AGRICULTURE RESEARCH GROUP ON SUSTAINABILITY

Annual ARGOS Dairy Farmer Report (Example)

Compiled by Dave Lucock, ARGOS

October 2008

TABLE OF CONTENTS

TABLE OF FIGURES

Preface

This report has compiled as an example of a farm management report that are received by farmers involved in ARGOS. It contains the following sections of information:

1. Economic report including financial analysis and a market access report
2. Environment report on birds, streams, microbial activity, clover root weevil and earthworms
3. Farm management report
4. Social causal mapping

This report will be updated annually and will be complemented with other information gathered by the ARGOS team. It will include information about the social, economic and ecological indicators being measured throughout the course of the research.

Every effort has been made to ensure that all the information is accurate. However, if there are any inaccuracies, please let us know as soon as possible.

Please be assured that this report and its information will remain confidential to the ARGOS team.

Please contact me if you have any questions.

Dave Lucock

03 365 6804

0272 580 771

dave@agribusinessgroup.com

www.argos.org.nz

1 ARGOS

Introduction

The Agricultural Research Group on Sustainability (ARGOS) is an unincorporated joint venture between the Agribusiness Group, Lincoln University, and the University of Otago. It is funded by the Foundation for Research, Science and Technology (FRST) and various industry stakeholders and commenced in October 2003. ARGOS is a six year research project with the aim to model the economic, environmental, and social differences between organic, and conventional systems of production. The aim is to detail the impact of these systems and develop indicators which reflect the interactions across the social, economic and environmental factors. The ARGOS study is also assessing market developments overseas and how these are likely to affect and be implemented in NZ. The costs of implementation and potential benefits of these will be further assessed using the LTEM (the Lincoln Trade and Environment Model). This enables the impact of various scenarios relating to the level of production and consumption, premiums and production costs to be assessed, both NZ and other countries. The project covers different farming systems in a number of sectors including kiwifruit, sheep & beef, high country, dairy and farms owned by Ngai Tahu landowners.

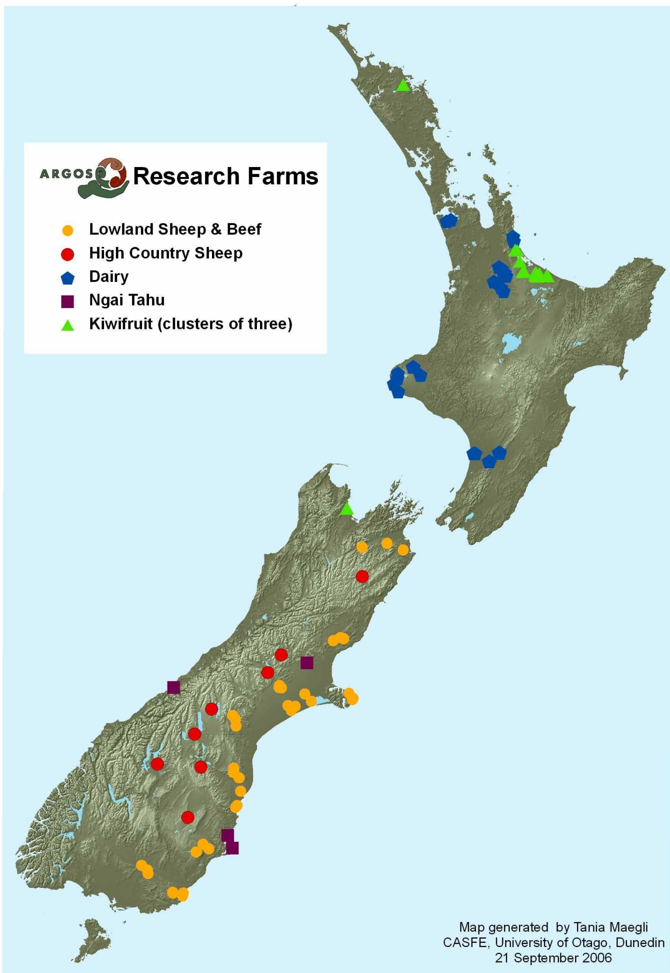


Figure 1 Location of Properties under study by ARGOS

1.1 Levels of focus in the ARGOS Project

The prime aims of this study are to undertake a comparison between agricultural sectors and between management systems within those sectors. Within the management systems, landforms, management units and soil monitoring sites are being studied. These are defined as follows:

Agricultural Sector. This includes dairy, high country and farms owned by Ngai Tahu landowners in addition to kiwifruit and sheep & beef farms.

Management System. For Dairy properties, the two management systems (Panels) are:

- Organic (initially converting to organic)
- Conventional

These 2 management systems may also be referred to as ‘Panels’ i.e. ARGOS is studying a panel of organic farms and a panel of conventional farms.

Cluster. ARGOS farms are arranged in clusters with each one containing two farms i.e. an organic and a conventional farm. The Dairy clusters are spread from South Auckland to the Manawatu. Within each cluster, farms are as close together as possible to minimize differences in background variables like soil type and climate.

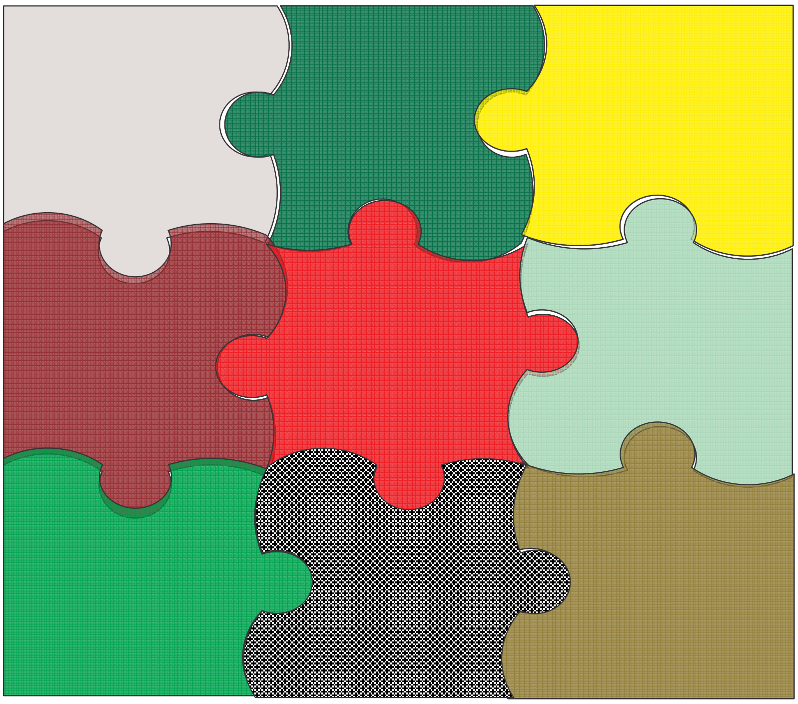
Landform This term is used to describe the different geomorphology within a property. The principal landforms monitored here can be broadly described as river terrace (flats), hill crest (crest) and mid-slope (slope). Given the huge variation in soils and landscape across the properties being studied, we only study the two most dominant landforms within each cluster. For flat farms, only the one landform is studied.

Management Unit Management unit (MU) is a paddock. For each landform, three management units (focal paddocks) are monitored.

2 Farm Management

Introduction

Farm Management, in ARGOS, is studied from a management systems approach with three main areas (‘objectives’) of study; economic, social and the ecological environment. The Economics objective looks at production (both financial and non-financial) through to socio-economics of production systems. The Social objective looks at the ‘people’ implications of farm systems, motivational drivers, life cycles, whilst the Environment objective looks at the impact/implications of the farming system on the environment. Boundaries of the three objectives overlap, leading to overarching research that is a transdisciplinary study of farming systems. It was recognised that generic descriptors, of the farms under study, need to be supplied to the three objectives and this led to a fourth objective, the Farm Management objective. This objective is responsible for collecting physical and managerial style farm data and the preliminary analysis of this data, where appropriate. Initially descriptive data was collected to provide an overview of each property. Additional data will be collected annually to cover the different parts of the farming system as outlined in Figure 2 These factors can be regarded as ‘dots in a box’, so the next step will be to learn how these factors interrelate.



Stock

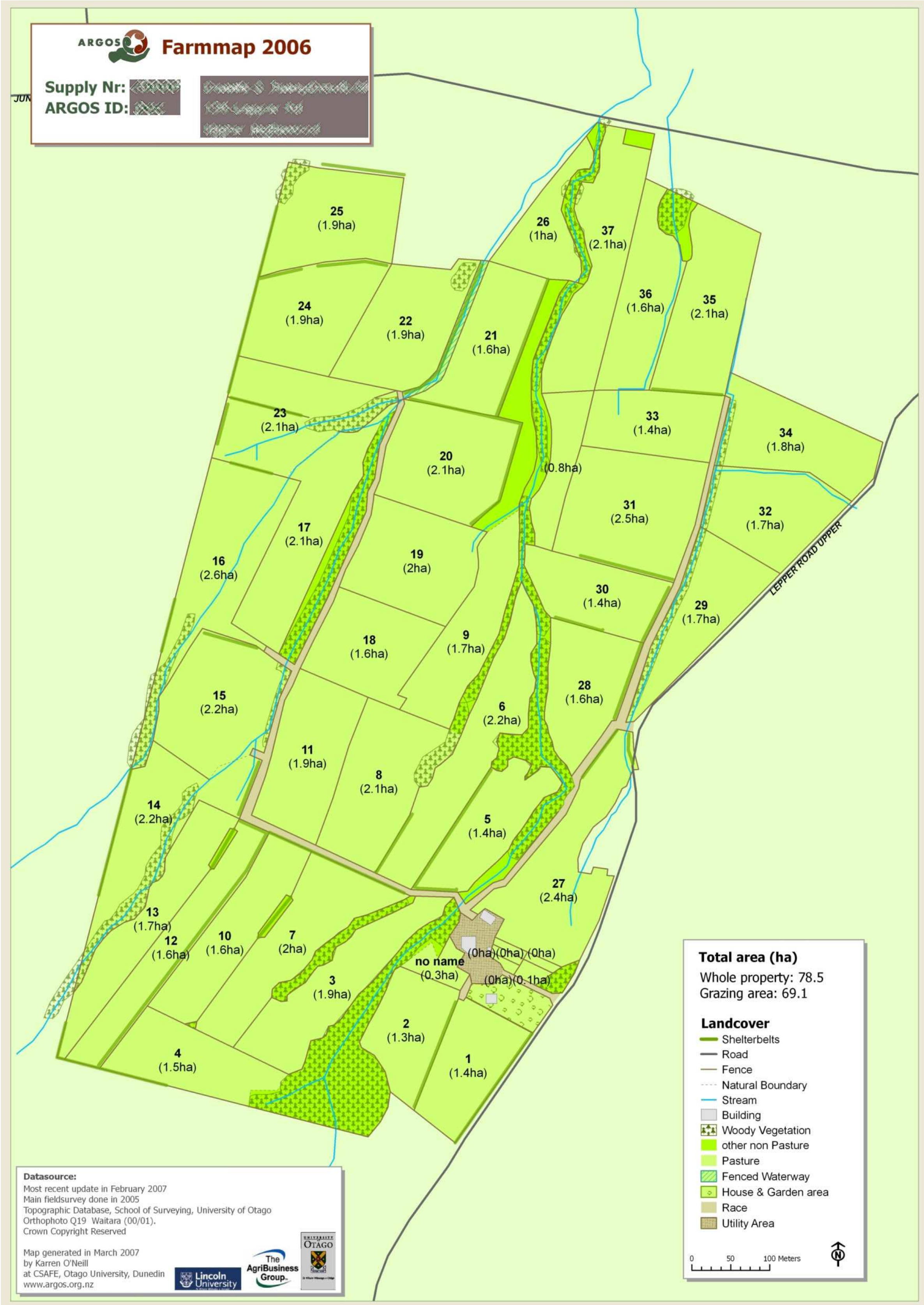
Figure 2 Farm management factors collected in annual surveys.

2.1 Farm Maps

Farm mapping is an integral part of ARGOS, providing information in a visual format that can simplify some of the complexities in a transdisciplinary project. The maps have also been designed to provide updates for farmers.

These maps will assist ARGOS researchers to plan their monitoring programmes and to interpret the results of these. GIS means that each map has associated levels of data linked to them which will facilitate the identification of patterns within farms. An example of one of these maps is presented below. Later, it should be possible to analyse spatial patterns in farm attributes like soil quality e.g. does soil quality depend on distance from shelterbelts?

Soil Re


ARGOS
Farmmap 2006
Supply Nr:
ARGOS ID:
25 (1.9ha)
26 (1ha)
37 (2.1ha)
24 (1.9ha)
22 (1.9ha)
21 (1.6ha)
36 (1.6ha)
35 (2.1ha)
23 (2.1ha)
20 (2.1ha)
(0.8ha)
33 (1.4ha)
34 (1.8ha)
31 (2.5ha)
32 (1.7ha)
17 (2.1ha)
16 (2.6ha)
19 (2ha)
30 (1.4ha)
29 (1.7ha)
LEPPER ROAD UPPER
18 (1.6ha)
9 (1.7ha)
15 (2.2ha)
28 (1.6ha)
6 (2.2ha)
11 (1.9ha)
8 (2.1ha)
14 (2.2ha)
5 (1.4ha)
27 (2.4ha)
13 (1.7ha)
12 (1.6ha)
10 (1.6ha)
7 (2ha)
no name (0.3ha)
(0ha) (0ha) (0ha)
(0ha) (0.1ha)
3 (1.9ha)
2 (1.3ha)
1 (1.4ha)
4 (1.5ha)
Total area (ha)
Whole property: 78.5
Grazing area: 69.1
Landcover
Shelterbelts
Road
Fence
Natural Boundary
Stream
Building
Woody Vegetation
other non Pasture
Pasture
Fenced Waterway
House & Garden area
Race
Utility Area
0 50 100 Meters
N
Datasource:
Most recent update in February 2007
Main fieldsurvey done in 2005
Topographic Database, School of Surveying, University of Otago
Orthophoto Q19 Waitara (00/01).
Crown Copyright Reserved
Map generated in March 2007
by Karren O'Neill
at CSAFE, Otago University, Dunedin
www.argos.org.nz
Lincoln University
The AgriBusiness Group
University of Otago

2.2 Database

The ARGOS database is centred on the Microsoft Access design. The database is developed alongside the development of the research programme, i.e. the data and the structure of the data is not determined in advance as it is ‘tailored’ through the linking of datasheets (Figure 3) to suit the research programmes needs. Each dataset that Argos collects will be related to this basic structure of properties and people. This data is seldom entered directly in the database and in most cases the database administrator will import data from Excel spreadsheets.

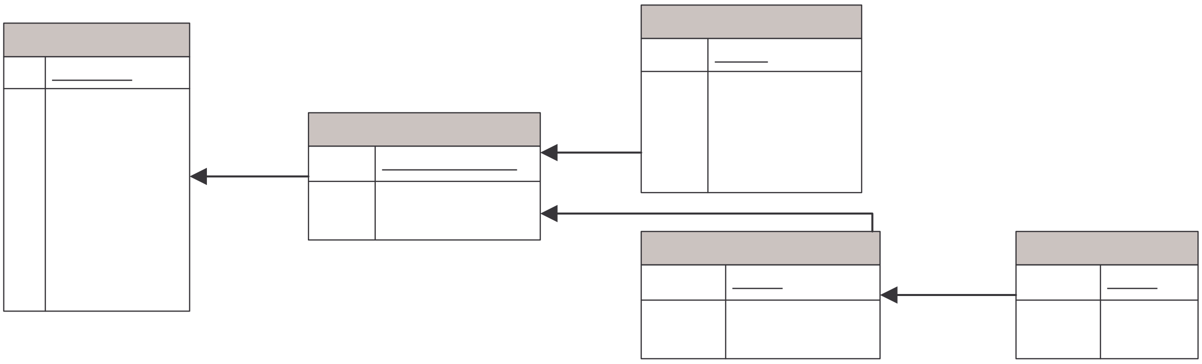


Figure 3 Database structure

2.3 Inputs

Farm management inputs ranging from time spent farming to soil inputs are recorded annually. Data from the previous two annual management surveys was collated and compared across farms. In this section reproductive management, somatic cell count and soil inputs strategies are reported.

2.3.1 Soil inputs

Compost and Biodynamic Teas were unable to be analysed due to lack of industry standards, however nutrient data was available for the fertiliser applied on the ARGOS dairy farms and was split into N, P, K, S, Ca and Mg nutrient inputs, on a kilogram per hectare (kg/ha) basis for the 2005/2006 and 2006/2007 financial years. Figure 4 and Figure 5 show how your fertiliser inputs compare with other dairy farms of your type (conventional or organic) in ARGOS using “quartiles”.

Definition for Quartile

First quartile = bottom 25% of the farms

Second quartile = 25 to 50%

Third quartile = 50 to 75%

Fourth quartile = top 25% of the farms

Note: The “bottom” or “top” does not mean “best” or “worst”. It is purely the range of data.

