AGRICULTURE RESEARCH GROUP ON SUSTAINABILITY

2010 Annual ARGOS Farmer Report

Compiled by David Lucock, ARGOS

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Fonterra
Dairy for life

The AgriBusiness Group

Lincoln University
Te Whare Wānaka o Aoraki

University of Otago
Te Whare Wānanga o Otāgo

TABLE OF CONTENTS

TABLE OF FIGURES

Preface

This report has been specially prepared for you. It contains the following sections of information:

1. Farm management report focusing on key performance indicators and production intensity
2. An energy return on investment (EROI)
3. Bird life on the farm
4. Comparing soils within and across sectors
5. Delving into the past - The retrospective social survey

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.

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1 ARGOS

1.1 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 longitudinal research project with the aim to model the economic, environmental, and social differences between organic, and conventional systems of production as well as to investigate other issues in relation to agricultural production and its impacts. 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 are being 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.

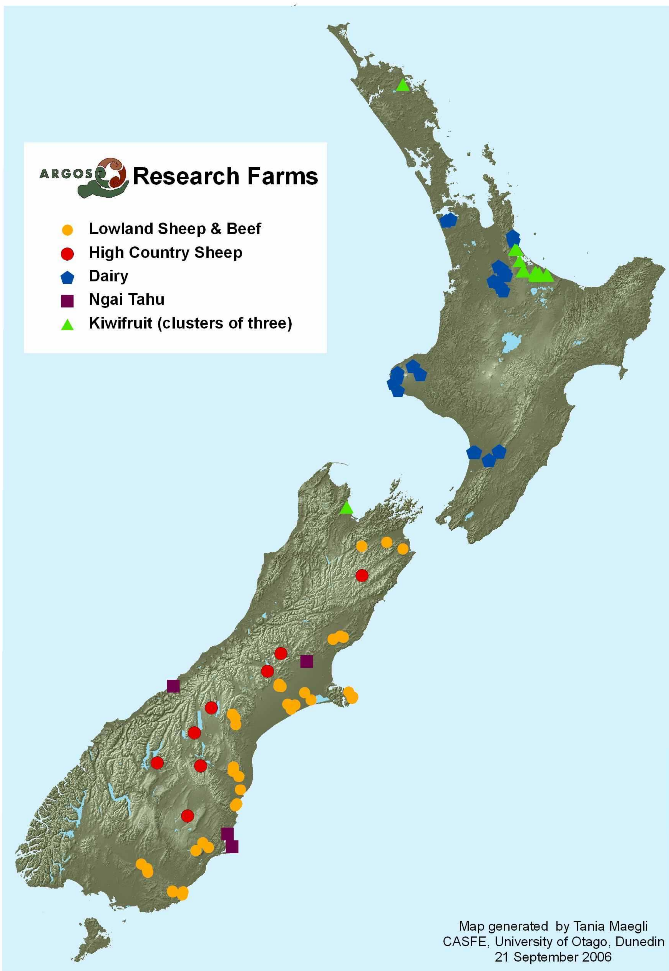


Figure 1 Location of Properties under study by ARGOS

1.2 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 studairy 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

2.1 Financial comparisons between organic and conventional dairy farms

2.1.1 Introduction

Financial comparisons were reported in the 2009 Annual ARGOS Farmer Report at the operating level between management types (12 Organic and 12 Conventional dairy farms) in the ARGOS project. The method used was to average data for 3 financial years and compare cash farm income, cash farm expenditure, cash farm surplus and some farm working expenses namely; labour, vehicle costs and animal health. What wasn't taken into account was that the premium received by Organic farmers for their milk increased, at differing rates, with time since conversion. As a consequence, some farmers were getting a greater premium than others during the study period. This contributed to a wide variation in the annual average cash farm surplus within the Organic management group and in hindsight should have been reported annually.

Subsequently, in this section the milk production data has been expanded to include 2008/2009 figures and will illustrate a breakdown of financial data, at the farm operating level, for each of the 2005/06, 2006/07 and 2007/08 financial years. In addition to premium differences Organic dairy farm systems have a closer alliance to 'closed' systems than the Conventional systems, in that the Conventional farm system tended to graze more cattle off the milking platform and brought in more supplement. This report attempts to put the two groups on a more even footing by comparing them after the effects of the 'open' system are removed.

2.1.2 Milk yield

Gross yields

During 2005/06 – 2008/09, overall milksolids production for the Organic group was 594 kgMS/ha/yr, which was 73% of the Conventional group (999 kgMS/ha/yr). On a per cow basis the gap was a little smaller, 323 kgMS/cow/yr, 90% of the Conventional group (359 kgMS/cow/yr). Milk yield was 9% lower for the Organic group during the season prior to their transition and declined further with each passing year such that in 2007/08 the difference was 35% of Conventional production (Figure 2). The difference was statistically significant in each year.

There was evidence that the rate of decline by the Organic group was slowing, as the decline was 11% in the first year following transition, but only 4% in the fourth year. The impact of the 2007/2008 drought has undoubtedly affected production as managers enforced a range of drought management strategies with varying effects on milk production. Both Conventional and Organic farmers have increased production in the 2008/2009 year and it will be interesting to monitor the comparisons

These results indicate that of the lower production on Organic farms; around one third is attributable to individual cows producing less while around two thirds is attributable to farm factors such as lower stocking rate.

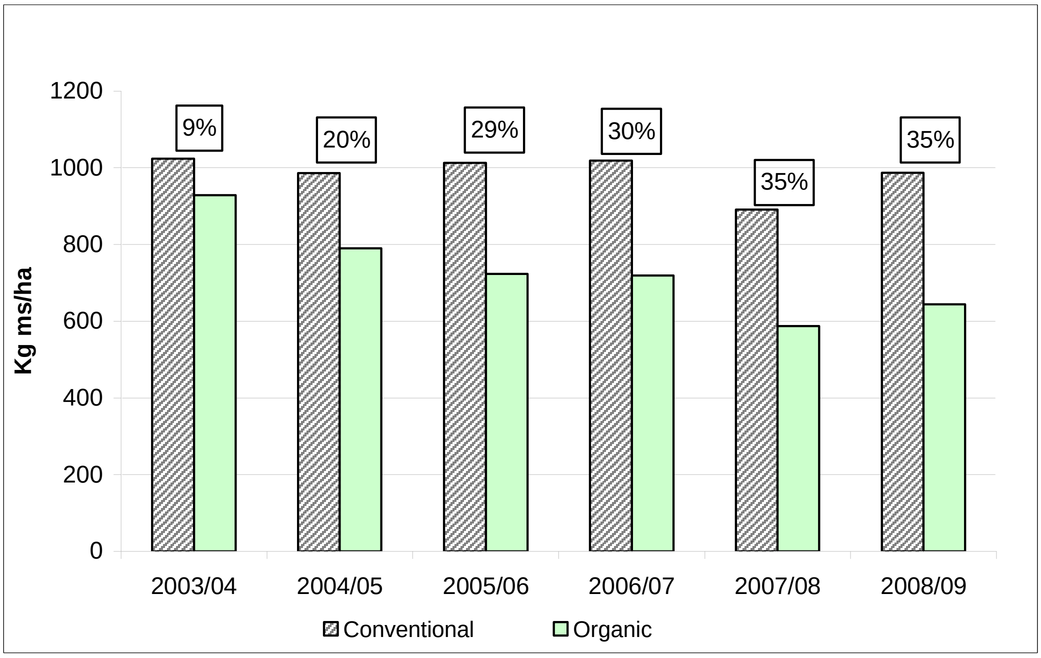


Figure 2 Milk production by the Conventional (striped) and Organic (solid) groups of farms from 2003/04 to 2008/09

Some of the lower stocking rates for the Organic farms can be attributed to the fact that they generally have more of a ‘closed’ system whereas the Conventional farmers tend to graze more animals off the milking platform and bring more supplements on to the platform. Table 1 shows kilograms of dry matter used to graze dry cows, and rising 1 and 2 year replacement heifers off the milking platform, which was then related back to the size of the milking platform. Hence, on average, the conventional farmers used 18,345 kg DM per milking platform hectare to graze dairy support animals outside of the milking platform whereas the Organic farmers used 35% less or 11,897 kg DM/ milking platform hectare. Similarly the Conventional farmers brought more supplement on to the milking platform to boost production than Organic farmers (

Table 2). Calculations for tables 1 and 2 can be found in the appendix.

Table 1 Kilograms of dry matter, per milking platform hectare, used to graze dairy support animals off the milking platform

	2006/07	2007/08
Conventional	18345	17071
Organic	11897	9989
Difference	35.2%	41.5%

Table 2 Kilograms of dry matter, per milking platform hectare, brought on to the dairy platform

	2006/07	2007/08
Conventional	6912	10343
Organic	5028	2197
Difference	27.3%	78.8%

2.1.3 Net yields

The difference between the 'closed' and 'open' aspects of these systems means that, to an extent, apples are being compared with oranges in Figure 2. Therefore it was decided to remove the milksolids created from brought in supplement and dry matter used for grazing dairy support stock off the milking platform. These milksolids were subtracted from the annual milksolid production to give net milksolids, which was then divided by hectares to give production per hectare of milking platform. The main assumption used was 15 kilograms of dry matter created one kilogram of milksolids (Charlotte Glass, Dairy NZ, Pers. Com.). Using net milksolid production figures reduces the differences between Conventional and Organic systems by 5% (i.e. from 30% to 25%) in 2006/07 and 8% (i.e. from 35% to 27%) in 2007/08 (Figure 3). One of the causes for the differences in the net yield between Organic and Conventional will undoubtedly be because of the inability for organic farmers to use artificial inputs such as Urea. As was mentioned earlier, the drought possibly impacted more severely on the Organic farmers through a limited choice of management options available to them compared with the Conventional farmers. It will be interesting to note the differences when 2008/09 data becomes available.

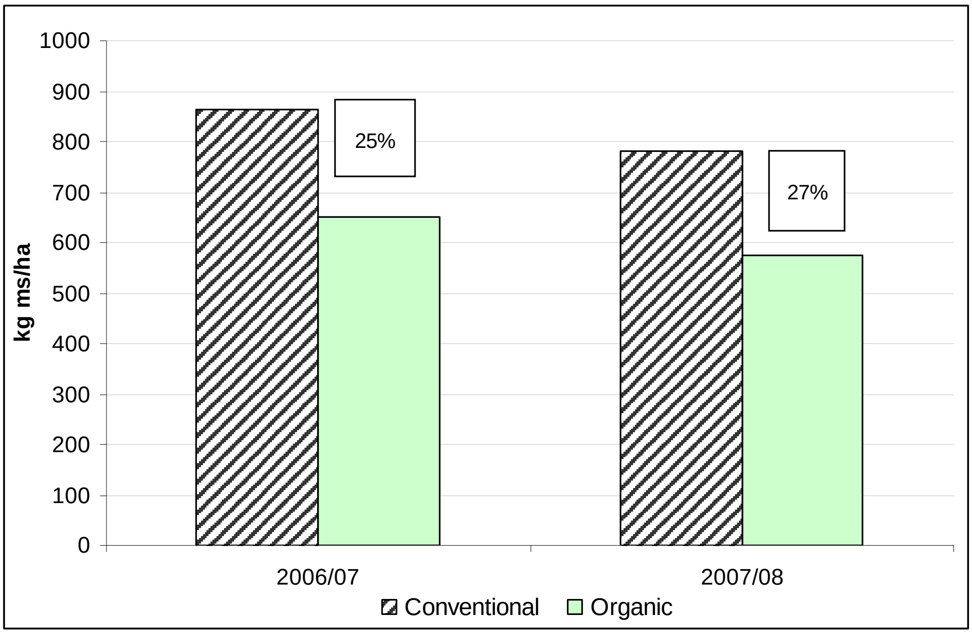


Figure 3 'Net' milk production by the Conventional (striped) and Organic (solid) groups of farms 2006/07 and 2007/08

2.1.4 Income

<u>Milk income</u>

Overall there was strong evidence of an increase in income on Organic farms (Figure 4) with each season, even though the premium varied between properties (

Table 3).

- In 2005/06 seven out of twelve Organic farms were receiving a 7% premium and one was receiving 20%.
- In 2006/07 eight out of twelve Organic farms were receiving a 7% premium and three were receiving 20%.
- In 2007/08 six out of twelve were getting 7% premium and 6/12 were getting 20%.

Table 3 Milk premiums received by farmers for milksolids

Farm	2004/05	2005/06	2006/07	2007/08	2008/09
A	0	7	7	7	7
B	0	7	7	7	20
C	0	0	20	20	20
D	0	20	20	20	20
E	7	7	7	20	20
F	0	7	7	20	20
G	0	7	7	7	20
H	0	0	7	20	20
I	7	7	20	20	20
J	0	0	7	7	7
K	0	0	0	7	7

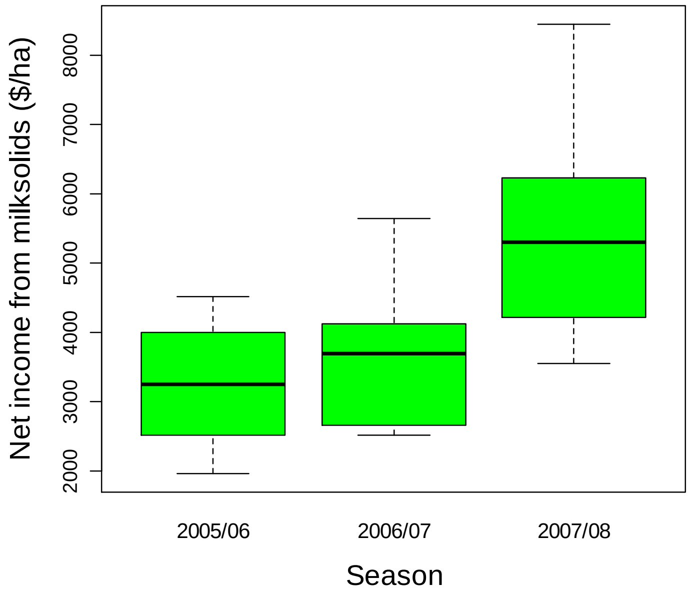


Figure 4. Net income from milksolids per hectare data for the Organic group across the three seasons

Was the increase in farm income over the three seasons influenced by a larger number of farmers receiving higher premiums or seasonal differences in milk payout?

