A1 6.14 Stakeholder Report: October 2007

2007 Annual ARGOS Sector Report

KIWIFRUIT

Compiled by Jayson Benge

October 2007

The AgriBusiness Group

Lincoln University

University of Otago

Preface

The first annual ARGOS report was produced in 2005 and contained findings from the first 12 – 18 months of the programme. The following 2006 report expanded on this and included the results of subsequent research carried out in 2005/06. This third annual report presents the findings of work carried out mainly in 2006/07 and includes the following new content:

Orchard management and production

- characterisation of recent differences in orchard practices
- trends in recent yield and dry matter
- trends in recent fertiliser and spray use

Environmental

- soils: an emphasis on biology
- cicadas and spiders: trends over four consecutive years (2004 - 2007)
- birds: results of 2006/07 survey

Financial:

- financial performance of orchards: trends over four consecutive years
- market analysis: identification of global and policy trends

Social:

- an overview of Green, Green Organic and Gold orchardists
- responses of orchardists to audit systems

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

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

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Acknowledgments

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

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

- Alistair Mowat (ZESPRI)
- 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'). 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 followed Industry trends.

Orchard history and management

- Most of the orchards were first planted with kiwifruit in the 1980's and were previously dairy farms.
- The majority of the orchards are owner-operated though a higher proportion of the Gold orchards are managed.
- Winter canopy management of Green and Gold has been comparable with the majority using low vigour wood. In contrast, a greater proportion of Green Organic orchards are using replacement canes.
- The number of hives used for pollination has not differed much between systems. Fewer Gold orchards have used artificial pollination in recent times.
- At least half of the ARGOS orchards are using trunk girdling (summer) to enhance fruit dry matter despite some reluctance because of the unknown longer-term impacts on vine health. At least a third of the orchards are cane girdling in spring to enhance fruit size.
- Fertiliser inputs for Green and Gold have generally been similar.
- Green Organic orchards have applied noticeably less quantities of macronutrients especially in mineral (and often more soluble) form. Lower nitrogen applications is thought to be a key limiting factor for organic production.
- In recent years, the total number of sprays applied to Green and Gold orchards has been similar though Gold has tended to apply more fruit sizing (i.e. Benefit) and Bt sprays as well as less hydrogen cyanamide (for budbreak).
- Overall, Green Organic orchards have generally applied slightly fewer sprays and these have mainly been for the control of insects. These sprays have all been certified organic and their potential risk to the environment is much lower than for conventional sprays.
- In the 2006/07 season, more Gold orchards used some form of frost control, more Green orchards used irrigation, and more Green Organic orchards undertook soil cultivation.

Economics

- Gold is the most different in terms of operating performance due to higher OGR (a result of higher yields and 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, are not different in terms of OGR and total growing costs. However, Green has had significantly lower fertiliser, vehicle and overhead costs.
- An analysis and comparison of financial indicators of sustainability like solvency and liquidity has not yet been possible due to the quality of equity data available i.e. capital, asset and liability values.

Environment

- 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, orchard floor vegetation).
- Green Organic orchards have had the most different environmental outcomes. This is not surprising given organic management is the most distinctive. Though organic orchards have tended to rank higher on some of the measured environmental indicators (e.g. more birds, more earthworms, higher soil quality), Green and Gold results are not necessarily indicative of negative environmental impacts. Also, the differences have not always been significant.

Social

- Characterisation of orchardists:
    - Kiwifruit orchardists, regardless of production system, have been shown to have a common set of social characteristics.
    - Green are considered content with their situation, are confident about their current practices, and don't see as much need to experiment. Gold growers 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 by the orchardists to both orchard health and production as well as the wellbeing of family, community and the environment.
- Responses to the implementation of audit systems:
    - Despite existing regulation of management practice under the KiwiGreen monitoring programme, a number of orchardists perceived the EurepGAP audit as a severe imposition on their identity as orchardists.
    - By comparison, the Taste ZESPRI programme elicits very distinct responses from the orchardists – some of them viewing the production of dry matter as a challenge worthy of their skill and ability whereas others believed that it was unfair to base payment incentives on a feature of the fruit that lacked a well defined set of practices with which to achieve it.

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. EUREPGAP and changes in the EU Agricultural Policy. The potential benefits and risks of these will be further assessed using the LTEM (the Lincoln Trade and Environment Model developed for government policy and planning). This enables the impact of various scenarios, relating to the level of production and consumption, premiums and production costs, to be assessed both for NZ and other countries.

1.3 Kiwifruit research design

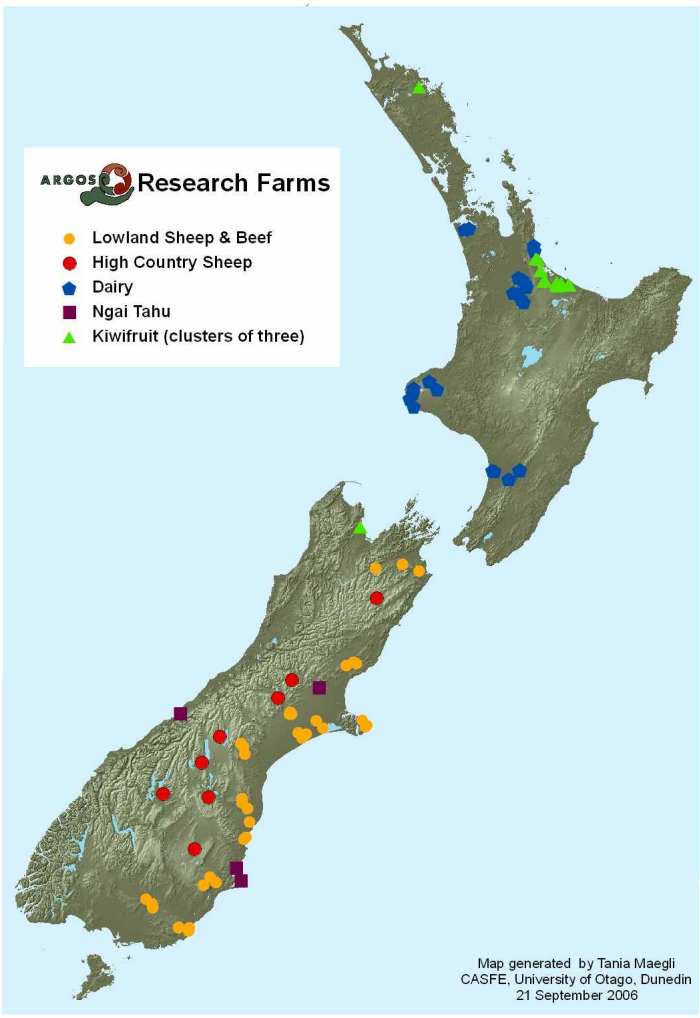
The following production systems (sometimes referred to as management systems or panels) are being studied in the kiwifruit sector:

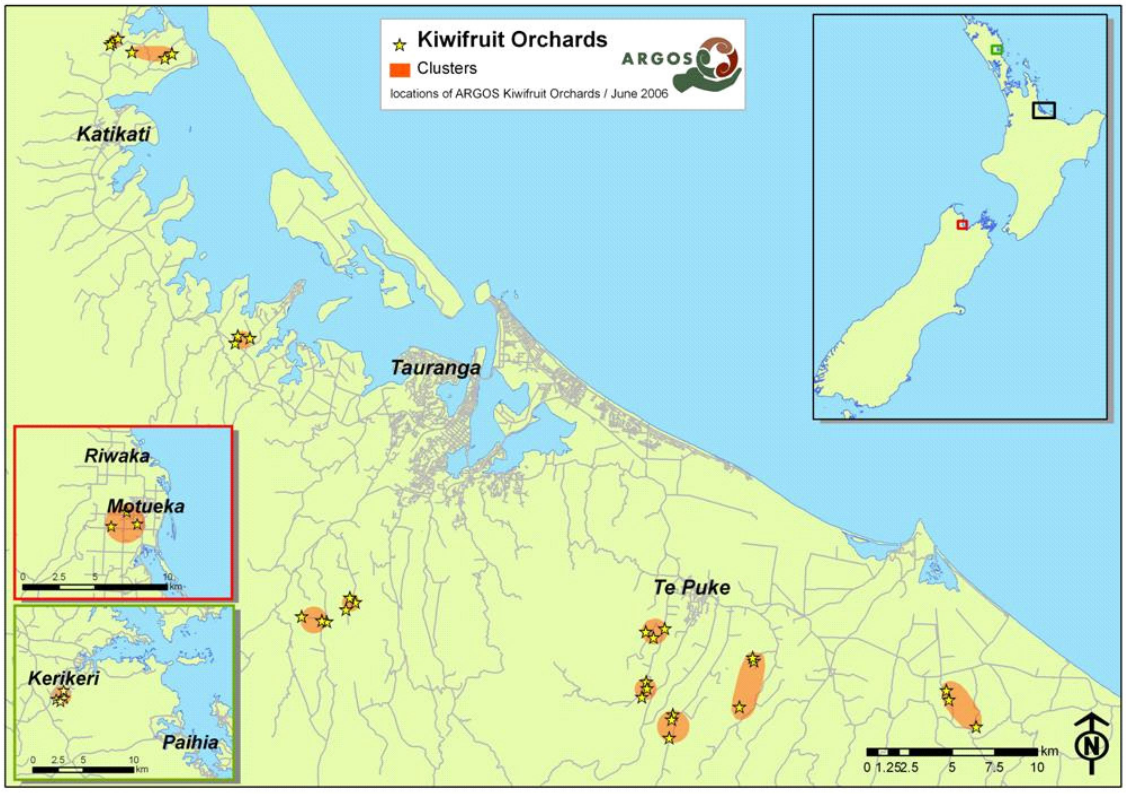
- Hayward (*Actinidia deliciosa*) variety grown under the KiwiGreen system ("Green")
- Hayward variety grown under the certified organic system ("Green Organic")
- Hort16A (*A. chinensis*) variety grown under the KiwiGreen system ("Gold")

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 Yield

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 growers, and packhouse/industry averages. In recent years, there has generally been a slight increase in the average yield of ARGOS orchards which is consistent with Industry trends (Figure 2).

For ARGOS orchards, the greatest increase in average yield has occurred with Gold – a result of younger orchards maturing and established orchards producing very good crops. The overall increases in average yields 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).

