2009 Annual ARGOS Sector Report

KIWIFRUIT

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The AgriBusiness Group

Lincoln University

University of Otago

Executive summary

The Agriculture Research Group On Sustainability (ARGOS) is investigating the environmental, economic and social characteristics of primary production systems in NZ with the goal of assessing the sustainability and resilience of farming. In the Kiwifruit sector, the three main production systems are being compared i.e. Hayward grown under integrated management ('Green'), Hort16A grown under integrated management ('Gold') and Hayward grown under certified organic management ('Green Organic'). This report describes the main features of these and the differences between them.

Production trends

- In recent years, Gold orchards in the ARGOS programme have produced significantly more and larger fruit than the Green and Green Organic orchards (i.e. since 2004).
- Dry matter levels have not differed significantly between the ARGOS Gold and Green orchards.
- In recent years, the Green ARGOS orchards have on average produced a third more trays than their Organic counterparts; the Organic orchards have also tended to produce smaller and lower dry matter fruit.
- The production trends for ARGOS orchards have generally followed Industry trends.

Orchard history and management

Previous land use

- Most of the orchards were first planted with kiwifruit in the 1980's and were previously pastoral farms.

Canopy management

- Significantly more Green Organic orchardists in ARGOS have preferred to use low vigour wood compared to their Green counterparts.
- ARGOS's Green and Gold orchards on average have not been significantly different in terms of the numbers using replacement cane versus low vigour.

Pollination

- The number of hives per ha on average has not differed significantly between ARGOS's Green, Green Organic and Gold orchards (average ~ 8.4 / ha).
- About a third of the ARGOS orchards have used artificial pollination each year with no significant difference between production systems.

Girdling

- The percentage of ARGOS orchardists that practiced trunk girdling increased from 27% in 2004/05 to 81% in 2008/09.
- The percentage of ARGOS orchardists that practiced double trunk girdling increased from 0% in 2004/05 to 44% in 2008/09.
- The percentage of orchardists that have trunk girdled (single or double) has been consistently highest for Gold and consistently lowest for Green, with Green Organic intermediate. However, the differences have not been statistically significant.
- Double trunk girdling started in 2006/07 for conventional and a year later for organic with the percentages for each system increasing ever since.
- There has been a general trend for trunk girdling to replace cane girdling.
- Trunk girdling has very much become standard practice for the majority of ARGOS orchardists as they strive to increase orchard gate returns through increased fruit quality and quantity. A small number of orchardists have not yet trunk girdled so it would be interesting to see if they eventually do and note the reasons for change.

Nutrition

- Gold and Green orchards have applied similar amounts of macro-nutrients.
- Organic orchards have received significantly less nitrogen (N), potassium (K), magnesium (Mg) and sulphur (S) but similar amounts of phosphorus (P) and calcium (Ca). These differences are likely to contribute to production differences.
- In a previous report, a simple nutrient budget showed that the amounts of macronutrients being removed by the harvested crop are well met by ground fertiliser applications. Therefore, there maybe an opportunity to be more efficient with fertiliser use.

Sprays

- The organic orchards on average have applied fewer sprays i.e. 5.3 per year vs. 6.4 for Green and 7.0 for Gold.
- The Organic orchards have on average had a significantly higher number of insecticide applications each year (i.e. 5.1 versus 3.6). These have all been certified organic sprays with lower potential toxicity to the environment.

Other practices

- Organic orchards on average have been mowed/mulched significantly fewer times each year.
- In the last couple of seasons, a third to a half of ARGOS orchards have irrigated to assist vine growth and health. Close to half the orchards have also used some form of frost protection. Only one or two orchards have carried out any form of soil cultivation which is a reflection of the good quality soil on which the majority of orchards are grown.

Environmental outcomes

- In previous ARGOS publications and reports like this a number of significant differences have been reported in measured environmental variables. Generally, organic orchards have been found to have better soil quality and biodiversity. However, this is not to say that the environment in conventional orchards is not good.
- Cicadas were once again sampled in 2009 and once again Green orchards were found to contain the most, Gold the least and Green Organic intermediate.
- Two main species are found almost exclusively on NZ's kiwifruit orchards i.e. *Amphipsalta cingulata* (Clapping Cicada) and *A. zelandica* (Chorus Cicada). The ratio of these on orchards seems to be affected by altitude i.e. the proportion of clapping cicada increases and the proportion of chorus cicada decreases as altitude increases.
- In 2008/09, fantails were studied to see if an iconic species like this could be used as an indicator or orchard health. This was carried out by a masterate student, Guinevere Coleman. Some differences have been detected between orchard systems.