Looking specifically at net milksolids income, all Organic farms had a much better year in 2007/08 than the preceding two seasons but the amount that their income increases annually does not appear to be strongly influenced by moving from one premium level to another (Figure 5). For example, the three lower most farms in the left hand graph have a similar rate of increase in income from 2006/07 to 07/08 even though one of them goes from a 7% premium to 20%. Similarly the three uppermost farms in the right hand graph have a similar rate of increase in income for 2007/08 even though one goes from receiving a 7% premium to a 20% premium.

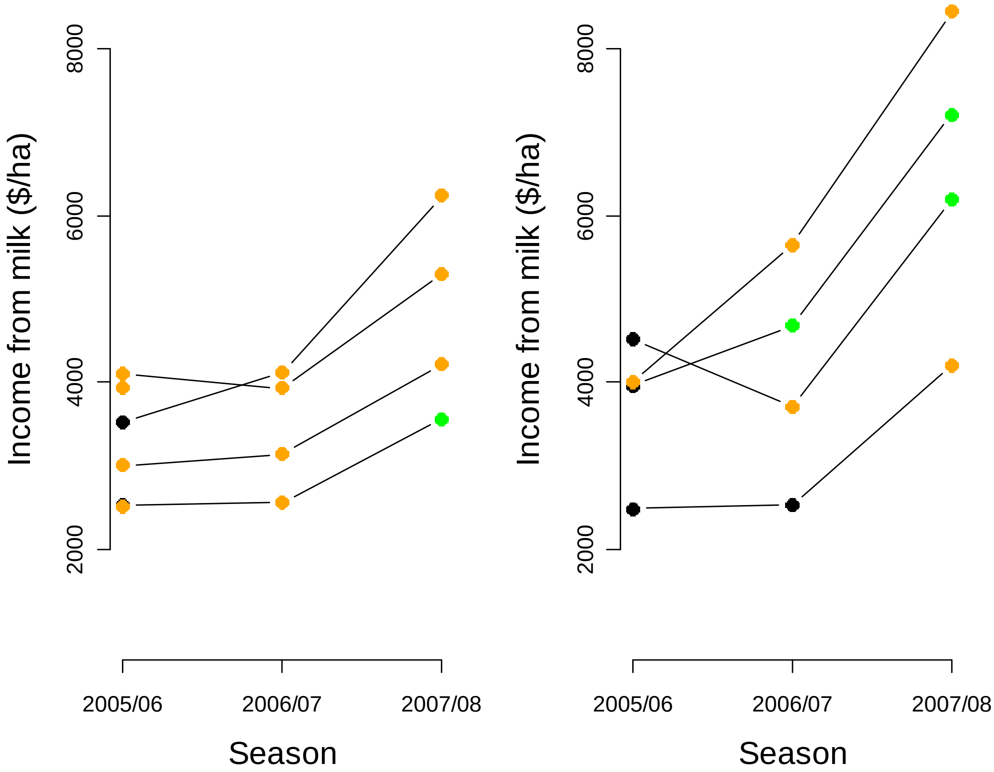


Figure 5 Annual net income ($/ha) from milk for each Organic farm, indicating their premium level in that year of either no premium (black points), seven percent (orange points), or twenty percent (green points)

Taking the annual average net milksolids income for each of the Organic and Conventional groups (Figure 6) showed that the Organic group was closing the gap on the Conventional group. In the three seasons from 2005/06 to 2007/08 the Organic group received 78%, 89%, and 93% of the income per hectare of the Conventional group.

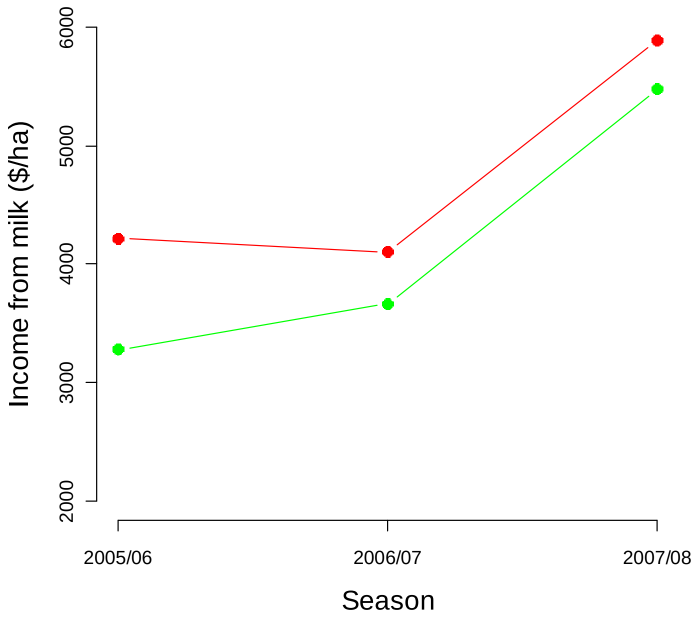


Figure 6. Average net income from milk for the Organic (green) and Conventional (red) groups of dairy farms

The figure above is broken down further in Figure 7, to show variability in net milk income within both management systems over the 3 year period.

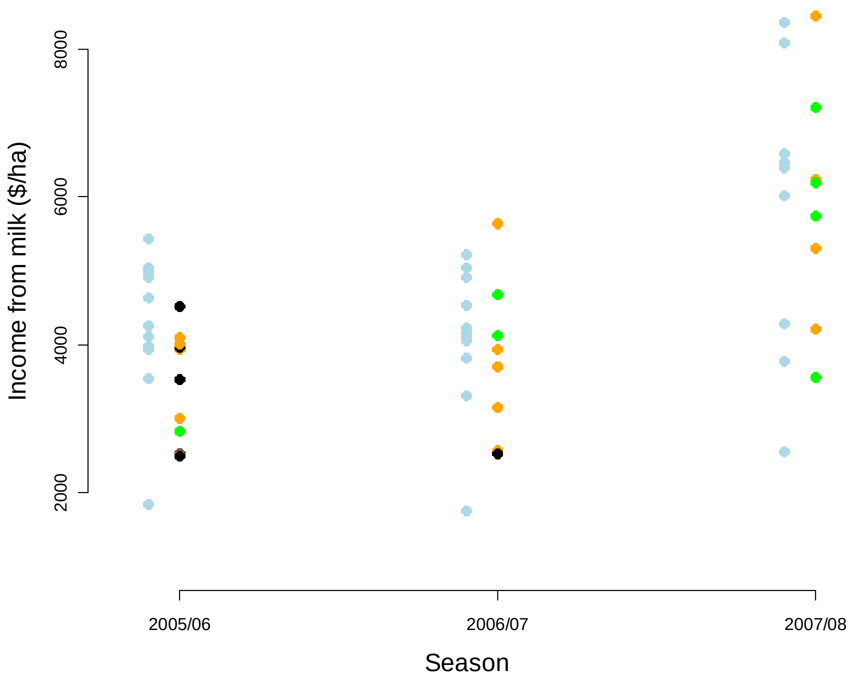


Figure 7. Seasonal income from milk that Conventional (blue) farms and Organic farms received for their milk either no premium (black points), seven percent (orange points) or twenty percent (green points)

Several points are worth noting in Figure 7:

- The first is the progression of the Organic farms through the premium options so that by 2007/08 they are all receiving either seven or twenty percent premium.
- The second is that generally the range of milk income values is about the same for Conventional and Organic groups and was greater for both groups in 2007/08. This suggests that they have a similar responsiveness to change, such as the good season, in 2007/08, to a similar degree.
- One Conventional farm had unusually low income from milk each year and this will have dragged the average value for the Conventional group down somewhat.

2.1.5 Cash farm income

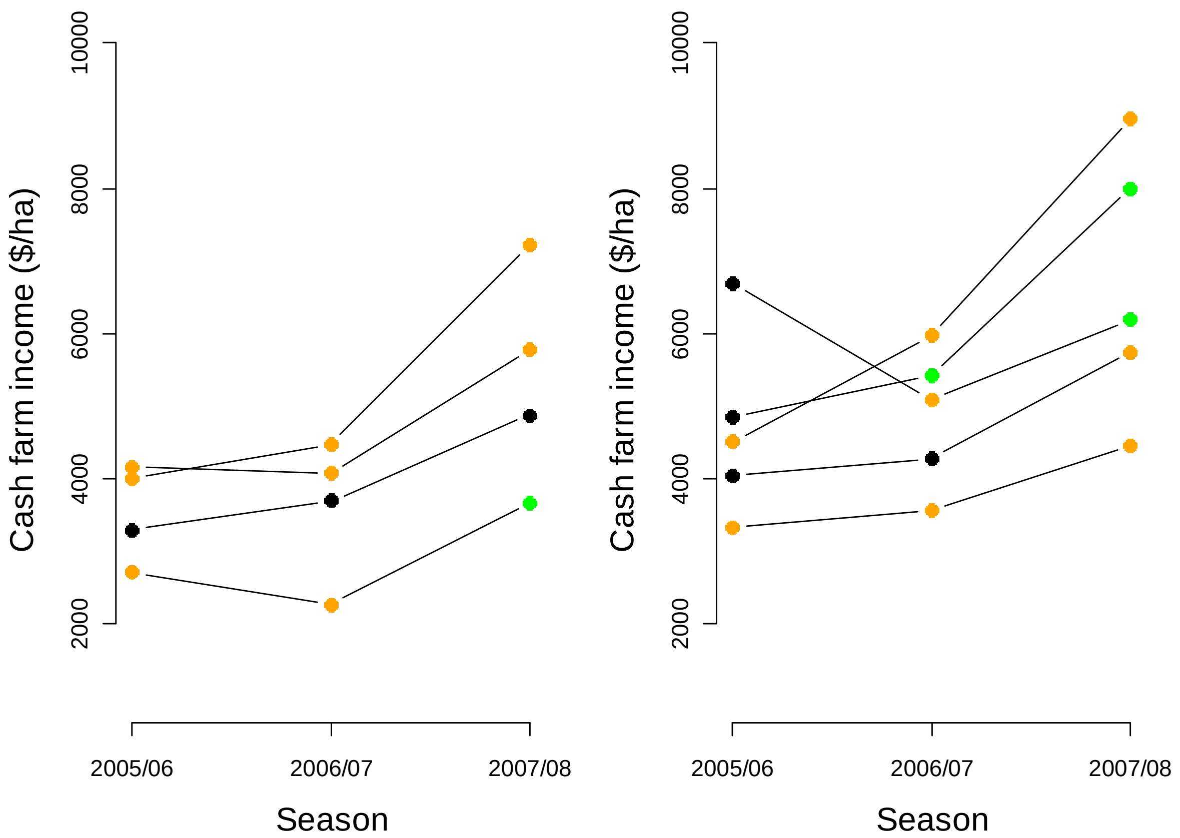


Figure 8 Cash farm income per hectare for nine Organic farms (spread over two graphs) with either no (black points), seven percent (orange points), or twenty percent (green points) premiums.

There is no clearly visible and consistent increase in cash farm income at the individual farm level in response to moving from one premium level to another (Figure 8) which indicates that while obviously assisting farm profitability, it is not a key driver. This observation was backed up by statistical analysis which showed the premium did not significantly influence cash farm income (P=0.732) while seasonal differences, of which the most important would probably be payout, had a very large effect (P=0.000). Three Organic farms are not shown, i.e. one was omitted due to abnormally high income values while the second and third had insufficient data.

If farms were aggregated according to region the overall increase in cash farm income in 2007/08 remains the strongest trend despite which region they were in (Figure 9). It should be kept in mind that data was collected from three farms in the Manawatu and three farms in the Taranaki.