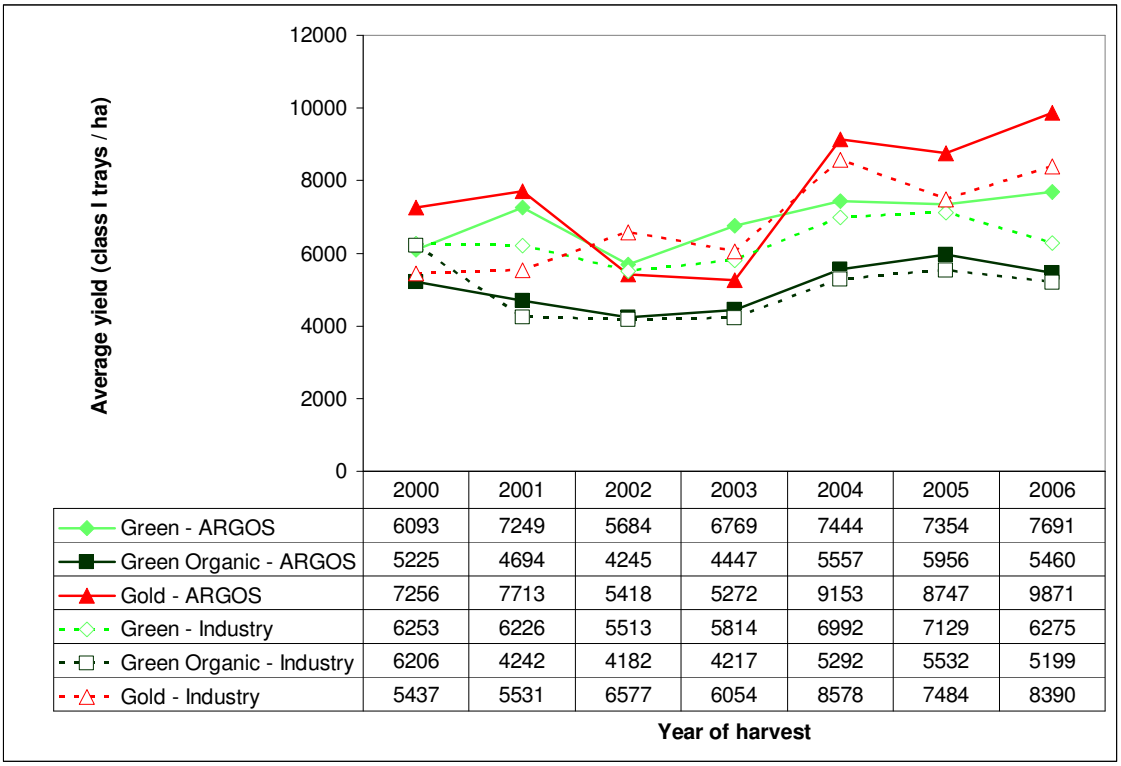
Since 2000, ARGOS Green orchards on average have produced about 35% more trays than their Organic counterparts. Across the Industry, Green has produced about 27% more (ZESPRI, 2007). This difference is likely to be mainly due to the use of budbreak agents (hydrogen cyanamide) on the Green Orchards to 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 about the same as the average Industry difference 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. 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.

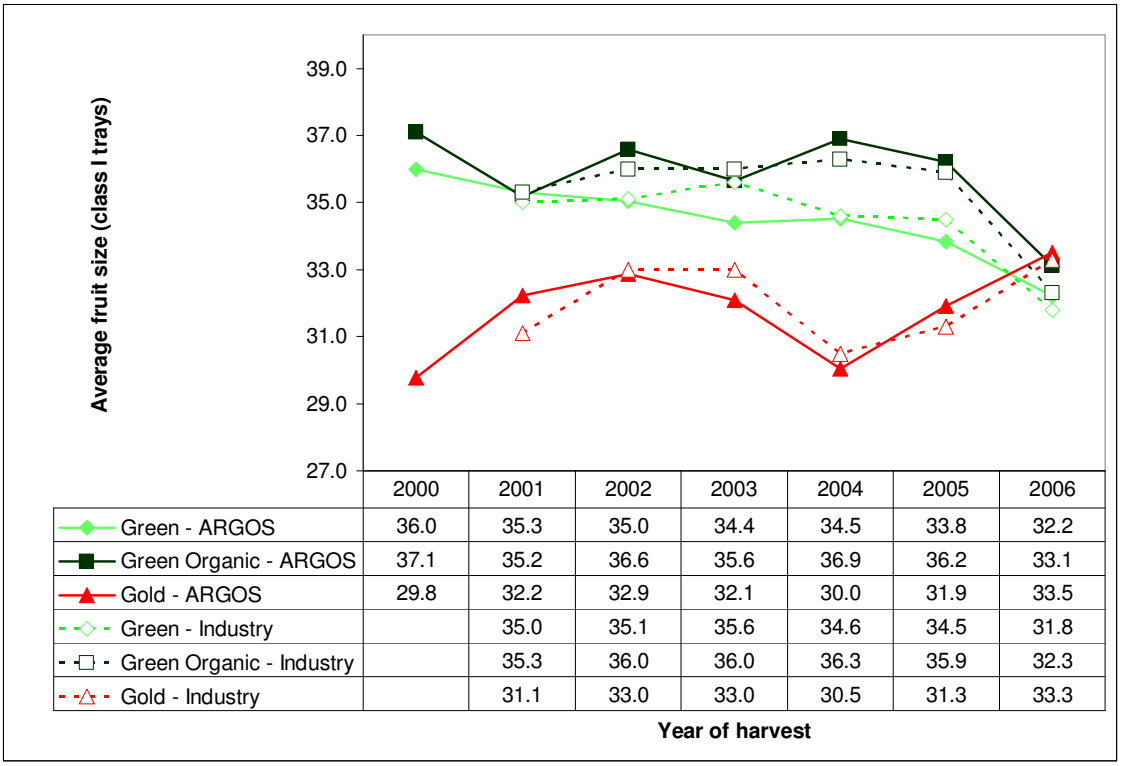
Average fruit size converged in 2006 with Gold decreasing and Green and Green Organic both increasing.

Figure 2. Trends in average yields (Class I) for Green, Green Organic and Gold orchards in ARGOS (solid lines + solid symbols) and for Industry (dashed lines + open symbols). 2007 data not available at the time of preparing this report. Notes: ARGOS data is submitted volumes. Industry data is shipped (FOBS) volumes after onshore fruit loss (Industry data from ZESPRI Annual Report 2005-06).



	2000	2001	2002	2003	2004	2005	2006
Green - ARGOS	6093	7249	5684	6769	7444	7354	7691
Green Organic - ARGOS	5225	4694	4245	4447	5557	5956	5460
Gold - ARGOS	7256	7713	5418	5272	9153	8747	9871
Green - Industry	6253	6226	5513	5814	6992	7129	6275
Green Organic - Industry	6206	4242	4182	4217	5292	5532	5199
Gold - Industry	5437	5531	6577	6054	8578	7484	8390

Figure 3. Trends in average fruit size (Class I) for Green, Green Organic and Gold orchards in ARGOS (solid lines + solid symbols) and for Industry (dashed lines + open symbols). 2007 data not available at the time of preparing this report (Industry data from ZESPRI Kiwifliers).



	2000	2001	2002	2003	2004	2005	2006
Green - ARGOS	36.0	35.3	35.0	34.4	34.5	33.8	32.2
Green Organic - ARGOS	37.1	35.2	36.6	35.6	36.9	36.2	33.1
Gold - ARGOS	29.8	32.2	32.9	32.1	30.0	31.9	33.5
Green - Industry		35.0	35.1	35.6	34.6	34.5	31.8
Green Organic - Industry		35.3	36.0	36.0	36.3	35.9	32.3
Gold - Industry		31.1	33.0	33.0	30.5	31.3	33.3

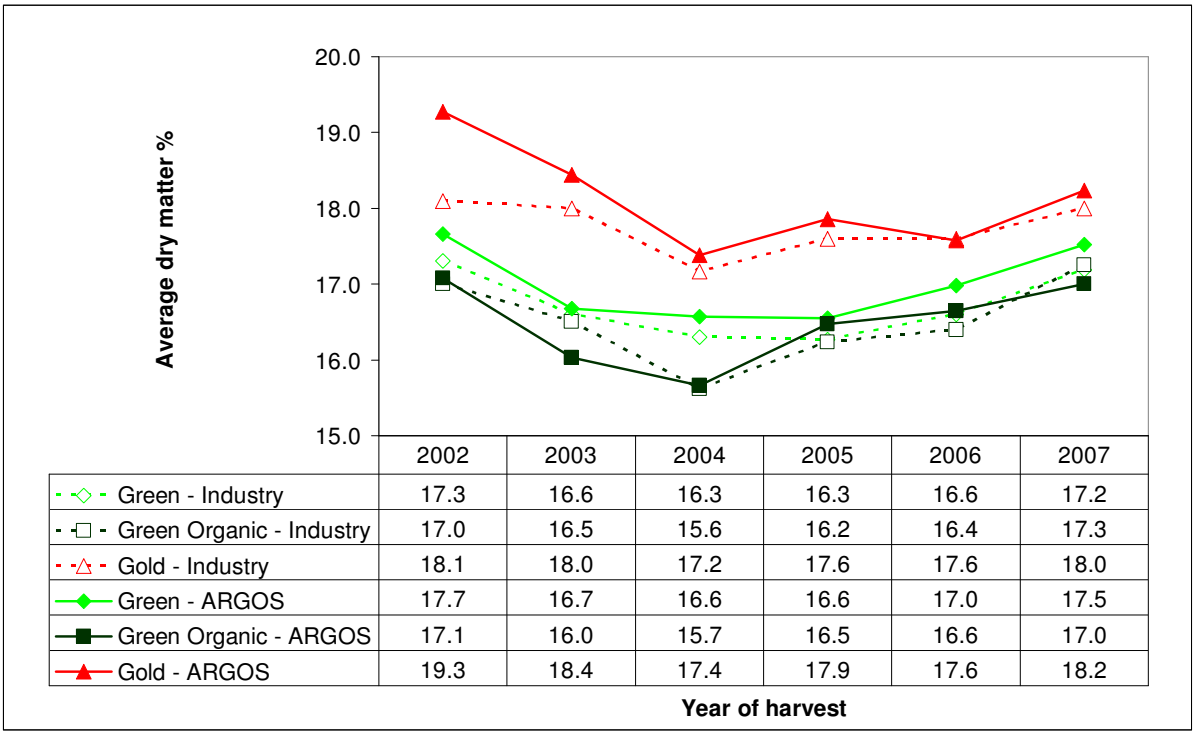
2.4 Dry matter

In the last 4 – 5 years, the dry matter content of kiwifruit has become a dominant measure of performance on orchards due to the willingness of consumers to pay more for better tasting fruit. In 2007, the maximum dry matter payments offered for Green, Green Organic and Gold were 40%, 50% and 60% respectively (ZESPRI, 2007). In practice it is very difficult to achieve the required dry matter levels to receive the maximum payment.

