atmospheric	43	0	0	0	0	0	0
To water	15	0.8	10	59	35	3	14
Change in internal pools							
Plant material	-2	0	-14	3	1	-1	-1
Organic pool	22	11	0	-1	0	0	0
Inorganic mineral	0	4	-10	0	-2	-3	-3
Inorganic soil pool	20	10	13	0	42	9	25

Nitrogen budget for irrigated sheep & beef trading farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Flats ##	1247	9	4.3	130	68
Rolling ##	693	11	5.3	109	31
Easy Hill ##	336	11	N/A	91	0
Kale	1069	43	**21.0**	192	0
Rape	1160	39	**18.0**	289	0
Irrigated Flats ##	877	12	1.8	141	68
Unproductive	30	3	N/A		
Other farm sources	35				
Whole farm	5447	15			
Less N removed in wetlands	0				
Farm output	5447	15			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for irrigated sheep&beef trading farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Flats ##	26	0.2	Low	Low	n/a
Rolling ##	50	0.8	Low	High *	n/a
Easy Hill ##	38	1.2	Medium	High *	n/a
Kale	8	0.3	n/a	n/a	n/a
Rape	9	0.3	n/a	n/a	n/a
Irrigated Flats ##	142	2	High	Medium *	n/a
Unproductive	1	0.1	n/a	n/a	n/a
Other farm sources	34				
Whole farm	308	0.8			

** Fertiliser loss is outside the range for New Zealand data - see comments for each block

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for irrigated sheep&beef trading farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		66
Fertiliser N	kg N/ha/yr		44
Other N added	kg N/ha/yr		6
Indices			
Average N loss to water	kg N/ha/yr	5-20	15
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		19.1
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	98
N conversion efficiency	%	15-25	16

C.12 Lamb and bull trading, 20% cropping

Nutrient budget for lamb and bull trading and 20% cropping farm

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	154	32	25	32	41	0	1
Rain/clover N fixation	58	0	2	4	2	4	19
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	55	8	7	7	8	2	2
Exported effluent	0	0	0	0	0	0	0
As supplements and residues	48	6	61	6	16	4	3
To atmospheric	43	0	0	0	0	0	0
To water	20	0.6	8	25	63	6	10
Change in internal pools							
Plant material	-32	-4	-48	-2	-6	-4	-2
Organic pool	-9	6	0	0	0	0	0
Inorganic mineral	0	4	-29	0	-3	-4	-5
Inorganic soil pool	87	9	28	0	-35	0	12

Nitrogen budget for lamb and bull trading and 20% cropping farm

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Flats ##	1212	17	5.6	203	173
Hunter	74	21	7.0	288	35
Barley	562	30	9.2	250	106
Other farm sources	14				
Whole farm	1862	20			
Less N removed in wetlands	0				
Farm output	1862	20			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for lamb and bull trading and 20% cropping farm

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Flats ##	32	0.5	Low	Low	n/a
Hunter	2	0.5	n/a	n/a	n/a
Barley	10	0.5	n/a	n/a	n/a
Other farm sources	8				
Whole farm	52	0.6			

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for lamb and bull trading and 20% cropping farm

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		56
Fertiliser N	kg N/ha/yr		154
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	20
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		14.4
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	118
N conversion efficiency	%	15-25	44

C.13 Sheep and beef breeding, summer dry

Nutrient budget for sheep & beef breeding farm, summer dry

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	8	16	0	19	13	0	0
Rain/clover N fixation	70	0	2	4	2	5	24
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	11	1	1	2	3	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements	0	0	0	0	0	0	0
To atmospheric	20	0	0	0	0	0	0
To water	8	0.2	8	22	18	2	11
Change in internal pools							
Plant material	-1	0	-3	0	0	0	0
Organic pool	35	4	0	0	0	0	0
Inorganic mineral	0	4	-20	0	-2	-3	-4
Inorganic soil pool	6	6	16	0	-3	7	17