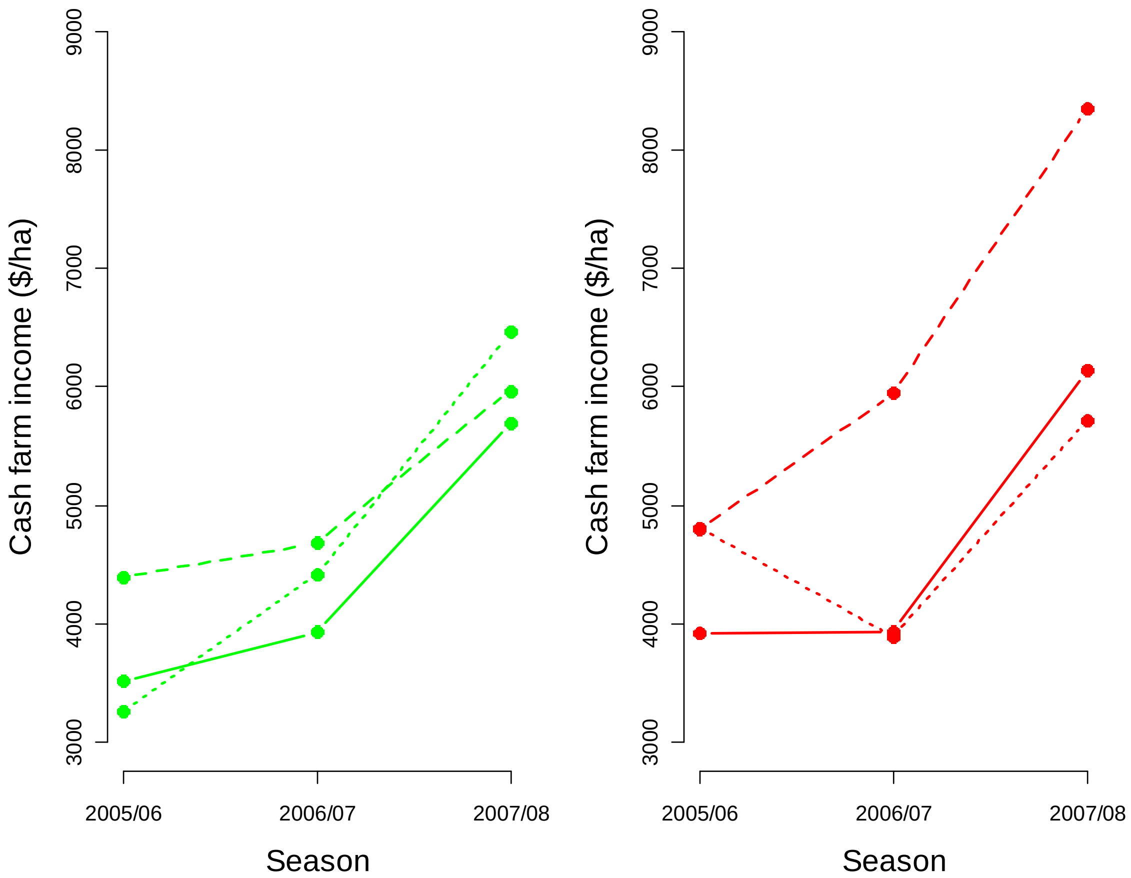


Figure 9. Cash farm income per year stratified by management system (Organic=green, Conventional=red) and region (Taranaki=solid line, Manawatu=dashed line, and Waikato=dotted line)

2.1.6 Expenditure

Farm working expenses, detailed in Figure 10 for the Organic group were 79% of the Conventional group for the 2005/06 season. This was due mainly to the difference in animal health, hay and silage, grazing, pasture renovation and fertiliser costs (Table 4), and is expected as Organic farmers tend to:

- Use less animal health products
- Have more of a closed system so tend to buy in less supplement or graze animals off.
- Do not use chemicals involved in pasture renovation
- Apply some fertilisers in different forms, most importantly nitrogen

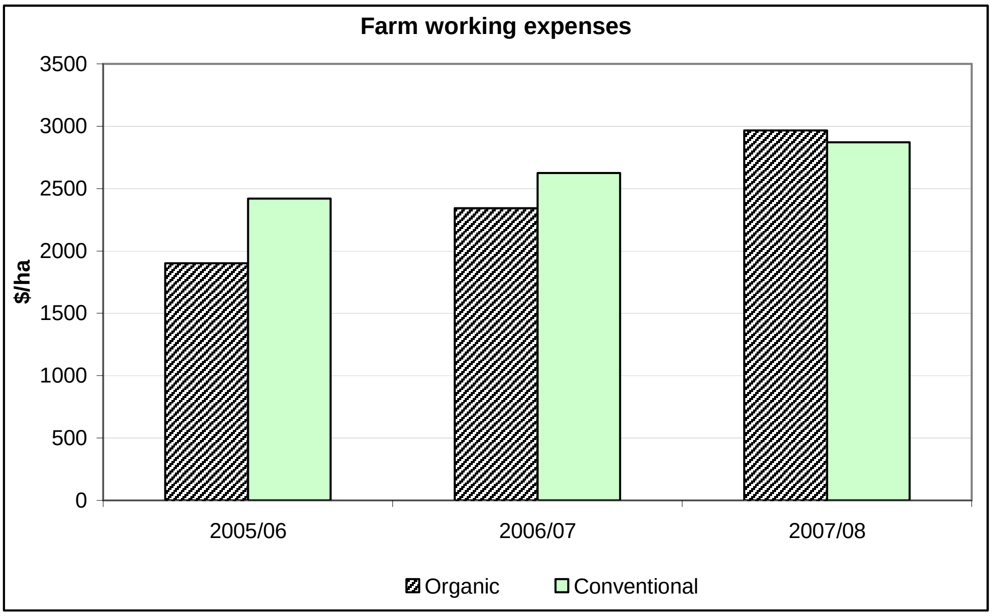


Figure 10 Organic and Conventional farm working expenses for dairy farms in the ARGOS project

In the 2006/07 and 2007/08 seasons the difference in farm working expenses decreased mainly due to the rising labour and fertiliser costs for the Organic group (Table 4). However this group continued to spend significantly less for animal health, hay and silage, and grazing. We expect the differences for hay and silage, and grazing will decrease over time as more farms with dairy support policies become Organic.

Farm working expenses increased at a greater rate in the Organic group during the studairy period, rising $1066/ha from $1900/ha to $2966/ha in 2007/08. In the same period farm working expenses for the Conventional group rose by $455/ha, i.e. slightly less than half as much. The long term average for farm working expenses is not known and may well be less than that recorded in 2007/08. The increases we saw in the Organic group appeared to be driven by increases in their spending on permanent wages, pasture renovation, fertiliser, vehicles, and repairs and maintenance. These five expenses increased by 41%, 61%, 81% and 72% respectively during the study period. In the same period these expenses for the Conventional group typically increased by less than half as much. The high spending in 2007/08 in many cases could well be explained by the high income received that year being used to catch up on jobs that had been put off. It could also be because some Organic farmers are adjusting to their new management systems.

Table 4 Expenditure details by season for ARGOS dairy farm groups

management	organic	conv	organic	conv	organic	conv
season	2005/06	2005/06	2006/07	2006/07	2007/08	2007/08
Labour						
permanent wages	335	366	459	361	472	429
casual wages	21	18	46	45	78	91
acc	23	35	23	32	31	33
Stock expenses						
animal health	153	264	149	282	186	271
shed expenses	40	38	53	46	67	50
feed hay and silage	117	267	49	119	61	138
feed grazing	122	130	127	274	163	218
feed fodder crops	6	9	3	13	0	0
Other expenses						
pasture renovation	301	425	322	419	484	460
fertiliser excl nitrogen	280	301	301	307	448	374
nitrogen	0	70	0	59	0	27
electricity	65	90	95	93	99	73
freight nei	29	22	43	27	57	32
vehicles	143	156	239	168	258	156
repairs and maintenanc	211	206	290	255	363	303
Overheads						
rates	67	69	95	77	91	65
communication	16	27	20	27	23	19
insurance	29	45	25	27	39	38
accountancy	21	38	31	41	35	32
legal	8	11	4	17	10	5
other admin	33	33	46	34	49	24
run off lease	12	0	10	12	0	0
other dairy	34	20	24	11	61	6
non dairy	46	0	0	0	0	0
farm work expenses	**1900**	**2418**	**2343**	**2626**	**2966**	**2873**
Operating profit	**1737**	**2164**	**1968**	**1650**	**3131**	**3494**

While total labour costs were 9.5% less for the Organic group in the 2005/06 season (Table 5), they were 20.5% and 5.1% more than the Conventional group for the following two seasons.

Table 5 Average farm working costs on Organic farms as a percentage of Conventional farms

	2005/06	2006/07	2007/08
Total labour	-9.5%	20.5%	5.1%
Animal health	-42.0%	-47.2%	-31.4%
Feed hay and silage	-56.2%	-58.8%	-55.8%
Feed grazing	-6.2%	-53.6%	-25.2%
Pasture renovation	-29.2%	-23.2%	5.2%
Tota fert excluding N	-7.0%	-2.0%	19.8%
Total N	-100%	-100%	-100%
Farm working expenses	-21.4%	-10.8%	3.2%
Operationg profit	-19.7%	19.3%	-10.4%

2.1.7 Operating profit

Average Operating Profit for the Organic group relative to the Conventional group was 80%, 119%, and 90% in 2005/06, 2006/07, and 2007/08 respectively and these differences were not statistically significant. Given the degree to which this measure of farm productivity can vary from year to year, it is not possible to make specific judgements on the relative profitability of Organics, but it does suggest profitability of the two groups may be similar.

On average operating profit was 20% less for the Organic farms for the 2005/06 financial year where 4 farms converting to Organic were not receiving a premium. The Organic group then averaged 19% higher and 10% lower for 2006/07 and 2007/08 respectively. Figure 11 shows the spread of operating profits amongst Conventional and Organic farms involved in the ARGOS project for the 2005/06, 2006/07 and 2007/08 financial seasons.

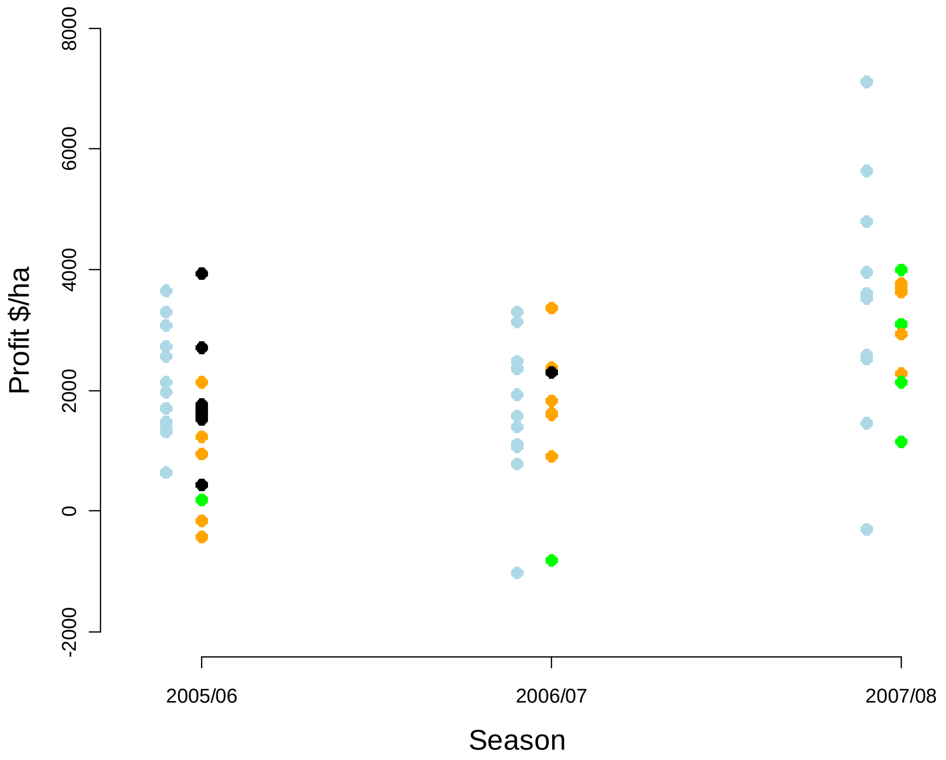


Figure 11 Annual farm operating profit (cash farm income – farm working expenses) in $/ha for the Conventional farms (blue) and Organic farms either no premium (black points), seven percent (orange points) or twenty percent (green points)

2.1.8 Summary

Milk yield was lower for the group of Organic farms at the start of the conversion process and decreased further for several years following conversion. Reasons for this decline include adapting to new a new management system and environmental impacts such as the 2007/08 drought. The last couple of years of data indicate that the decline has ceased and may in fact be in the process of being reversed.

Operating profit is influenced by many factors and consequently was variable for both the Organic and Conventional groups. It is not a sensitive measure of the effects of changing to Organic production practices. There was no statistically significant difference in operating profit between the Organic and Conventional dairy farms.

Net milksolids income is one of the more sensitive means of evaluating the impact of Organic dairying. The gap in Net milksolids income between the Organic and Conventional groups closed during the last three years of the study period and in 2007/08 the Organic group averaged 93% of the income for the Conventional group.

The milk yield margins were less when both management types were compared on a ‘closed systems’ basis.

Net milksolids income is influenced to a greater degree by milk payout prices and environmental factors than by the premium they received for their milk.

Expenditure, initially lower for the Organic group than the Conventional group, increased at a greater rate for the Organic group. This may have been due to Organic farm managers spending on maintenance in response to a season with high income and in light of the fact that they had been Organic for several years by 2007/08 and had not seen great financial losses, so felt more comfortable in their financial sustainability. It may also have been due to Organic farm managers adjusting to their changing farm systems, but increases in spending due to management adjustment would probably have occurred in the first couple of years following conversion.

3 An Energy return on investment (EROI) analysis

An EROI analysis is essentially a ratio of outputs to inputs. It is a flexible method for measuring the energy cost of energy and is well suited to evaluating the energetic efficiency and intensity of agricultural production systems. For instance high input systems have been compared with low input systems financially. In this section two systems, organic and conventional, are compared in terms of energy.

Over 6 years the energetic intensity and efficiency (EROI, energy return on investment) of production was evaluated under conventional or organic management of the sheep/beef farms (SHEEP/BEEF) and dairy farms in ARGOS. Two EROI ratios (outputs: inputs) were calculated where the boundary of the system was defined as within the physical boundary of the farm.

The first ratio contained energy embodied in fertiliser, supplementary feed and electricity as inputs. Output from the SHEEP/BEEF farms was energy embodied in liveweight, crops, and wool. Output from the dairy farms was energy embodied in milk and cull cows. The second EROI ratio was calculated for the SHEEP/BEEF group only and included the additional inputs of energy embodied in animal remedies, agrichemicals, and capital items.

However, the organic farms were no more efficient at converting input energy into output energy, as indicated by similar EROI values to the conventional farms.

The organic farms were clearly less intensive than their conventional counterparts as reflected in their having significantly less input and output energy per unit area. The greatest single difference between the groups was the omission of urea from the organic farms.

However, the organic farms were no more efficient at converting input energy into output energy, as indicated by similar EROI values to the conventional farms. This result is consistent with two earlier studies (Pimentel 2006; Refsgaard *et al.* 1998) but contrasts with a MAFF UK simulation studairy which estimated EROI values of 1.10 and 2.47 for conventional and organic upland livestock production systems (Cormack 2000).