Like yield, in recent years there has generally been a slight 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 from KiwiTech Handout – September 2007)



	2002	2003	2004	2005	2006	2007
Green - Industry	17.3	16.6	16.3	16.3	16.6	17.2
Green Organic - Industry	17.0	16.5	15.6	16.2	16.4	17.3
Gold - Industry	18.1	18.0	17.2	17.6	17.6	18.0
Green - ARGOS	17.7	16.7	16.6	16.6	17.0	17.5
Green Organic - ARGOS	17.1	16.0	15.7	16.5	16.6	17.0
Gold - ARGOS	19.3	18.4	17.4	17.9	17.6	18.2

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.

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 are owner-operated (Table 1). Gold orchards tend to fall more into the managed category though the reasons for this are unclear.

Table 1. Percentage of ARGOS orchards which are owner-operated or managed (2006/07).

	Green	Green Organic	Gold
Owner-operated (involved in the day-to-day running of orchard)	75	67	50
Managed (mainly an overseeing role; may carry out some work)	25	33	50

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 targetting replacement canes rather than lower vigour wood (Table 2).

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 to enhance fruit dry matter levels is becoming more common because of increasing financial rewards i.e. in 2007, the maximum payment for dry matter in Green increased to 40% of fruit value from 20%. One or two ARGOS orchardists who were previously reluctant to trunk girdle are now doing this because they felt they had too much to lose from not maximizing fruit dry matter. In the 2006/07 season, at least a third of all ARGOS orchards cane girdled in the spring to enhance fruit size and at least a half trunk girdled in the summer to enhance dry matter (Table 2).

Table 2. Percentages of ARGOS orchards undertaking winter pruning and girdling in the 2006/07 season.

Orchard practice	Type	Green	Green Organic	Gold
Winter pruning – main style	Cane replacement	25	58	33
	Low vigour	50	17	58
	Mix	25	25	8
Cane girdling	Spring	33	42	33
	Summer	8	8	0
	Spring + summer	0	0	0
Trunk girdling	Spring	8	0	25
	Summer	58	50	67
	Spring + summer	8	0	8

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 the 2006/07 season, 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 frequency and timing varies between orchards. Organic orchardists on average have tended to mow less often than Green and Gold orchardists (Table 3) suggesting that they can tolerate longer sward.

Table 3. Average number of times ARGOS orchards have been mowed annually.

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

[1] This does not include the odd occasion where orchardists mow the with-in row areas (under the leaders) only usually with ride-on mowers.

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 4, Appendix 1) particularly leafroller and armoured scale. In recent years, the total number of sprays applied to Green and Gold orchards has been similar though Gold has tended to apply more fruit sizing (i.e. Benefit) and Bt sprays as well as less hydrogen cyanamide (for budbreak).

Green Organic orchards have mainly applied sprays to control insects however these have been certified organic and the potential risk of these to the environment is much lower than conventional sprays (Appendix 2).

Table 4. Average number of times major sprays have been applied annually to ARGOS orchards over the 1999/00 to 2006/07 period.

Type	Active ingredient	Green	Green Organic	Gold
Fungicide	Iprodione	0.5	0.0	0.4
Fungicide Total		**0.7**	**0.0**	**0.4**
Herbicide	Glyphosate	0.9	0.0	0.9
Herbicide Total		**0.9**	**0.0**	**0.9**
Insecticides - conventional	Chlorpyrifos	0.8	0.0	0.7
	Diazinon	1.4	0.0	1.4
	Emamectin	0.2	0.0	0.3
Insecticides - certified organic	Bt	0.3	2.3	0.6
	Mineral oil	0.0	2.4	0.0
Insecticide Total		**3.7**	**4.8** (all certified organic)	3.8
Plant growth agent	Benefit	0.1	0.0	1.0
	Hydrogen cyanamide	0.9	0.0	0.6
Plant growth agent Total		**1.0**	**0.0**	**1.7**
Grand Total		**6.5**	**4.9** (all certifed organic)	**7.3**

3.4.6 Soil nutrition

In recent years, Green and Gold orchards have generally applied similar amounts of N,P,K,Mg and S in mineral form (Figure 5, Appendix 3). This is not surprising given that research on the nutritional requirements of the newer Gold variety is limited and so the recommendations for Green tend to form the basis. Due to the restriction of inputs, Organic orchards have tended to apply less nutrients in mineral form particularly nitrogen. Instead, Organic orchards tend to apply large quantities of plant and animal based fertilisers like compost and fish (Table 6). While the nutritional content of these is small (just a few percent) the large quantities applied means potentially large amount of nutrients are applied although it seems that the amount of nitrogen supplied has been much lower than suggested rates (Figure 5). 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 5). 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 above, will contribute significantly to differences in soil quality; other influential factors include orchard history and previous land use.

Figure 5. Average amounts of nutrients applied to kiwifruit orchards in the ARGOS programme for the 2003/04 to 2006/07 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**).

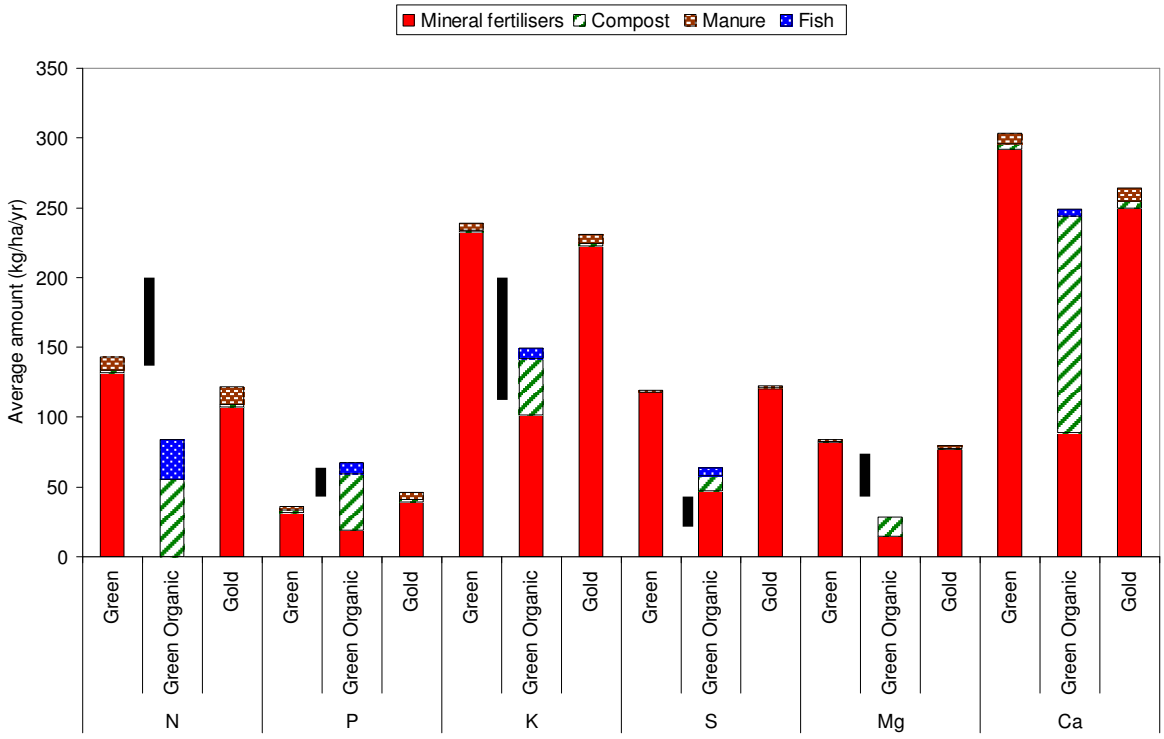


Table 5. Most commonly used mineral fertilisers on Green, Green Organic and Gold orchards in the ARGOS programme. Average rates (kg/ha/yr) for the 2003/04 to 2006/07 period are shown (rounded to the nearest 50).

Product	Approx. nutrient content	Green	Green Organic	Gold
Lime	37% Ca	550	50	450
Calcium Ammonium Nitrate (CAN)	27% N, 8% Mg	350	0	250
Sulphate of Potash (SOP, potassium sulphate)	40% K, 17% S	250	200	250
Muriate of Potash (MOP, potassium chloride)	50% K	150	50	150
Gypsum (calcium sulphate)	18% S, 24% Ca	150	50	150
Reactive Phosphate Rock (RPR)	12% P, 34% Ca	0	200	0
Patent Kali (potassium sulphate + magnesium sulphate)	25% K, 17% S, 6% Mg	0	100	0

* 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 6. Average amounts of organic fertilisers applied annually to kiwifruit orchards in the ARGOS programme for the 2003/04 to 2006/07 period (rounded to the nearest 100).

	Green	Green Organic	Gold
Compost (kg/ha)	200	6,600	300
Manure (kg/ha)	600	0	800
Average of Fish (L/ha)	0	1,00	0

3.4.7 Other practices

In the 2006/07 growing season, at least a third of all ARGOS orchards applied water to assist vine growth and health though the amounts applied were not quantified (Table 7). Close to a half of orchards had also used some form of protection against frost; more Gold orchards had been protected possibly because the earlier growth of this variety coincides with more frost events. Only four orchards had carried out any form of soil cultivation which is a reflection of the good quality soil on which the majority of orchards are grown.

Table 7. Percentages of ARGOS orchards undertaking other cultural practices.

Type	Green	Green Organic	Gold
Frost protection used	42	42	67
Irrigation used	50	33	33
Soil cultivation	8	25	0

4. Environment

4.1 Introduction

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

ARGOS recognises that ecological processes and biodiversity on New Zealand's farmed landscapes have received very little study so far. In addition to monitoring the effects of different farming systems this research will also study general ecological processes in farm agro-ecosystems 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.

In the initial 12 – 18 months of the programme (2003 – 2005), baseline surveys of the physical environment of kiwifruit orchards were undertaken with the results presented in earlier sector reports like this one. Since then, repeat sampling of environmental indicators has occurred and here we focus on soil quality and invertebrates.

4.2 Soil health

4.2.1 Soil fertility

ARGOS has sampled soil in its kiwifruit orchards on two separate occasions, in 2004 and 2006. Here, a summary of results are presented including an analysis of soil biology. Full results are available in Carey and Benge, 2007.

Generally, soil fertility was high for all three production systems (Table 8). 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).

Green Organic orchards tend to apply P in the form of reactive phosphate rock (RPR) and so would be expected to have soil with higher proportions of residual-P, relative to Olsen-P, because P is released relatively slowly from RPR (Ramakrishnan and Perrott, 2004). However, the similar linear relationships between Olsen-P and resin-P for each of the systems suggests that Green Organic orchards are not building up relatively large reserves of residual-P (and nor are they lacking in available-P).