I4 PropertyCode
I2 IndustryCode
I1 ClusterCode
Mgmt
I3 MgmtCode
T_
PK
FK

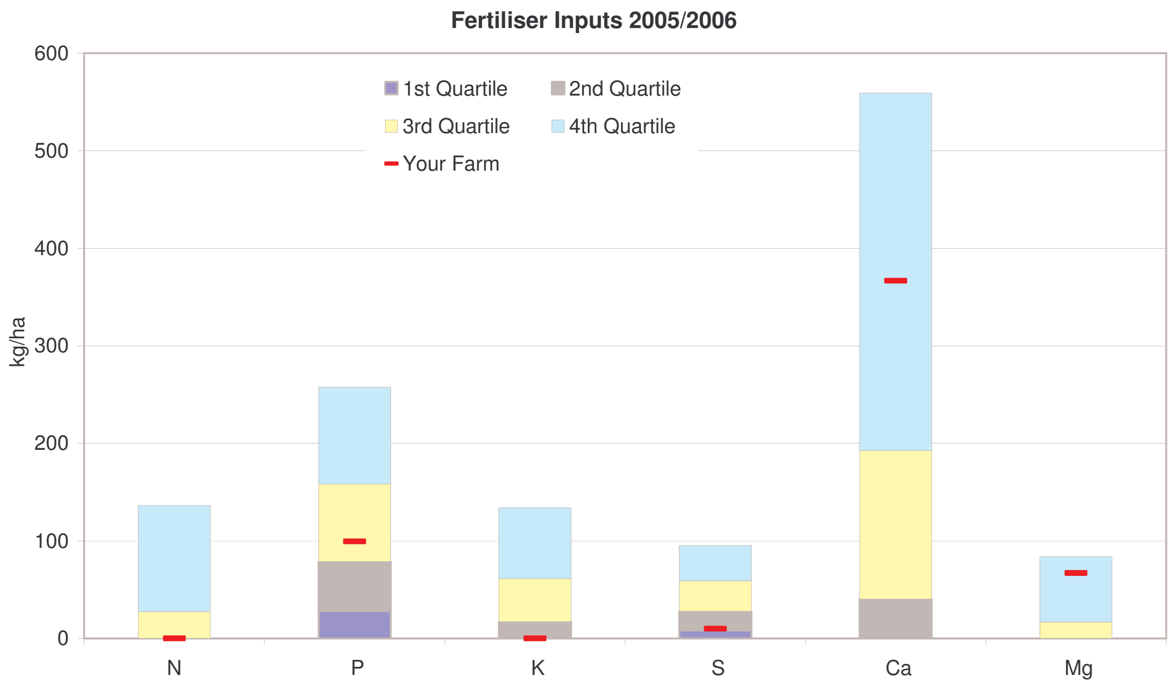


Figure 4 Your fertiliser inputs for 2005/2006 compared with other dairy farms of your management system in ARGOS

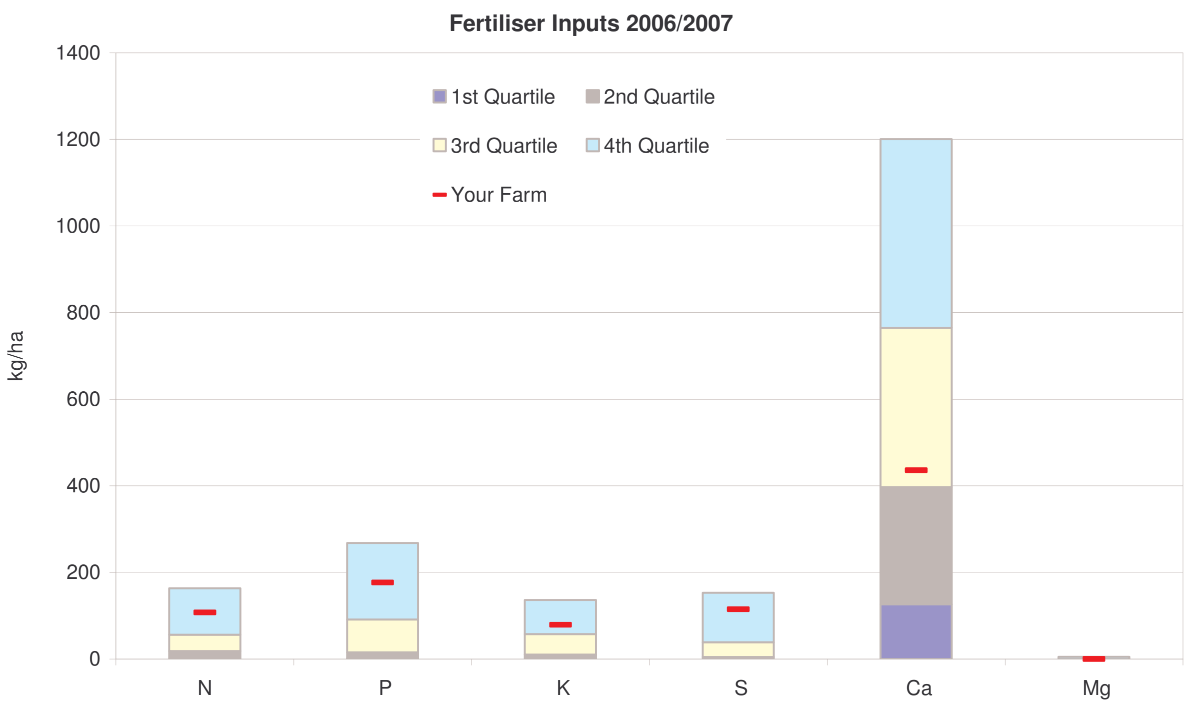


Figure 5 Your fertiliser inputs for 2006/2007 compared with other dairy farms of your management system in ARGOS

2.3.2 Reproduction

There was no difference between organic and conventional systems in regards to the number of weeks of AB, number of weeks that the bull was out, the empty rate and the number of days to the mid- calving date. Figure 6 shows how your farm compares with all other dairy farms in ARGOS using quartiles (see definition page 9).

All but one farmer used tailpaint to detect cows in heat and 6 farmers used Kamar heat detectors (or the equivalent). Four farmers used Cdirs as a synchronization method.

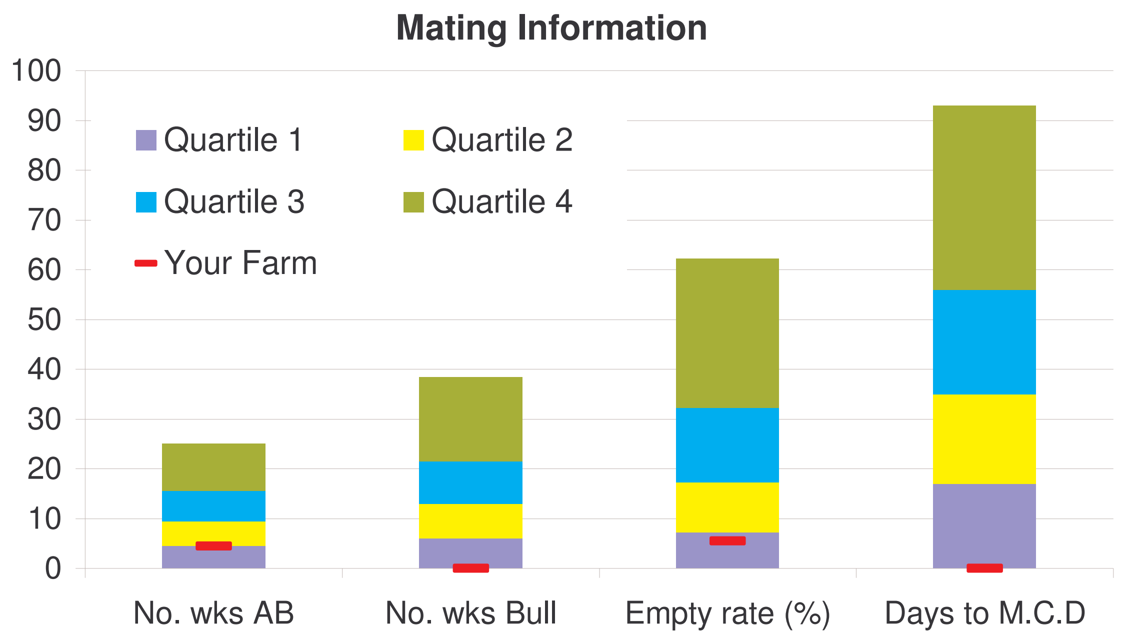
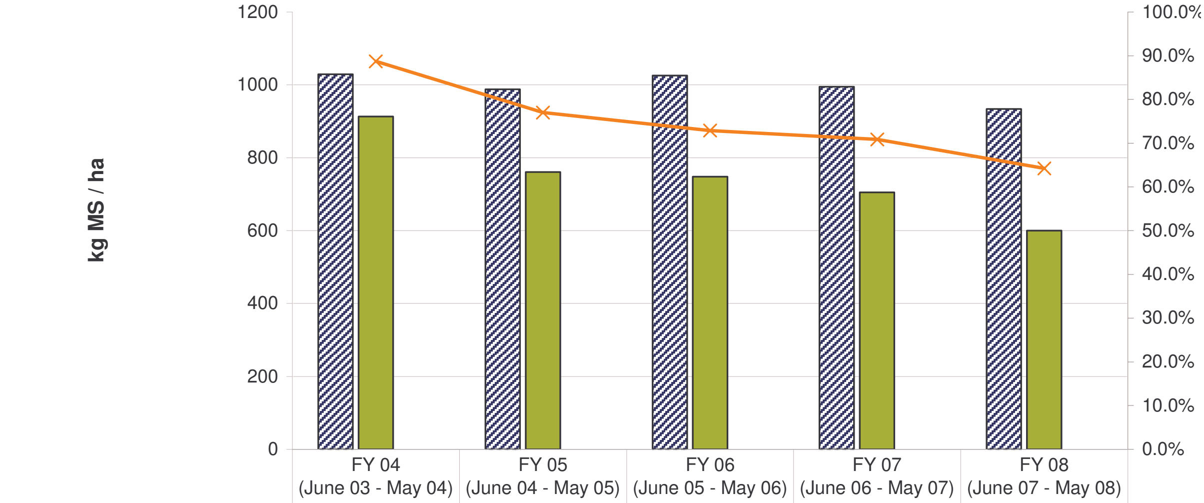


Figure 6 Reproductive indices used to compare your farm with all ARGOS dairy farms

2.3.3 Milk production

The milksolid production per hectare decreased by 12% on the organic farms compared with their conventional neighbors/comparators in the 05/06 season and this increased to a 36% difference in the 07/08 season. This is illustrated by the orange line in the graph below.



	FY 04 (June 03 - May 04)	FY 05 (June 04 - May 05)	FY 06 (June 05 - May 06)	FY 07 (June 06 - May 07)	FY 08 (June 07 - May 08)
Conventional	1029	988	1026	995	934
Converting	913	761	748	705	600
P<	0.01	0.001	0.001	0.001	0.001
Converting/conventional (%)	88.7%	77.0%	72.9%	70.9%	64.2%

Figure 7 Milk production figures for 5 seasons from 2003/2004 to 2007/2008

These figures were analysed further to show how your milk production compares with other farms in your region on an annual basis over five years (Figure 8) and a monthly basis (Figure 9) over the 2006/2007 season

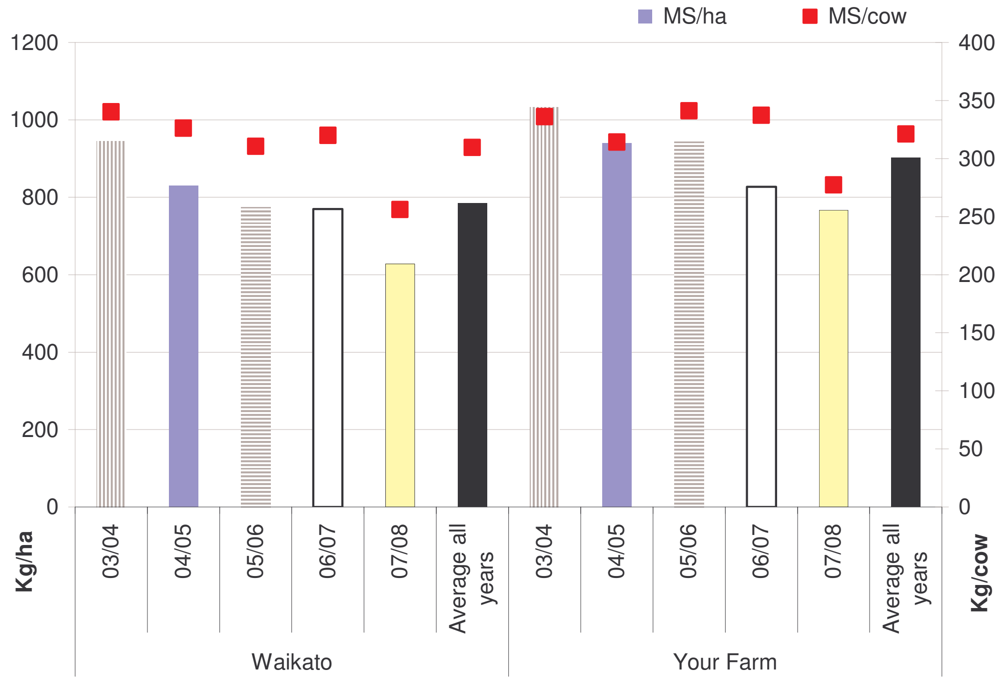


Figure 8 Annual milk production figures for five seasons from 2003/2004 to 2007/2008 comparing your farm with ARGOS dairy farms in your region.

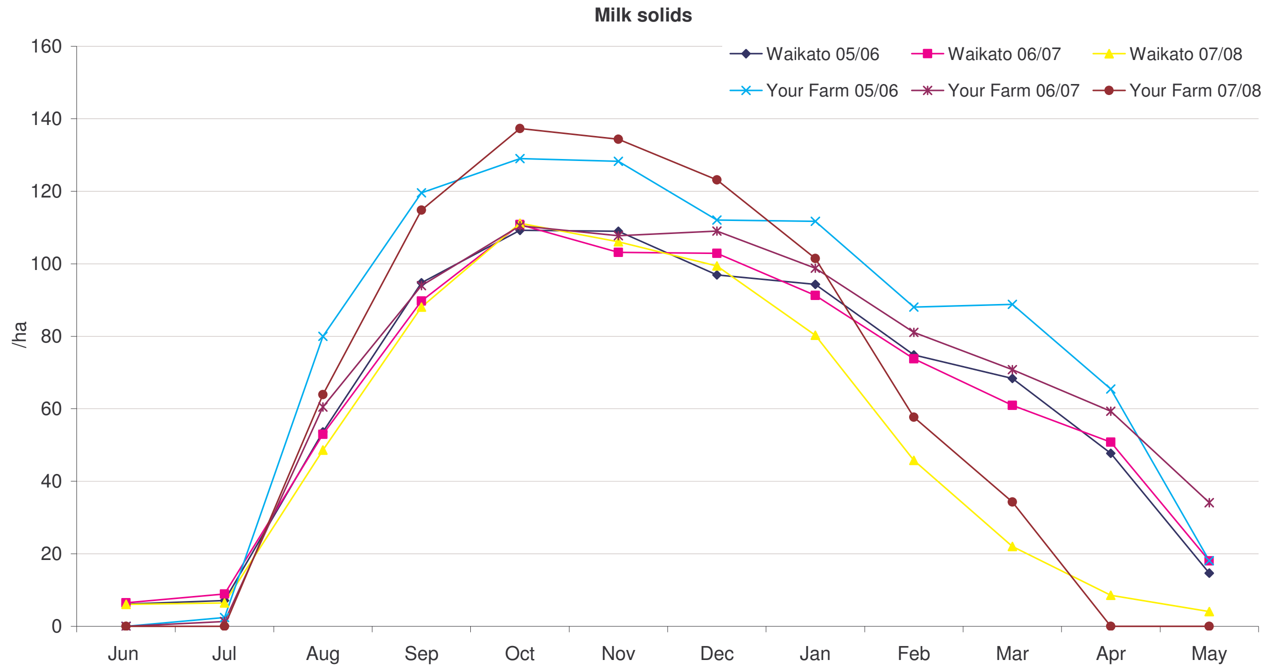


Figure 9 Monthly milk production figures. Comparing your farm with ARGOS dairy farms in your region

Average percentage of milk as milksolids was 8.8% with a range from 7.7 to 10.1% and there was no suggestion of panel effects between organic and conventional systems. The range of fat and protein percentages was very small at 1.3% and 0.5% respectively. Figure 10 shows how your farm compares with all other dairy farms in ARGOS using quartiles (see definition page 9).

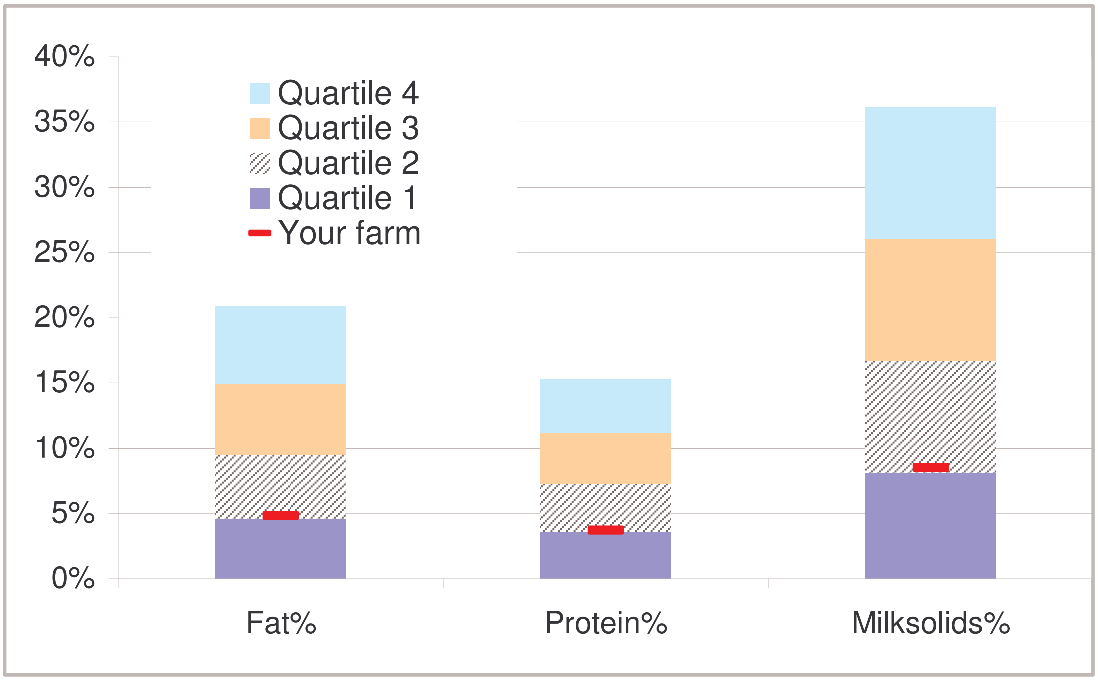


Figure 10 Fat, protein and total milksolid percentages comparing your farm with other dairy farms in ARGOS

2.3.4 Somatic cell counts

Teat spraying was the common preventative treatment used by conventional and organic farmers and the drying off dates were based around cow condition (so that cows could get back to calving condition), milk flow, feed availability and somatic cell counts. Approximately half of the conventional farmers used dry cow therapy over the entire herd with the balance selecting problematic cows with continually high cell counts. The organic farmers used homeopathic remedies such as Nosodes, Phytolacca and cider vinegar.

The initial analysis of the somatic cell count (SCC) data shows that, even though all scc were high, more organic farms had a higher SCC than conventional farms in the 2005/2006 season (Figure 11). In the 2006/2007 season, conventional farmers decreased their scc average by 14% whereas the organic farmers' scc average increased by 8% in the 2006/2007 season (Figure 12).

Monthly somatic cell count and bactoscan data will be required to assist in identifying strategies to reduce the incidence of somatic cell counts.