The reason for this contrast could not be deduced from the summarised MAFF UK report available, while the full report was confidential. It must be stressed that the comparison of EROI studies should be made with great care because EROI values depend on the system boundary and the methodology with which system components are evaluated.

The efficiency with which input energy was converted into output energy was far greater for the crops than for the animal based products. Crop EROI values were consistent with previous research (Pimentel 2006; Wells 2001) and indicate that if the goal of sustainability was simply to improve energy efficiency, it could be achieved through the focus of agriculture shifting from animal production more toward plant-based products.

The aim of this studairy was to compare the intensity and efficiency of different management systems based on output energy and the energy contained in key inputs rather than to conduct a comprehensive EROI analysis. Consequently the EROI values studied here provide a sound basis for comparisons within this studairy but would be considerably larger (indicating greater efficiency) than the true values which would include other important inputs such as the energy embodied in sunlight reaching the farm area, human labour, and diesel.

Sustaining or increasing present levels of energy output from agriculture will become increasingly difficult as resources are constrained by either physical or legislative means. For example, demand for oil is predicted to outstrip supply within a decade, according to the synopsis of available models on the Oil Drum website (www.theoildrum.com), causing price spikes of increasing regularity and severity. The oil price spike in July 2008 caused the price of urea to more than double (Profercy Report 2009) and the negative impact of this on agricultural output could have been substantial if the spike had persisted. To sustain current levels of energetic output in the face of fewer or more expensive inputs agriculture must become more efficient.

4 A perspective on differences in soil properties between organic and conventional farming in dairy and sheep and beef sectors

The following is a summary of a report presented at a recent Grasslands Association Conference by Peter Carey (LRS (Land Research Services) Ltd.). He introduces energy to an already comprehensive report comparing organic and conventional management systems of the Dairy and Sheep/beef sectors in participating in ARGOS.

> Back-drop refers to whether the question of whether organic systems have better soil properties than Conventional systems is dependent on the intensity of the sector or the setting within which farming is occurring. So in Sheep/Beef, is the sector so extensive that you aren't likely to pick up many differences as compared with Dairy?

<u>Introduction</u>

A major part of any comparison of sustainability and resilience between agricultural production systems is soil quality and whether an organic system produces fewer detrimental effects than a “conventional” system. The back-drop to this question is the intensity of the farming in the primary sector and whether dairying could aggravate such effects and reduce the soil’s biological function more than a more extensive sector like sheep and beef. We set out to test a simple null hypothesis that there are no differences in soil properties between management systems (panels) for all production sectors.

<u>Intensification measures</u>

Dairy EROI values (see above report on energy return on investment) were almost an order of magnitude higher than those for sheep/beef and were due to dairy energy outputs being 10-20 times greater than for sheep/beef whilst inputs were only 2-3x higher. However, not all energy input data was available for the dairy farms with inputs restricted to fertiliser, electricity and supplementary feed. Those for sheep/beef were more comprehensive (Barber & Lucock 2006; Barber et al. 2008; Wells 2001) but Wells (2001) compiled such a list for dairy within New Zealand and our estimate is that that dairy inputs are actually about 30-40% higher for most farms on the same basis. This reduces dairy EROI values accordingly but would still mean values at least 5 times greater that sheep/beef. This was used as our main indicator for increased intensity of production between sectors.

Organic producers generally had lower energy inputs and outputs than the other management systems although these were not significantly different within each sector and did not measurably result in greater efficiency. In terms of imported nutrient use, sheep/beef organic was the lowest user, averaging 13 kg/ha (P, K and S) annually compared with 80 and 60 kg/ha (N, P, K and S) for integrated and conventional, respectively. dairy organic averaged ~110 kg/ha annually (N, P, K and S) compared with twice that for conventional.

> Schipper et al. (2007) has documented a gradual loss of soil carbon from some New Zealand soils, especially pastures, in the past 20 years. Whether this process is related to increased intensification of land use and whether dairy organic farming will slow or even reverse this process will require longitudinal monitoring.

Soil fertility

Olsen-P, resin-P and sulphate-S values were significantly ($P<0.001$) lower for sheep/beef than for dairy reflecting the total amounts of imported nutrients applied but some small amount of variance could also be attributed to differences in soil order (Sparling & Schipper 2002). Similarly, within each sector, the differential application rates between managements systems meant the organic panel values were consistently lower than those for conventional and integrated ($P<0.01$) In sheep/beef, average organic panel values were lower than optimum (P 20-30; S 10-12) for New Zealand pastures (Roberts et al. 1994) whilst, conversely, Olsen-P values for conventional dairy were about 50% higher on average than the top of the recommended optimal range (20-40).

Sheep and beef, as the most extensive of our pastoral sectors, relies on modest fertiliser use, mainly superphosphate, to underpin clover growth and N fixation (Morton et al. 1994). Consequently, soil fertility values for sheep/beef tend to be at the lower end although in this group only organic-S appears to be less than optimal (Morton et al. 1994). Conversely, dairy P and S values are around twice those of sheep/beef and reflect a policy to maximise production from smaller pastoral areas by ensuring major nutrients are adequate. Olsen-P values for dairy conventional are well above the recommended optimal range and these have the capacity to lead to water quality issues from farmland runoff (McDowell et al. 2001; Watson et al. 2002; Wilcock 1986; Wilcock et al. 2006).

Soil pH, cation and total base saturation (BS) values were highest for dairy but not cation exchange capacity (CEC). Although most of the dairy cluster were on allophanic soils with high pH and a moderate-to-strong variable-charge component (Theng 1980), sheep/beef clusters were dominated by twice as many finer textured clay loams as dairy (Figure 12). Consequently, sheep/beef clusters generally had higher CECs despite (slightly) lower pH. Between sectors there were several system interactions with sheep/beef Organic having lower CEC and BS% values than either conventional/integrated but not for dairy. Greater use of nitrogen fertiliser and higher animal stocking rates on dairy conventional farms may explain this difference through greater acidification and cation leaching rates.

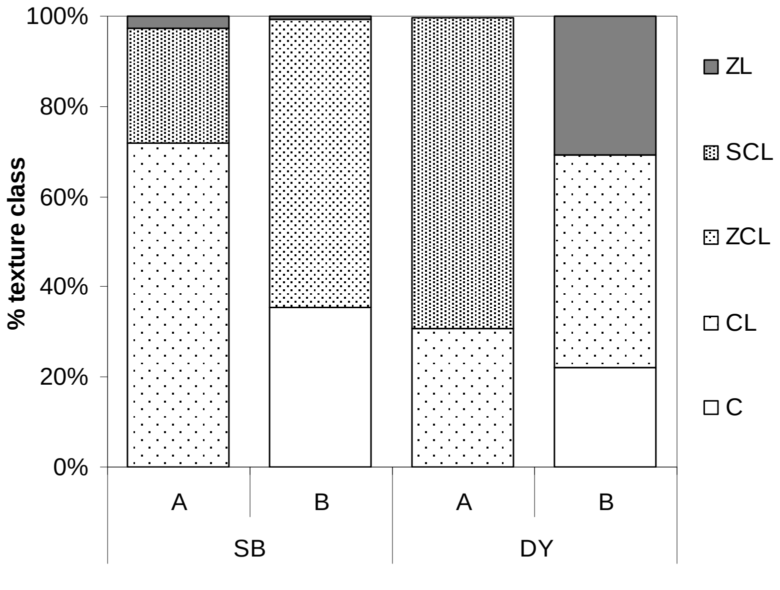


Figure 12 Mean soil texture classification for A and B horizons for SB and DY sectors; (Key for soil orders: C = clay, CL= clay loam, ZCL= silt clay loam, SCL= sandy clay loam, ZL= silt loam, SL= sandy loam).

Soil organic matter (SOM) values for C and N were greater on average for dairy than sheep/beef but no significant differences were recorded between panels for either sector. Differences between sectors are more likely founded in the soil order and the greater number of dairy clusters on allophanic soils rather than landuse per se (Sparling & Schipper 2002). With dairy organic farms, the younger of the two sectors in their establishment, and 50% of farms still to reach accreditation at the time of sampling, there may be further changes in soil properties still to occur. Schipper et al. (2007) has documented a gradual loss of soil carbon from some New Zealand soils, especially pastures, in the past 20 years. Whether this process is related to increased intensification of land use and whether dairy organic farming will slow or even reverse this process will require longitudinal monitoring.

Although soil C and N values between panels did not differ significantly for any sector, C/N ratios did for both sectors ($P<0.001$) and panels ($P<0.05$). The more intensive use of N fertilisers and greater stocking rates in dairy probably explains most of this between sector variation. Higher soil C/N ratios for Organic panels convey that, without applied external N, organic returns will also have higher C/N ratios and therefore, less N is being cycled overall. Potentially (anaerobic) mineralisable-N (AMN) values were greater ($P<0.001$) for dairy but whilst there was no overall management effect, there was a sector-by-panel interaction for sheep/beef, where organic was lower than conventional ($P<0.05$). Whilst this may be due to not using any N fertilisers it may also reflect less than optimal P and S for some of these farms and reduced legume vigour (During 1984). When AMN values were expressed on a soil-N basis these trends were still evident if not significant.

<u>Soil biological condition</u>

Earthworm numbers and weights were similar between dairy and sheep/beef and across panels but there was an interaction ($P<0.05$) in earthworm numbers between sectors with dairy organic having greater worm numbers than conventional but not for sheep/beef where organic and conventional were similar (integrated had the lowest numbers). There was no increase in earthworm weights between dairy and sheep/beef panels that suggests that although worm numbers were about 20% greater under dairy organic they were individually smaller, which might reflect fewer available food sources but lower treading effects from reduced stocking rates.

Soluble-C, basal respiration and metabolic quotient values were higher ($P<0.001$) for dairy than for sheep/beef but when SMB-C, N and basal respiration were calculated on a soil C or N basis, values were substantially lower than the equivalent sheep/beef values ($P<0.01$). This is probably due to a large part of the SOM held in allophanic soils being stabilised by the clay minerals allophane and ferrihydrite, which resists degradation by soil micro-organisms (Parfitt et al. 1997). These soils make up the majority of the dairy clusters and consequently, a greater proportion of total soil carbon, as compared with sheep/beef soils, and is not a major contributor to soil biological respiration. Higher soluble-C and metabolic quotient values for dairy probably reflects the higher excreta returns and increased respiration as a result.

Panel differences were restricted to sheep/beef and values for SMB-C ($P<0.05$) and basal respiration (per unit soil-C; $P<0.05$). Greater SMB-C for integrated (and N to a lesser extent) over organic/conventional may simply reflect the lower C/N ratios of organic returns. It is questionable to make a firm explanation for the higher respiration rate per unit soil-C for sheep/beef organic but this may be related to increased microbial stress and higher soil C/N ratios of the organic returns. Further monitoring and investigation is required.

Soil physical condition

VSA scores for soil porosity (P<0.05; Figure 13) and aggregation (P<0.05) were ranked highest overall for sheep/beef with most scores ranked “very good-to-excellent”. Physical condition for dairy overall, however, was still ranked “good”. Qualitative measures for porosity and aggregation using VSA scoring have been shown to have a strong relationship with macroporosity and aggregate mean weight diameter measurements, respectively (Shepherd 2003). Just under 20% of dairy, and 4% of sheep/beef porosity scores were ranked “fair” or “bad”, a rating that ranks below the macroporosity value of 10%, the accepted margin for optimal maintenance of pasture production (Drewry et al. 2008). There were no significant differences in porosity or aggregation scoring between panels for either dairy or sheep/beef.

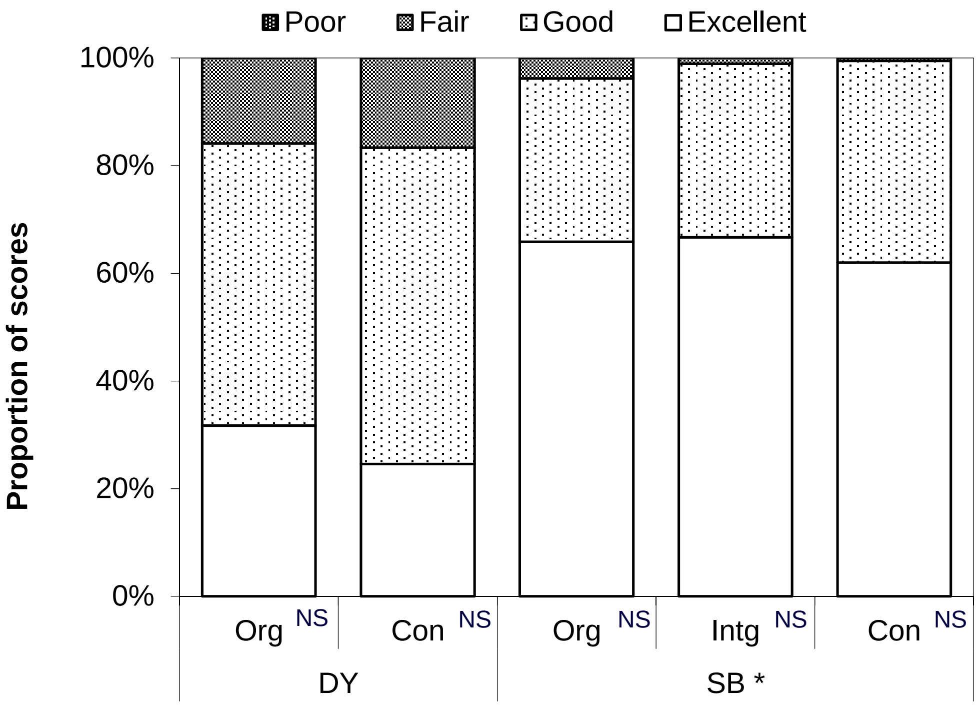


Figure 13 Soil porosity score distribution for each panel DY and SB sectors. An asterisk denotes a significant difference (P<0.05) in scores at an individual level or cross-sector basis (NS; not significant).

