A1 6.16 Stakeholder Report: October 2008

2008 Annual ARGOS Sector Report

KIWIFRUIT

Compiled by Jayson Benge

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Preface

The first Annual ARGOS Sector Report for Kiwifruit was produced in 2005 and contained findings from the first 12 – 18 months of the programme. The following two reports presented the results of subsequent research carried out in 2005/06 and 2006/07. This fourth report summarises most of the work to date including new work carried out in 2007/08.

Full reports for much of the content in this report are available from ARGOS; many can be downloaded freely from www.argos.org.nz

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.

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Acknowledgments

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The ARGOS programme has been designed and implemented with the intention of providing quality information to both farmers and orchardists 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)
- Jayson Benge (ARGOS Field Manager - Kiwifruit)
- Jon Manhire (ARGOS Programme Manager)
- Ross Haycock (Orchard advisor)
- Tim Oliver (Organic orchardist)
- Garry Hill (Scientist, HortResearch)

ARGOS would also like to thank everyone at ZESPRI who provided data for this report.

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 determining the environmental, economic and social characteristics of primary production systems in NZ with the goal of assessing the sustainability and socio-ecological resilience of farming. In the Kiwifruit sector, the three main production systems are being compared i.e. KiwiGreen Hayward ('Green'), KiwiGreen Hort16A ('Gold') and Organic Hayward ('Green Organic'). Twelve orchards from each production system are being studied. This report characterises the production, management, economic, social and environmental features of ARGOS orchards and orchardists with an emphasis on the main differences between production systems.

Recent production

- As expected, Gold orchards in the ARGOS programme have tended to produce the most, largest and highest dry matter fruit.
- In recent years, Green orchards in ARGOS have on average produced a third more trays than their Organic counterparts; Green Organic orchards have also tended to produce smaller and lower dry matter fruit.
- The production trends for ARGOS orchards have tended to follow Industry trends.

Orchard history and management

- Most of the orchards were first planted with kiwifruit in the 1980's and were previously dairy farms.
- In terms of winter canopy management, the majority of Green orchardists have preferred to use replacement cane or a mixture of wood. In contrast, the majority of Green Organic orchardists have preferred to use low vigour. Similar numbers of Gold orchards have used replacement cane and low vigour.
- The number of hives used for pollination has not differed much between systems. Fewer Gold orchards have used artificial pollination.
- The majority of Green Organic and Gold orchards have been trunk girdling mainly to enhance fruit dry matter. Fewer Green orchards have been trunk girdled. About a third of orchards have been cane girdling in spring to enhance fruit size while only one or two have been cane girdled in the summer.
- In comparing average soil fertiliser inputs for Green and Gold:
    - Green orchards have received slightly more nitrogen (N). Lower N for Gold may be a measure to minimise excessive growth in this more vigorous variety.
    - Gold orchards have received slightly more phosphorus (P).
    - Similar amounts of potassium (K) and sulphur (S) have been applied.
    - Previously, Gold had received more magnesium (Mg) but in recent years have received less.
    - Green orchards have receive much more Calcium (Ca).
- Green Organic orchards have generally received less macro-nutrients with the exception of P. Lower nitrogen applications is thought to be a key limiting factor for organic production.
- A simple nutrient budget shows that the amounts of macronutrients being removed by the harvested crop are well met by ground fertiliser applications. Therefore, there maybe an opportunity to be more efficient with fertiliser use.
- In recent years, the total number of sprays applied to Green and Gold orchards has been similar (a total of 7 – 8 each year).
- Green Organic orchards have tended to receive slightly more sprays for the control of insects but these have all been certified organic with much lower potential toxicity to the environment.
- In the last couple of seasons, a third to a half of ARGOS orchards have irrigated to assist vine growth and health. Close to half the orchards have also used some form of frost protection. Only one or two orchards have carried out any form of soil

cultivation which is a reflection of the good quality soil on which the majority of orchards are grown.

Economics

- Gold is the most different in terms of operating performance due to higher OGR (a result of higher yields and/or OGR per tray) but also higher costs (a result of greater labour requirements to manage the greater vigour). Despite these differences, the operating surplus has not been significantly different between systems.
- Green and Green Organic, statistically, have not been different in terms of OGR and total growing costs (per ha). Green has had consistently higher spray & chemical, repairs & maintenance, pollination and wage costs but the differences have not been great. Green has also had consistently lower admin, fertiliser and vehicle costs.

Environment

- Our data and anecdotal observations indicate that the environmental health of kiwifruit orchards is generally good.
- Environmentally, we have found a lot more similarities than differences between Green and Gold orchards particularly with respect to soil quality and terrestrial biology (birds).
- Green Organic orchards have had the most different environmental outcomes such as more native birds, more earthworms and higher soil quality.

Social

The results of a 2nd round of causal mapping interviews are presented. This process asks orchardists to identify the most important factors in their production systems and the relationships (causal influences) between factors. Differences between Green, Green Organic and Gold systems were as follows:

- Compared to Green, Green Organic orchardists placed significantly greater importance on cash orchard surplus, satisfaction and family needs, and significantly less importance on the packhouse.
- Green orchardists compared to Gold, placed significantly greater importance on fertiliser and soil fertility, and significantly less importance on post harvest quality and family needs.
- Green Organic compared to Gold, placed significantly greater importance on orchard environmental health and vine health but significantly less importance on packhouse and postharvest quality.

In 2005 and 2008, decision maker, fruit yield and quality, and orchard gate return were identified as the most important factors by the ARGOS orchardists. Differences between years are currently been explored further and will be reported elsewhere in a full ARGOS report on causal mapping.

Management vs. environmental outcomes

Now that ARGOS has collected several years of data, we can now turn our attention to identifying causation for the different environmental outcomes across farms particularly between those under the same production system i.e. why do conventional or organic orchards vary in their soil quality or level of biodiversity etc? This is something we will be putting a lot of effort into during the final stages of the project as it will allow us to identify the impacts of particular practices on the environment.

As an example, we've recently looked at relationships between insecticide numbers and bird density on orchards. In both 2004/05 and 2006/07, there was no relationship evident for any of the three production systems. This finding could be interpreted as a positive outcome because it implies orchardists who need to apply a greater number of sprays to produce an economic crop can do so without having a greater impact on the environment. This is just a preliminary finding and we will be analysing the data further.

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.

ARGOS is undertaking a longitudinal study, called "Pathways to Sustainability", which is determining the environmental, economic and social characteristics of primary production systems in NZ with the goal of assessing the sustainability and socio-ecological resilience of farming. A number of agricultural sectors are involved including kiwifruit, sheep & beef (lowland and 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 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%) (HortResearch, 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. GlobalGAP 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.

1.3 Kiwifruit research design

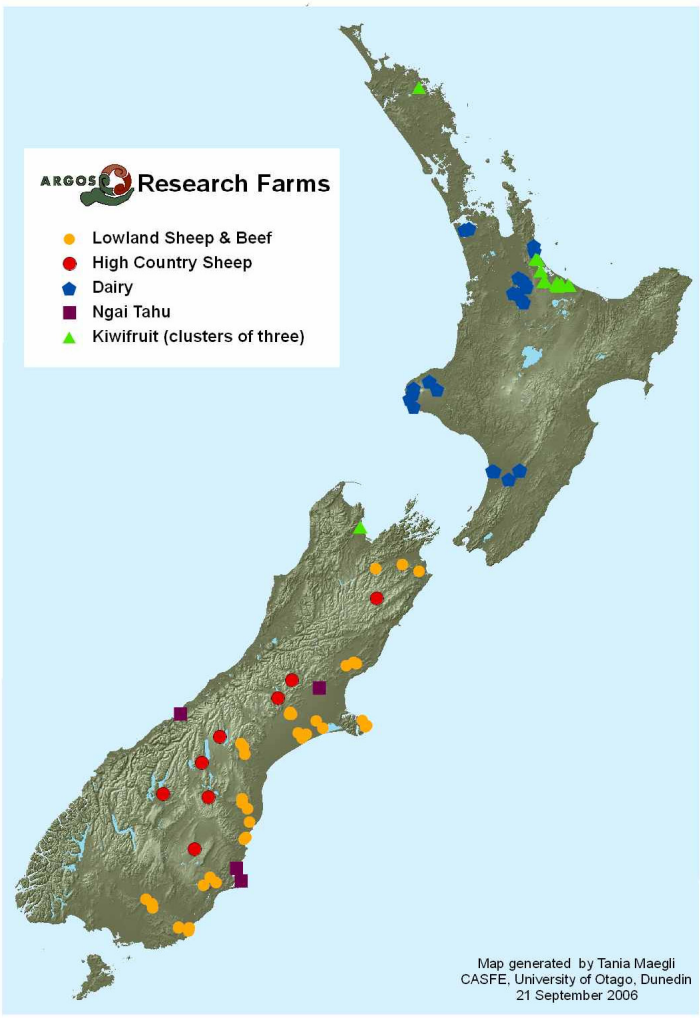
The following production systems (sometimes referred to as management systems or panels) are being studied in the kiwifruit sector:

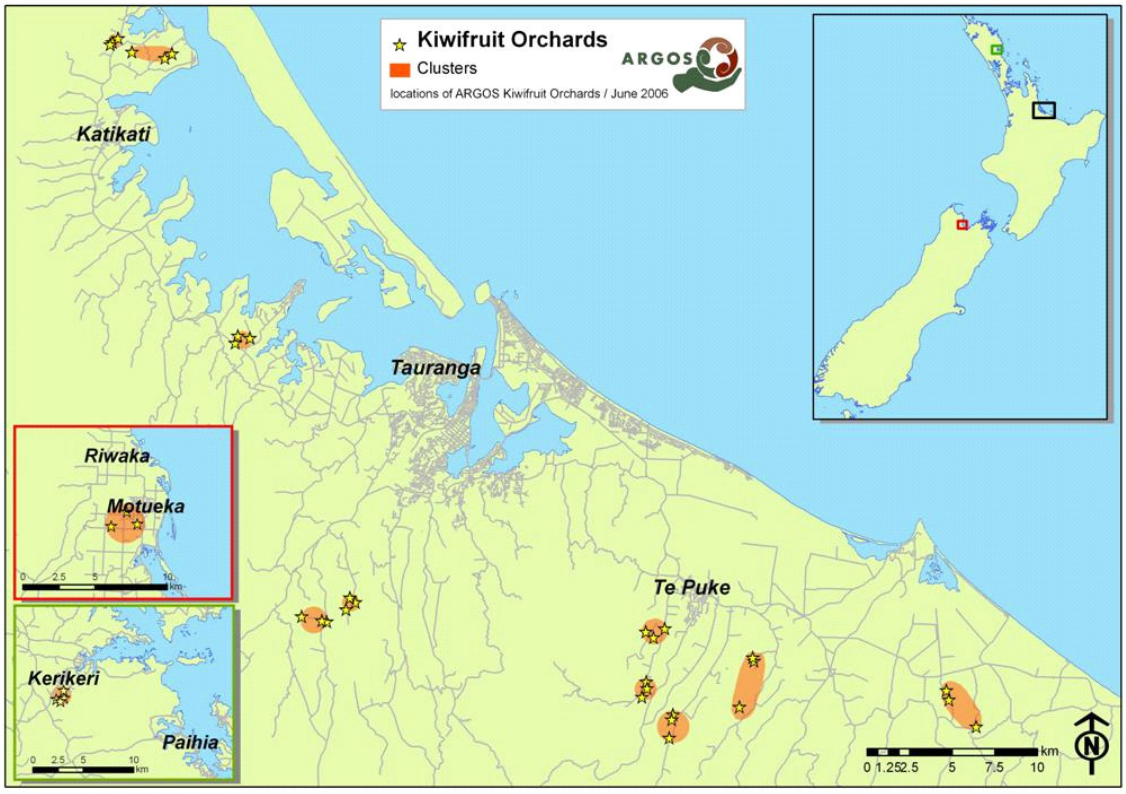
- Hayward (*Actinidia deliciosa*) variety grown under the KiwiGreen system ("Green")
- Hayward variety grown under the certified organic system ("Green Organic")
- Hort16A (*A. chinensis*) variety grown under the KiwiGreen system ("Gold")

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). The orchards within each cluster are close together to minimise differences in background factors like soil type and climate. 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.

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





2. Orchard Production

2.1 Introduction

This section of the report provides average production 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 between management systems. It is hoped that with time, we will be able to contribute to a better understanding of what might be contributing to these differences. Differences are likely to be due to a combination of environmental, financial and social factors, all of which are addressed in the transdisciplinary approach adopted by the ARGOS programme. Industry data presented here was obtained from ZESPRI databases and publications.

2.2 Number of trays

The performance of individual orchards is often measured in terms of its yield particularly the number of export (Class I) trays produced. Orchardists often benchmark their yields against neighbours, other orchardists, and packhouse/industry averages. In recent years, there has generally been a slight increase in the average no. of trays for ARGOS orchards which is consistent with Industry trends (Figure 2).

For ARGOS orchards, the greatest increase in average tray numbers has occurred with Gold – a result of younger orchards maturing and established orchards producing very good crops. The overall increases in tray numbers can be attributed to favourable growing conditions and improved and new practices. Girdling (ring-barking) is an example of a new practice which although primarily used to increase fruit quality has the effect in Hayward of increasing return bloom and potential yield in the following season (this increase is not always desirable as it can result in the need for increased thinning (and cost), and potentially reduced fruit size due to a dilution effect).

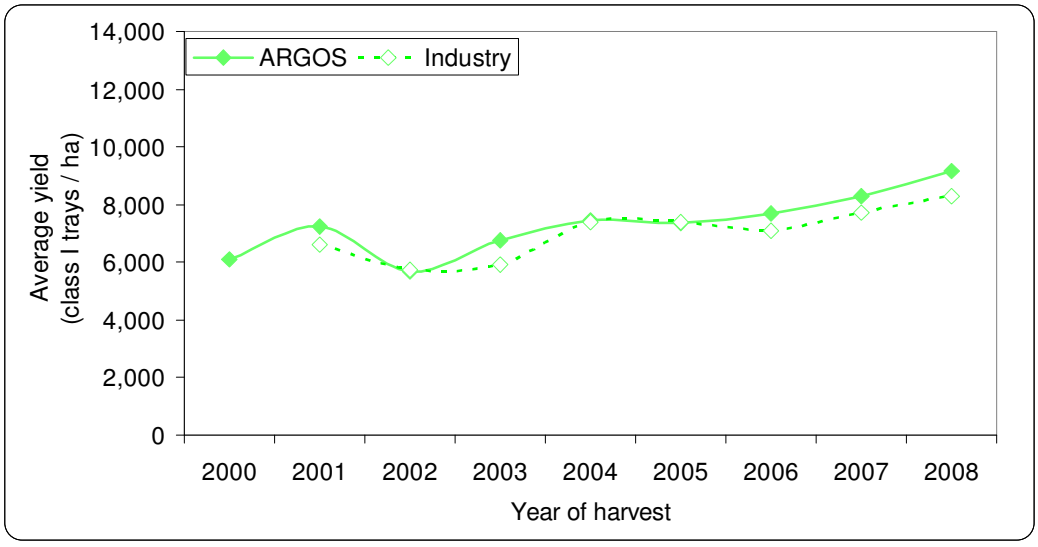
Since 2000, ARGOS Green orchards on average have produced about 35% more trays than their Organic counterparts which is similar to the Industry difference of about 32%. This difference is likely to be mainly due to the use of budbreak agents (hydrogen cyanamide) on Green Orchards that enhance production. Such chemicals are not permitted for use on Organic orchards. ARGOS Gold orchards have yielded about 10% more trays on average than their Green counterparts (which is lower than the average Industry difference of about 19% for the same period). A survey conducted in 2005 by ARGOS revealed Gold to have higher density of winter buds and greater budbreak which is consistent with the greater yields (2006 Annual ARGOS Sector Report - Kiwifruit).