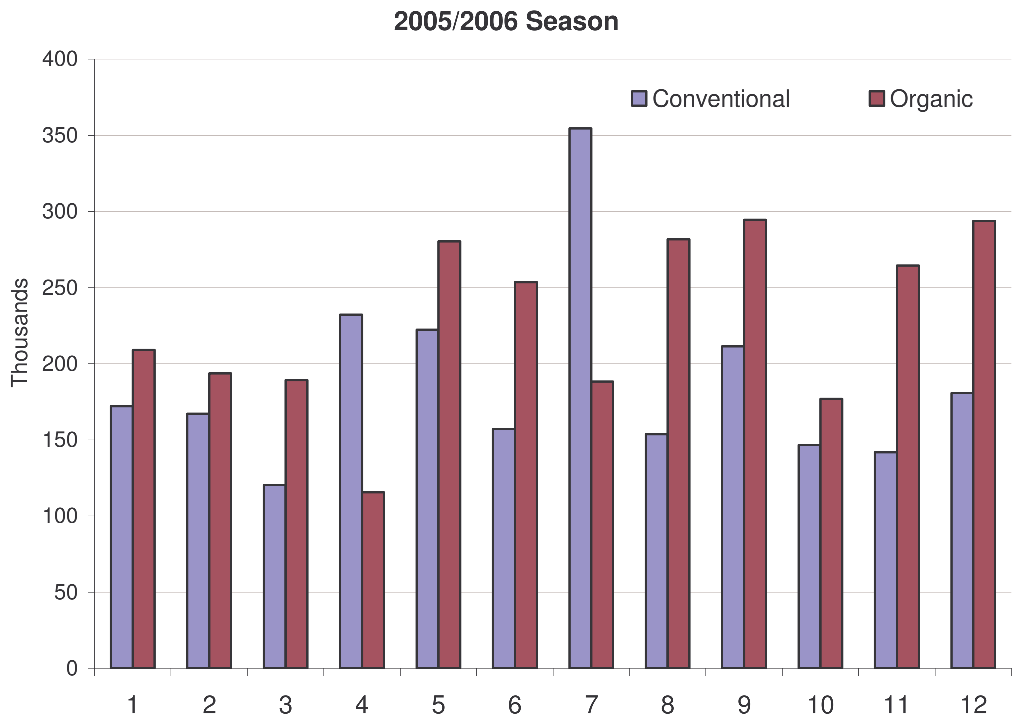


Figure 11 Somatic cell counts in 2005/06 for dairy farms involved in the ARGOS project

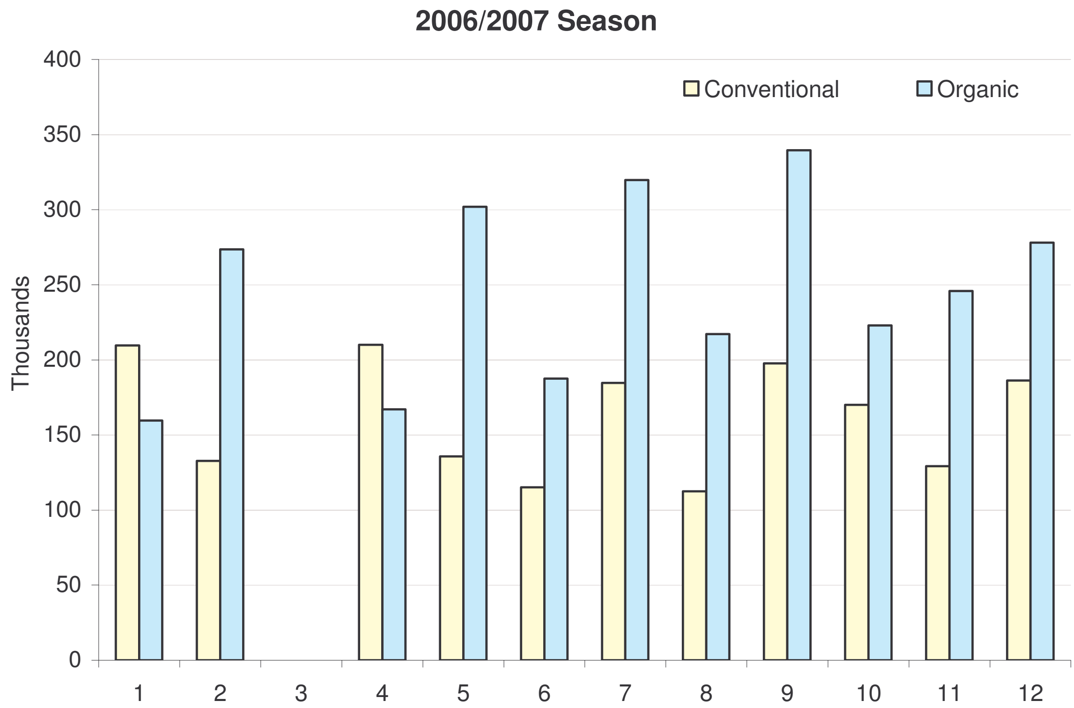


Figure 12 Somatic cell counts in 2006/07 for dairy farms involved in the ARGOS project

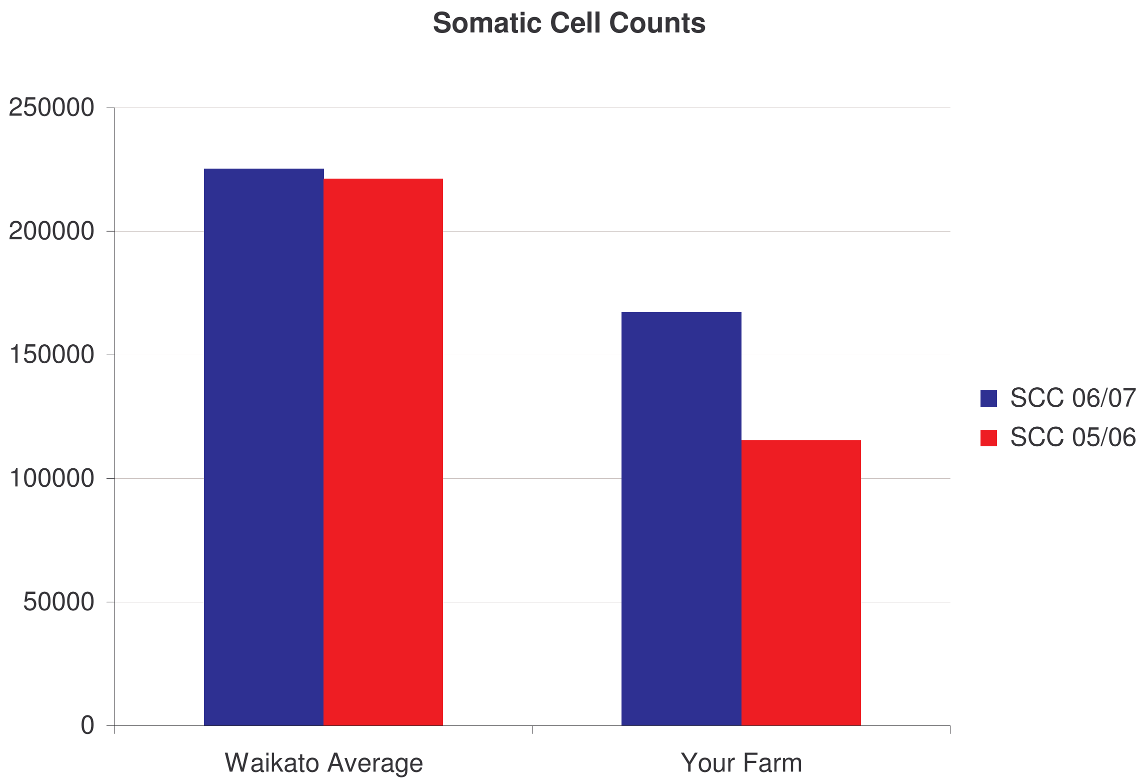


Figure 13 Comparing somatic cell counts for your farm with the average in your region

2.3.5 Financial

Preliminary analysis of the farm accounts for 2006/07 has been completed and shows little difference for Cash Farm Income, Farm Working Expenses and the Operating Surplus between conventional and organic dairy farm systems (Figure 14). However comparisons using 'Minimum', 'Maximum' and 'Median' show differences between systems in a variety of expenses as depicted in Table 1 and simplified in Figure 15 and Figure 16. Statistical analysis is required to validate these findings and they will then be linked to time series data to assess trends between the conventional and organic management systems

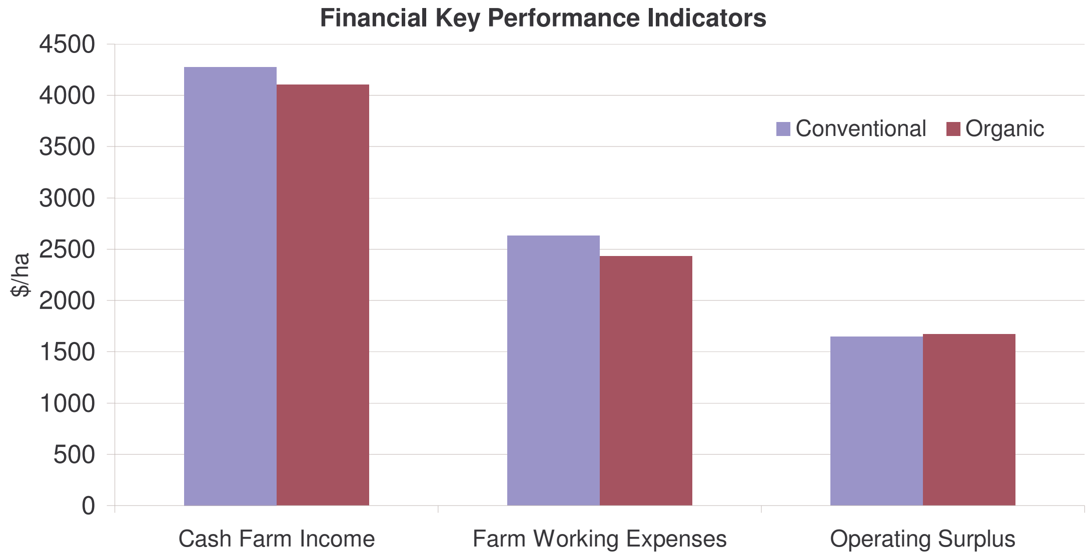


Figure 14 Comparing financial data between ARGOS conventional and organic dairy farms

Table 1 Comparing financial data between ARGOS conventional and organic dairy farms

ARGOS	Conventional Median	Organic Median	Percentage Difference
Cows milked	2.92	2.26	-22.6%
Total milk solids	996	798	-19.9%
REVENUE			
Milksolids - base payout	4111	3849	-6.4%
Net milk solids income	4109	3821	-7.0%
Gross stock income	385	418	8.6%
Less: Cattle Purchases	328	75	-77.2%
Other dairy income	19	11	-44.6%
Non Dairy Farm Income	78	111	43.4%
Cash Farm Income	**4452**	**4173**	-6.3%
EXPENDITURE			
Labour Expenses			
Permanent wages	268	565	110.8%
Casual wages	16	6	-63.4%
ACC	17	24	40.4%
Ag.contracting (not crop/cult.)	269	142	-47.3%
Stock Expenses			
Animal health	42	38	-8.9%
Feed - purchased (all types)	233	199	-14.5%
Feed (grazing)	102	26	-74.9%
Feed Hay and Silage	254	151	-40.8%
Feed -fodder crops			
Total-fodder crops	0	0	0%
Pasture renovation			
Seed	5	5	-12.6%
Fertiliser & lime excl N	352	277	-21.1%
Fertiliser N	16	0	-100%
Contract cultivation	10	0	-100%
Weed and pest	10	1	-85.2%
Total Pasture renovation	494	315	-36.3%
Other expenses			
Electricity	93	98	5.8%
Freight	16	19	18.3%
Vehicle costs (including fuel)	181	174	-4.2%
R & M farm	238	196	-18%
Overheads			
Rates (including water rates)	83	76	-9.2%
Communication costs	23	16	-31.8%
Insurance	0	0	0%
Accountancy	34	29	-12.9%
Legal and consultancy	13	0	-100%
Other admin	30	47	55.3%
Run-off lease	33	32	-3.8%
Other dairy	5	20	295%
Non dairy	0	0	0%
FARM WORKING EXPENSES	**2592**	**1968**	-24.1%
Interest	506	856	69%
Rent	0	387	100%
CASH FARM EXPENDITURE	**3254**	**3704**	13.8%

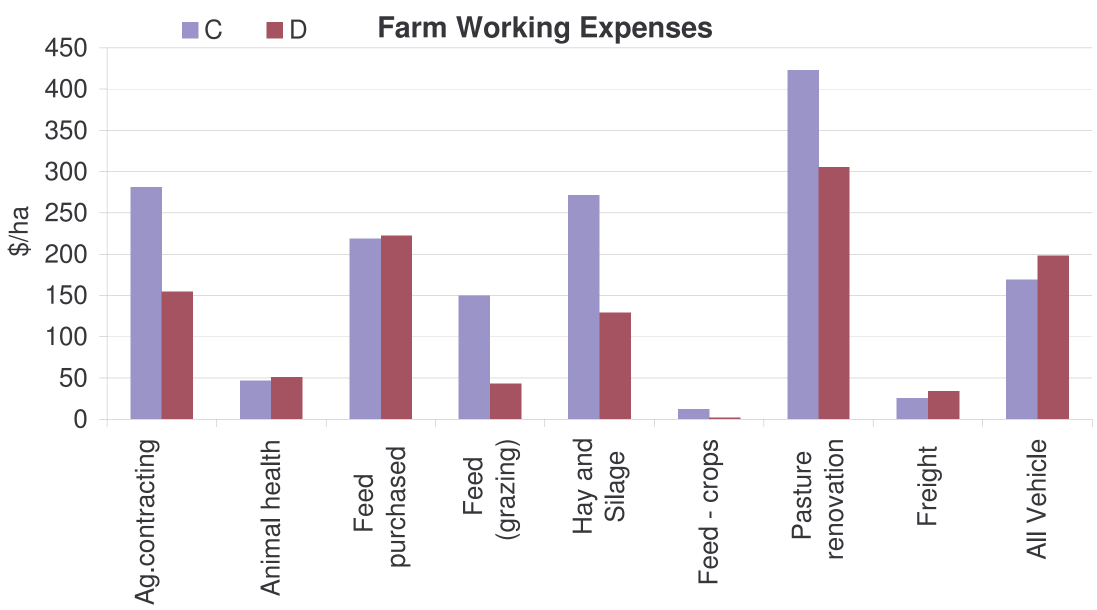


Figure 15 Comparison of selected farm working expenses between conventional (C) and organic dairy farm is ARGOS

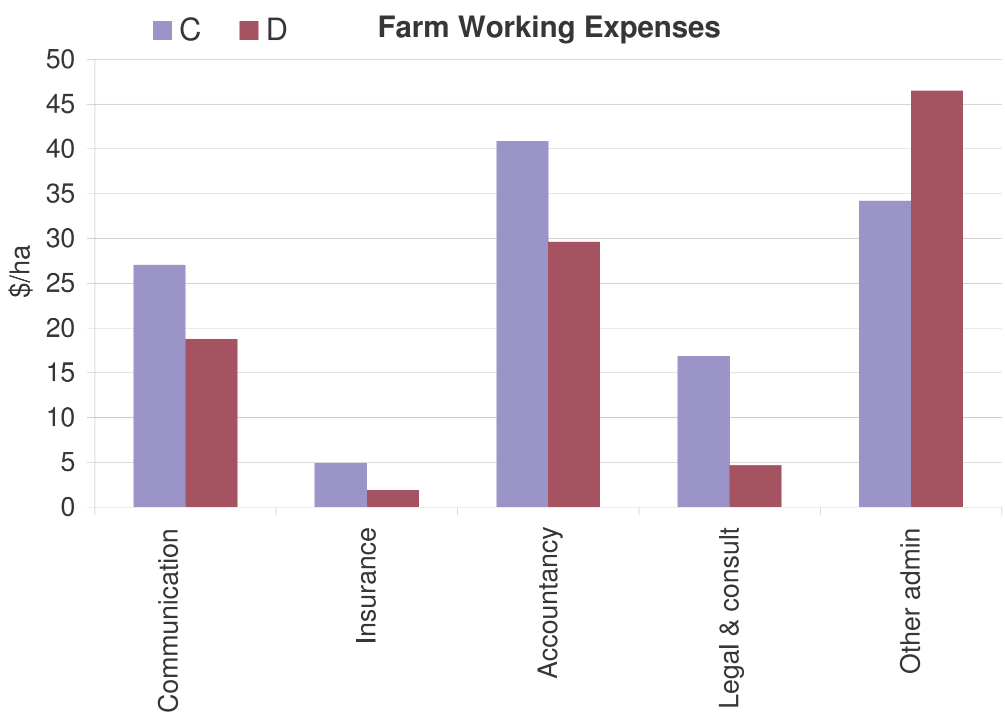


Figure 16 Comparison of selected admin expenses between conventional (C) and organic dairy farm is ARGOS (cont)

Figure 17 and Figure 18 portray the variability of costs across the ARGOS dairy farms using quartiles (see definition page 9) and shows a comparison with your farm.

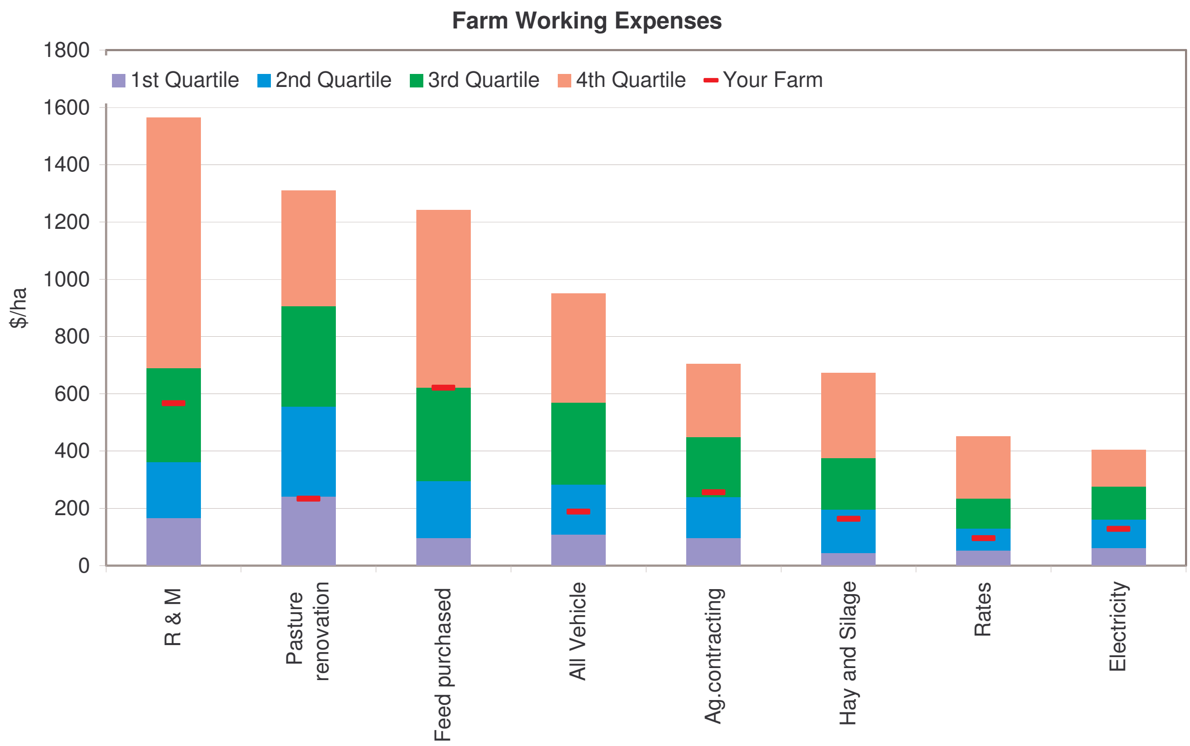


Figure 17 Comparison of farm working costs between your farm and all dairy farms in ARGOS using quartiles.

