ARGOS
Comparative Dairy Research

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Gratitude is extended to the 24 participating dairy farmers involved in the project.

The information in this report is accurate to the best of the knowledge and belief of the author(s) acting on behalf of the ARGOS Team. The author(s) has exercised all reasonable skill and care in the preparation of information in this report.
Executive Summary

Welcome to the ARGOS comparative dairy research project. ARGOS stands for the Agriculture Research Group on Sustainability. This research group is an unincorporated joint venture between the AgriBusiness Group, Lincoln University and the University of Otago.

ARGOS seeks to find a better understanding of environmental effects, and the social and economic consequences of different farming practices in New Zealand. This will help farmers to achieve sustainability within their land-use systems as well as continue to satisfy the demands of market and community stakeholders. The ARGOS Field Research Manager for dairy is based at Fonterra Milk Supply, Hamilton.

This research in the dairy sector forms part of the greater ARGOS research in the sheep/beef and kiwifruit sectors. This research is funded by MAF Sustainable Farming Fund (SFF) and the industry partner Fonterra, with additional project support from Foundation for Research, Science and Technology – Pathways to Sustainability.

Fonterra presently collects organic milk from 32 fully certified organic farms. Another 36 farms entered the organic conversion process, some of which are participating farmers in this research. This research complements Fonterra’s Best On-Farm Practice (BOFP) and Market Focused (Environmental Management System for New Zealand Dairy Farmers) in the areas of soil/fertiliser management and promoting alternatives to agrichemicals and hormone use for inductions.

Recruitment of farmers into the Fonterra organic programme and certified organic milk production was the initial objective of this research project. Twelve matched pairs of farms have been selected to provide comparative data between conventional dairy farms (12) and those converting to certified organic production (12). There are 12 farms located in the Waikato, six in Taranaki and six in the Manawatu. Establishing regular interaction with farmers and exchange of information is an important part of this research.

In the first six months of the project the first of the major fieldwork components of soil monitoring and farm mapping was completed. The first year of data collection will provide a baseline which will be updated over time to establish trends and possibly differences in performance within farms, between regions, and between the organic and conventional farms.

Production and financials

In terms of production there is a significant difference in milk production between the converting and conventional farms for 2005/06 and for the previous 03/04 and 04/05 years. The stocking rate (cows/ha) is also lower on converting farms (2.5 vs 2.8) although both conventional and converting farms have followed a general trend of reducing stocking rate over the previous two seasons.

<table>
<thead>
<tr>
<th>Table 1. Kg MS per hectare</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Kg MS /ha</td>
</tr>
<tr>
<td>Conventional</td>
</tr>
<tr>
<td>Converting</td>
</tr>
<tr>
<td>Stocking rate</td>
</tr>
<tr>
<td>Conventional</td>
</tr>
<tr>
<td>Converting</td>
</tr>
</tbody>
</table>
The average revenue per hectare is higher on conventional farms and the difference is
approaching statistical significance. However, the operating profit per hectare is not significantly
different as the converting farms have lower operating expense per hectare. On a per kgMS
basis we are approaching a statistically significant difference in operating profit, with converting
7 cents higher than conventional. This higher figure does not fully compensate for the lower
production (kgMS/ha) of converting farms.

Although there are differences in individual expense and income categories, the overall
conclusion must be that for the 2004/05 year there is no consistent overall difference in
profitability (Total Operating Profit/Ha) between converting and conventional farms.

**Soil results**

Analysis of soil nutrients shows few overall significant differences between farms in the Waikato
and Taranaki regions and limited mainly to higher levels of soil organic matter and sodium
levels on the Taranaki farms. Despite the converting to organic farms being only officially in
their first year of transition from conventional to full organic certification there were some
important differences. These probably stem from changes in fertiliser and agrichemical inputs
for several years prior to 2005. Phosphate status is decreasing on the converting farms
compared to the conventional farms whilst exhibiting higher soil pH and increasing microbial
carbon and soil carbon/nitrogen ratios. These differences, although small, appear to indicate
that converting farms are maybe starting to experience slower organic matter turnover, possibly
due to less N being applied and thus a build-up in microbial populations.

The mean phosphate levels (Olsen P) for both the conventional and converting farms were 58
and 47, respectively. These levels are well above the optimum target range of 30-40 Olsen P
(mgP/l) for ash and sedimentary soils (Roberts and Morton 1999). Soil Resin P means for the
conventional farms were 134 and 112 % w/w respectively, for the conventional and organic
farms, well above the optimum range of 50-100. The only other significant difference between
the two systems was a pH of 5.9 and 6.1 for the conventional and organic farms, both in the
desirable range of 5.8-6.0.

<table>
<thead>
<tr>
<th>Table 1: Significant differences in soils</th>
</tr>
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<tr>
<td></td>
</tr>
<tr>
<td>Conventional</td>
</tr>
<tr>
<td>Mean phosphate levels (Olsen P)</td>
</tr>
<tr>
<td>Soil Resin P</td>
</tr>
<tr>
<td>PH</td>
</tr>
</tbody>
</table>

Landform differences between crest, slope and flat were also evident and most likely due to
stock transfer of nutrients, differential fertiliser application and absence of superphosphate and
nitrogen applications on converting to organic farms.

**Work in progress and the next 6 months**

The Stream and Weed survey was completed on the farms in February / March. Measurements
were taken on farm of the pH / temperature / conductivity / clarity, nutrient concentration and
Escherichia coli and faecal coliform levels of stream water. The number of eels, fish and koura
(if present) was also recorded in a spotlight survey. A weed survey was also conducted to
determine the presence and extent of seven target species of woody vegetation (broom, gorse,
hawthorn, barberry, bracken, manuka / kanuka). The weed survey data is important to monitor
the changes as the farms progress through the organic certification process. The objective
being we will have the information to address issues such as the spread of weeds on organic
farms.
Future activity planned for the next six months includes reporting of the stream and weed surveys, further detail added to the farm maps, and analysis of capital in the 2004/05 financial accounts. Research planned for the next six months includes qualitative and quantitative social surveys, farm management surveys and soil monitoring for the four new farms in the Manawatu. Future extension activities include presentation of the ARGOS soil and financial results at the Fonterra Organic Conference in June 2006 and regional field days.
1 Introduction

1.1 ARGOS
The Agriculture Research Group On Sustainability (ARGOS) project in the dairy industry commenced in July 2005 and has a mandate to examine the environmental, social and economic sustainability of New Zealand dairy farm systems.

