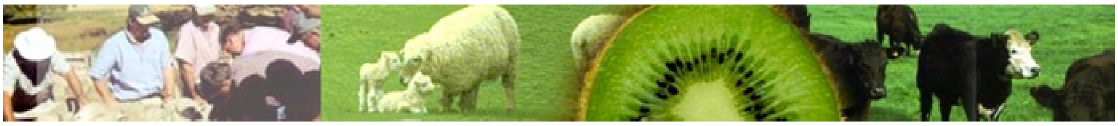
ARGOS

AGRICULTURE RESEARCH GROUP ON SUSTAINABILITY



A1 6.12 Stakeholder Report: October 2006

2006 Annual ARGOS Sector Report

KIWIFRUIT

Compiled by Jayson Benge, ARGOS

October 2006

The AgriBusiness Group

Lincoln University

University of Otago

Preface

The first annual ARGOS report was produced in 2005 and contained findings from the first 12 – 18 months of the programme. This 2006 report expands on that and contains results from additional management, financial, social and environmental surveys and questionnaires. Specifically, the following new content is included:

Orchard management and production

- trends in recent yield and dry matter, including 2006
- trends in recent fertiliser and spray use

Environmental

- soils: 2006 results and a comparison with 2004 data
- cicadas and spiders: trends over three consecutive years (2004 - 2006)
- spring canopy assessment (2005/06)
- orchard floor survey (2006)
- analysis of shelterbelts
- orchard mapping

Financial:

- trends over three consecutive years (2002/03, 2003/04 and 2004/05)

Social:

- causal mapping results (factors which orchardists perceive to be important to production and management)
- quantitative survey (national postal survey of farmers' attitudes and opinions)
- second qualitative interview (constraints to production/management)

Every effort has been made to ensure that all the information within is accurate. However, if there are any errors, please let us know as soon as possible so that we can correct our data for future analyses.

If you have any questions about the content of this report or other ARGOS reports, please contact:

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Contents

List of figures and tables

Acknowledgments

This work is funded by the Foundation for Research, Science and Technology (Contract Number AGRB0301). ARGOS also acknowledges financial assistance from Industry stakeholders including ZESPRI, Fonterra, Merino New Zealand Inc., COKA (Certified Organic Kiwifruit Growers Association) and in-kind support from Te Runanga O Ngāi Tahu.

The ARGOS programme has been designed and implemented with the intention of providing quality information to both farmers and growers and their associated industries to ensure that they are broadly sustainable, internationally competitive and profitable. To facilitate this we greatly value the inputs provided by all the participants and industry partners.

Each sector in the programme has an oversight committee which typically meets twice a year to review progress and provide suggestions on how ARGOS can enhance its overall performance. ARGOS is grateful to the contribution of everyone on these committees. The current members of the Kiwifruit Oversight Committee are:

- Alistair Mowat (ZESPRI Scientist)
- Jayson Benge (ARGOS Kiwifruit Field Manager)
- Jon Manhire (ARGOS Programme Manager)
- Ross Haycock (participating orchard manager)
- Tim Oliver (Organic orchardist) – *Joined in 2005*
- Garry Hill (Scientist, HortResearch) - *Joined in 2005*

ARGOS would also like to thank the following ZESPRI people for providing data in this report: Callum Kay, Jayne Chamberlain and Glenda Williamson.

In 2005, David Steven of IPM Research Ltd left the oversight committee. ARGOS would like to acknowledge the important contribution which David made. David was replaced by Garry Hill of HortResearch.

A number of ARGOS staff and affiliated researchers have contributed content to this report and this is gratefully acknowledged.

Executive summary

The Agriculture Research Group On Sustainability (ARGOS) is investigating the environmental, economic and social consequences of different farming systems in various NZ agricultural sectors including kiwifruit, dairy, sheep and beef and Maori land holdings. ARGOS is a team of expert researchers and farm advisors from Lincoln University, The University of Otago and The Agribusiness Development Group Ltd. This research started in 2003 and will run for a minimum of six years.

In kiwifruit, the three main NZ production systems are being studied: Hayward (*Actinidia deliciosa*) variety grown under the KiwiGreen system ("Green"); Hayward variety grown under the certified organic system ("Green Organic"); and Hort16A (*A. chinensis*) variety grown under the KiwiGreen system ("Gold"). KiwiGreen is the integrated management system used for producing kiwifruit in NZ. A summary of findings for the kiwifruit sector follows.

ORCHARD PRODUCTION

Industry trends

- On average, Green Organic orchards have consistently had the lowest export yields (Class I); 20 - 30% (1600 trays/ha) less than Green in recent years. Gold has tended to be higher yielding than Green although the difference from year to year has varied.
- In the last 4 or so years, average yields have generally increased with Gold increasing the most - probably the result of younger plantings moving towards full production.
- On average, Gold has consistently produced the highest average dry matter %. While Gold Organic consistently returns the highest results, there are very few Gold organic orchards (data not presented). Hort16A seems to be a higher dry matter variety.
- The average dry matter results for Green and Green Organic have not differed much with Green having a slight edge (average of 0.26 units higher for the 2003 to 2006 period with the largest difference occurring in 2004 when the difference was 0.7 units).

ARGOS vs. Industry trends

- On the whole, trends in average yield and dry matter for ARGOS orchards have followed Industry trends.
- In recent years, the average yields and dry matter of ARGOS orchards have not differed significantly from Industry averages:
  - For the 2000 to 2005 period, the average ARGOS yields were 444, 121 and 650 trays/ha more for Green, Green Organic and Gold respectively. These differences are not significant.
  - For the 2003 to 2006 period, the average ARGOS dry matter (%) was 0.25, 0.05 and 0.23 units more for Green, Green Organic and Gold respectively. These differences are not significant.
- Of the three sets of orchards in ARGOS, the organic set is closest to Industry in terms of recent yield and dry matter.

ORCHARD MANAGEMENT

Production outcomes will be driven significantly by management. Understanding differences in management on the ARGOS orchards, between and within production systems, will contribute significantly to understanding differences in production as well as other orchard characteristics (e.g. orchard biodiversity, soil quality, financial performance, social life). Recently, ARGOS has looked at two important management practices namely the use of agrichemicals and ground fertilisers. Both of these have significant impacts in orchards.

Agrichemicals and organic remedies

- Generally, the average total number of applications of insecticides, fungicides, herbicides and plant growth agents used across the ARGOS orchards has not changed substantially in the past 5 years with perhaps the exception of plant growth agents in Gold.
- Green and Gold orchards have consistently applied similar numbers of insecticides.
- In both Green and Gold, diazinon and chlorpyrifos insecticides have been the most commonly applied sprays, followed by BT and permethrin products (insecticides).
- Gold orchards have tended to apply fewer fungicides than Green orchards especially in recent years.
- Gold orchards have consistently applied more plant growth agents than Green especially in recent years. Both consistently apply hydrogen cyanamide and so the difference is due to fruit sizing agents (e.g. Benefit PZ) which are consistently applied to Gold for fruit size.
- In the 2003/04 season, there was an increase in the use of BTs (for leafroller) and diazinon (mainly for Scale) on Green and Gold orchards which was brought about by the removal of permethrin products.
- Herbicides are typically applied about once a year on average to both Green and Gold orchards.
- The most frequently used remedies on Green Organic orchards have been mineral oils and BTs, for the control of pests like scale and leafroller; on average, at total of 4 to 6 applications per year have occurred. Very few organic remedies have been applied for the control of fungi or for plant growth (i.e. budbreak).

Fertilisers

The following results are for the known quantities of nutrients applied to orchards (mostly in inorganic forms) and does not include compost, fish or manure products as the nutrient composition of these was unknown.

- On average, Green Organic orchards have consistently applied less nitrogen (virtually none), phosphorus, potassium, sulphur, magnesium and calcium than Green and Gold orchards.
- Compared with Green, Gold orchards have consistently applied slightly less nitrogen and similar levels of potassium and magnesium. In 2002/03 and 2003/04, Green also applied less phosphorus and sulphur but the levels have increased recently to that applied on Gold orchards.
- On average, the amount of nitrogen and magnesium applied to orchards has not changed much. Potassium applications have decreased slightly. Phosphorus additions have increased in Green and Green Organic but decreased slightly in Gold. Sulfur use has increased on Green in recent years but remained steady for Green Organic and Gold orchards. The amount of Ca applied in each production system seems to be increasing.
- Large volumes of compost have been consistently applied to many of the Green Organic orchards: 3 – 5 tonnes per hectare. Liquid fish products are often applied to Green Organic orchards too and in some cases very large quantities (several thousand litres per hectare). While Green and Gold orchards have not generally applied composts, one or two have applied a few tonnes per hectare of chicken based manure.

ORCHARD ENVIRONMENT

Orchard mapping

Detailed GIS maps have been produced for each ARGOS orchard. These will assist researchers to plan their monitoring programmes and to interpret the results of these. GIS means that each map has associated levels of data linked to them which will facilitate the identification of patterns within orchards.

Macro-invertebrates - spiders and cicadas (2004, 2005 and 2006)

Gold has consistently contained fewer spider webs (an indication of the abundance of web-spinning spiders) with no difference between Green and Green Organic. There has been an overall decline in average web numbers across all three production systems.

On average, the most cicada shells have consistently been found in Green orchards and the least in Gold orchards. There has been an overall increase in the average number of shells across all three production systems.

Soil quality (2004 and 2006)

Soil chemistry

- Across all orchards, the following did not change significantly between 2004 and 2006: pH, Olsen P, potassium (K), sodium (Na), sulfur (S), P-retention, total base saturation (TBS), total nitrogen (N %) or total carbon (C %) (Table 3). CEC, calcium (Ca), magnesium (Mg) and mineralisable N all increased significantly while the C: N ratio decreased significantly.
- Generally, the levels of cations and Olsen-P have been with the normal ranges specified for kiwifruit (calcium was slightly high in 2006).
- On average, Green Organic orchards have had the highest levels of cations, CEC, TBS, potentially mineralisable N and C % but the lowest levels of P and S. Soil pH has not differed noticeably between systems.
- The ratio of C: N has been similar for all production systems and at a level (about 12) which favours the release of minerals from organic material.
- CEC, Ca and Na have been significantly higher in the alleyways (between-row) compared to under the leaders (within-row). Higher organic matter in the alleyways would contribute to higher CEC and less leaching of cations like Ca. Olsen P has been significantly higher under the leaders in both years.

Soil structure

- For all production systems, soil structure (i.e. aggregation and porosity) in 2006 was similar to that in 2004 although aggregation seems to have deteriorated slightly in the alleyways probably as a result of continued traffic there.
- Green Organic orchards have had better soil structure, especially porosity, compared with Green and Gold orchards. Green orchards have had better soil structure, than Gold orchards, especially aggregation.
- Soil aggregation and porosity has been more favourable within-row (under the leaders) compared to between-row (alleyways). This is likely to be a consequence of less traffic under the leaders.
- Under the leaders, soil aggregation and porosity seems to have improved between 2004 and 2006. The reasons for this are unclear.

Earthworms

- The average earthworm density (no./m^2) increased between 2004 and 2006 for Green and Green Organic but decreased slightly for Gold. The overall effect is a slight increase in density on orchards.
- In both years, Green Organic orchards on average contained significantly more earthworms than Gold orchards and in 2006, significantly more than Green orchards.

- Earthworm numbers have not differed significantly between Green and Gold.
- On average, significantly more earthworms were found in the alleyway than under the leader in both 2004 and 2006. This could be the result of more organic matter in the alleyways.

Nematodes
In 2004, the composition of nematode feeding groups was similar across the three orchard systems. Most nematodes were bacterial-feeders and plant-feeders. Omnivorous nematodes made a higher contribution to overall nematode assemblages in the Green Organic orchards. Soil nematodes are probably not practical indicators of soil quality because they are not easy to measure and may be expensive. They are also not widely recognisable to growers. Other indicators of soil quality would be more preferable.

Soil invertebrates
In the summer of 2004/05, there was no evidence that organic or KiwiGreen orchards had different soil invertebrate activity (as measured by bait removal from bait lamina strips). There was no evidence that soil biological activity was different under the leaders compared to in the alleyways.

Orchard floor vegetation (2006, summer)

- The average height of sward was found to be significantly highest in the Organic orchards with no difference between the Green and Gold orchards.
- The average number of species was highest in the organic orchards but the difference was small.
- Excluding bare ground which on average occupied 41% of the surveyed sites, grass was the most predominant element under all management systems (30%); buttercup (8%) and clover (5%) were the next most abundant species.
- The average sward height was higher within-row compared to between-row on orchards. This was driven largely by markedly higher sward within-row on the organic orchards, a feature which is likely to be a reflection of less sward control there i.e. infrequent mowing and absence of herbicide.
- For Green and Gold, average sward height between-row and within-row did not differ significantly. On average, there were more species found between-row (2.0) compared to within-row (1.4).

Canopy assessments (2005, spring)
The amount of budbreak and flowers differed significantly between management systems. This was expected given differences in the use of budbreak enhancers and the inherent differences between the Hort16A and Hayward varieties. On average, the density of winter buds did not differ significantly between Green and Green Organic orchards but was significantly higher in the Gold orchards. There was no noticeable difference in the length of wood available on each orchard and so the higher density of winter buds in Gold orchards must have been due to shorter internode lengths i.e. the distance between buds. Note - the quality of wood (e.g. cane diameter, position) and buds was not surveyed here.

The measured canopy attributes were considered together in a linear multiple regression analysis in an attempt to explain variation in average yield (Class I trays/ha). When each attribute was considered separately, the number of flower buds and % budbreak significantly explained about 41% and 47% respectively of the total variation in average yield across all sampled orchards. When all possible combinations of attributes were analysed, there was no significant improvement in the amount of variation explained. The unexplained variation will have been due to factors like pollination, fruit thinning/culling, natural attrition, and losses during harvest and packing.

When each production system was considered separately, canopy attributes were generally poor at explaining variation in average yields for Green and Gold. However, for Green Organic orchards, the number of flower buds, length of 1-year wood and length of older wood together explained 81% of the variation in average yield. This implies that other factors which may affect final Class I yield, like pollination and fruit losses, were not a major influence for Green Organic in the 2005/06 season. On the other hand, they were for Green and Gold.

Shelterbelt analysis (2004)
There was no evidence that the stature and porosity of shelterbelts differed between Organic and KiwiGreen systems, so shelter is unlikely to be driving differences in mean fruit production, fruit quality and animal diversity and abundance between orchard systems.

ORCHARD ECONOMICS

Data from three financial years have now been analysed i.e. 2002/03, 2003/04 and 2004/05. On a per hectare basis, the average yield for Green has been consistently more than Green Organic with the differences being statistically significant in the last two years. Despite this, the average orchard gate return for Green has only been slightly higher and not statistically different. This is because the difference in yield has been offset by a higher OGR/tray for Green Organic. The average cash orchard expenditure (COE) for Green has been consistently higher than Green Organic but the differences have not been statistically significant. This with only a slightly higher OGR means little difference in average operating surplus per hectare.

On average, Gold has consistently incurred greater operating expenditure (statistically significant) than Green and Green Organic, a reflection of the greater attention needed by this crop. While initially this was not matched by significantly greater OGR, in the most recent year (2004/05), the average yield almost doubled which resulted in a much larger OGR (on a per hectare basis). This doubling is the result of dramatic increases for just a few of the study orchards. The higher cash orchard expenditure for Green compared to Green Organic can be largely attributed to consistently higher labour cost (c. $3,500/ha more annually). Green has also had higher spray and chemical, pollination, and repairs and maintenance costs. Only vehicle costs have been consistently lower in Green. Fertiliser cost has been similar. The end result is a higher average cash operating expenditure for Green, as mentioned earlier. The higher cash orchard expenditure for Gold compared to Green and Green Organic can be largely attributed to consistently much higher labour cost i.e. $5,200 more than Green and $8,700 more than Green Organic each year. Fertiliser and vehicle costs are other items which tended to be higher in Gold. Green pollination and repairs and maintenance have tended to be slightly higher than in Gold.

THE ORCHARDISTS (SOCIAL RESEARCH)

Types of kiwifruit orchardists
We formed a profile of a typical kiwifruit orchardist (the ‘core’), and then differentiated between Green, Green Organic and Gold to form different types of orchardist.

Attitudes of ARGOS orchardists to the Taste ZESPRI™ programme
These were determined in February and March 2006. On the whole, Gold orchardists appeared to be the most positive and supportive of the TZ programme. There was no clear difference in the level of support or resistance for the programme between Green and Green Organic orchardists. In terms of management, TZ has changed canopy management on many of the orchards with greater focus now on maximising

light in the canopy. Generally, changing management to pursue higher DM has incurred additional cost but this has been relatively small. Overall, the impacts of the changes in management on DM are not known as the changes have not been implemented long enough. Across all three groups, the most common concern was that current knowledge and tools did not consistently result in high DM fruit.

Second qualitative interview - constraints

The general conclusion we can draw from the interviews on constraints is that the growing of kiwifruit in New Zealand faces few constraints and that these can be successfully managed with existing and emerging strategies. This does not suggest that the life of a New Zealand kiwifruit orchardist is without its challenges (e.g. the potential financial constraints associated with a prolonged period of low production or returns). It is, however, evident that the typical orchardist can expect to achieve some level of success— however they might define it—in the sector. The sustainability of any given kiwifruit operation can be enhanced to the extent that its manager/owner is willing to remain abreast of emerging trends in management practice, aware of developments in the marketing of kiwifruit, and responsive to concerns of neighbours and society regarding the practice of orcharding. Challenges to sustainability appear to be associated with such factors as extreme climatic events, poorly understood regulatory and compliance measures, and a growing division between urban and rural perspectives on land use and management.

National farm survey – farmer attitudes and opinions

The ARGOS panels (Green, Green Organic and Gold) were surveyed alongside a larger set of orchardists representing the sector.

ARGOS panels

Overall, the results show that most of the differences relate to the organic panel. The panel shows differences as expected about alternative management positions. However, they see future prospects as less bright perhaps because they are aware of the limitations of the organic system on production or that they are responding to the reduction to the premium for organic kiwifruit. The Green differences are modest and consistent with their management system being equivalent to a conventional position. They have been on their orchard for less time. The Gold differences are consistent with their management being based on a different species.

ARGOS panels vs. sector

Overall, the Green and Gold panels in ARGOS are similar to the sector. The general pattern for the Organic panel in ARGOS, compared to the sector, is for a slightly more serious approach to organic production, with less household food sourced from the orchard, less dependence on chemicals and less interest in shooting.

Causal mapping

Causal mapping allows us to see in a glance what factors comprise the orchardists' complex system and can show critical issues to growers. The causal map for all ARGOS orchards reflects a strong production orientation. Organic orchardists produced a panel map having the most distinctive qualities but they also shared a number of distinctive characteristics with Gold orchardists.

1. Introduction

1.1. ARGOS

ARGOS stands for the **A**griculture **R**esearch **G**roup **O**n **S**ustainability and is an unincorporated joint venture between Lincoln University, The University of Otago and The Agribusiness Development Group Ltd. *Profiles of ARGOS researchers are available in Appendix 8.*

ARGOS is undertaking a longitudinal study, called “Pathways to Sustainability”, which is investigating the environmental, social and economic consequences of different farming systems in a number of agricultural sectors in NZ including kiwifruit, sheep & beef, high country, dairy and farms owned by Ngai Tahu landowners. ARGOS is also assessing market developments overseas and how these are likely to affect and be implemented in NZ. The costs of implementation and potential benefits of these will be further assessed.

This research, which is funded by the Foundation for Research and Technology (FRST) and Industry, started in 2003 and will run for a minimum of six years.

1.2. Programme context and market access drivers

Kiwifruit is by far New Zealand’s largest horticulture export industry and a major player in the global market. In 2005, NZ horticultural exports were valued at $2.3 billion with kiwifruit accounting for 31% of this. Approximately 0.7 million tonnes of kiwifruit enter world trade each year and NZ is one of the largest contributors at 32% (Italy provides 35% and Chile 15%) (Fresh Facts, 2005).

The success of agriculture in New Zealand, including kiwifruit, is facing continual emerging threats to market access. ARGOS is continually monitoring overseas market access issues and assessing how these are likely to be implemented and what the impact will be to the New Zealand kiwifruit industry e.g. EUREPGAP and changes in the EU Agricultural Policy. The potential benefits and risks of these will be further assessed using the LTEM (the Lincoln Trade and Environment Model developed for government policy and planning). This enables the impact of various scenarios, relating to the level of production and consumption, premiums and production costs, to be assessed both for NZ and other countries.

One example of an emerging threat is `food miles’ - the theory that the further food has to travel to market, the worse its impact on the environment. The research output from ARGOS has been of significant value in providing accurate information to counter these types of arguments as highlighted in these extracts from a press release made by Agriculture Minister Jim Anderton and Trade Minister Phil Goff on 13 September 2006 - they welcomed the findings of a report debunking the concept of food miles and stated "The concept of food miles is both flawed and too often promoted by those motivated by self-serving objectives rather than genuine environmental concerns," Jim Anderton said. "It is being used in Europe by self interested parties trying to justify protectionism in another guise." "The Lincoln University report, completed in July 2006, found the production of key New Zealand agricultural exports was more energy efficient. It resulted in fewer emissions than the same primary products produced in Europe. This was even after taking into account the distance New Zealand exports have to travel to reach key markets," Phil Goff said. "The Lincoln University report follows a comprehensive approach. It shows that when consideration is given to New Zealand farming methods and the total amount of energy used, especially in the production phase, the overall picture is one of New

Zealand producers being more energy efficient and creating fewer emissions. This is even after the energy consumed by transport is taken into account", said Jim Anderton.

There are also issues in relation to possible changes to the overall `rules' governing trade. In recent years, there have been successful World Trade Organisations (WTO) cases bought against Japan because of its use of phytosanitary standards as barriers to trade. These are reflective of the emergence of new trade barriers that countries are trying to establish to try and limit market access to overseas imports by a number of countries - not just Japan. In the current WTO Doha round - the European Union (EU) managed to get environmental impacts onto the agenda. The EU intends to introduce tougher, domestic environment policies and wants to restrict imports which do not meet those standards. The WTO currently does not permit this. The EU also supports use of trade sanctions against non-parties in multilateral environment agreements. WTO rules generally do not permit use of trade sanctions however the EU wants to change the WTO rules to allow such trade restrictions. The EU also wants agreement in the Doha negotiations to use environmental standards to protect its farmers. If successful a whole range of possible market access barriers could emerge and would only be able to be addressed if there was substantive information to show equivalence in environmental performance - something ARGOS is working on. Though these initiatives are currently been driven by the EU it would be anticipated that if successful - they would be adopted by other countries – including possibly Japan.

The ARGOS programme will provide independent and robust information that will allow agriculture sectors in NZ to respond to emerging issues like those above.