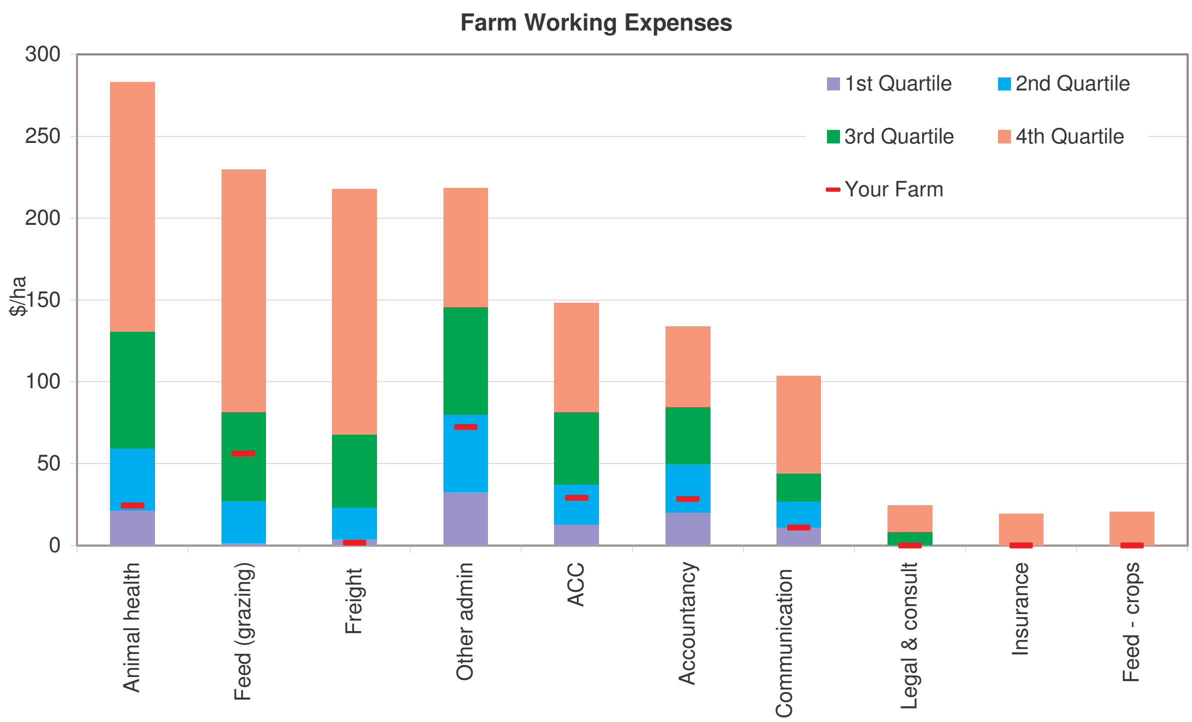


Figure 18 Comparison of farm working costs between your farm and all dairy farms in ARGOS using quartiles (cont).

3 Environment

3.1 Soils

Introduction
Soil quality is recognised as a keystone of modern agricultural production and as such, can be highly sensitive to land management. Accordingly, monitoring soil quality is a key focus for ARGOS's environment objective. The sensitivity of the soil to land management practice is determined by the soil forming factors (climate, topography, parent materials, organisms and time) meaning soil quality is often a relative quantity that differs from region to region and is variable to management pressures.

Management practices likely to have the greatest impact on pastoral soils are those closely associated with stocking rate and soil nutrient status (different fertilisers may be used). Soil chemical analysis is important to determine if soil nutrient status is being sustained. Changes in soil nutrient status may affect pasture production or composition, and in turn, stocking rates or systems to accommodate changes in feed availability. Flow-on effects to soil biological processes and physical condition can occur from these changes. Soil micro-organisms recycle essential nutrients when they decompose dead plant and animal material. Hence an active microbial population is a key component of good soil quality. Soils were sampled in 2005 and a second time in 2007. A complete report on the first year of sampling is available on the ARGOS website1. This section of the report:

- reviews the 2005 soil survey results
- reports timeline comparative nutrient results for Conventional and Organic dairy farms
- shows comparative soil biology results between your farm, conventional and organic farms for
    - microbia
    - earthworms
    - clover root weevil

3.1.1 Recap of 2005 survey

Soil chemical tests revealed lower P levels in Converting (to organic) and Conventional farms, although the majority of farms still exceeded recommended guidelines (Olsen-P >40 mg P/ml). Appendix 6.1 at the end of this report discusses 'Soil Phosphorus and Sulphur Levels in Dairy Farms'. Evidence of higher soil pH, soil-C and C/N ratios for Dairy Converting farms probably signifies both greater root inputs of C to SOM and less mineral-N from the withholding of N fertilisers contributing to lower rates of carbon turnover than in Conventional systems.

3.1.2 The 2005 and 2007 nutrient soil results

In the 2007 year the focus shifted towards soil biology, as opposed to traditional nutrient analysis. One reason for this is to enhance understanding of the soil biota and how this links to production.

The direction of differences between Organic and Conventional farms in 2007 were similar to those in 2005 (see graphs below). With only two data points, 2005 and 2007, it is too early to

[1] http://www.argos.org.nz/pdf_files/Research_Report_07_01_Dairy_SB_Soils.pdf

comment about any trends but this is the beginning of a time series that will eventually let us assess the slower changes in soils that occur over time.

The following definitions are provided to help you interpret our soils results:

- Soil pH.
    - Indicates the level of acidity or alkalinity of the soil sample.
- Olsen P.
    - A measure of the phosphorus readily available to the plant.
- Potentially mineralisable N (AMN).
    - An indication of the nitrogen that may become available to plants through mineralisation of organic matter. An increased carbon to nitrogen ratio will decrease the availability of nitrogen to plants.
- Carbon Nitrogen ratio
    - Measure of carbon relative to nitrogen in the soil. There is less nitrogen available for plant growth when the ratio is high

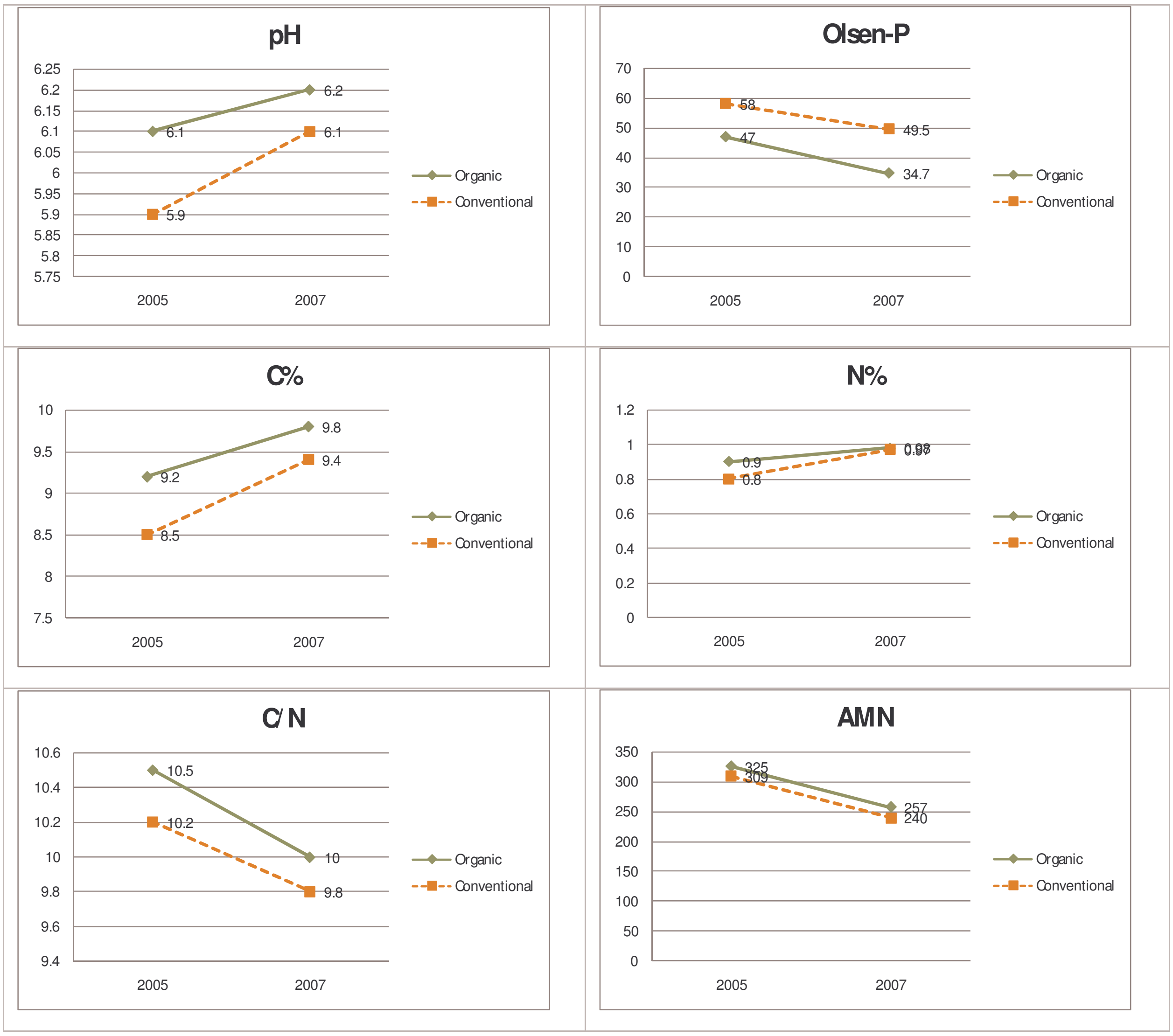


Figure 19 Soil analysis comparing Organic with Conventional dairy farms

3.1.3 Your 2007 nutrient soil results

Figure 20 compares nutrient results between paddocks and between landforms on your farm

Results for individual paddocks

			2005 sampled		27/07/2005			
Farm ID			2007 sampled		30/08/2007			
Paddock (see map)	Landform	Year	pH	Olsen-soluble P ug/mL	Anaerobic Min N kg/ha	Total Nitrogen % w/w	Total Carbon % w/w	C/N Ratio
5	Crest	2005	6.3	38	262	1.0	9.6	10
		2007	6.3	30	213	1.1	10.2	10
17	Crest	2005						
		2007	5.9	40	204	1.1	10.2	10
19	Crest	2005	5.9	48	313	1.0	9.4	10
		2007	6.3	53	223	1.1	10.1	10
32	Slope	2005	5.7	75	350	1.0	10.3	10
		2007	5.7	51	234	1.0	9.9	10
33	Slope	2005	5.8	63	331	0.7	7.6	11
		2007	6.0	54	276	0.9	9.2	10
37	Slope	2005	5.8	56	293	1.0	9.4	10
		2007	6.3	65	254	0.9	9.2	10

Landform averages (3 paddocks sampled per landform)

Farm ID							
Landform	Year	pH	Olsen-soluble P ug/mL	Anaerobic Min. N kg/ha	Total Nitrogen % w/w	Total Carbon % w/w	C/N Ratio
Crest	2005	6.1	43	288	1.0	9.5	10
	2007	6.2	41	213	1.1	10.2	10
Slope	2005	5.8	65	325	0.9	9.1	10
	2007	6.0	57	255	0.9	9.4	10

Figure 20 Nutrient results for paddocks and landforms on your farm

3.1.4 Soil Microbial Results

Measures of biological properties showed that despite Dairy Converting farms only being 1-2 years into conversion to full Organic, there was a small, but significant, difference between the systems in microbial-C. Together with increased soil C/N ratios, this suggests that the withholding of N fertiliser in conversion to an Organic system may be leading to increased root exploration (or conversely, a reduction in root mass under heavily fertilised pastures) and greater root-C inputs leading to increases in soil microbial biomass. Microbia can not be simply weighed over a set of scales, so a series of measurements are assessed to deduce the quality, quantity and efficiency of the microbial population. This is explained as follows.

Explanation of measurements shown in graphs

Substrate for microbes (soluble C)

Sol-Cwgt = soluble C per weight of soil (mg C/kg soil)

Sol-C_C = soluble C per weight of soil-C (mg C/g soil-C)

This is a measure of substrate (food) available for microbiology in the soil. Higher soluble C can reflect higher OM turnover and may also reflect increased microbial biomass and respiration.

Microbial content (microbial C)

MCwgt = microbial C biomass per weight of soil (mg MC/kg soil)

MC_C = microbial C biomass per weight of soil-C (mg MC/g soil-C)

This is a measure of the total amount of living microbes in a soil. In temperate climates there is often a fast rate of microbial turnover that suggests that microbial biomass is a more sensitive indicator of changes in total soil organic matter than total soil carbon. Microbial biomass levels will differ between soil types and land use history.

Microbial activity (basal respiration)

CO2wgt = respiration per wgt soil (mg CO2/kg soil/min)

CO2_C = respiration per wgt soil-C (mg CO2/g soil-C/min)

Soil micro-organisms recycle essential nutrients when they decompose dead plant and animal material. Hence an active microbial population is a key component of good soil quality. Measured in the laboratory, basal microbial respiration is a process that reflects the background activity of the soil microbial population. Microbial respiration is the amount of carbon dioxide production over a fixed period.

Microbial efficiency

Met-Q = metabolic quotient; measure of microbial respiration efficiency (mg CO2/g MC/min)

The metabolic quotient is the ratio between microbial biomass carbon (the size of the soil microbial population) and basal respiration (the activity of the soil microbial population). It is a useful indicator of the metabolic efficiency of the microbial population. The lower the MetQ values, the more efficient the respiration for a given set of conditions and unit biomass

Enzyme activity

ArgN = aminase enzyme activity (converts Soil OM to mineral-N NH4; mg N/kg soil/h)

FDA = general microbial activity (units absorbance/g soil/h)

This is a measure of a key enzyme level that measures the ability of the soil to break down amino acids from organic matter to ammonium that in turn, may be converted to nitrate. Both ammonium and nitrate can be taken up by plants roots for plant nutrition.

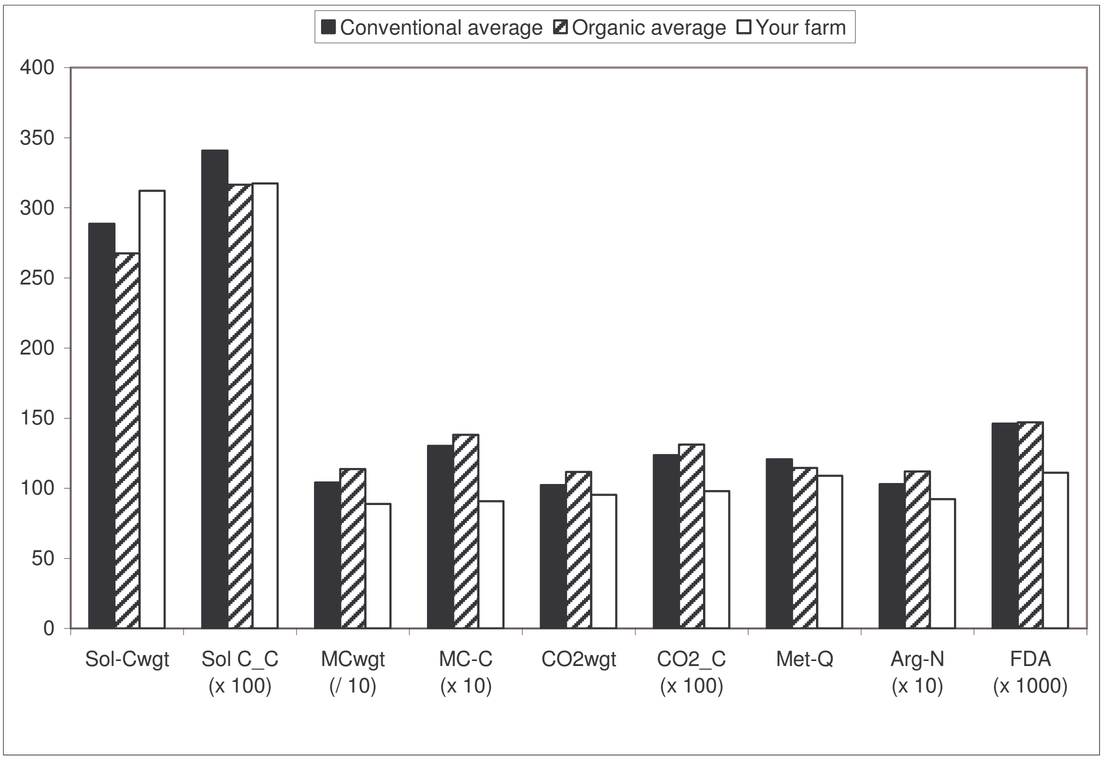


Figure 21 Microbial health comparing your farm with organic and conventional farms

3.1.5 Earthworms

Introduction

Earthworms can play a variety of important roles in agroecosystems. Their feeding and burrowing improve the physical and nutrient status of the soils by burying and decomposing plant material, mixing the soil, improving soil structure and creating channels through the soil. As the earthworms ingest soil, litter and dung, there is an increase in the mineralisation of soil nitrogen and in the availability of phosphorus. Earthworms improve soil physical properties, which increase water drainage and infiltration, aeration and root development. The increased root development also aids nutrient uptake and water availability

Earthworms are most active during the winter months, as, unless the soil is irrigated, it generally becomes too hot and dry for them during the summer. Some species may even appear to die out altogether in the summer, but they will have left their eggs behind ready to hatch when the conditions become suitable for them. Other species burrow down to a cooler spot in the soil and tie themselves up into a small knot ready to get through the dry summer months. Once the conditions are suitable these earthworms will become active again.

Overall, a much larger population of earthworms is usually supported under a pasture than under a crop, since higher amounts of organic matter are returned to the soil under a pastoral system. Earthworm populations can be up to three times higher under direct drilling than conventional cultivation.

As worms are deemed important to a pasture based system, and the environment as a whole, a worm collection and identification survey was carried out in August 2005 on the ARGOS Dairy farms. Worms were collected from a spit measuring 15 x 15 x 20cm deep from the soil monitoring sites (3 per focal paddock and 3 to 6 focal paddocks per farm) used to collect soil bulk density and nutrient core data. Preliminary survey results are presented below.

Preliminary Survey Results

<u>Total worms found</u>

In total, 2445 worms were collected and identified during the 2005 winter. Figure 22 shows the three most common species were *Aporrectodea caliginosa* (869), *Lumbricus rubellus* (735) and *Lumbricus terrestris* (516). These made up 87% of worms found.