Inorganic-S values were lower for Green Organic though they remained above optimum levels; Organic-S for Green Organic was higher than Green but lower than Gold. Higher anaerobic mineralisable nitrogen (AMN) values for Green Organic orchards can likely be attributed to the large volumes of organic fertilisers used (Table 6). Since inorganic-N is not added in Organic systems, a build-up of readily-mineralisable organic-N is advantageous to make sure that sufficient N is mineralised throughout the growing season for vine growth and fruit development.

Soil quality has been measured both within-rows (under the leaders) and between-rows (alleyways). Total carbon, AMN, total nitrogen, CEC and cations were on the whole 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.

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.

Table 8. Two-year average (2004 & 2006) gravimetric values for a range of soil chemical properties for Green, Green Organic and Gold kiwifruit systems. Values with letters in common within a row are not significantly different at the 5% level.

		System		
Soil attribute	**Unit**	**Green**	**Green Organic**	**Gold**
Olsen-P	mg P/kg soil	48.1 ab	43.7 a	57.8 b
Resin-P		104 ab	95 a	134 b
P-retn. (ASC %)		62.8 a	65.5 a	64.9 a
Sulphate-S	mg S/kg soil	17.9 ab	14.5 a	20.1 b
Organic-S		6.5 a	7.2 a	8.7 b
Total-C	w/w %	5.1 a	5.7 b	5.6 b
Total-N		0.43 a	0.47 b	0.47 b
C/N	ratio	12.1 ab	12.1 b	11.9 a
AMN-N	g/kg soil-N	23.7 a	27 b	22.5 a
pH		6.5 b	6.7 c	6.4 a
CEC	cmol/kg soil	17.6 a	19.5 b	18.6 ab
Ca		11.6 a	13.6 b	11.4 a
Mg		1.9 a	2.3 b	2.0 ab
K		0.7 a	0.8 a	0.7 a
Na		0.1 a	0.1 ab	0.1 b

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

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

4.2.2 Soil structure

Generally, soil bulk densities (SBD) to a depth of 15 cm were moderate overall (0.7 - 0.9 g/cm^3) (Table 9). Green Organic had lower SBD at both the 0 - 7.5 cm and 7.5 - 15 cm sample depths whilst Green had the highest. Soil porosity and aggregation was also significantly better for Green Organic orchards (data not presented here). It is not clear what caused these differences 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 was generally better within-row possibly because of greater compaction from machinery use between-rows.

4.2.3 Soil biology

Soils from the Green Organic orchards generally have had larger microbial populations than those from Green and Gold orchards (Table 9). The amounts of microbial nitrogen (N) in particular were significantly highest for Green Organic. The microbial carbon (C) levels for Green Organic were significantly higher than Green (but not Gold) when expressed per unit of soil but not when expressed per unit of soil-C. These results suggests that Organic management may be having some beneficial effects on microbial populations.

Higher microbial populations were evident between-row and is 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.

Soil respiration in 2004 was found to be significantly lowest for Green (Pearson and Reid, 2005). However, in 2006, there were no significant differences between production systems or landforms (Table 9). 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 between systems.

Earthworm numbers were only 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.

Table 9. Average values for soil bulk density and a range of soil biology properties for Green, Green Organic and Gold kiwifruit systems. Bulk density, microbial-C and earthworm values are the averages of 2004 and 2006 while microbial-N and respiration values are the averages for 2006 only. Values with letters in common within a row are not significantly different at the 5% level.

Indicator	Green	Green Organic	Gold
Soil bulk density (g/mL, depth 0-15cm)	0.82 a	0.75 b	0.78 ab
Microbial content:			
- microbial carbon per unit of soil (*u*g microbial-C /g soil)	356.0 a	427.3 b	384.1 ab
- microbial carbon per unit of soil carbon (mg microbial-C/g soil-C)	7.3 a	7.7 a	7.2 a
- microbial nitrogen per unit of soil (mg microbial N/g soil)	86.2 a	124.3 b	100.2 a
- microbial nitrogen per unit of soil nitrogen (mg microbial N/g soil-N)	20.6 a	25.9 b	20.7 a
Microbial activity i.e. soil respiration:			
- per unit of soil (mg CO_2/kg soil/day)	19.9 a	22.3 a	19.7 a
- per unit of soil carbon (mg CO_2/kg soil-C/day)	404 a	407 a	418 a
- per unit of microbial carbon (mg CO_2/g microbial-C/day)	53.1 a	48.2 a	50.4 a
Earthworms (number)	74 a	133 b	73 a

4.3 Orchard health

4.3.1 Birds

The relative abundance of birds on orchards was first surveyed in the 2004/05 summer with the results presented in Blackwell, et al., 2005. A second survey was conducted in the 2006/07 summer with the main results presented here. Each time, distance sampling and 5-minute bird counts were both employed with each orchard sampled only once.

In 2006/07, the average total number of birds was highest for Gold, intermediate for Green Organic and lowest for Green (Figure 7, A) but the differences were not significant. The total number of species (Figure 7, B), the number of native birds (Figure 7, C), the number of native species (Figure 7, D), and the proportion of native species (Figure 7, E) were all highest on Green Organic orchards and lowest on Green though none of the differences were significant. In 2004/05, only the number of species was found to be significantly different with more species found on organic orchards.

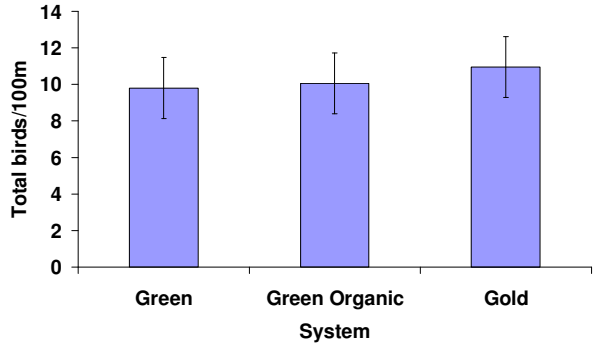
Overall, the most common species found were the introduced passerines i.e. blackbird, thrush, house sparrow and finches (Figure 8); these were also the most common in the summer of 2004/05. The next most common were native species i.e. fantail, silvereye, kingfisher, grey warbler and tui, with the latter two being only found in NZ (endemic).

Figure 6. The most common introduced and native species of bird found on ARGOS kiwifruit orchards (in both 2004/05 and 2006/07). Source: http://nzbirds.com.

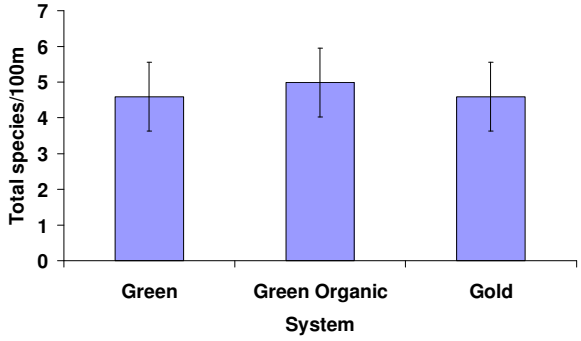
Blackbird	**Piwakawaka, the fantail**
	
Other common names: — Black ouzel, woozel, merle, chucket, gottling, *Turdus vulgaris*. *Description:* — Introduced bird: 25 cm, 90g; adult male, black with bright orange bill; adult female, dark brown with pale throat and mottled breast, bill brown and dull orange; juveniles, rust brown with mottled breast, bill dark brown; immature males have brown wings against a brown body, patches of black; bill dark.	*Other common names:* — Pied fantail, tiwakwaka. *Description:* — Native bird: 16 cm.,including long fanned tail, 8g., pied bird hs grey head, white eyebrow, brown back, yellow underparts, black and white tail., juvenile similar but browner body; black phase, sooty black but for white spot behind the eye.

Figure 7. The relative abundance of birds in ARGOS kiwifruit orchards in the summer of 2006/07. The number of birds seen or heard while walking along transects was recorded. Sampling occurred once. Predicted mean values are shown from ANOVA. The error bars represent 95% confidence intervals.

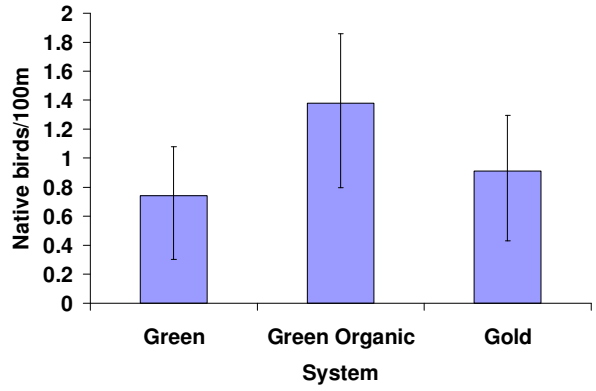
A. Total number of birds.



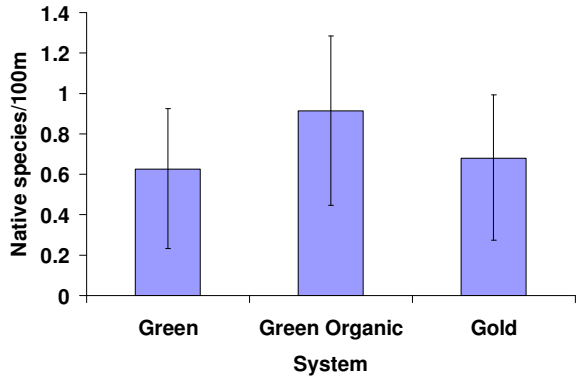
B. Total number of species.