1.3. Kiwifruit research design

The following production systems (sometimes referred to as management systems) are being studied in the kiwifruit sector:

- Hayward (*Actinidia deliciosa*) variety grown under the KiwiGreen system ("Green")
- Hayward variety grown under the certified organic system ("Green Organic")
- Hort16A (*A. chinensis*) variety grown under the KiwiGreen system ("Gold")

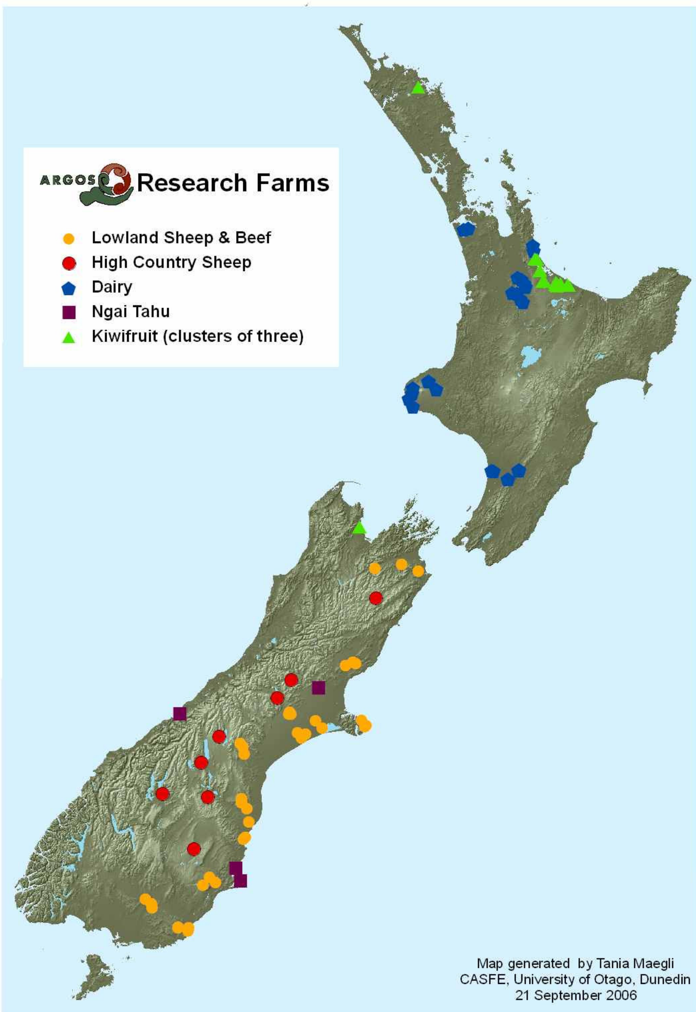
KiwiGreen is the integrated management system used for growing kiwifruit in NZ.

Twelve clusters of orchards are being studied with each cluster containing one of each orchard type (36 orchards in totals). Ten clusters are in the Bay of Plenty with one in each of Kerikeri and Motueka (Figure 1). These locations are consistent with the industry distribution of orchards and will potentially allow extrapolation to the wider industry.

With regards to on-orchard monitoring, two landforms are being studied i.e. within-row zones (under the leaders) and between-row zones (in the middle of the alleyways). Potentially, these two areas are managed very differently within orchards and so they may differ environmentally.

On-orchard activity (field activity) by ARGOS in the 2005/06 research year (which runs from July 1 to June 30) is illustrated in Figure 2. In addition to this there has been continual research and analysis, the results of which are presented herein.

Figure 1. Location of ARGOS farms (top) and kiwifruit orchards (bottom) in NZ.



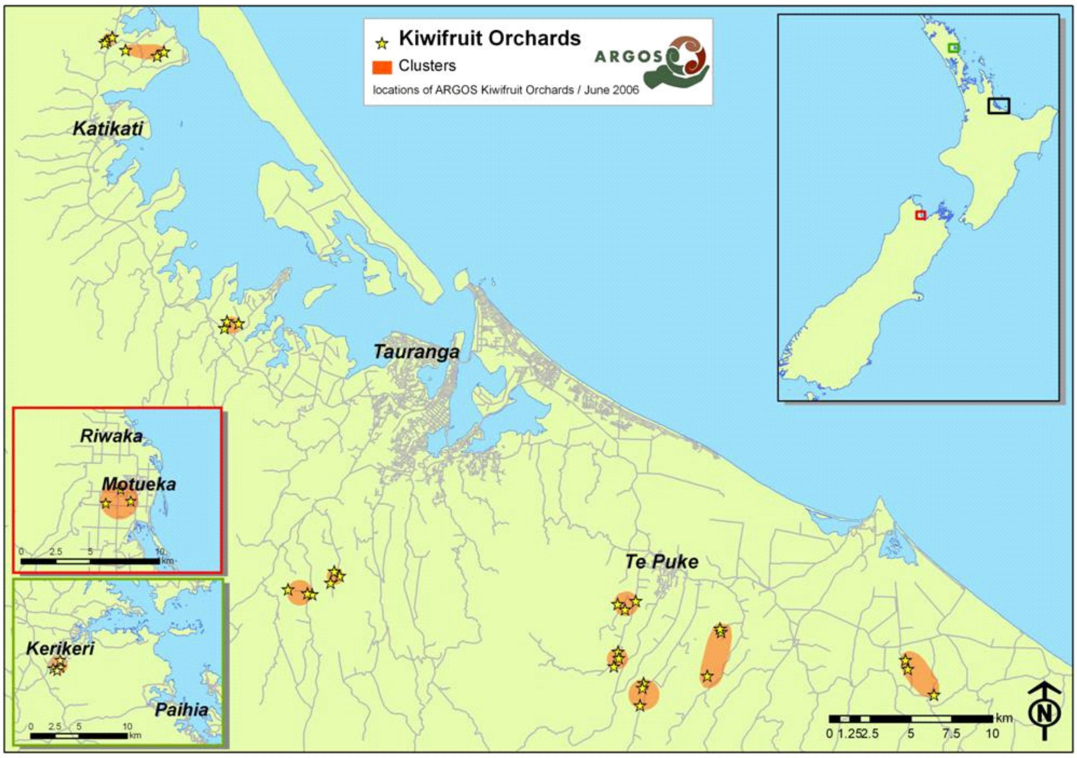


Figure 2. Main on-orchard activities for ARGOS in the 2005/06 research year.

Objective	Activity	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Orchard management / financials	Annual management interview												
Environment	Orchard floor survey												
	Canopy survey												
	Cicada shell and spider web survey												
	Soil sampling (continued into July)												
Social	National farm survey (postal)												
	Causal mapping interview												
	Qualitative 2 interview												

*Information for orchard maps is continually checked during orchard visits.

Legend

	Orchard management / economics
	Environment
	Social

1.4. Sharing of ARGOS knowledge

There are a range of possible processes that could be used to assist farmers and orchardists to systematically review their farming operations, identify areas for improvement, plan appropriate actions and implement these. A review of the potential value and effectiveness of various planning processes is being undertaken to establish their potential for facilitating the adoption of best management practices identified by ARGOS and the establishment of more sustainable farming systems.

In an effort to share knowledge specifically with the kiwifruit community, the following presentations have been provided in the 2005/06 research year:

- Inaugural ARGOS conference for the kiwifruit sector (July 2005, Tauranga)
- Multiple presentations at the 2006 International Kiwifruit Symposium (February 2006, Rotorua)
- Presentation at a HortResearch workshop on soil nutrition (March 2006, Te Puke)
- Presentation to certified organic kiwifruit growers association (COKA) (May 2006, Tauranga)

The following written work has also been produced:

- First annual report for the kiwifruit sector (September, 2005)
- Annual reports for participating orchardists containing individual data
- ARGOS update for the kiwifruit journal (October 2005)
- Updates to COKA (2005 and 2006)
- Papers for various international journals including *Acta Horticulturae*

ARGOS has also produced several detailed research reports, some of which are available to the general public. These are listed at the end of this document.

2. Orchard production

2.1. Introduction

This section of the report provides average data for the Green, Green Organic and Gold orchards in the ARGOS programme as well as average Industry data. This information is designed to illustrate key production differences between ARGOS orchards and management systems. It is hoped that with time, we will be able to contribute to a better understanding of what might be contributing to differences in production particularly between orchards within the same production system (reasons for differences between systems are reasonably well known e.g. use of hydrogen cyanamide for enhancing budbreak). Differences are likely to be a due to a combination in environmental, financial and social factors, all of which the ARGOS programme is attempting to provide some insight on (in a transdisciplinary approach). *Industry data presented here was obtained from ZESPRI databases and publications.*

2.2. Recent trends

Figure 3 presents trends in recent average yields (Class I) for Green, Green Organic and Gold orchards across the whole industry and for just the ARGOS orchards. Similarly, Figure 4 presents trends in recent average dry matter.

Industry trends:

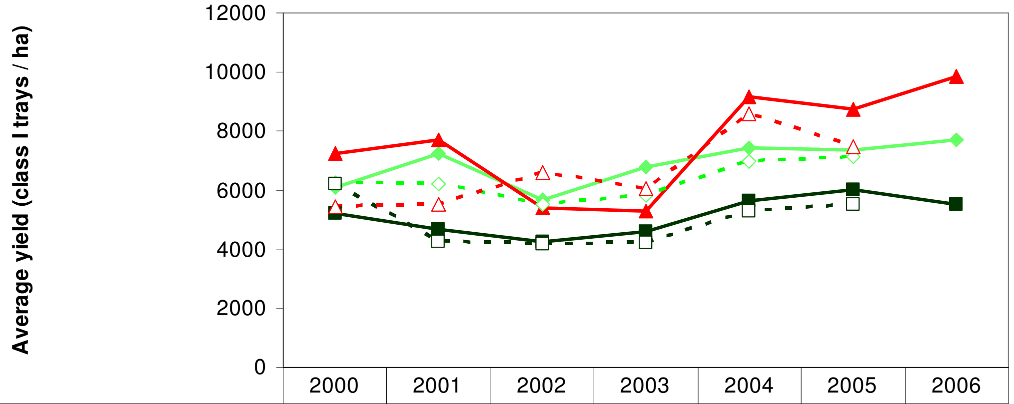
- On average, Green Organic orchards have consistently had the lowest export yields (Class 1), on a per hectare basis; 20 – 30% (1600 trays/ha) less than Green in recent years.
- Gold has tended to be higher yielding than Green although the difference from year to year has varied.
- In the last 4 or so years, average yields have generally increased with Gold increasing the most - probably the result of younger plantings moving towards full production.
- On average, Gold has consistently produced the highest average dry matter %. While Gold Organic consistently returns the highest results (data not presented), there are very few Gold organic orchards. Hort16A seems to be a higher dry matter variety.
- The average dry matter results for Green and Green Organic have not differed much with Green having a slight edge (average of 0.26 units higher for the 2003 to 2006 period with the largest difference occurring in 2004 when the difference was 0.7 units).

ARGOS vs. Industry trends

- According to Figure 3 and Figure 4, the trends in average yield and dry matter for ARGOS orchards have, on the whole, followed those of industry.
- In recent years, the average yields and dry matter of ARGOS orchards have not differed significantly from the Industry averages:
    - For the 2000 to 2005 period, the average ARGOS yields for Green, Green Organic and Gold were 444, 121 and 650 trays/ha more respectively than the Industry averages. These differences are not significant.
    - For the 2003 to 2006 period, the average ARGOS dry matter percentages for Green, Green Organic and Gold were 0.25, 0.05 and 0.23 units more respectively than the Industry averages. These differences are not significant.
- Of the three sets of orchards in ARGOS, the organic set is closest to Industry in terms of recent yield and dry matter.
- There has been reasonable spread in average yield within each group of ARGOS orchards - the range (difference between min and max) since 2000 has on average been about 6,000, 5,500 and 9,100 trays/ha for Green, Green Organic and Gold

respectively (Appendix 1). Similarly, there has been reasonable spread in average dry matter % within each group of ARGOS orchards - the range (difference between min and max) since 2003 has on average been about 2, 2.3 and 3 units for Green, Green Organic and Gold respectively (Appendix 2). *This range in production outcomes is important from a research point of view as it provides a tangible measure of differences in management approaches within each system.*

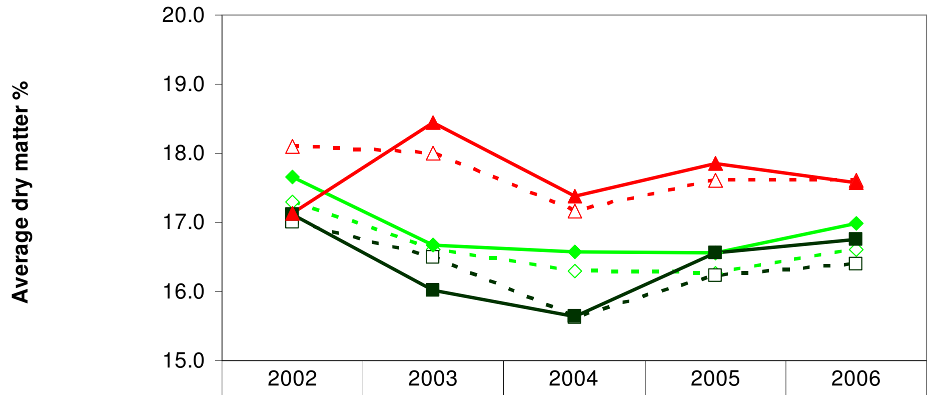
Figure 3. Trends in average yields (class I) for Green, Green Organic and Gold orchards. Industry (dashed lines + open symbols) and ARGOS (solid lines + solid circles) averages are presented. 2006 average data for Industry not yet available.



	2000	2001	2002	2003	2004	2005	2006
Green - ARGOS	6093	7249	5684	6769	7444	7354	7691
Green Organic - ARGOS	5225	4694	4245	4596	5624	6013	5528
Gold - ARGOS	7256	7713	5418	5272	9153	8747	9871
Green - Industry	6253	6226	5513	5814	6992	7129	
Green Organic - Industry	6206	4242	4182	4217	5292	5532	
Gold - Industry	5437	5531	6577	6054	8578	7484	

Year

Figure 4. Trends in average dry matter for Green, Green Organic and Gold orchards. Industry (dashed lines + open symbols) and ARGOS (solid lines + solid circles) averages are presented.



	2002	2003	2004	2005	2006
Green - Industry	17.3	16.6	16.3	16.3	16.6
Green Organic - Industry	17.0	16.5	15.6	16.2	16.4
Gold - Industry	18.1	18.0	17.2	17.6	17.6
Green - ARGOS	17.7	16.7	16.6	16.6	17.0
Green Organic - ARGOS	17.1	16.0	15.6	16.6	16.8
Gold - ARGOS	17.1	18.4	17.4	17.9	17.6

Year

3. Orchard management

3.1. Introduction

Production outcomes, like those discussed in the previous section, will be driven significantly by management. Understanding differences in management on the ARGOS orchards, between and within production systems, will contribute significantly to understanding differences in production as well as other orchard characteristics (e.g. orchard biodiversity, soil quality, financial performance, social life). Recently, ARGOS has looked at two important management practices namely the use of agrichemicals and ground fertilisers. Both of these have significant impacts in orchards.

3.2. Agrichemicals

3.2.1. Green and Gold

Figure 5 below presents the trends in the major non-organic spray types used in Green, Green Organic and Gold orchards in the ARGOS programme. This includes insecticides, fungicides, plant growth agents (including fruit sizing agents and hydrogen cyanamide) and herbicides. Other types of sprays (e.g. frost and bird control sprays, fruit cleansers) are not included as their use is sporadic. Also foliar fertiliser sprays are not considered here.

Generally, the average total number of applications of insecticides, fungicides, herbicides and plant growth agents used across the ARGOS orchards has not changed substantially in the past 5 years with perhaps the exception of plant growth agents in Gold.

Comparisons of production systems have revealed:

- Green and Gold orchards have consistently applied similar numbers of insecticides.
- In both Green and Gold, diazinon and chlorpyrifos insecticides have been the most commonly applied sprays, followed by BT and permethrin products (insecticides).
- Gold orchards have tended to apply fewer fungicides than Green orchards especially in recent years.
- Gold orchards have consistently applied more plant growth agents than Green especially in recent years. Both consistently apply hydrogen cyanamide and so the difference is due to fruit sizing agents (e.g. Benefit PZ) which are consistently applied to Gold for fruit size.
- In the 2003/04 season, there was an increase in the use of BTs (for leafroller) and diazinon (mainly for Scale) on Green and Gold orchards which was brought about by the removal of permethrin products.
- Herbicides are typically applied about once a year on average to both Green and Gold orchards.
- In addition to non-organic sprays, organic sprays have occasionally been used on Green and Gold orchards (Appendix 3).

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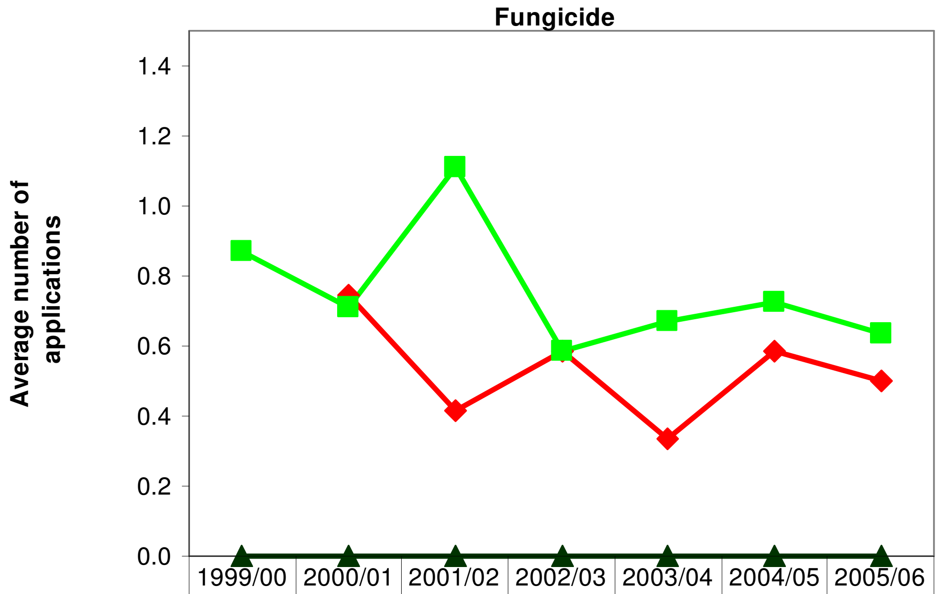
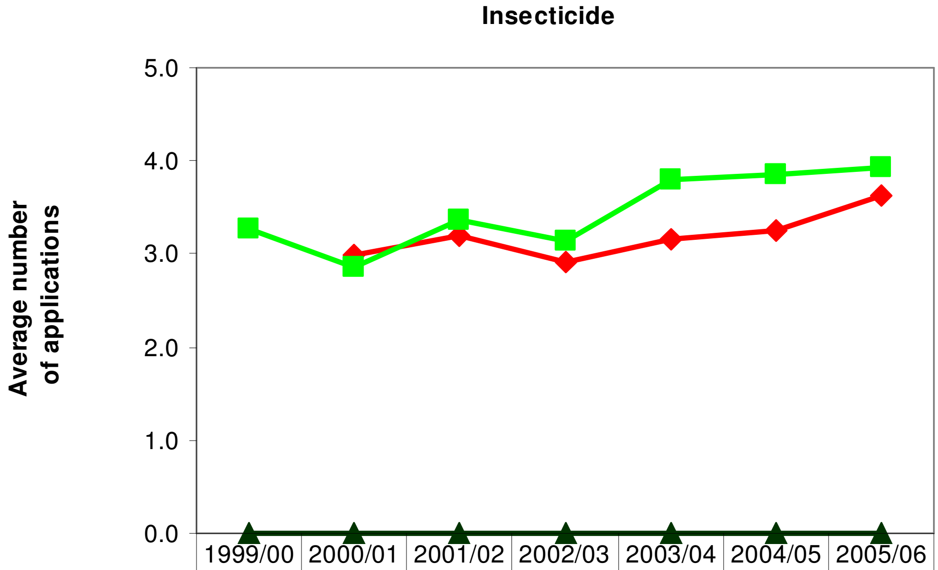
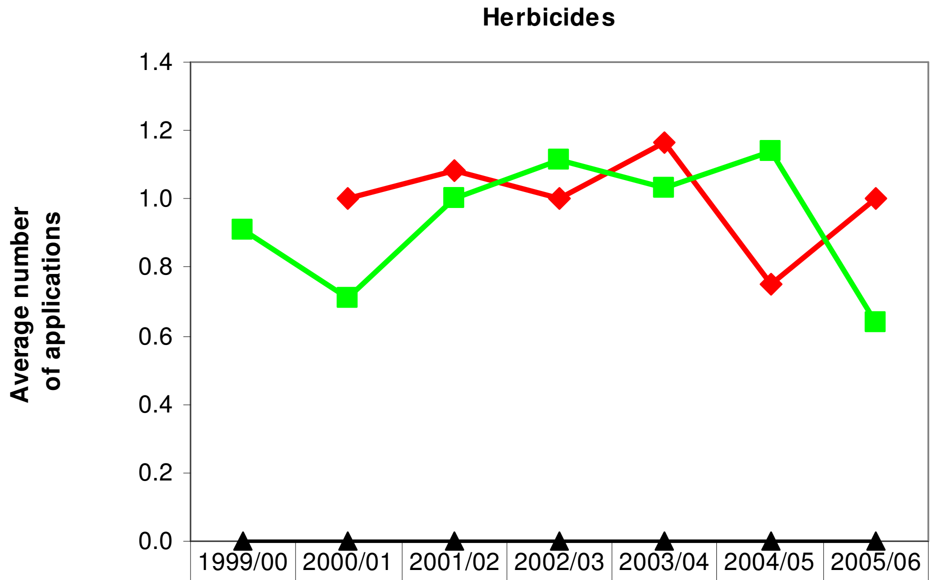
Figure 5. Trends in the average number of times that <u>non-organic</u> fungicide, insecticide, plant growth agent (including benefit and hydrogen cyanamide) and herbicide sprays have been used recently on Green, Green Organic and Gold orchards in the ARGOS programme. The specific active ingredients which contribute to these averages are available in Appendix 3.