This project compliments other ARGOS research that investigates the environmental, social and economic effects of different farm types and systems:

- Lowland sheep and cattle farms - 12 conventional, 12 integrated and 12 organic.
- High country Merino farms - 8 farms with different levels of intensity
- Kiwifruit orchards - 12 Integrated Pest Management [(IPM) (Zespri Green )], 12 certified organic Hayward growers and 12 IPM (Zespri Gold )
- An adjunct study of Ngāi Tahu land holdings that encompass a variety of types of farming

ARGOS seeks to find a better understanding of the environmental effects, and the social and economic consequences of different farming practices in New Zealand. This will help farmers to achieve sustainability within their land-use systems as well as continue to satisfy the demands of market and community stakeholders.

The broad goal of the ARGOS research is to facilitate innovation and improved performance in primary production systems. An immediate goal of ARGOS is to compare the sustainability of conventional and organic dairy farm systems. However, it is also committed to discovering determinants of sustainability in general, irrespective of farming sector and the particular type of farming being applied

The ARGOS projects main objectives are:

- To provide an objective assessment of the relative sustainability (environmental / economic / social) of the participating dairy farms under conventional and organic management systems.
- To provide an objective assessment of the environmental performance against selected indicators of the participating farms under conventional and organic management systems.
- To determine which social factors influence the operation of different management systems and determine how management systems affect social factors.

Further information can be found on our website: www.argos.org.nz.

1.2 ARGOS and the Dairy Industry
This project supports a number of Dairy Industry initiatives;

1.2.1 Organic Production
This project supports the Fonterra initiative to increase the number of organic dairy farms. The Field Research Manager for dairy has been involved in extension activities including field days (March & November, 2005), information days (May, 2005), and promotion at Organic Expos (May & October, 2005 and March, 2006) and currently part of planning committee and proposed presenter for the Fonterra Organic Conference in June 12-13, 2006.

Farmers are offered a 7% above base payout incentive to convert to organic production for the first three years until they achieve full organic certification that meets the New Zealand Food Safety Authority’s Technical Rules of Organic Production and Appendices, the organic standard used for the export of products from NZ. Then a 20% premium is paid (minus transport charges
if applicable) above base milk payout once full certification is achieved to the export standard.

All the converting farmers participating in this project from Waikato and Taranaki have gained conversion organic certification with either BioGro or AgriQuality and entered contracts to supply Fonterra. The three Manawatu farms are in the process of gaining organic certification.

Figure 1 shows the number of farms (26) that entered organic certification (BioGro or AgriQuality) and organic milk contracts. Black indicates those in the Waikato and blue those located in Taranaki. One other farm from the Bay of Plenty also entered the Fonterra organic programme. There have been no new organic contracts for the first quarter of 2006.

Figure 1: Number of farms that entered 7% Organic contracts in 2005 for conversion to organic milk production.

![Figure 1: Number of farms that entered 7% Organic contracts in 2005 for conversion to organic milk production.](image)

1.2.2 Complementary to Fonterra Systems

This research complements Fonterra’s Best On-Farm Practice (BOFP) and Market Focused (Environmental Management System for New Zealand Dairy Farmers) which states:

'We see the environment encompassing the land, the water, the air, our animals and the community. As an industry we have a social responsibility to protect the environment in which we pride ourselves, and to continue to uphold New Zealand’s clean green image on which we market our products. The natural environment is the backbone of our industry and as such Fonterra is fully committed to delivering sound environmental management and values’…

On farm, this research translates to support the industry BOFP objectives relating to:

- **Water Management** – to avoid degradation of water quality and destruction of native flora and fauna by promoting fencing of waterways and monitoring water quality.

- **Fertiliser Management** – to monitor soil fertility, and implement annual nutrient budgets to determine fertiliser requirements that meet the nutrient outputs of the farm and reduce losses to the environment. Promote record keeping of fertiliser use and identify areas of effluent application on farm maps.

- **Soil Management** – recognise limitations of farm soil type to avoid erosion and compaction damage, visually monitor and assess soil quality.
Organic systems support the BOFP objectives of minimising the use of agrichemicals and inductions as both these are not permitted under organic certification standards. The industry would like to see the number of inductions to be less than 2% by 2010 of total dairy cow numbers.

1.2.3 Strategic Research

The ARGOS infrastructure, researchers and participating farmers, have the potential to contribute to Fonterra's knowledge in areas of specific importance to the cooperative as well as some of the Dairy Insight key priority areas and the desired outcomes of 'The Strategic Framework for Dairy Farming's Future' which was adopted jointly by the Boards of Dairy InSight and Dexcel in 2004 as well as the intent of the Dairy 21 initiative. With the ability to link environmental outcomes with economics and social drivers, the ARGOS project can provide a vehicle to efficiently and cost effectively deploy research activities that provide robust and unbiased research result to help industry responses to changing regulatory, market and social dynamics.

Robust research results will aid the development of tools and associated extension methodology that support farmers in environmental management and improve the resilience of the New Zealand dairy industry.

1.3 Project setup

The first objective of the project was to recruit farmers into the Fonterra organic programme and then select the comparative farms for this research. The farms have been selected in Fonterra’s target areas of supply of organic milk – Waikato, Taranaki and Manawatu (Figure 2). The farms have been allocated into 12 clusters (a group of farms in close geographical proximity) of two farms per cluster. A cluster consists of one conventional farm and one converting farm. A conventional dairy farm can be defined as a dairy system that has not met or is not in the process of meeting the Organic Certification Standards of either BioGro New Zealand or AgriQuality New Zealand to be compliant with the New Zealand Food Safety Authority's Technical Rules of Organic Production and Appendices, and a converting farm is defined as having every intention to do so. As an industry there is a large variation in the management of conventional farms with some using practices that are in keeping with organic principals i.e. no nitrogen, use of RPR, no inductions, and use of homoeopathic animal health remedies. Conventional farms selected for this project use nitrogen, superphosphate and antibiotics.