Soil bulk density (SBD) values were greatest for sheep/beef and lowest for dairy (P<0.001), a characteristic largely attributable to soil order (Sparling & Schipper 2002). However, about 30% of variation is still attributable to land use and it expected that treading effects and higher stocking rates for dairy would increase SBD, comparatively, over sheep/beef. Soil moisture content (SMC) at field capacity inversely mirrored SBD with higher moisture contents under dairy than sheep/beef. There were no strong differences between dairy and sheep/beef panels for organic and conventional/integrated but with many of the dairy farms still undergoing transition to organic there may be some further divergence with changes in stocking rates. Current soil physical condition for dairy is, however, good based on current VSA scoring so there may be few further beneficial effects to be gained from organic production.

Conclusions

Our comparison of soil properties between sheep and beef and dairy sectors showed that although there were large differences in energy inputs and EROI values, there were few differences that indicated these increased with an increase in farming intensity. A greater number of differences in soil properties were observed in response to management effects between organic and conventional/integrated systems across both sectors, mainly those related to soil fertility. Most of the overall difference in soil properties found between sectors and panels was due to soil order and land-use characteristics rather than management system effects. With dairy Organic an establishing group, further differences in soil properties between organic and conventional panels may still yet develop.

5 Farm Management Inputs

In this report the style of farm management inputs has been changed to the same format of Dairybase. This is to strengthen the relevance of our data set by benchmarking to a national standard. This section compares the production, reproduction, animal health, labour, nutrient application and feed management indicators between organic and conventional management systems for the 2009 season. This data has been extracted from farms participating in Dairybase.

Production

Figure 14 compares a particular farm (your farm) with conventional and organic management systems involved in ARGOS and shows carrying capacity (kilograms of liveweight per hectare), production (milksolids per hectare and per cow), and average days that the cows were in milk for the 2009 season.

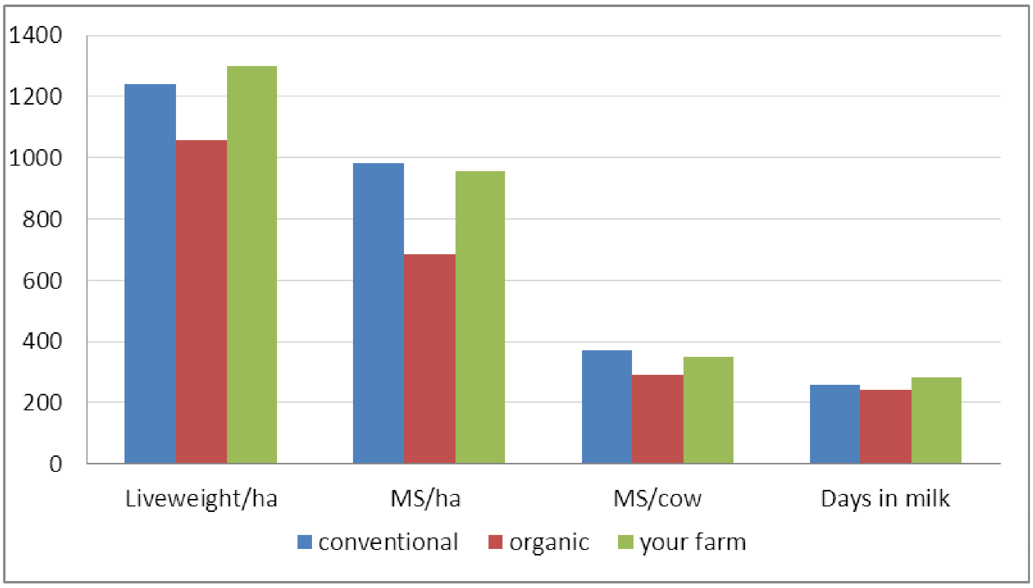


Figure 14 Production data comparing "your" farm with conventional and organic management

It essentially shows that the organic farmers have a lighter carrying capacity and this is reflected in the difference in milk production per hectare, which is greater than the difference in the production per cow. Figure 15 describes carrying capacity in cows per hectare and then shows the difference between conventional and organic farms for kilograms of milksolids per cow per day as an average over the 10 day peak, and the average milksolids per cow per day for the overall season; also described as days in milk Figure 14.

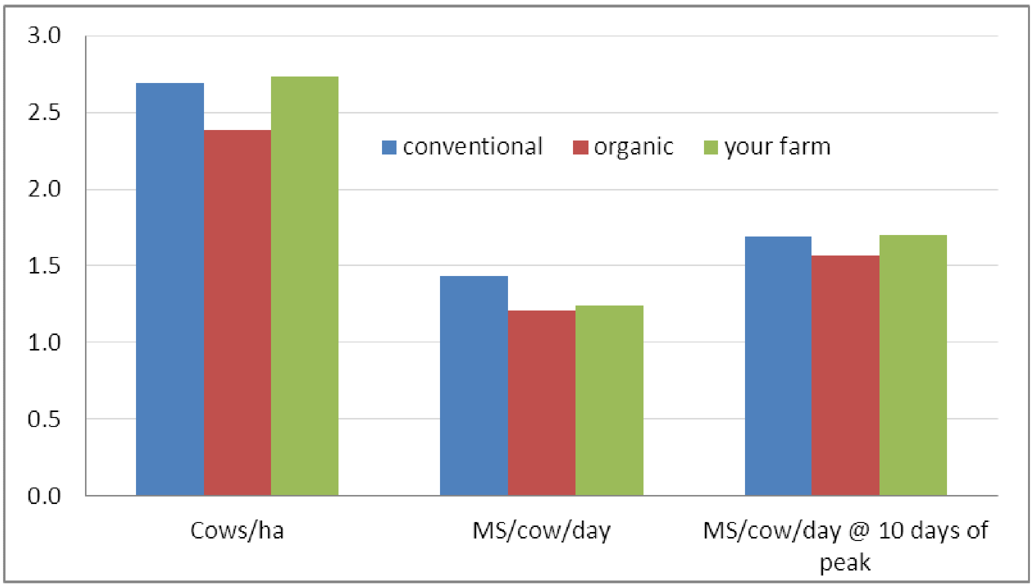


Figure 15 Production data comparing "your" farm with conventional and organic management **(**cont.)

Another performance indicator to assess milk production is milksolids per cow as a percentage of her liveweight, effectively an indicator of the efficiency of a cow to produce milk relative to her bodyweight. This can be used at both the individual animal and farm level along with the percentage drop in milk production from the peak milk output date to December 31 for that season. At the farm level these indicators can be manipulated by feed management.

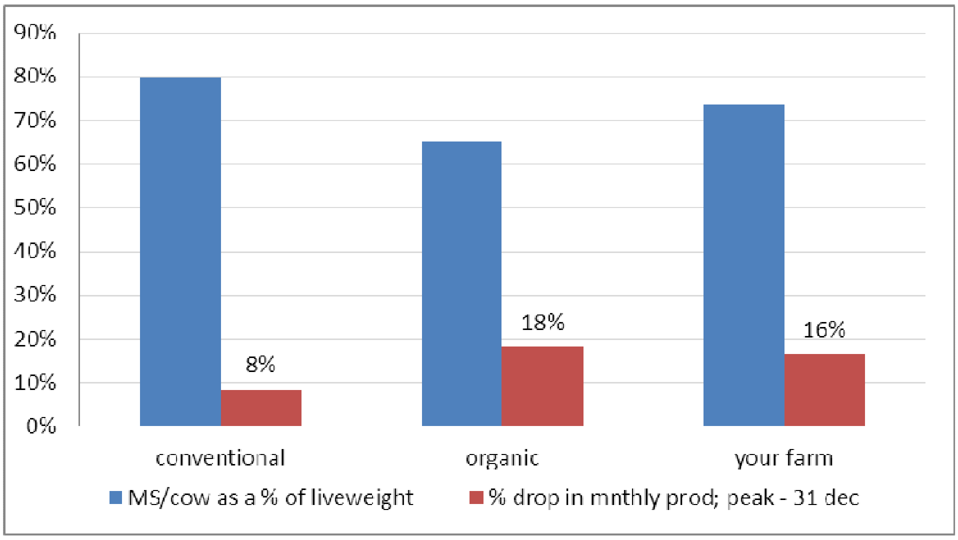


Figure 16 Production as a percentage of liveweight and rate of production drop from peak to 31 December

Feed

Figure 17 describes total pasture and crop offered to cows in tonnes of dry matter per hectare. Total feed eaten includes total pasture and crop, imported supplements and grazing for dry cows grazed off the milking platform (tonnes of dry matter per hectare). Feed utilisation describes the utilisation of feed imported as supplement.

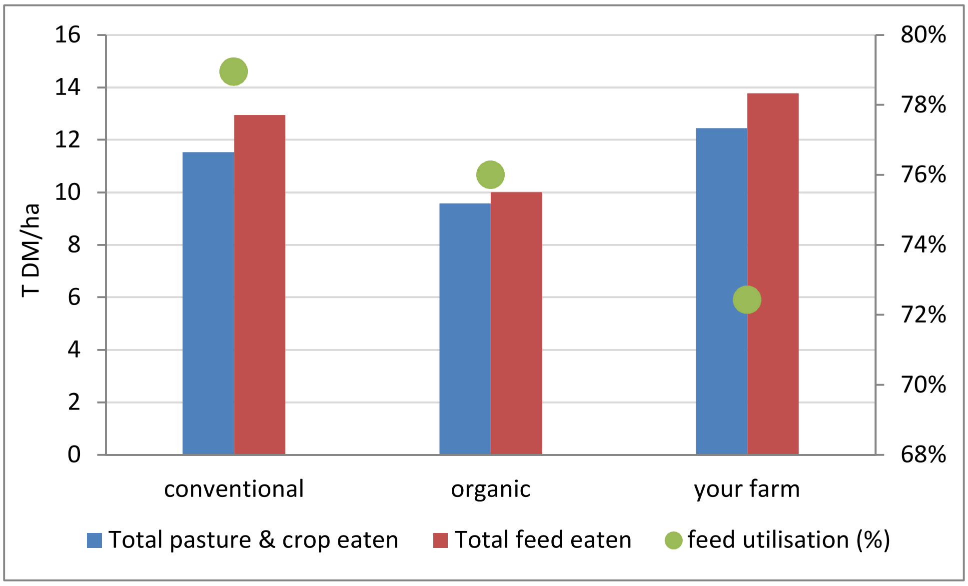


Figure 17 Feed management comparing "your" farm with conventional and organic management

<u>Reproduction</u>

Organic farms, on average, had a higher submission rate at 21 days than the conventional and also had a higher empty rate for mating in 2008/09.

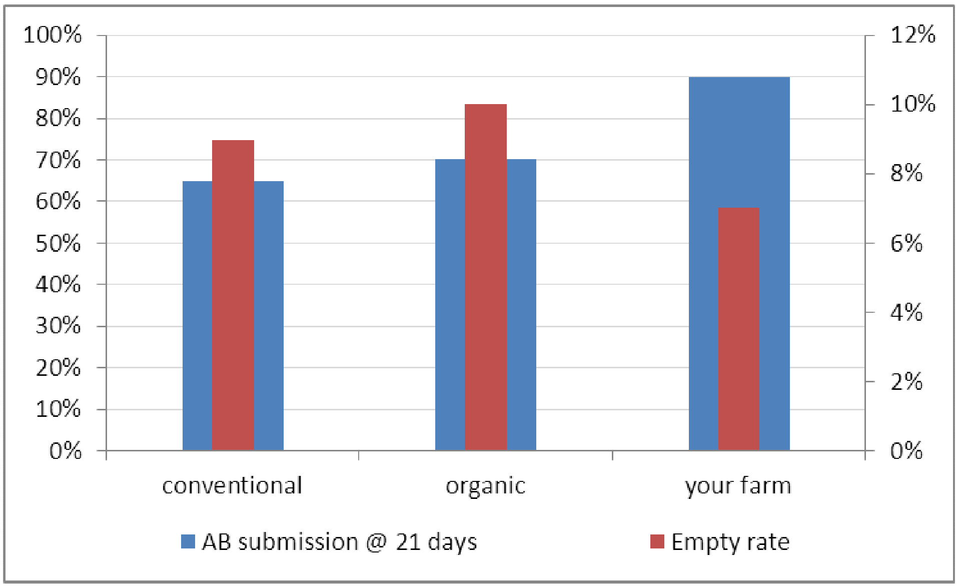


Figure 18 Artificial breeding (AB) and empty rates comparing "your" farm with conventional and organic management

The mating periods were longer, on average, for organic with artificial breeding and total mating one week longer than conventional (Figure 18)

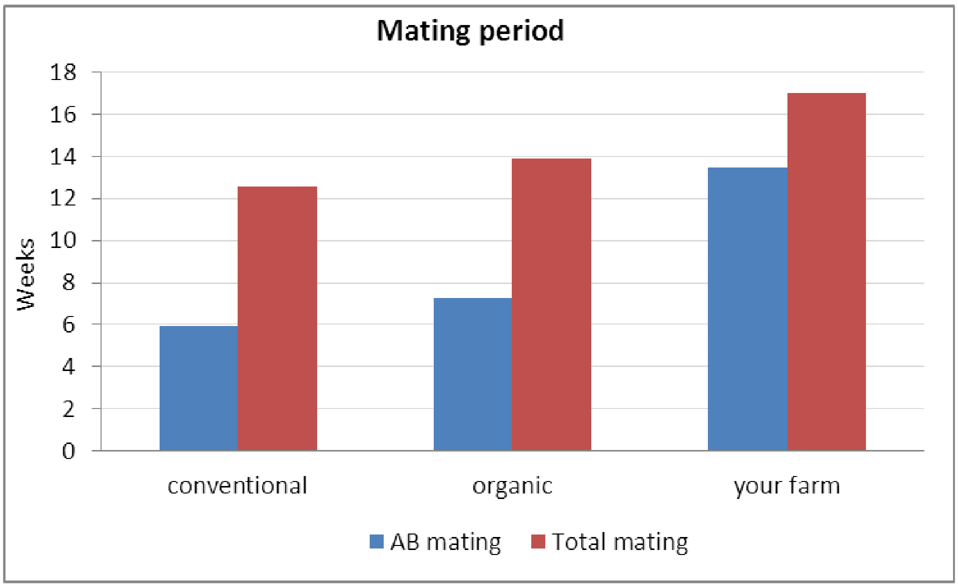


Figure 19 Two performance indicators comparing "your" farm with conventional and organic management

Calving spread was similar between the 2 management systems with 49% of the conventional and 45% of the organic cows calved within 3 weeks. By 6 weeks this had increased to 70% of the conventional and 74% of the organic cows that had calved. There were minimal inductions with only 2 conventional farmers inducing cows. Four conventional farmers used CIDRs as a synchronisation tool for mating, so overall 6% of conventional cows mated had been CIDRd compared with 0% for organic (Figure 21).