	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Gold		0.7	0.4	0.6	0.3	0.6	0.5
Green	0.9	0.7	1.1	0.6	0.7	0.7	0.6
Green Organic	0.0	0.0	0.0	0.0	0.0	0.0	0.0

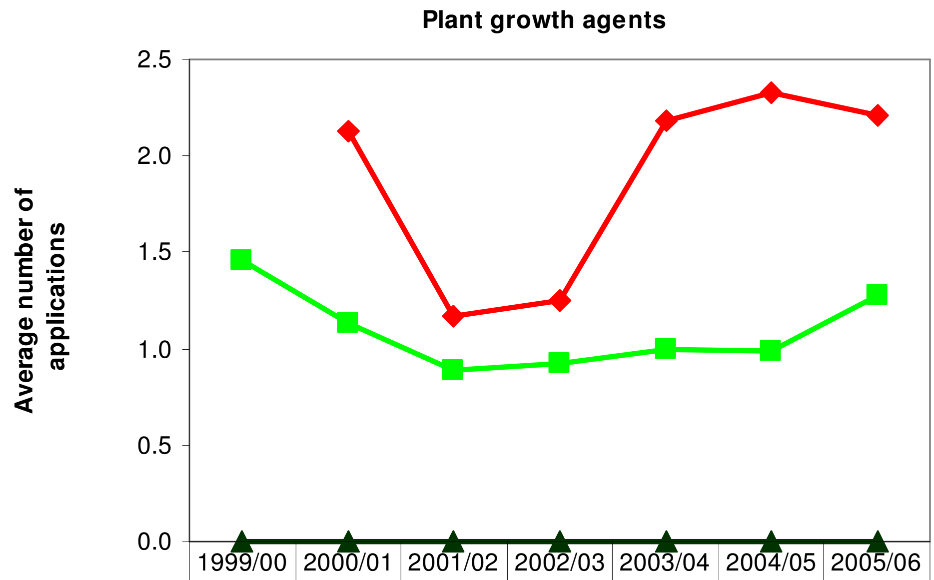


	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Gold		3.0	3.2	2.9	3.2	3.3	3.6
Green	3.3	2.9	3.4	3.1	3.8	3.8	3.9
Green Organic	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Season	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Gold		1.0	1.1	1.0	1.2	0.8	1.0
Green	0.9	0.7	1.0	1.1	1.0	1.1	0.6
Green Organic	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Season



Season	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Gold		2.1	1.2	1.2	2.2	2.3	2.2
Green	1.5	1.1	0.9	0.9	1.0	1.0	1.3
Green Organic	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Season

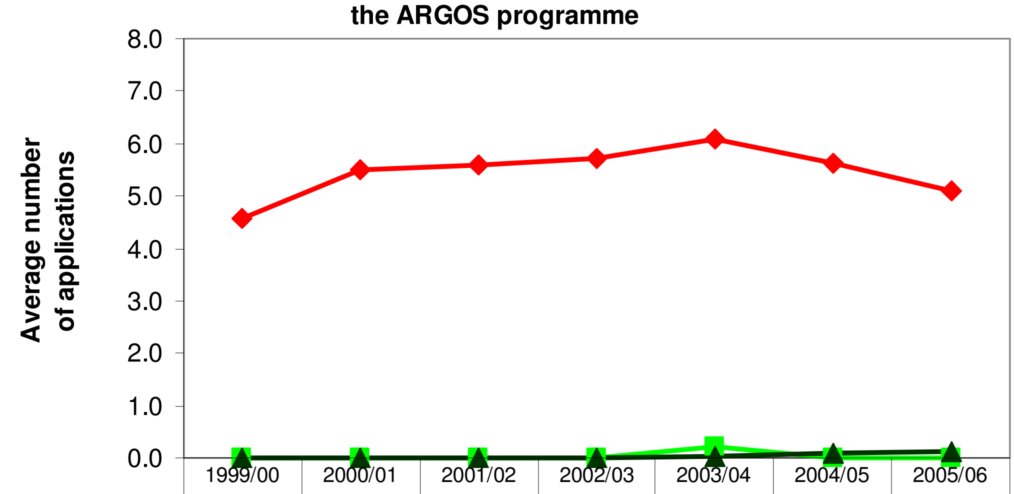
3.2.2. Green Organic

Sprays used on Green Organic orchards must be approved as certified organic by BioGro NZ. The website www.biogro.co.nz lists inputs currently certified by BioGro and growers must have a copy of the current BioGro certificate or other written approval from BioGro for any spray at the time it is used.

Generally, the number applied to Green Organic orchards has not changed much in recent years (Figure 6). Those used most frequently have been mineral oils and BTs for the control of pests like scale and leafroller; on average, a total of 4 to 6 applications per year have occurred. Very few organic remedies have been applied for the control of fungi or for plant growth (i.e. budbreak).

Oil, lime sulphur, pyrethrum and copper are restricted sprays in organic production, and must be used only in accordance with BioGro requirements (ZESPRI™ CROP PROTECTION PROGRAMMES FOR EXPORT KIWIFRUIT 2006 – 2007).

Figure 6. Trends in the use of CERTIFIED ORGANIC remedies used on Green Organic orchards in the ARGOS programme. The specific active ingredients which contribute to these averages are available in Appendix 3.



	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
For pests	4.6	5.5	5.6	5.7	6.1	5.6	5.1
For fungi	0.0	0.0	0.0	0.0	0.2	0.0	0.0
For plant growth	0.0	0.0	0.0	0.0	0.0	0.1	0.1

3.3. Fertiliser use

3.3.1. NPKSMg fertilisers on ARGOS orchards.

Recent rends in the average amounts of nutrients applied to ARGOS orchards (as ground fertilisers) are presented in Figure 7. This does not include nutrients supplied by composts, manures and fish products as the nutrient composition of these is unknown. Below is a summary of trends and differences between production systems. Suggested annual fertiliser inputs are presented in Table 1.

Nitrogen (N)
- On average, 80 – 160 kg/ha of N has been applied to Green and Gold orchards. Generally, less N has been applied to Gold orchards especially in recent years. Presumably this is because Hort16A is a more vigorous variety.
- Organic orchardists have had to rely heavily on organic fertilisers, especially compost, for N.

Phosphorous (P)
- In 2002/03 and 2003/04, Green applied less phosphorus but the level has increased recently to that applied on Gold orchards. The amount applied to Gold orchards appears to be declining slightly.
- Until 2003/04, very little P was applied to Green Organic orchards but this changed because of the introduction of reactive phosphate rock.

Potassium (K)
- The amount of K applied has remained reasonably constant over the years with little difference between Green and Gold orchards.
- Green Organic orchards have on average consistently applied less K and the amount has not changed much.

Sulphur (S)
- Like phosphorus, Green applied less sulfur in 2002/03 and 2003/04 but the level has increased recently to that applied on Gold orchards. Given the relative lack of restrictions on fertiliser use for Green, this seems to be a straight increase in the amounts applied.
- Sulphur applications to Gold and Green Organic orchards have remained relatively constant with much less added to the Green Organic.

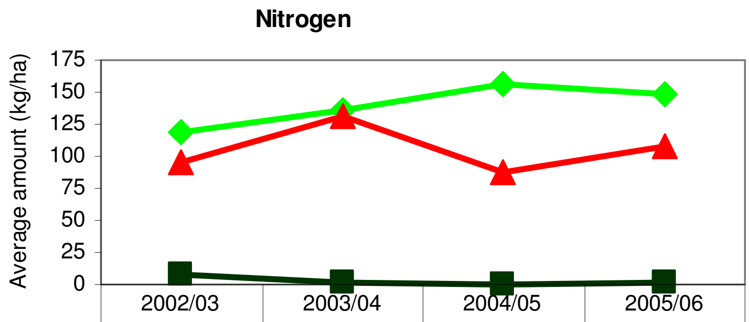
Magnesium (Mg)
- Magnesium applications on Gold and Green orchards have been similar with there being a steady increase in recent years.
- Like Gold, magnesium applications of Green Organic orchards have been constant albeit much less than for Green and Gold.

Table 1. Suggested annual fertiliser requirements for maintaining yields on established kiwifruit vines and the estimated nutrient loss in an 8,000 trays/ha crop.

	Application rate (kg/ha)	Crop removal (kg/ha)
Nitrogen	140 – 200	61
Phosphorus	40 – 60	8
Potassium	110 – 200	106
Magnesium	20 – 40	5
Sulphur	40 – 70	7

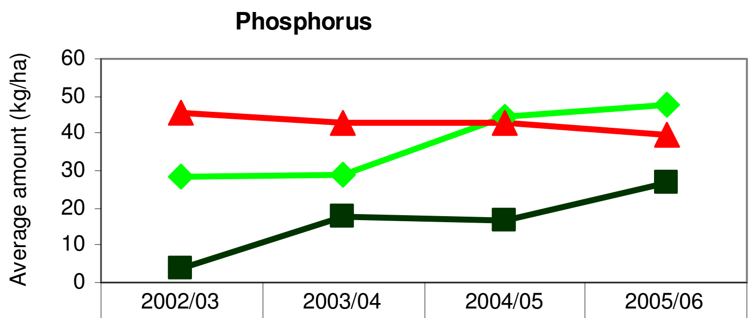
(Source: http://www.hortnet.co.nz/publications/guides/fertmanual/kiwifrt.htm)

Figure 7. Trends in the average amounts of N, P, K, S and Mg recently used on Green, Green Organic and Gold orchards in the ARGOS programme. This does not include nutrients supplied by composts, manures and fish products.



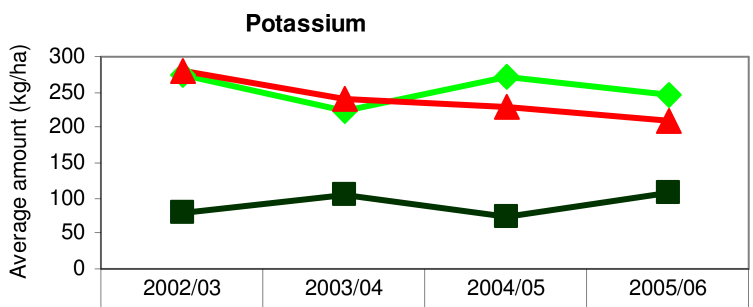
	2002/03	2003/04	2004/05	2005/06
Green	119	135	157	148
Green Organic	7	2	0	1
Gold	95	130	88	107

Season



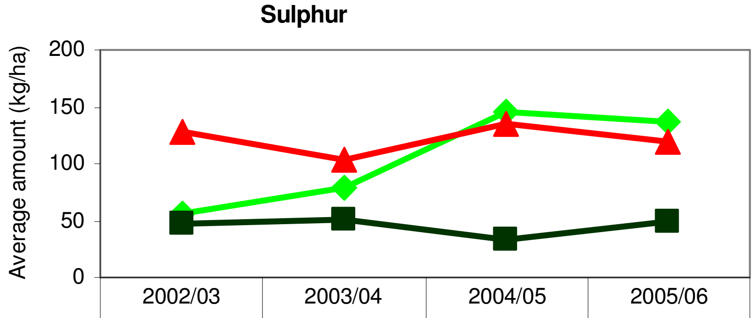
	2002/03	2003/04	2004/05	2005/06
Green	28	29	45	48
Green Organic	4	17	17	27
Gold	46	43	43	40

Season

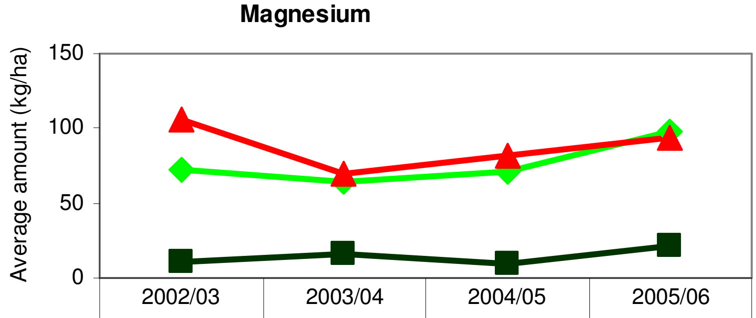


	2002/03	2003/04	2004/05	2005/06
Green	275	223	272	247
Green Organic	80	103	73	108
Gold	280	240	228	208

Season



	2002/03	2003/04	2004/05	2005/06
Green	56	79	145	138
Green Organic	47	51	34	50
Gold	127	103	135	119



	2002/03	2003/04	2004/05	2005/06
Green	73	64	71	98
Green Organic	11	16	9	21
Gold	106	69	81	93

*Orchard 1A excluded from the previous graphs as it was very different to others.

3.3.2. Calcium use on ARGOS orchards

Calcium (Ca) is important for kiwifruit quality and is typically added to orchards as lime and gypsum or with phosphate fertilisers e.g. superphosphate (20% Ca) and RPR (34% Ca). For this reason, there is a low incidence of calcium deficiency in kiwifruit. That said boosting the levels of calcium in kiwifruit is likely to be beneficial to fruit quality.

It is difficult to illustrate Ca applications to ARGOS orchards because of the large range in amounts applied. Presenting averages would be misleading. Instead, the amounts applied have been represented using box and whisker plots in Appendix 4 - this approach allows the range in values to be shown as well as the levels of Ca which are most applied. The downside is that the plots can be difficult to interpret.

The following trends in applications of Ca (excluding compost, manure and fish applications) are taken from Appendix 4:

- On average, Green Organic orchards have tended to apply considerably less Ca than Green and Gold orchards.
- Green orchards have tended to apply more Ca than Gold orchards.

- The maximum amounts applied to Green and Gold orchards are much more than for Green Organic.
- For Green Organic, the lower quartile in every year is 0 which means 25% of these orchards are applying no Ca.
- The amount of Ca applied in each production system seems to be increasing.
- Commonly used Ca fertilisers for each production system are shown in Table 2.
- Despite being permitted for use in organic systems, fertilisers like lime and gypsum don't appear to be widely used on ARGOS organic orchards. This is probably because they view these products as being used for modifying pH but that their pH levels are fine.

Table 2. The most commonly used calcium fertilisers on ARGOS Green, Green Organic and Gold orchards in recent years (2003/04 to 2005/06).

Production system	**Product**
Green	Lime, gypsum and triple superphosphate
Green Organic	Reactive phosphate rock
Gold	Lime and gypsum

3.3.3. Organic fertilisers - composts, fish and manures

In addition to the nutrients in Figure 7, large volumes of compost have been consistently applied to many of the Green organic orchards: 3 – 5 tonnes per hectare (Appendix 5). Liquid fish products are often applied to Green Organic orchards too and in some cases very large quantities (several thousand litres per hectare). While Green and Gold orchards have not generally applied composts, one or two have applied a few tonnes of chicken based manure per hectare.

Composts, manures and fish products contain something like 1 – 5% of N, P and/or K on a dry weight basis (http://www.hortnet.co.nz/publications/guides/fertmanual/intro.htm#I3). Consequently, Organic orchards which are applying large amounts of organic fertilisers are actually applying significant amounts of N, P and K…possibly more than KiwiGreen growers are applying using inorganic forms. For example, 10T/ha of compost could provide as much as 250kg/ha of N (assuming compost is about 50% water) but most are probably applying less than this. KiwiGreen orchardists on average are applying between 80 and 140 kg/ha of N annually (Figure 7). This N is more readily available whereas the nutrients supplied by organic fertilisers like compost are released slowly over several years.

3.3.4. Foliar fertilisers – yet to be studied

ARGOS has not yet undertaken an analysis of foliar fertiliser use on its orchards as insufficient data has been collected. More detailed study of these fertilisers may be undertaken in the future.

4. Orchard environment

4.1. Introduction

The environment objective of the ARGOS programme aims to clarify the environmental impacts of different farming systems to assist in the identification and subsequent implementation of more sustainable and resilient farming systems.

ARGOS recognises that ecological processes and biodiversity on New Zealand's farmed landscapes have received very little study so far. In addition to monitoring the effects of different farming systems this research will also study general ecological processes in farm agro-ecosystems. This research will provide an understanding of why the indicators are or are not changing. Identifying the reasons for the observed changes or lack of them is the key to better advice on how to bring the desired improvements in sustainability and resilience.

The environmental research team wants to help farmers assert their rightful place as stewards of the land and build their capacity to make a contribution to reducing the present decline of indigenous biota. ARGOS will also focus on defusing a damaging divide between some regulatory agencies and farmers by facilitating dialogue, sharing information and creating tools that build mutual respect and co-operation between land owners and regional councils and national institutions (MAF, DoC, and Ministry for the Environment).

In the initial 12 – 18 months of the programme, baseline surveys of the physical environment of kiwifruit orchards were undertaken. Subsequently, repeat sampling of potential environmental indicators was performed including macro-invertebrates and soil quality. Additional unmeasured features of the orchard environment were also quantified, where resources permitted e.g. orchard floor vegetation and spring canopy characteristics. The results of this sampling are presented here.

4.2. Orchard mapping

Farm mapping is an integral part of ARGOS, providing information in a visual format that can simplify some of the complexities in a transdisciplinary programme.

In the middle of 2006, each of the participating orchards in the ARGOS programme received draft versions of orchard maps prepared by ARGOS using GIS (Geographic Information Systems) and aerial photography. It is hoped that final versions of these maps will be available by the end of 2006 once comments have been received from orchardists (maps will be updated annually if major changes occur).

These maps will assist ARGOS researchers to plan their monitoring programmes and to interpret the results of these. GIS means that each map has associated levels of data linked to them which will facilitate the identification of patterns within orchards. As an example, Figure 8 below shows the locations of soil monitoring sites on an ARGOS orchard. Measurements carried out at each of these sites are shown in the associated table. Later, it should be possible to analyse spatial patterns in orchard attributes like soil quality e.g. does soil quality depend on distance from shelterbelts?

The ARGOS farm mapping is currently being undertaken by Tania Maegli at the University of Otago.

Figure 8. Example of kiwifruit orchard map prepared by ARGOS using aerial photography and GIS. Soil monitoring sites are shown.

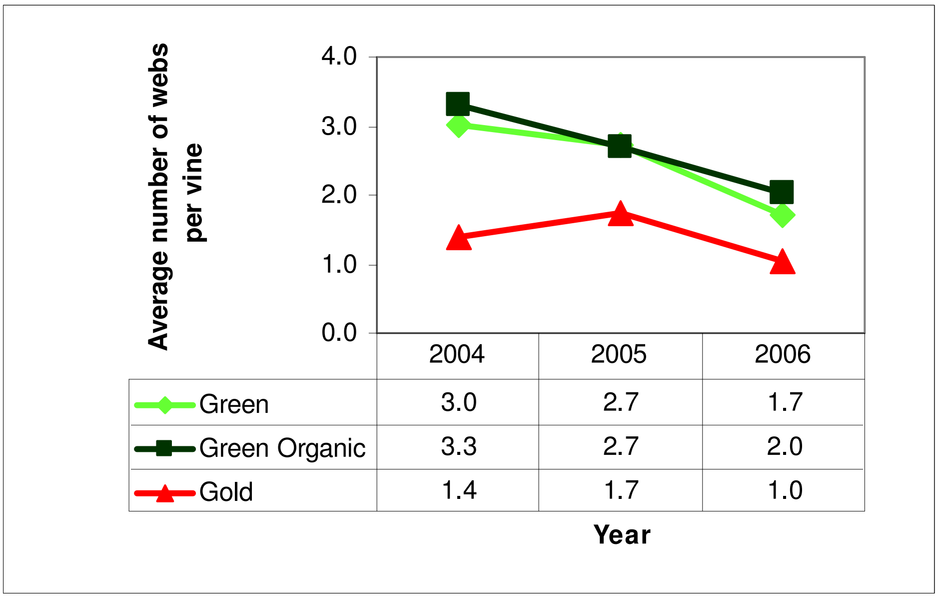
4.3. Macro-invertebrates (cicadas and spiders)

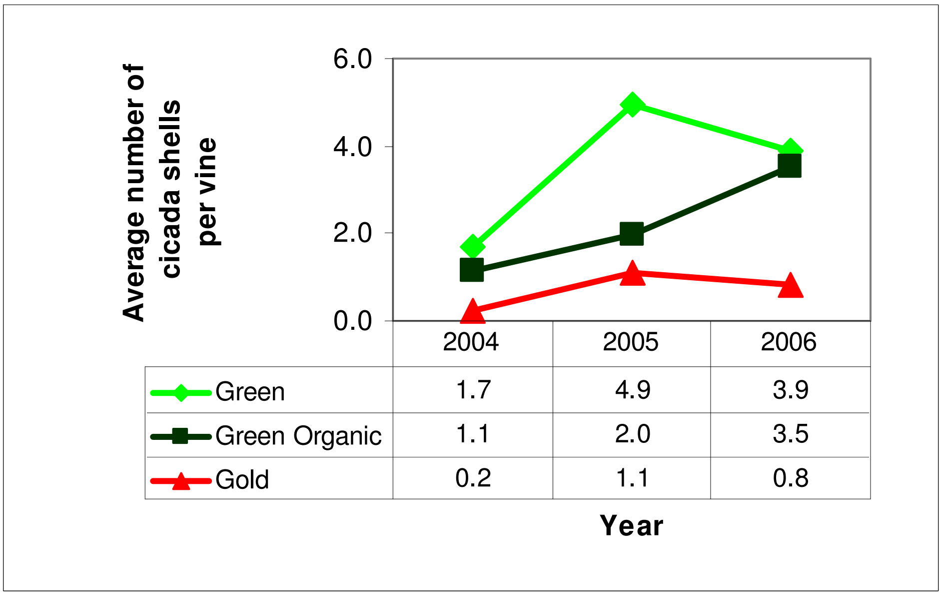
The amount of spider webs and cicada exuviae (shells) attached to vines in ARGOS orchards has now been determined over 3 consecutive years. This information could provide an indication of the dynamics of these macro-invertebrates and tell us something about the ecological state of orchard environments.

Gold has consistently contained fewer spider webs (an indication of the abundance of web-spinning spiders) with no difference between Green and Green Organic. There has been an overall decline in average web numbers across all three production systems.

On average, the most cicada shells have consistently been found in Green orchards and the least in Gold orchards. There has been an overall increase in the average number of shells across all three production systems.

Figure 9. Average numbers of spider webs (top) and cicada shells (bottom) per vine for Green, Organic and Gold orchards in ARGOS.





4.4. Soil quality

4.4.1. Introduction

Soil quality is highly sensitive to land management practices. Accordingly, monitoring soil quality is a key component of the environmental objective of ARGOS. The prime aims of this monitoring are to identify and characterise any differences in soil quality between agricultural sectors (e.g. kiwifruit, dairy, sheep and beef) and between different management systems.

In 2005, we reported the findings from the baseline sampling in 2004. Here we present some of the findings from our 2006 sampling which has been recently completed. At the time of writing this report, soil samples were still being analysed for some components. A full set of results will be available in due course.

4.4.2. Soil chemistry

Average data for both 2004 and 2006 is presented here to assess change over time.

2004 vs. 2006 (across all orchards)

- The following did not change significantly between 2004 and 2006: pH, Olsen P, potassium (K), sodium (Na), sulfur (S), P-retention, total base saturation (TBS), total nitrogen (N %) or total carbon (C %) (Table 3).
- CEC, calcium (ca), magnesium (Mg) and mineralisable N all increased significantly between 2004 and 2006.
- C: N ratio decreased significantly between 2004 and 2006, remaining at a level which favours the release of minerals from organic matter.
- Generally, the levels of cations and Olsen-P have been with the normal ranges specified for kiwifruit (calcium was slightly high in 2006).

Table 3. Average soil attributes in 2004 and 2006 of ARGOS orchards. Items in bold are significantly different between years ($P < 0.05$, paired t-test). A negative % change means the values has decreased. Normal ranges for kiwifruit are presented.

Attribute	2004	2006	% change
pH	6.5	6.5	0
Olsen P (ug/mL)	37.6	42.2	12
SO4-S (ug/g)	16.4	17.7	8
P-retention	64.8	63.2	-2
CEC (me/100g)	**16.7**	**20.4**	**22**
Calcium (me/100g)	**10.6**	**13.7**	**30**
Magnesium (me/100g)	**1.8**	**2.3**	**26**
Potassium (me/100g)	0.7	0.8	11
Sodium (me/100g)	0.1	0.1	-1
Mineralisable N (kg/ha)	**99.1**	**136.7**	**38**
Total base saturation (%)	78.7	81.9	4
N %	0.4	0.5	6
C %	5.5	5.4	0
C:N	**12.4**	**11.7**	-6

Normal ranges for kiwifruit (Source: R J Hill Laboratories Ltd)

Element	Unit	Range
pH		5.8 - 6.5
Olsen P	ug/mL	30 - 60
Potassium	me/100 g	0.60 - 1.20
Calcium	me/100 g	6.0 - 12.0
Magnesium	me/100 g	1.00 - 3.00
Sodium	me/100 g	0.00 - 0.40
CEC	me/100 g	12.0 - 25.0
Volume Weight	g/mL	0.60 - 1.00

Production systems

- In 2004 and 2006, Green Organic had the lowest Olsen P values and in 2004 the lowest Resin P value (Table 4). The resin P test provides a measure of the P available in reactive phosphate rock (RPR) which the Olsen P test doesn't account for. This result is likely to be a result of the lower amounts of P (including P from RPR) being added to the Green Organic orchards (see Figure 7).