The Waikato clusters are located in Putaruru, Cambridge, Matamata, Waharoa and Waihi, and includes two farms in South Auckland.

The Taranaki clusters are located in Inglewood, Stratford, Okato and Opunake, and the Manawatu clusters are situated in Linton, Ashhurst and Foxton.

The farmers required in the Waikato and Taranaki regions were all recruited in the winter of 2005, with the first Manawatu cluster recruited in September 2005. There was a delay in the selection of the last two Manawatu clusters due to fact there has been a lack of farmers wishing to convert to organic production in this area.

Since the establishment of this project participating farmers have been visited on farm by the Field Research Manager and / or members of the research team at least three times. This does not include the four new farms recruited in March who have only had two farm visits.
Figure 2: Location of farm clusters
2 Economic monitoring

2.1 Milk Production

The production data of participating farms will be collected on a monthly basis and analysed with a focus on detecting statistically significant differences on individual farms, between farming systems and the longer term trends associated with these differences. Historical data on milk production provides a solid baseline and already in this data we find statistically significant differences.

The difference in milk production (kg MS/ha) between the 12 conventional and the 12 converting ARGOS farms is statistically significant (P<0.01) for three individual time periods; the 03/04, 04/05, and 05/06 season. As the farms only officially entered organic certification (BioGro / AgriQuality) from the start of the 05/06 season we can not conclude that the differences are an organic versus conventional induced difference. We might suspect that the farms that have decided to join the Fonterra organic supply scheme had a consistently lower milk production as far back as 03/04, for reasons that have yet to be determined. Most likely they were running a low input operation already in 03/04.

The difference between management systems percentage wise are 11% lower for converting farms in 03/04, 23% in 04/05, and 27% for the 05/06 season, indicating a trend of increasing differences between the panels (panel=group of farms with the same management system).

A comparative project at Massey University showed little difference in milk solids production per hectare during the first two years of transition to organics (959 vs 993 for 2001/02 and 742 vs 722 for 2002/03 for converting and conventional, respectively). Milk solids production (kg MS/ha) for both 2003/04 (925 vs 1094) and 2004/05 seasons (721 vs 902) was approximately 20% less on the organic compared with the conventional farmlet.

The differences between the ARGOS panels in per cow milk production are not significant for the 03/04 and the 04/05 season, however the difference in the 05/06 season is. The difference between management systems is smaller on a per cow basis than a per hectare basis, 14% versus 27%, indicating a difference in stocking rates.
### Table 1 Stocking rate on Conventional and Converting Farms

<table>
<thead>
<tr>
<th>Time period</th>
<th>Conventional (C)</th>
<th>Converting (D)</th>
<th>Significance (P)</th>
<th>D/C (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/06</td>
<td>2.833</td>
<td>2.498</td>
<td>0.086</td>
<td>88.18%</td>
</tr>
<tr>
<td>04/05</td>
<td>2.858</td>
<td>2.532</td>
<td>0.109</td>
<td>88.59%</td>
</tr>
<tr>
<td>03/04</td>
<td>2.95</td>
<td>2.685</td>
<td>0.074</td>
<td>91.02%</td>
</tr>
</tbody>
</table>

#### 2.1.1 Monthly milk production trend in 05/06 season

Differing management practices between conventional and converting farms resulted in a significant difference (P<0.01) in milk production/ha between the two groups. The difference in milk production across the months of the 05/06 season were also statistically significant (P<0.01), as well as the time/management interaction (P<0.01). These results are visualised in Figure 4 below where we see;

- A distinct difference between conventional and converting at all individual times (management effect).
- A distinct difference in production when comparing different time points for both converting and conventional farms (time effect).
- A distinct ‘closing of the gap’ between converting and conventional farms as the season progresses (time/management interaction). Converting farms seems to peak later in the season and then taper off slower than conventional farms. This is most likely the combined effect of the use of urea on the conventional farms to stimulate early pasture growth and the lower stocking rates of the converting farms.

![Figure 4. September 05 to February 06 milk production for conventional and converting farms.](image-url)
2.1.2 Regional effects
The results also indicate farm management practices have a greater impact on production than location/region.

The ARGOS comparative farms can be assigned to three regions; Waikato, Manawatu, and Taranaki. The regional factor is not a statistically significant predictor of differences in milk production at this stage, and in general the region seems less powerful than cluster in filtering out excessive variance when determining the management system effect. It should also be noted that as the number of data points to analyse grows over the years, our ability to determine the effects of other factors than management system will be much stronger. Still, there are some tendencies worth noting for further analysis;

- There is an indication of an interaction effect between region and time, i.e. the production curve differs between the regions throughout the season.
- There is no interaction effect between region and management, i.e. the difference in milk production caused by management system is the same between regions.

2.2 Financial results
There have been few reports published that have analysed the financial returns of organic dairy production, and provided information to farmers wishing to consider the economic implications of conversion to organic dairying. One of the outputs of the ARGOS project will be detailed reporting of the financial results and key performance indicators (KPIs) on the conventional and converting organic farms included in the study. As the project is based on farms that entered the organic certification process in the 2005/06 season, financial data directly comparing conventional and organic farms will not be available until after the end of the 2005/06 season. However, where possible, the 2004/05 and 2003/04 data for the comparative farms has been collected to establish a baseline and provide background data.