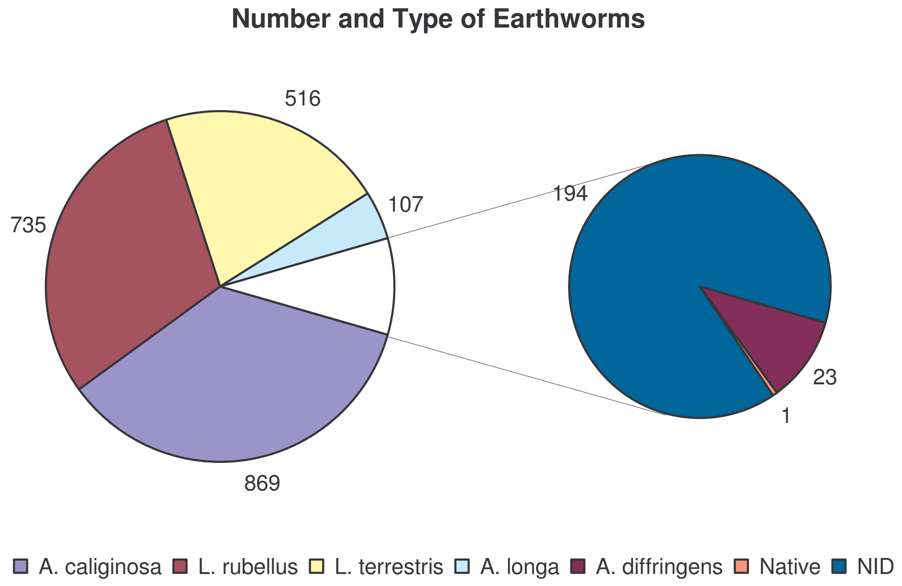


Figure 22 Species of worms found on ARGOS Dairy farms

<u>Three common worm species</u>

Aporrectodea caliginosa

This field worm is the most common in New Zealand that does most of the work of mixing and recycling dead plant matter in our soils. Pastures devoid of these species tend to develop a thatch of plant material, which limits the ability of water and fertiliser to integrate into the soil. These are the species that are commonly used to improve these 'thatch bound' soils.

Lumbricus rubellus

Otherwise known as the 'Dung' or 'Red' worm this one lives near the surface and is often the type that blackbirds can be seen pulling out of the lawn. They are very active and can move rapidly across the surface. Hence they were the 'escape' artists during the worm collection process.

Lumbricus rubellus is a useful soil incorporating worm that is quite often found in soils with high organic levels. Their numbers can be reduced by ammonium sulphate fertilisers or pesticides such as carbaryl.

Lumbricus terrestris

These tend to make permanent burrows in the soil that can be more than 3 m deep and survive best in undisturbed areas where their burrows can remain intact. They tend to forage about on the soil surface for food and then drag food such as leaves down into their burrows for consumption.

Lumbricus terrestris can be a particularly useful species in situations where large amounts of organic matter are left on the soil surface. In orchards for example, they help in the removal of the large number of leaves that annually fall onto the soil surface.

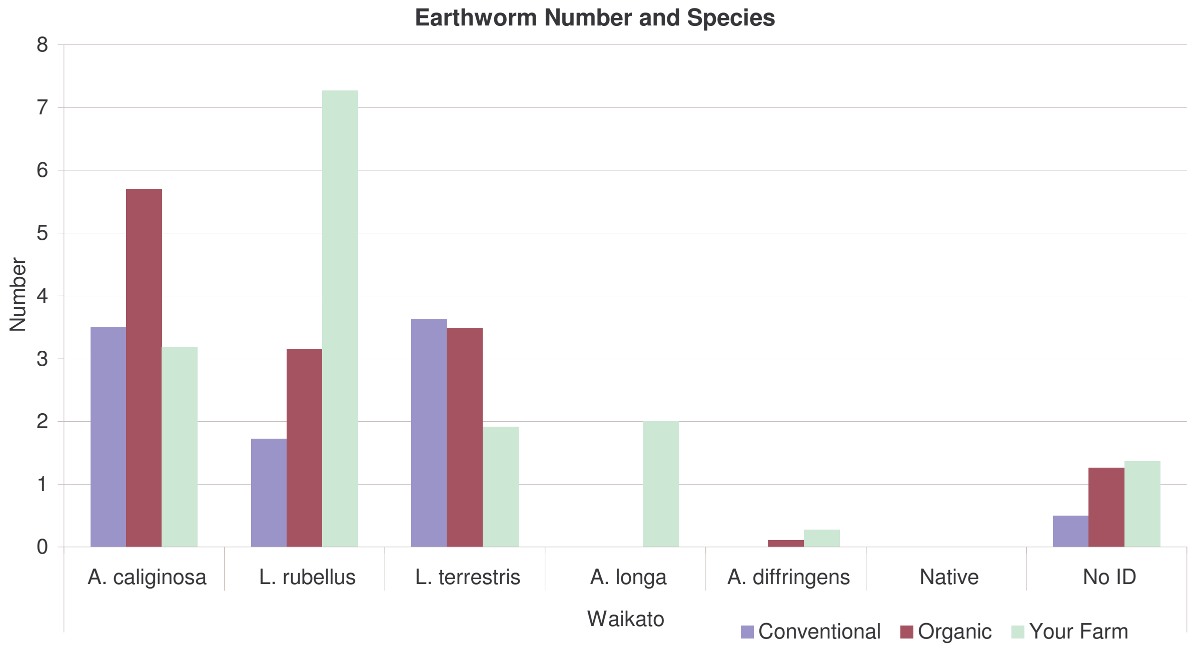


Figure 23 Number of earthworms per hole comparing your farm with organic and conventional

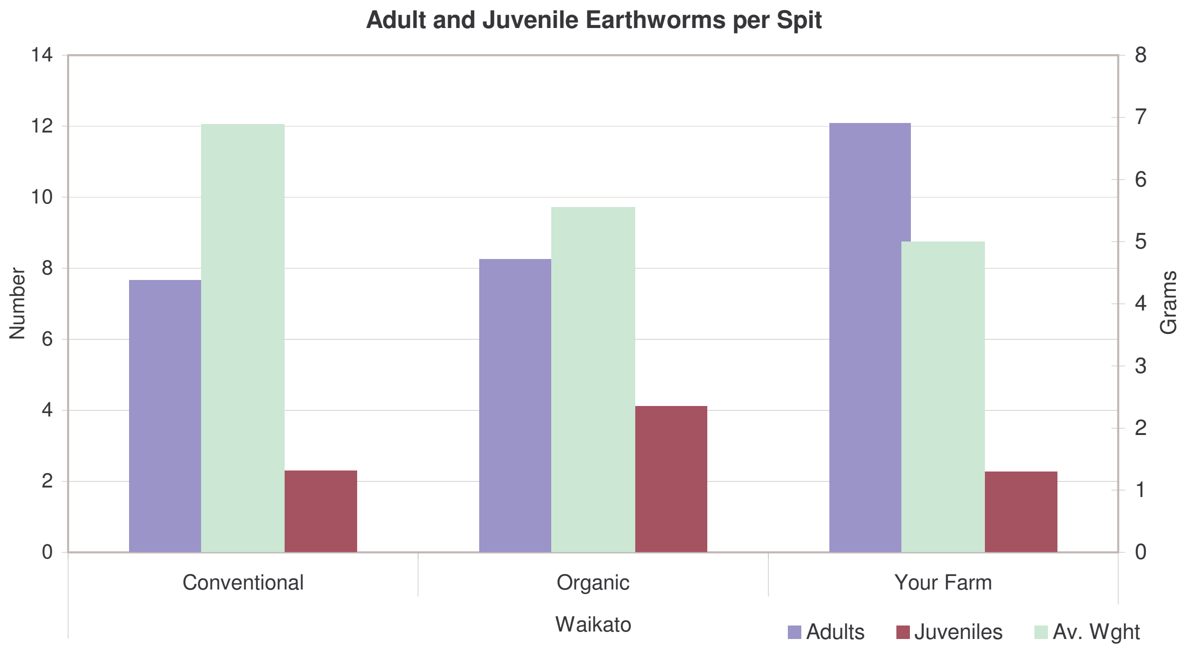


Figure 24 Weight and number of adult versus juvenile worms per hole comparing your farm with farms in your region

3.1.6 Clover Root Weevil

Clover root weevil (CRW), *Sitona lepidus*, was first discovered in 1996 in Waikato and Auckland, and by 2004 it had spread throughout the North Island. The adult stage of CRW feeds on clover leaves and the larval stages feed on clover roots. Young larvae tend to feed in clover root nodules (which capture atmospheric nitrogen), while bigger larvae will feed anywhere on the root system.

CRW larvae and adults reduce the clover's growth rate and survival through the physical damage they cause to the roots and leaves.

In the North Island, CRW damage is particularly significant in dairy pastures. North Island dairy farmers have reported substantial loss of productivity due to CRW, with reductions in nitrogen fixation by clover of 50% to 100%[2]. CRW was counted at each soil monitoring site on your farm in 2005. Figure 25 compares the average number of CRW found per hole dug (15cm X 15cm X 20cm).

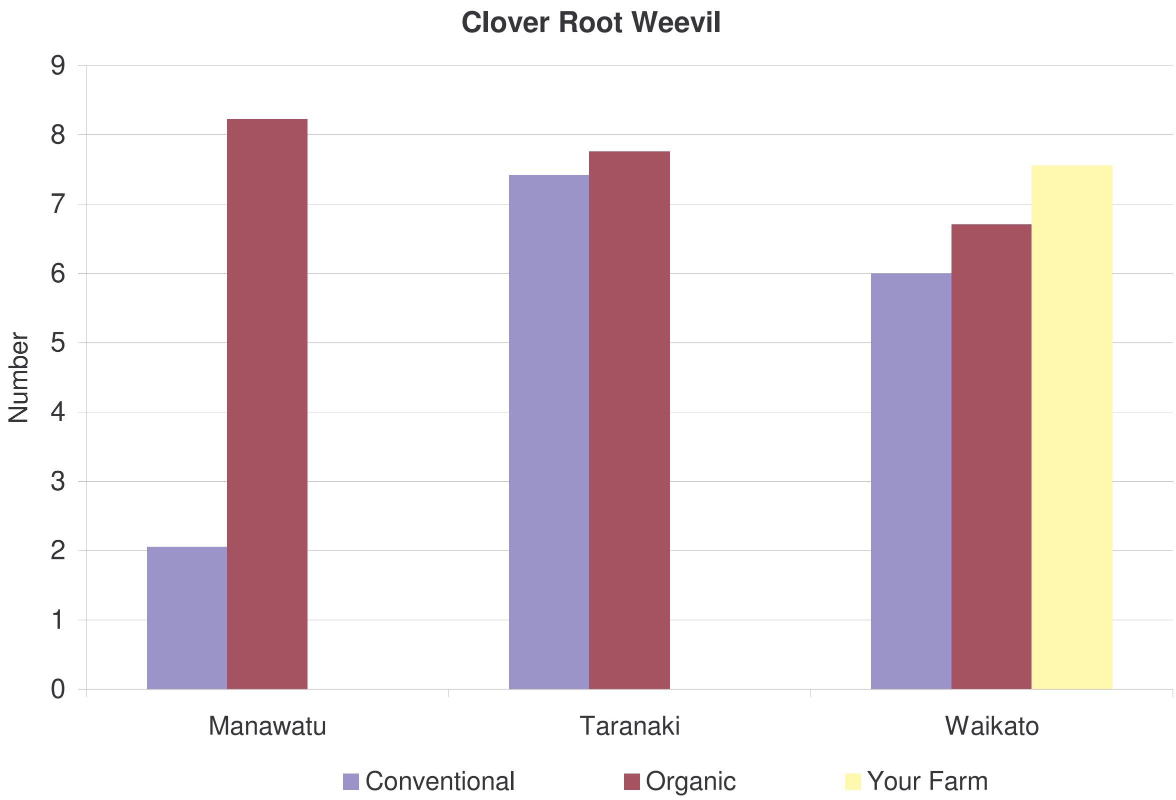


Figure 25 Number of Clover Root weevil found per hole comparing your farm with other dairy farms involved in ARGOS

[2] http://www.agresearch.co.nz/crw/

3.2 Bird relative abundance and habitat use on ARGOS dairy farms

Introduction

The distribution and abundance of different bird species tend to be associated with the type of habitat that is in an area. Production landscapes, with their generally lower habitat diversity and complexity and lower levels of native flora are widely hypothesised to support introduced granivorous (those feeding on grains or seeds) species such as chaffinches, redpolls and starlings, whereas areas of native forest and scrubland are more likely to contain native frugivorous/omnivorous (those feeding on fruit/vegetables and meat, alive or dead!) and insectivorous species such as bellbirds, kereru, fantails and grey warblers. In addition, different farm management practices and strategies (i.e. organic and conventional) may also impact on avian species richness and abundance, although there have been no specific investigations of the avifauna associated with different management approaches in NZ.

ARGOS dairy farms provide an excellent opportunity to look at the effects of changing management systems on bird communities.

The Survey

At the time of survey (summer 2006/2007) the organic conversion farms were two years into the three-year conversion process. Because of this we expected to see some differences in bird species and densities.

We used data from the ARGOS GIS database and from the 2006/07 summer bird survey of ARGOS dairy farms to first compare the landscape composition of organic conversion and conventional farms, before comparing the bird abundance and diversity on the farm. We then focused specifically on the use of open pasture by selecting key species that may show rapid behavioural response to changes in pasture composition and quality.

Findings

As for sheep/beef farms, the landscape composition measures were highly variable between the geographic clusters of dairy farms. Once this variation was controlled for there were no detectable differences between organic conversion and conventional farms for any of the habitat measures.

The main differences in habitat use were as follows:

- Skylarks were the only species to show any differences in habitat use between the two management systems, and were recorded significantly more often in open habitats on conventional than on organic conversion farms
- There were non-significant trends for increased use of pasture on organic conversion farms by blackbirds

The reasons for these differences are unclear, but may be related to differing plant diversity and associated food resources in pasture for different species offered by conventional and organic conversion dairy farms. Habitat use and abundance of birds in woody vegetation were very similar on the organic conversion and conventional farms, perhaps mainly because of similar habitat extent and composition.

Bird species and density identified on your property compared with other ARGOS dairy farms are depicted in Figure 26 below.

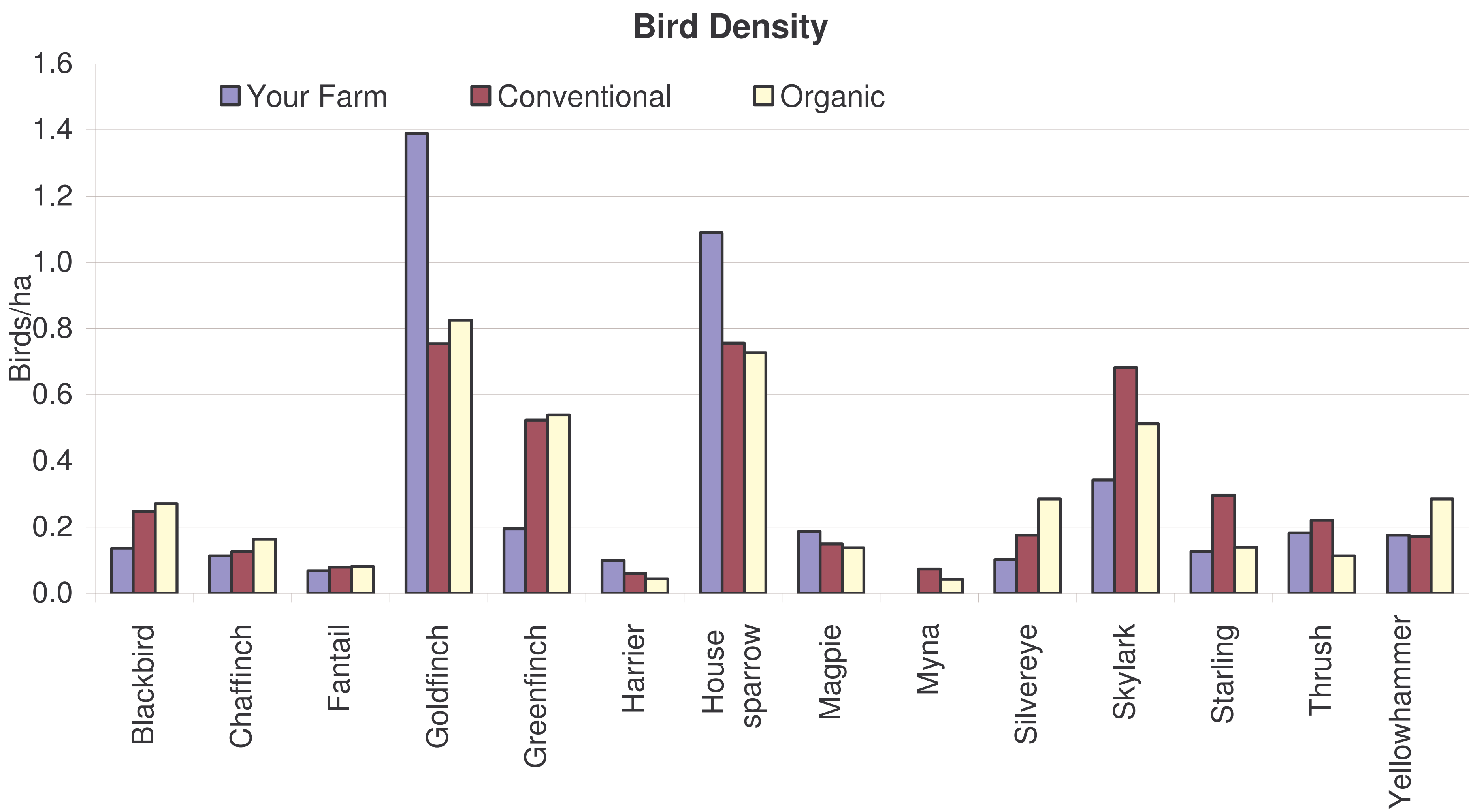


Figure 26 Density of bird species comparing your property with other ARGOS dairy farms

3.3 Stream Health

Introduction

In this study, we examined whether different farm and waterway management actions on sheep/beef and dairy farms resulted in changes in water quality and ecosystem functioning at the farm scale. We measured physical parameters, periphyton and aquatic macro-invertebrate communities, nutrient and sediment levels, at upstream and downstream sites in streams on the 24 ARGOS Dairy properties. We used the Stream Health Monitoring and Assessment Kit (SHMAK), an assessment tool developed for use by farmers and landholders, as well as additional measures to record relative changes in water quality and stream functioning at the farm scale.

ARGOS performed this study as the first step in a long term effort to support New Zealand farmers to identify and instigate practical farm management strategies to improve stream health and associated water quality. The study had four specific aims:

1. Provide baseline data on waterway quality and ecosystem function on farms, from which future trends in stream health can be determined;
2. Identify any relative impacts of organic and conventional farming systems on water quality and aquatic ecosystem function;
3. Assist in customised stream care management strategies for each participating farmer for incorporation into long-term whole-farm management plans; and
4. Establish an effective stream health and water quality monitoring process through the evaluation of the Stream Health Monitoring and Assessment Kit (SHMAK) and additional tests.