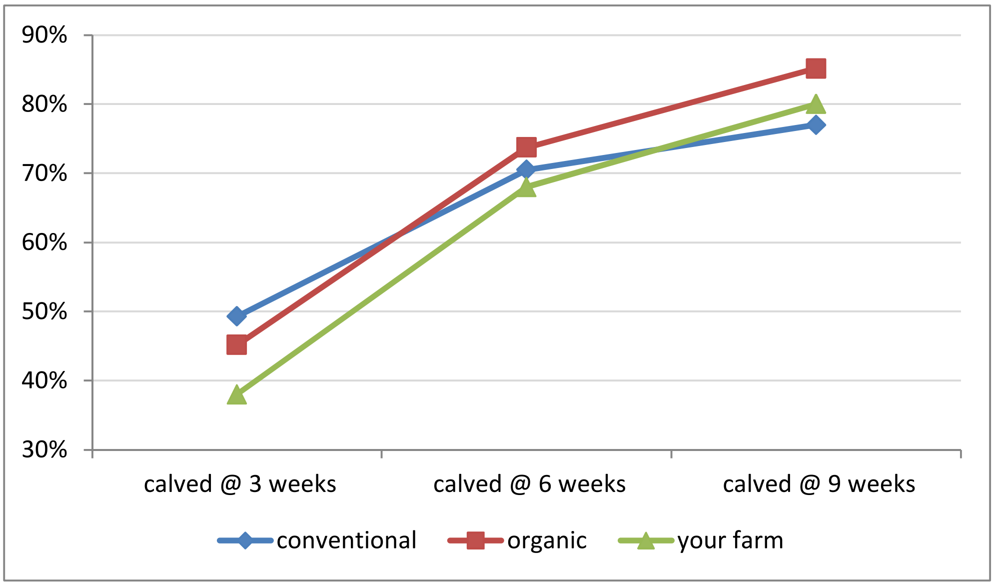


Figure 20 Calving spread for 2010 comparing "your" farm with conventional and organic management

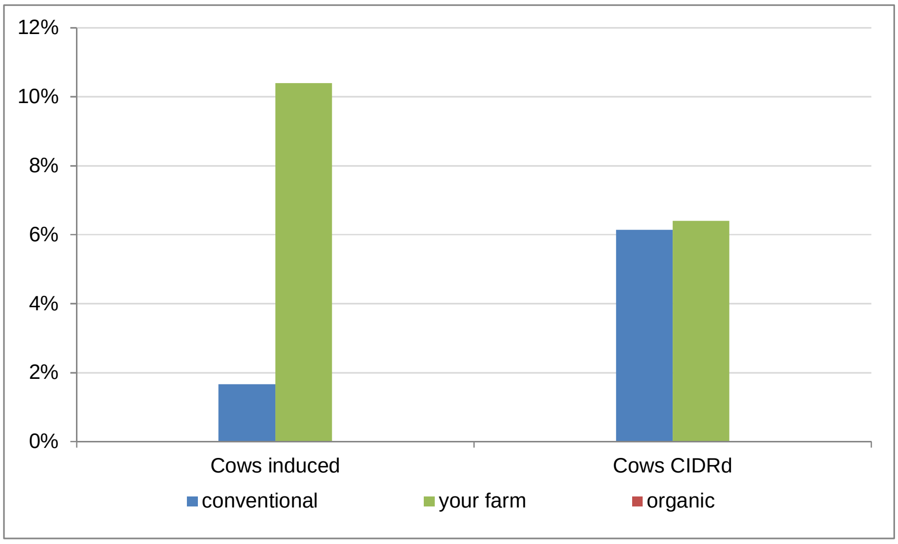


Figure 21 Mating and calving management practices to condense calving

Animal health

Percentage of cows treated one or more times for lameness, and the average somatic cell count (as recorded by the Dairy Company) was less for the conventional than organic management systems. However there was very little difference between conventional and organic for the number of clinical cases of mastitis in the first six weeks of milking (one cow treated 3 times is counted as one cow) (Figure 22)

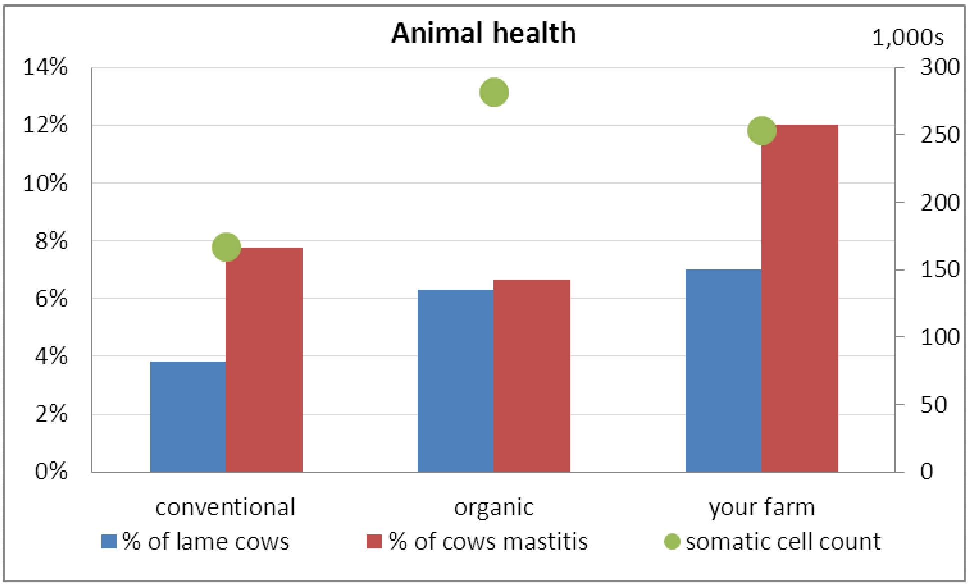
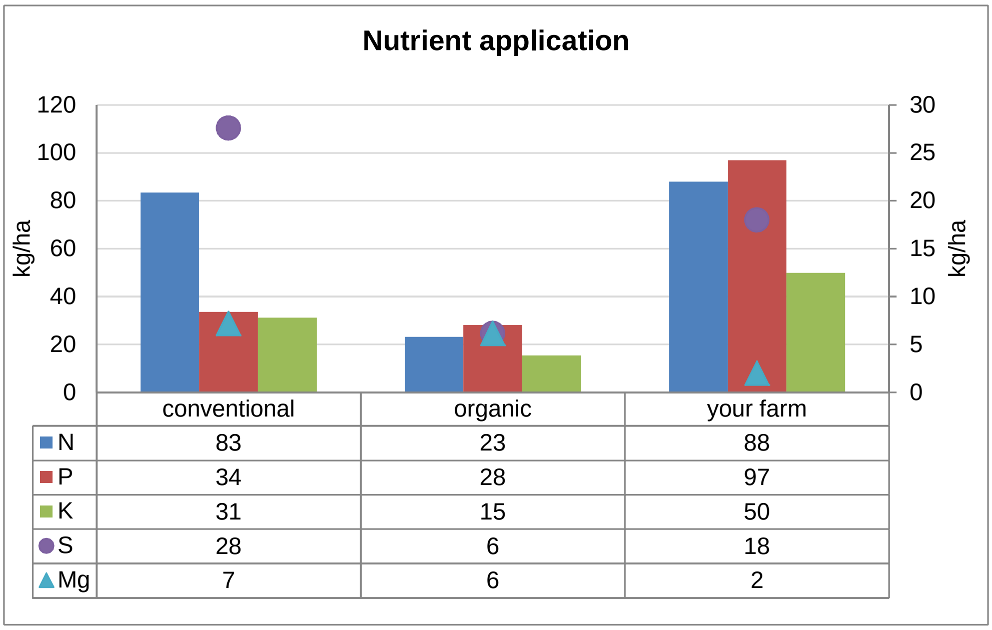


Figure 22 Indicators of animal health comparing "your" farm with conventional and organic management

Soil management

Nutrient application in the form of fertiliser is depicted in Figure 23 (lime in Figure 24) and continues the trend reported previously that conventional farmers used 3.6 times more nitrogen, 1.2 times more phosphate, 2.0 times more potassium, 4.7 times more sulphur, 1.2 times more magnesium, whereas the organic farmers applied 2.4 times more lime. It needs to be flagged that there are inconsistencies in comparing these as:

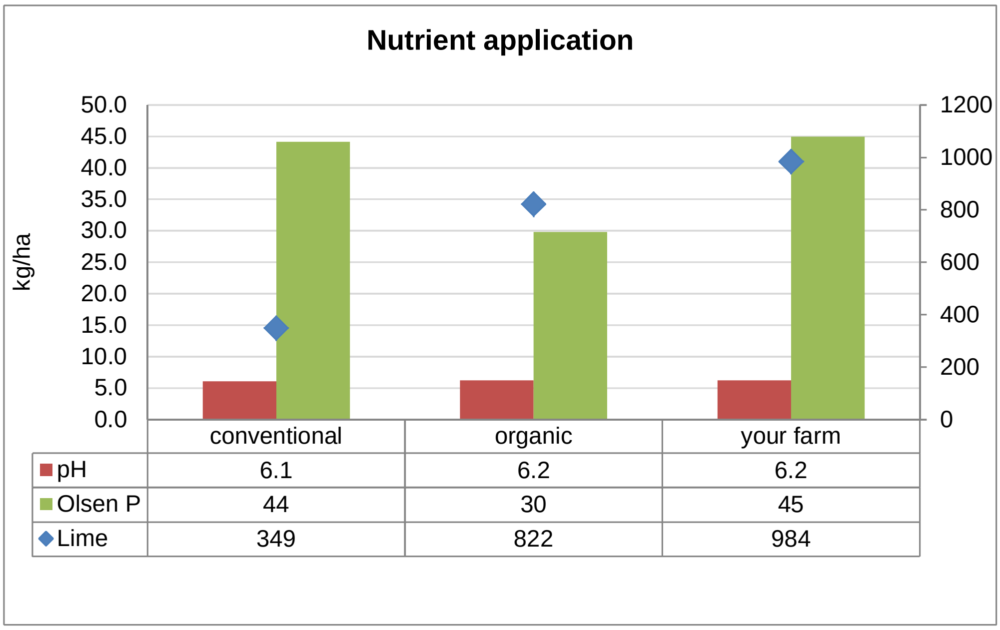
- Some organic fertilisers, Compost and Biodynamic Teas were not included in the analyses due to lack of information on their nutrient content.
- It is recognised that there are different philosophical approaches to soil fertility, or the 'well-being' of soil between conventional and some organic farmers.



	conventional	organic	your farm
N	83	23	88
P	34	28	97
K	31	15	50
S	28	6	18
Mg	7	6	2

Figure 23 Nutrients applied through fertiliser comparing "your" farm with conventional and organic management

The above flags are pertinent in comparing management systems using Olsen P for fertility as many of the organic community prefer to use the Resin P test which has a value of approximately 2.5 times that of the Olsen P test. Average pH was very similar between the 2 management systems.



	conventional	organic	your farm
pH	6.1	6.2	6.2
Olsen P	44	30	45
Lime	349	822	984

Figure 24 Olsen P, pH soil status and tonnes of lime applied comparing "your" farm with conventional and organic management

Labour

Labour was assessed as one full time labour equivalent working 2400 hours per annum and is a combination of paid and unpaid labour required to run the farm. It excludes any specific contract work such as cultivation or fencing etc. On average conventional had one FTE per 154 cows compared with 137 for organic (Figure 25). They (conventional) also produced 56,548 kilograms of milksolids per FTE compared with 38,593 for the organic farms.