- Gold has had the highest average Olsen P and Resin P values which is consistent with these orchards applying the most P in the past few years.
- In both years, Green Organic has had the lowers Sulphate-S (SO4-S) levels with the differences increasing in 2006. The much lower amounts of S added to these orchards (see Figure 7) will be contributing to this difference.
- In both years, Green Organic orchards on average have had the highest levels of CEC, cations, and total base saturation. The higher CEC is probably due to higher soil organic matter and this will be enhancing the soils ability to hold onto cations which might otherwise be leached. While fewer cations are added in the form of non-organic fertilisers to Organic orchards (see Figure 7), organic fertilisers will be contributing cations.
- Soil pH has not differed much between systems and on average, was identical for each production system between 2004 and 2006.
- Total N (N %) has been similar for all systems but potentially mineralisable N has been highest in Green Organic. This is a measure of the N which is potentially available from organic matter over a short time frame (1 – 2 months).
- Total carbon (C %) has been highest in Green Organic and lowest in Green. This is effectively a measure of the amount of organic carbon available and is directly proportional to the amount of soil organic matter (SOM). Green Organic orchards therefore contained the most SOM which is consistent with these orchards having the highest potentially mineralisable N.
- The ratio of C: N has been similar for all production systems (about 12) and at a level which favours the release of minerals from organic material (as opposed to immobilization).

Table 4. Average soil attributes for ARGOS Green, Green Organic and Gold orchards in 2004 and 2006.

	2004			2006		
Soil attribute	**Green**	**Green Organic**	**Gold**	**Green**	**Green Organic**	**Gold**
pH	6.5	6.7	6.4	6.5	6.7	6.4
SO4-S (ug/g)	16.8	14.5	18.2	17.7	14.5	20.8
CEC (me/100g)	16.2	17.5	16.5	19.0	21.5	20.6
Ca (me/100g)	10.4	11.9	9.7	12.8	15.3	13.0
Mg (me/100g)	1.7	2.0	1.8	2.1	2.5	2.2
K (me/100g)	0.7	0.8	0.7	0.7	0.9	0.8
Na (me/100g)	0.1	0.1	0.1	0.1	0.1	0.1
Total base sat (%)	79.3	84.6	73.3	82.2	86.9	76.9
P Retention (%)	63.7	66.5	66.5	62.0	64.5	63.4
Olsen P (ug/ml)	37.8	31.9	40.7	41.6	35.1	48.9
Resin P (mg/kg)		Not measured		103.8	95.3	133.7
N (%)	0.4	0.4	0.5	0.4	0.5	0.5
C (%)	5.2	5.6	5.6	5.1	5.8	5.5
Mineralisable N (kg/ha)	92.4	113.9	91.9	120.0	156.4	132.2
C:N ratio	12.3	12.5	12.2	11.7	11.8	11.6

Between-row vs. within-row zones (data not presented)

- Total carbon, potentially mineralisable nitrogen, and total nitrogen have all been higher between-row in both years. This is probably because of more organic matter (e.g. vegetation and pruning wood) in the between-row zones.
- CEC, calcium and sodium have been significantly higher between-row in both years. Higher organic matter in these zones would contribute to higher CEC and less leaching of cations like calcium.
- Olsen P has been significantly higher within-row in both years. The reason for this is unclear but perhaps the greater vegetation between-row (on average – data not shown) is utilising the P added there.

- Fertilisers are nearly always broadcast evenly across the orchard floor so differences in fertiliser placement probably do not account for the above differences.

4.4.3. Soil structure (visual soil assessments)

Soil structure was assessed visually in both 2004 and 2006. Soil porosity, aggregation and discolouration were scored on an ordinal scale of 1 (very good) to 4 (poor). For consistency, the assessments were carried out by the same person each time using a standardised sampling procedure and visual key.

Specific data is not presented as it is difficult to present clearly and to interpret. However, some preliminary observations from the data are below.

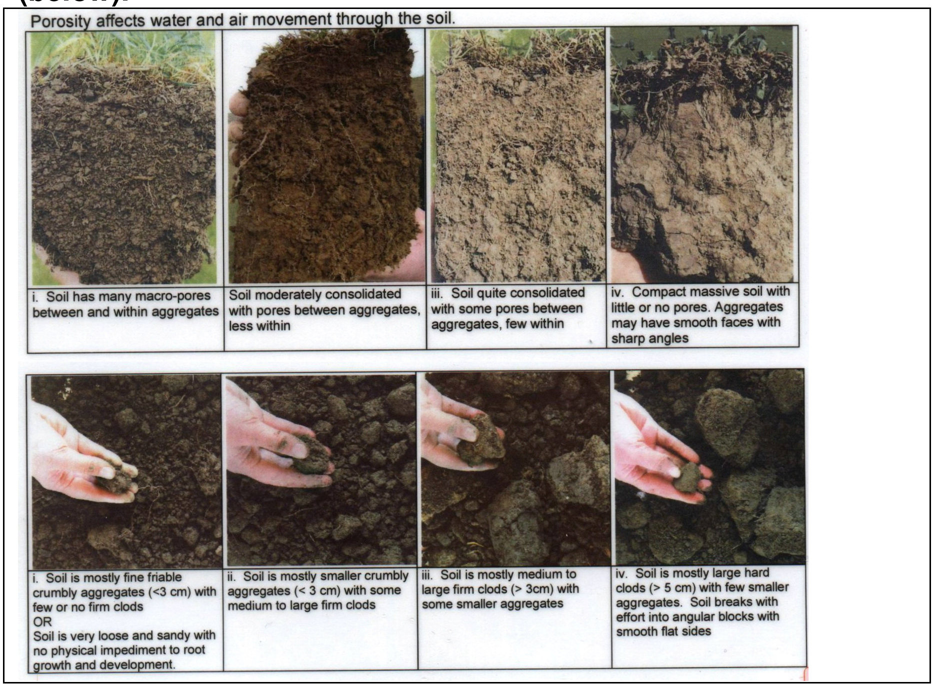
Comparison of production systems:

- For all production systems, soil aggregation and porosity in 2006 was similar to that in 2004 although aggregation seems to have deteriorated slightly in the alleyways probably as a result of continued traffic there.
- Green Organic orchards have had better soil structure, especially porosity, than Green and Gold orchards.
- Green orchards have had better soil structure, especially aggregation, than Gold orchards.
- No discolouration (mottling) was observed anywhere.

Within–row vs. between-row zones:

- Soil aggregation and porosity has been more favourable within-row (under the leaders) compared to between-row (middle of alleyways). This is likely to be a consequence of less traffic under the leaders.
- In the alleyways, soil porosity has not changed much. Under the leaders, soil aggregation and porosity seems to have improved between 2004 and 2006. The reasons for this are unclear.

Score cards used in the field to assess soil porosity (top) and aggregation (below).



4.4.4. Soil microbial activity

In 2004, the microbial biomass carbon and basal respiration of soil samples was determined and on average, highest in Green Organic and lowest in Green. These same measures are currently being carried out on the 2006 soil samples and will be reported elsewhere.

4.4.5. Earthworms

The average number of earthworms, per square metre, increased between 2004 and 2006 for Green and Green Organic but decreased slightly for Gold. The overall effect is a slight increase in density for kiwifruit. A comparison of systems reveals:

- In both years, Green Organic orchards on average contained significantly more earthworms than Gold orchards and in 2006, significantly more than Green orchards (Figure 10).
- Earthworm numbers did not differ significantly between Green and Gold in 2004 or 2006.
- On average, significantly more earthworms were found in the alleyway than under the leader in both 2004 and 2006 (Figure 11). This is likely to be the result of more organic matter returned to the soil in the alleyways. Herbicide use on some orchards under the leader would reduce organic matter there.

The number of earthworms in ARGOS pastoral sectors has been found to be about 5 times more than in kiwifruit (Figure 12).

Examples of introduced earthworm species found in ARGOS kiwifruit orchards.

1. *Octolasion cyaneum*

2. *Eisenia foetida* (tiger worm)

(Source: http://soilbugs.massey.ac.nz/oligochaeta.php)

Figure 10. Average numbers of earthworms found in ARGOS kiwifruit orchards. Within each year, bars with letters in common are not significantly different (P<0.05).

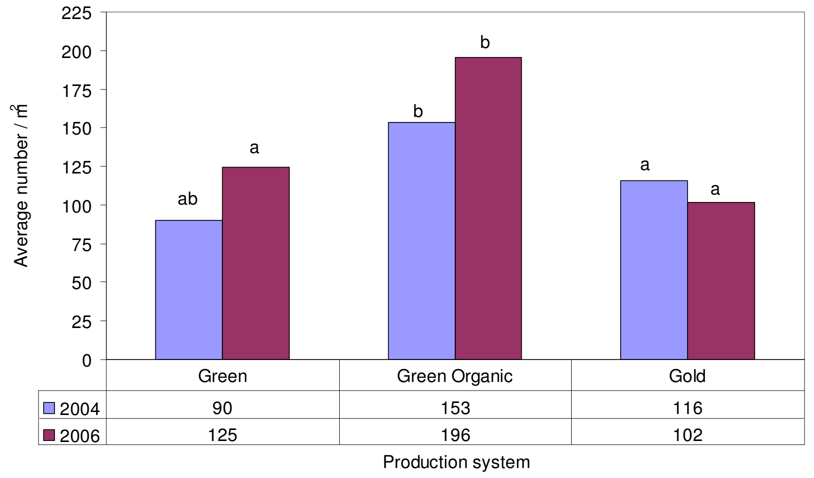


Figure 11. Average numbers of earthworms in ARGOS kiwifruit orchards within-row (WR, under the leader) and between-row (BR, alleyway). Within each year, the differences are significant (P<0.05).

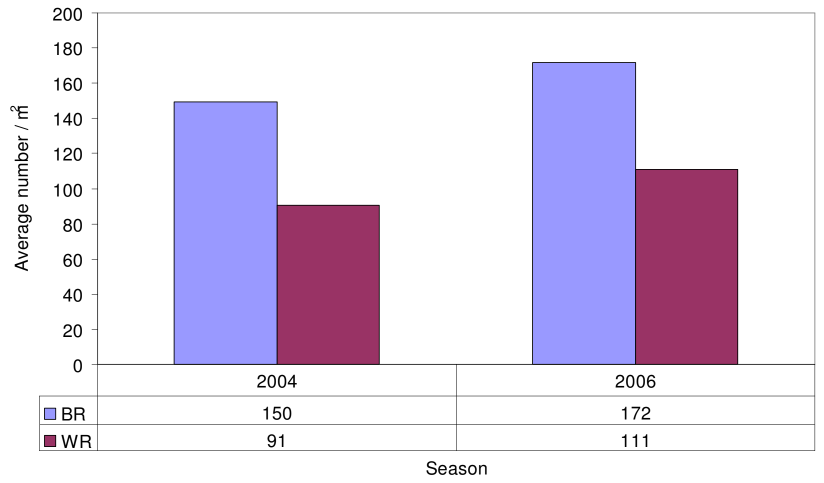
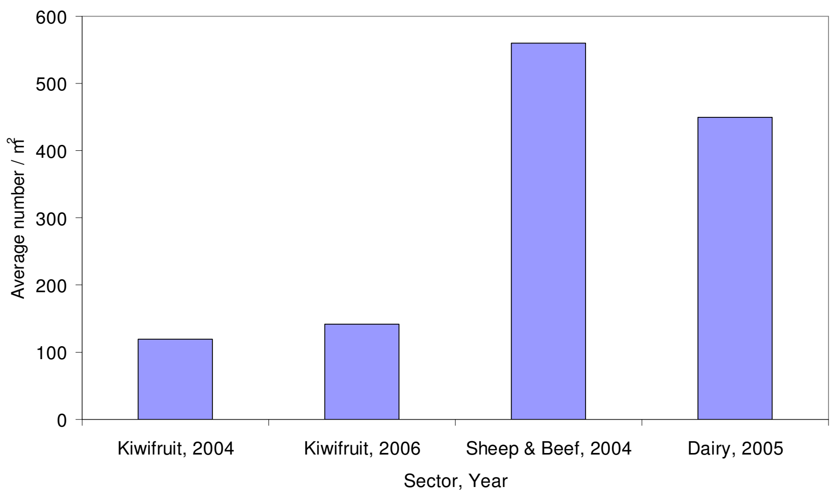


Figure 12. Average number of earthworms (per m^2) found in each of the ARGOS sectors.



4.4.6. Nematodes

In 2004, Sarah Richards, a master's student from the University of Otago, undertook a survey of nematodes on ARGOS orchards in the Bay of Plenty. The main findings from Sarah's work are below (taken from ARGOS Research Note 15). Soil nematodes are probably not practical indicators of soil quality because they are not easy to measure and may be expensive. They are also not widely recognisable to growers. Other indicators of soil quality would be more preferable.

"The composition of nematode feeding groups was similar across the three orchard systems. Most nematodes were bacterial-feeders and plant-feeders. Omnivorous nematodes made a higher contribution to overall nematode assemblages in organic orchards.

Exploration of relationships between the nematode assemblages and other soil properties measured by ARGOS at each site revealed a positive relationship between plant-feeding nematodes and soil moisture content, and a negative relationship between these nematodes and soil bulk density and potassium levels. These findings indicate that soil nematode assemblages and soil properties are related to each other."

Nematode (*Helicotylenchus* sp.) at 40x magnification

4.4.7. Soil invertebrates

In 2005, Kate Hewson, an Honours Student from the University of Otago, undertook a bioassay of soil biological activity using bait lamina probes. The results of this work are summarised in the following taken from Kate's dissertation.

"Sustainable farming systems depend on maintaining or enhancing soil health. The main part of this study evaluated the bait lamina test as a bioassay of soil biological activity for monitoring long term trends in soil health and to compare soil biota between 30 certified organic and Integrated Management (IM) kiwifruit (*Actinidia deliciosa* and *A. chinensis*) orchards in the Bay of Plenty, in January and February 2005. A secondary and smaller scale study compared soil biological activity close to kiwifruit shelterbelts and on the edges and middle of blocks of kiwifruit vines.

Baits in lamina probes inserted 80 mm into the soil were removed extremely quickly (99% gone in five days) and a coating of compressed soil prevented scoring bait removal on many probes. Consequent bait exhaustion and missing values meant there was low power to detect differences between orchard management systems and zones (within-row and between-row) within orchards.

There was no evidence that organic or IM orchards had different overall average rates of bait removal, but organic orchards had slightly faster bait removal approximately 80 mm below the surface than had IM soils. Although this difference was highly statistically significant ($p<0.001$), it is doubtful that it is ecologically important except as a potential indicator of increased soil biological activity at greater depths (>80 mm).

There was no evidence that soil biological activity was different along the vine lines compared to in the alleyways between the vine lines.

Increased soil biological activity correlated with increased soil aggregation ($p<0.001$), increased soil moisture ($p<0.05$) and increased soil phosphorus levels ($p<0.05$). There was no evidence of co-variation in soil biological activity and soil porosity, bulk density, pH, potassium, magnesium, calcium, sodium, cation exchange capacity, soil carbon, nematode abundance, microbial biomass or earthworm abundance.

Soil biological activity was much reduced at the very edge of orchard shelterbelts. Particularly low activity at shelterbelts running north to south may indicate the reduced exposure of the shelterbelt to rainfall that occurred during sampling. There was no evidence that soil biological activity is any different on the edges of kiwifruit vine blocks compared to in the middle of blocks.

The lamina bait test is inexpensive, rapid and repeatable. High statistical power can be achieved from the extensive replication possible, but its primary disadvantage is that it can not inform researchers on what is removing the baits. The experiments described here must be repeated over much shorter time periods and at deeper levels in the soil before optimum long term soil health monitoring protocols can be designed."

Bait lamina probe used to bioassay soil biology.

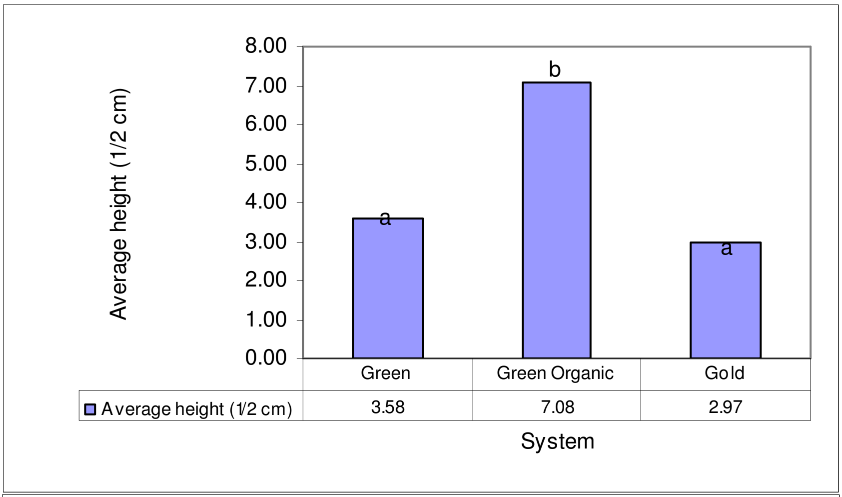
4.5. Orchard floor vegetation

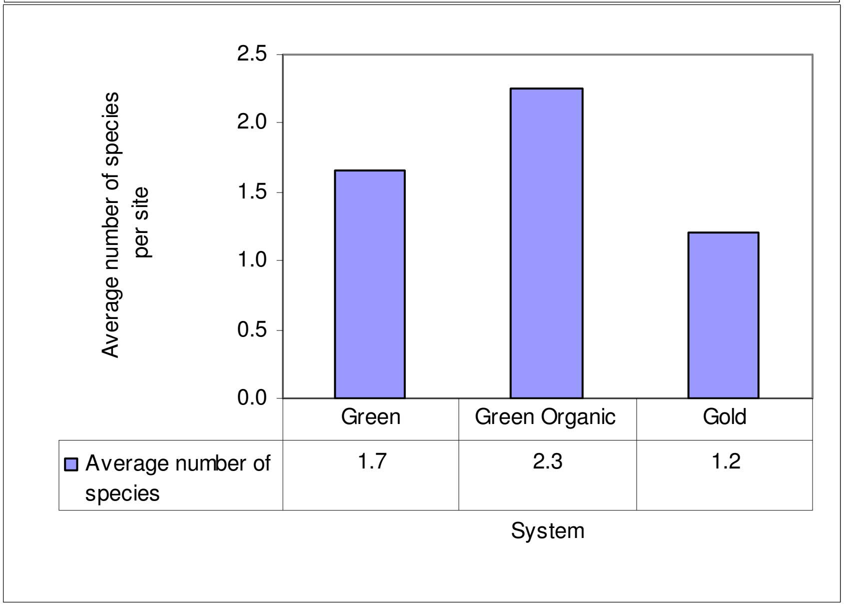
In the summer of 2006 the orchard understorey in ARGOS orchards was surveyed for species composition and abundance. Such information could help to explain differences in soil quality.

The average height of sward (which was measured using a rising plate meter) was found to be significantly highest in the Organic orchards with no difference between the Green and Gold orchards (Figure 13, top). The average number of species was highest in the organic orchards (Figure 13, bottom) but the difference was small. Excluding bare ground which on average occupied 41% of the surveyed sites, grass was the most predominant element under all management systems (30%); buttercup (8%) and clover (5%) were the next most abundant species.

The between-row (alleyway) and within-row (under the leader) zones were compared and the average sward height was higher within-row. This was driven largely by markedly higher sward within-row on the organic orchards, a feature which is likely to be a reflection of less sward control there i.e. infrequent mowing and absence of herbicide. Sward height did not differ significantly between zones on the Green and Gold orchards. On average, there were more species found between-row (2.0) compared to within-row (1.4). The statistical significance of differences in species numbers has not yet been determined.

Figure 13. Average orchard sward height (top) and average number of species (bottom) for Green, Green Organic and Gold orchards in the ARGOS programme. For sward height, bars with the same letter are not significantly different (P < 0.05).





4.6. Spring canopy assessments 2005

In the spring of 2005, various canopy characteristics were surveyed on the 30 ARGOS orchards in the Bay of Plenty. The purpose of this was to get a feel for the canopy characteristics which contribute to differences in production between systems.

The amount of budbreak and number of flowers buds (Table 5) differed significantly between management systems which was expected given differences in the use of budbreak enhancers and the inherent differences between the Hort16A and Hayward varieties. On average, the number of winter buds did not differ significantly between Green and Green Organic orchards but was significantly higher in the Gold orchards. There was no noticeable difference in the length of wood available on each orchard and so the higher density of winter buds in Gold orchards must have been due to shorter internode lengths i.e. the distance between buds. Note - the quality of wood (e.g. cane diameter, position) and buds was not surveyed here.

Table 5. Average canopy characteristics for Green, Green Organic and Gold ARGOS orchards in the Spring of 2005. Within each row, values with the same letter are not significantly different (P< 0.05).

Attribute	Gold	Green	Green Organic
Metres of 1 year old wood per m^2	1.6 a	1.8 a	2.0 a
Metres of 2+ year old wood per m^2	1.0 a	1.0 a	0.8 a
Number of winter buds per m^2	42 a	31 b	32 b
% budbreak	74 a	46 b	37c
Number of flower buds per m^2	57 a	40 b	27 c
Number of flower buds per winter bud	1.4 a	1.3 a	0.9 b

4.7. Spring canopy characteristics vs. yield

The previous canopy attributes were considered together in a linear multiple regression analysis in an attempt to explain variation in average yield (Class I trays/ha). When each attribute was considered separately, the number of flower buds and % budbreak significantly explained about 41% and 47% respectively of the total variation in average yield across all sampled orchards (predicted versus actual values are shown in Figure 14). When all possible combinations of attributes were analysed, there was no significant improvement in the amount of variation explained. The unexplained variation will have been due to factors like pollination, fruit thinning/culling, natural attrition, and losses during harvest and packing.

When each production system was considered separately, canopy attributes were generally poor at explaining variation in average yields for Green and Gold (all combinations were tested). However, for Green Organic orchards, the number of flower buds, length of 1-year wood and length of older wood together explained 81% of the variation in average yield (predicted versus actual values are shown in Figure 15). Alone, each of these factors was poor at explaining the variation in average yield for Green Organic. These results imply that other factors which may affect final Class I yield, like pollination and fruit losses, were not a major influence for Green Organic in the 2005/06 season. On the other hand, they were for Green and Gold.

Figure 14. Relationship between actual and predicted average yield (Class 1 trays/ha) for all orchards sampled in the 2005/06 season. Predictors are number of flower buds (left) and % budbreak (right).