Definitions

Periphyton is a complex matrix of algae, cyanobacteria, heterotrophic microbes, and debris that is attached to submerged substrata in almost all aquatic ecosystems. It serves as an important food source for invertebrates and some fish, and it can be important to absorb contaminants. The periphyton is also an important indicator of water quality

Aquatic macro-invertebrate refer to organisms, with no vertebrate, living in or on the water.

Pollutants to stream health

Most direct sources of pollution associated with agriculture (such as direct input of dairy shed effluent or leaching from silage or offal pits) have been removed or controlled over the last 10 – 15 years. Consequently, the majority of pollution entering waterways in agricultural systems now comes from indirect or 'diffuse' sources, such as leaching of excess nutrients from fertiliser and animal manure and increased sediment loads.

The three main indirect source pollution threats to flowing and groundwater in agricultural systems in New Zealand are:

- **Increased nutrient levels** Application rates of both nitrogen and phosphorous have been increasing in New Zealand over the last 50 years, particularly in recent decades.

Over 300,000 tonnes of urea and 1,200,000 tonnes of phosphate were applied to production lands in 2002. The total application rates of urea and other nitrogen fertilisers increased by 160% from 1996 levels, while those of phosphorous stayed fairly static. High levels of nitrogen and phosphorous in waterways can lead to excess algae and aquatic macrophyte growth. This can alter community structure and functioning, and alter flow and flooding rates. High levels of nitrogen and phosphorous can also make water unsafe for stock and human consumption

- **Microbial contamination** Animal faeces can contain high levels of bacteria and other microbes that can pose human health risks if these species enter waterways. Livestock, particularly cattle are carriers of a range of micro-organisms that can cause gastroenteritis in humans, noticeably *Giardia*, *Escherichia coli*, *Campylobacter* spp. and *Cryptosporidium.* Microbes can enter waterways either via surface runoff or via infiltration through the soil profile into groundwater. Input rates into flowing waters can also be rapid in areas with tile or mole drains
- **Sediment loading**. Increased rates of sediment input into streams have been rated as one of the most severe water quality impacts on agriculture in New Zealand. Current threats come from direct bank erosion by stock and water and wind erosion of bare soils, particularly in cropping areas. Sediment inputs are also the major source of phosphorous enrichment in waterways.

Phosphorous and sediment

Phosphorous tends to stay bound to sediment in aerobic conditions so as oxygen levels drop (e.g. as temperatures rise) more P is released back into the water column in a dissolved usable form.

The following nutrients were also analyzed for each upstream and downstream site.

- **Ammonia (NH_3 µg/L)**
- **Total nitrogen (TN µg/L) and total phosphate (TP µg/L)**
- **Dissolved Reactive Phosphate (DRP µg/L)**
- **Nitrate and Nitrite (NO_3 + NO_2 µg/L)**
- **Total organic carbon (TOC)**
- **Total suspended solids**
- **Total dissolved solids**

Additional sampling included

- **Organic stream deposits** - suspended sediment samples were collected from each site.
- **Invertebrate samples** – these were collected to allow more detailed assessment of the macro-invertebrate community present at each site.
- **Fish and Crustacean** – a survey of these communities was undertaken with a spotlight survey on each farm. Spotlighting has been selected as the primary fish

sampling technique for the ARGOS project, as the technique is fast and efficient, and relatively inexpensive.

Table 5 Parameters recorded in the Stream Health Monitoring and Assessment Kit (SHMAK).

Parameter	Units	How recorded
Stream width	Metres	Average of width at bottom, middle and top of survey site
Stream depth	Metres	Average of depth at true left bank, centre, and true right bank at the bottom, middle and top of the study site
Flow velocity	Metres/second	Average time for a floating object to travel the length of the survey site (three replicates)
Water temperature	Degrees centigrade	Bulb thermometer temperature of water in the middle of the channel at the upstream end.
pH	$-\log_{10}(H^+$ ion concentration)	Merck Neutralit pH strips in a container of stream water for 10 minutes
Water conductivity	Microseimens cm^{-1}	EUTECH Cybernetics TDScan 3 hand-held conductivity meters in a container of stream water
Water clarity	Detection distance (metres)	Distance at which a black disc can be detected along a 1-metre length clear acrylic tube filled with stream water (three replicates)
Stream bed	Index between -20 - +20	Percentage cover of different substrate types, weighted by their ecological function (see text)
Riparian vegetation	Index between -10 - +10	Percentage cover of different vegetation types, weighted by their ecological function (see text)
Deposits	Index between -10 - +10	Qualitative assessment of the extent of substrate covered by sediment and other deposits
Invertebrates	Index between 0 - 10	Abundance of different stream invertebrates weighted by their ecological requirements and sensitivity to stream modification
Periphyton	Index between 0 - 10	Percentage cover of different algae taxa weighted by their ecological requirements and sensitivity to enrichment

3.3.1 Stream Results

Interpretation of Figure 27 to Figure 30

<u>Stream Physical data</u>

Clarity is shown as a positive number in centimetres, followed by a ‘% clarity dif’ which is the difference in clarity between the upstream and downstream sampling sites. A negative % means that the clarity decreased between sites.

The same applies in the following nutrient graphs; however a negative % difference is good as it means that that particular nutrient loading decreased between the upstream and downstream sites.

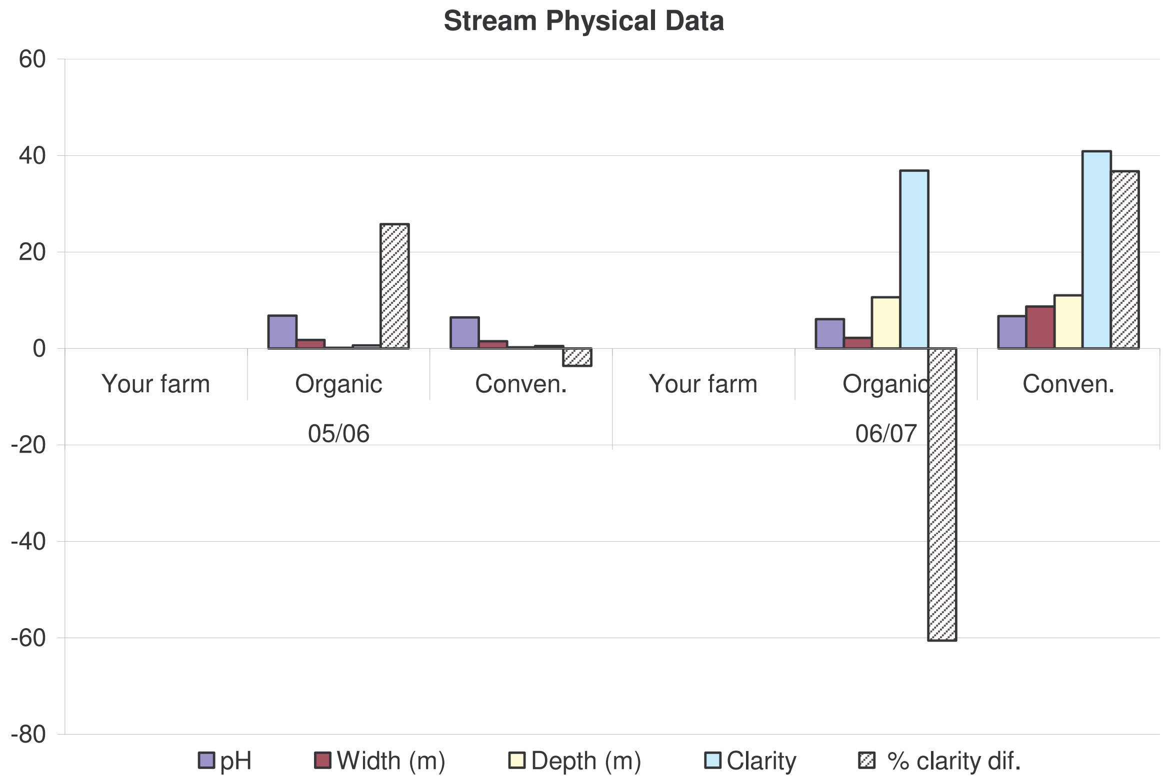
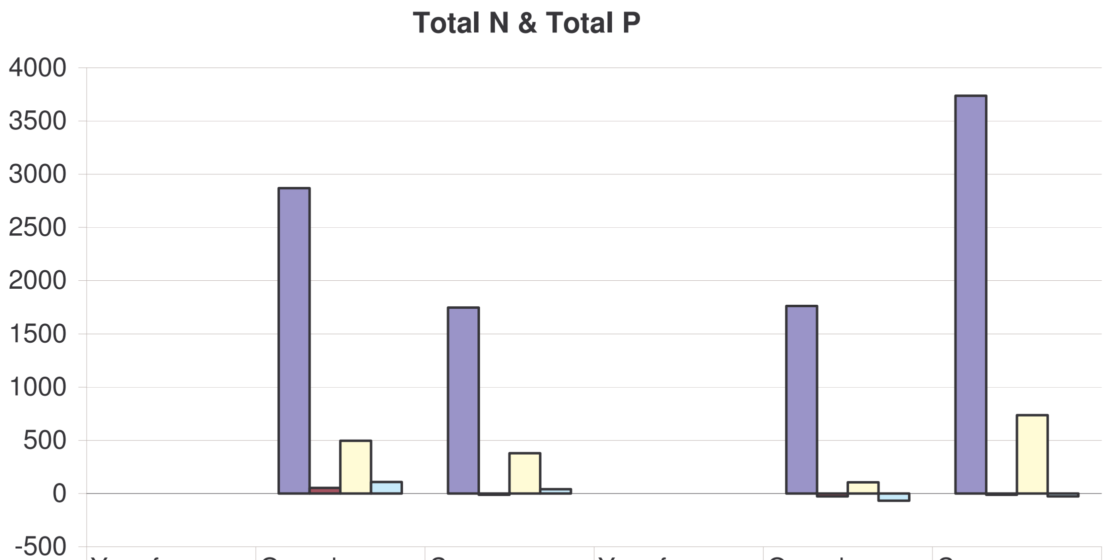


Figure 27 Physical stream data; comparing your farm with ARGOS dairy farms



	Your farm	Organic	Conven.	Your farm	Organic	Conven.
		05/06			06/07	
TN	0.0	2868.4	1746.5	0.0	1761.5	3735.8
% TN dif.	0.0	52.0	-11.9	0.0	-26.2	-12.4
TP ug/L	0.0	495.5	380.8	0.0	105.7	736.0
% TP dif.	0.0	108.8	39.3	0.0	-66.4	-27.7

Figure 28 Total N & Total P; comparing your farm with ARGOS dairy farms

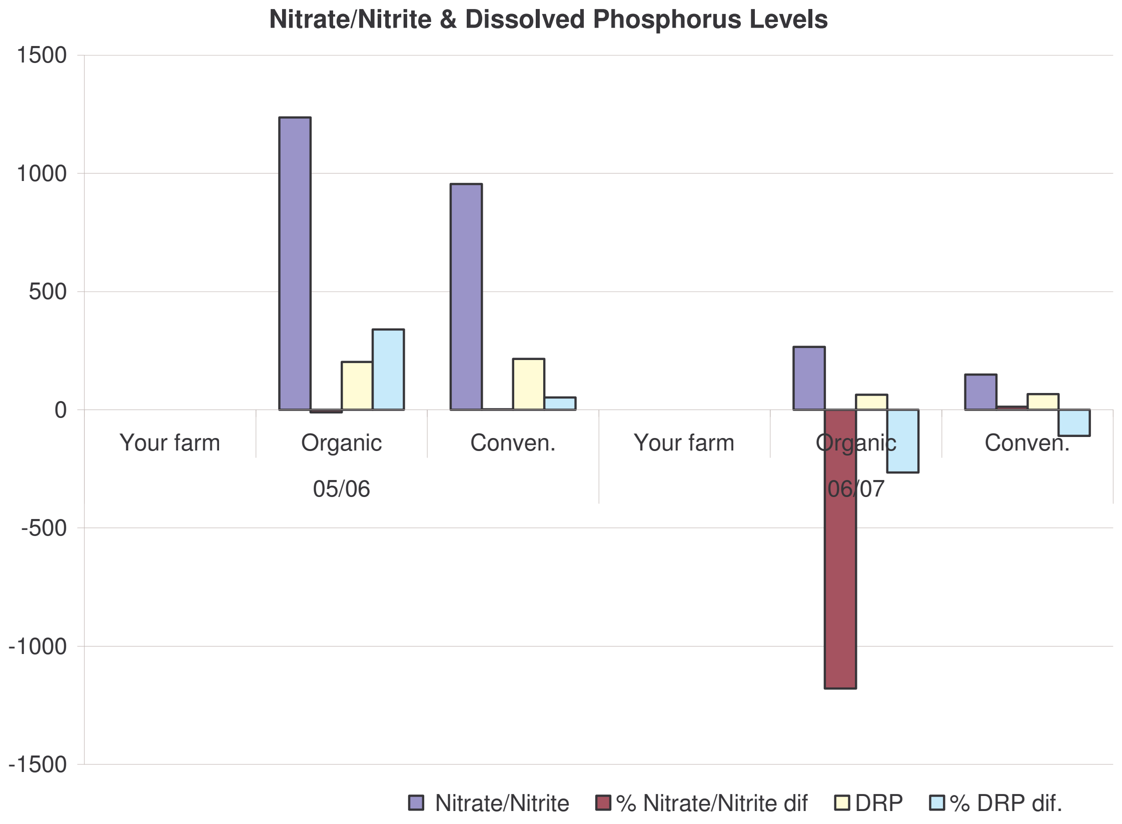


Figure 29 Nitrate/Nitrite & Dissolved Phosphorus Levels (DRP); comparing your farm with ARGOS dairy farms

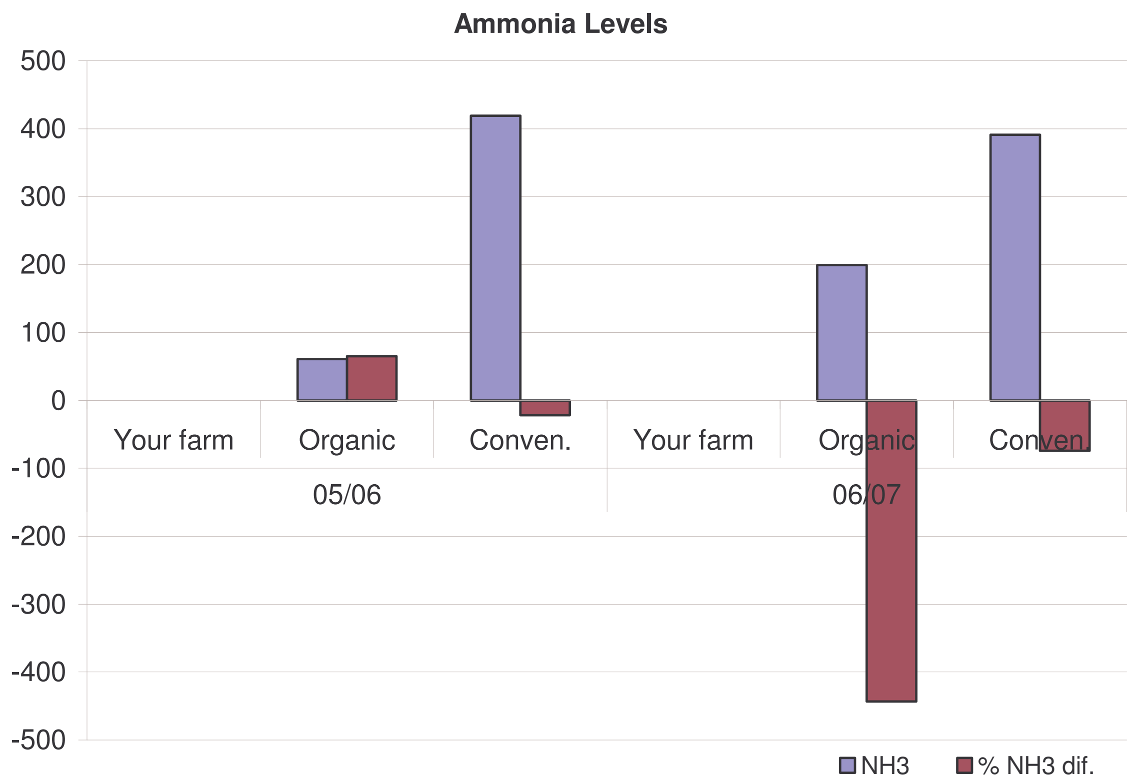


Figure 30 Ammonia levels; comparing your farm with ARGOS dairy farms

4 Economic

Introduction
The economic objective of ARGOS focuses on the relationship between agricultural markets and resource allocation in New Zealand. The economic research is, therefore, undertaken at two levels: the global market (and its impacts on New Zealand agriculture), and the operations of the ARGOS farms. The research on global markets and their impacts on New Zealand agriculture have involved the identification and understanding of issues that may affect access to export markets and consumer demands.

At the farm level, researchers have been collecting farm financial accounts. Each year's data has been analysed to determine trends over time, as well as systematic differences amongst the three different management systems. In addition, this year the economics research team looked at the extent to which key performance indicators for conventional businesses can be applied to farm businesses.

4.1 Market Access

Introduction
There are currently a number of market, consumer, policy trends/changes that have the potential to impact on NZ's agriculture industry. These include the changes in consumer behaviour and increasing emphasis on the sustainability attributes of products, such as carbon footprinting but growing into areas such as water footprinting and wildlife and biodiversity protection.

The following is a synopsis of a larger report from the AERU, Lincoln University and covers global market access issues.

Market Access issues
Market developments

- There are an increasing number of consumers that are concerned with environmental and social sustainability. Associated with this are the growing trends of buy seasonal, buy local, alternative food networks and ethical production. Often these trends are supported through industry and government initiatives. These trends may potentially lead to a reduction in the consumption of imported products.

Food prices

- Global food price hikes are being attributed to a range of factors. These include poor harvests, restrictive trade policies, increasing price of oil, diversion of crops for biofuels and increasing demand especially from developing nations such as China. This may lead to the facilitation of a rise in the price of meat as consumer demand increases. The offset to this is demand for food security in some countries and potential to reduce imports.

Environmental concerns

- Of increasing importance are the issues of water scarcity ('water miles' or 'water footprints'), water quality, and biodiversity/wildlife. These issues may lead to imposition of additional audit requirements for farmers so as to meet market/customer specifications.

Trade factors

- The recent WTO Doha negotiations collapsed meaning a resolution of the round is now some way off. The potential benefits of a resolution for the NZ agriculture industry is a reduction in tariffs currently applied in export markets. However, depending on how additional policies unfold there may be the potential for increased competition from domestic producers in some export markets.