2.3 Fruit size

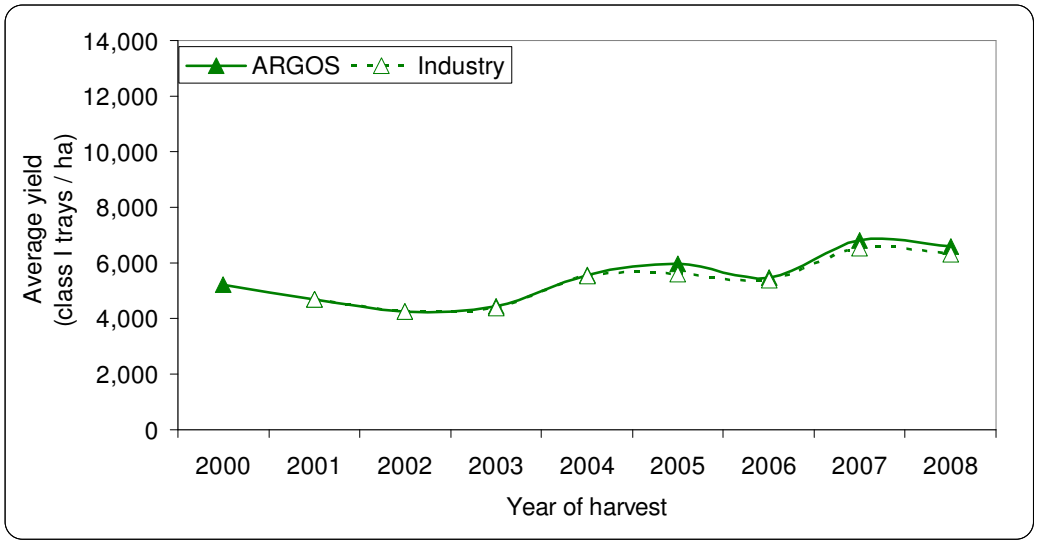
Fruit size is another important measure of orchard production as consumers and markets have preferred sizes. Orchardists strive to maximise yields of preferred size. On the whole, the average size of fruit from ARGOS orchards has been similar to Industry averages with the trends across time also being similar (Figure 3). Gold vines are capable of producing larger fruit which is reflected by the larger average fruit size for Industry and ARGOS Gold. Fruit size has generally increased since 2000 for Green but remained relatively flat for Green Organic and Gold (perhaps with the exception of a spike in fruit size in 2006 for Green Organic). Compared to Green, Green Organic orchards in ARGOS have on average produced smaller fruit (the difference has been significant in some years – 2004 & 2005). This is thought to be due mainly to a lack of available nitrogen during fruit development.

Figure 2. Trends in average tray numbers (Class I Submit) for ARGOS orchards (solid lines + solid symbols) and for Industry (dashed lines + open symbols). Industry data sourced from ZESPRI Kiwifliers.

Green



Green Organic



Gold

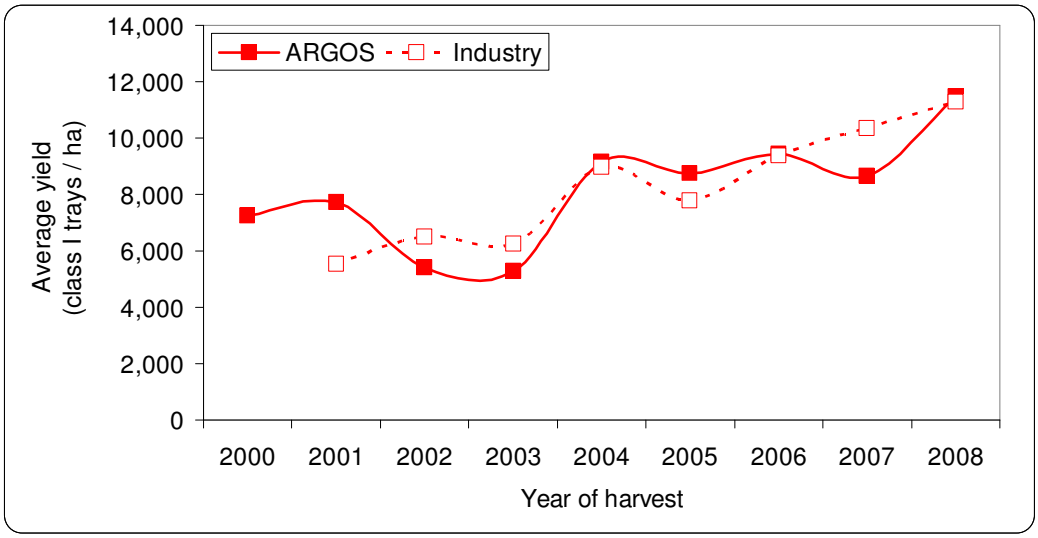
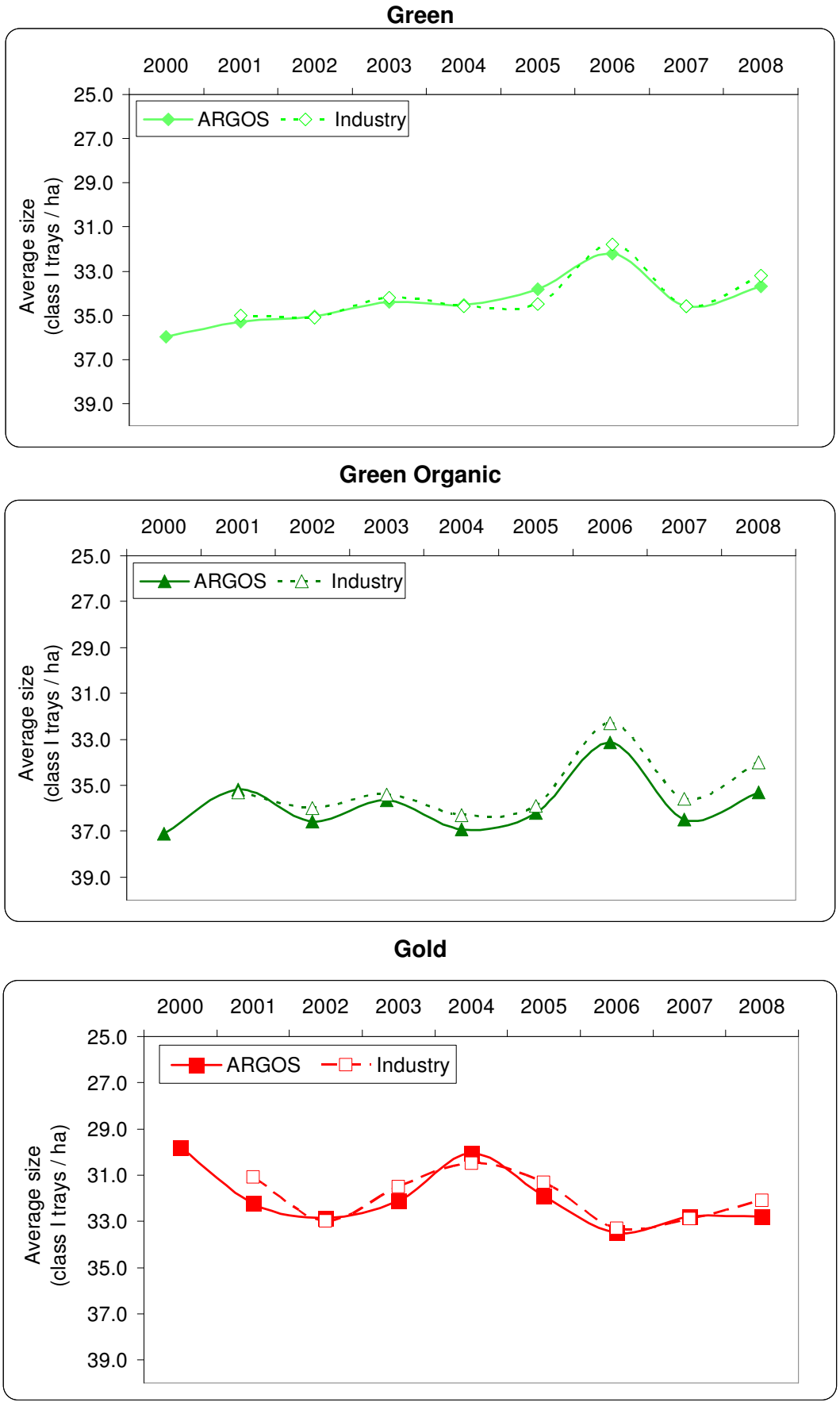


Figure 3. Trends in average fruit size (Class I Submit) for ARGOS orchards (solid lines + solid symbols) and for Industry (dashed lines + open symbols). Industry data sourced from ZESPRI Kiwifliers.



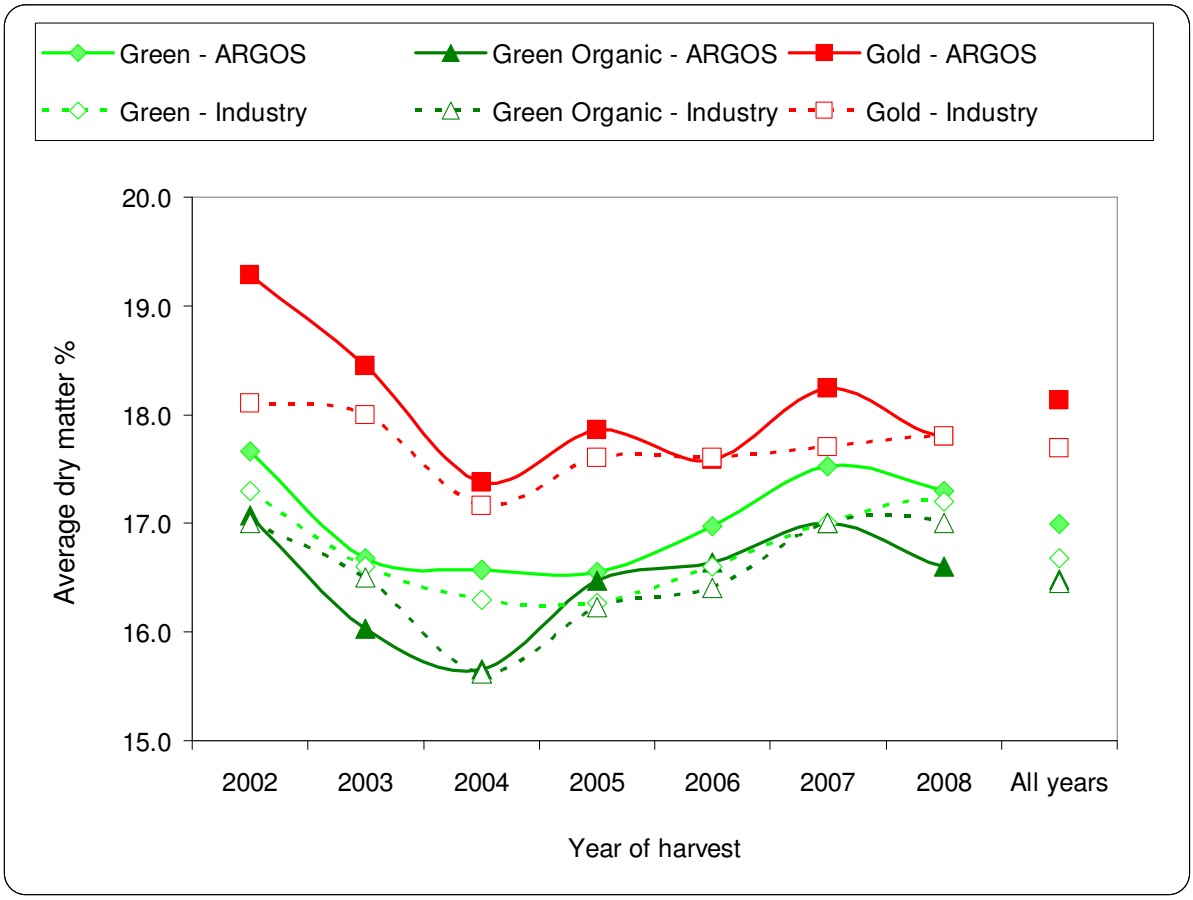
2.4 Dry matter

Since about 2002, the dry matter content of kiwifruit has become a dominant measure of orchard performance due to the willingness of consumers to pay more for better tasting fruit (higher dry matter = higher taste). In 2007/08 and 2008/09, the maximum dry matter payments offered for Green, Green Organic and Gold were 40%, 50% and 60% respectively (ZESPRI, 2007, ZESPRI, 2008).

Since about 2004 there has generally been an overall increase in average dry matter levels of fruit from ARGOS orchards which is consistent with Industry trends (Figure 4). These increases can be attributed to favourable seasonal factors as well as improved practices impacting on the final dry matter content of fruit.

Gold kiwifruit has consistently had higher dry matter levels because it is a naturally sweeter variety. The average dry matter levels have on average been higher in Green than in Green Organic though the differences have been small in recent years.

Figure 4. Trends in average fruit dry matter levels for Green, Green Organic and Gold orchards in ARGOS (solid lines + solid symbols) and for Industry (dashed lines + open symbols). The averages are based on the highest dry matter results for each maturity area (Industry data obtained from KiwiTech Bulletins and ZESPRI).



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). Here we discuss the recent management factors and practices on kiwifruit orchards and the differences between production systems. This information has been collected through annual interviews with the orchardists.

3.2 Management structures

Kiwifruit orchardists have a range of management options. These range from having no involvement in the orchard (a leased situation) to having an overseeing role (a managed situation) to having a day-to-day hands-on role (owner-operated). Traditionally, orchards have been owner-operated where the owners (including family) have performed most of the work including mowing, spraying, fertilising and pruning. Across the Industry, there seems to be a decline in the number of owner-operated orchards in favour of managed and leased models. The majority of ARGOS orchards would tend to fall into the owner-operated category with the owners working full-time on their orchards. A greater proportion of Gold orchards would fall into the managed category though the reasons for this are unclear (it could possibly reflect the owners treating their orchards more as production blocks).

3.3 Orchard history

In addition to orchard practices, orchard history and previous land use are important considerations when comparing the outcomes of different orchards and production systems. Current soil quality for example will be influenced by how the land was previously farmed. Unfortunately, the exact year that many of the ARGOS orchards was established is not known as the current owners were not on the orchards at that time. Nevertheless, many of the orchardists (at least 25 out of 36) have indicated that their orchards were first planted with kiwifruit in the early 1980's. Nearly all of the orchards were previously dairy farms with the others having a tobacco (the Motueka orchards) or cropping history.

3.4 Orchard practices

3.4.1 Introduction

The main cultural practices carried out on kiwifruit orchards in a production season include:

- Canopy and crop management + pollination
- Orchard floor management
- Soil management
- Crop protection
- Harvest

These practices can vary considerably not only between production systems but also between orchards with the same production system. The main differences between ARGOS orchards are discussed here.

3.4.2 Canopy and crop management

Management of the canopy is the largest undertaking on a kiwifruit orchard and for this reason the greatest regular cost. Probably the biggest difference between production systems occurs with the winter pruning of canopy. Winter pruning is the task of replacing last season fruiting wood with new wood to carry the next season's crop. As organic vines are generally of lower vigour, getting complete canopy fill can be an issue especially at wider plant spacings or following summers during which a lot of replacement wood has been lost to wind, frost or just poor growth. Often greater use is made of more vigourous cane on

organic orchards to ensure vines don't "runt out". This is evidenced by the greater proportion of Organic orchardists in ARGOS that are targeting replacement canes rather than lower vigour wood. There doesn't seem to have been much change in wood selection between 2006/07 and 2007/08 with maybe one or two orchards under each production system changing their preference (Table 1).

Summer canopy management is undertaken to ensure next year's fruiting wood remain as well lit as possible through the growing season. It consists mainly of squeezing/tipping of shoots in spring, removal of excess growth in the leader zone, removal of blind unfruitful shoots in the fruiting canopy, removing excessive tangles, and pruning of males after flowering and through the summer as required. Because wood quality is very influential in the floralness of next season's wood, greater attention to the quality of summer canopy work is required in organic production to achieve similar yields as conventional orchards.

An important aspect of crop management is thinning or culling of unwanted fruit in order to optimise fruit numbers, size and quality. Virtually all orchards undertake some level of thinning or culling.

Girdling of vines can enhance fruit dry matter levels and is now common practice in the Industry because of the associated financial rewards. ARGOS orchardists who were previously reluctant to trunk girdle are now doing so because they feel they have too much to lose financially from not maximising fruit dry matter. Generally there haven't been any major shifts in the total number of ARGOS orchards girdling which suggests that orchardists who have not yet adopted this are not likely to unless there is a significant shock to their system. Conversely, orchardists likely to adopt girdling are likely to have done so by now.

Table 1. Number of ARGOS orchards (out of 12 for each production system) with different wood selection and girdling for the 2007/08 seasons. Values in brackets are for 2006/07. Wood preferences were verbally communicated to us by the orchardists. No formal assessments were made in the field.

Orchard practice	Type	Green	Green Organic	Gold
Winter pruning – main style	Cane replacement	3 (3)	8 (7)	5 (4)
	Low vigour	5 (6)	2 (2)	5 (7)
	Mix	4 (3)	2 (3)	1 (1)
Cane girdling	Spring	5 (4)	3 (5)	4 (4)
	Summer	3 (2)	1 (1)	0 (0)
	Spring + summer	2 (0)	0 (0)	0 (0)
	Total cane girdling	6 (6)	4 (6)	4 (4)
Trunk girdling	Spring	3 (1)	4 (0)	3 (3)
	Summer	4 (6)	8 (8)	10 (8)
	Spring + summer	3 (1)	3 (0)	3 (1)
	Total trunk girdling	4 (6)	9 (8)	10 (10)

3.4.3 Pollination

Because kiwifruit require transfer of pollen from male to female vines for fruitset, high stocking rates of specially managed honey bee hives are usually required in orchards. Orchards in high density orchard areas can use less than the recommended eight to ten hives per hectare because of high bee densities on neighbouring orchards with hives. Organic orchards generally flower later (and for a longer period) than their conventional neighbours and may not benefit from this situation.