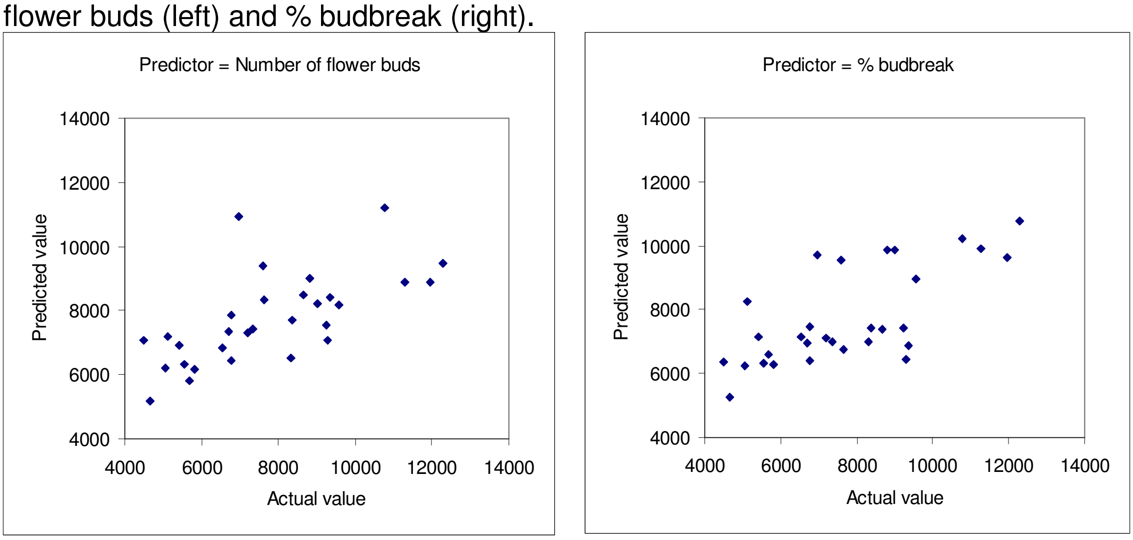
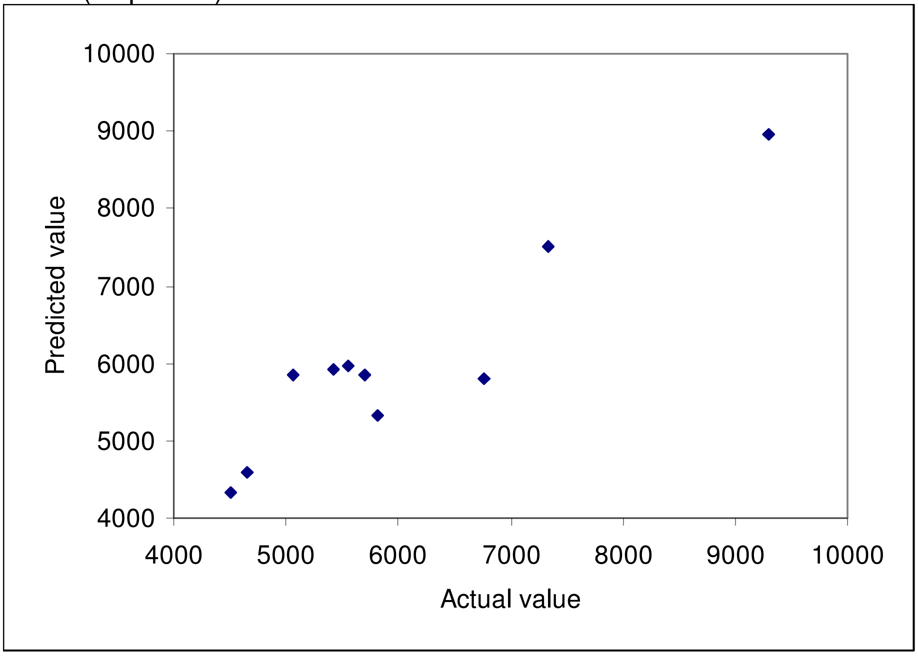


Figure 15. Relationship between actual and predicted average yield (Class 1 trays/ha) for Green Organic orchards sampled in the 2005/06 season. Predictor variable(s) = number of flower buds, length of 1-year old wood and length of older wood (all per m^2).



4.8. Analysis of shelterbelts on orchards

Species composition and stature of shelter on the ARGOS orchards was compared using data collected during the baseline habitat survey in 2004. Shelterbelts protect fruit and vines from wind damage that would otherwise reduce yield and fruit quality. They also affect the microclimate in orchards and occupy space that could be used for fruit production. Not surprisingly, shelterbelts around the perimeter of orchards were found to be more substantive than internal shelterbelts. The predominant shelter species (*Cryptomeria japonica*, *Casuarina* spp and *Salix* spp.) were similar between the Green, Green Organic and Gold orchards, but shelterbelts in Organic orchards had a greater diversity of woody incidental species, less accumulation of dense litter beds and more rank grass.

Shelterbelts harbour incipient weed threats, but also provide potentially important refuges for maintaining biodiversity on orchards. Some orchardists have removed shelterbelts or replaced them with wind-cloth screens, partly to increase fruit dry matter by reducing shade.

There was no evidence that the stature and porosity of shelterbelts differed between Organic and KiwiGreen systems, so shelter is unlikely to be driving differences in mean fruit production, fruit quality and animal diversity and abundance between orchard systems.

5. Economics

5.1. Introduction

The economic objective of ARGOS focuses on the relationship between agricultural markets and resource allocation in New Zealand. The economic research is, therefore, undertaken at two levels: the global market (and its impacts on New Zealand agriculture), and the operations of the ARGOS farms. At the farm or orchard level, researchers have now collected financial accounts for three consecutive years (2002/03, 2003/04 and 2004/05). Each year's data have been analysed to provide information to ARGOS farmers and to compare the performance of these farms with regional and industry benchmarks. This data is also being analysed to determine trends over time, as well as systematic differences amongst farms. The results to date are presented below.

ARGOS has used a similar template to that used by the Ministry of Agriculture and Fisheries (MAF) for presenting its financial data. More detailed MAF Farm Monitoring data can be downloaded from the MAF Website (**www.maf.govt.nz**) or obtained from your Field Manager.

5.2. Global economic analyses

The research on global markets and their impacts on New Zealand agriculture have involved several components in the last year. The reviews from previous years have allowed the economic researchers to use the updated Lincoln Trade and Environment Model (LTEM) to analyse several international developments. One set of analyses has focused on the potential impacts of Single Farm Payments in Europe. The parameters of these payments have been set by the European authorities, but countries and smaller jurisdictions have some leeway in how they meet the regulations. The trade analysis has examined how different methods of implementing Single Farm Payments could affect New Zealand. A second set of analyses has examined the impacts on New Zealand and Europe of China's accession to the WTO, and subsequent patterns of liberalisation.

5.3. Food miles

Major research undertaken by the Agribusiness and Economics Research Unit (AERU) at Lincoln University with ties to the ARGOS programme has been on the issue of food miles. 'Food miles' is defined as the distance that food has to travel from farm to fork. The idea that consumers should prefer locally-produced food to food that has travelled thousands of miles is gaining some traction in the US, the UK, and Europe. It is becoming an important, although emotive, issue in these areas. On the face of it, the issue could be quite damaging for New Zealand, because its exports travel long distances to almost all overseas markets. However, the concept has a fundamental flaw. It addresses only the energy consumption and pollution associated with transporting food, but neglects the energy use and pollution of its production. New Zealand production of pastoral products is essential solar-based as extensive pastures capture solar energy and provide feed for livestock. By contrast, a feedlot system or an intensive pasture system relies more heavily on other inputs, such as large amounts of petroleum-based nitrogen, to produce meat and milk. Careful analysis of total energy use in agriculture (as published in a recent AERU research report) has found that New Zealand's total energy use in producing key exports is lower than in UK agriculture, even accounting for the costs of transporting the commodities to the UK.

5.4. Financial performance of ARGOS orchards

On a per hectare basis, the average yield for Green has been consistently more than Green Organic (Figure 16) with the differences being statistically significant in recent years. Despite this, the average orchard gate return for Green has only been slightly higher and not statistically different. This is because the difference in yield has been offset by a higher OGR/tray for Green Organic i.e. $1.25, $2.34 and $1.63 in the 2002/03, 2003/04 and 2004/05 financial years respectively. The Industry average for Green Organic was about $2.00/tray more for the 2002 – 2005 period according to recent ZESPRI Annual Reports.

The average cash orchard expenditure (COE) for Green has been consistently higher than Green Organic but the differences have not been statistically significant. This with only a slightly higher OGR means little difference in average operating surplus per hectare (i.e. net OGR).

On average, Gold has consistently incurred greater operating expenditure (statistically significant) than Green and Green Organic, a reflection of the greater attention needed by this crop. While initially this was not matched by significantly greater OGR, in the most recent year we analysed (2004/05), the average yield almost doubled which resulted in a much larger OGR (on a per hectare basis). This doubling is driven by dramatic increases for just a few of the Gold orchards.

Trends in categories of operating expenditure are shown in Figure 17. The main trends in the average data are:

- The higher average cash orchard expenditure for Green compared to Green Organic can be largely attributed to consistently higher labour cost (about 3,500/ha annually). Green has also had higher spray and chemical, pollination, and repairs and maintenance costs. Only vehicle costs have been consistently lower in Green. Fertiliser cost has been similar. The end result is a higher average cash operating expenditure (COE) for Green, as mentioned earlier.
- The higher average cash orchard expenditure for Gold compared to Green and Green Organic can be largely attributed to consistently much higher labour cost i.e. $5,200 more than Green and $8,700 more than Green Organic each year. Fertiliser and vehicle costs are other items which tended to be higher in Gold. Green pollination and repairs and maintenance have tended to be slightly higher than in Gold.
- While there are a number of consistent differences in the main expenditure categories, these are generally not statistically significant. The exception being labour for Gold which has been much higher than both Green and Green Organic.

Notes for interpreting cash orchard expenditure:

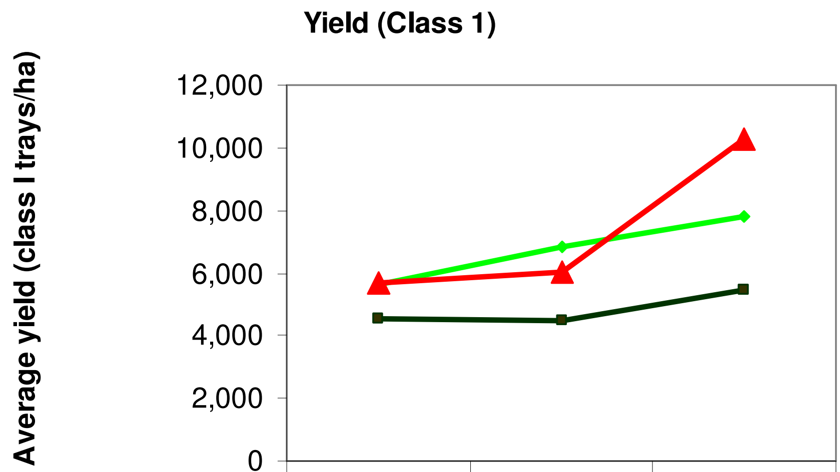
1. Artificial shelter has been excluded as it can severely distort cash operating expenditure. Instead, it has been categorised as 'Capital expenditure' which will be analysed in future work.
2. T-bar to pergola conversion and structure repairs (e.g. Agbeaming) has been included in 'Repairs and maintenance'.

A full budget for the 2004/05 financial year with average and median data for Green, Green Organic and Gold orchard in the ARGOS programme is available in Figure 18.

Figure 16. Trends in recent average yields (Class I), orchard gate return (OGR), cash operating expenditure (COE), and net OGR (OGR – COE) for Green, Green Organic and Gold ARGOS orchards, on a per hectare basis.

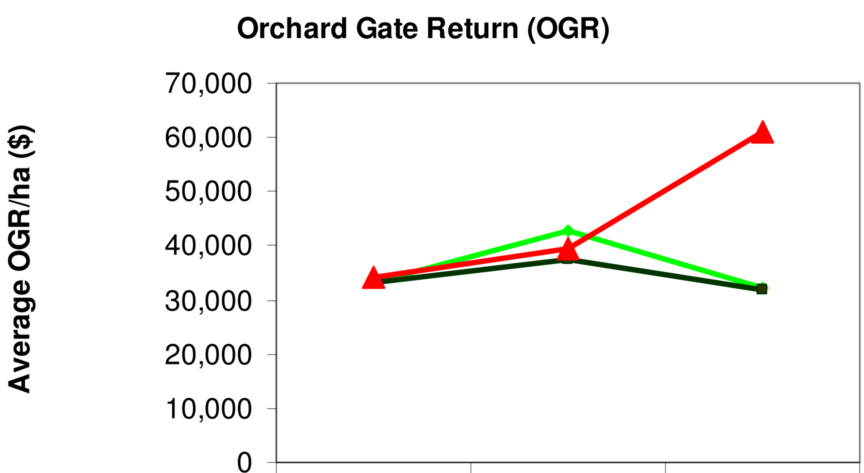
Notes for interpreting the following graphs:

- The yield data here may differ to earlier yield data as not all orchards may have been included here.
- OGR in a given financial year consists mainly of progress payments for the crop harvested in that financial year as well as final payments for the crop harvested in the previous financial year.
- Unlike OGR, the yield shown for a given financial year is for one crop i.e. the crop harvested in May of that financial year. This drives most of the OGR in a given financial year.
- The Gold averages below are derived from only 6 or 7 of the 12 orchards as financial data was not available for the others.



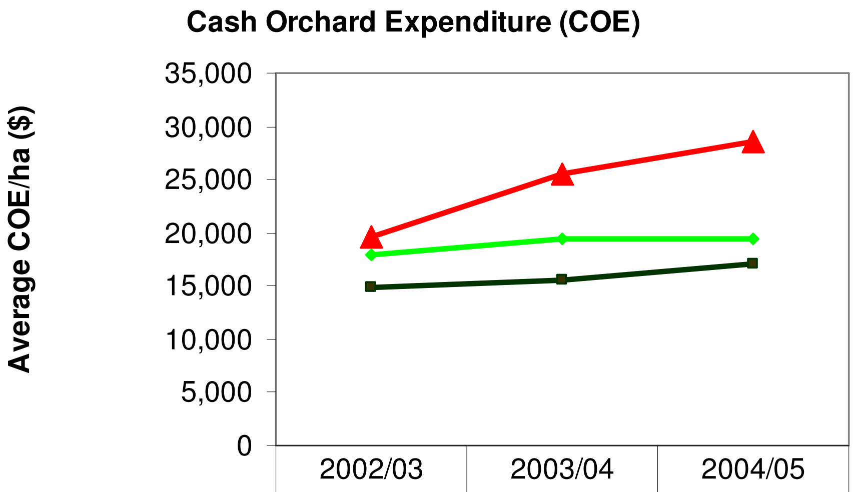
	2002/03	2003/04	2004/05
Green	5,628	6,819	7,829
Green Organic	4,554	4,480	5,438
Gold	5,678	6,018	10,303

Financial Year



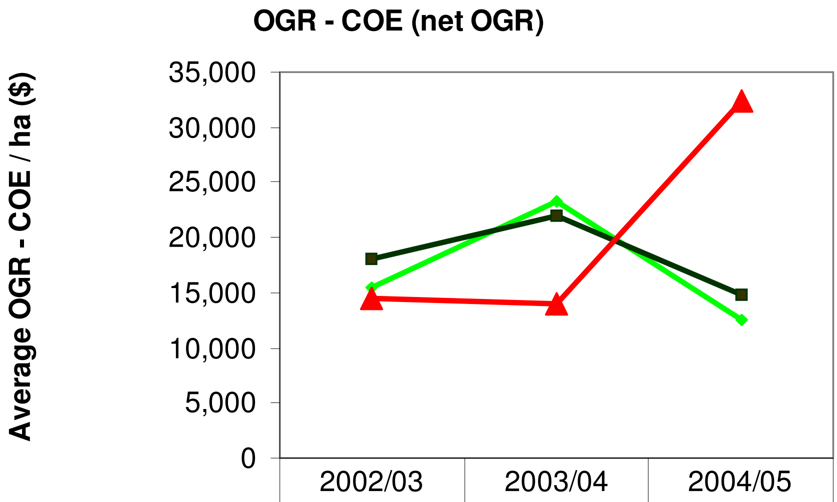
	2002/03	2003/04	2004/05
Green	33,304	42,638	32,063
Green Organic	33,018	37,588	31,899
Gold	34,183	39,450	60,914

Financial Year



	2002/03	2003/04	2004/05
Green	17,842	19,361	19,467
Green Organic	14,887	15,582	17,017
Gold	19,668	25,475	28,581

Financial Year



	2002/03	2003/04	2004/05
Green	15,462	23,277	12,596
Green Organic	18,130	22,006	14,883
Gold	14,515	13,975	32,333

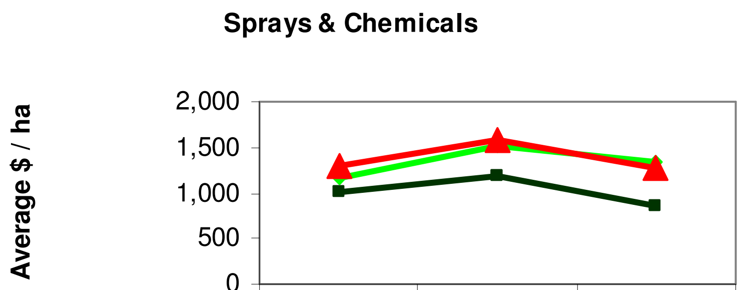
Financial Year

With some financial indicators, there are large differences between orchards within each production system which are not represented in the previous graphs of averages. Variation between orchards in OGR and COE is illustrated in Appendix 6 and Appendix 7 respectively.

Figure 17. Trends in the recent average costs of major operating categories for Green, Gold and Green Organic ARGOS orchards.

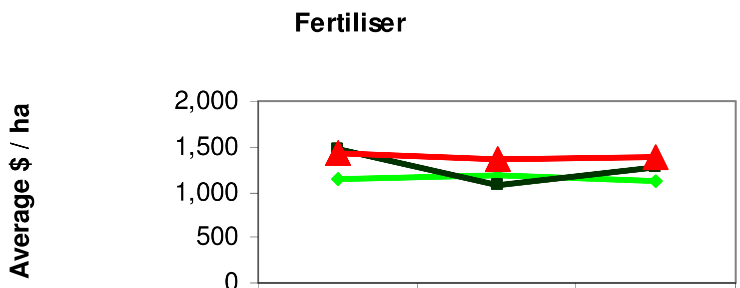
	2002/03	2003/04	2004/05
Green	9,138	9,848	10,483
Green Organic	5,358	6,392	6,880
Gold	12,386	14,749	17,720

Financial year



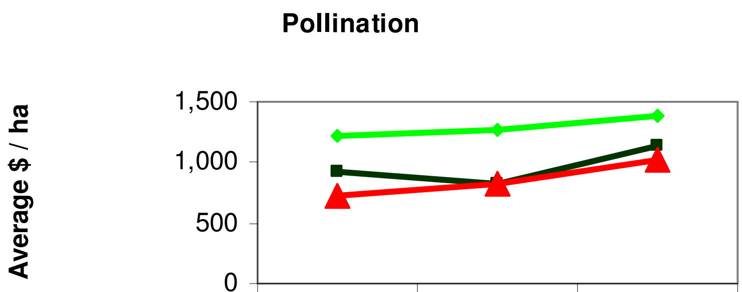
	2002/03	2003/04	2004/05
Green	1,173	1,520	1,347
Green Organic	1,019	1,176	860
Gold	1,292	1,581	1,274

Financial year

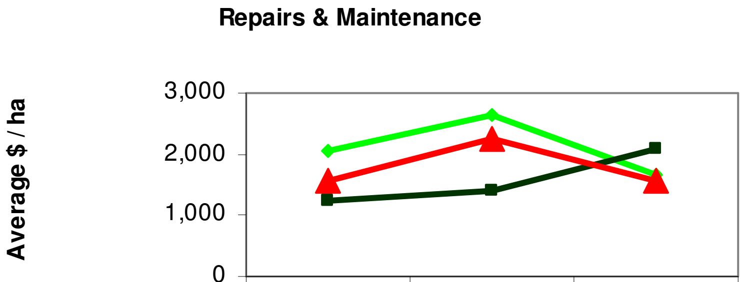


	2002/03	2003/04	2004/05
Green	1,151	1,196	1,119
Green Organic	1,467	1,069	1,278
Gold	1,421	1,357	1,389

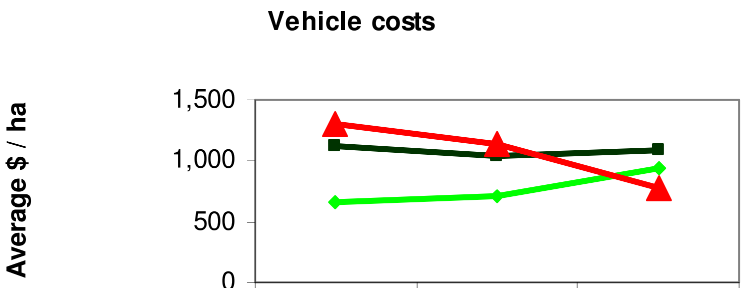
Financial year



	2002/03	2003/04	2004/05
Green	1,215	1,261	1,381
Green Organic	925	816	1,137
Gold	733	820	1,026



	2002/03	2003/04	2004/05
Green	2,051	2,635	1,678
Green Organic	1,224	1,409	2,082
Gold	1,570	2,249	1,551



	2002/03	2003/04	2004/05
Green	653	712	934
Green Organic	1,114	1,036	1,095
Gold	1,297	1,130	778

Figure 18. Average 2004/05 financial data for Green, Green Organic and Gold orchards in the ARGOS programme, on a per hectare basis.

Key Performance Indicators

MAF figures are based on a model farm consisting of 4.5 ha Green and 0.5 hectares Gold.
Average data for Gold is based an 6 Gold orchards only - the other orchards contain Green and data not available by variety.

ARGOS averages ($ / ha)	Green			Green Organic			Gold		
	2003/04	2004/05	% change	2003/04	2004/05	% change	2003/04	2004/05	% change
Gross Orchard Revenue (GOR)	42,708	32,884	-23.0%	37,252	31,782	-14.7%	39740	61456	54.6%
Cash Orchard Expenditure (COE)	19,361	19,467	0.5%	15,582	17,017	9.2%	25475	27736	8.9%
Operating Surplus (GOR-COE)	23,348	13,417	-42.5%	21,670	14,766	-31.9%	14265	33720	136.4%
COE / GOR	45.3%	59.2%	n/a	41.8%	53.5%	n/a	64.1%	45.1%	n/a

Details for the 2004/05 Financial Year ($ / ha)

	Green		Green Organic		Gold		MAF 04/05
	Average	**Median**	**Average**	**Median**	**Average**	**Median**	**Average**
Canopy Hectares	3.8	3.7	3.8	3.6	2.8	2.5	4.5 green /0.5 gold
Export trays/ha	7,829	8,423	5,438	5,775	10,110	9,350	7385 green/9800 gold
Revenue							
Green - OGR progress	29,510	29,772	29,574	31,295	0	0	28,432
- previous crop final	2,553	2,404	2,325	2,350	0	0	2,304
Gold - OGR progress	0	0	0	0	58,389	50,740	0
- previous crop final	0	0	0	0	2,525	2,465	3,976
Other fruit crops	0	0	0	0	0	0	660
Rebates/hire	822	22	428	0	542	0	654
Gross Orchard Revenue	**32,884**	**32,343**	**31,782**	**34,834**	**61,456**	**57,002**	**34,206**
Expenditure							
Wages							
Wages	7,871	7,433	5,058	4,363	14,440	13,060	11,100
Picking Wages	2,378	2,591	1,488	1,584	3,153	3,001	2,288
ACC	233	113	330	318	127	143	520
	10,483	10,138	6,875	6,264	17,720	16,204	13,908
Spray & Chemicals	1,347	1,200	860	600	1,274	1,283	1,370
Pollination	1,381	1,280	1,137	852	1,026	843	1,290
Fertiliser	1,119	1,043	1,278	929	1,389	1,433	1,160
Vehicle cost	934	871	1,095	962	778	512	1,600
Repairs & Maintenance	1,678	1,016	2,082	725	1,551	1,020	2,600
Admin & Other							
Electricity	170	91	171	166	163	83	185
Rates	544	498	510	407	273	167	650
Communication costs	167	118	212	190	240	227	480
Insurance	273	297	222	213	245	245	395
Accountancy	509	434	390	395	301	318	660
Legal & consultancy	38	0	327	119	233	134	220
Other admin	167	162	485	548	603	197	190
Other expenditure	448	300	969	481	1,397	675	360
	2,317	1,901	3,286	2,519	3,456	2,046	3,140
Cash Operating Expenditure	**19,467**	**21,783**	**17,017**	**16,557**	**27,736**	**24,024**	**25,068**

Note that averages DO NOT sum due to appropiate measures taken for missing values.