- The EU's Common Agricultural Policy (CAP) 'Health Check' is increasingly moving towards cross compliance in relation to environmental issues and the US Farm Bill is also implementing similar policies. The changing focus of agricultural policy expenditure in the EU and US will aid their farmers to meet the growing requirements of market assurance schemes from retailers which emphasise the sustainability attributes of products. This will only make it more likely that retailers will demand more of these attributes.
- The changing focus of agricultural policy expenditure in the EU and the US will help their farmers to meet growing requirements of market assurance schemes from retailers which emphasise the sustainability attributes of products. This will only make it more likely that retailers will demand these attributes.

5 Social

5.1 Emissions Trading Scheme (ETS)

Introduction

During the last twelve months, greenhouse gases and emissions trading have become common terms in debates on agricultural policy in New Zealand. In response to this, ARGOS has been awarded additional funding to examine issues related to climate change and farming. The New Zealand government and industry already invests a large amount of money in the development of technological solutions for emissions reduction, however the perceptions and understanding about climate change among farmers have received little attention. It is also very obvious that the issues surrounding New Zealand's efforts to comply with the Kyoto Protocol are poorly understood in the general public and have become overly politicised.

Because of this situation, our current research focuses both on providing information on the state-of-play for the regulation of greenhouse gas emissions and on developing a better understanding of farmers' response to and knowledge of climate change issues. Through this work we have been made very aware of the discontent among farmers in regard to policies such as the emissions trading scheme (ETS) and have voiced such concerns to MAF Policy representatives.

> "Through this work we have been made very aware of the discontent among farmers in regard to policies such as the emissions trading scheme (ETS) and have voiced such concerns to MAF Policy representatives."

The challenge of emissions

While there is a need to challenge unfair or poorly developed aspects of existing climate change policy, we believe that it is also important for farmers to prepare for the growing emphasis on carbon and environmental costs in global agri-food markets. Within the existing reality of the Kyoto Protocol, the New Zealand economy is faced with the challenge of accounting for and reducing the emission of greenhouse gases (a principal factor in global climate change) to 1990 levels. The extent of the challenge is especially evident in the agriculture sector where emissions in the form of methane (primarily for pastoral animals) and nitrous oxide (from synthetic fertilisers and animal wastes) combine with carbon dioxide (mostly from farm vehicles) to make up nearly 50% of all greenhouse gas emissions in New Zealand. As a result of this situation, farmers are expected to contribute to the reduction of emissions at a level that reflects the sector's responsibilities. Current policy does not include agriculture in the regulation of emissions until 2013 (and then proposes a gradual increase in exposure over the next several years) in order to allow the sector to develop response strategies, which are likely to require longer timeframes for implementation. In order to allow for such strategies to emerge, however, farmers will need a better understanding of policies that are targeted at emissions reduction.

Current policy proposals

The current policy proposals in New Zealand (and in Australia and Europe) are based on the concept of a 'cap-and-trade' approach that relies on market-driven response from those responsible for emissions throughout the New Zealand economy. This approach involves limiting (that is, capping) emissions at their 1990 levels. In order to do this, each country participating in the Kyoto Protocol can claim a set number of 'carbon credits' (each equivalent to a tonne of carbon and totaling 1990 emissions). Because current emissions are higher than in 1990, it is necessary to create a system for the allocation of these credits to those with emissions liabilities. Thus, the purpose of the ETS is to provide the opportunity to buy and sell credits under the assumption that the cost of such credits will reflect the willingness of people to pay rather than engage in practices and activities that emit less carbon. (For example, a factory owner will buy credits only if they are cheaper than installing equipment that removes greenhouse gases from the factory's emissions.) For pastoral farmers, this means that the cost of production will increase as carbon liabilities become another element of farm accounts. The extent of the cost increase will depend on such decisions as stocking rates (carbon liabilities are currently calculated on a 'per-head' basis), fertiliser application and the creation of 'carbon sinks' (such as tree plantations). MAF is also proposing policies to encourage tree planting on farms in order to help with early adaptation to the emphasis on carbon in the economy.

Farm example

In our research project, we introduced some of the ARGOS sheep/beef and dairy farmers to the proposed ETS and the associated afforestation policies. This included providing an **estimate** of the cost of carbon liabilities for each farm visited. For example, a sheep/beef farm with 3000 sheep and 200 beef cattle would have a total liability of $33,500 (with a cost of $25 per carbon credit). This liability would not be assessed until 2013, and then the government would provide 90% of the necessary credits as a free allocation reducing the 2013 liability to $3,350. A dairy farm of 300 cows, by comparison, would have a liability of $18,750, or $1,875 in 2013 with the 90% free allocation. (Note that neither of these estimated figures involves the costs of synthetic nitrogen fertilisers, which will also increase in order to compensate for estimated nitrous oxide emissions.)

"A dairy farm of 300 cows, by comparison, would have a liability of $18,750, or $1,875 in 2013 with the 90% free allocation"

Some of this cost can also be 'off-set' by credits earned from trees planted after 1990 (ranging from 20-30 tonnes – or $500-750, assuming $25 credits – per hectare in mature *pinus radiate* to 2-6 tonnes – $50-150 – per hectare for a native species such as totara). The accumulation of credits from trees (and a similar situation holds for soil carbon) is only given for the increase from the previous year's amount, including any harvest or accidental loss as a reduction. In other words, **a mature plantation subject to rotational harvest**

would likely sequester only enough carbon to compensate for harvested trees and, therefore, not earn any carbon credits.

Research findings

Besides the ETS contributing a bucket-load of confusing detail for participants to stew over, our research confirmed that the level of awareness about the ETS is very low and that farmers view the ETS as a mechanism to penalise agricultural producers (as opposed to fairly distributing carbon credits throughout the economy). These findings were the primary messages that we shared during a workshop in late July 2008 with members of the MAF Policy team involved with development of the scheme.

What now?

In the circumstances discussed above, it is very important that farmers develop knowledge about the impact of various aspects of farm management on the emission of greenhouse gases and on the sequestration of carbon.

The current ARGOS research provides a depth and breadth of data not available elsewhere in New Zealand, which can contribute to our understanding of carbon processes in farm ecosystems as well as to improved means of compliance with the Kyoto Protocol. Because we are actively collecting economic and social – as well as environmental – data, the ARGOS project is well positioned to inform both farmers and policy makers about the interactions, opportunities and potential barriers to a viable system of greenhouse gas regulation for the agriculture sector.

> "it is very important that farmers develop knowledge about the impact of various aspects of farm management on the emission of greenhouse gases and on the sequestration of carbon"

Specific objectives for our future research targeted in this area include:

- developing means of verifying the environmentally friendly nature of New Zealand farming for export markets,
- maintaining contacts with MAF to help inform policy development and
- contributing to the creation of a decision support tool to help farmers develop response strategies.

We would greatly appreciate your feedback in regard to any of the issues addressed in this section. In addition, if you think that any of our future research objectives are of particular importance, our ability to fund such research is greatly enhanced when you make these issues known to fellow farmers, farmers' groups (such as Federated Farmers), industry and government representatives.

5.2 Causal mapping

As part of the ARGOS social objective, causal mapping was used to document how the participating dairy farmers described and explained the factors involved in their farming systems, broadly defined to include economic, social and environmental factors. Participants identified which factors in the 41 provided were important to the management and performance of their farms and linked these together in the form of a map.

The 20 ARGOS dairy farmers who were available first completed a Q sort of 41 factors to identify the more important ones, and then used these to create their map showing the important factors and the causal links between them. The strength of these linkages was also recorded on a 1 – 10 scale with one being weak and ten being strong. Centrality scores indicated the importance of each factor. An overall or group map was produced by taking an average across the individual farm maps and this map characterised the overall farm system. A similar process was used for each of the two management systems being studied (conventional and converting to organic), and for each of the two groups of farmers identified from Q-sort analysis.

Your Causal map can be found on page 44

Group map

The overall group map shows that dairy farming involves the management and response to a wide variety of factors, including economic, environment and social ones. At the core of the map are personal (farmer decision maker and satisfaction) and production factors surrounded by soil, environmental, climatic, family and financial factors. True to the family farm structure of much of New Zealand farming, the map shows the closely integrated role of family in the farming system expressed as family needs. The map is not insular since there are connections extending outwards including other people and related factors, especially the marketing or processing organisation and considerations of time in farm work. There is a strong production orientation in the map with some of the strongest connections from farmer decision maker to fertiliser and soil fertility health and to production. However, the environment is also important, reflected in farm environmental health and, to a lesser extent, farm environment as a place to live. The sources of satisfaction (production, fertiliser and soil fertility health, farmer decision maker, family needs, farm environment as a place to live and net profit before tax) are quite varied and reflect the broad mix of factors at the core of the map.

Other data rounded out the general findings. Just over one half of dairy farmers reported that quality of production, rather than quantity of production, was most important and just over one third said both. A modest majority stated that their farms were below average in terms of level of inputs per hectare. Farm environmental health was defined in terms of soil, streams, sustainability, ecosystem, system, variety and balance. The farmers expressed a flexible attitude to change on their farms. Farmers also stated that a resilient farm had financial flexibility or was adaptable in other ways.

Many of the core factors in the map are connected with bidirectional arrows so they are in a dynamic and complex relationship with each other. Changes in one factor would necessitate changes in nearby factors. These dairy farmers are juggling many factors in the day-to-day and longer-term planning and management of their farms. It is because of this complexity of factors shown at the generic level for all 20 farmers that farmers create specific ways through the complexity by developing a strategy or approach that makes sense to them and appears to meet their needs. These different strategies mean that there are distinctive ways that farmers combine and relate factors despite having some core similarities. The maps for the panels and the Q-sort types illustrate these different strategies.

Comparison across high country, dairy and sheep/beef sectors in terms of causal maps:

- There was broad similarity across the three farming sectors in that each of the group maps has the same top five factors within the top six rankings. Figure 31 shows how 8 key factors compare across Sheep/Beef, High Country and Dairy sectors

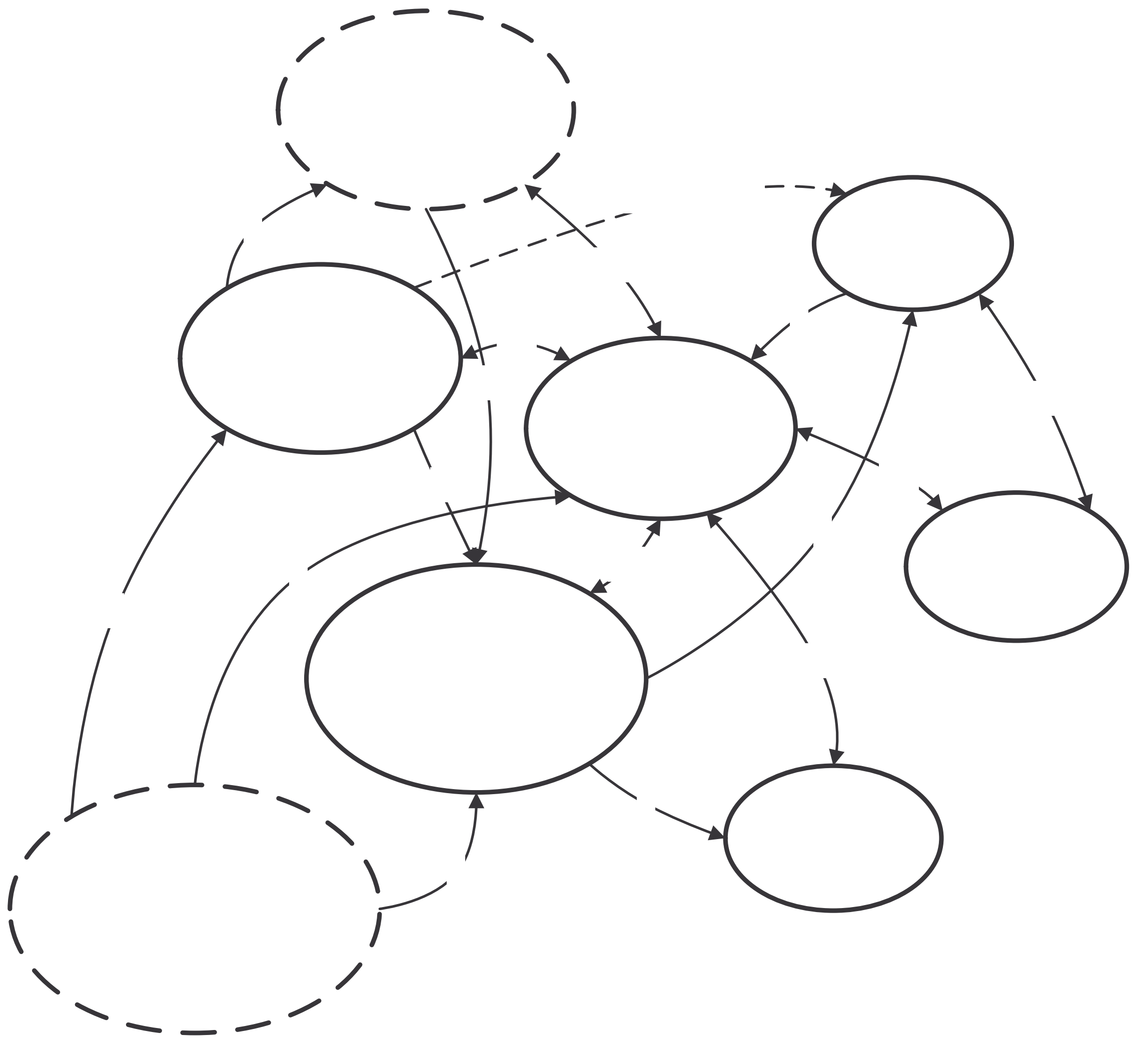


Figure 31 The eight key factors in pastoral systems as exhibited by high country, dairy and sheep/beef farm causal maps (averaged data)

Even though overall group maps for the dairy, sheep/beef and high country sectors were similar, there are some differences:

- The dairy map had three additional factors but not advisors and consultants.
- Dairy farmers had the connection between farmer decision maker and expenses in the opposite direction compared to sheep/beef farmers.
- Dairy farmers had customer requirements connected to Fonterra; for sheep/beef it was connected to farmer decision maker.

- Dairy had weather/climate connected to farmer decision maker at four: for sheep/beef it was seven.
- Dairy had more connections to farm environmental health.
- Dairy had stocking rates connected to quality and quantity of production at five; for sheep/beef it was three.
- Dairy had quality and quantity of production connected to net profit, and net profit was connected to satisfaction.
- The high country farming system had less emphasis on production and more emphasis on family, soil type and neighbours.
- High country, compared to dairy only, gave more importance to weather and climate, and to off-farm activities.
- High country, compared to sheep/beef only, gave less importance to off-farm product quality.
- Sheep/beef, compared to dairy only, gave more importance to customer requirements and to advisors and consultants.
- Location and time in farm work were more important to high country farmers as a source of satisfaction while farmer decision maker was not an important source of satisfaction.

Comparisons across sectors in terms of map characteristics:

- High country, compared to dairy and sheep/beef, had more factors and lower map density (fewer connections compared to the number of factors).
- Dairy, compared to high country and sheep/beef, had more transmitter factors (arrows going out) and fewer receiver factors (arrows going in).
- Dairy compared to sheep/beef had fewer double arrows.

Interpretation

- Farm environmental health is less important to high country farmers because they see nature as robust and healthy or because they see their farming systems as fragile and have learned to work in synergy with the environment.
- The importance given to weather and climate, soil type and topography, neighbours, off-farm activities and family needs is consistent with the particular character of high country farming. High country farmers assigned relatively less importance to production.
- There is evidence that high country causal maps are more complex than those for the sheep/beef and dairy farming.
- Across the high country, sheep/beef and dairy sectors there are some key similarities which show up as eight common elements of pastoral systems and can be illustrated as a map.

Table 2 compares the sources of satisfaction across high country, dairy and sheep/beef farms. The table shows that while there are some overlaps in the sources of satisfaction, these occur more across dairy and sheep/beef. Location and time in farm work are more important to high country farmers while farmer decision maker is not an important source of satisfaction.

Table 2: Comparison of sources of satisfaction across the three pastoral sectors.

Link to satisfaction	High country	Dairy	Sheep/beef
This location	4	2	1
Time in farm work	3	2	1
Production	3	6	6
Family needs	4	5	3
Farm environment as a place to live	4	4	3
Farmer decision maker	2	4	5
Net profit before tax	2	3	2

An example of dairy specific, generic causal map is depicted on the following page.