With the exception of the Organic orchard in Kerikeri, all ARGOS orchards regularly introduce hives to pollinate their fruit with the stocking rates ranging from 6 – 12 hives per hectare with an overall average of eight per hectare for Green and Green Organic, and nine for Gold. In both 2006/07 and 2007/08, five Green and six Green Organic orchards used artificial pollination in addition to hives; only two Gold orchards used artificial pollination.

3.4.4 Orchard floor management

Control of the orchard sward in kiwifruit orchards is normally achieved mechanically by mowing. The number of times ARGOS orchards have been mowed in recent years has been relatively constant (Table 2). Organic orchardists on average have tended to mow less often than Green and Gold orchardists suggesting that they can tolerate longer sward.

Table 2. Average number of times ARGOS orchards have been mowed fully each year.

Season	Green	Green Organic	Gold
2005/06	8	6	8
2006/07	7	5	7
2007/08	7	5	7

3.4.5 Crop protection

An important aspect of kiwifruit production is the use of agrichemicals to manage animal risks on orchards that might significantly impact on production or the ability to sell fruit. The most commonly applied agrichemicals are for the control of insect pests (Table 3, Appendix 1) particularly leafroller and armoured scale. In recent years, Gold orchards have received slightly more sprays than Green mainly because of the regular application of fruit sizing agents (i.e. Benefit). While Green Organic orchards have applied more insecticides, these have been certified organic with a lower potential environmental risk than conventional sprays (Appendix 2).

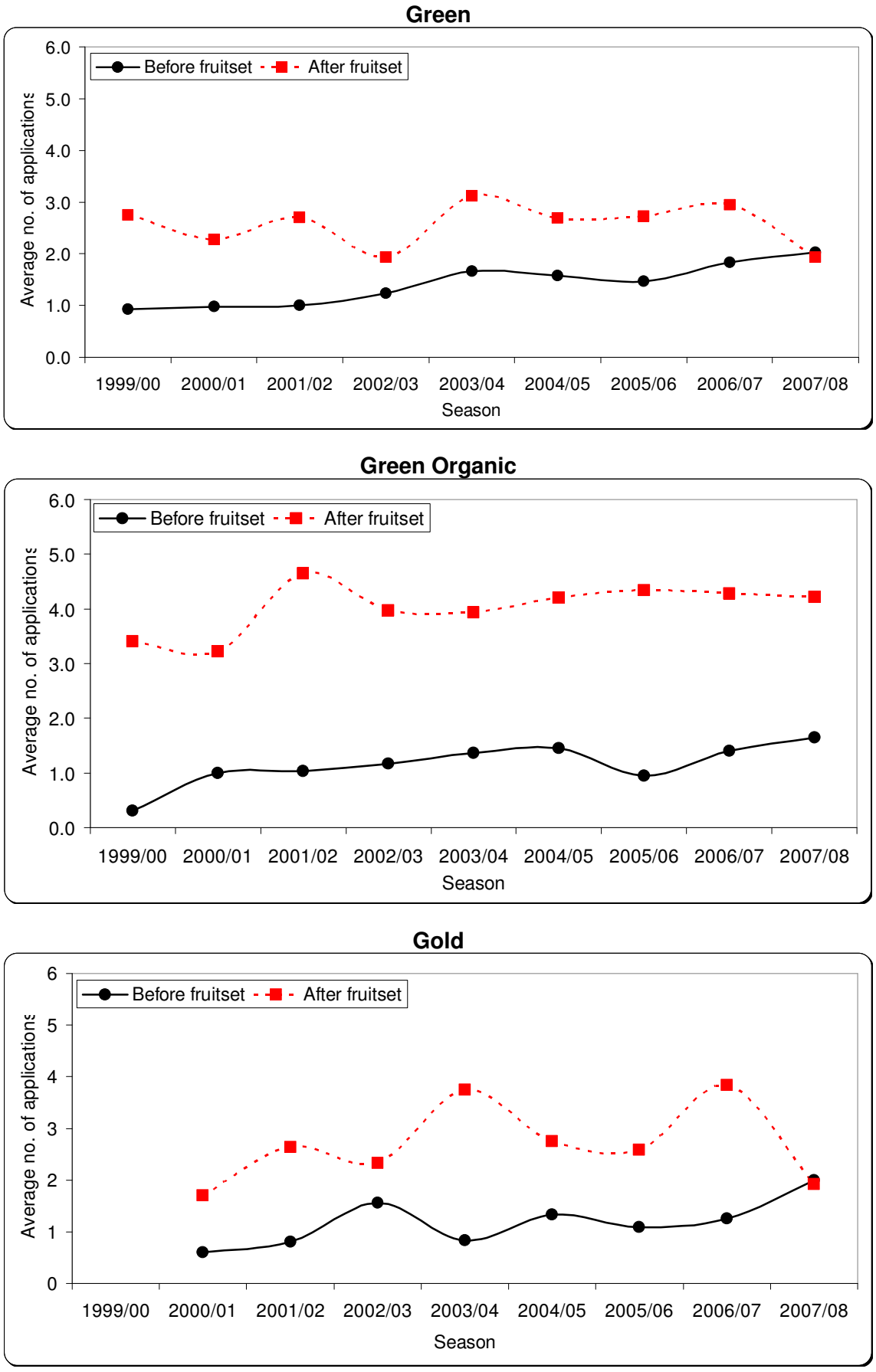
Table 3. Average number of times major sprays have been applied annually to ARGOS orchards over the 1999/00 to 2007/08 period. Based on data obtained directly from spray diaries held by ZESPRI.

	Green	Green Organic*	Gold
Fungicide	0.8	0.1	0.5
Herbicide	0.9	0.0	0.9
Insecticide	4.0	5.6	4.0
Budbreak enhancer	1.0	0.0	0.7
Other (incl. Benefit)	0.5	0.3	1.8
Grand Total	7.1	6.0	7.9

*Certified organic sprays only are permitted.

For all three production systems, pre-flowering use of insecticides seems to have increased slightly over time (Figure 5) which can be explained by an increasing effort by Industry (tech transfer) to promote pre-flowering use of sprays. However, despite the apparent increase in pre-flowering sprays, the number of sprays post-flowering does not seem to have decreased (prior to 2007/08). In 2007/08, there was a strong push by Industry to reduce post-flowering sprays because of a need to provide residue free fruit. It should be remembered that the trends here are the averages for just 12 orchards per system and that spray use on some individual orchards has been up and down over time. It would be interesting to see how these results compare with a larger sample however this would require considerable effort as until recently sprays diaries have been paper ones.

Figure 5. Trends in total insecticide use on ARGOS orchards pre- and post-flowering. Based on data obtained directly from spray diaries held by ZESPRI.



3.4.6 Soil nutrition

Trends in the levels of macro-nutrients applied to the soil of ARGOS orchards is shown in Figure 6 with the average differences for the 2003/04 to 2007/08 period shown in Figure 7.

The main differences between Green and Gold can be summarised as follows:

- Green orchards have received slightly more nitrogen (N). Lower N for Gold may be a measure to minimise excessive growth in this more vigorous variety.
- Gold orchards have received slightly more phosphorus (P).
- Similar amounts of potassium (K) and sulphur (S) have been applied.
- Previously, Gold had received more magnesium (Mg) but in recent years has received less.
- Green orchards have received much more Calcium (Ca).

Organic orchards have generally received less macro-nutrients with the exception of P. Organic orchards tend to receive large quantities of plant and animal based fertilisers like compost and fish. While the nutritional content of these is small (just a few percent) the large quantities applied (an average of 6 T/ha of compost and 1,200 L/ha of fish annually) means potentially large amount of nutrients are applied. The nutrients in organic fertilisers are likely to be released slowly, potentially over several years.

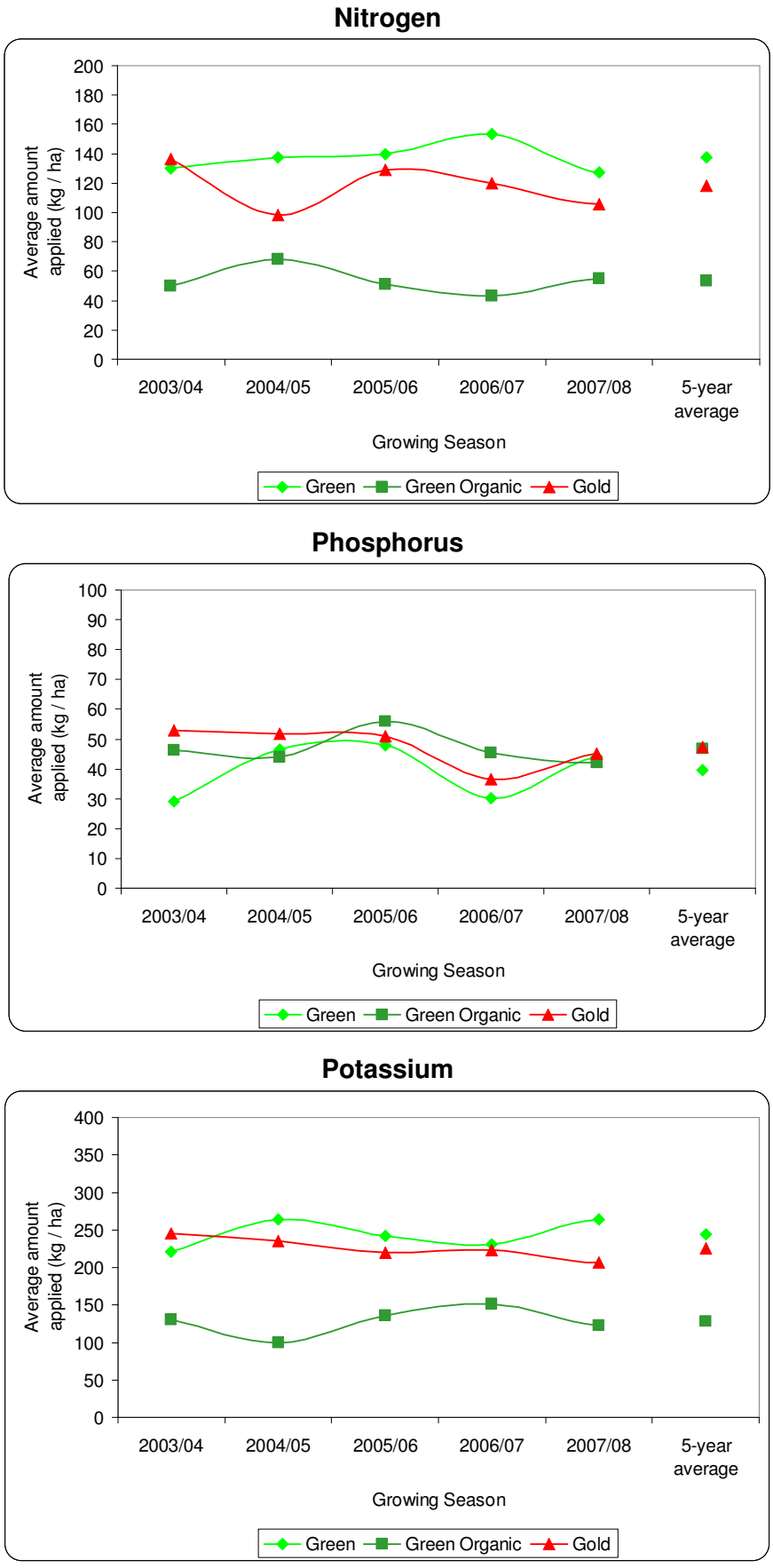
Lime, Sulphate of Potash (SOP; potassium sulphate), Muriate of Potash (MOP, potassium chloride), and Calcium Ammonium Nitrate (CAN) are the most commonly applied mineral fertilisers for Green and Gold (Table 4). SOP is also commonly applied to Organic orchards as are RPR and Patent Kali.

In the ARGOS programme, Organic orchards were generally found to have soils with slightly better physical and biological attributes while many chemistry measures were also higher in value (see section 4.2). Organic orchards were also found to contain significantly less P and S though the levels were still acceptable. Differences in the amounts and types of fertilisers used, as discussed here, will contribute significantly to differences in soil quality; other influential factors include orchard history and previous land use.

Is too much fertiliser being applied?

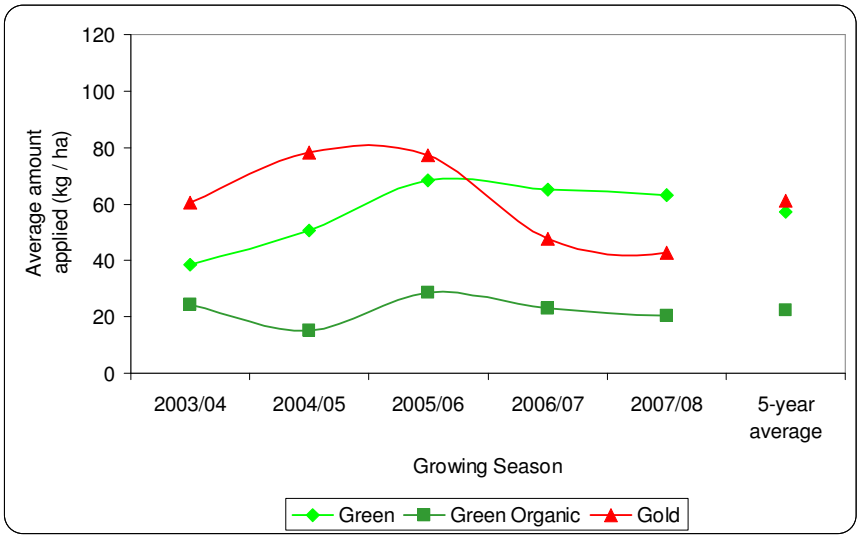
Our results (indicating good soil fertility) make us wonder if fertiliser applications could be reduced even on organic orchards where soil fertility is generally good. A simple nutrient budget shows that the amounts of macronutrients being removed by the harvested crop are well met by ground fertiliser applications (Table 5). The apparent surplus allows for nutrient interactions with the soil, inefficiencies in plant uptake and losses by leaching but there may also be an indiscriminate aspect to the amounts of fertiliser being added. Given the growing awareness about the impacts of food production on the environment, reducing fertiliser inputs is something that might be considered especially given the rising costs and unavailability of some fertilisers. Fertiliser inputs, particularly inorganic nitrogen, are also a large component of the energy budgets on the orchard so reducing applications could help step the kiwifruit industry towards carbon neutrality and improved market security and value. Reducing fertiliser inputs could be trialed while measuring soil and leaf nutrient levels to ensure that no nutrient deficiencies are occurring. Orchardists thinking about changing should discuss with their advisors who will have a specific understanding of the soils on their orchards and crop requirements.

Figure 6. Trends in the average levels of macro-nutrients added to soils in ARGOS kiwifruit orchards between 2003/04 and 2007/08. All types of fertiliser are included. Generally, data was obtained from orchardists fertiliser recommendations with additional information provided by the orchardists.



Sulphur

Magnesium



Calcium

Figure 7. Average amounts of nutrients applied to kiwifruit orchards in the ARGOS programme for the 2003/04 to 2007/08 period. The black vertical lines represent suggested annual fertiliser requirements for maintaining yields on established Hayward kiwifruit vines for a 8,000 trays/ha crop (Source: **www.hortnet.co.nz**). Generally, data was obtained from orchardists fertiliser recommendations with additional information provided by the orchardists.

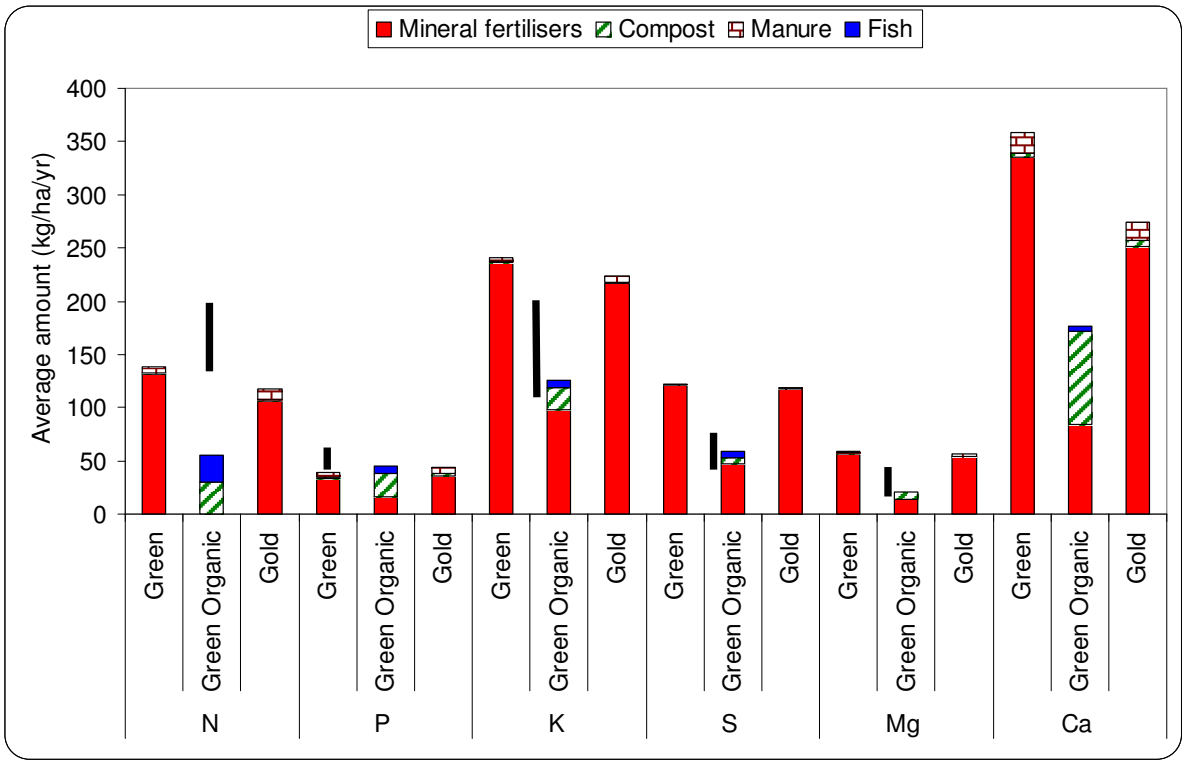


Table 4. Most commonly used mineral fertilisers on Green, Green Organic and Gold orchards in the ARGOS programme. Average rates (kg/ha/yr) for the 2003/04 to 2007/08 period are shown. Generally, data was obtained from orchardists fertiliser recommendations with additional information provided by the orchardists.