6. The orchardists (social research)

6.1. Introduction

Improving the sustainability of farming involves social, as well as economic and environmental, dimensions. For example, while it is possible to assess the relative viability of farm incomes, the earning potential of a given farm household may reflect issues of succession, retirement objectives, ethical decisions or pressures exerted by family or society more generally. Similarly, whereas the promotion of more bio-diverse farmscapes may appear to involve relatively straight forward decisions regarding resource management, the influence of shared ideas of appropriate farm management or the availability of sufficient skills and labour may limit the feasibility of such decisions. The social research component of the ARGOS programme is designed to examine a range of social features, including those identified above, that have been shown to impact the way in which farmers approach farm management and engage with issues of sustainability.

In last year's report, we presented a summary of the findings from the first qualitative interview that was conducted in 2004 – this consisted of open questions covering topics like vision, goals and constraints. A description of the types of orchardists has since emerged out of this piece of work and is presented here. The second qualitative interview, carried out at the end of 2005, focussed on constraints and the results of this are presented here. In addition, the results of the 2005 quantitative survey (postal questionnaire) are presented here as well as results of a causal mapping interview. In 2006, the ARGOS orchardists were asked what they thought about the Taste ZESPRI™ incentive programme and the results are presented here.

Through the analysis of the participants' responses to our social research, we expect to become more informed about the limitations to an ideal system that orchardists experience as well as factors that enable and sustain their existing management practices. This research contributes to our growing understanding of the multifaceted aspects of social sustainability—as well as sustainability more broadly—within the kiwifruit sector.

6.2. Types of kiwifruit orchardists

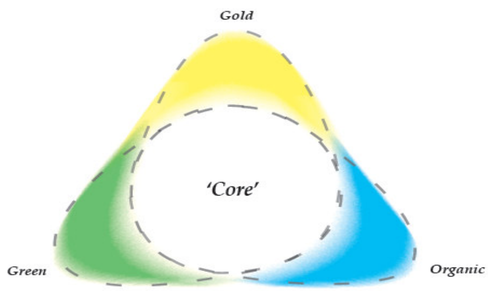
The following description of orchardists has since emerged from the first qualitative survey (copied directly from ARGOS Research Note No. 8 which was prepared by Lesley Hunt).

"During 2004, 35 kiwifruit participants were interviewed (11 KiwiGreen Hayward - Green, 12 organic Hayward - Organic, 12 KiwiGreen Hort 16A - Gold). Using their responses we formed a profile of a typical kiwifruit orchardist (the 'core'), and then differentiated between Green, Organic and Gold to form different types of orchardist (Figure 19). These types, based on ARGOS data only, should not be generalised across the kiwifruit sector. They do not represent the best orchardist nor would any single person have all the characteristics of a type. Types are a useful way of comparing those who practice different systems and could be used, for example, to tailor communication and learning to appeal to different types. This work is ongoing and will be added to as the ARGOS programme continues.

The typical orchardist

The typical orchardist is a male who purchased his orchard with capital obtained in past employment. He does some mowing, pruning and/or spraying, as well as keeping the books and organising labour, contractors and consultants. Contracted labour is often used for pruning, spraying, fertilising and harvesting. On-orchard work gives him a knowledge and awareness of the orchard environment. He feels confident about his orchard management. Financial viability is a major goal alongside a concern about the environmental impact of his practices. Constraints come from factors relating to the impact of the physical environment on yield, finances, and industry through its marketing, limiting management options and increasing bookwork. Risk is managed by mitigating the impact of frost, wind and spray drift and by having alternative sources of income. The orchard supports the community by providing many employment opportunities. A primary motivation for being an orchardist is lifestyle. It is seen as ‘family friendly’. The typical orchardist enjoys his work – being outside and engaging in physical work – and the autonomy of self-employment. This lifestyle is felt to be under threat from urban-oriented values. Non-orcharding neighbours are perceived to lack understanding and acceptance of standard orchard practices. Orcharding neighbours are seen to be the source of useful feedback and comparisons. The typical orchardist links environmental health to birds’ presence, the limited use of orchard sprays and soil health. He routinely relies on tests and recommendations from consultants and/or packhouse employees.

Figure 19. Orchardist types.



The typical Green orchardist
The Green orchardist is most like the typical orchardist, is content with his situation and is confident about his management practices. He considers KiwiGreen practices to be ‘environmentally friendly’, but is concerned about the impact of hydrogen cyanamide (e.g., Hicane™) on health. He relies on established production methods for kiwifruit, rarely engages in experimentation nor sees the need for further capital investment in the orchard. The typical Green orchardist likes a tidy orchard and takes a pride in it, seeing a tidy orchard as a way of managing risk, an indicator of environmental health, or providing feedback that his management practices are correct. Threats to production are thought to originate from factors outside the direct control of the orchardist, for example, the climate, or the bush gullies. For the Green orchardist, the orchard is often seen as a way of managing an ‘active’ retirement in which the work he does can be slowly decreased and replaced by contractors or a manager while he can continue to live on the property. There is a sense in which he (along with the Organic orchardist) is ‘here to stay’.

The typical Organic orchardist
The Organic orchardist practices a philosophy of looking after the environment that surpasses good management practices and incorporates broader ideals about stewardship of the land. He wishes to create a ‘haven’ on his orchard which benefits, not only him, his family and neighbours, but also animals, both wild and domestic. He links his sense of wellbeing closely to his enjoyment of his orchard. The limited management tools he can use as an organic grower are seen as constraining. An Organic orchardist is more prepared to admit to having problems with his orchard management practices. He is less confident, complaining that there is inadequate

research on organic methods. Hence, he is likely to experiment. He wishes to demonstrate that kiwifruit can be grown just as well using organic methods.
The Organic orchardist recognises that there are natural limits to productivity and feels he is working with the vine to produce kiwifruit. Quality is regarded as an intrinsic part of his product. One of his major goals is to increase his orchard's productivity and is he is very concerned about the possible impact of his neighbour's orchard practices on his orchard and the environment. He hopes he is providing a quietly restrained model of environmentally friendly practices.

The typical Gold orchardist
The Gold orchardist is the most willing to spend on capital investment and is likely to complain about costs. Costs, rather than just orchard gate returns, are regarded as essential to the assessment of financial wellbeing. As such a Gold orchardist has a more sophisticated understanding of his finances. If kiwifruit production provided less returns than expected he would probably sell, grow a more lucrative crop, or seek another challenge. He is very competitive with other Gold orchardists but also compares returns with Green. He is likely to be growing Hayward Green kiwifruit as well. Lifestyle is very important to the typical Gold orchardist but it is seen as a commodity on which a dollar value can be placed, and is related to the area in which he lives and its attractions. Hence, the land value of his property is also very important to him. He is less likely to live on the orchard than other types, and, therefore, has less personal knowledge of the orchard environment. The challenge of growing Gold kiwifruit appeals to the Gold orchardist. He expects to be rewarded for taking on the financial risk of planting a new variety. As a result, he is more likely to experiment with vine management and complain about not getting the vines pruned the way he wants. He talks frequently about how little is known about growing Gold kiwifruit and how the demand for better taste should come with well researched instructions."

6.3. Attitudes of ARGOS orchardists to the Taste ZESPRI™ programme

In February and March of 2006, 35 of the 36 ARGOS kiwifruit orchardists (11 Green, 12 Green Organic and 12 Gold) were asked how they felt about the Taste ZESPRI™ (TZ) programme which rewards orchardists according to the level of dry matter (DM) in fruit. The impacts of TZ on the management of orchards were also determined. These questions were part of a larger management questionnaire which is undertaken annually with each ARGOS orchardist.

On the whole, Gold orchardists appeared to be the most positive and supportive of the TZ programme. Just over half of Green and Green Organic orchardists (7 each) stated that they supported or understood the need for TZ; there was no clear difference in the level of support or resistance between these two groups. It seems that the more noticeable support from Gold orchardists is partly a reflection of their different typology or profile (see section 6.2) and not just a response to the high incentive. Green Organic orchardists were generally not as positive despite the high incentive.

In terms of management, TZ has changed canopy management on many of the orchards with greater focus now on maximising light in the canopy (by manipulating both the females and males), more attention to the timing of pruning, and a move towards low vigour practices (although for some, this change has other drivers like reduction in labour). Two orchardists are paying more attention to the impacts of chemicals and fertilisers on fruit DM. Trunk girdling has been adopted by many of the Gold and Green Organic orchardists but only two of the Green orchardists. Perhaps this is a reflection of the more conservative nature of Green orchardists (see section 6.2) or the importance placed on other production incentives like fruit size and yield compared to the incentive for DM. It may also reflect a lack of confidence that Green orchardists have towards consistently delivering high DM fruit. For some orchardists, the TZ has increased their awareness of factors that may affect DM. Across all three groups, the most common concern was that current knowledge and tools did not consistently result in high DM fruit.

Generally, changing management to pursue higher DM has incurred additional cost. However, many feel this cost is small relative to the potential payback. Girdling was the most easily quantifiable cost for orchardists ("a few hundred dollars per hectare"). Changes in canopy management were often said to save money in the final analysis as vigour was eventually reduced. For two Green Organic orchardists and one Gold orchardist, a change in contractors, which was an added cost, was necessary to apply the required pruning style. Change in canopy management was occasionally said to be an issue of improved timing rather than a change in the amount of pruning.

Overall, the impacts of the changes in management on DM are not known as the changes have not been implemented long enough. Some growers believe there has been an increase in DM based on small trials carried out in their orchards in the last year of two.

6.4. Second qualitative survey – constraints

The second qualitative interview (conducted near the end of 2005 by Chris Rosin and Lesley Hunt) with ARGOS participants examined the extent to which orchardists faced and managed constraints on orchard management and performance. From our previous interviews, we identified groups of potential constraints such as those related to the environment, to government policies, to industry standards and audit systems, to the availability of inputs, and to the acquisition of knowledge or innovation. We used these groupings to focus our discussion of constraints and to understand what factors both in the kiwifruit industry and in the characteristics of individuals allowed these constraints to be managed in a satisfactory, and potentially sustainable, manner.

Perhaps the most noteworthy feature of the second round of interviews was the fact that orchardists identified very few factors that were perceived to act as constraints on their orchard management (a feature not unlike that in other established sectors such as dairy and sheep/beef). For example, whereas most of those interviewed were able to identify at least one environmental factor that they took into account when managing their orchard, very few of them qualified these factors as constraints. In other words, kiwifruit orchardists—for the most part—appear to have developed adequate strategies for managing the potential limitations and negative effects of the environment e.g. high wind, frost, declining soil fertility, pests and weeds. Those cases in which an environmental factor (in the interviews, frost was the most likely candidate) was identified as a constraint this was due either to a recent trend toward more severity in its impact or to a lack of experience in dealing with the factor on the part of a particular orchardist. This attitude toward the environment most likely reflects the fact that the orchardists have access to sufficient information as well as a variety of technologies with which to ameliorate negative impacts. In addition, the system of kiwifruit production is such that environmental factors seldom threaten the viability of an orchard except in the most marginal climatic regions (e.g. the lack of winter chill for organic orchards in Kerikeri).

Likewise, few of the orchardists recognised policies and regulations (ranging from those implemented at the national or regional level to those associated with the attitudes of family and the local community) or access to inputs as constraints. On rare occasions, an orchardist would recall difficulties and delays involved with getting RMA consents or would voice perceptions of potential limitations to water access for irrigation and frost protection. There was also a fairly strong consensus that economic policies at the national level could more favourably address the needs and concerns of the agricultural sector. Overall, however, the orchardists appear to have come to terms with the demands placed on their practices as the result of the potential impacts on neighbours and a wider society. In relation to inputs, there was uniform agreement that orchardists had ready access to inputs including labour, although those dependent on contract labour might be dependent on availability to complete scheduled tasks. There was also some concern with the skill and reliability of labour and contract labourers, in particular. This concern appears to have become more critical as orchardists test alternative pruning methods that are not always followed by pruning teams. The discussion of constraints related to inputs also indicated one of the differences for the organic orchardists who were more likely to acknowledge some difficulties in locating appropriate inputs, especially for cost effective fertilisers.

In the interviews, we also suggested that knowledge and skill acquisition specific to kiwifruit management might pose constraints to orchardists. Response to this suggestion reflected the range of experience of ARGOS participants—from those recently purchasing orchards to those having a lifetime of experience with kiwifruit. The consistent aspect in all of the interviews, however, was a strong desire among participants to further their knowledge about the care of kiwifruit and the orchard environment. For most, the greatest current challenge involved the successful (and consistent) production of high dry matter. Some participants complained that the demand for (and rewarding of) high dry matter content was not accompanied by recommendation for realising this quality. On the other end of the spectrum, several orchardists were actively experimenting with a variety of methods (from soil management, to pruning, to wind control) that they expected to ensure higher dry matter in their orchards.

It appears that the most widely acknowledged influences on orchard management are those associated with participation in the kiwifruit industry. Many orchardists expressed frustrations with the increased paperwork as a result of Eurep-GAP compliance within the industry. The most frequent complaint involved the perceived excessive detail of the audit, which has forced them to dedicate additional time to administration. As a result, they believe that the audit detracts from their primary responsibility of tending to the orchard. Others complained about specific elements of the audit (e.g. tractor maintenance) that have no readily apparent relationship to fruit quality or that suggested a lack of skill on their part (e.g. mandatory GrowSafe training). In addition, several organic orchardists noted that requirements to post signage warning of potentially toxic substances would contradict their claims to safer and healthier production practices. An equal number of orchardists, by contrast, readily recognised the necessity of compliance with the Eurep-GAP audit, especially for maintaining export outlets in Europe's profitable market. This difference in attitudes toward the audit appears less likely to reflect a specific management type (i.e. Green, Green Organic, or Gold) than it does an individual's previous experience with auditing more generally. Often those who complained the most about the time constraints imposed by the system of audit were those committing the most amount of time to on-orchard management and improvements in dry matter more specifically. Many orchardists have been able to cope with the demands of audits through the assistance of partners or other family members who a more willing to do the paperwork involved.

The general conclusion we can draw from the interviews on constraints is that the growing of kiwifruit in New Zealand faces few constraints and that these can be successfully managed with existing and emerging strategies. This does not suggest that the life of a New Zealand kiwifruit orchardist is without its challenges (e.g. the potential financial constraints associated with a prolonged period of low production or returns). It is, however, evident that the typical orchardist can expect to achieve some level of success— however they might define it—in the sector. The sustainability of any given kiwifruit operation can be enhanced to the extent that its manager/owner is willing to remain abreast of emerging trends in management practice, aware of developments in the marketing of kiwifruit, and responsive to concerns of neighbours and society regarding the practice of orcharding. Challenges to sustainability appear to be associated with such factors as extreme climatic events, poorly understood regulatory and compliance measures, and a growing division between urban and rural perspectives on land use and management. As ARGOS continues to analyse and compare the results of research from each of the teams, we expect that the knowledge gained in this interview will help us to provide information and recommendations more appropriate to the conditions that orchardists face.

6.5. Quantitative survey – farmer attitudes and opinions

6.5.1. Introduction

In 2005, a self administered postal questionnaire was used to collect data on the attitudes and opinions of farmers in New Zealand. Several sectors were surveyed including Sheep & Beef, Dairy, Kiwifruit and other Horticulture. The questions asked covered a range of topics including background to farming, farm and farmer character, farm management, farm environment, Maori and cultural connections, and nature. All ARGOS participants received the questionnaire as did a larger sample of other farmers. A summary of key findings for the kiwifruit sector is presented here first followed by the specific results for the ARGOS orchardists. These results have been taken directly from reports prepared by Andrew Cook, John Fairweather and Lesley Hunt from Lincoln University, and Chris Rosin and Hugh Campbell from the University of Otago. Note, the term panel is used throughout the ARGOS programme to refer to each study group i.e. Green, Organic and Gold panels.

6.5.2. Kiwifruit sector

These results are for the broader population of kiwifruit orchardists.

Farm character

- The total area of Gold orchards was smaller than Green and Green Organic but suffered no loss of revenue.
- Revenue was less than that from sheep/beef farms and other horticultural properties, and considerably less than for dairy farmers.
- Average off-farm income was higher than for other sectors and hence, unlike other sectors, off-farm work was more important as a primary income source.

Respondent characteristics and background

- Like other farmers, most kiwifruit orchardists had a rural background.
- More kiwifruit orchardists had their upbringing further than 100 kilometres from their orchard (59 per cent compared with 31 per cent for all other sectors).
- Proportionately fewer orchards (15 per cent) had a successor compared to all other sectors (23 per cent).
- Green Organic orchardists had owned their orchards longer than Gold orchardists (21 years compared with 16 years). While Gold has only been grown commercially for about 10 years, the Gold orchardists who responded must have been growing Green for longer than that.
- Most lived on their orchard (80 per cent) but this was a smaller proportion than all other sectors (91 per cent).
- The orchards had a greater proportion of farm managers making key decisions (38 per cent compared with 19 per cent for all other sectors).

Genetically modified organisms (GMO) and organic intentions

- Like other farmers and horticulturalists, kiwifruit orchardists were not keen to use GMOs.
- Green and Gold orchardists tended to be neutral about their intentions to use organic methods.

Management strategies and values

- Organic orchardists were more positive about alternative management systems.

Dependency on inputs

- Green and Gold orchardists were more dependent on chemicals and manufactured fertilisers while organic orchardists were more dependent on composts and organic remedies.
- The use of chemicals and other inputs did not differ between Green and Gold orchardists, except for the use of fertiliser – Green orchardists being more dependent.

Other attitudes and characteristics

- Kiwifruit orchardists tended to be satisfied with their situation and saw a generally bright future.

Orchard environment

- Environmental conditions were judged to have improved in the last five years.

Resilience practices (these buffer orchards from shocks e.g. unavailability of inputs)

- Two practices (protection of natural enemies and avoiding dependency on external inputs) were more important for Green Organic orchardists.
- Compared with other sectors, there was less difference between Green Organic and other orchardists.
- Like other sectors, no practice was judged generally to be unimportant or of neutral importance.

Relationship to the land and Maori connections

- Kiwifruit orchardists as much as other farmers tended to feel they were part of the land.
- Like other farmers, Maori connections were not strong for kiwifruit orchardists.

Attitudes towards nature

- Kiwifruit orchardists tended to agree with the cultured nature viewpoint.

6.5.3. Comparison of ARGOS panels

The results show a number of differences between the ARGOS panels.

The Organic orchardists compared to Gold and Green orchardists:

- Have a stronger intention to use organic methods.
- Disagreed with the Committed Conventional position on alternative management systems.
- Agreed with the Committed Organic position on alternative management systems.
- Disagreed with the Environmentally Conscious but not Organic position on alternative management systems.

- Have lower dependence on chemicals for pests and parasites, for weeds, and for manufactured fertilisers, and higher dependence on composts and organic remedies for control of pests.
- See future prospects as less bright.

Organic orchardists compared to Gold orchardists only:
- Gave less importance to money made from other farming business in enabling orchard ownership.
- Give some importance to wetlands being inappropriate for the environment of their farm.

Organic orchardists compared to Green orchardists only:
- Has higher dependency on organic remedies for control of weeds.
- Has a stronger intention not to use GMOs.
- Gave more importance to money made from outside farming in enabling orchard ownership.
- Have more agreement with the statement that when humans interfere with nature it often produces disastrous consequences.
- Have less agreement with the statement that human ingenuity will ensure that we do not make the earth unliveable.
- Rates as neutral (cf. important) achieving a balance between crop production and animal husbandry.

Green orchardists compared to Gold and Organic orchardists:
- Has been associated with the orchard for fewer years.

Green orchardists compared to Gold orchardists only:
- Lower importance (cf. neutral) to inherited land in enabling farm ownership.
- Disagree with the Pragmatic Organic position on alternative management systems.

Overall, the results show that most of the differences relate to the organic panel. The panel shows differences as expected about alternative management positions. However, they see future prospects as less bright perhaps because they are aware of the limitations of the organic system on production or that they are responding to the reduction to the premium for organic kiwifruit. The Green differences are modest and consistent with their management system being equivalent to a conventional position. They have been on their orchard for less time. The Gold differences are consistent with their management being based on a different species.

6.5.4. Representatitiveness of ARGOS panels

Compared to the sector, the Gold panellists rated importance of inherited land in enabling farm ownership as more important. They had some agreement with the Pragmatic Organic position and were not dependent on organic remedies. They were more positive about the future, saw waterfowl shooting as more unimportant, but gave slight importance to spending time looking at wetland areas. Overall, the Gold panel is similar to the sector.

Compared to the sector, the Green panel have owned their orchards for fewer years. They rated as more important achieving pest control by protecting natural enemies, and they assigned less importance to waterfowl shooting. Overall, the Green panel is very similar to the sector.

Compared to the sector, the Organic panel has more disagreement with the third option on alternative management systems, namely the practiced but not formalised position (Environment Conscious but not Organic) presumably because it refers to being unregistered. The panel rated as less important the succession of lease in orchard ownership, and rated as more important borrowing from the bank. They reported less dependence on chemicals for control of weeds, and a lower proportion of household food sourced from the farm. Achieving a balance between crop production and animal husbandry was rated as neutral, while waterfowl shooting was rated unimportant. Overall, there are seven differences here. The general pattern is for a slightly more serious approach to organic production, with less household food sourced from the orchard, less dependence on chemicals and less interest in shooting. Presumably, orchards in the sector are slightly more diverse in their land use and that why they rated balancing crop production and animal husbandry as important.

6.6. Causal mapping

The following is taken directly from an ARGOS Research Note prepared by John Fairweather of Lincoln University.

Introduction
ARGOS is undertaking a long-term investigation of the sustainability of agriculture in NZ. For the kiwifruit sector, the three main management systems ('panels') are being compared i.e. Kiwigreen Hort 16A ('Gold'), Kiwigreen Hayward ('Green') and Organic Hayward ('Organic').The results from the first interview of each ARGOS orchardist by the social science team gave a detailed account of many aspects of orcharding, including management. Subsequently, we trialled a type of cognitive mapping called causal mapping to develop a better understanding of orchard management as it is important for the researchers to appreciate the way that orchardists deal with economic, environmental and social factors on a regular basis. We also wanted to see in what ways the three ARGOS panels were similar or different in their approach to management.

Method
The mapping method we used allows orchardists to identify the factors important in the management of their orchard system by connecting factors that causally influence each other. We used a generic map with 36 factors and then asked orchardists to connect the factors using a score from 1 to 10 to show how strong they were causally linked. Each orchardist completed a map and data from each map was then used to prepare an aggregated or group map. Data from the group map were used to characterise the orchard system as a whole and each of the three panels.

Results
The group map is shown in Figure 20. It shows all 36 factors and only the moderate to strong causal linkages (scores of four or more). The less important factors have hatched lines around them, and linkages characteristic of particular panels are shown in hatched lines. Group map data provide a measure of the overall importance of each factor using the sum of the weights of linkages to and from the factors. The most important factors, shown with a hatched background include: the decision maker (orchardist), quality and quantity of production, financial aspects (represented by returns, expenditure and orchard surplus), ZESPRI (marketing company), contractors/packhouse and satisfaction.