Soils update

In 2009 soil fertility was assessed on a subset of 12 ARGOS orchards i.e. four clusters. Other orchards were not able to be sampled as fertiliser was applied prior to sampling (it is hoped that these will be sampled in 2010). Despite the smaller sample size in 2009, some consistent trends emerged across sample years with respect to differences between production systems i.e.

- significantly lower pH for Gold
- significantly higher total base saturation (BS), available nitrogen, calcium and magnesium for Green Organic
- significantly lower organic matter (OM), total carbon and total nitrogen for Green
- greater use of organic inputs on organic orchards is a key reason for differences in soil quality

Similarly, consistent differences emerged across years for the two different areas that were sampled in each orchard (alleyways versus under the leaders) i.e.

- olsen P significantly lower in the alleyways

- available nitrogen, total C & N, organic matter and calcium all consistently higher in the alleyway; this is likely due to greater organic matter deposits there and no herbicide

Economics

- Gold orchards have had significantly higher Gross Orchard Revenues, Orchard Gate Returns, Orchard Working Expenses and Cash Orchard Expenses than Green and Green Organic orchards.
- Due to consider variation between orchards, we lacked the statistical power to be able to conclude if there were any differences in total revenue and total expenditure between Green and Green Organic orchards.
- Similarly, considerable variation in bottom-line measures like Cash Orchard Surplus, Net Orchard Profit Before Tax or Economic Orchard Surplus meant we did not have enough statistical power to be able to conclude if there were any real differences here.
- There were some statistically significant differences in individual cost categories.
- Using ARGOS social data, orchardists were classified as either having a stronger focus on "business" or a stronger focus on "lifestyle". There was insufficient statistical powerful to enable us to conclude if there were any significant differences between the revenue of these two groups. However, the "business" group had significantly lower costs and significantly greater bottom-lines than the "lifestyle" group.
- This work highlights the difficulty in getting a sufficient amount of good comparable financial data to identify any differences that might exist in the financial bottom lines of different production systems.

Social research

National farm survey results

In 2008, a national farm survey was deployed to gauge opinions on issues of farm management and sustainability. Despite an apparent growing concern globally amongst consumers about the impacts of food production, orchardists as a whole currently don't feel that issues like biodiversity and reduction of emissions are high priorities. They placed much stronger importance on maximising production and financial outcomes, as well as plant health, and soil health and fertility (which presumably they associate with production). They saw broader environmental indicators (e.g. biodiversity, number of birds) as slightly important at best. They also agreed slightly that farmers were being asked to bear too much responsibility for emissions and that technological solutions are required to mitigate this. All of this means that care needs to be exercised when developing policies which look to enhance broader sustainability of orchards like biodiversity and emission reduction. On the positive side, the lack of any great negativity to environmental questions may signal an open mindedness to environmental initiatives.

- Recently ARGOS has been exploring the use of bird symbols to market production as environmentally friendly. However, the national farm survey showed that orchardists expressed little enthusiasm for participating in such a scheme. This may highlight a disconnection in values between the market and the producers. If consumers do value such factors then producers will need to be convinced of this.

Orchardists identified the social aspects of orcharding to be important particularly those to do with them and their families; the wellbeing of staff was important too. This reflects that the lifestyle and wellbeing of the community is important in addition to making a living. Community participation was low but this is a reflection of the lifecycle stage of the orchardists rather than anything else. Orchardists placed a lot of importance on customer requirements/satisfaction (an acknowledgement that this is crucial for repeatedly selling their fruit at good prices) as well as on family needs and personal satisfactions. Succession was only slightly important.

The overall lack of differences in survey responses between Green, Green Organic and Gold orchardists in the ARGOS programme implies that initiatives around enhancing orchard

sustainability are likely to receive similar responses. The exception might be a greater resistance from Gold orchardists to any policies enhancing broader biodiversity and birds on orchards.

Linking attitudes to outcomes

Using the survey data, orchardists were able to be segregated according to their level of focus on production and also their level of focus on orchard tidiness (regardless of whether they were Green, Green Organic of Gold). The outcomes of these groups were compared to provide some insight into how orchardists' attitudes play out in practice.