Product	Approx. nutrient content	Green	Green Organic	Gold
Lime	37% Ca	520	70	350
Calcium Ammonium Nitrate (CAN)	27% N, 8% Mg	330	0	370
Sulphate of Potash (SOP, potassium sulphate)	40% K, 17% S	240	110	170
Muriate of Potash (MOP, potassium chloride)	50% K	140	30	120
Gypsum (calcium sulphate)	18% S, 24% Ca	100	30	120
Reactive Phosphate Rock (RPR)	12% P, 34% Ca	0	120	0
Patent Kali (potassium sulphate + magnesium sulphate)	25% K, 17% S, 6% Mg	0	80	20

* A small number of standard kiwifruit mixes, supplied by fertiliser companies, were applied to a small number of orchards. These mixes contained some of the above products, however their average contribution (across all orchards) was low and therefore not included here.

Table 5. Average production levels for ARGOS kiwifruit orchards for the 2004 to 2006 period and the estimated amounts of nutrients exported in the fruit and added as inorganic and organic ground fertilisers. (Base nutrient data sourced from: **www.hortnet.co.nz**).

	Amounts of nutrients (kg/ha) added as ground fertilisers			Amounts of nutrients (kg/ha) removed in harvested fruit		
	GREEN	GOLD	GREEN ORGANIC	GREEN	GOLD	GREEN ORGANIC
Production (trays/ha)				7,500	9,200	5,700
Nitrogen	140	120	60	40	50	30
Phosphorus	40	50	50	10	10	5
Sulphur	120	120	60	5	10	5
Potassium	240	230	120	70	110	60
Magnesium	50	80	20	5	5	5

3.4.7 Other practices

In the last couple of seasons, a third to a half of ARGOS orchards has irrigated to assist vine growth and health though the amounts applied have not been quantified. Close to half the orchards have also used some form of frost protection. Only one or two orchards have carried out any form of soil cultivation which is a reflection of the good quality soil on which the majority of orchards are grown.

4. Environment

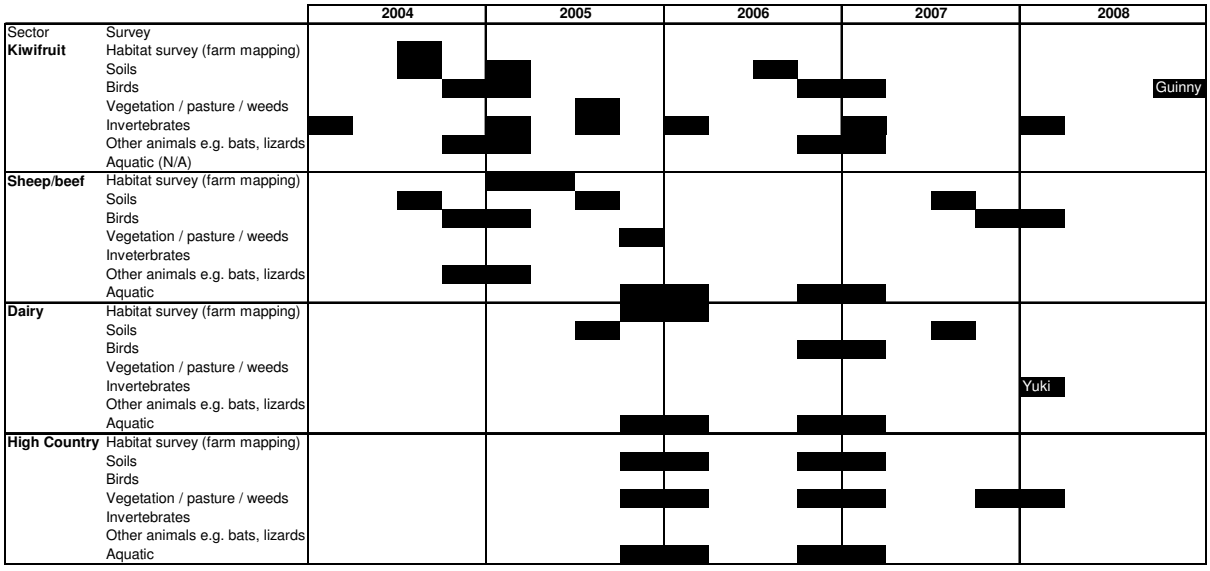
4.1 Introduction

Consumers are becoming increasingly concerned about how their food is produced and the associated impacts. This is being reflected in assurance schemes globally which are beginning to place more emphasis on the environmental impacts of farming. Take for example Tesco's 'Nature's Choice' Integrated Crop Management System which encourages the use of beneficial insects rather than chemicals to control pests. Orchardists are asked to draw up a farm conservation plan, which guides them in protecting important wildlife and landscapes. Closer to home, GlobalGap contains an 'Environment and Management' section which aims to increase orchardist's awareness of the impacts of orcharding on flora and fauna. Requirements like these are likely to increase and for this reason the kiwifruit industry needs to improve its understanding of the impacts of production. The environment objective of the ARGOS programme aims to clarify the environmental impacts of different production systems which will also 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 and provide an understanding of why the selected indicators are or are not changing. Identifying the reasons for the observed changes or lack of them is the key to providing better advice on how to bring the desired improvements in sustainability and resilience.

A summary of the environmental monitoring that has been carried out by ARGOS across the various sectors is presented in Figure 8. In the initial 12 – 18 months of the programme (2004 – 2005), baseline surveys of the physical environment of kiwifruit orchards were undertaken with the results presented in earlier sector reports like this one. This was followed by repeat sampling of environmental indicators like soil quality and invertebrates. In the last 12 months environmental monitoring has been minimal due to budget strictures and the need to spend more time analysing previously collected data. Here we provide an overview of the main findings to date.

Figure 8. Core environment monitoring that has been carried out by ARGOS across different agricultural sectors.



4.2 Soil health

4.2.1 Introduction

The quality of the soil is fundamental to sustaining production, livelihoods and diverse and abundant ecological communities on farms. Soils and associated microbes and animals are equally important across all farming sectors and production systems, thus providing a common ground to compare across all ARGOS farms. For these reasons, soil quality has been the highest priority for ARGOS's environmental monitoring. Two complete soil sampling rounds have been completed for kiwifruit (2004 and 2006) with the results summarised here.

4.2.2 Soil fertility

Generally, soil fertility was high for all three production systems. Green Organic orchards, despite not using highly soluble fertilisers, did not appear to be compromised and for some parameters, they even exceeded Green and Gold i.e. pH, CEC, exchangeable cations and anaerobic mineralisable nitrogen (AMN). For all three systems, there was no evidence that fertility differed significantly between 2004 and 2006. This suggests that current soil management practices are adequately meeting the nutritional requirements of kiwifruit over time.

Soil quality has been measured both within-rows (under the leaders) and between-rows (alleyways). Total carbon, AMN, total nitrogen, CEC and cations were generally higher between-row. A probable cause of this is more organic matter (e.g. vegetation and prunings) in the between-row zones. In contrast, Olsen P was higher within-row. The reason for this is unclear but perhaps greater vegetation between-row is utilising P that is added there.

4.2.3 Soil structure

A general indicator of soil structure and compaction is soil bulk density (SBD). This has been moderate overall for ARGOS orchards (0.7 - 0.9 g/cm^3 to a depth of 15cm). Green Organic has had lower SBD whilst Green has had the highest. Soil porosity and aggregation, which has been assessed visually, has also been significantly better for Green Organic orchards. The reasons for these differences are not clear though it is possible that Organic orchards use machinery less often and so compaction is lower; anecdotally, Organic orchards appear to mow less and according to (Barber and Benge, 2006), Organic orchards use less diesel inferring less tractor use. Also, higher organic matter content in the Organic soils compared to Green may be a contributing factor.

The physical condition of the soil has generally been better within-row possibly because of greater compaction from machinery use between-rows.

4.2.4 Soil biology

Soils from the Green Organic orchards generally have had larger microbial populations than those from Green and Gold orchards suggesting that organic management may be having some beneficial effects on microbial populations.

Higher microbial populations were evident between-row and are probably due to the organic matter returns from grass and herbage root turnover that dominate these areas. Within-row areas are often treated with herbicide (in Green and Gold) which would reduce organic matter returns there.

We have not detected any consistent differences in microbial activity (i.e. basal respiration rates) between systems. The difficulty of establishing differences in basal respiration rates between Organic and Conventionally managed orchards has been noted before (Goh et al., 2000) and given that most soils in this study were generally in good condition, it is not surprising that differences have not been consistently detected.

Earthworm numbers have only been about 10% - 25% of those typical for pastures (Carey et al., 2006, Fraser et al., 1996). Larger numbers were found under Green Organic probably reflecting the greater organic matter sources available like compost. Fewer earthworms were found within-rows and the use of herbicides in these areas on Gold and Green orchards would partly explain this as herbicides often remove food sources (Hartley et al., 1996). Whilst herbicides and pesticides can affect earthworm activity, it is probably not the major reason for differences as both vegetation cover and soil physical management are more likely to impact on earthworms numbers (Hansen and Engelstad, 1999, Hartley et al., 1996, Springett et al., 1994). Springett et al., 1994 found that a completely undisturbed kiwifruit orchard block lost its earthworm population over seven years despite no active management whilst a commercial organically-managed orchard maintained a similar earthworm presence to that at the start.

4.2.5 Nematodes and other soil invertebrates

Soil invertebrates and nematodes have been studied in ARGOS pilot trials as potential indicators of the impact of production on soil quality. However, little or no differences were observed in overall soil invertebrate activity and in the overall soil nematode population. This combined with the practical difficulties of measuring these animals, especially nematodes, led us to abandon any further monitoring in this area. Further details on these studies can be found in ARGOS's 2006 Annual Sector Report for Kiwifruit.

4.3 Orchard health

4.3.1 Birds

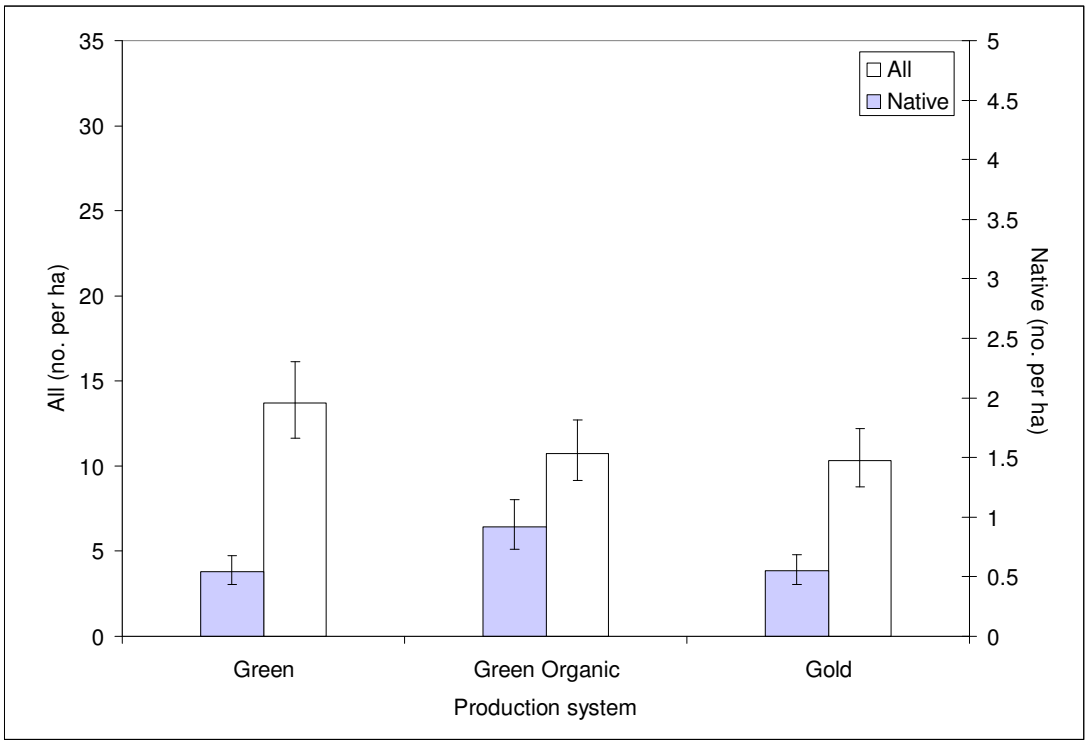
Studies on European farms have identified widespread declines in birds and consequently triggered rising concern about the impact of agricultural intensification on biodiversity. ARGOS will now monitor trends in birds, hopefully for the next 20 years, to see if similar problems are occurring here and, if so, what can be done about them. If the abundance and diversity of New Zealand farmland birds is stable or increasing, the growing environmental awareness of overseas consumers could create an incentive to buy New Zealand's products.

The relative abundance of birds on ARGOS kiwifruit orchards has been surveyed in 2004/05 and 2006/07. The total density of birds (no. per ha) does not seem to have differed between production systems (Figure 9). However, there is some evidence that the density of native birds has been higher in organic orchards. Densities were much higher in 2006/07 and we are currently checking if this was a real difference or due to an improved methodology used.

Overall, the most common species found have been the introduced passerines i.e. blackbird, thrush, house sparrow and finches (Figure 10). The next most common were native species i.e. fantail, silvereye and tui, with the latter only being found in NZ i.e. endemic.

Figure 9. Average density (no. / ha) of all birds and native birds on ARGOS orchards in 2004/05 (top) and 2006/07 (bottom). Predicted means are shown with standard error bars.