Some features of the group map are:

- Fertiliser and soil fertility, and weed and pest management were the only production factors with a strong link to quality and quantity of production, not labour or machinery.
- Fertiliser and soil fertility, weed and pest management and contractors/packhouse were the only production factors with feedbacks to decision maker.
- Satisfaction was derived from cash orchard surplus and quality and quantity of production.
- Orchard environment health was mainly influenced by the decision maker.

There were some differences in the map for the three panels and the relevant results are shown in Figure 20 in parentheses. The following linkages were at a higher level for each panel:

Organic:
- The decision maker to orchard environmental health.
- Orchard environment health to satisfaction.

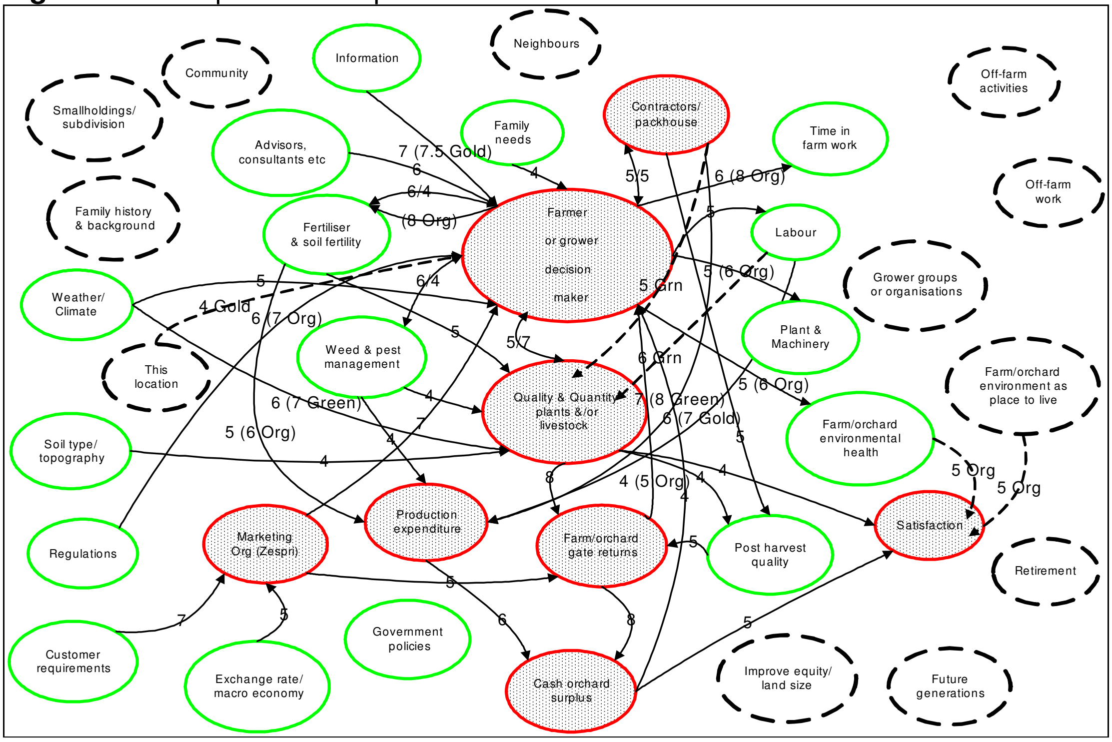
Green:
- Contractors/packhouse to quality and quantity of production.
- Labour to quality and quantity of production.

Gold:
- Information and this location to decision maker.

Conclusion

The results show that the group map reflects a strong production orientation. Organic orchardists produced a panel map having the most distinctive qualities but they also shared a number of distinctive characteristics with Gold orchardists. Causal mapping allows us to see in a glance what factors comprise the orchardists' complex system and can show critical issues to growers.

Figure 20. Group causal map for ARGOS kiwifruit orchardists.



Note – individual causal maps were sent to all participating orchardists in 2005.

7. List of additional results available in 2005 ARGOS Report

The first Annual ARGOS Report from 2005 contains the following additional results from baseline surveys carried out earlier in the programme. Some of these surveys may be repeated in the future to assess change.

- Orchard biodiversity (2004/05 summer) – birds, freshwater fish and frogs, bats (none found) and lizards (none found).
- Canopy invertebrates (2004/05) – insects and mites in the summer canopy.
- Orchard habitat survey (2004).
- First qualitative interview – broad ranging survey of topics including vision, goals and constraints.

8. List of ARGOS reports and resources

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

06/09 Understanding kiwifruit management using causal mapping, by John Fairweather, Lesley Hunt, Chris Rosin, Hugh Campbell, Jayson Benge and Mike Watts, September 2006

06/08 Kiwifruit energy budgets to be published, Andrew Barber et al

06/07 Sheep & Beef energy budgets to be published, Andrew Barber et al

06/06 to be published

06/05 to be published

06/04 to be published

06/03 Stream survey to be published. Grant Blackwell et al

06/02 Weed survey to be published, Henrik Moller et al

06/01 Understanding Approaches to Sheep/Beef Production in New Zealand: Report on First Qualitative Interviews of ARGOS Sheep/Beef Participants, by Lesley Hunt, Chris Rosin, Marion Read, John Fairweather, Hugh Campbell, February 2006

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

05/09 to be published

05/08 to be published

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

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

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

05/03 Soil quality on ARGOS sheep & beef farms, 2004-2005, by Andrea Pearson, Jeff Reid, and Dave Lucock, June 2005

05/02 Soil quality on ARGOS kiwifruit orchards, 2004-2005, by Andrea Pearson, Jeff Reid , Jayson Benge and Henrik Moller, June 2005

05/01 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

ARGOS High Country Environmental Report

No. 1, August 2006 - High Country Environmental Monitoring Report 2005-06

Working Papers

Working Paper 1: Social Dimensions of Sustainable Agriculture: a Rationale for Social Research in ARGOS by Hugh Campbell, John Fairweather, Lesley Hunt, Carmen McLeod and Chris Rosin

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)

Working Paper 7: He Whenua Whakatipu Sustainability Report by John Reid

The following two reports were commissioned by ZESPRI Innovation Ltd and are reports on data related to ARGOS Research.

An Analysis of ZESPRI's 2003 Organic Kiwifruit Database: Factors Affecting Production by Lesley Hunt and John Fairweather, AERU, Lincoln University 2004

Results from a Survey of Organic Kiwifruit Growers: Problems and Practices that affect Production by Andrew Cook, Lesley Hunt and John Fairweather, AERU, Lincoln University 2004.

Research Notes (short research summaries)

1. Background to the ARGOS Programme
2. Transdisciplinary Research
3. Cicadas in Kiwifruit Orchards
4. Market Developments for NZ Agricultural Produce
5. Spiders in Kiwifruit orchards
6. Organic Kiwifruit Survey 2003
7. Analysis of ZESPRI's Organic Kiwifruit Databases
8. Types of Kiwifruit Orchardist
9. First Kiwifruit Interview: Individual and Orchard Vision
10. Sketch Map Results: Kiwifruit Sector
11. Sketch Map Results: Sheep/Beef Sector
12. Wellbeing 1: Sheep/Beef Sector
13. Wellbeing 2: Sheep/Beef Sector
14. Wellbeing 3: Sheep/Beef Sector
15. Soil nematodes in kiwifruit orchards
16. Understanding kiwifruit management using causal maps

ARGOS Newsletters

1. June 2004
2. January 2005
3. July 2005

Posters from ZESPRI's 2004 Marketing and Innovation Conference (Nov, 2004)

1. Background to ARGOS
2. Research results on Kiwifruit Orchards

Posters from Kiwi2006: International Kiwifruit Symposium - February 2006

1. Soil Biota Poster
2. Birds Poster

<u>RESTRICTED REPORTS</u>

The following reports are not publicly available on the ARGOS website. Please contact ARGOS if you wish to view any of these.

Working Papers

Working Paper 1: Social Dimensions of Sustainable Agriculture: a Rationale for Social Research in ARGOS by Hugh Campbell, John Fairweather, Lesley Hunt, Carmen McLeod and Chris Rosin

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Working Paper 7: He Whenua Whakatipu Sustainability Report by John Reid

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 kiwifruit 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

Other Reports

- Attitudes of Green, Green Organic and Gold kiwifruit orchardists towards the Taste ZESPRI™ Incentive Programme in 2006 by Jayson Benge, Chris Rosin, John Fairweather, Lesley Hunt and Jon Manhire
- ARGOS 6 monthly report to Fonterra, April 2006 by Amanda Phillips, Peter Carey, Glen Greer, Martin Emanuelsson
- 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

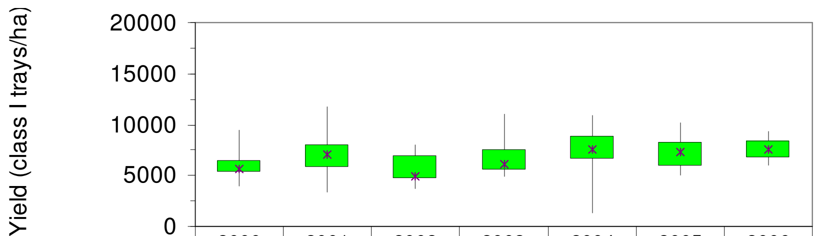
Kiwi2006: International Kiwifruit Symposium - February 2006

The Active Kiwifruit Orchard: Orchard/Orchardist Interaction by Lesley Hunt and Chris Rosin

9. Appendices

Appendix 1. Box and whisker plots of yields (Class 1) for Green, Green Organic and Gold orchards in the ARGOS programme, on a per hectare basis. Each box represents 50% of the orchards and each whisker 25% of orchards. The whiskers extend to the minimum and maximum values. The asterisks represent medians.

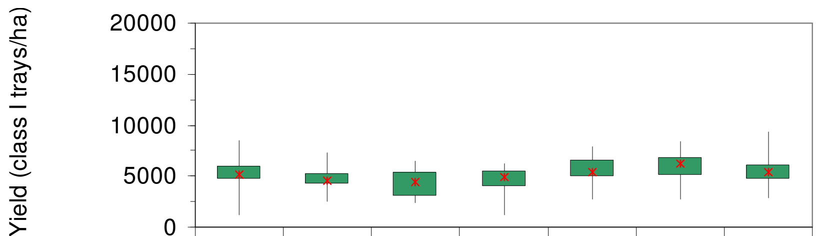
Green



	2000	2001	2002	2003	2004	2005	2006
Lower Quartile	5251	5745	4693	5520	6614	5832	6749
Minimum	3935	3365	3715	4893	1273	5081	5987
Maximum	9443	11742	8033	11000	10851	10125	9361
Upper Quartile	6462	7988	7005	7488	8814	8217	8436
× Median	5623	7044	4950	6125	7519	7298	7581

Year of harvest

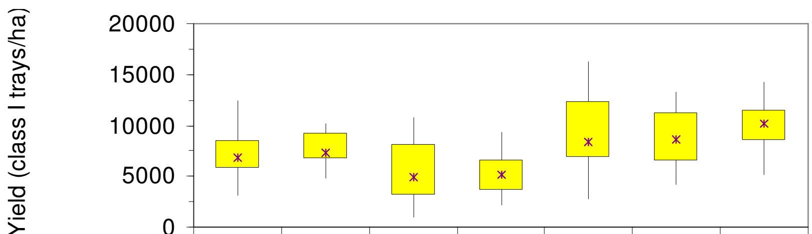
Green Organic



	2000	2001	2002	2003	2004	2005	2006
Lower Quartile	4656	4215	3050	3961	4948	5012	4622
Minimum	1228	2536	2387	1185	2761	2749	2832
Maximum	8535	7300	6448	6219	7880	8440	9291
Upper Quartile	5953	5264	5357	5495	6621	6801	6054
× Median	5196	4570	4431	4872	5390	6186	5438

Year of harvest

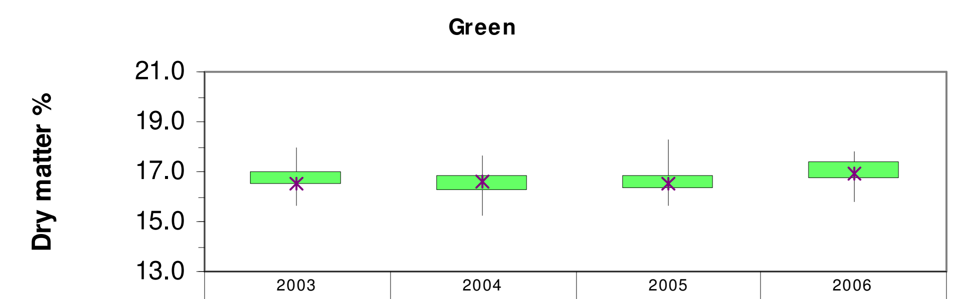
Gold



	2000	2001	2002	2003	2004	2005	2006
Lower Quartile	5724	6683	3108	3564	6786	6487	8504
Minimum	3120	4781	919	2114	2764	4147	5115
Maximum	12422	10162	10828	9371	16292	13305	14305
Upper Quartile	8483	9175	8169	6607	12386	11236	11452
× Median	6833	7335	4894	5189	8441	8658	10167

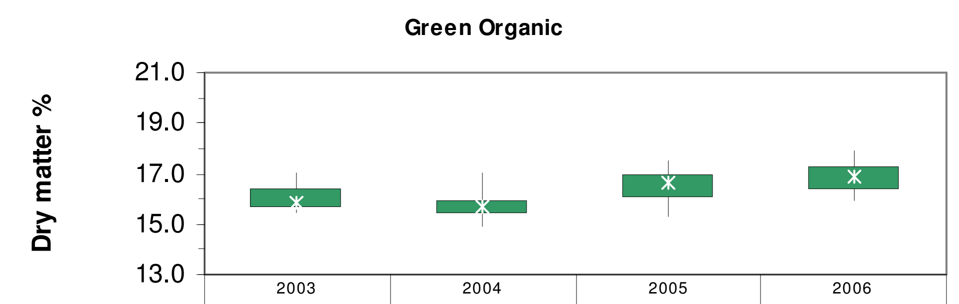
Year of harvest

Appendix 2. Box and whisker plots for average dry matter % (highest results per maturity area) across Green, Green Organic and Gold orchards in the ARGOS programme. Each box represents 50% of the orchards and each whisker 25% of orchards. The whiskers extend to the minimum and maximum values. The asterisks represent medians.



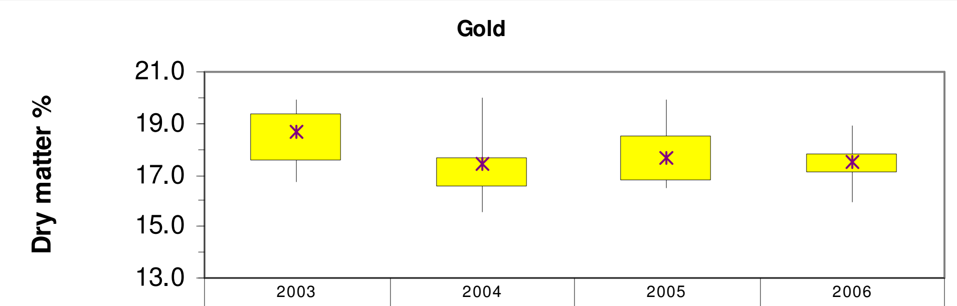
	2003	2004	2005	2006
Lower Quartile	16.4	16.2	16.3	16.6
Minimum	15.6	15.3	15.7	15.8
Maximum	18.0	17.6	18.2	17.8
Upper Quartile	17.0	16.9	16.8	17.4
Median	16.6	16.6	16.5	16.9

Year of harvest



	2003	2004	2005	2006
Lower Quartile	15.6	15.3	16.0	16.3
Minimum	15.4	14.9	15.3	15.9
Maximum	17.0	17.0	17.5	17.9
Upper Quartile	16.4	15.9	17.0	17.2
Median	15.9	15.7	16.7	16.8

Year of harvest



	2003	2004	2005	2006
Lower Quartile	17.5	16.5	16.7	17.0
Minimum	16.8	15.6	16.5	16.0
Maximum	19.9	20.0	20.0	18.9
Upper Quartile	19.3	17.7	18.5	17.8
Median	18.6	17.4	17.7	17.5

Year of harvest

Appendix 3. Specific active ingredients in non-organic and organic insecticides, fungicides, herbicides and plant growth agents used on ARGOS orchards. The numbers represent the average number of times each ingredient has been applied to an orchard.

Green

		1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Fungicide	Benomyl	0.3	0.3	0.2	0.2	0.1		
	Benzalkonium chloride + copper						0.1	
	Copper	0.1						
	Iprodione	0.5	0.4	0.9	0.4	0.6	0.7	0.6
Fungicide Total		0.9	0.7	1.1	0.6	0.7	0.7	0.6
Herbicide	Glyphosate	0.9	0.7	1.0	1.1	1.0	1.1	0.6
Herbicide Total		0.9	0.7	1.0	1.1	1.0	1.1	0.6
Insecticide	Chlorpyrifos	0.7	0.6	1.0	1.1	1.2	0.8	0.6
	Diazinon	1.7	1.2	1.3	0.9	2.0	1.7	1.8
	Emamectin						0.6	0.5
	Indoxacarb			0.2				
	Permethrin + diazinon	0.4	0.6	0.5	0.5			
	Permethrin + pirimiphos-methyl	0.5	0.3	0.4	0.5			
	Spinosad					0.3	0.4	0.2
	Synthetic pyrethroid		0.1					
	Tebufenozide				0.2	0.4	0.2	0.1
	Thiamethoxam						0.1	
	Methoxyfenozide							0.4
	Thiacloprid							0.2
	Bifenthrin							0.1
Insecticide Total		3.3	2.9	3.4	3.1	3.8	3.8	3.9
Plant growth agent	Fruit sizing	0.5	0.3					0.3
	Hydrogen cyanamide	0.9	0.9	0.9	0.9	1.0	1.0	1.0
Plant growth agent Total		1.5	1.1	0.9	0.9	1.0	1.0	1.3
Certified organic insecticide	Bt	0.0	0.1	0.2	0.1	0.9	0.6	0.5
	Mineral oil	0.0	0.0	0.1		0.2		
Certified organic insecticide Total		0.1	0.1	0.3	0.1	1.1	0.6	0.5

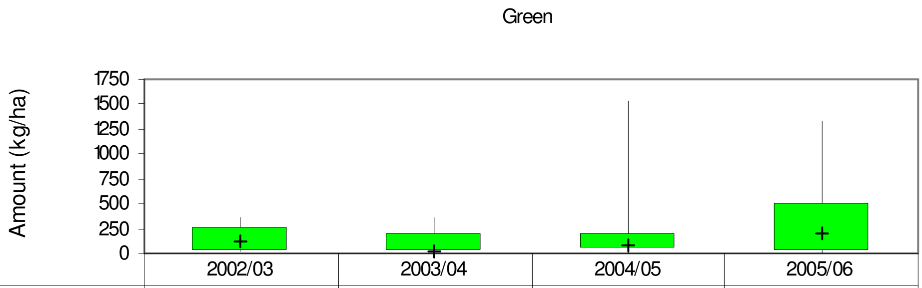
Green Organic

		1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Certified organic insecticide	Bt	2.6	2.8	2.6	2.8	2.7	2.6	2.3
	Lime Sulphur				0.1			
	Mineral oil	1.9	2.5	2.9	2.8	3.4	2.7	2.8
	Organic remedies		0.1	0.1			0.3	
	Pyrethrins	0.0	0.0		0.0	0.0	0.0	
Certified organic insecticide Total		4.6	5.5	5.6	5.7	6.1	5.6	5.1
Certified organic plant growth agent	Budbreak					0.0	0.1	
	(blank)							0.1
Certified organic plant growth agent Total						0.0	0.1	0.1
Certified organic fungicide	Fungal agonist					0.1		
	Trichoderma					0.1		
Certified organic fungicide Total						0.2		

Gold

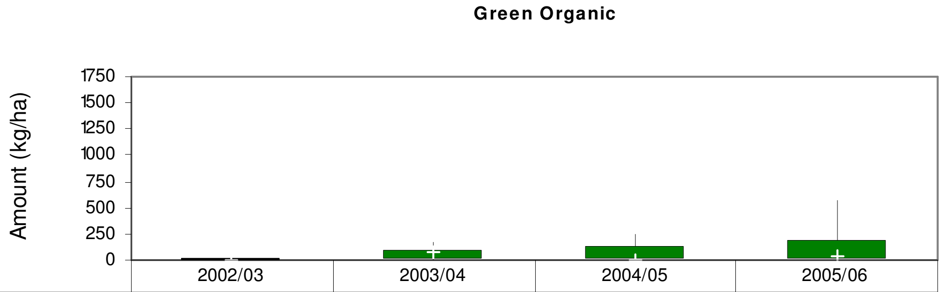
		2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Fungicide	Benomyl				0.2		
	Benzalkonium chloride + copper	0.1					
	Copper	0.1		0.2			
	Iprodione	0.6	0.4	0.4	0.2	0.6	0.5
Fungicide Total		0.7	0.4	0.6	0.3	0.6	0.5
Herbicide	Glyphosate	1.0	1.1	1.0	1.2	0.8	1.0
Herbicide Total		1.0	1.1	1.0	1.2	0.8	1.0
Insecticide	Chlorpyrifos	0.8	0.8	0.8	0.8	0.9	0.6
	Diazinon	1.5	1.4	1.0	1.8	1.4	1.6
	Emamectin					0.3	0.6
	Indoxacarb	0.1	0.2		0.2		
	Permethrin + diazinon	0.4	0.4	0.6			
	Permethrin + pirimiphos-methyl	0.3	0.3	0.3			
	Spinosad			0.1		0.3	0.3
	Tebufenozide			0.1	0.3	0.3	0.3
	Methoxyfenozide						0.1
	Bifenthrin						0.1
	Insect Arrest Gel				0.1	0.1	
Insecticide Total		3.0	3.2	2.9	3.2	3.3	3.6
Plant growth agent	Fruit sizing	1.5	0.6	0.7	1.4	1.2	1.2
	Hydrogen cyanamide	0.7	0.6	0.6	0.6	0.8	0.9
	NAA				0.3	0.4	0.1
Plant growth agent Total		2.1	1.2	1.2	2.2	2.3	2.2
Certified organic insecticide	Bt	0.8	0.4	0.5	1.3	0.9	0.3
	Lime Sulphur			0.1			0.1
	Mineral oil					0.1	
	Pyrethrins			0.1	0.1		
Certified organic insecticide Total		0.8	0.4	0.7	1.4	1.0	0.4

Appendix 4. Box and whisker plots for calcium (Ca) use in Green, Green Organic and Gold orchards in the ARGOS programme. Each box represents 50% of the orchards and each whisker 25% of orchards. The whiskers extend to the minimum and maximum values. The crosses represent medians.