Overall there were clear differences between the financial and production outcomes of orchardists depending on their level of focus on production. Generally however there were few differences in the environmental outcomes. Interestingly the group with the lower focus on production produced the highest dry matter fruit and had the greatest infestation with mites (in a one-off survey in 2005) which could be interpreted as having vines under greater stress.

Orchardists who seemed to keep tidier orchards were found to have higher pollination and working expenses. Could this reflect less biodiversity (particularly pollinators) in the orchards and a greater effort to keep the orchard tidy? Lower soil available nitrogen was also associated with the tidier orchards.

Indices of economic focus, breadths of view and innovativeness

Indices were created using previously collected data. All three ARGOS panels were shown to be equally strongly focused on the economics of their operations. This was born out in the national farm survey. Gold tended to have a narrower social breadth of view meaning they had lower focus on the social impacts of their orcharding outside of their families. There was no significant difference between panels in their environmental breadth of view. By their own assessment, Gold and Green Organic orchardists indicated that they were more likely to be innovative than Green orchardists.

Preface

ARGOS was formed at the end of 2003 with work beginning in earnest in 2004. The first Annual ARGOS Sector Report for Kiwifruit was produced in 2005 and contained findings from the first 12 – 18 months of the programme. The following three annual reports presented the results of subsequent research. This fifth instalment focuses on findings from the last 12 months i.e. 2008/09.

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

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

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

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The ARGOS programme has been designed and implemented with the intention of providing quality information to both farmers and orchardists and their associated industries to ensure that they are broadly sustainable, internationally competitive and profitable. To facilitate this we greatly value the involvement of 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.

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.

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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 2008, NZ horticultural exports were valued at nearly $3 billion with kiwifruit accounting for close to 30% of this (Plant&FoodResearch, 2008). Global kiwifruit production is expected to reach a record 1.75 million metric tonnes in 2008/09 with NZ being the third largest contributor (~20%) behind Italy (~25%) and China (~25%) (Belrose, 2009).