C. Number of native birds.



D. Number of native species.



E. Percentage of native species.

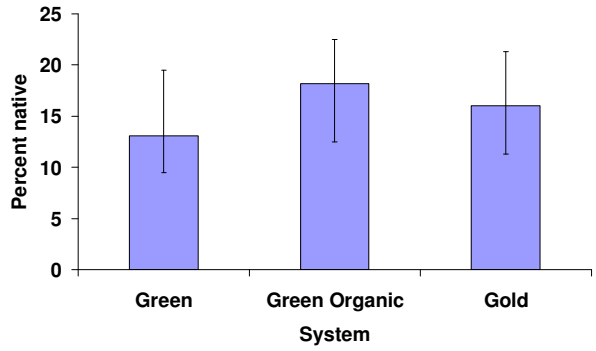
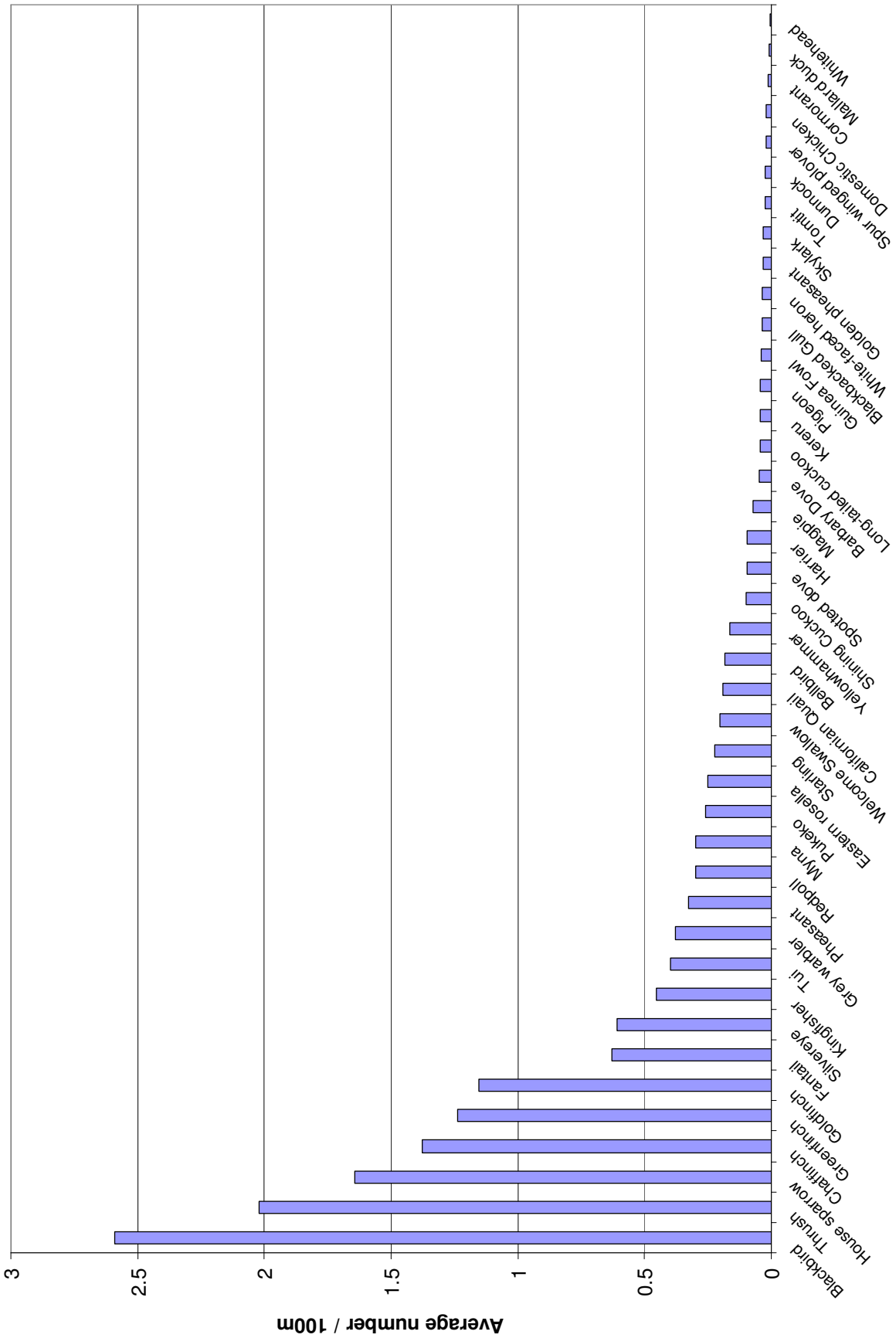


Figure 8. Average number of individual bird species observed across all ARGOS kiwifruit orchards in the 2006/07 summer. The number of birds seen or heard while walking along transects was recorded. Sampling occurred once.



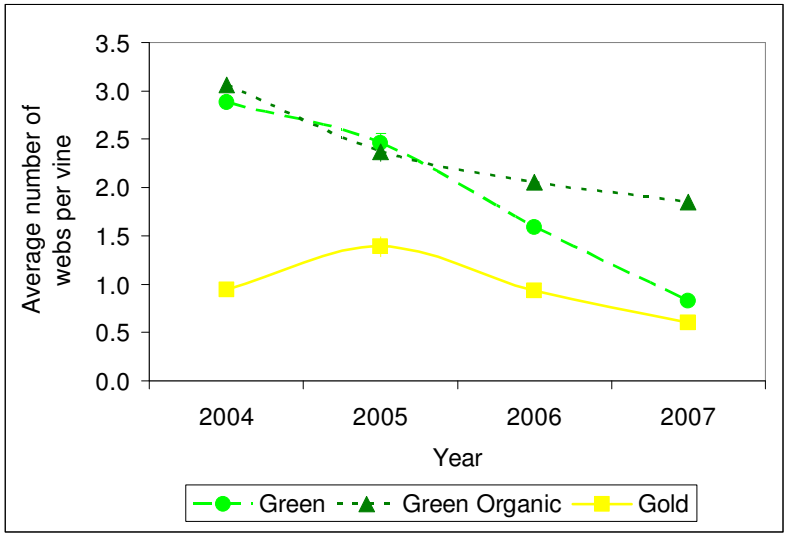
4.3.2 Invertebrates - cicadas and spiders

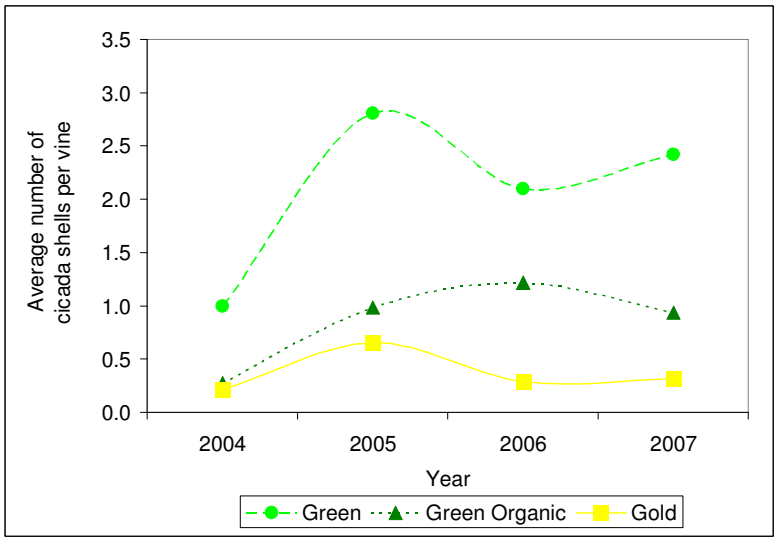
The amount of spider webs and cicada exuviae (shells) attached to vines in ARGOS orchards has now been determined over four consecutive years. This information could provide an indication of the dynamics of these macro-invertebrates and tell us something about the ecological state of orchard environments.

Gold has consistently contained the least spider webs (an indication of the abundance of web-spinning spiders) though the difference has been closing (Figure 9, 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 9, bottom).

Figure 9. 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 11).

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) is scheduled to occur 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 between kiwifruit production systems is shown in Table 11; indicators which have not differed significantly are presented in Table 10. 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 system which has evolved from the system for Green and so management of Green and Gold is still similar in many ways hence the smaller differences e.g. fertiliser inputs are comparable (Table 5).

Table 10. 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	2005: Total abundance, native abundance & richness	No difference between systems	Blackwell, et al., 2005
		2007: Total abundance and species richness, native abundance and richness	No difference between systems	This report
	Lizards	Lizard abundance	None found	Benge, 2005
	Bats	Bat abundance	No confirmed sightings	Benge, 2005
Habitat	Shelterbelts	Structure (height, porosity, length)	No difference between systems	Moller, et al., 2006

Table 11. 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
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 two ARGOS Kiwifruit Market Access Reports (Saunders, 2007, Saunders, 2007). Some of these are expanded on here.

Trade factors: • World Trade Organisation negotiations • Bilateral Trade Agreements **Agricultural Policies:** • The Common Agricultural Policy • 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 • Organically produced food **Environmental issues:** • Climate change and carbon footprinting • Biodiversity • Water usage and quality standards • Reduction of pesticide use

5.2.1 Environmental issues

Climate change and carbon footprinting

The growing opportunities in accessing world markets, especially high-value ones, may well rely on production meeting various environmental criteria. The impact of agricultural production on climate change is the most recent example of these criteria from which issues such as food miles have arisen. Food miles is clearly an erroneous concept as it ignores the full energy and carbon emissions from production as shown in the 2006 Lincoln AERU Food Miles report (Saunders, et al., 2006). Whilst food miles is a concept that still is having traction with the popular media and maybe consumers, it has lost credibility with the supermarkets and government agencies in the UK who have turned their attention to carbon footprinting. The emphasis now is therefore on measuring the carbon footprint of products and currently in the UK, DEFRA (Department for the Environment, Food, and Rural Affairs), the Carbon Trust, and British Standard Institute are developing a method to do this. The aim of this is to reduce carbon footprint over time. The rise in importance of the carbon footprint cannot be seen as a temporary issue given the policy and consumer attitudes around this. Nor is this just an issue in the UK as the EU as other markets such as Japan have proposed some from of reduction in emissions. There are even signs in the US that this is growing in importance. It is to be emphasised that producers overseas, particularly in the EU are likely to be subsidised to meet these targets.

Biodiversity
In Europe, the presence of farmland birds is considered an important indicator of biodiversity and can be a good barometer of environmental change. The ongoing decline in bird numbers in Europe has been blamed on intensive farming techniques and has prompted a call for more money spent on programmes that promote the stabilisation and growth of farmland bird populations. For example, the UK government has an agri-environmental scheme that supports the development of 'skylark plots'. Producers are receiving payments for leaving a small plot of arable land uncultivated over the winter to provide a habitat for skylarks to nest. It is important for New Zealand producers to take note of the importance of birds as a biodiversity indicator in the EU market and to work on improving New Zealand's biodiversity.

Water usage and quality standards
Water usage and quality standards are also important environmental criteria. Agriculture accounts for the largest proportion of water use in the EU (approximately 70 percent) and negatively affects water quality in New Zealand and EU, as well as most other developed countries. There are pressures to develop new technologies and pricing policies to cope with these water issues. In the EU for example, the concept of 'user pay' for water consumption and a Nitrates directive are heavily debated.

Reduction of pesticide use
The use of pesticide is another important environmental factor, and potentially a food safety factor. Members of the European Parliament have called for specific EU targets to reduce the use of pesticides by 25 percent within five years and by 50 percent within ten years. In addition, there has been a proposal to ban aerial pesticide spraying. Given the assurance programmes used by NZ's Kiwifruit sector, the impact of this is likely to be relatively low for kiwifruit exports.

5.2.2 Consumer trends

Various market research studies undertaken in the last year consistently show that there is a great demand for food that is healthy, nutritious and safe; conveniently packaged; has a low carbon footprint; and is produced in an ethical manner. For example, reports from Datamonitor (the world's leading provider of online data, analytic and forecasting platforms for key vertical sectors) show that saturated fat intake reduction is the main priority for 74 percent of European and US consumers who look to improve their diets, and 59 percent of consumers are seeking healthy food in convenient packaging. A survey of New Zealand consumers by Moxie Design Group (www.moxie.co.nz) shows that 32 percent are driven by environmental factors when purchasing food products, which is a six percent increase from two years ago. Below is more detailed information about consumer trends in the area of health and nutrition, environmentally friendly food, and the demand for organically produced food.