2004/05



2006/07

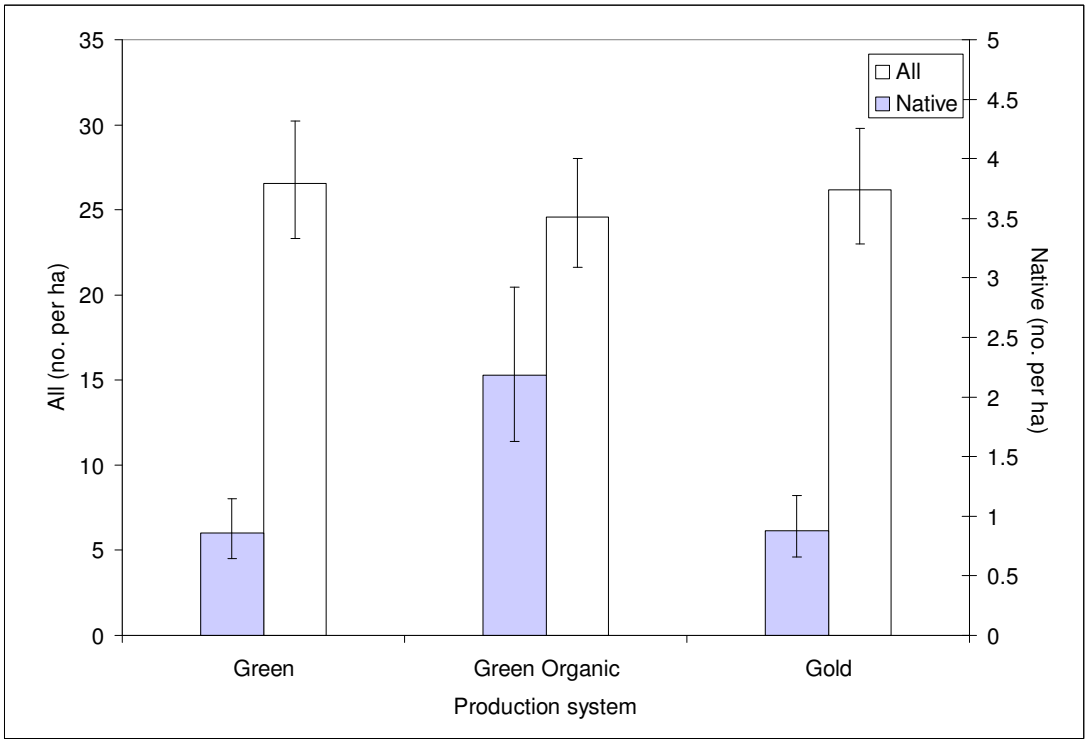
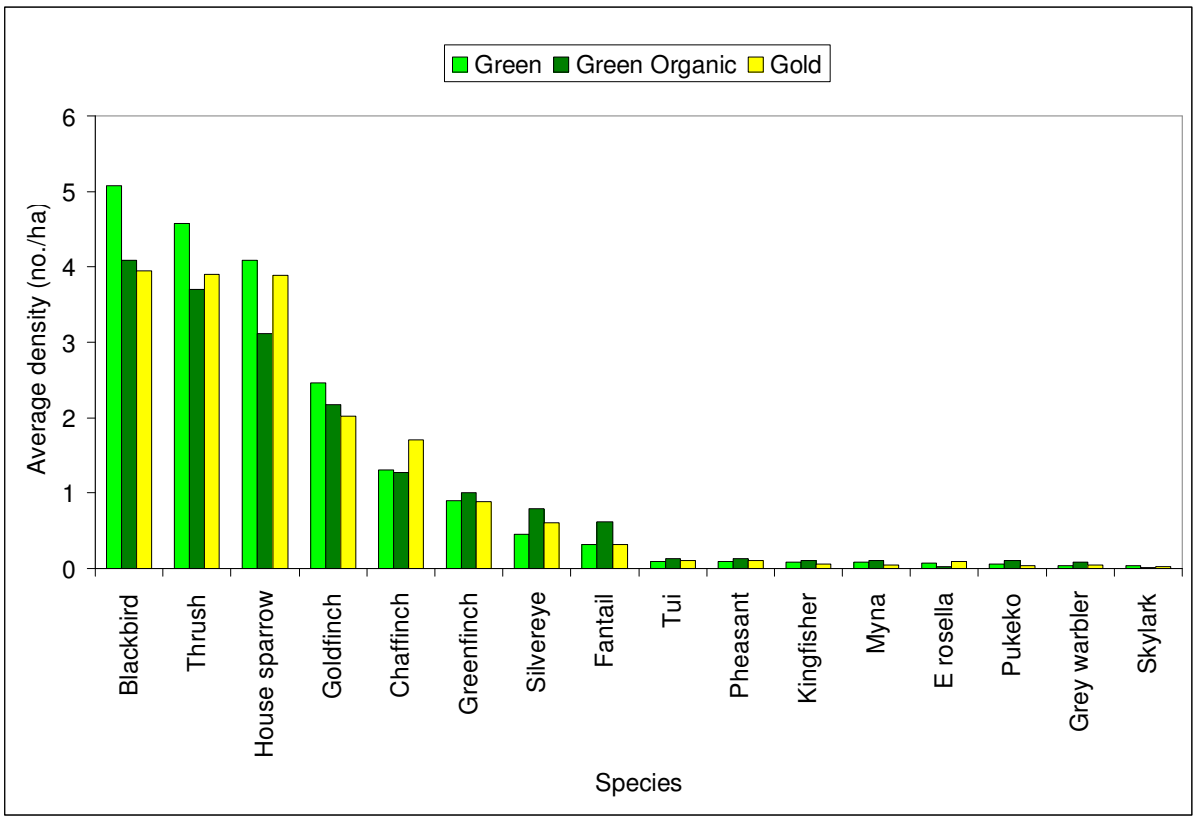


Figure 10. Average density (no. per ha) of individual bird species found on ARGOS orchards in 2004/05 and 2006/05. Actual means shown.



4.3.2 Cicadas and spiders

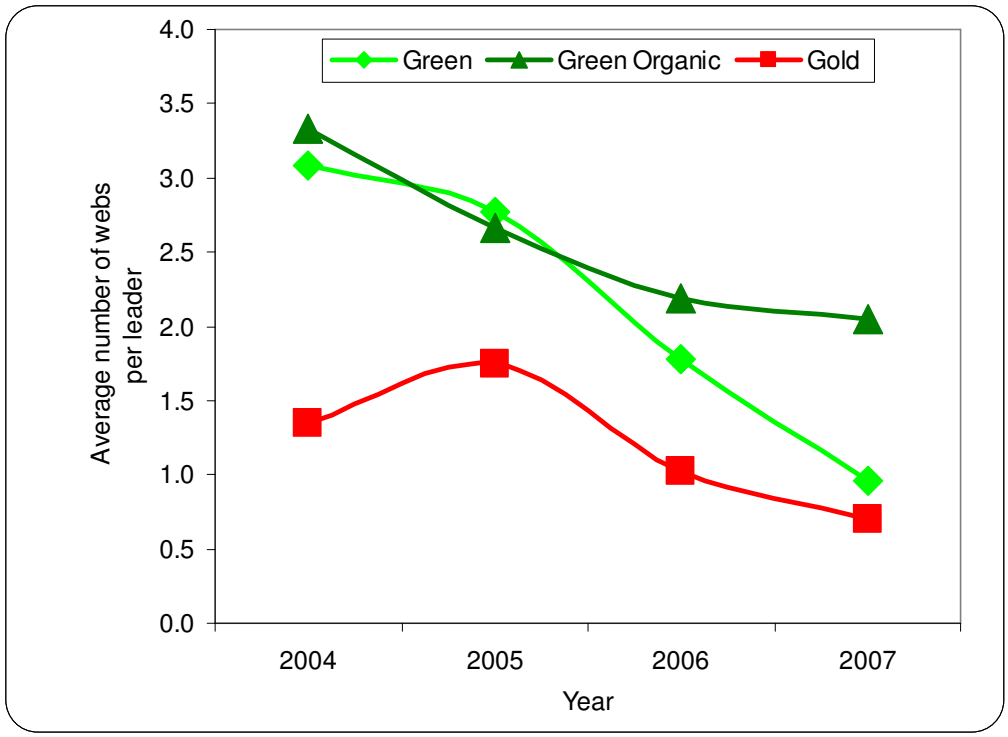
Research and monitoring of invertebrates, which includes insects, mites and spiders, is necessary to understand functioning of agro-ecosystems and the influences of farming on them. The invertebrate fauna is a very rich source of diversity in terrestrial ecosystems and in many situations will be the most numerous and most diverse component of the animal life present. This extreme diversity makes it impractical to monitor the entire fauna and focusing of effort is needed. We have therefore singled out some pest invertebrates for targeted monitoring and spiders as keystone predators.

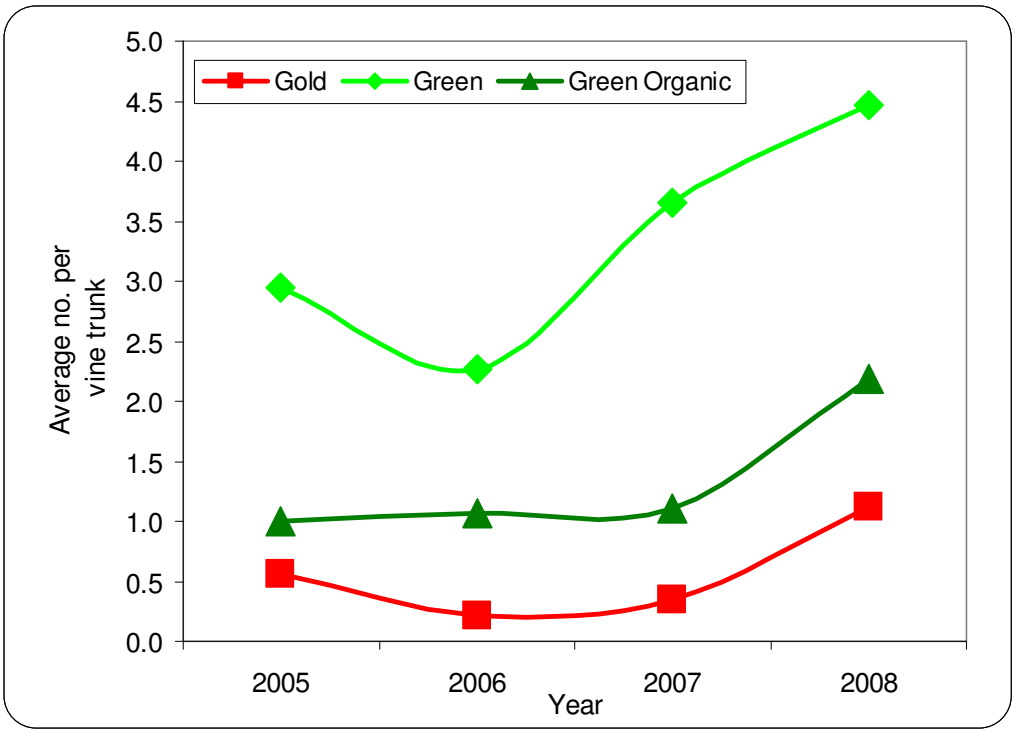
Cicadas were chosen as a potential focal species for ARGOS partly because they are classified as a minor pest (adults can cause fruit marking and the eggs are laid in the vines potentially weakening them) and partly as a potential indicator species (they are highly visible, well known and easy to sample). Spiders are a conspicuous component of the orchard fauna, provide food for birds and are valuable invertebrates in their own right. In addition, they are widespread, generally easily indexed (counts of webs can give an index of abundance), and likely to be affected by orchard management practices. For these reasons, spider abundance has been indexed on orchards.

The amount of spider webs and cicada exuviae (shells) attached to vines in ARGOS orchards has now been determined over four consecutive years. Gold has consistently contained the least spider webs (an indication of the abundance of web-spinning spiders) though the difference has been closing (Figure 11, top); in contrast, the gap between Green and Green Organic seems constant. Overall, there seems to have been a decline in average web numbers across all three production systems. On average, the most cicada shells have consistently been found in Green orchards with the least consistently found in the Gold orchards (Figure 11, bottom).

Information like this could provide an indication of the dynamics of these macro-invertebrates and tell us something about the ecological state of orchard environments.

Figure 11. Trends in the average number of spider webs (top) and cicada shells (bottom) found on vines in ARGOS kiwifruit orchards.





*predicted values from a statistical model (REML) are shown above as these take into account variation and would be expected to be closer to the true population means.

4.3.3 Other invertebrates

A survey of invertebrates present in the kiwifruit canopy occurred in the summer of 2004/05. The results of this were presented in previous reports (Benge, 2005, Steven and Benge, 2006) with significant differences found in terms of total insect abundance and the amounts of armoured scale and different types of mites (Table 7).

ARGOS is currently supporting a PhD student (Jacqueline Todd) who is modelling the impact of biological control agents on invertebrates in orchards. As part of this research trapping of insects (flying through the air and crawling on the ground) occurred in ARGOS 'Hayward' orchards in the Bay of Plenty during the 2007/08 growing season. This should provide us with a greater understanding of ecological differences across kiwifruit production systems. The results of this work will be presented in future ARGOS reports.

4.4 Summary

A summary of the statistically significant differences we've found between kiwifruit production systems is shown in Table 7; indicators which have not differed significantly are presented in Table 6. Generally, the greatest difference has been between Organic and the other two systems with fewer and smaller differences detected between Green and Gold. This is not surprising given that the Organic management system is the most distinct of the three with greater restrictions placed on inputs particularly fertiliser and agrichemical use. Gold is a relatively new variety (commercialised in the late 1990's) and its production system has evolved from the system for Green hence there are some management similarities.

Table 6. Environmental indicators which have not been found to differ significantly between Green, Green Organic and Gold kiwifruit production systems.

Element	Sub-element	Indicator	Comment	Reference
Soil	Fertility	K Soluble-C Microbial-C (per unit of soil-C) C:N ratio	No difference between systems	Carey and Benge, 2007
	Biology	Basal respiration Metabolic quotient	No difference between systems	Carey and Benge, 2007
		Nematode abundance General invertebrate level	No difference between systems	Richards et al., 2006
	Structure	Surface condition (damage)	Low level of damage across all orchards	Carey and Benge, 2007
Terrestrial vertebrates	Birds	Total density	No difference between systems	This report
	Lizards	Lizard abundance	None found	Benge and Moller, 2005
	Bats	Bat abundance	No confirmed sightings	Benge, 2005
Habitat	Shelterbelts	Structure (height, porosity, length)	No difference between systems	Moller et al., 2006

Table 7. Environmental indicators which have been found to differ significantly between Green, Green Organic and Gold kiwifruit production systems.

Element	Sub-element	Indicator	Comment	Reference
Soil	Fertility	Olsen P and Sulphate-S	Green Organic < Gold	Carey and Benge, 2007
		pH, exchangeable cations, potentially mineralisable N	Green Organic > (Green, Gold)	
		Total C & N	(Green Organic, Gold) > Green	
		Organic-S	Gold > (Green, Green Organic)	
		Anaerobic Min. N, Ca	Green Organic > (Green, Gold)	
		pH	Green Organic > Green > Gold	
		CEC, Mg	Green Organic > Green	
	Biology	Microbial N	Green Organic > (Green, Gold)	Carey and Benge, 2007
		Microbial C (per unit of soil)	Green Organic > Green	
		Earthworm abundance	Green Organic > (Green, Gold)	
		Nematodes	Omnivorous levels: Green Organic > (Green, Gold)	Richards et al., 2006
	Structure	Bulk density	Green Organic < Green	Carey and Benge, 2007
		Aggregation and porosity (visually assessed)	Green Organic < (Green, Gold)	
Terrestrial invertebrates	Pests / beneficials	Cicada density & diversity	More in Green and less in Gold with Green Organic intermediate More *Amphipsalta cingulata* and less *A. zelandica* found in Green	Benge, 2006
		Armoured scale abundance	Green Organic > (Green, Gold)	Steven and Benge, 2006
		Insect abundance	Green Organic > (Green, Gold)	
		Mite abundance	Predator mites: Green < (Green Organic, Gold) Tydeid mites (detrital feeders): Green Organic < (Green, Gold) *Czenspinksia* mites (another detrital feeder): Green Organic > (Green, Gold)	
		Spider web density	Gold < (Green, Green Organic)	Benge, 2006
Terrestrial vertebrates	Bird communities	Species richness	Green Organic > (Green, Gold)	Blackwell et al., 2005
		Native bird density	Green Organic > (Green, Gold)	This report
Habitats	Orchard sward	Sward height	Green Organic > (Green, Gold)	Benge, 2006
		Species diversity		
	Shelterbelts	Species diversity	Incidental woody species: Green Organic < (Green, Gold)	Moller et al., 2006

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.

5.2 Global market and policy trends

At the global market level, ARGOS is monitoring market and/or policy trends which may affect New Zealand's Kiwifruit sector. The purpose of this is to identify factors that may affect the export of kiwifruit in the medium term including trends in market access schemes; internal and external agricultural and environmental policy in key export countries; and changes in consumer behaviour. This work has identified the following factors which are detailed in previous ARGOS Kiwifruit Market Access Reports for ZESPRI.

Trade factors: • World Trade Organisation negotiations • Bilateral trade agreements **Agricultural policies:** • The Common Agricultural Policy (CAP) • Fruit and vegetable reform • Removal of compulsory 'set- aside' • Rural development and agri-environmental programmes • The US Farm Bill **Production issues:** • Food safety and traceability	**Consumer trends:** • Health and nutrition • Nutritional labeling • Health and nutrition claims • Environmentally friendly food • Country Of Origin Labelling (COOL) • Organically produced food **Environmental issues:** • Climate change and carbon footprinting • Biodiversity • Water usage and quality standards • Reduction of pesticide use

The following is a summary of recent developments taken directly from Market Access Report 4 (August 2008) for ZESPRI:

Market developments

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

Food prices

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

Environmental concerns

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

Trade factors

- The recent WTO Doha negotiations collapsed meaning a resolution of the round is now some way off. A potential benefit of a resolution for kiwifruit is a reduction in tariffs currently applied in export markets. However, depending on how additional policies unfold there may be the potential for increased competition from domestic producers in some export markets.
- The CAP 'Health Check' is increasingly moving towards cross compliance in relation to environmental issues and the US Farm Bill is also implementing similar policies. The changing focus of agricultural policy expenditure in the EU and US will aid their farmers to meet the growing requirements of market assurance schemes from retailers which emphasise the sustainability attributes of products. This will only make it more likely that retailers will demand more of these attributes.

Future changes to market access requirements are likely to place greater demands on food producers and so NZ's kiwifruit industry should expect this.

5.3 Financial performance of ARGOS orchards: 2002/03 to 2006/07

At the farm or orchard level, we have now collected financial accounts for five consecutive years (2002/03 to 2006/07). 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 so that comparisons can be made if required. More detailed MAF Farm Monitoring data can be downloaded from the MAF Website (**www.maf.govt.nz**).