The financial analysis methodology and reporting framework used are based on the industry-wide reporting system recently developed by the ‘Dairy Industry Database and Benchmarking Project’. This will facilitate comparison of ARGOS results, on a regional and national basis, with information collected for the new DairyBase database (that replaces ProfitWatch and the Economic Survey of New Zealand Dairy Farms), due to be released in June, 2006. In addition, DairyBase involves a number of participating accountants whose clients will be able to compare the ARGOS results directly with the key performance indicators (KPIs) reported in their farm accounts in future.

Each year accounts will be collated and analysed for each farm, detailed reports on revenue and expenditure categories will be prepared and KPIs summarising profitability, liquidity and wealth by farm and by management system will be calculated. While these reports will allow comparisons with DairyBase and, to a lesser extent, MAF Farm Monitoring data, it should be noted that the “average” ARGOS farm is not intended to be representative of the national average as are the model farms reported by other monitoring programmes. Instead the focus is on determining the differences that develop under conventional and organic management systems on two panels of farms that are similar in other respects.

The “whole farm” approach of ARGOS, and the relatively small number of farms included in the study, makes the normal industry practice of reporting properties managed by sharemilkers on the basis of the share of income, expenditure and capital of the sharemilker alone impracticable. In the future, additional information will be obtained from farm owners so that the farm, rather than farmer(s), is the entity to be analysed, and direct comparisons can be made between the whole of the conventional and organic farm panels. As the result of changes in both ownership and sharemilking arrangements 2005/06 data collection will be more straightforward on most of the sharemilking operations.
2.2.1 Review of 2003/04 and 2004/05

The financial results of the eight sharemilking operations (4 conventional and 4 converting in FY 04 and 4 conventional and 3 converting in FY 05) included among the ARGOS farms have been excluded from the financial summaries presented in the following tables since their inclusion would result in an underestimation of the total costs of dairy production by the amount expended by farm owners on items such as fertiliser, repairs and maintenance, rates, etc. A further two farmers have yet to supply financial information to the project. Consequently, the KPIs and income and expenditure summaries in these tables are average values from the fourteen owner-operated farms for which financial results are presently available.

Caution should exercised when drawing conclusions from the averages, as averages can be misleading due to uneven representation across geographical areas, farm size, and other factor conditions. The matched pair design of ARGOS is targeted to address these issues by running more sophisticated statistical models. However, as financial data is more variable and less consistent than for example production data (kgMS), and the farms currently is in an converting process, our ability to say something definitive (statistically significant) about the financial performance of the farms. We could of course loosen the standards fro significance, from the 95% level to the 80% level, but we hesitate to do that with only two years of data and none where the farms are fully converted.

On the next page, we therefore present averages, some of the statistical results, and a few tentative conclusions.
## Table 2. Key performance indicators

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<tbody>
<tr>
<td></td>
<td>Conventional</td>
<td>Converting to organic</td>
<td>P</td>
<td>Conventional</td>
</tr>
<tr>
<td>Dairy: Gross Farm Revenue/ha:</td>
<td>4,586</td>
<td>3,796</td>
<td>0.143</td>
<td>4,063</td>
</tr>
<tr>
<td>Dairy: Operating Expenses/ha:</td>
<td>3,359</td>
<td>2,804</td>
<td>0.185</td>
<td>3,177</td>
</tr>
<tr>
<td>Dairy: Operating Profit (EFS)/ha</td>
<td>1,228</td>
<td>991</td>
<td>0.644</td>
<td>886</td>
</tr>
<tr>
<td>Dairy: Gross Farm Revenue/Kg MS</td>
<td>4.88</td>
<td>4.72</td>
<td>0.431</td>
<td>4.09</td>
</tr>
<tr>
<td>Dairy: Operating Expenses/Kg MS</td>
<td>3.74</td>
<td>3.50</td>
<td>0.767</td>
<td>3.34</td>
</tr>
<tr>
<td>Dairy: Operating Profit (EFS)/Kg MS</td>
<td>1.14</td>
<td>1.21</td>
<td>0.148</td>
<td>0.76</td>
</tr>
<tr>
<td>Dairy: FWE/Kg MS</td>
<td>2.88</td>
<td>2.57</td>
<td>0.625</td>
<td>2.55</td>
</tr>
<tr>
<td>Dairy: Operating Profit Margin %</td>
<td>27%</td>
<td>26%</td>
<td>0.251</td>
<td>22%</td>
</tr>
<tr>
<td>Dairy: Interest and Rent/GFR</td>
<td>12%</td>
<td>29%</td>
<td>0.014</td>
<td>11%</td>
</tr>
<tr>
<td>Dairy: Interest and Rent/Kg MS</td>
<td>0.58</td>
<td>1.39</td>
<td>0.008</td>
<td>0.45</td>
</tr>
</tbody>
</table>

<table>
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</thead>
<tbody>
<tr>
<td></td>
<td>Conventional</td>
<td>Converting to organic</td>
<td></td>
<td>Conventional</td>
</tr>
<tr>
<td>Net Cash Income:</td>
<td>495,761</td>
<td>424,348</td>
<td></td>
<td>443,556</td>
</tr>
<tr>
<td>Farm Working Expenses:</td>
<td>286,511</td>
<td>240,801</td>
<td></td>
<td>272,872</td>
</tr>
<tr>
<td>Cash Operating Surplus:</td>
<td>209,251</td>
<td>183,547</td>
<td></td>
<td>170,684</td>
</tr>
</tbody>
</table>

The average revenue per hectare are higher on conventional farms and the difference is approaching statistical significance (P=0.143). However, the operating profit per hectare is not significantly different as the converting farms has lower operating expense per hectare (P=0.185). On a per kgMS basis we are approaching a statistically significant difference in operating profit (P=0.148), with converting 7 cents higher than conventional. As this represents a 6.1% increase it does not compensate for the 23% difference in kgMS/ha (see section 3.1).

Of the more detailed financial data on next page, a few stands out as significantly different between the panels (P<0.10), and are highlighted with a shadowed cell.

Although there are differences in individual expense and income categories, the overall conclusion must be that for the 2004/05 year there is no consistent overall difference in profitability (Total Operating Profit/Ha) between converting and conventional farms.
Table 3. Financial analysis of ARGOS farms for the 2004/05 season.