Health and nutrition
Health concerns are a strong driver of food consumption and product differentiation on the basis of health components is critical. For example, the Australian food industry has vowed to reduce trans-fat within its products by the end of 2007 to meet customers demand for healthy food. Some companies have gone as far as to remove all saturated fats. There is also a trend towards personalized nutrition based on 'nutrigenomics". Research is undertaken to understand the relationship between specific nutrients and specific nutrient regimes on human health. While the aim of nutrigenomics is for personalised dietary advice, it is a science still in its infancy.

Nutritional labelling
The demand for healthy and nutritional food has put pressure on adequate nutritional labelling. However, there is a debate over how nutritional information is best presented. The Food Standards Agency (FSA) in the UK supports a traffic light front-of-pack labelling which allows consumers to quickly see if a food item is high, medium or low is certain nutrients

(saturated fat, sugar, salt) and is used by supermarkets such as Sainsbury's, Asda and Marks & Spencer. Some of UK's biggest food manufacturers, such as Kellogg's Nestle and Kraft, have launched a £4m campaign to promote another nutritional labelling system, GDA (Guideline Daily Amount of four key nutrients). In the EU, the Commission intends to put forward proposals for the revision of nutritional labelling this year and the retail sector engages through the Platform on Diet, Physical Activity and Health to develop an industry-led nutritional labelling initiative.

Health and nutrition claims
Standards for health and nutrition claims on food products are also being discussed in many countries. The Food Standards Australia and New Zealand (FSANZ) has proposed a voluntary health and nutrition claims standard with nutrient profiling and percentage daily intake. New legislation has come into force in the EU on how food manufacturers need to prove health and nutrition claims, and will only be able to make claims about nutritional and health benefits that are approved by the European Food Safety Authority.

Environmentally friendly food
Consumers are concerned about the environmental effects of food production and there is a demand for 'clean and green food'. For example, there is a trend towards a reduction in meat consumption because meat production is perceived as damaging to the environment. Some food manufacturers have responded to consumers' environmental concerns by reporting on their environmental practices and have taken steps to reduce their carbon footprint. These measures allow them to differentiate themselves from competitors. There is also a trend towards carbon footprint labelling though there is a debate on how the carbon footprint will be measured and how it will be presented on labels.

Country of Origin Labelling
There is pressure from consumers for Country of Origin Labels (COOL) on food products. For example, a poll of over 4,500 people in the US showed that 85 percent would like to know the origin of their food as this is perceived to help them to make safer food choices (Clapp, 2007). For this reason, it is essential that New Zealand maintains its reputation of being clean, green and disease free. In addition the local food market is predicted to rise from 2 billion to 7 billion in 2010.

Organically produced food
The demand for organically produced food continues to increase. The world market for certified organic food was estimated at $23-25 billion in 2003 with an annual growth of 19 percent. Research is being undertaken to ascertain whether organic food products contains more nutrients than non-organic products and whether increased nutrients results in extra health benefits. In addition, research is also conducted in the EU to establish organic processing standards and a code of practice that can be used to determine whether food processing methods are compatible with organic principles. The Codex Committee on Food Labelling is revising the Guidelines for the Production, Processing, Labelling and Marketing of Organically Produced Foods with the aim to create international food safety standards and tighter rules on organic production and labelling. In addition, DEFRA in the UK is currently reviewing their organic standards.

The Canadian government has recently launched a new organic logo and will be permitted for use only on food items certified at meeting Canadian standards for organic production. Furthermore, it has been agreed in the EU to have a logo for products that contains at least 95 percent organic ingredients. The term 'EU ORGANIC' will be compulsory although organisations are able to retain their own logos as well. The EU is also planning on restricting the permitted levels of genetically modified organisms (GMO) in organic products and is likely to fix the GMO tolerance level at 0.9 percent. Food organic products imported to the EU will be subject to the same requirements.

Another important debate at the moment is whether the use of air freight for organic food goes against organic principles and whether air-freighted food should be allowed to have an organic status. Whilst this is not an issue for the New Zealand organic kiwifruit sector, it is an important debate as it may affect the supply of organically produced food and disadvantage developing countries. It is also important to note that certain supermarkets in the UK have taken to labelling food air freighted with airplane sticker.

The demand for healthy, safe, environmentally friendly and organically produced food highlights the importance of marketing assurance schemes, including labelling and verification of production methods, for New Zealand producers in order to ensure market access.

5.3 Financial performance of ARGOS orchards: 2002/03 to 2005/06

At the farm or orchard level, researchers have now collected financial accounts for four consecutive years (2002/03, 2003/04, 2004/05 and 2005/06). 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**) or obtained from your Field Manager.

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)
Despite the consistently higher average yield of Green, the OGR has been slightly higher for Green Organic (Figure 10) with the difference not being significant. This is because of the higher tray OGR for Green Organic which on average have been 40% higher than Green in recent years; this difference is consistent with the average Industry differential (ZESPRI, 2007). The average OGR for Gold had been noticeably higher, especially in recent years, because of higher yields and tray returns.

Orchard working expenses (OWE)
For the 2003/03 to 2005/06 period, the total cost of growing Gold, on average, has been significantly higher than that of Green and Green Organic (Figure 10). 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 growing costs of Green and Green Organic have been similar. Although Green has had consistently higher spray & chemical, R & M, pollination and wage costs (Appendix 4) the differences have not been significant. This has been balanced by consistently lower other, administration, fertiliser and vehicle expenditure with the later three being significantly lower (Figure 11). 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 (Table 6).

Cash Operating Surplus
Due to the similar OGR and growing costs of Green and Green Organic, the average operating surplus has not been significantly different (Figure 10). Similarly, the average surplus for Gold has not differed from that of the other systems, a result of the higher costs balancing out the higher OGR.

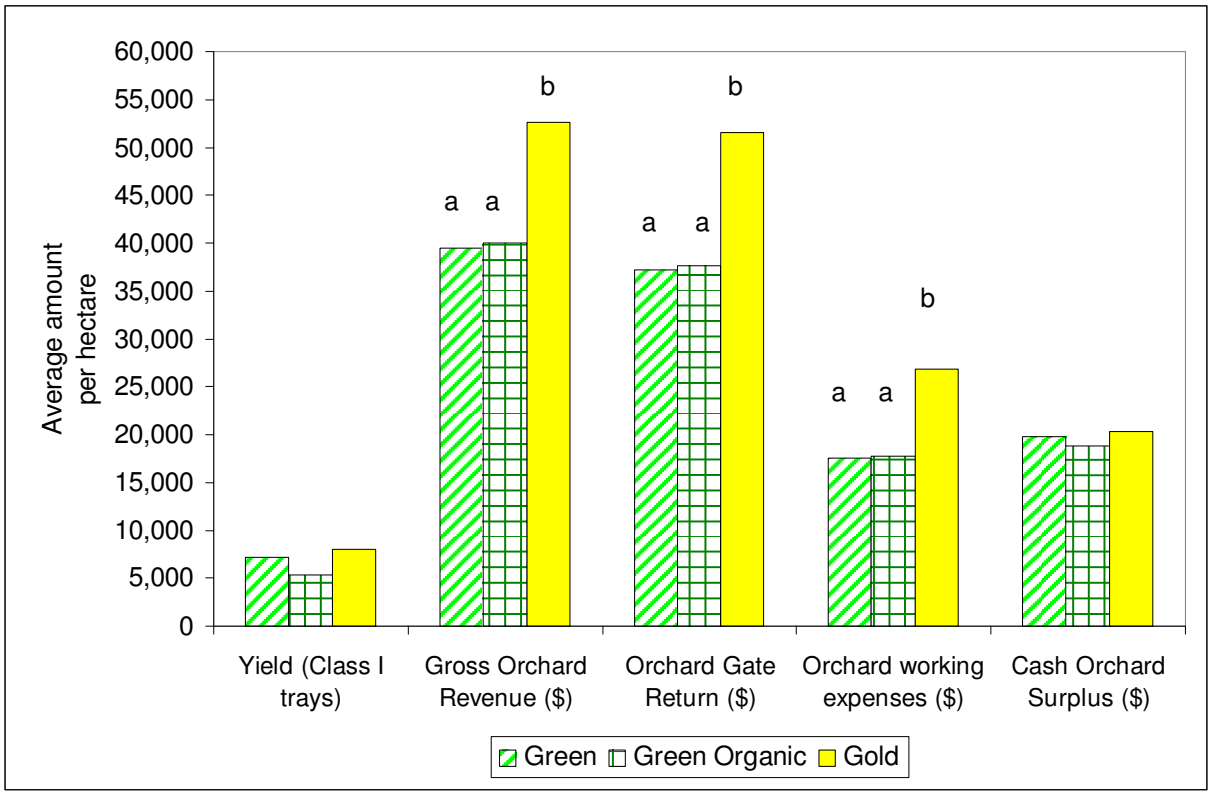
Orchard equity
Due to difficulties in collecting sufficient amounts of equity data (namely capital, asset and liability values), statistical comparisons of systems has not yet been possible. This data is required to estimate sustainability indicators of financial performance (like profitability solvency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

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 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 are not different in terms of OGR and total expenditure.