Nitrogen budget for sheep&beef breeding farm, summer dry

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Flat ##	487	9	2.8	87	33
Rolling ##	3325	8	2.7	74	8
Steep	937	7	N/A	70	0
Turnips	230	15	5.0	259	11
Unproductive	180	3	N/A		
Other farm sources	89				
Whole farm	5248	8			
Less N removed in wetlands	0				
Farm output	5248	8			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for sheep&beef breeding farm, summer dry

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Flat ##	3	0	Low	Low	n/a
Rolling ##	52	0.1	Low	Low	n/a
Steep	25	0.2	Low	n/a	n/a
Turnips	2	0.1	n/a	n/a	n/a
Unproductive	6	0.1	n/a	n/a	n/a
Other farm sources	36				
Whole farm	123	0.2			

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for sheep&beef breeding farm, summer dry

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		68
Fertiliser N	kg N/ha/yr		8
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	8
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		1.7
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	67
N conversion efficiency	%	15-25	14

C.14 Finishing beef, 65% cropping

Nutrient budget for sheep & beef finishing farm, 65% cropping

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	77	35	8	19	0	0	0
Rain/clover N fixation	38	0	2	3	2	3	12
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	59	11	7	6	11	2	2
Exported effluent	0	0	0	0	0	0	0
As crop residues	9	1	33	2	4	1	1
To atmospheric	35	0	0	0	0	0	0
To water	20	0.5	5	24	33	4	13
Change in internal pools							
Plant material	-27	-4	-56	-1	-5	-3	-3
Organic pool	-115	-7	0	-9	0	0	0
Inorganic mineral	0	4	-7	0	-3	-5	-6
Inorganic soil pool	133	30	27	0	-39	5	5

Nitrogen budget for sheep & beef finishing farm, 65% cropping

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Pasture	2325	13	4.1	104	89
Pac Choy	630	62	**15.9**	322	162
Barley	545	10	3.2	201	51
Peas	2229	73	**17.4**	175	56
Oats	1041	39	**11.8**	269	155
Plantain	544	12	3.7	233	44
Feed Barley	286	16	4.9	272	97
Unproductive	60	3	N/A		
Other farm sources	38				
Whole farm	7697	20			
Less N removed in wetlands	0				
Farm output	7697	20			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Phosphorus budget for sheep & beef finishing farm, 65% cropping

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Pasture	37	0.2	Low	Low	n/a
Pac Choy	14	1.3	n/a	n/a	n/a
Barley	27	0.5	n/a	n/a	n/a
Peas	20	0.6	n/a	n/a	n/a
Oats	25	0.9	n/a	n/a	n/a
Plantain	21	0.5	n/a	n/a	n/a
Feed Barley	9	0.5	n/a	n/a	n/a
Unproductive	2	0.1	n/a	n/a	n/a
Other farm sources	17				
Whole farm	173	0.5			

Nitrogen summary for sheep & beef finishing farm, 65% cropping

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		36
Fertiliser N	kg N/ha/yr		77
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	20
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		17.7
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	56
N conversion efficiency	%	15-25	51

C.15 Dairy support, 15% cropping, summer dry

Nutrient budget for dairy support farm with cropping, summer dry

	N	P	K	S	Ca	Mg	Na
	(kg/ha/yr)						
Nutrients added							
Fertiliser, lime & other	0	26	0	31	57	0	0
Rain/clover N fixation	68	0	2	4	2	5	20
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	27	5	4	2	3	1	1
Exported effluent	0	0	0	0	0	0	0
As supplements, crop exports	31	5	32	3	6	3	3
To atmospheric	30	0	0	0	0	0	0
To water	15	0.3	6	34	25	3	15
Change in internal pools							
Plant material	-21	-2	-19	0	-2	-1	-1
Organic pool	-48	1	1	-4	0	0	0
Inorganic mineral	0	5	-25	0	-5	-8	-9
Inorganic soil pool	34	10	3	0	32	7	12