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Converting to organic</th>
<th>Conventional</th>
<th>Converting to organic</th>
<th>Conventional</th>
<th>Converting to organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. effective milking area</td>
<td>115</td>
<td>112</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av peak cow nos</td>
<td>327</td>
<td>282</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cows/ha</td>
<td>2.84</td>
<td>2.51</td>
<td></td>
<td></td>
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<tr>
<td>Milksolids (kg)</td>
<td>105,415</td>
<td>89,823</td>
<td></td>
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<td></td>
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<tr>
<td>GROSS FARM REVENUE (GFR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Net Milk Sales</td>
<td>472,733</td>
<td>377,094</td>
<td>4.46</td>
<td>4.25</td>
<td>1.460</td>
<td>1.312</td>
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<tr>
<td>Net Livestock Sales</td>
<td>23,028</td>
<td>24,754</td>
<td>0.20</td>
<td>0.43</td>
<td>67</td>
<td>143</td>
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<tr>
<td>Value of Change in Dairy Livestock</td>
<td>29,782</td>
<td>10,488</td>
<td>0.22</td>
<td>0.03</td>
<td>73</td>
<td>10</td>
</tr>
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<td>Other Dairy Revenue</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dairy Gross Farm Revenue</td>
<td>525,543</td>
<td>434,836</td>
<td>4.88</td>
<td>4.72</td>
<td>1,800</td>
<td>1,464</td>
</tr>
<tr>
<td>Non-Dairy Cash Income</td>
<td>12,174</td>
<td>32,509</td>
<td>0.10</td>
<td>0.24</td>
<td>34</td>
<td>81</td>
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<tr>
<td>GROSS FARM REVENUE</td>
<td>537,716</td>
<td>467,345</td>
<td>4.99</td>
<td>4.95</td>
<td>1,634</td>
<td>1,545</td>
</tr>
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<td>OPERATING EXPENSES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wages and Salaries</td>
<td>65,679</td>
<td>47,603</td>
<td>0.53</td>
<td>0.47</td>
<td>172</td>
<td>151</td>
</tr>
<tr>
<td>Labour adjustment</td>
<td>47,724</td>
<td>46,904</td>
<td>0.58</td>
<td>0.64</td>
<td>164</td>
<td>186</td>
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<td>Total Labour Expenses</td>
<td>113,403</td>
<td>94,507</td>
<td>1.10</td>
<td>1.11</td>
<td>356</td>
<td>337</td>
</tr>
<tr>
<td>Stock Expenses</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal health</td>
<td>19,434</td>
<td>12,841</td>
<td>0.18</td>
<td>0.13</td>
<td>58</td>
<td>41</td>
</tr>
<tr>
<td>Herd improvement</td>
<td>12,727</td>
<td>5,507</td>
<td>0.12</td>
<td>0.07</td>
<td>40</td>
<td>22</td>
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<tr>
<td>Farm dairy</td>
<td>5,068</td>
<td>8,386</td>
<td>0.05</td>
<td>0.09</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Electricity</td>
<td>8,378</td>
<td>8,735</td>
<td>0.09</td>
<td>0.10</td>
<td>28</td>
<td>32</td>
</tr>
<tr>
<td>Total Stock Expenses</td>
<td>45,607</td>
<td>35,469</td>
<td>0.44</td>
<td>0.40</td>
<td>142</td>
<td>125</td>
</tr>
<tr>
<td>Feed Expenses</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Supplement Exp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchased less sold</td>
<td>7,811</td>
<td>10,115</td>
<td>0.13</td>
<td>0.12</td>
<td>47</td>
<td>36</td>
</tr>
<tr>
<td>Made</td>
<td>19,684</td>
<td>19,055</td>
<td>0.21</td>
<td>0.20</td>
<td>65</td>
<td>61</td>
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<td>Feed Inventory Adjustment</td>
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<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Grazing &amp; Run off Exp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grazing</td>
<td>22,471</td>
<td>19,475</td>
<td>0.19</td>
<td>0.23</td>
<td>62</td>
<td>70</td>
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<td>Run-off lease</td>
<td>429</td>
<td>1,875</td>
<td>0.00</td>
<td>0.01</td>
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<td>3</td>
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<td>Owned Run-off Adjustment</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
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<td>0</td>
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<td>Total Feed Expenses</td>
<td>50,395</td>
<td>50,520</td>
<td>0.54</td>
<td>0.56</td>
<td>175</td>
<td>170</td>
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<tr>
<td>Other Working Expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertiliser (incl N)</td>
<td>47,203</td>
<td>40,301</td>
<td>0.43</td>
<td>0.46</td>
<td>139</td>
<td>145</td>
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<td>Crop and Regrassing</td>
<td>3,588</td>
<td>1,347</td>
<td>0.04</td>
<td>0.01</td>
<td>12</td>
<td>4</td>
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<tr>
<td>Weed &amp; Pest</td>
<td>1,808</td>
<td>880</td>
<td>0.02</td>
<td>0.01</td>
<td>8</td>
<td>2</td>
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<td>Repairs &amp; Maintenance</td>
<td>28,356</td>
<td>19,913</td>
<td>0.26</td>
<td>0.17</td>
<td>83</td>
<td>56</td>
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<td>Freight and General</td>
<td>4,782</td>
<td>4,716</td>
<td>0.05</td>
<td>0.05</td>
<td>17</td>
<td>16</td>
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<td>Total Other Working Expenses</td>
<td>85,738</td>
<td>66,175</td>
<td>0.81</td>
<td>0.70</td>
<td>259</td>
<td>222</td>
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<td>Overheads</td>
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<td>Vehicles</td>
<td>15,594</td>
<td>18,595</td>
<td>0.17</td>
<td>0.18</td>
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<td>55</td>
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<tr>
<td>Administration</td>
<td>8,464</td>
<td>8,964</td>
<td>0.09</td>
<td>0.11</td>
<td>29</td>
<td>33</td>
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<td>Standing Charges</td>
<td>15,035</td>
<td>13,474</td>
<td>0.15</td>
<td>0.15</td>
<td>50</td>
<td>47</td>
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<td>Depreciation</td>
<td>29,540</td>
<td>28,230</td>
<td>0.29</td>
<td>0.29</td>
<td>93</td>
<td>91</td>
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<tr>
<td>Total Overheads</td>
<td>65,633</td>
<td>69,264</td>
<td>0.70</td>
<td>0.72</td>
<td>227</td>
<td>225</td>
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<tr>
<td>Total Dairy Operating Expenses</td>
<td>363,775</td>
<td>315,935</td>
<td>3.59</td>
<td>3.50</td>
<td>1,159</td>
<td>1,079</td>
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<td>Non-Dairy Operating Expenses</td>
<td>6,256</td>
<td>111</td>
<td>0.15</td>
<td>0.00</td>
<td>55</td>
<td>1</td>
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<td>TOTAL OPERATING EXPENSES</td>
<td>370,031</td>
<td>316,046</td>
<td>3.74</td>
<td>3.50</td>
<td>1,214</td>
<td>1,080</td>
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<tr>
<td>OPERATING PROFIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAIRY OPERATING PROFIT (EFS)</td>
<td>161,768</td>
<td>118,901</td>
<td>1.30</td>
<td>1.22</td>
<td>441</td>
<td>385</td>
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<tr>
<td>Non_Dairy Operating Profit</td>
<td>5,918</td>
<td>32,399</td>
<td>-0.05</td>
<td>0.24</td>
<td>-21</td>
<td>80</td>
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<tr>
<td>TOTAL OPERATING PROFIT</td>
<td>167,686</td>
<td>151,300</td>
<td>1.25</td>
<td>1.45</td>
<td>420</td>
<td>465</td>
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</table>
3 Environmental Monitoring