Production

As detailed in Section 2, Green orchards in ARGOS have on average consistently produced more than their Organic counterparts while the Gold orchards have produced more than the Green ones, especially in recent years. Yield is a significant driver of orchard returns so understanding these differences is important for interpreting orchard financial performance.

Orchard gate revenue (OGR) per ha

Despite the consistently higher average yield of Green compared to Green Organic, the average OGR/ha has been slightly higher for Green Organic though the difference has not been significantly different (Figure 13). The lower yields of Green Organic have been offset by the higher OGRs/tray which on average have been 50% higher between 2002/03 and 2006/07; this difference is consistent with the average Industry differential of 50% between 2002 and 2007 (ZESPRI, 2008). The average OGR/ha for Gold has been higher than both Green and Green Organic because of higher yields and/or tray returns.

Orchard working expenses (OWE) per ha

Trends in the major cost categories are shown in Figure 12. On average, the total operating costs (i.e. orchard working expenses) for Gold have been significantly higher than that of Green and Green Organic (Figure 13). This is largely driven by the greater vigour of this variety and the need for additional labour and resources to manage the canopy. The total orchard working expenses of Green have been slightly higher than Green Organic but the difference has not been significant. Although Green has had consistently higher spray & chemical, R & M, pollination and wage costs the differences have not been great. Green has had consistently lower administration, fertiliser and vehicle costs (Figure 14). Higher administration costs for organics is probably due to higher certification costs while the higher fertiliser costs may be a result of having to apply large volumes of compost and fish products.

Cash operating surplus (COS) per ha
The average COS/ha has been higher for Green Organic compared to Green which reflects the higher average revenue and lower expenses for Green Organic. The averages however have not been significantly different. The average COS/ha for Gold has not differed from that of the other systems because the much higher growing costs for Gold have offset the higher returns.

Orchard equity
Due to difficulties in collecting sufficient amounts of equity data (namely capital, asset and liability values), statistical comparisons of systems has not yet been possible. This data is required to estimate sustainability indicators of financial performance (like profitability solvency and liquidity). We will endeavour to collect this data in coming years.

Relationships between expenditure and revenue
A preliminary and simple analysis (of the averages for the 2002/03 to 2005/06 period) has not surprisingly shown that higher yields results in higher OGR. In contrast, no strong correlations have yet been found between total orchard costs, or individual cost categories, and OGR i.e. orchard expenditure does not seem to be a good predictor of revenue.

Summary
On the whole, Gold is the most different system in terms of operating performance due to greater OGR (a result of higher yields and/or returns per tray) and also greater growing costs (mainly due to the greater labour costs required to manage a more vigourous canopy). Despite Green's higher yields, statistically, Green and Green Organic have not been different in terms of total revenue and total expenditure (per ha).

Variability in the financial data and small sample size may be limiting our ability to detect significant differences and this is something we are currently exploring.

Figure 12. Trends in the major operating expenses on ARGOS orchards. Predicted means and standard errors are shown. Values each year have been adjusted using the Farm Expenses Price Index to represent values as at March 2008. **Note, data from only 4 of the 12 Gold orchards are used.** Outliers are not included.

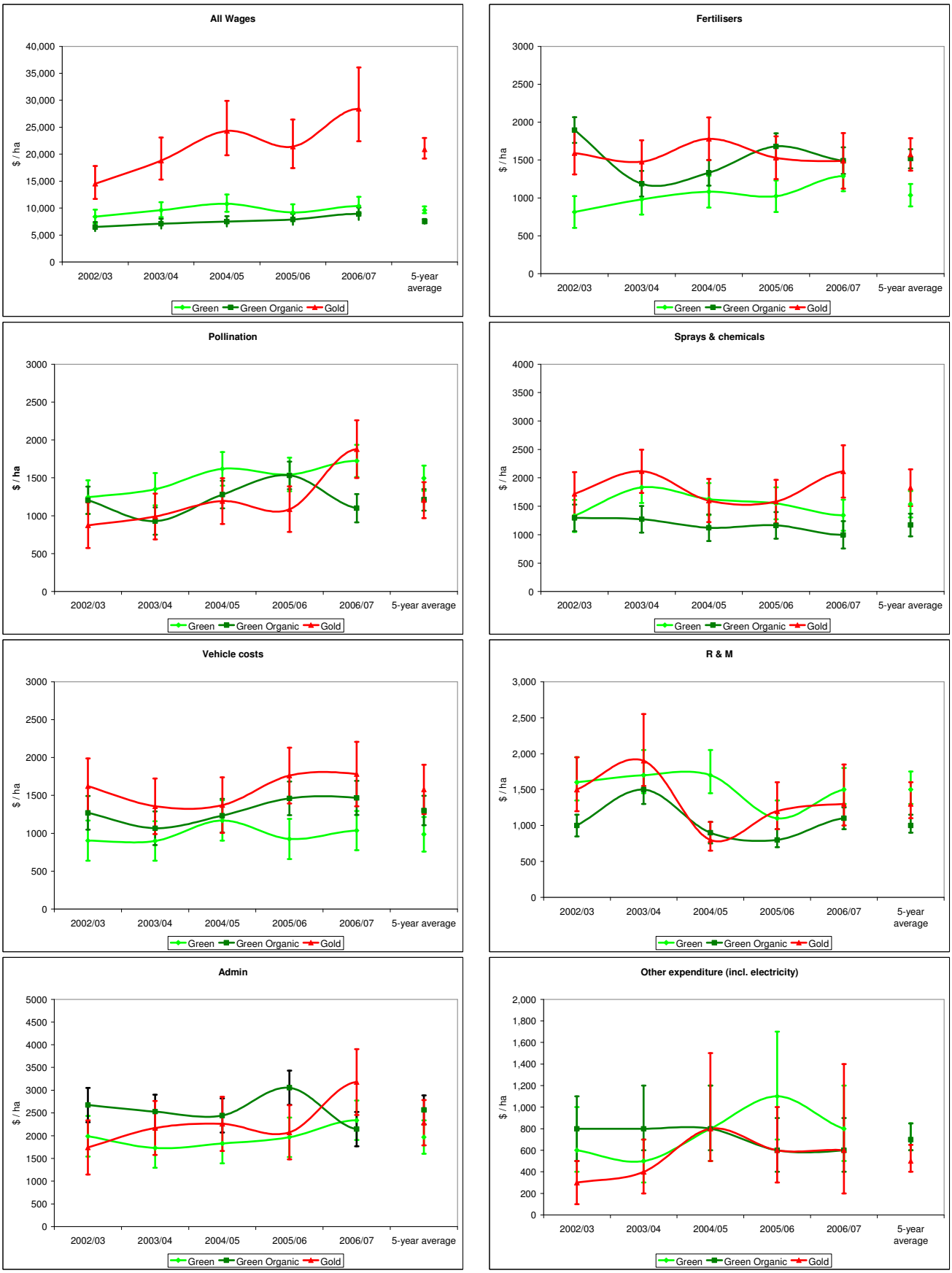
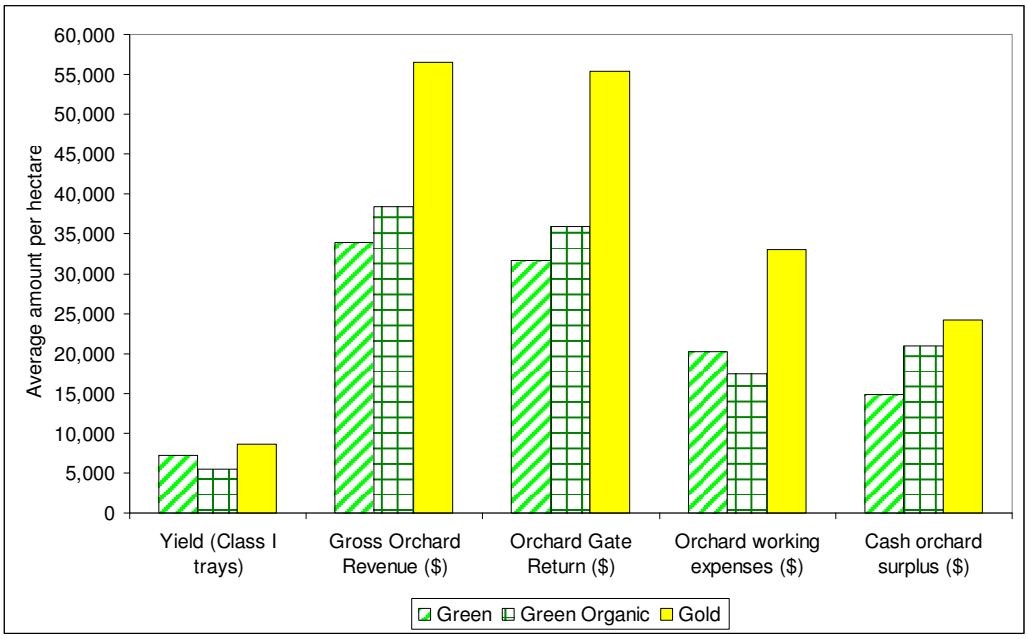
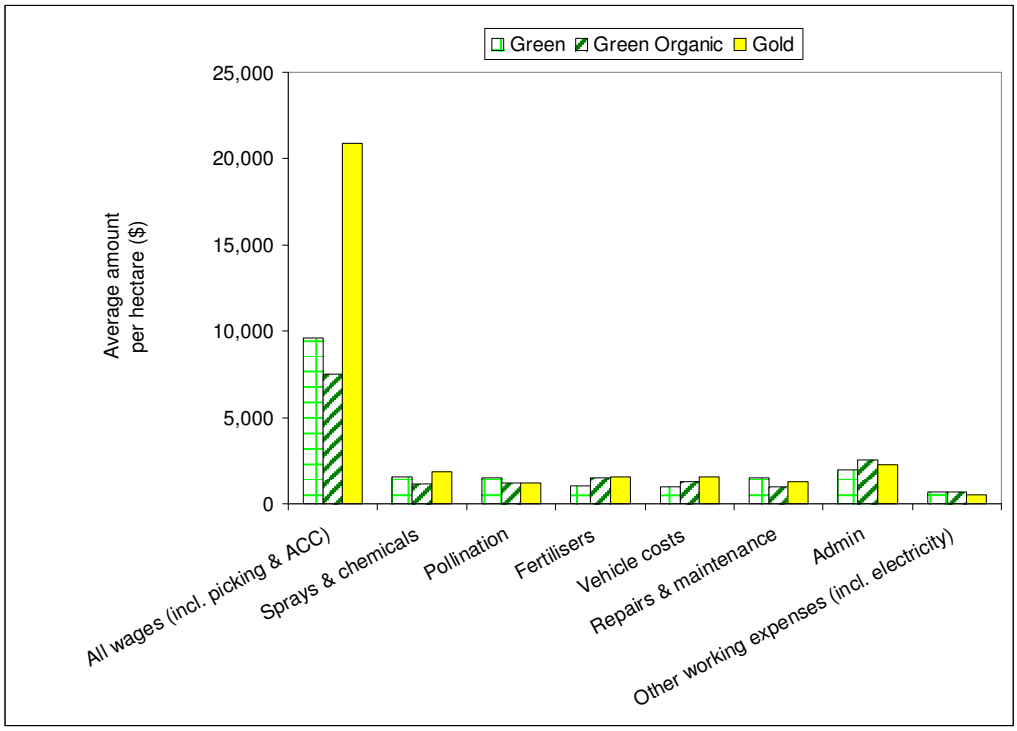


Figure 13. Five-year (2002/03 to 2006/07 period) averages of key financial operating indicators, on a per hectare basis, for ARGOS orchards. **Note, data from only 4 of the 12 Gold orchards are used.** Outliers are not included.



- Predicted values from a statistical model (REML) are shown above as these take into account variation and would be expected to be closer to the true population means.
- Orchard working expenses includes: all cash labour (wages, picking & acc), sprays & chemicals, pollination, fertiliser, vehicle costs, R&M, admin and other expenditure (a catch all including electricity).
- Gross Orchard Revenue includes OGR and sundry and other orchard related income (NET) like dividends but not income from other significant crops.
- Cash Orchard Surplus = Gross Orchard Revenue minus (Orchard Working Expenses + Debt Servicing).

Figure 14. Five-year (2002/03 to 2006/07 period) average values of individual expenditure categories. **Note, data from only 4 of the 12 Gold orchards are used.** Outliers are not included.



*predicted values from a statistical model (REML) are shown above as these take into account variation and would be expected to be closer to the true population means.

6. Social

6.1 Introduction

The ARGOS social research team has used various quantitative and qualitative methods to examine the social dimensions of orchard and farm management (Table 8). The results from most of these have been presented in previous ARGOS reports and will not be repeated here. However, we have included the following summaries at the end of this report:

1. An overall characterisation of Green, Green Organic and Gold orchardists from the 2007 Annual ARGOS Sector Report for Kiwifruit (Appendix 3).
2. A summary of findings from recent work carried out in the pastoral sector on the Emissions Trading Scheme (ETS) (Appendix 4). Aspects of this will be relevant to the kiwifruit industry.

Here, we focus on the results of a second round of Causal Mapping interviews which were carried out in 2008.

Table 8. Interviews and questionnaires which have been deployed by ARGOS's Social Objective.

Survey Name	Year	Interviewers
Qualitative Interview 1 Goals, vision, constraints, production issues	2004	Lesley Hunt
Qualitative Interview 2 Constraints/enablers	2005	Chris Rosin & Lesley Hunt
Causal Mapping 1 Understanding orchard systems	2005	John Fairweather
Causal Mapping 2 Understanding orchard systems and changes	2008	John Fairweather & Jayson Benge
National Farm Survey 1	2005	John Fairweather
National Farm Survey 2	2008	John Fairweather
Qualitative Interview 2 (proposed)	2009	Chris Rosin & Lesley Hunt

6.2 Causal Mapping 2 – preliminary results

In 2005, we undertook a type of cognitive mapping called causal mapping with each of the ARGOS orchardists to develop a better understanding of orchard management and to see in what ways orchardists were similar or different in their approach to management. In 2008, we decided to repeat this to assess any changes in how orchardists viewed their production systems. A similar but improved method was used which had worked well for us in other agricultural sectors.

The most important factors identified overall by ARGOS orchardists in 2008 are shown in Figure 15. These include decision maker, fruit yield and quality, orchard gate returns, vine health, orchard surplus, ZESPRI and satisfaction.

Table 9 shows only the factors where significant differences were found between production systems ('panels') in 2008. Each factor has an average centrality score which is the average of all the scores placed on arrows going to or from each factor; this is a measure of the importance of factors i.e. the higher this score, the more important the factor. The main differences were as follows:

- Compared to Green, Green Organic orchardists placed significantly greater importance on cash orchard surplus, satisfaction and family needs, and significantly less importance on the packhouse.
- Green orchardists compared to Gold, placed significantly greater importance on fertiliser and soil fertility, and significantly less importance on post harvest quality and family needs.
- Green Organic compared to Gold, placed significantly greater importance on orchard environmental health and vine health but significantly less importance on packhouse and postharvest quality.

Figure 15. 2008 causal map for kiwifruit.

This map shows the factors (in balloons) which ARGOS orchardists identified as the most important to their orchard systems. Each factor has an associated centrality score which is a measure of the overall influence – the higher this score the more important the factor. Arrows between factors indicate the direction of influence; numbers next to the arrows represent the strength of the influence on a scale of 1 to 10 e.g. the influence of the 'Decision maker' (i.e. orchardist) on 'Contractors/Labour' has an average strength of 3 out of 10 i.e. a relatively low influence. Arrows in both directions represent a causal relationship in both directions e.g. 'Vine health' influences 'Decision Maker' but 'Decision Maker' also influences 'Vine health'. The most important factors are shaded.