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

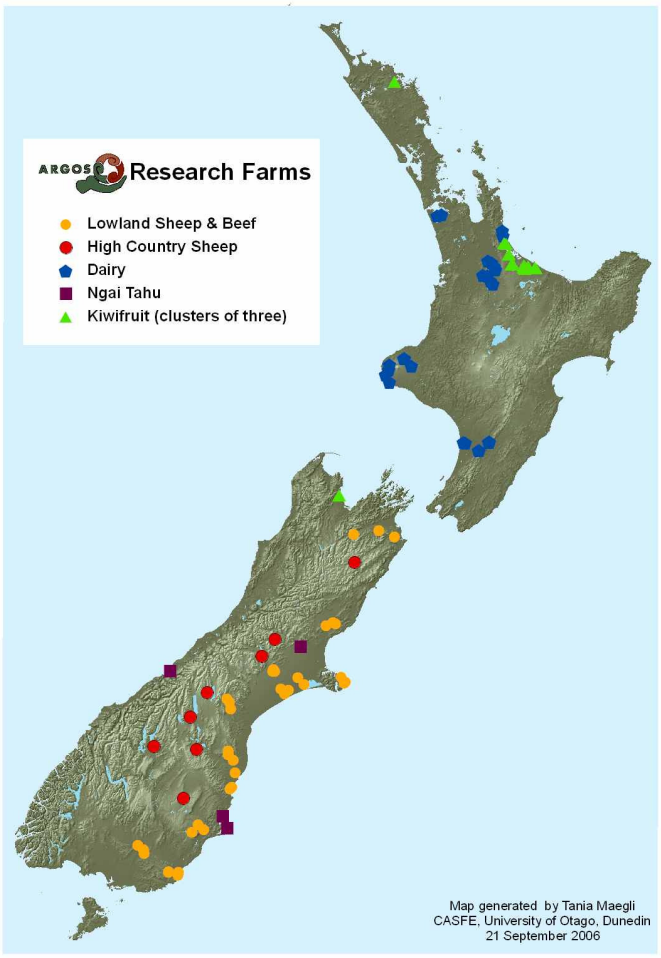
1.3 Kiwifruit research design

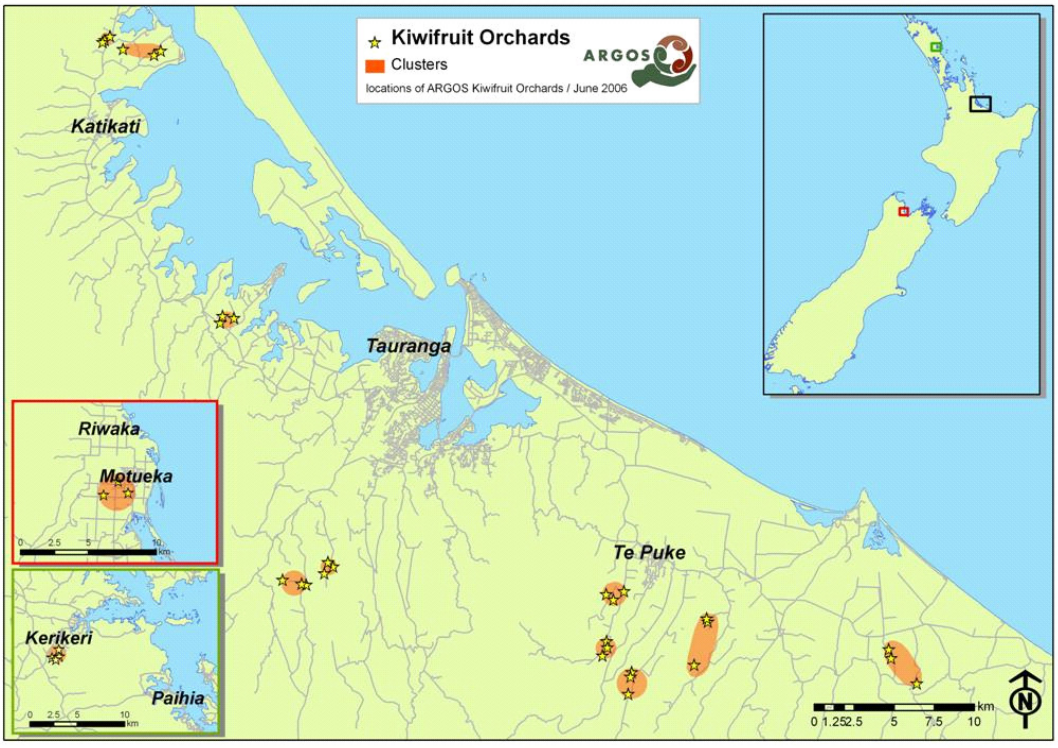
The following production systems (sometimes referred to as management systems or panels) are being studied in the kiwifruit sector:

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

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. Overview of main research activities

ARGOS kiwifruit research activities commenced in 2004. The first major undertaking was a survey of the habitats present on each orchard and the creation of detailed orchard maps (an example is provided in Figure 2). Since then a number of orchard monitoring events and interviews have occurred (Figure 4) i.e.

- annual interviews with each participant to collect orchard management and input data as well as financial data
- regular social interviews
- regular environmental monitoring with a focus on soil quality and terrestrial biodiversity (particularly birds)

Alongside this a number of reports with a focus on kiwifruit have been delivered to ZESPRI and Industry (Figure 3). These have included annual stakeholder reports which have summarised the main findings each year. A number of other reports have also been produced by ARGOS and these are listed in the back of this report. Similar monitoring and reporting is planned for the next couple of years.

Figure 2. Example of orchard map created by ARGOS.