3.1 Soil Monitoring
For the ARGOS comparative dairy research project, soil quality monitoring consists of testing a suite of chemical, biological and physical indices in the field and laboratory. Visual and tactile examination of the soil in the field is the prime tool. It is complemented with a combination of standard and innovative laboratory techniques.

The overall ARGOS approach is to concentrate on groups (clusters) of commercial farms that are under conventional or organic management systems and are within close geographic proximity with similar landforms, soil type and climatic conditions.

Given this, and the large variation in soil quality, we chose to monitor paddocks that represent the two most dominant landforms (crest, slope, and flat) within each cluster using permanent Soil Monitoring Sites (SMS). For each landform, three management units (paddocks) were monitored, each with three SMS sites. While paddocks were chosen randomly, some dedicated effluent paddocks were excluded because of their unique land use within the farm. The three SMS located randomly within each paddock needed to be at least 15m apart, and all had to be at least 10m away from fences, water troughs, or vegetation less than 2m high. For trees greater than 2m in height and buildings, SMS needed to be 30 metres away. An eight degree threshold was used to define slope to distinguish between variations in landform within the same paddock.

The success of long term monitoring relies on consistency and sampling from these permanent soil monitoring sites. We intend to repeat routine monitoring at least every second year.

Figure 5. Finding random positions for SMS in irregular shaped paddocks.
A number of laboratory tests were performed on the soil samples:

- Soil pH indicates the level of acidity or alkalinity of the soil sample.
- Olsen P is a measure of the phosphorus readily available to plant. Resin Phosphate is a measure of the potentially plant available P from fertilisers such as reactive phosphate rock (RPR).
- Exchangeable cations (Calcium (Ca$^{2+}$), Magnesium (Mg$^{2+}$), Potassium (K$^+$) and Sodium (Na$^+$)). Calcium, magnesium and potassium are major nutrients for plant growth.
- Cation exchange capacity is a measure of the soil’s capacity to hold cations (retain nutrients) and is strongly influenced by clay content and Soil Organic Matter (SOM). Obviously the ability for a soil to retain nutrients is a useful function as long as they can become plant available. Increasing SOM will increase the soil CEC.
- Phosphate retention (%) indicates how strongly the soil will immobilise added phosphate. It is a function of the soil’s parent material and the level of clay minerals or iron oxides present that immobilise phosphorus. A moderate P retention is best (see section 4.1.2 for specific recommendations), but this measure characterises the soil rather than labelling it good or bad.
- Anaerobic mineralisable N is an indication of the nitrogen that is potentially available to plants through mineralisation of organic matter. It simply indicates the amount of N that could/should be available through the growing system. Obviously if this is high (~400 kg N/ha), you don’t need to add N fertiliser although its availability doesn’t always match with plant demand which is the advantage of N applications.
- Total organic C and N % organic matter is fundamentally important to the physical structure of soils as well as its role in retaining nutrients and water. Soil carbon is directly proportional to the soil organic matter (%C x 1.72 = %SOM).

Chemical, biological and physical data was statistically tested using an unbalanced ANOVA approach (GENSTAT 8.0) because of the farm selection structure. Regional analysis of farms is restricted to those farms in the Waikato and Taranaki regions as insufficient data for the Manawatu region was available.

### 3.1.1 Regional effects

Only a small number of significant differences were generally found between test values from the Taranaki and Waikato regions. These significant differences were:

- soil C% and N% (P<0.001),
- extractable organic-S (P<0.05),
- anaerobic mineralisable (AM) N (P<0.01) and
- Ca (P<0.05) and Na (P<0.001) base saturation.

Most of these appear related to the greater organic matter content of the Taranaki farm soils compared with those of the Waikato (8.8% vs 10.5% C, respectively). The differences in soil N may also explain the greater (~10%) mean values for anaerobic mineralisable-N (AMN) for the Taranaki soils although this relationship is not necessarily linear. Differences in Ca and Na base saturation may simply reflect the more westerly position of the Taranaki region and a greater exposure to salt–bearing winds leading to increased Na deposition.

### 3.1.2 System and Landform Effects

Most soil indices tested for conventional and converting systems were not significantly different but these were the important exceptions.