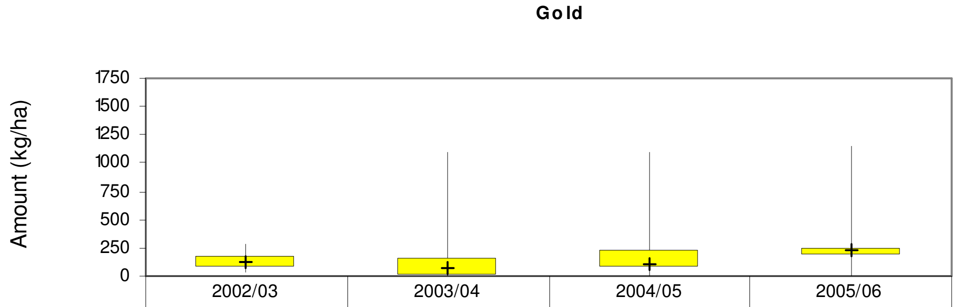
	2002/03	2003/04	2004/05	2005/06
Lower Quartile	28	21	43	24
Minimum	27	0	0	0
Maximum	370	370	1530	1323
Upper Quartile	260	208	204	494
+ Median	126	28	75	205

Season



	2002/03	2003/04	2004/05	2005/06
Lower Quartile	0	0	0	0
Minimum	0	0	0	0
Maximum	7	170	255	574
Upper Quartile	5	104	133	184
Median	1	78	0	40

Season

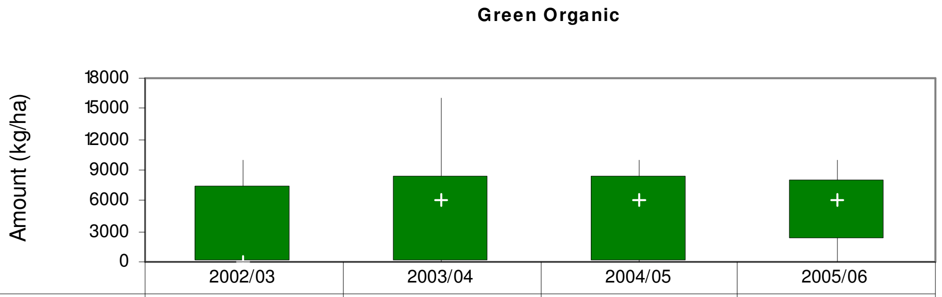


	2002/03	2003/04	2004/05	2005/06
Lower Quartile	75	0	73	177
Minimum	44	0	0	0
Maximum	286	1098	1098	1145
Upper Quartile	182	166	232	253
+ Median	117	79	114	235

Season

Appendix 5. Box and whisker plots for compost and liquid fish use in Green Organic orchards in the ARGOS programme. Each box represents 50% of the orchards and each whisker 25% of orchards. The whiskers extend to the minimum and maximum values. The crosses represent medians.

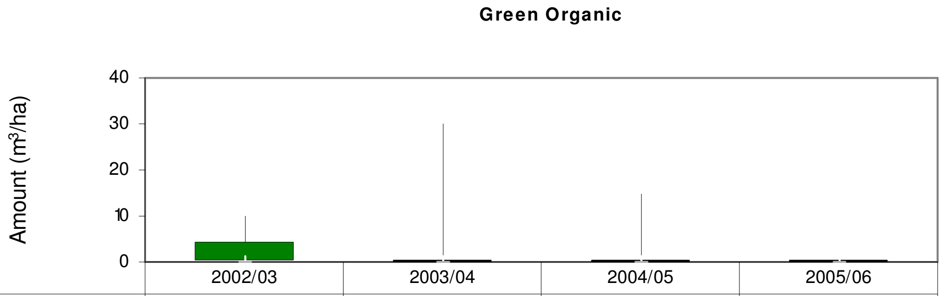
Compost (kg/ha)



	2002/03	2003/04	2004/05	2005/06
Lower Quartile	0	0	0	2250
Minimum	0	0	0	0
Maximum	10000	16000	10000	10000
Upper Quartile	7500	8500	8500	8000
Median	0	6000	6000	6000

Season

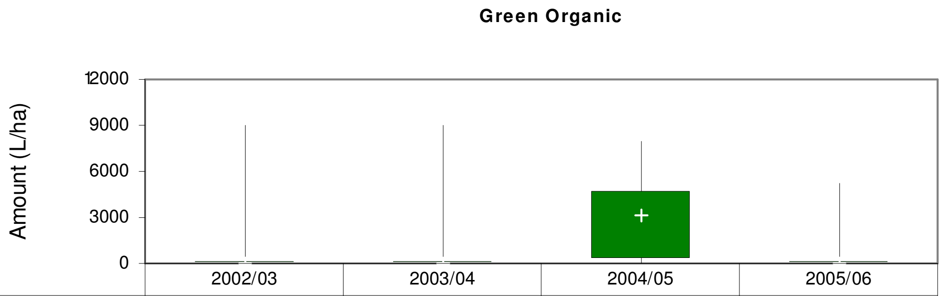
Compost (m^3/ha)



	2002/03	2003/04	2004/05	2005/06
Lower Quartile	0	0	0	0
Minimum	0	0	0	0
Maximum	10	30	15	0
Upper Quartile	5	0	0	0
Median	0	0	0	0

Season

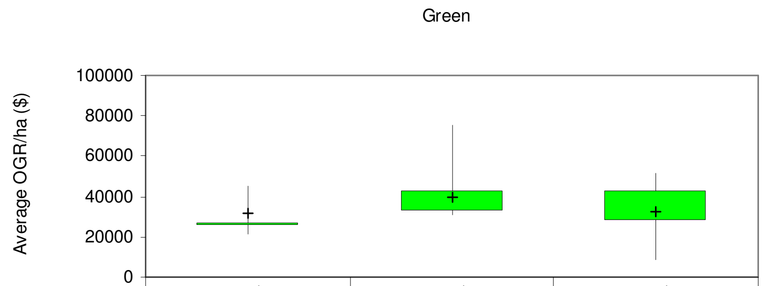
Liquid fish (L/ha)



	2002/03	2003/04	2004/05	2005/06
Lower Quartile	10	15	235	23
Minimum	0	0	0	0
Maximum	9000	9000	8000	5264
Upper Quartile	95	120	4674	88
Median	60	50	3132	30

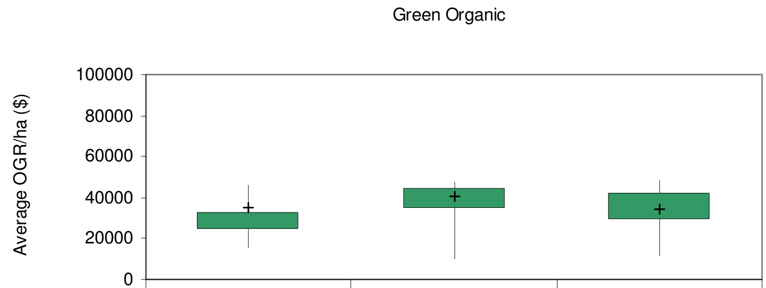
Season

Appendix 6. Box and whisker plots of orchard gate return (OGR) for Green, Green Organic and Gold ARGOS orchards, on a per hectare basis. Each box represents 50% of the orchards and each whisker 25% of orchards. The whiskers extend to the minimum and maximum values. The crosses represent medians.



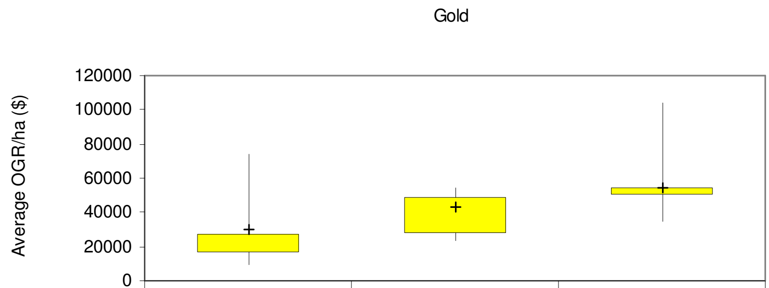
	2002/03	2003/04	2004/05
Lower Quartile	25360	32661	27798
Minimum	21583	30811	8827
Maximum	45047	75125	51313
Upper Quartile	26899	42600	42760
+ Median	31764	39405	32343

Season



	2002/03	2003/04	2004/05
Lower Quartile	24403	34121	28756
Minimum	15778	10002	11668
Maximum	46429	47930	48296
Upper Quartile	32668	44197	42255
+ Median	35489	40259	34623

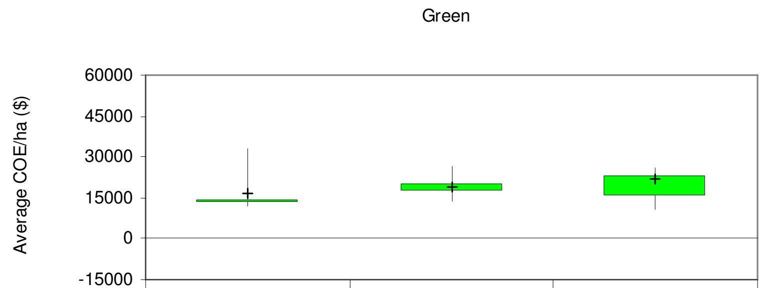
Season



	2002/03	2003/04	2004/05
Lower Quartile	15489	27256	49266
Minimum	9693	23160	34605
Maximum	74023	54229	103820
Upper Quartile	27056	48922	54229
+ Median	30370	43425	54213

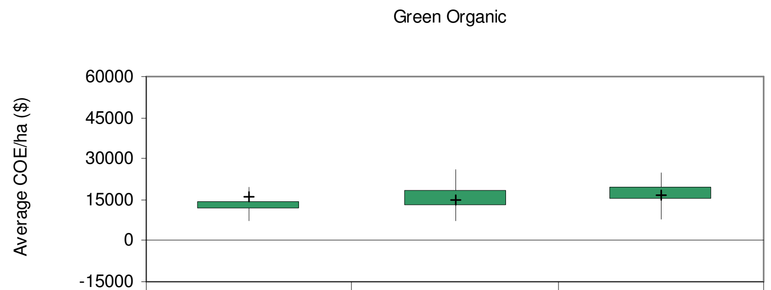
Season

Appendix 7. Box and whisker plots of cash orchard expenditure (COE) for Green, Green Organic and Gold ARGOS orchards, on a per hectare basis. Each box represents 50% of the orchards and each whisker 25% of orchards. The whiskers extend to the minimum and maximum values. The crosses represent medians.



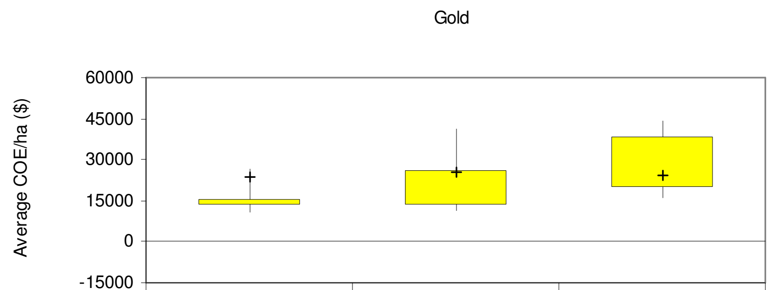
	2002/03	2003/04	2004/05
Lower Quartile	13208	17329	15493
Minimum	12245	13626	10595
Maximum	33144	26563	25999
Upper Quartile	14470	20372	23129
+ Median	16482	19072	21783

Season



	2002/03	2003/04	2004/05
Lower Quartile	11342	12507	14812
Minimum	7404	7491	8113
Maximum	19812	25806	24551
Upper Quartile	14020	18377	19332
+ Median	15882	14699	16557

Season



	2002/03	2003/04	2004/05
Lower Quartile	12927	12927	19484
Minimum	10842	11356	15925
Maximum	26473	41224	44043
Upper Quartile	15607	26281	38212
+ Median	23644	25705	24024

Season

Appendix 8. ARGOS personnel (Source: ARGOS website - www.argos.org.nz).

Jon Manhire

Jon is the Programme Leader for ARGOS. Jons' expertise lies in business and strategic planning for the primary production industry - both agriculture and horticulture - for producers, businesses and sectors. He also performs market and industry analyses and has specific knowledge of environmental integrity systems - not only organic and sustainable markets but conventional production systems also. Jon also designs and implements primary sector research and development projects. He has undertaken international consultancy work in South Africa, South America, China, Europe and the Pacific Islands, and has experience in developing effective solutions for both large and small enterprises.

Hugh Campbell

Hugh is an Agricultural Sociologist with long-standing research interests in the changing lives of farm households in New Zealand. His PhD research examined the impacts of Rogernomics on farms in the 1980s. His interest in sustainable agriculture began in 1994 and followed the fortunes of the Watties organics initiative in Canterbury. This initial case study of organic production by corporate New Zealand grew into a FRST funded programme called Greening Food: Social and Industry Dynamics which operated out of the University of Otago and the AERU at Lincoln University (working primarily with John Fairweather).

John Fairweather

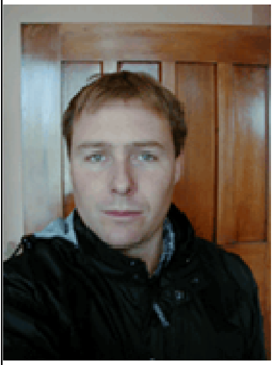
John likes to solve problems and do research well. His research usually involves working with sociological theory and methods to improving our understanding of New Zealand society, and in applied sociology to describe and monitor contemporary changes in farming, rural society and other aspects of contemporary society. His research role typically is to provide reports or documents that contribute to the needs of groups or organisations such as government ministries, businesses or non-profit groups. He is well rounded in his education with degrees in agricultural science and sociology, and has considerable experience with on-farm research. Current research includes studies of the effects of tourism (including the social, economic, environmental and cultural effects of tourism in Kaikoura, Rotorua, Hokitika and Christchurch), public perceptions of biotechnology, social aspects of forestry, and documenting the phenomenon of smallholdings. Over the last 20 years his full-time research includes the topics of land use change and socio-economic consequences, farmer surveys and rural monitoring, studies of rural communities, farmer decision making and innovation, and general innovation and change.

Caroline Saunders

Caroline has 20 years research expertise in the UK and New Zealand. She has over 100 publications specialising in agri-environmental issues and policy. Her research has focused on evaluating the link between economics and the environment. Her current research also specialises in evaluating trade and the environment, including an assessment of international market policies and their impact on the development of the NZ agricultural export sector. She has a track record in researching impacts of novel technologies on the agricultural sector, including the development of organic and GM food. She has undertaken research for a wide range of private and public bodies both here and overseas. These include the EU commission, MAF, MFAT, Treasury, MfE and various producer groups.

Henrik Moller

Henrik leads the "environmental sustainability" Objective of the ARGOS programme. He has over 25 years of experience studying the ecology and control of introduced species in New Zealand, sustainable harvest management and conservation of threatened species. Henrik teaches wildlife management part time at the University of Otago and works as an ecological consultant for ARGOS for the remaining time. Work on introduced wasps and their biocontrol led on to research on cats, ferrets, stoats, rabbit and rat impacts on native biodiversity and how best to control them. Henrik's research highlighted the importance of ferrets as wild animal vectors of bovine tuberculosis in farming landscapes. Another study assessed the conservation value of beekeeping and whether honey bees sometimes promote weed problems. Henrik was part of a MAF team that assessed gaps in knowledge and research priorities to promote more environmentally friendly farming and forestry in New Zealand. He is a passionate advocate of conservation through sustainable use and farmer-led approaches to simultaneous capturing of the best economic, social and environmental outcomes for farmers and their communities.



John Reid

Tena koutou. John's iwi is Ngati Pikiao. He is the contracted leader for Ngai Tahu Development Corporation's He Whenua Whakatipu research objective. He is currently a Ph.D. candidate at Lincoln University, with a resource management honours degree in community forestry. He has a trade in landscape construction and has operated his own business in this industry. He has also worked as a farmer. For the past three years John has undertaken action research and development, through his Ph.D., with flax-roots Maori communities adopting organic farming methods in Taitokerau and Tairawhiti. His research has primarily focused on the interaction between indigenous people and modern technology. In particular he has focused on distinguishing the different modes of indigenous development that arise when relationships with modern technology differ. John is now contracted by Ngai Tahu Development Corporation to investigate how the Ngai Tahu whanui can develop sustainable development pathways for their land-holdings. He feels that it is an honour for him to be leading this work.

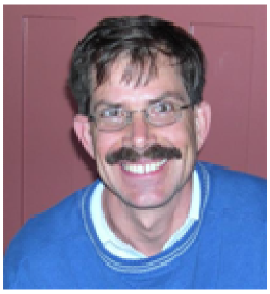
Lesley Hunt

Lesley has had what could be called a varied career! It started with lecturing in statistics for three years in the Maths Department at Otago University after graduation with a B.Sc. (Hons) in mathematics in 1968. Then she had a year teaching in schools in London, following the typical Kiwi OE pattern, then eight years in Te Kuiti, starting a family and doing some maths and physics teaching. In 1981 she moved to Christchurch where she has been ever since. In this time she has lectured a course in research methods to social work students at the University of Canterbury for twelve years, learned the piano and then become a piano teacher, spent seven years as a part-time biometrician with AgResearch at Lincoln, trained as a secondary teacher at the Christchurch College of Education, and recently completed a PhD at Lincoln University. The PhD was an organisational ethnography which studied why employees doing science in a particular Crown Research Institute were unhappy at work and what they did about it. It was titled 'Compliance at work: protecting identity and science practice under corporatisation'. She now works as a researcher with the Agribusiness and Economics Research Unit at Lincoln University, hence her association with the ARGOS programme. With her skills and experience she can bring to the fore the views of farmers and growers on sustainability and how these people working on conventional and organic farming systems make meaning of their work.

Martin Emanuelsson

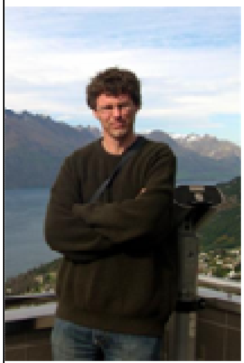
Martin is the Programme Manager for ARGOS. His main focus is on managing the dissemination and practical application of the ARGOS research findings. Data management and general project coordination comes alongside that.

Prior to joining the ARGOS programme Martin worked as a management consultant in Sweden as well as lecturing and doing research at the School of Economics and Management at Lund University.



Chris Rosin

Chris is a member of the social objective team and, together with Lesley and Carmen, has the responsibility of interviewing farmer and grower participants in ARGOS. He comes to the programme as a geographer with research experience in both social and environmental aspects of agriculture and sustainable production. His Ph.D. thesis (University of Wisconsin-Madison, 2004) examined the response of small-scale verba mate producers in Brazil and Paraguay to the new economic demands of regional free trade in MERCOSUR. The varied experiences and interpretations of producers with free markets provided the principal focus of the thesis. In earlier research, he has worked with both farmers and agriculture extension agents in Costa Rica, the United States, and Germany. He also has personal experience in extension and development activities stemming from 2+ years of service with the US Peace Corps in Paraguay. Chris expects to learn a great deal about agricultural production in New Zealand and looks forward to contributing to discussion about and promotion of sustainability in the sector.



Grant Blackwell

Grant is part of the ARGOS environment team, and works along-side Henrik Moller in investigating the environmental sustainability aspects of the program. Originally from Palmerston North in the North Island, Grant studied the interactions between introduced mammalian predators and native species in native forests for his PhD, before spending the last three years investigating the impacts of foxes on native mammals in Australia. He comes to ARGOS with an interest in all things furry, feathery and fishy, and is particularly interested in how productive farms can successfully fit into the larger landscape. He lives in Dunedin with his partner Suzanne in their newly purchased house (complete with an old dog, untamed garden, and too many DIY jobs to list!), and largely spends his spare time working on the aforementioned newly purchased house, and dreaming of motorbikes, cars, and other environmentally unfriendly past-times!"

Andrew Barber

Andrew's primary role in the ARGOS programme is to examine total energy use indicators together with water use efficiency. Having graduated from Massey University he has been involved in engineering consultancy for over 10 years, initially with Agriculture NZ and now in his own company which is a member of The AgriBusiness Group. He has previously worked on energy analysis for the dairy industry, outdoor vegetable and arable industries, the greenhouse industry and the kiwifruit industry. Most of this work has been initiated by market demands, either actual or future perceptions, to account for energy use and to provide quantifiable environmental indicators. Andrew also manages the Franklin Sustainability Project which is a long running initiative by outdoor vegetable growers, primarily in response to soil erosion but which also encompasses a whole range of sustainability issues. This multi stakeholder project was the recipient of an MfE Green Ribbon Award in 2000.

Chris Perley

Chris comes from a background in integrated land use, policy making and natural resource management. He added philosophy to his forestry science and agricultural science qualifications in the 1990s, with a particular interest in environmental philosophy. He comes from a farming background in Gisborne/Hawkes Bay, and has worked as a field forester, an advisor to farm foresters, a land use and resource management consultant, and a government policy analyst. He is interested in land use systems, and the potential for such an approach to provide gains in environmental, economic and social values for land owners and communities, hence his association with ARGOS. His Otago University PhD studies are in socio-ecological systems and sustainable land management.

Jayson Benge

Jayson is the Field Research Manager for kiwifruit. His main responsibilities are to identify and recruit suitable orchards and to co-ordinate and assist in the research that will be carried out on those orchards. While ARGOS brings together a number of specialist researchers, Jayson will be the face for the kiwifruit industry.

Jayson is a graduate of Massey University and has a Horticulture degree and a Ph.D. in Plant Science (kiwifruit production). Recently, Jayson has worked within Zespri Innovation where he gained a valuable insight into the kiwifruit industry. Jayson brings to ARGOS a good grounding in kiwifruit production issues and a strong science background.

Jayson lives in Mount Maunganui with his wife and two boys. His interests include sports, the outdoors and computers. Jayson can be reached in the ZESPRI Office on 07 572 7799, on his cell phone on 027 258 0770 or by email: jayson@agribusinessgroup.com

Dave Lucock

Dave is the Field Research Manager for Sheep and Cattle. He is now based in Christchurch after 20 years of sheep, cattle and dairy farming. His role in the ARGOS Programme is to coordinate the 'on the farm' research, facilitate discussion groups and manage the relationships between farmers, other stakeholders and the research team.
He enjoyed his farming career and now wants to help enhance the agricultural industry, which he firmly believes this research programme will do.

Communication wise, Dave has an open door policy and can be reached at: 03 365 6804 (work), 0272 580 771 (cell) or dave@agribusinessgroup.com

Mark Stevenson

Mark is the Field Research Manager for the high country component of the ARGOS programme. His role within the high country component is to coordinate the 'on farm' research, facilitate discussion groups and manage the relationships between farmers, other stakeholders and the research team. Mark is based in Christchurch with The New Zealand Merino Company, having recently returned from two years at the University of Illinois, USA where he completed a Masters Degree in Agricultural Economics (Agribusiness). His research looked at the New Zealand Merino industry and the organisational changes that have taken place within it. Prior to this, Mark completed a B.Com Ag (Farm Management) at Lincoln University. Mark brings to ARGOS a strong farming background backed up by a practical understanding of high country issues. Mark can be reached on (03) 377 7990 (work), 027 460 8621 (mobile), and mdstevenson@paradise.net.nz

Amanda Phillips

Amanda is the Field Research Manager for the Dairy sector. Her role in the Argos Programme is to manage the comparative research between both conventional and organic dairy farmers and their interaction with the research team. She has an agricultural science degree from Massey University, a diploma in sustainable horticulture and is in the process of completing a Masters of Agricultural Science from Lincoln University. Amanda previously spent four and a half years as a Consulting Officer in the Waikato, before going dairy farming in Canterbury. After returning from overseas in 2001, she worked for several organisations completing research contract projects.

Amanda's email is Amanda@agribusinessgroup.com.