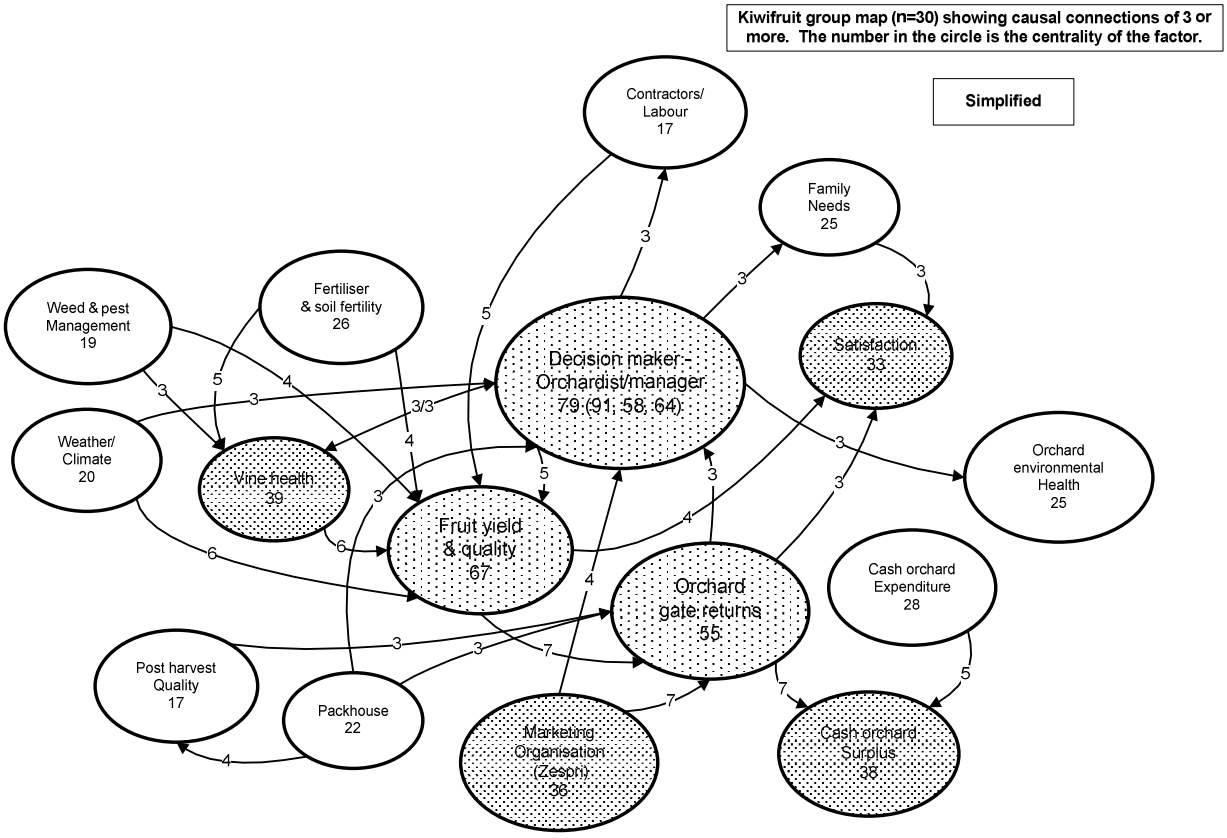


Table 9. Average centrality scores and map characteristics for each ARGOS production system ('Panel').

Centrality is the sum of the scores placed on all arrows going to or from each factor and a measure of the importance of factors i.e. the higher this score, the more important the factor. Values with the different letters as superscripts are statistically different at the 5% level.

		Panels		
Factor	**All 30 orchards**	**Green**	**Organic**	**Gold**
Cash orchard surplus	38	23 [a]	**46** [b]	41
Satisfaction	33	16 [a]	**45** [b]	33
Fertiliser and soil fertility	26	23 [a]	**34** [a b]	19 [b]
Packhouse	22	**24** [a]	15 [b]	**28** [a]
Orchard environmental health	25	21	**34** [a]	17 [b]
Vine health	39	36	**48** [a]	30 [b]
Post harvest quality	17	13 [a]	16 [a]	**24** [b]
Family needs	25	6 [a]	**32** [b]	**32** [b]
Total centrality	735	698	**816** [a]	668[b]
Number of connections		41 [a]	**50** [b]	44
Connections/variable		1.75	**2.07** [a]	1.69[b]
Cash orchard surplus	38	23 [a]	**46** [b]	41
Satisfaction	33	16 [a]	**45** [b]	33

Table 10 shows the most important factors identified during mapping in both 2005 and 2008. In both years, decision maker, fruit yield and quality, and orchard gate return were the most important factors. Differences between years are currently been explored further and will be reported elsewhere in a full ARGOS report on causal mapping.

Table 10. Ranking of the most important factors identified during causal mapping in 2005 and in 2008. An improved methodology was used in 2008 which may account for some of the differences here (we are currently investigating this possibility further).

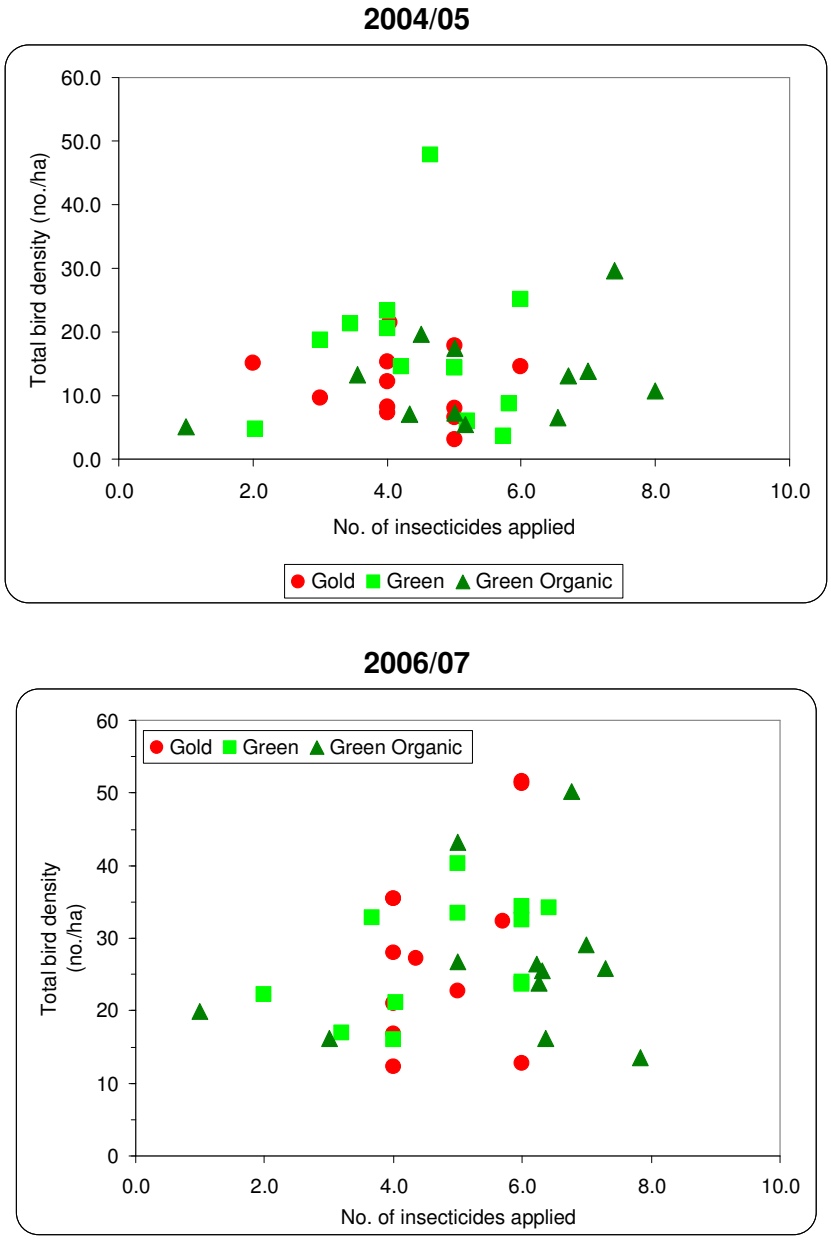
Factor	2008	2005
Decision maker	1	1
Fruit yield and quality	2	2
Orchard gate returns	3	3
Vine health	4	-
Cash orchard surplus	5	7
Marketing organisation (ZESPRI)	6	4
Satisfaction	7	8
Cash orchard expenditure	8	5
Fertiliser and soil fertility	9	9
Orchard environmental health	10	12
Family needs	11	25
Packhouse	12	6
Weather/climate	13	16
Weed & pest management	14	10
Post harvest quality	15	13
Contractors/labour	16	6

7. Management vs. environmental outcomes

Now that ARGOS has collected several years of data, we can now turn our attention to identifying causation for the different environmental outcomes across the ARGOS farms and orchards particularly between those under the same production system i.e. why do conventional or organic orchards vary in their soil quality or level of biodiversity etc? This is something we will be putting a lot of effort into during the final stages of the project as it will allow us to identify the impacts of particular practices on the environment.

As an example, we've recently looked at relationships between insecticide numbers and bird density on orchards. In both 2004/05 and 2006/07, there was no relationship evident (Figure 16) for any of the three production systems. In other words, the number of insecticides per se does not seem to be a good predictor of bird density on orchards. Other factors like habitat structure within and around orchards are likely to be more influential. This finding could be interpreted as a positive outcome because it suggests that a relatively high number of insecticides are no worse than a low number. This is just a preliminary finding and we will be analysing the data further.

Figure 16. Spray numbers and bird density on ARGOS orchards in 2004/05 and 2006/07.



8. Summary

The ARGOS research programme, "Pathways to Sustainability in Primary Production", commenced in 2003 with the goal of evaluating the sustainability and socio-ecological resilience of farming in NZ. The basis of this work is the characterisation of the management, environmental, economic and social features of different farming systems. This report focuses on the most recent findings for the Kiwifruit sector where the three main production systems are being studied. Generally, the Green Organic kiwifruit system has emerged as the most different with the differences between Green and Gold being fewer or less pronounced (Table 11). Financially, Gold can be singled out as the most different because of higher returns but also higher costs.

Table 11. General overview and comparison of kiwifruit production systems.

	Green & Gold	**Green Organic**
Management	These two systems have a lot of similarities particularly in terms of soil management and crop protection. The biggest difference between the two has probably been with regards to canopy management - Hort16A (Gold) is a naturally more vigourous variety and so management has been more intensive. Now new approaches to managing the vigour on Gold are beginning to decrease labour requirements. Gold fruit is more sensitive to physical damage so management must be more careful.	This is the most distinctive of the three kiwifruit production systems with greater restrictions on inputs especially fertilisers and agrichemicals. Less toxic mineral oils and bacterium products *(*like *Bacillus thuringiensis)* form the basis of crop protection while nutritional programmes are based around plant and animal-based fertilisers, though some mineral fertilisers are allowed. Canopy management generally differs too i.e. often greater use is made of more vigourous wood as the use of low vigour wood has resulted in poorer production.
Production	Hort16a seems to be a more fruitful species that produces sweeter fruit and so yield and fruit dry matter content (the industry measure of sweetness) exceeds that of Hayward.	Green Organic orchards have produced significantly less than their conventional counterparts. This is probably due largely to the use of budbreak agents (like HiCane™, active ingredient = hydrogen cyanamide) in Green. Nutrition, particularly a lack of soluble N, is also likely to contribute to lower Organic yields.
Environment	*Generally, kiwifruit orchard environments seem healthy regardless of whether they are Green, Green Organic or Gold.* Environmentally, Green and Gold have had a lot more similarities than differences particularly with respect to soil quality and terrestrial biology (birds, orchard floor vegetation). There have been some noticeable differences like Green having more cicadas.	Green Organic has had the most different environmental outcomes. This is not surprising given organic management is the most distinctive. Organic orchards have tended to rank higher on a number of measured environmental indicators e.g. more native birds, more earthworms, and higher soil quality.
Energy	Energy use has been shown to be similar for Green and Gold orchards. Energy data is not presented in this report.	Energy use on Green Organic orchards has been shown to be lower per hectare due to lower indirect inputs like fertilisers and agrichemicals. But because of lower yield, energy use was higher per tray for Green Organic. These differences were not significant.
Economic	Gold is more labour intensive than Green and has incurred significantly greater costs (labour cost is the largest single regular cost when growing kiwifruit). However, Gold is primarily sold to the high returning markets and so returns are much higher for Gold. On balance, the cash operating surplus of Gold and Green has not been significantly different.	Despite lower yields, recently, the financial bottom lines have been similar for Green and Green Organic, primarily because of higher returns for Organic fruit.
Social	Kiwifruit orchardists, regardless of production system, have been shown to have a common set of social characteristics. Green are considered more content with their situation, are confident about their current practices, and don't see as much need to experiment. Gold orchardists on the other hand are considered more proactive and adventurous and enjoy the challenge of growing Gold.	Green Organic orchardists appear to be the most distinctive. They tend to treat the environmental and biological processes on their orchards as elements of a wider landscape. Optimisation of these processes is considered important to both orchard health and production as well as the wellbeing of family, community and the environment.

9. List of ARGOS reports and resources

Many of the following are publicly available on the ARGOS website (www.argos.org.nz) for download. Please contact ARGOS if you would like a hard copy.

Research Reports

- 08/02 Causal mapping of ARGOS high country farms and comparisons to sheep/beef and dairy farms, by John Fairweather, Lesley Hunt, DaveLucock, Chris Rosin
- 08/01 Causal mapping of ARGOS dairy farms and comparisons to sheep/beef farms, by John Fairweather, Lesley Hunt, Chris Rosin and Hugh Campbell
- 07/14 Transdisciplinary synthesis, by ARGOS
- 07/13 Social Objective Synthesis Report: Differentiation among Participant Farmers/Orchardists in the ARGOS Research Programme, by Chris Rosin, Lesley Hunt, John Fairweather and Hugh Campbell
- 07/12 Environmental indicators from alternative farm management systems: Signposts for different pathways to sustainable primary production in New Zealand?, by Tanja Maegli, Sarah Richards, Sarah Meadows, Peter Carey, Marion Johnson, Monica Peters, Katherine Dixon, Jayson Benge, Henrik Moller, Grant Blackwell, Florian Weller, David Lucock, David Norton, Chris Perley and Catriona MacLeod.
- 07/11 Economics Objective Synthesis Report, by Caroline Saunders, Glen Greer, Eva Zellman
- 07/10 Sustainability Monitoring Report of Case Study Farms in the He Whenua Whakatipu Research Objective, by John Reid, Tim Jenkins and Martin Emanuelsson
- 07/09 Management and Production Features of ARGOS farms and Differences between Production systems, by Jayson Benge, Dave Lucock, Martin Emanuelsson, Jon Manhire
- 07/08 New Zealand Farmer and Grower Attitude and Opinion Survey: Kiwifruit Sector, by John Fairweather, Lesley Hunt, Andrew Cook, Chris Rosin, Jayson Benge and Hugh Campbell
- 07/07 New Zealand Farmer and Grower Attitude and Opinion Survey: Analysis by Sector and Management System, by John Fairweather, Lesley Hunt, Andrew Cook, Chris Rosin, Hugh Campbell
- 07/06 There are Audits, and There are Audits: Response of New Zealand Kiwifruit Orchardists to the Implementation of Supermarket Initiated Audit Schemes, by Chris Rosin, Lesley Hunt, Hugh Campbell and John Fairweather
- 07/05 Becoming the Audited: Response of New Zealand Sheep/Beef Farmers to the Introduction of Supermarket Initiated Audit Schemes, by Chris Rosin, Lesley Hunt, Hugh Campbell and John Fairweather
- 07/04 Applicability of Performance Indicators to Farms and Orchards, by Caroline Saunders, Eva Zellman, William Kaye-Blake
- 07/03 The Representativeness of ARGOS Panels and Between Panel Comparisons, John Fairweather, Lesley Hunt, Andrew Cook, Chris Rosin, Hugh Campbell
- 07/02 Understanding sheep/beef farm management using causal mapping: development and application of a two-stage approach, by John Fairweather, Lesley Hunt, Chris Rosin, Hugh Campbell and Dave Lucock
- 07/01 Soil Properties on ARGOS Dairy and Sheep & Beef Farms 2005-6, by Peter Carey, Dave Lucock and Amanda Phillips, May 2007
- 06/10 New Zealand Farmers and Wetlands, by Carmen McLeod, Lesley Hunt, Chris Rosin, John Fairweather, Andrew Cook, Hugh Campbell, November 2006
- 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 and Jayson Benge
- 06/07 Total Energy Indicators: Benchmarking Organic, Integrated and Conventional Sheep and Beef Farms, by Andrew Barber and Dave Lucock, September 2006
- 06/06 to be published

- 06/05 Prevalence and diversity of non-forage herbaceous plants on sheep/beef pastures in the South Island, by Grant Blackwell, Dave Lucock, Henrik Moller, Richard Hill, Jon Manhire and Martin Emanuelsson
- 06/04 to be published
- 06/03 Cleaner streams and improved stream health on North Island dairy and South Island sheep/beef farms, by Grant Blackwell, Mark Haggerty, Suzanne Burns, Louise Davidson, Gaia Gnanalingam and Henrik Moller, June 2006
- 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

Research Results - Published Articles

Any published papers will be posted on this site as and when they become available.

Journal Articles

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- Campbell, H. and R. Le Heron. 2007. Supermarkets, Producers and Audit Technologies: The Constitutive Micro-Politics of Food, Legitimacy and Governance. Pp. 131-153 in Lawrence, G. and Burch. D. (eds) Supermarkets and Agri-Food Supply Chains: Transformations in the Production and Consumption of Foods. Edward Elgar: London.
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- 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)

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4. Market Developments for NZ Agricultural Produce
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41. The Relevance of Performance Indicators Used for Non-Agribusinesses to Kiwifruit Orchards
42. The Relevance of Performance Indicators Used for Non-Agribusinesses to Sheep and Beef Farms

43. Common elements of pastoral farming systems as shown by causal mapping

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- No. 2, January 2007, ARGOS Comparative Dairy Research - an update, by Grant Blackwell, Chris Rosin, Martin Emanuelsson, Amanda Phillips and Jon Manhire
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Maori farmers' perspectives and experience of pasture soil health: indicators, understandings and monitoring methodology - Case studies in the southern South Island of New Zealand, by Monica A. Peters, University of Otago, November 2006.