- Both Olsen-P (P<0.05) and resin-P (P<0.01) were higher overall for the conventional farm soils (Figure 9)
• Soil pH (P<0.01), microbial carbon (mg MC/g soil-C) and soil C/N ratio (both P<0.05) were significantly higher in the converting farm soils (Figure 10).

• The relationship between Resin-P and Olsen-P was robust and similar for both conventional and converting farms (Figure 11).

**Figure 9. Phosphate Levels (Olsen-P and Resin-P) for conventional and converting farms in 2005.**

![Figure 9](image-url)

**Figure 10 Microbial Carbon and carbon / nitrogen ratio of conventional and dynamic farms in 2005**

![Figure 10](image-url)
Of more significance however, was the high proportion of farms above the optimal Olsen-P recommendation of 30-40 (Roberts and Morton 1999); 75% of Conventional farms and 57% of converting farms. Recorded increases in microbial carbon rates and C/N ratio for converting farms although small appear to indicate that these systems are maybe starting to experience slower organic matter turnover, possibly due to less N being applied and thus a build-up in microbial populations. Less N use may also explain the slightly higher pH values (less nitrification) for the converting farm soils which in itself may contribute to higher microbial-C biomass in high organic matter soils although this effect is by no means clear.

Effects of landform on both conventional and converting farms were apparent with statistically significant differences for pH, Olsen and Resin-P, bulk density and quick test Mg, K and Na. These differences were signified in lower overall values for slope or hill areas and most likely either the result of differential fertiliser application or stock transfer of nutrients from slopes to crest and/or flat areas.

As the converting farms are only officially in transition to full organic certification since 2005, any differences between systems might have been expected to be slight. However some of the converting farms had not used N fertiliser and had substituted reactive phosphate rock (RPR) for soluble phosphate fertiliser prior to 2005. The large changes in P status already incurred between systems have obviously occurred partly as a result of this policy and through fixation, leaching and stock transfer of nutrients.

Figure 11. Relationship between Olsen-P and resin-P indices for conventional and converting dairy farms.
3.1.3 **Soil Biological Properties**

**Earthworms**

Earthworm populations give an indication of the biological, chemical and physical fertility of a soil. Earthworms are important for breaking down and incorporating organic matter and making the nutrients available to plants. Through burrowing, earthworms also mix soil and improve soil aeration and drainage. The total number of whole worms in the 2005 soil samples is approaching a significant difference between the conventional and converting management systems, but so far the difference is too small and inconsistent to induce any kind of conclusions.

**Soil Respiration**

Soil respiration is a complementary process to plant photosynthesis. For optimum growth the soil must be able to supply sufficient amounts of O\(_2\) to meet the combined respiration demands of plants and soil micro-organisms.

Whilst small differences were apparent between conventional and converting farms, no significant effect was apparent overall. Some significant differences between regions (Figure 12) and landforms were noted and are probably related to the activity of soil carbon within the soils but are yet to be fully explained.

![Figure 12. Respiration of dairy Taranaki vs. Waikato soils (wgt. CO2 per unit soil carbon per second; mg CO2/kg soil-C/s). LSD bars shown (5%).](image)

3.1.4 **Soil Physical Properties**

Soil Bulk Density (BD) is a measure of soil compaction and is inversely proportional to soil porosity and air-filled pores. Soils with high BD are likely to have reduced production due to poor root penetration and anaerobic conditions which are not conducive to healthy roots and good nutrient uptake. BD is measured by taking a volume of soil, weighing it wet and then
taking a sub-sample for gravimetric analysis. The difference by weigh of water is subtracted and the dry soil contained within the volume is then known.

Management system has had, thus far, no statistically significant effect on bulk density in either the 0-7.5 cm (BDA) or 7.5-15 cm (BDB) layers. The main source of variation in the data is cluster, which explains approximately 65% of the variance.

3.1.5 Conclusions

Significant differences between paired farms from the Waikato and Taranaki regions were few overall and limited mainly to differences in soil organic matter and Na levels (Taranaki farms both higher). Although the Converting farms are only officially into the first year transition from conventional to full organic certification there were some important differences which probably stem from reduced or absence of fully acidulated phosphate and nitrogen fertiliser and agrichemical inputs for several years for a number of the farms prior to 2005. The most obvious of these is that P status is decreasing on the Converting farms compared with Conventional farms whilst exhibiting higher soil pH and increasing microbial carbon and soil C/N ratios.

However, it should be noted that the Olsen phosphate levels for both the conventional and converting to organic farms were above the target soil test ranges of 30 -40 for ash or allophonic soils found in the Waikato and Taranaki and sedimentary soils (yellow-grey earth and yellow brown sands) of the Manawatu (Roberts & Morton, 1999).

Landform differences between crest, slope and flat farm sectors are evident and most likely due to stock transfer of nutrients, differential fertiliser application and decreasing P and N applications on converting farms.
4 Work in progress and the next 6 months

The ARGOS project setup is essentially a longitudinal study designed to detect and understand changes over time across a range of land use options and management practises. This means that the first year or two has a focus on establishing baseline measures of a number of important environmental, social, and economic indicators. Building a strong foundation also makes it possible to add on studies in a very cost efficient way.

Despite the longitudinal aspect of the project and its early stage, many research results are now available, a number of which are presented in this report.

Current work in progress includes a stream and weed survey that was completed on the farms in February / March. Measurements were taken on farm of the pH / temperature / conductivity / clarity, nutrient concentration and Escherichia coli and faecal coliform levels of stream water. The number of eels, fish and koura (if present) was also recorded in a spotlight survey. A weed survey was also conducted to determine the presence and extent of seven target species of woody vegetation (broom, gorse, hawthorn, barberry, bracken, manuka / kanuka). The weed survey data is an important baseline for detecting potential changes as the farms progress through the organic certification process. This might allow us to address potential issues with the spread of weeds on organic farms.