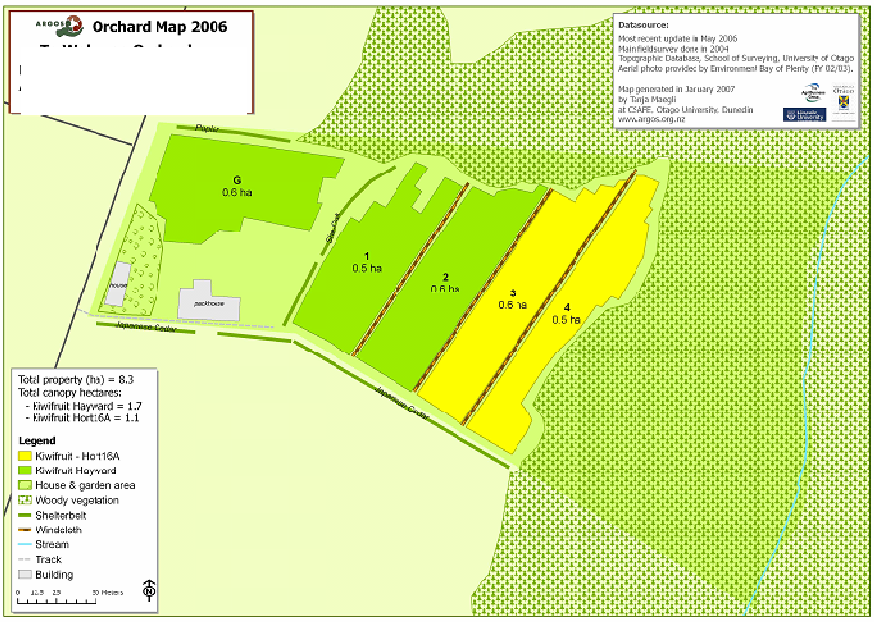
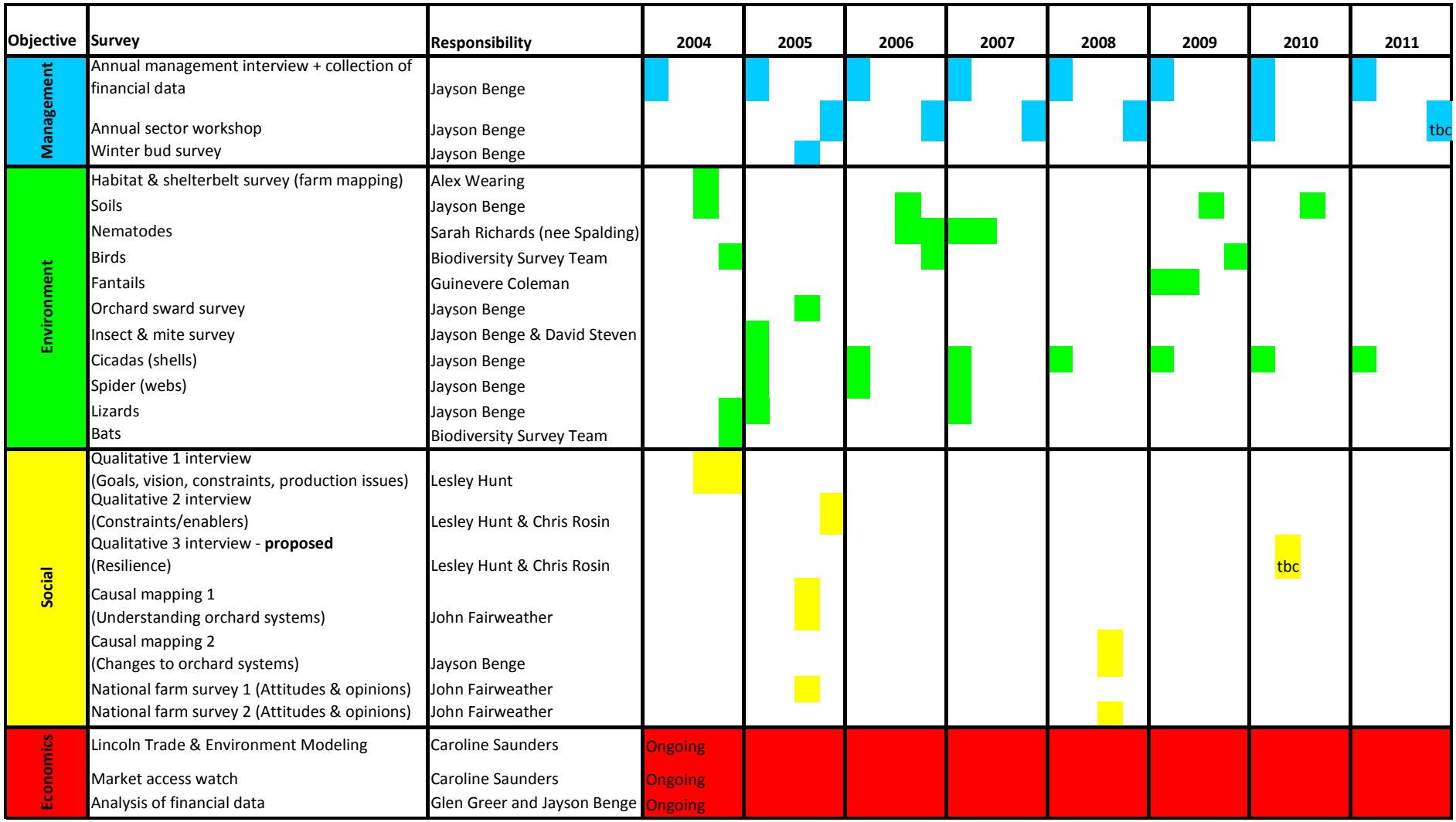


Figure 3. Key ARGOS reports delivered to Industry.