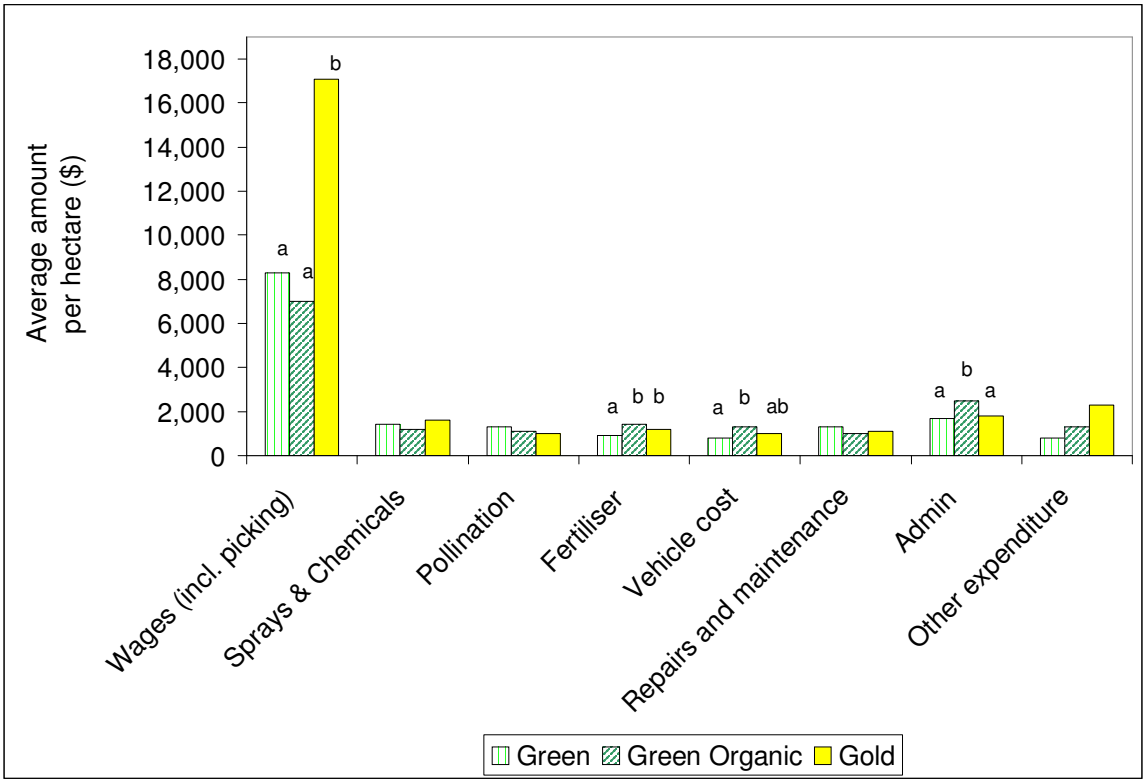
Variability in the financial data and small sample size may be limiting our ability to detect significant differences and this is something we are currently exploring.

Figure 10. Four-year (2002/03 to 2005/06 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. For each indicator, bars with the same letter above them are not significantly different at the 5% level. Only significant differences are shown.



- Predicted values from a statistical model (unbalanced ANOVA) are shown above as these take into account variation and would be expected to be closer to the true population means.
- 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 11. Four-year (2002/03 to 2005/06 period) average values of individual expenditure categories. Note, data from only 4 of the 12 Gold orchards are used. For each category, bars with the same letter above them are not significantly different at the 5% level. Only significant differences are shown.



*predicted values from a statistical model (unbalanced ANOVA) 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. These methods have included qualitative interviews, cognitive/causal mapping and postal questionnaires. Analysis and findings from each set of data have been presented in previous ARGOS reports and will not be repeated here. Instead, based on the research to date, the following discussion presents an overall characterisation of the groups of kiwifruit orchardists ('i.e. panels'). These characterisations are followed by an analysis of orchardists' responses to the introduction of the EurepGAP audit and the Taste ZESPRI programme.

6.2 Overall characterisation of Green, Green Organic and Gold orchardists

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 growers may not agree) and a well established formula/set of management practices (comfort or stability). This, of course, excludes to some extent those growers 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 growers 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 grower is responsible solely for mowing and shelterbelt maintenance, the tidiness of the orchard becomes the most obvious means of accessing the grower'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 growers reason to identify bird populations as an indicator of their environmental awareness and concern.

Along with their Organic counterparts, Green growers 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 growers 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 growers 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 growers 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 growers' 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 growers who appear to prefer the more settled and proven management system for the Hayward variety. In regard to their social perspective, Gold growers 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 growers 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.

6.3 Response to the implementation of supermarket initiated audit schemes

New Zealand's kiwifruit industry is strongly focused on its commitments to producing a high quality product that meets the increasing demands of its main export markets. This section examines the recent introduction of two programmes designed to meet this goal – a retailer driven audit scheme (EurepGAP) and a fruit quality incentive plan (Taste ZESPRI) – from the perspective of the ARGOS research framework that seeks to assess and enhance the social, economic and environmental sustainability of the sector. The analysis involves the response of the 36 orcharding households participating in the ARGOS project. Each of the households participated in a semi-structured, qualitative interview designed to elicit their understandings of and response to constraints on orcharding practice. This section focuses specifically on those constraints associated with participation in the kiwifruit industry, of which EurepGAP and Taste ZESPRI were most frequently identified. Comparison of the orchardists' responses to each programme provides insight to the use of such tools in order to promote both tangible fruit qualities as well as socially and environmentally responsible orchard management.

Response to the two programmes varied among the orchardists depending in part on the extent to which either conformed to existing understandings of good orchard management. (It is noteworthy that the choice of management system did not explain this variation.)

- Despite existing regulation of management practice under the KiwiGreen monitoring programme, a number of orchardists perceived the EurepGAP audit as a severe imposition on their identity as orchardists. Several features of the audit contributed to this perception:

    1. The view that the EurepGAP audit is an externally imposed assessment of good orchard management;

    2. The lack of significant alteration of management practice relative to that undertaken to meet existing KiwiGreen auditing;

    3. The excessive detail of the audit, often involving items or practices for which the orchardists saw no clear association with improved outcomes;

    4. The shift in focus for the assessment of a good orchardist from the practices 'in the orchard' to those 'in the office';

    5. An apparent lack of reward associated with compliance (especially the case as kiwifruit prices have not increased compared to pre-EurepGAP prices)

- By comparison, the Taste ZESPRI programme elicits very distinct responses from the orchardists – some of them viewing the production of dry matter as a challenge worthy of their skill and ability whereas others believed that it was unfair to base payment incentives on a feature of the fruit that lacked a well defined set of practices with which to achieve it. General acceptance of Taste ZESPRI appears to be enhanced by the reward of the price incentive (although some orchardists viewed this as a penalty) and the direct association between dry matter and fruit quality.

- Analysis of orchardist response to the introduction of EurepGAP and Taste ZESPRI indicates several characteristics which would contribute to similar attempts to promote higher quality kiwifruit, including:

    1. The promoted practices must either conform to existing perceptions of good farming among orchardists, or be justified as contributing to desired outcomes (e.g., higher quality fruit, globally recognised best practice, etc.).

    2. The outcomes of the practices should be evident and provide an achievable means of benchmarking good practice (e.g., reward structures, recognition of the superiority of New Zealand kiwifruit, etc.)

It is also evident from the interviews that any new programme, no matter its positive features, is subject to some dissatisfaction and will likely require a period of time before it becomes a fully normalised feature of good orcharding practice.

7. 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 12).

Table 12. 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	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 have had the most different environmental outcomes. This is not surprising given organic management is the most distinctive. Though organic orchards have tended to rank higher on the measured environmental indicators (e.g. more birds, more earthworms, higher soil quality), the Green and Gold results are not necessarily indicative of negative environmental impacts.
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, due to a combination of higher returns for Organic fruit and lower growing costs.
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 growers 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.

8. List of ARGOS reports and resources

PUBLIC REPORTS

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

Research Reports

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

ARGOS High Country Environmental Report

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

Working Papers

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

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

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

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

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

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

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

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

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

Research Notes (short research summaries)

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

ARGOS Newsletters

1. June 2004
2. January 2005

3. July 2005

Posters from ZESPRI's 2004 Marketing and Innovation Conference (Nov, 2004)
1. Background to ARGOS
2. Research results on Kiwifruit Orchards

Posters from Kiwi2006: International Kiwifruit Symposium - February 2006
1. Soil Biota Poster
2. Birds Poster

RESTRICTED REPORTS

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

Working Papers

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

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 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

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

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

ARGOnoteS

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

- ARGOnoteS 13: Qualitative research methodology, July 2005 by Lesley Hunt
- ARGOnoteS 14: Statistical hypothesis testing on ARGOS farms – some pros and cons of different approaches, July 2005 by Henrik Moller
- ARGOnoteS 15: Preliminary Results from the Argos Database by Caroline Saunders, William Kaye-Blake, Louise Ferguson, and Glen Greer
- ARGOnoteS 16: Survey of orchard floor vegetation in kiwifruit orchards by
- Jayson Benge, Henrik Moller and Richard Hill

Other Reports

- Attitudes of Green, Green Organic and Gold kiwifruit orchardists towards the Taste ZESPRI™ Incentive Programme in 2006 by Jayson Benge, Chris Rosin, John Fairweather, Lesley Hunt and Jon Manhire
- ARGOS 6 monthly report to Fonterra, April 2006 by Amanda Phillips, Peter Carey, Glen Greer, Martin Emanuelsson
- ARGOS Annual Kiwifruit Sector Report, September 2005 by Jayson Benge
- ARGOS Annual Sheep/Beef Sector Report, September 2005 by Dave Lucock
- A draft farm-based sustainability monitoring system for Maori in the Ngai Tahu takiwa by John Reid

Kiwi2006: International Kiwifruit Symposium - February 2006

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

9. References

Barber, A. and Benge, J., 2006. Total Energy Indicators: Benchmarking Green, Green Organic and Gold Kiwifruit Orchards. ARGOS,

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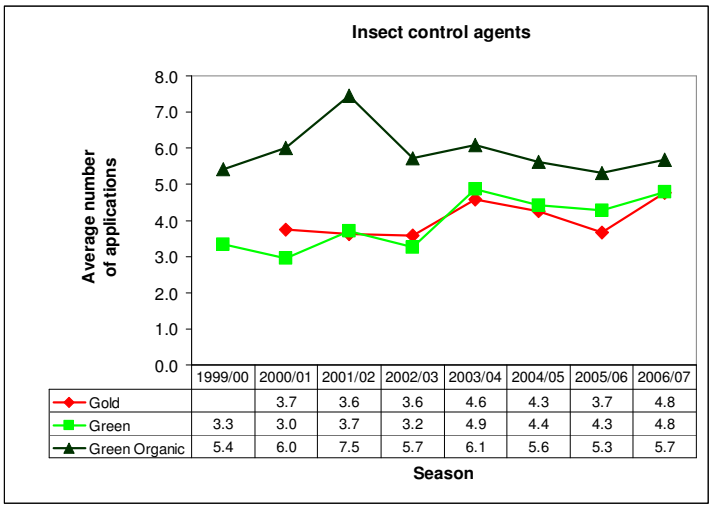
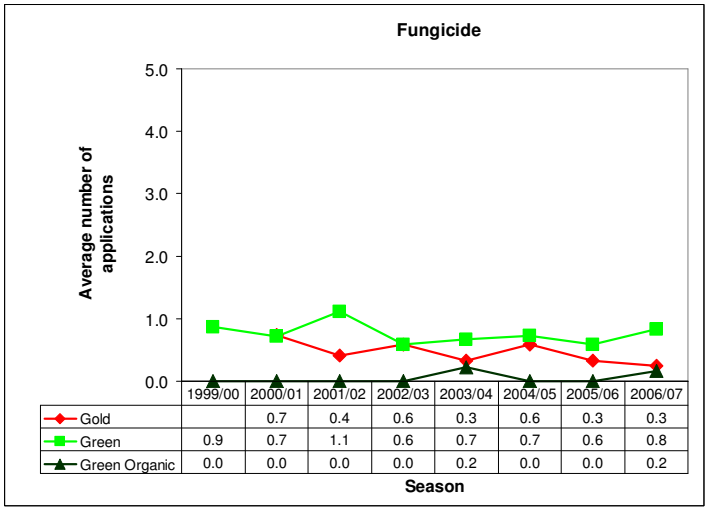
10. Appendices