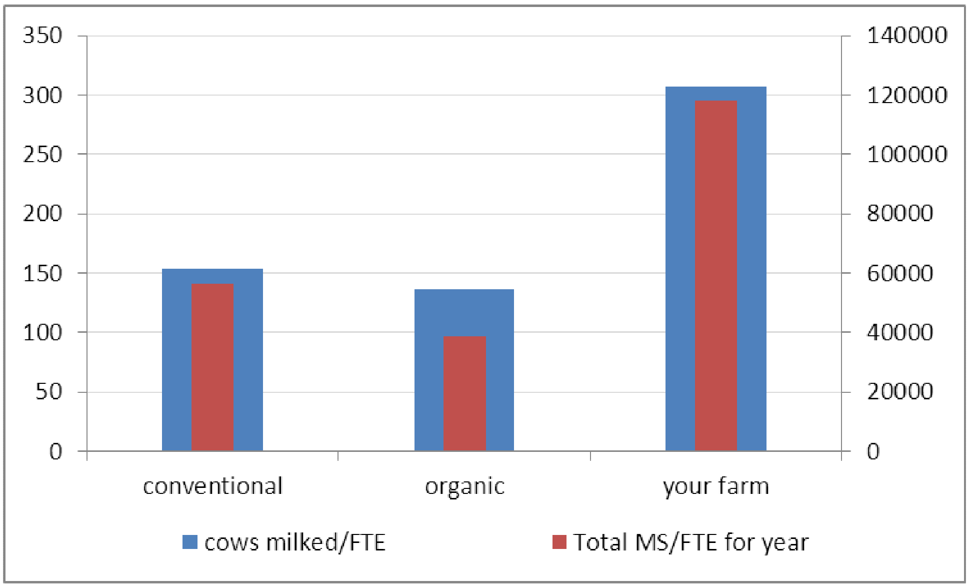


Figure 25 Labour inputs for 2010 comparing "your" farm with conventional and organic management

6 Farm Management Inputs Economics

6.1 Capital Based Sustainability Indicators as a Possible Way for Measuring Agricultural Sustainability

The most frequently quoted and perhaps most widely accepted definition of sustainable development is the one articulated by the Bruntland Commission –

> *development that 'seeks to meet the needs and aspirations of the present without compromising [the] ability to meet those of the future'* (WCED 1987, p. 43).
>
> *This requires 'a non-declining capital stock over time'* (Solow, 1986, and Repetto, 1986)

where capital stock is understood in its broadest terms to include human capital, social capital, cultural capital, human-made capital and natural capital.

Human capital includes knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being. It is created through lifelong experience as well as formal education. **Social capital** has been defined as the 'network of shared norms, values and understanding that facilitate co-operation within and between groups' (OECD 2001). **Human-made capital** refers to public and private capital such as buildings, factories, office blocks, plant and machinery, computers, infrastructure, airports, seaports, highways, roads, railways, schools and hospitals.

Natural, or environmental, capital in economics is generally classified into three types:

I. extractive resources such as soil, minerals, forests, fish and water;

II. amenity values (direct and indirect) such as landscapes, native bush, recreational fishing; and

III. assimilative capacity which is the ability of the environment to 'process' waste pollution.

Natural capital is different from the other types of capital discussed in the previous paragraph because of the irreversibility of some forms of natural capital when used. Another factor in assessing natural capital (and indeed other forms of capital) is the multi-functionality of this capital and hence whether all the associated benefits are properly assessed. This is related to the stability and/or resilience of the natural system, resilience being the ability of an ecosystem to maintain itself when shocked by natural or human disturbance. Sustainability therefore requires that human interactions with the environment should consider the impact on ecosystems as a whole rather than just on resources themselves with care to avoid threatening the stability of the ecosystem (Common and Perrings, 1992).

While there is likely to be varying views about what is required within the various components in ensuring sustainability within a given situation, when it concerns agriculture, in all cases there is a strong dependence on the availability of a range of different types of resources (van Loon et al*.*, 2005). In fact, agricultural activities appear to rely on all five types of capital discussed above. As noted by van Loon et al*.* (2005, p. 48) these include:

- Natural capital – the soil resource, water from rainfall or other sources, the air, animals used for their labour and as a source of manure, the surrounding natural vegetation
- Human capital – humans who supply labour, not only physical labour but also intellectual input for planning production strategies
- Social capital – systems providing labour and marketing support as well as information related to agriculture and health services
- Financial capital – markets for purchase and sale of goods, a credit system supplying funds to all levels of agricultural workers
- Human-made capital – implements needed for agriculture, roads and means of transport, factories for processing of farm produce.

Initial research in ARGOS has provided the opportunity to identify and report on three of the above indicators, human-made, social and natural capital, and to determine whether they are useful in characterising different forms of capital. While only a small number of farms were used within the current work, it enables a brief look at the feasibility of using such measures, and the ability to identify any differences that exist between the different management systems used by farmers. Not all data collected is presented here, rather a selection of different measures collected for the different types of capitals.

Six years of data were available for the **human-made** capital analysis (2002/03 to 2007/08) for the sheep and beef farms, however a significant difference is only observed for stock units per hectare (F=0.031), showing that conventional and integrated farms both have a significantly higher number of stock units per hectare than do organic farms.

No significant difference were found between management systems for the four measures of **social capital** used; voting in national elections; voting in local elections; providing cash financial support to community activities; and agreement with the statement 'my orchard is contributing to the local community'. A range of differences were found Olsen P in the **natural capital** variables used. However there were no differences within the other natural variables in the analysis namely Soluble C; Microbial biomass N; pH; and the number of earthworms.

Although this initial work does show a number of significant differences for different measures of capital, what is important to note is that many of these measures have no right or wrong level as to what is acceptable. What is more important are the changes that are occurring over time. For most measures, remaining consistent or increasing over time is more important than level itself. For example, for many of the social capital measures, the level of, say, voting participation should remain the same over time, if not increase to show how involvement in the local community is increasing (or remaining constant). Having said that, there are some measures that need to remain constant or decrease, e.g., greenhouse emissions. Similarly, many of the natural capital measurements are likely to have an 'ideal' range at which they should fall between (to ensure that deterioration is not occurring to the natural environment).

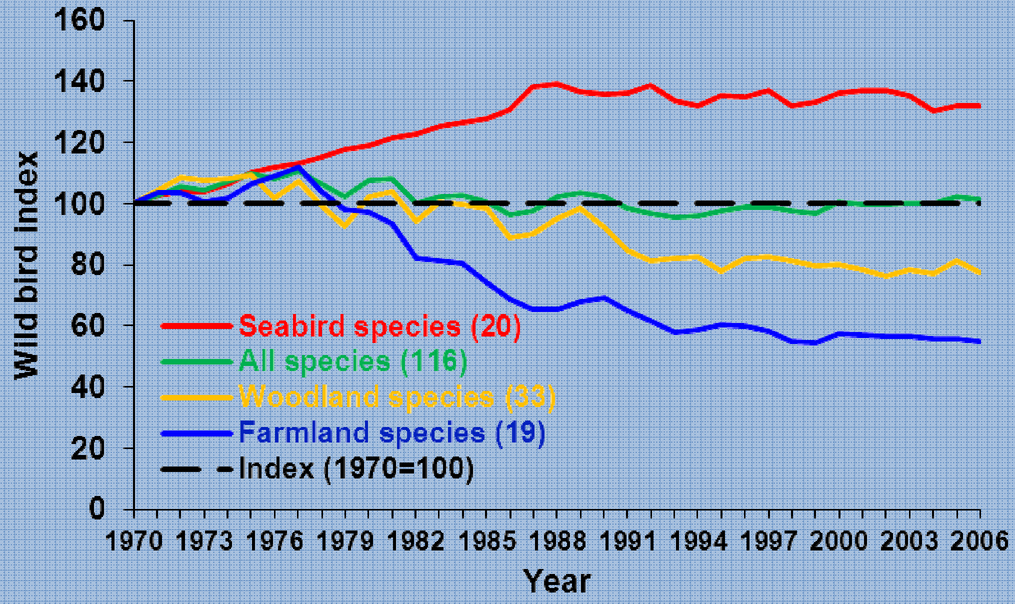
7 Environment

7.1 Bird monitoring on ARGOS farms

Birds were selected as potential indicators for the ARGOS environmental programme for three reasons: (a) they are good indicators of the wider ecosystem health and functioning, (b) they are generally well recognised and familiar to farmers, politicians and the public, and (c) some species have potential as indicators of good farming system practices for increased farm produce market access. For the same reasons, a similar indicator was developed in the UK (Box 1).

Box 1: Birds used to measure quality of life

The UK government recently introduced 15 headline indicators of 'quality of life' for measuring the country's progress towards sustainable development (Anon. 2002). The wild bird index was one of the 15 indicators, as it is considered '*a good indicator of the broad state of the wildlife and countryside.*'



The wild bird index shows that while bird population trend based on all species is relatively stable, species associated with farmland, and to a lesser extent woodland, habitats have declined significantly. Declines in farmland populations were particularly high during the 1970s and 1980s when farming practices intensified. However, since the introduction of agri-environmental schemes in the late 1990s to mitigate the adverse impacts of intensification, overall the farmland populations have stabilised.

ARGOS' bird monitoring scheme is New Zealand's first large-scale scheme for the agricultural landscape. It is, therefore, providing novel information about the composition, distribution and abundance of bird species within three different sectors (Dairy, Kiwifruit and Sheep/beef). Our analysis is based on data collected in the dairy sector during one breeding season (2006–07).

Bird densities (i.e. the average number of birds per hectare) were calculated for 14 species, with 10 introduced species (Blackbird, Chaffinch, Goldfinch, Greenfinch, House sparrow, Myna, Skylark, Starling, Song Thrush, Yellowhammer) and 4 native species (Fantail, Harrier, Magpie, Silvereye). Total bird densities for introduced species were approximately ten times higher than native ones (Figure 26). The fantail, the only native insectivorous species was considered in our analyses, was found at very low densities compared to the five introduced insectivorous species (Blackbird, Song Thrush, Myna, Starling, Chaffinch).

There was no evidence that bird densities varied in relation to management panel within the dairy sector for any of the subsets of species considered in our analyses (Figure 26), including introduced seed-eating species or granivores (House sparrow, Goldfinch, Greenfinch, Yellowhammer, Skylark) and native nectar-feeder (Silvereye). The next step in our analyses is to investigate whether bird densities vary in relation to habitat composition and land management practices on dairy farms.

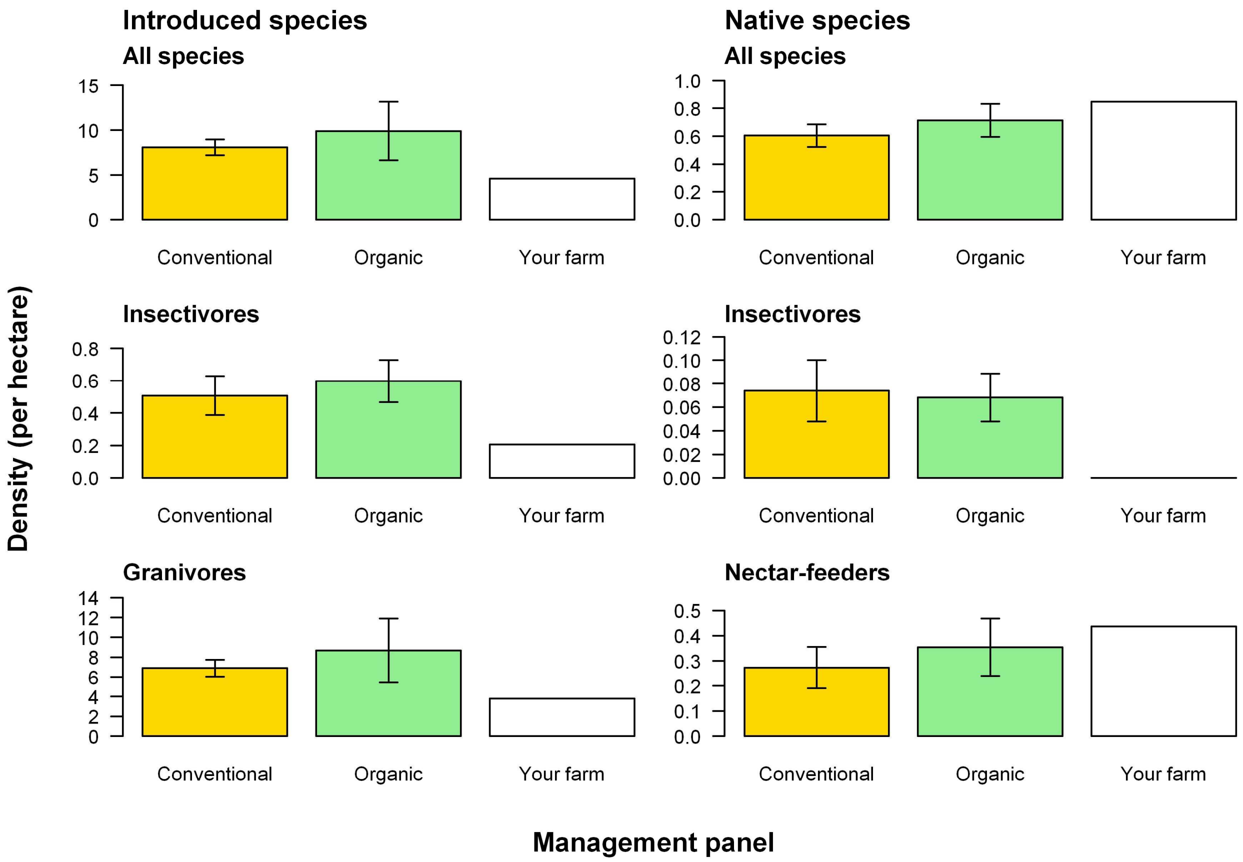


Figure 26: Bird densities in relation to management panel within the dairy sector for all introduced and native bird species, introduced and native insectivores, introduced granivores (seed-eating species) and native nectar feeder.

8 Social

8.1 The social dimensions of sustainable agriculture – six years on:

During the past year, the ARGOS social research team initiated a new round of interviews to examine the historical experience of crisis and change in each of the project's sectors: dairy, sheep/beef and kiwifruit. While it is too early to report on findings from these interviews (that are only in the initial stages of coding and analysis), we expect them to provide good insight to the capacity for resilience demonstrated by ARGOS participants as well as the pathways that have contributed to or enhanced this capacity. What is evident from our initial reflections on our conversations with all of you, is that your personal experience with 'crises' in your farming sector has occurred under very different circumstances. In other words, a period of low milk prices may be much more difficult for those who are also dealing to crises in their family life and/or facing large debt loads, et cetera. Such information will help us to identify factors that contribute to a more resilient response to adverse conditions, as well as to recommend more appropriate pathways to encourage resilience in the sector as a whole.