Full report:
http://www.argos.org.nz/pdf_files/Research_Report_08_01_Dairy_Causal_Map.pdf

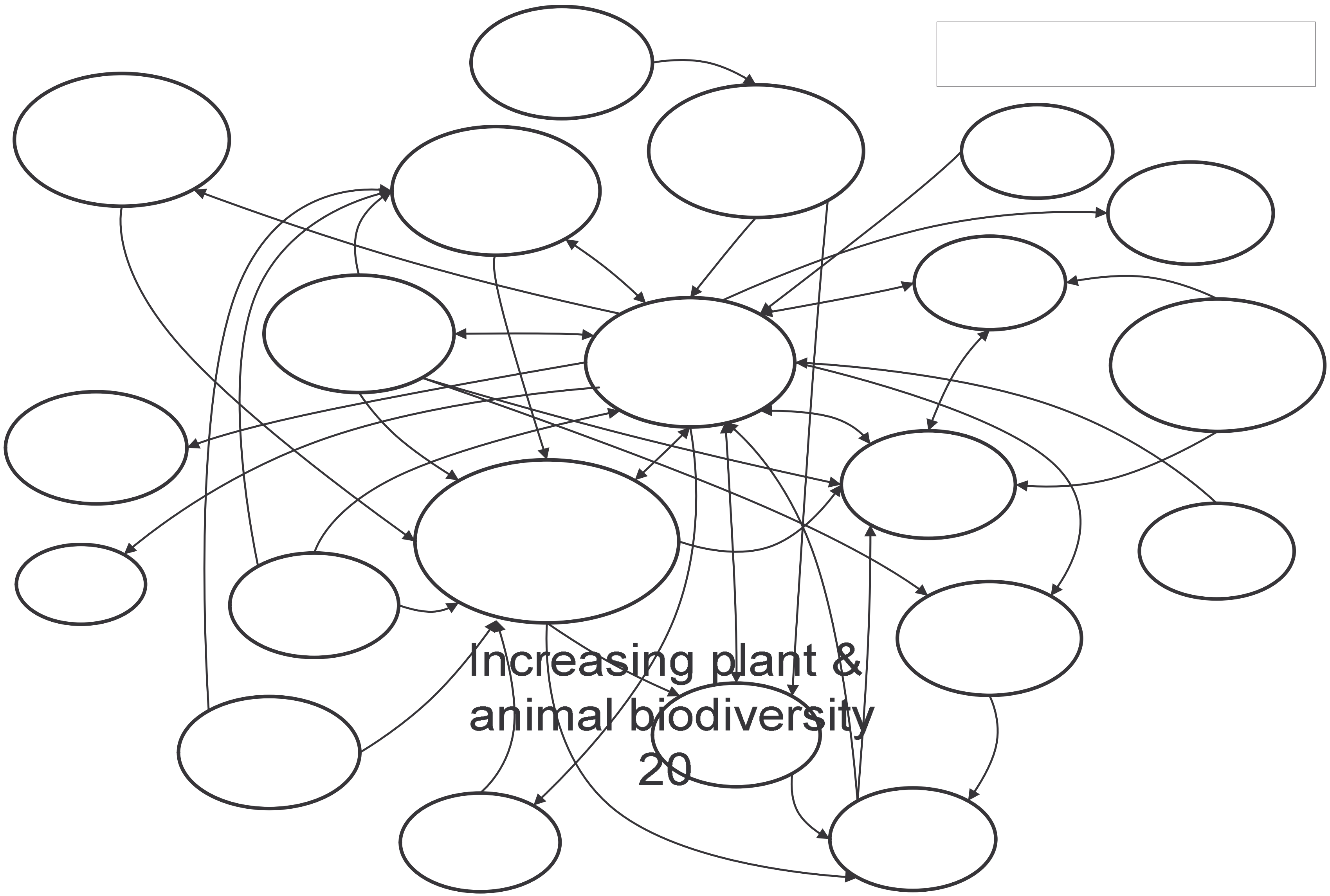


Figure 32 Generic causal map complied from 20 dairy farmers

4

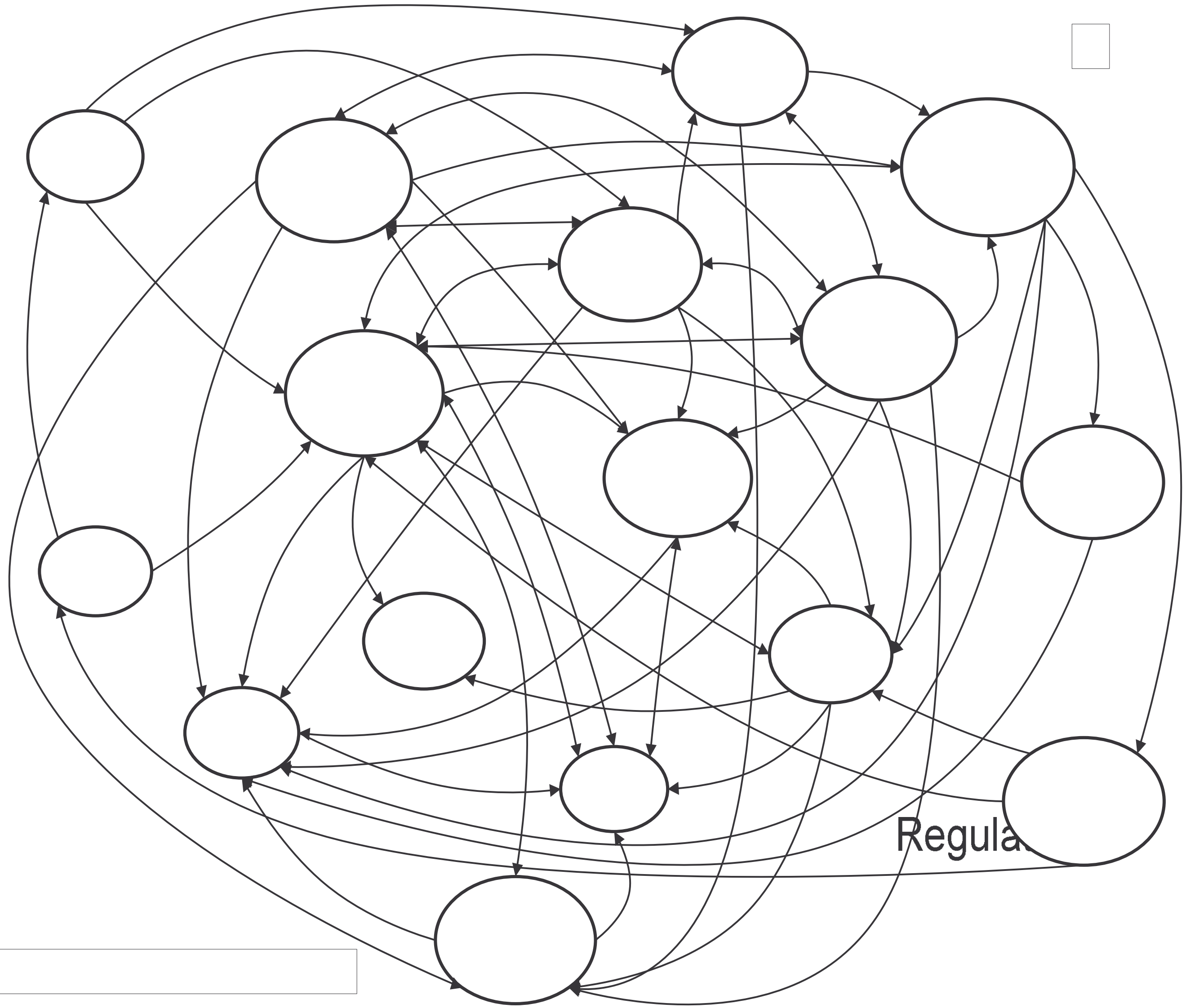


Figure 33 Your Causal map

6 Appendix

6.1 Acknowledgments and References

Acknowledgements
The ARGOS programme has been designed and implemented with the intention of providing quality information to both farmers and their associated industries to ensure that they are broadly sustainable, internationally competitive and profitable. To facilitate this, we greatly value the input provided by the farmers and industry partners to enable us to undertake the research and ensure that our outputs are relevant.

Thank you for your support and input.

PUBLIC REPORTS

The following are publicly available on the ARGOS website (www.argos.org.nz). Please contact ARGOS if you would like a copy.

Research Reports

05/04 Food Markets, Trade Risks and Trends, by Caroline Saunders, Gareth Allison, Anita Wrexford and Martin Emanuelsson, May 2005

05/06 Bird community composition and relative abundance in production and natural habitats of New Zealand, by Grant Blackwell, Erin O'Neill, Francesca Buzzi, Dean Clarke, Tracey Dearlove, Marcia Green, Henrik Moller, Stephen Rate and Joanna Wright, June 2005

06/03 Cleaner streams and improved stream health on North Island dairy and South Island sheep/beef farms, by Grant Blackwell, Mark Haggerty, Suzanne Burns, Louise Davidson, Gaia Gnanalingam and Henrik Moller, June 2006

07/01 Soil Properties on ARGOS Dairy and Sheep & Beef Farms 2005-6, by Peter Carey, Dave Lucock and Amanda Phillips, May 2007

08/01 Causal mapping of ARGOS dairy farms and comparisons to sheep/beef farms, by John Fairweather, Lesley Hunt, Chris Rosin and Hugh Campbell

08/02 Causal mapping of ARGOS high country farms and comparisons to sheep/beef and dairy farms, by John Fairweather, Lesley Hunt, DaveLucock, Chris Rosin

Conference Papers

Campbell, H. and C. Rosin. “After the Suits and Cellphones: Reflections on the Transformation of Organic Agriculture in NZ”. Organics Aotearoa NZ Conference. Lincoln University, 17th August, 2007.

Carey, P., Jayson Benge, Henrik Moller, Dave Lucock and Amanda Phillips. What effect does farming Organic vs. Conventional have on soil properties across increasingly intensive (sheep & beef, dairy and kiwifruit) production sectors? Organic Aotearoa New Zealand Conference, Lincoln University, 17 August 2007.

Fukuda, Y., Burns, B. and Moller, H. (2008). The effects of farming practices and shelterbelt types on invertebrate biodiversity in dairy farms. The 47th New Zealand Entomological Society Conference, University of Canterbury, Christchurch, 4-8 April 2008.

Hunt, L.M. (2008). Watching cows: associating farmer wellbeing and cows. Reflecting on our Relationships: Animals and Agriculture. Workshop, University of Auckland, 18 July 2008.

Mondot, M., Blackwell, G. and Maegli, T. (In Press). Does organic conversion promote bird community diversity and abundance by habitat modifications on New Zealand dairy farms? Proceedings of the 69th New Zealand Grasslands Association Conference, November 2007, Taupo, New Zealand.

Saunders, C.M. Marshall, L. Kaye Blake, W., Greenhalgh, S. and de Aragao Pereira (2008) Impact of US biofuel polices on international trade in meat and dairy products. Paper presented to Agricultural Economics Society Conference, Cirencester UK March 2008.

Saunders, C.M., Marshall, L., Kaye-Blake, W., Greenhalgh, S. and de Aragao Pereira, M. (2007). Impacts of U.S. biofuel policies on international trade in meat and dairy products. Paper presented at the Center for North American Studies conference, Domestic and Trade Impacts of U.S. Farm Policy: Future Directions and Challenges, Washington, D.C., 15-16 November, http://cnas.tamu.edu/SessIBPaperSaundersKayeBlakeEtAl.doc. Conference programme available at http://cnas.tamu.edu/.

Research Notes (short research summaries)

1. Background to the ARGOS Programme
2. Transdisciplinary Research
3. Cicadas in Kiwfruit Orchards
4. Market Developments for NZ Agricultural Produce
5. Spiders in Kiwifruit orchards
6. Organic Kiwifruit Survey 2003
7. Analysis of ZESPRI's Organic Kiwifruit Databases
8. Types of Kiwifruit Orchardist
9. First Kiwifruit Interview: Individual and Orchard Vision
10. Sketch Map Results : Kiwifruit Sector
11. Sketch Map Results: Sheep/Beef Sector
12. Positive aspects of wellbeing for ARGOS sheep & beef farmers
13. What makes ARGOS sheep & beef farmers stressed?
14. Ways in which ARGOS sheep & beef farmers managed the stress of farming
15. Soil nematodes in kiwifruit orchards
16. Understanding kiwifruit management using causal maps
17. Bird Sampling Methods
18. Birds on sheep/beef farms
19. Birds on kiwifruit orchards
20. Management of Data in ARGOS
21. Evaluation of the bait-lamina test for assessing biological activity in soils on kiwifruit orchards
22. Annual monitoring of cicadas and spiders to indicate kiwifruit orchard health
23. Cicada Species in Kiwifruit Orchards
24. Shelterbelts in kiwifruit orchards
25. Biodiversity on Kiwifruit Orchards: the Importance of shelterbelts
26. Kiwifruit orchard floor vegetation
27. Monitoring stream health on farms
28. Stream management: it really matters what you do on your own farm!
29. Soil Phosphorus and Sulphur levels in Dairy farms
30. Soil Phosphorus and Sulphur levels in Sheep & Beef farms
31. Assessing the sustainability of kiwifruit production: the ARGOS study design
32. Fertiliser use on ARGOS kiwifruit orchards
33. How ARGOS uses Geographical Information Systems (GIS)
34. Food Miles
35. Understanding sheep/beef management using causal maps
36. Earthworms in kiwifruit orchards
37. Four types of sheep/beef farmers across the ARGOS panels
38. Audits and Sheep/Beef Farm Management
39. Quality Assurance Programmes in Kiwifruit Production
40. High Country Woody Weeds
41. The Relevance of Performance Indicators Used for Non-Agribusinesses to Kiwifruit Orchards
42. The Relevance of Performance Indicators Used for Non-Agribusinesses to Sheep and Beef Farms
43. Common elements of pastoral farming systems as shown by causal mapping

6.2 Soil Phosphorus and Sulphur Levels in Dairy Farms

Introduction

Phosphorus (P) and sulphur (S) are probably the two most common nutrient deficiencies found in the soils of NZ. Most New Zealand soils have naturally low amounts of P and S because these elements are either not present in sufficient amounts in the parent materials (minerals and rocks) or like sulphate-S, are highly soluble and easily leached. P and S are retained in soil organic matter (SOM) but are released only slowly.

The use of P and S fertilisers to overcome these deficiencies has enabled NZ agricultural and horticultural industries to flourish. The pastoral industries in particular, have had a strong reliance on superphosphate fertilisers to increase the legume content and in turn, soil nitrogen (N) that can then be utilised by the other pasture species to increase both quality and DM yield.

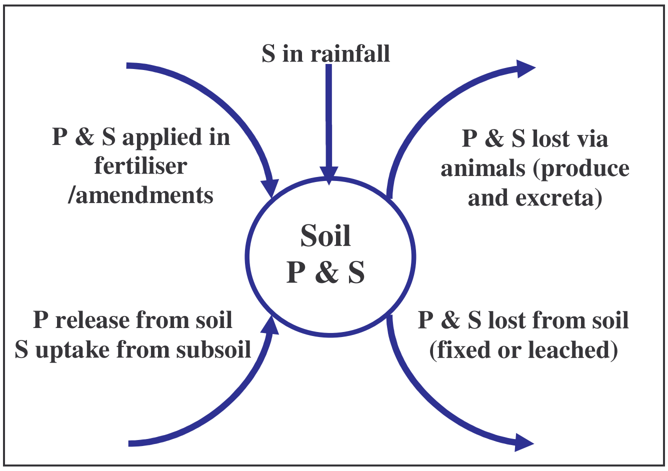


Figure 1 Soil P and S cycle

Farm trials have shown for some time that the optimal P limits for dairy farms is 30-40 (mg P/L; Olsen test) but many farms exceed these levels despite the evidence that they are highly unlikely to be achieving any extra production or response.

Conventional vs. Organic

In 2005, ARGOS initiated a comparative study of 12 clusters of dairy farms with matched Conventional and (converting to) Organic Dairy farms mainly in the Waikato and Taranaki regions. Soil testing of the main landforms within each farm was carried out for a range of chemical, biological and physical properties to measure differences between systems at time zero and into the future. Soil tests for P and S included Olsen-P, (NZ std. P soil test), Resin-P, (used to measure both available and slowly-available sources of P), Sulphate-S, (immediately available S) and Organic-S (long-term supply). One of the main differences between Conventional and Organic systems is the withholding of soluble P and S fertilisers from Organic farms. P and S can still be added but must be either slowly-soluble or slowly reactive materials like reactive phosphate rock (RPR) or elemental sulphur. However, whatever the form of the nutrients added, they must still be in an available form for the plant to use otherwise deficiency symptoms may occur and/or production reduces if nutrients levels decline too far.

Effects of conversion to organic

Initial soil testing has shown that both conventional and organic dairy farms are currently well above the top of the optimal range (40 mg P/L) as indicated by the dotted line in Figure 2 below. Conventional, however, is considerably higher than Organic indicating that the converting farms may be already seeing an effect of withholding soluble P after 1-2 years although they may, of course, have been lower to start with. Of the Conventional farms, 75% were higher than the top optimal guideline P value whilst 57% of Organic farms were. We would expect Organic soil-P values to be able to continue to decline further with no immediate effect on production. Resin-P values showed no current stores of unreacted RPR in the Organic farms. High soil P values (>60) are of concern because farm runoff can contain both dissolved P and P-rich soil particles which, once in streams and rivers, can lead to poor water quality and algal blooms.

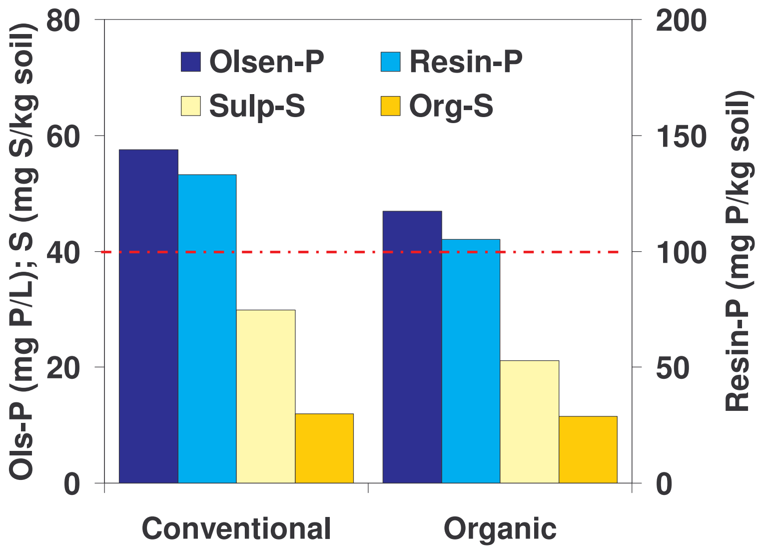


Figure 2 Mean P and S soil test values for Conventional and Organic dairy farms.

Sulphate-S values generally reflected similar differences between Dairy systems as for P although S is not usually of environmental concern. Organic-S was also marginally lower for Organic farms which may suggest that regular monitoring of both inorganic (sulphate) and organic-S would be wise to ensure S reserves don't become depleted over time. With less S being added in fertiliser there is less incorporated in SOM so S should be applied in Organic farms in products such as elemental sulphur.

Nutrient distribution around paddocks

Sampling of each farm meant getting representative samples from each major landform ie. flats, slopes and crests (flatter areas above slopes). A major issue that arises in terms of hill farms that affects both Conventional and Organic farms is of excreta transfer. Stock tend to camp on the flatter areas of hill farms overnight so that there is a transfer of nutrients from slope areas, where stock graze, to crest sites (see Figure 3 below). The resulting transfer can see soil test values for slope soils become depleted of P, S and other nutrients over time and this may affect Organic systems disproportionately more because of lower nutrient inputs. Crest sites on the other hand can become nutrient enriched so less fertiliser is required on these areas.

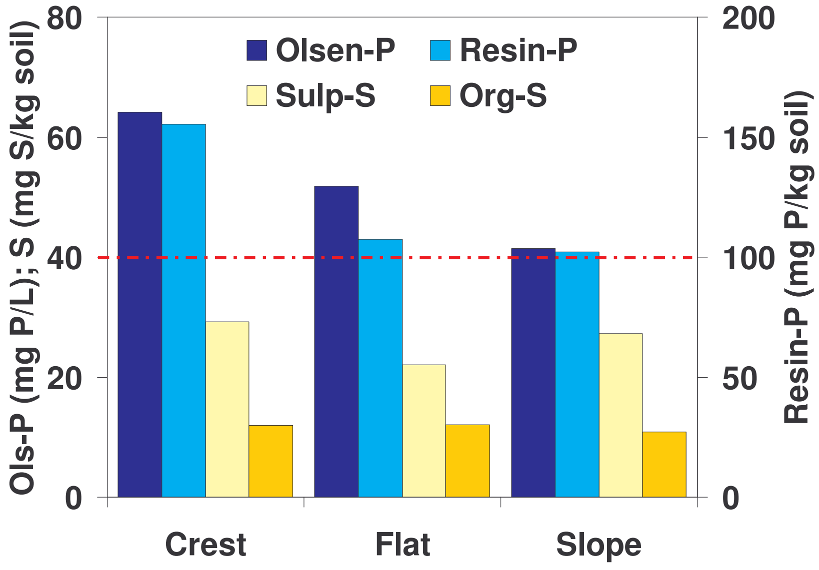


Fig. 3 Mean P and S soil test values for crest, flat, and slope landforms for Dairy.

Future work

We will continue to monitor these sites to see how nutrient status changes over time and to investigate what effect P & S levels have on the sustainability and resilience of each system and whether over-fertilisation continues to be an issue.