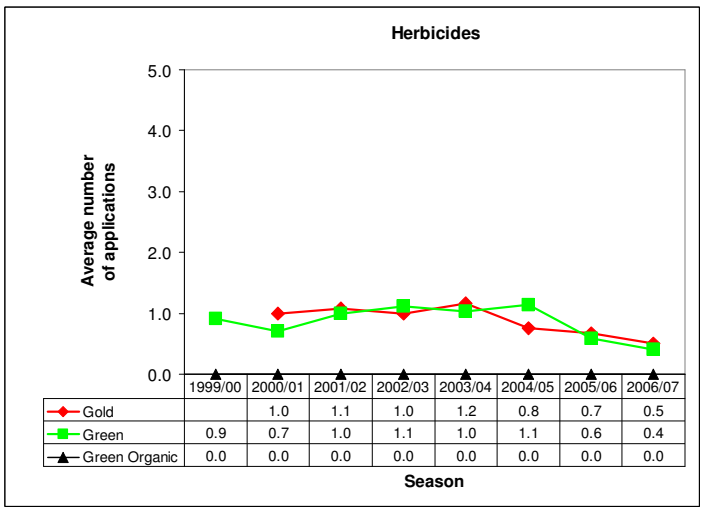
Appendix 1. Trends in the average number of sprays applied to orchards in the ARGOS programme.



	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Gold		3.7	3.6	3.6	4.6	4.3	3.7	4.8
Green	3.3	3.0	3.7	3.2	4.9	4.4	4.3	4.8
Green Organic	5.4	6.0	7.5	5.7	6.1	5.6	5.3	5.7

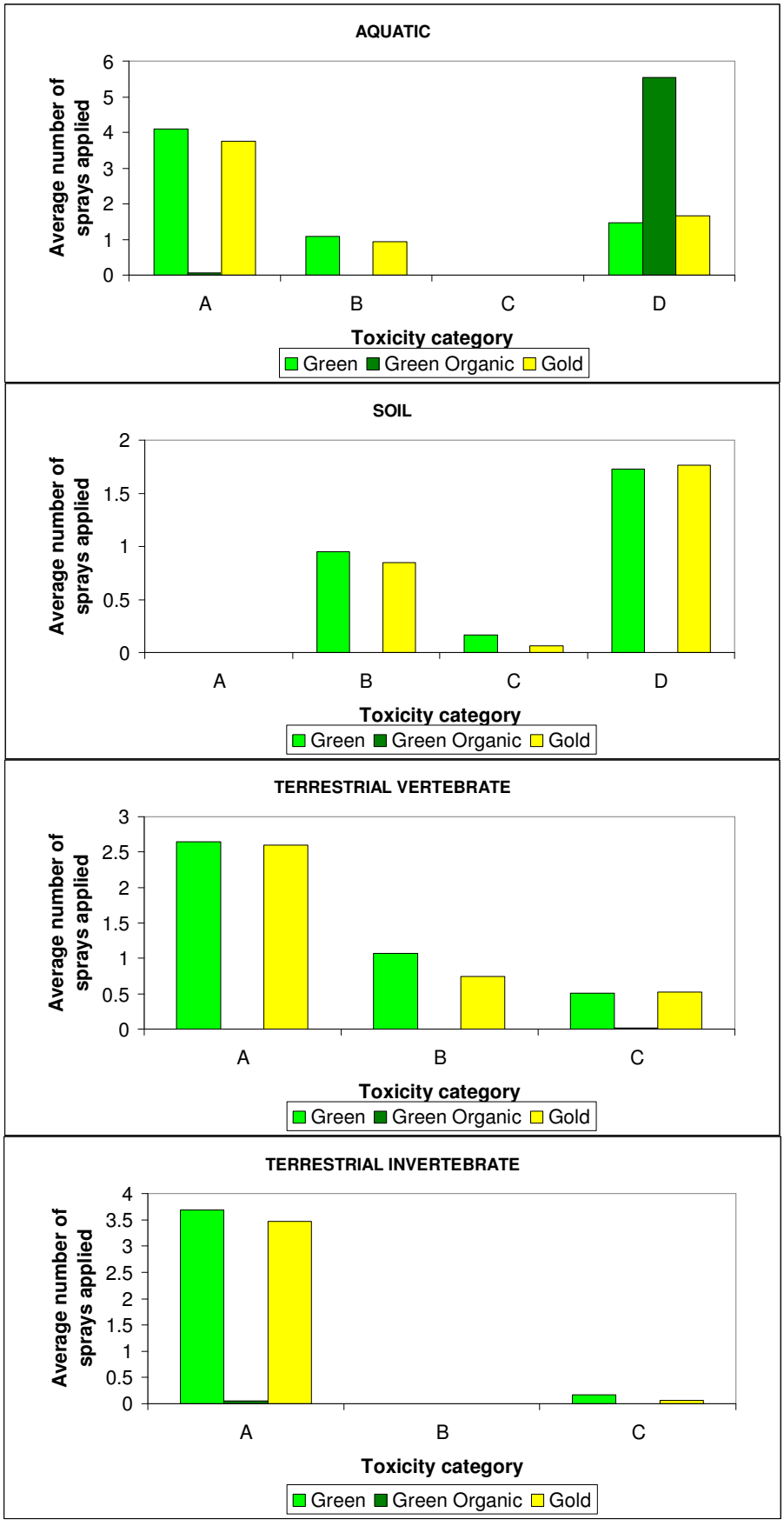


	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Gold		0.7	0.4	0.6	0.3	0.6	0.3	0.3
Green	0.9	0.7	1.1	0.6	0.7	0.7	0.6	0.8
Green Organic	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2

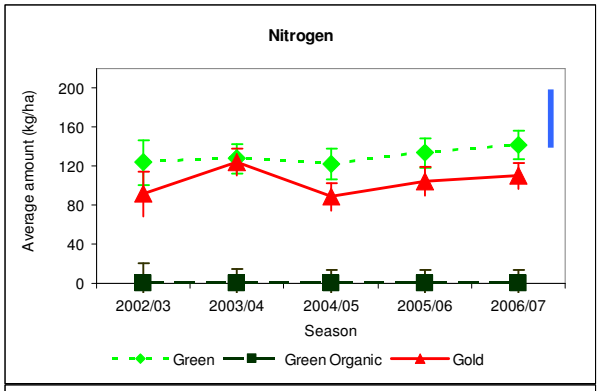


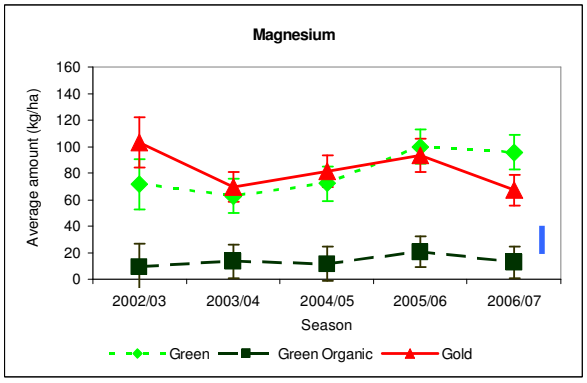
	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Gold		1.0	1.1	1.0	1.2	0.8	0.7	0.5
Green	0.9	0.7	1.0	1.1	1.0	1.1	0.6	0.4
Green Organic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

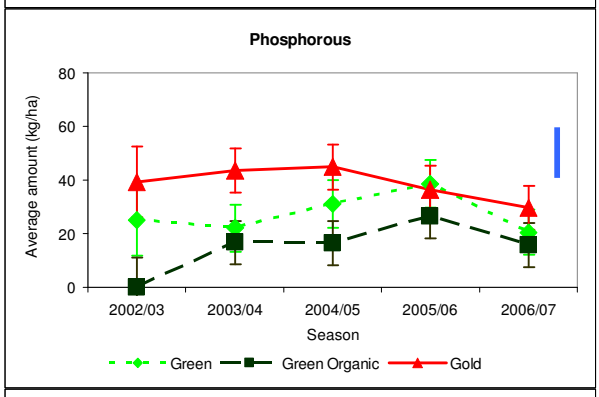
Appendix 2. Average number of sprays used on ARGOS kiwifruit orchards and their relative toxicity, for the 2002/03 to 2006/07 period. Toxicity categories are from A (highest) to D (lowest) based on The Hazardous Substances and New Organisms (HSNO) Thresholds and Classifications of Hazardous Substances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

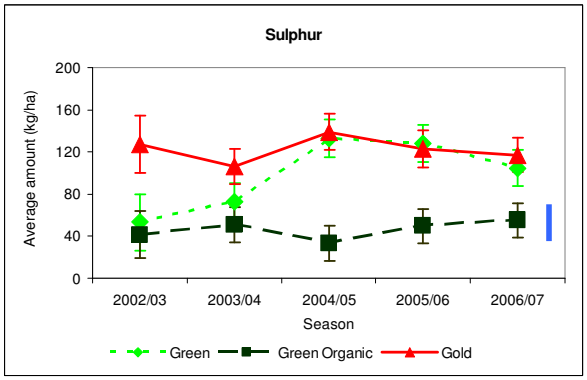


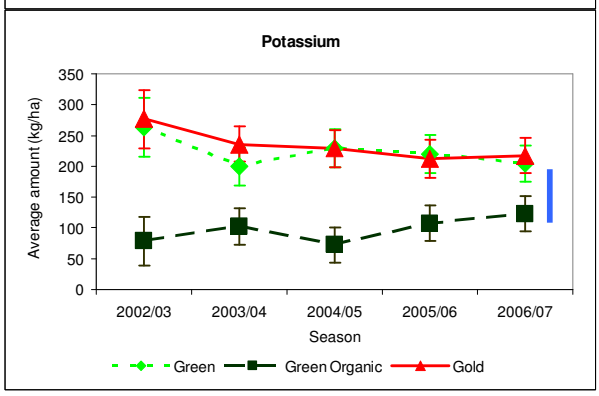
Appendix 3. Average amounts of N,P,K,S and Mg added to orchards in the form of mineral fertilisers. The vertical lines (blue) on the right side of each graph represent historically recommended levels (www.hortnet.co.nz).











Appendix 4. Trends in the average values of major operating costs for ARGOS orchards. The vertical bars represent 95% confidence intervals. Note, data for only 4 Gold orchards used. Values shown are predicted from a statistical model (unbalanced ANOVA) and would be expected to be closer to the true population means.