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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

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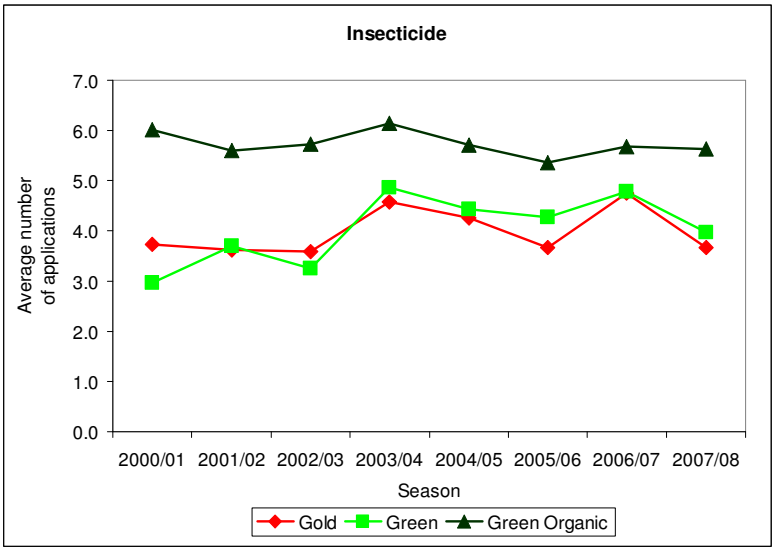
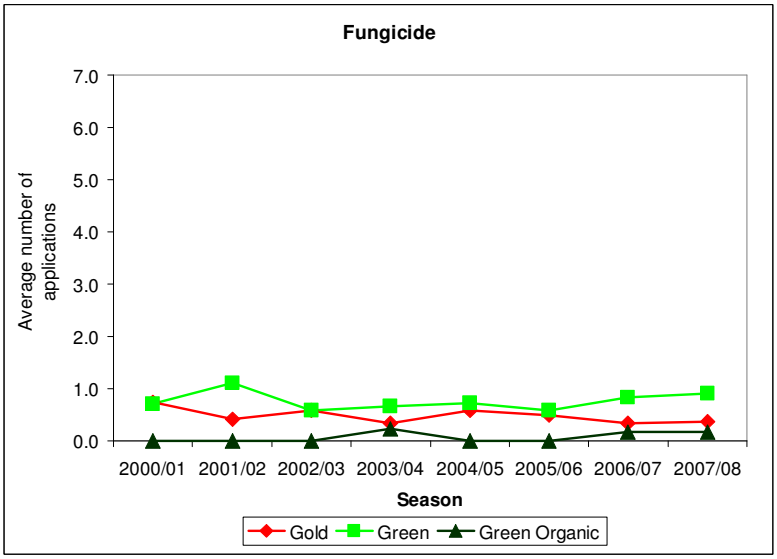
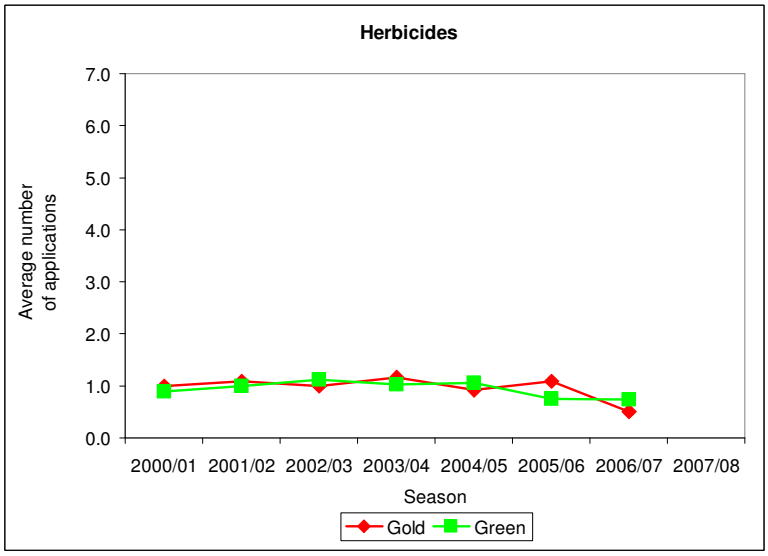
11. References

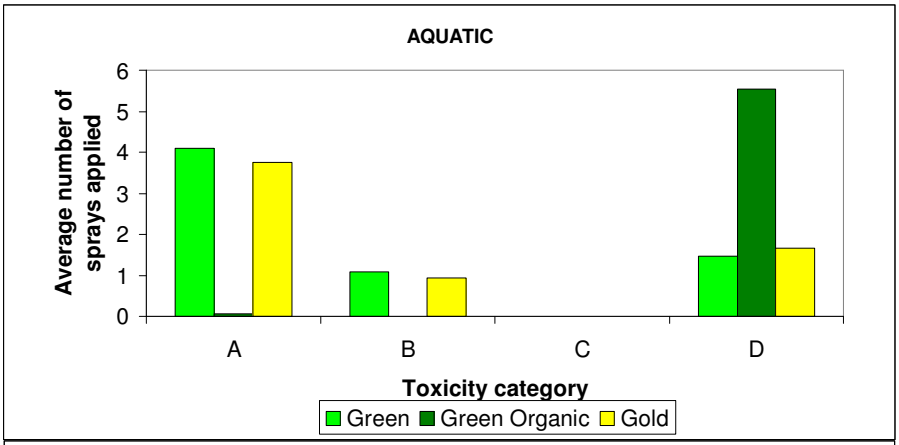
Appendix 1. Trends in the average number of sprays applied to orchards in the ARGOS programme. *All sprays applied to organic orchards are certified organic and have lower potential toxicity.*

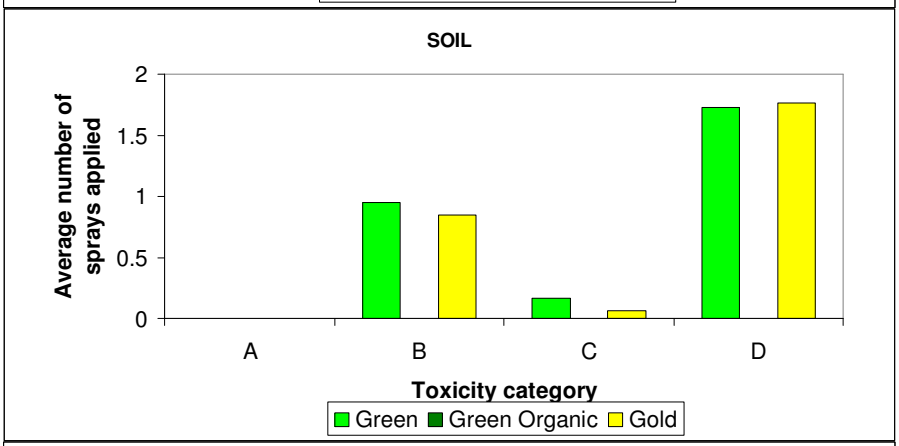


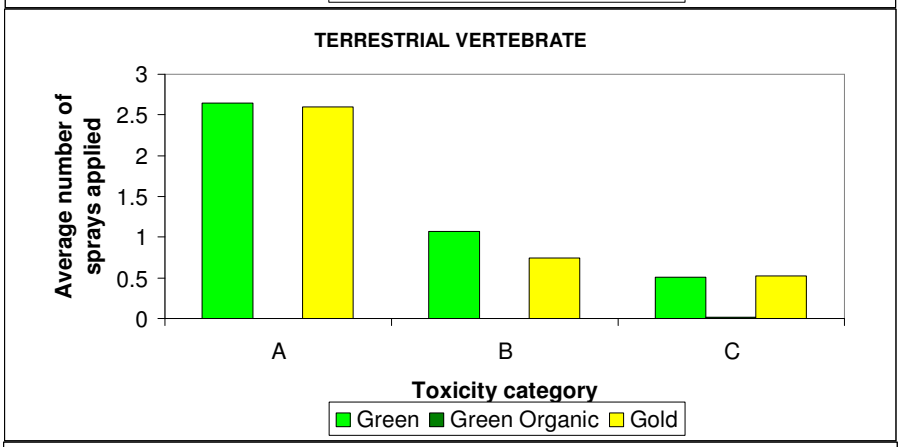


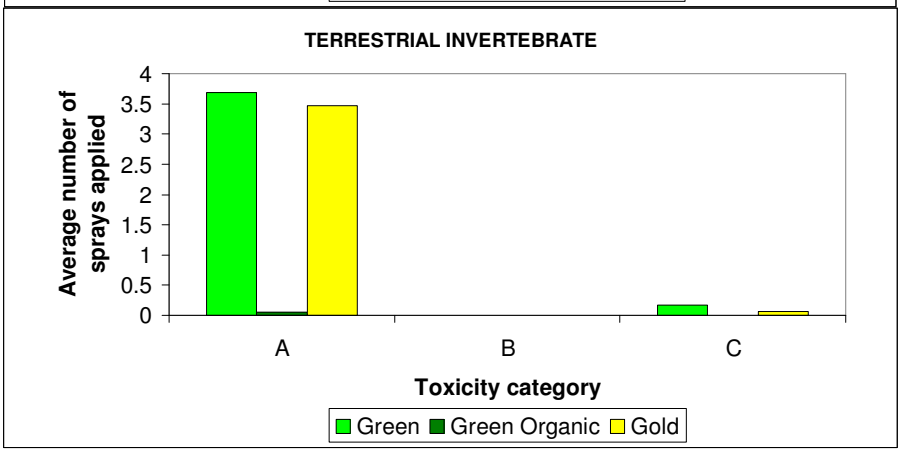


Appendix 2. Average number of sprays used on ARGOS kiwifruit orchards and their relative toxicity, for the 2002/03 to 2006/07 period. Toxicity categories are from A (highest) to D (lowest) based on The Hazardous Substances and New Organisms (HSNO) Thresholds and Classifications of Hazardous Substances (2001).









Appendix 3. Overall characterisation of Green, Green Organic and Gold orchardists (from 2007 Annual ARGOS Sector Report for Kiwifruit)

Green orchardists

These appear largely to be people who have entered the kiwifruit industry as a form of investment - as an agricultural sector, kiwifruit offers relatively good returns with relatively stable harvests (predictability though Organic orchardists may not agree) and a well established formula/set of management practices (comfort or stability). This, of course, excludes to some extent those orchardists who have been in the industry for a long period of time, for whom orcharding has contributed financially to the full life cycle of the household as opposed to the later stages of that cycle. Because of their predominant rationale for participation in the sector, Green orchardists are more likely to rely on – and to identify the benefits of – contract labour, especially as they become less capable of performing some of the more physically demanding tasks of orchard management. (The comparison here with Gold orchardists is not completely decisive given the number of managed orchards in the latter panel.)

There is a greater emphasis on tidiness in Green orchards, which may also reflect the owner's level of participation in regards to management. If, for instance, the orchardist is responsible solely for mowing and shelterbelt maintenance, the tidiness of the orchard becomes the most obvious means of accessing the orchardist's abilities. Other means of benchmarking the orchardist's abilities (production, pruning, etc.) are subject to the practices of contractors and can, as such, be excused or rationalised (for example, blamed on the lack of attention to detail, etc.). A less expected feature of the Green orchardist is their strong emphasis on birds and the biodiversity of bird populations (cf. Organic orchardists who emphasise biodiversity more generally and Gold orchardists who did not demonstrate a focus on any form of biodiversity). This situation likely reflects the role of the KiwiGreen programmes in reducing pesticide impacts on birds, in particular, giving the Green orchardists reason to identify bird populations as an indicator of their environmental awareness and concern.

Along with their Organic counterparts, Green orchardists show the desire to make the orchard a liveable place. The latter, however, tend to emphasise the quality of the residence as compared to the overall environment of the orchard. Finally Green orchardists, focus more exclusively on the impact of their orchard management on family or local community, especially in comparison to Organic orchardists who are more likely to point to the impact of organic management on a wider society. This is not to say that Organic or Gold orchardists are any less concerned about their family or local community. They appear, by contrast, to be more willing to acknowledge that the impact of their management extends beyond the personal or local.

Green Organic orchardists

Organic orchardists are socially the most distinctive panel. Based on the ARGOS social data, Organic orchardists (and organic sheep/beef and dairy farmers for that matter) demonstrate distinct perspectives on life, society and environment from those of non-organic participants. This is most evident in their discussion of the environment in which they are more likely to expand their understanding of their interactions with the environment to include features that are located and processes that occur beyond the boundaries of the orchard (and often the property). This is often demonstrated in their desire to create an 'environmental haven' for themselves, wildlife and neighbours. A similarly broader perspective is evident in their references to the social effects of their practice: while they are creating a haven locally, they are also producing good food and a good environment for people beyond the local community.

In part because of the challenge of striving to achieve similar production levels as their Green counterparts, the Organic orchardists are more willing to experiment with alternative management practices. This is especially true for innovative means of improving soil fertility

or vine management. In comparison to the Gold orchardists, the experimentation of the Organic orchardists is more likely to be rationalised with references to local knowledge or the enhancement of biologic processes. Based on these characteristics, it is possible to conclude that the core organic producers (there are some who claim they would abandon organic certification if the price premium did not sufficiently compensate their efforts and the lower production) show a willingness to forgo convenience and a more settled or comfortable management 'system' in order to pursue their ideals of environmental and social responsibility.

Gold orchardists

The feature that distinguishes the Gold orchardists on the basis of the social data (and this may be a factor of the greater number of orchard managers rather than owners among the participants in the panel) is their willingness to assume what others would view as unsettling financial risk. To some extent, this might be compared to the Organic orchardists' willingness to assume the social risk of pursuing a less conventional understanding of good farming practice.(although this is less the case in kiwifruit than in the sheep/beef sector where organic practice has yet to become a 'normalised' or accepted form of management). The acceptance of risk also transfers to the Gold orchardists' willingness to experiment with alternative management techniques (often at a capital cost as compared to the Organic 'experimentation' which is often more labour intensive). Here the more definitive contrast would be found in regard to the Green orchardists who appear to prefer the more settled and proven management system for the Hayward variety. In regard to their social perspective, Gold orchardists tend to emphasise the amenity value of the orchard – that is, its location near the urban centre of Tauranga and also within easy distance of the ocean and beaches. Finally, there is less emphasis on the orchard as an element of retirement planning – the accounting of returns is more immediate (this, in particular, may reflect the manager cf. owner bias in this group). As far as the environment is concerned the Gold orchardists are perhaps the least proactive in the pursuit of environmental improvements and are most focused (although certainly not true in all cases!) on the productive area of the orchard as the site of the environmental impacts of their management practice.

Appendix 4. Emissions Trading Scheme (ETS) – A Pastoral Perspective

Introduction

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

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

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

The challenge of emissions

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

Current policy proposals

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

proposing policies to encourage tree planting on farms in order to help with early adaptation to the emphasis on carbon in the economy.

Farm example

In our research project, we introduced some of the ARGOS sheep/beef and dairy farmers to the proposed ETS and the associated afforestation policies. This included providing an estimate of the cost of carbon liabilities for each farm visited. For example, a sheep/beef farm with 3000 sheep and 200 beef cattle would have a total liability of $33,500 (with a cost of $25 per carbon credit). This liability would not be assessed until 2013, and then the government would provide 90% of the necessary credits as a free allocation reducing the 2013 liability to $3,350. A dairy farm of 300 cows, by comparison, would have a liability of $18,750, or $1,875 in 2013 with the 90% free allocation. (Note that neither of these estimated figures involves the costs of synthetic nitrogen fertilisers, which will also increase in order to compensate for estimated nitrous oxide emissions.) Some of this cost can also be 'off-set' by credits earned from trees planted after 1990 (ranging from 20-30 tonnes – or $500-750, assuming $25 credits – per hectare in mature *pinus radiate* to 2-6 tonnes – $50-150 – per hectare for a native species such as totara). The accumulation of credits from trees (and a similar situation holds for soil carbon) is only given for the increase from the previous year's amount, including any harvest or accidental loss as a reduction. In other words, **a mature plantation subject to rotational harvest would likely sequester only enough carbon to compensate for harvested trees and, therefore, not earn any carbon credits.**

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

Our research findings

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

What now?

In the circumstances discussed above, it is very important that farmers develop knowledge about the impact of various aspects of farm management on the emission of greenhouse gases and on the sequestration of carbon. The current ARGOS research provides a depth and breadth of data not available elsewhere in New Zealand, which can contribute to our understanding of carbon processes in farm ecosystems as well as to improved means of compliance with the Kyoto Protocol. Because we are actively collecting economic and social – as well as environmental – data, the ARGOS project is well positioned to inform both farmers and policy makers about the interactions, opportunities and potential barriers to a viable system of greenhouse gas regulation for the agriculture sector. Specific objectives for our future research targeted in this area include:

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

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