Nitrogen budget for dairy support farm with cropping, summer dry

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Maramau ##	1117	8	2.3	72	0
Woodside Stones ##	1093	13	3.6	95	0
Barley Woodside	481	51	**11.6**	136	0
Barley Maramau	181	13	3.4	146	0
Wheat Maramu	151	15	3.6	-13	0
Maize Silage Maramu	179	18	4.8	230	0
Rape	1124	118	**34.9**	257	0
Other farm sources	38				
Whole farm	4363	15			
Less N removed in wetlands	0				
Farm output	4363	15			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Has a fodder crop rotating though, results for pastoral block component only

Phosphorus budget for dairy support farm with cropping, summer dry

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Maramau ##	23	0.2	Low	Low	n/a
Woodside Stones ##	18	0.2	Low	Low	n/a
Barley Woodside	4	0.4	n/a	n/a	n/a
Barley Maramau	6	0.4	n/a	n/a	n/a
Wheat Maramu	4	0.4	n/a	n/a	n/a
Maize Silage Maramu	5	0.5	n/a	n/a	n/a
Rape	6	0.6	n/a	n/a	n/a
Other farm sources	12				
Whole farm	77	0.3			

Has a fodder crop rotating though, results for pastoral block component only

Nitrogen summary for dairy support farm with cropping, summer dry

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		31
Fertiliser N	kg N/ha/yr		69
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	93
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		14.9
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	76
N conversion efficiency	%	15-25	25

C.16 Dairy support, 48% cropping, summer wet

Nutrient budget for dairy support farm with cropping, summer wet

	N	P	K	S	Ca	Mg	Na
				(kg/ha/yr)			
Nutrients added							
Fertiliser, lime & other	69	19	17	15	31	1	0
Rain/clover N fixation	33	0	2	4	3	5	21
Irrigation	0	0	0	0	0	0	0
Supplements imported	0	0	0	0	0	0	0
Nutrients removed							
As products	26	5	4	2	5	1	1
Exported effluent	0	0	0	0	0	0	0
As crop residues	7	1	20	2	4	1	1
To atmospheric	45	0	0	0	0	0	0
To water	93	1	8	20	96	9	30
Change in internal pools							
Plant material	-4	-1	16	5	5	1	3
Organic pool	-67	-9	2	-11	1	0	0
Inorganic mineral	0	5	-26	0	-7	-11	-13
Inorganic soil pool	2	17	-4	0	-70	6	-1

Nitrogen budget for dairy support farm with cropping, summer wet

Block name	Total N lost (kg N/yr)	N lost to water (kg N/ha/yr)	N in drainage * (ppm)	N surplus (kg N/ha/yr)	Added N ** (kg N/ha/yr)
Flat	968	6	1.1	125	40
Kale Yr 1	9645	193	**30.9**	303	122
Barley	6598	132	**17.7**	182	30
Kale Yr 2	10558	211	**33.8**	327	143
Other farm sources	65				
Whole farm	27832	93			
Less N removed in wetlands	0				
Farm output	27832	93			

* Estimated N concentration in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is not an environmental water quality standard).

** Sum of fertiliser and external factory effluent inputs.

N/A: N in drainage not calculated for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Phosphorus budget for dairy support farm with cropping, summer wet

Block name	Total P (kg P/yr)	P lost (kg P/ha/yr)	P loss categories		
			Soil	Fertiliser	Effluent
Flat	73	0.5	Low	Medium	n/a
Kale Yr 1	75	1.5	n/a	n/a	n/a
Barley	46	0.9	n/a	n/a	n/a
Kale Yr 2	99	2	n/a	n/a	n/a
Other farm sources	11				
Whole farm	304	1			

Nitrogen summary for dairy support farm with cropping, summer wet

	Units	Benchmark farm	Current farm
Inputs (farm average)			
Clover N	kg N/ha/yr		31
Fertiliser N	kg N/ha/yr		69
Other N added	kg N/ha/yr		2
Indices			
Average N loss to water	kg N/ha/yr	5-20	93
includes N lost as effluent	kg N/ha/yr		0
N_2O emissions	kg N/ha/yr		14.9
For pastoral area of farm:			
Farm N surplus	kg N/ha/yr	30-80	76
N conversion efficiency	%	15-25	25

REPORT ENDS