Future activity planned for the next six months includes reporting of the stream and weed surveys, further detail added to the farm maps, and analysis of capital in the 2004/05 financial accounts, and soil monitoring for the four new farms in the Manawatu.

The social baseline fieldwork will take place during the next six months which involves qualitative interviews with all farmers on, among other things, visions and constraints to farming. The qualitative data will be complemented with quantitative social surveys that also have been distributed nationally, which provides a foundation for inference from the detailed ARGOS results to the general farming population.

Further to these social surveys a farm management survey will be deployed to detail some of the management decisions that take place on each farm.

Future extension activities include presentation of some of the ARGOS environmental and economic results at the Fonterra Organic Conference in June and regional field days.
5 References and resources


Understanding the Costs and Risks of Conversion to Organic Production Systems – maf.govt.nz

5.1 ARGOS resources

Listed below are reports, research papers, ARGOS notes and other publications that have been produced by the ARGOS team on the ARGOS programme or aligned topics.

5.1.1 AI 6 - On-farm Management
AI 6.1 Rationale for selection of Kiwifruit Orchards
AI 6.2 Rationale for selection of Sheep and Beef farms
AI 6.3 High Country Review and Plan
AI 6.4 Dairy Review and Plan
AI 6.5 Baseline report for Sheep/beef participants 2004
AI 6.6 Baseline report for Kiwifruit participants 2004
AI 6.7 Baseline report for High Country participants 2005
AI 6.8 Baseline report for Dairy participants 2005
AI 6.9 Sheep/beef Stakeholder Report 2005
AI 6.10 Kiwifruit Stakeholder Report 2005

5.1.2 Articles and Books
Intensification of New Zealand agriculture since 1960 and its implications for biodiversity conservation, by Catriona MacLeod and Henrik Moller.

5.1.3 ARGOS Research Papers
05/01 Understanding Approaches to Kiwifruit Production in New Zealand : Report on First Qualitative Interviews of ARGOS Kiwifruit Participants, by Lesley Hunt, Chris Rosin, Carmen McLeod, Marion Read, John Fairweather and Hugh Campbell, June 2005
05/02 Soil quality on ARGOS kiwifruit orchards, 2004-2005, by Andrea Pearson, Jeff Reid, Jayson Benge and Henrik Moller, June 2005
05/03 Soil quality on ARGOS sheep & beef farms, 2004-2005, by Andrea Pearson, Jeff Reid, and Dave Lucock, June 2005
05/04 Food Markets, Trade Risks and Trends, by Caroline Saunders, Gareth Allison, Anita Wreford and Martin Emanuelsson, May 2005
05/05 ARGOS biodiversity surveys on Kiwifruit Orchards and Sheep & beef farms in summer 2004-2005: rationale, focal taxa and methodology, by Grant Blackwell, Stephen Rate and Henrik Moller, June 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

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

05/08 to be published

05/09 to be published

05/10 Sketch Maps: Features and Issues Important for the Management of ARGOS Orchards and Farms, by Marion Read, Lesley Hunt and John Fairweather, July 2005

5.1.4 Working Papers


Working Paper 2: Social Research Compendium: Key Questions on Social Dimensions of Agricultural Sustainability (The Corpse) by Hugh Campbell, John Fairweather, Lesley Hunt, Carmen McLeod and Chris Rosin

Working Paper 3: Economics Rationale for ARGOS by Caroline Saunders and Martin Emanuelsson

Working Paper 4: He Whenua Whakatipu Rationale for ARGOS by John Reid

Working Paper 5: Scoping Report for monitoring and evaluation processes within ARGOS by Esther Water (Members only)

Working Paper 6: Environmental Monitoring and Research for Improved Resilience on ARGOS Farms by Henrik Moller, Alex Wearing, Andrea Pearson, Chris Perley, David Steven, Grant Blackwell, Jeff Reid and Marion Johnson (Appendix 3: Visual Soil Assessment)

5.1.5 ARGOS Research Notes

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

5.1.6 Posters

1. Background to ARGOS ZESPRI’s 2004 Marketing and Innovation Conference (November 2004)
2. Research results on Kiwifruit Orchards ZESPRI’s 2004 Marketing and Innovation Conference (November 2004)

5.1.7 Conference Papers


5.1.8 ARGOnoteS
ARGOnoteS 1: Outline of BACI design, October 2003 by John Fairweather
ARGOnoteS 2: Some BACI design points, January 2004 by John Fairweather
ARGOnoteS 3: Threats to validity in BACI design, February 2004 by John Fairweather
ARGOnoteS 4: Matching Social and Economic variables in BACI design, February 2004 by John Fairweather
ARGOnoteS 5: BACI postponed, March 2004 by John Fairweather
ARGOnoteS 6: Panels, not Cohorts, January 2005 by John Fairweather
ARGOnoteS 7: Causation and BACI, February 2004 by Henrik Moller
ARGOnoteS 8: Broadening Research Focus and strengthening ethical safeguards in ARGOS, April 2004 by Henrik Moller
ARGOnoteS 9: Towards Transdisciplinary Research within ARGOS: an ecologist’s suggestions for process and research priority setting, July 2004 by Henrik Moller
ARGOnoteS 10: Monitoring relative lizard abundance in ARGOS kiwfruit orchards, June 2005 by Jayson Benge
ARGOnoteS 11: Kiwifruit Property reports, June 2005 by Alex Wearing
ARGOnoteS 12: A pilot evaluation prey facsimiles to compare the relative abundance of invertebrate predators in kiwifruit orchards by Kate Hewson and Henrik Moller
ARGOnoteS 13: Qualitative research methodology, July 2005 by Lesley Hunt
ARGOnoteS 14: Statistical hypothesis testing on ARGOS farms – some pros and cons of different approaches, July 2005 by Henrik Moller

5.1.9 Other Reports
ARGOS Annual Kiwifruit Sector Report, September 2005 by Jayson Benge
ARGOS Annual Sheep/Beef Sector Report, September 2005 by Dave Lucock
A draft farm-based sustainability monitoring system for Maori in the Ngai Tahu takiwa by John Reid