The topic and structure of the latest interviews was largely a response to both the achievements and shortcomings of our earlier interactions with ARGOS participants. Our existing social data has an almost exclusive focus on current conditions (and, to some extent, future aspirations) of the farming and orcharding families participating in the project. These data have allowed us to develop a better understanding of existing situations and to draw strong conclusions regarding the sustainability of the management panels in each sector. (These findings are summarised below.) We were, however, not able to provide confident assessments of farmers' response to crisis that would contribute to attempts to model the impacts of possible changes in the context of agricultural production in the future. The objective of our analysis of the current set of interviews is to develop greater insight to the types of response that occurs as farmers and orchardists are faced with new or more intensive challenges to the viability of their farms and orchards in the future.

What we already understand:

In the process of synthesising our findings across the different social data collected and analysed so far (two interviews, a causal map exercise and three postal surveys), we have identified both that there is great similarity within each of the sectors and that there is a strong basis for differentiating among the management panels as well. The similarities show that the people who chose to practice a particular form of production (sheep/beef, kiwifruit or dairy) have adopted a largely shared form of adaptation to the demands and challenges of that sector. Another way to say this would be that similar types of people are attracted to the advantages and challenges of a given form of production —most dairy farmers would be less 'happy' growing kiwifruit than raising stock, especially given the extent that management practice is audited in the former sector. Thus, there is some basis for using generalities when referring to the types of actions and responses that are common to a given sector.

That said, it is possible to identify slight differences of approach and orientation among the ARGOS dairy farmers (and sheep/beef farmers and kiwifruit orchardists). The differences appear to be relatively small in comparison to the similarities; but they also help to explain the fact that farmers choose to employ distinct management systems, which the ARGOS project refers to as conventional and organic. We have attributed these differences to five general social dimensions:

- environmental positioning;
- good farming;
- breadth of view;
- response to feedbacks; and
- approaches to risk and innovation.

Our research suggests that these social dimensions influence choice of management system where they show differences between the conventional and organic panels.

- *Environmental positioning:*

The dairy farmers' perceptions of and engagement with the environment (their *environmental positioning*) provide a means of differentiating between the panels. Throughout the social data, topics related to the environment provide a principal axis along which the organic can be distinguished from the conventional panel. For example, the organic farmers are consistently more proactive in their engagements with the environment (for example, as a group, they plant more woody vegetation to encourage biodiversity or to improve stream health), are more apt to refer to management as *working with* nature. By comparison, the conventional panel is more likely to refer to the need to *control* aspects of the environment (soil fertility, weed growth, etc.) that impeded the growth rate of stock or the condition of the pasture. Therefore, in regard to the ARGOS research questions, the environmental positioning of the dairy farmers indicates that the organic ones are more likely to defer to environmental rationales in developing their management strategies. This does not imply that only organic farmers show concern for the environment, rather that they tend to place greater emphasis on that concern compared to the conventional farmers. The relevance of this positioning for the sustainability of the agriculture sector will depend on the relative economic, social and environmental benefits and costs that accrue to practices that are perceived to be more or less sustainable.

- *Good farming:*

The concept of *good farming* refers to the shared understandings of what constitutes good practice on farms and how that practice is measured. In other words, farmers frequently evaluate each other based on standards of *good farming* that are evident in visual aspects of the farm, for example the state of the pasture and the health of the stock. In the dairy sector, the reference to good farming was more intense than in the other sectors due in large part to Fonterra's recent recognition of organic as a desirable marketing option and to strong public perception of environmental benefits associated with organic practice. This situation frequently encouraged a competitive response to comparisons of the panels—conventional farmers expressing the need to defend the 'goodness' of their practice and organic farmers challenged by a loss of milk solid production. The extent to which the basis for good farming involved the daily tanker receipt was very evident in this regard with production (and the ability to track and compare it) becoming a central element of good farming for the conventional panel. The organic panel, by comparison, referred to other aspects of their management systems (such as animal health, reduced costs/higher profitability per cow, etc.) as indicators of good practice.

Tidiness is a visible feature of farms that is often identified as an element of good farming and it is very evident in the kiwifruit sector. In the qualitative interviews with the dairy farmers tidiness was less of a focus for differentiating between conventional and organic except in some specific cases where neighbours differed in their emphasis of this factor. There were also the occasional remarks disparaging organic practice because of a perceived inability to control weeds—resulting, according to some, in a less tidy pasture. That said, tidiness is identified as an important indicator of good management in the most recent survey data by the great majority of respondents, suggesting that it may be a ‘taken for granted’ aspect of pastoral farming. The lack of emphasis on tidiness by either the conventional or organic farmers suggests that, if differences exist, they are generally less obvious than differences in the production of the two management systems.

Another subtle distinction in good farming which emerged involved the relative willingness of the panels to use external inputs (for example, feed supplements, fertilisers, etc) in their management systems. For many of the conventional farmers, such inputs were an accepted and appropriate means to achieve greater production—and, thus, greater status as a good farmer. The organic farmers, however, tended to take pride in their self-reliance and low-input systems in which they took responsibility of treating diseased cows, developed strategies to ensure sufficient feed from on the farm and incorporated diverse pasture species to facilitate nitrogen fixation in soils and access to trace nutrients for the stock. The organic panel is also distinctive in that their concept of good farming involves a stronger emphasis on the condition and health of the environment especially in regard to the soil. The focus on self-reliance and on adapting pasture composition and animal health to local conditions suggests that the organic farmers exhibit greater potential for developing locally relevant knowledge that is considered an important element of resilience. They also demonstrate the ability to consider alternative practices despite established good farming indicators, which may provide them with a greater range of management options when challenged by the environmental and social impacts of their existing management systems. While such characteristics suggest greater resilience, it is also evident that the organic farmers are very dependent on the continued access to a price premium for organic milk to compensate for lower production levels.

- *Breadth of view:*

Breadth of view refers to the scope of reference used by individuals when discussing the impact of farm management on the environment (the relative focus on ecological relations in the productive area, the drainage basin, or the globe), society (from farm family to local community to global) and the economy (from farm accounts to international trade), respectively. <u>While we found very obvious differences among panels in the other sectors, the breadth of view demonstrated by the dairy farmers was relatively similar for both the conventional and organic farmers.</u> The one point of difference was evident in the scope of environmental impact recognised by each of the panels, with the conventional farmers largely focusing on the ecological relations occurring within the boundaries of the farm or sometimes within the productive area of the farm. Several of the organic farmers referred to the broader potential consequences of their management within the catchment, the region or even globally. They also placed the greatest emphasis on off-farm product quality in the causal maps. By comparison, the conventional and integrated panels demonstrated a more narrow focus on the processes and conditions that they recognised within the boundaries of their own farms or their local communities. The similarity in the social and economic breadth of view may reflect the recent conversion of the organic farmers who had not yet distinguished themselves as a separate social or economic group. These characteristics suggest that organic farmers are more likely to incorporate a broader set of environmental concerns within their management decisions, although it is not possible to establish the impact this has on the resilience of farming practices.

- *Feedbacks:*

The category of *feedbacks* is somewhat related to breadth of view in that it refers to the range of indicators that influence an individual's ongoing management practice (for example climate events on decision making). In this case, however, we are interested in the number and type of indicators that provide direct feedback on management practices. Despite the differences in the environmental positioning of the panels, the dairy farmers appear to share relatively similar responses to *feedbacks* within their production systems. For example, both panels refer to the importance of the state of the paddocks and of stock health as indicators of environmental wellbeing, with the organic panel putting greater emphasis on the soil and soil biota. The indicators of economic wellbeing are also overwhelmingly similar, with an emphasis on returns being the most important gauge.

Stronger differences between panels are evident in the feedbacks which are used to justify good farming practice. The conventional farmers, for example, refer to milk solid production as the most important measure of relative farming acumen. By comparison, the organic panel emphasises its lower costs and their environmental practices when comparing themselves to non-organic peers. These differences reflect the distinctive emphases of their management orientations and suggest that each panel would employ different assessments of innovation or change with varying impacts on the resilience of their farming practice.

- *Risk and innovation*

As discussed in regard to feedbacks, it is possible to differentiate among the dairy panels according to their response to risk and innovation. For example, in the qualitative interview, the organic farmers demonstrated a capacity to meet the challenges of animal health and pasture production without reliance on chemical remedies. In addition, their willingness to undertake a management system that involved lower production indicates that they also assumed the social risk of exclusion or derision by their dairy farming peers. The conventional farmers, by contrast, tend to emphasise the extent to which they farm within environmental or social constraints and act as good citizens. These differences in attitude have the potential to impact on the relative reliance of the panels as organic farmers may be better positioned to adopt alternative practices that counter existing norms whereas the conventional farmers are more likely to benefit from their farming relationships.

<u>Conclusion:</u>

The differences in these five key social dimensions appear as relatively slight deviations from shared characteristics within sectors. We believe that they are important enough, however, to help explain the relative attraction of particular aspects of the different management approaches used by the ARGOS panels. While we are able to identify difference, we do not claim that these necessarily indicate better practice or more resilient individuals. On the contrary, it appears that the variation in farmers' approaches to management is a vital element in the resilience of the sector as a whole. Each panel or type of farmer contributes to the capacity of the sector to provide consistent supply and to continually explore and experiment with alternative practices and technologies. For example,

- the conventional farmers ensure that a continuity of supply to an industry currently focused on export commodity production.
- the organic farmers provide a real world laboratory in which alternative and less chemically intensive practices can be attempted, tested and perfected as potential future options for the whole of the sector.

The understandings of farmers' actions and attitudes developed during the first six years of the ARGOS project also help us to assess a variety of pathways to sustainability. Such findings are highly relevant to the potential implementation of audit (quality assurance) schemes to ensure the use of a range of practices from animal welfare to environmental protection to social responsibility. While these have not had a large presence in the dairy sector to this point, they are very much a feature of horticultural production in New Zealand and promise to expand their influence in the pastoral sectors as well.

Our findings also offer insight to farmers' response to the Emissions Trading Scheme (ETS). Of most interest to our analysis is the extent to which the regulation of greenhouse gas emissions is perceived as a political rather than an environmental or moral issue. Due to both the contentious reception of climate change science and the apparent implication of fault (that is, farmers believe that they are punished by the ETS as polluters, rather than acknowledged as environmental stewards and economic drivers), the policy is viewed as a challenge to the societal role of farming. It, thus, directly challenges strongly held perceptions of good farming and a shared understanding of social worth among dairy farmers, overwhelming any differences in regard to environmental positioning, breadth of view or feedbacks. This suggests the need for regulation and incentives that better fit farmers' desires and aspirations as valued members of New Zealand society and economy.

9 Appendix

9.1 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

09/03 New Zealand Farmer Attitude and Opinion Survey 2008: Management systems and farming sustainability, by John Fairweather, Lesley Hunt, Chris Rosin, Henrik Moller and Solis Norton

09/02 New Zealand Farmer and Orchardist Attitude and Opinion Survey 2008: Characteristics of organic, modified conventional (integrated) and organic management, and of the sheep/beef, horticulture and dairy sectors, by John Fairweather, Lesley Hunt, Jayson Benge, Hugh Campbell, Glen Greer, Dave Lucock, Jon Manhire, Sarah Meadows, Henrik Moller, Chris Rosin, Caroline Saunders and Yuki Fukuda

08/04 Soil Properties on ARGOS Dairy and Sheep & Beef Farms 2007, by Peter Carey, Dave Lucock and Jayson Benge

08/03 Linking farmer wellbeing and environmentally sustainable land use: a comparison between converting organic and conventional dairy farmers, by Belinda Mortlock and Lesley Hunt

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

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

07/14 Transdisciplinary synthesis, by ARGOS

07/13 Social Objective Synthesis Report: Differentiation among Participant Farmers/Orchardists in the ARGOS Research Programme, by Chris Rosin, Lesley Hunt,

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07/12 Environmental indicators from alternative farm management systems: Signposts for different pathways to sustainable primary production in New Zealand?, by Tanja Maegli, Sarah Richards, Sarah Meadows, Peter Carey, Marion Johnson, Monica Peters, Katherine Dixon, Jayson Benge, Henrik Moller, Grant Blackwell, Florian Weller, David Lucock, David Norton, Chris Perley and Catriona MacLeod.

07/11 Economics Objective Synthesis Report, by Caroline Saunders, Glen Greer, Eva Zellman

07/09 Management and Production Features of ARGOS farms and Differences between Production systems, by Jayson Benge, Dave Lucock, Martin Emanuelsson, Jon Manhire

07/07 New Zealand Farmer and Grower Attitude and Opinion Survey: Analysis by Sector and Management System, by John Fairweather, Lesley Hunt, Andrew Cook, Chris Rosin, Hugh Campbell

07/06 There are Audits, and There are Audits: Response of New Zealand Kiwifruit Orchardists to the Implementation of Supermarket Initiated Audit Schemes, by Chris Rosin, Lesley Hunt, Hugh Campbell and John Fairweather

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

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05/07 Interspecific interaction and habitat use by Australian magpies (Gymnorhina tibicen) on sheep and beef farms, South Island, New Zealand, by Marcia Green, Erin O'Neill, Joanna Wright, Grant Blackwell and Henrik Moller, July 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

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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.

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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
15. Soil nematodes in kiwifruit orchards
16. Understanding kiwifruit management using causal maps
17. Bird Sampling Methods
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
31. Assessing the sustainability of kiwifruit production: the ARGOS studairy design
32. Fertiliser use on ARGOS kiwifruit orchards
33. How ARGOS uses Geographical Information Systems (GIS)
34. Food Miles
36. Earthworms in kiwifruit orchards
39. Quality Assurance Programmes in Kiwifruit Production
41. The Relevance of Performance Indicators Used for Non-Agribusinesses to Kiwifruit Orchards
43. Common elements of pastoral farming systems as shown by causal mapping
44. Differences in soil quality within kiwifruit orchards
45. Differences in soil quality between organic and conventional kiwifruit orchards
46. Strong production focus shown in kiwifruit causal mapping