Reports	Delivery responsbility	2004	2005	2006	2007	2008	2009	2010	2011
Annual stakeholder reports	Jayson Benge								
Total energy indicators report	Andrew Barber & Jayson Benge								
National farm survey report (attitudes & opinons to sustainability)	Jayson Benge								
Kiwifruit environment report	Jayson Benge & Jon Manhire								
Market access update reports	Caroline Saunders								
Food miles report	Caroline Saunders								

Figure 4. Timeline of main ARGOS field activities in the kiwifruit sector (tbc = to be confirmed).



3. Orchard production

3.1 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.

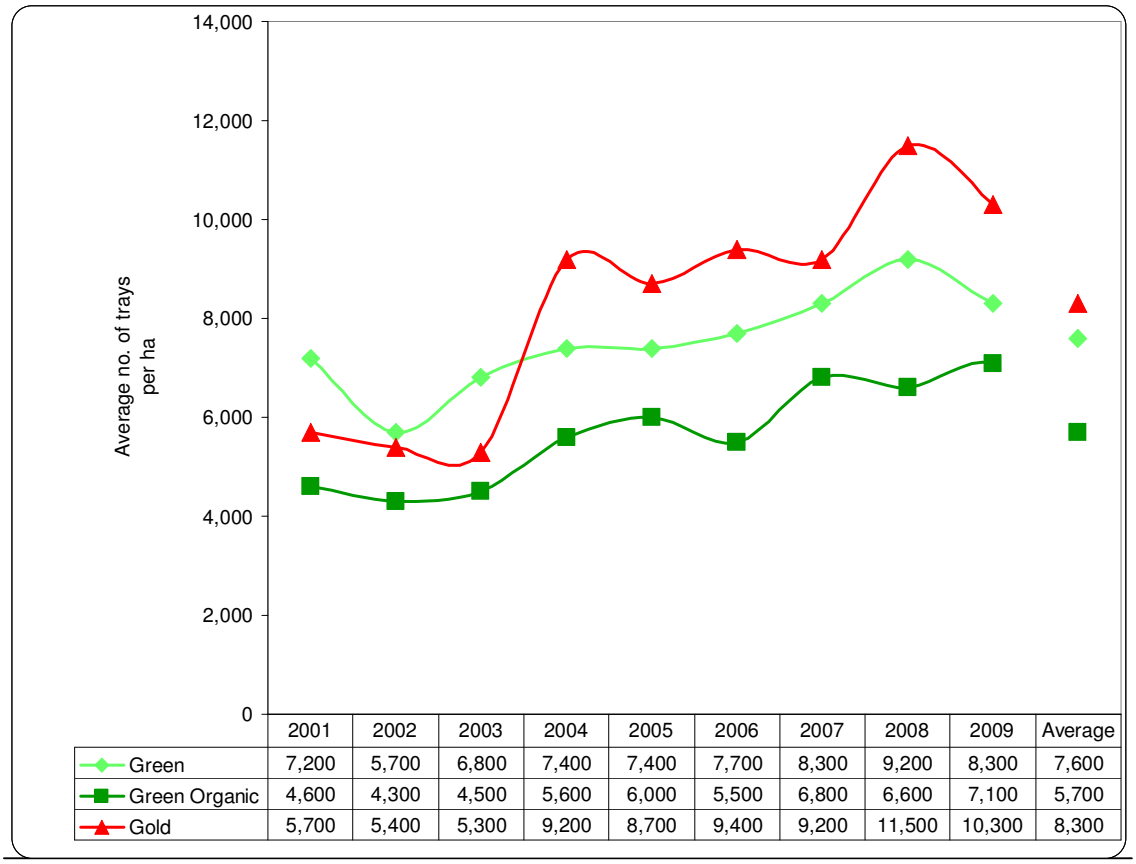
3.2 Number of trays

The performance of individual orchards is often measured in terms of its yield particularly the number of export trays produced. Orchardists often benchmark their yields against neighbours, other orchardists, and packhouse/industry averages.

- Since 2001, the average no. of trays for ARGOS panels has increased linearly:
  - On average Green orchards have increased their production each year by about 300 trays / ha.
  - On average Green Organic orchards have increased their production each year by about 350 trays / ha.
  - On average Gold orchards have increased their production each year by about 750 trays / ha.
- Overall between 2001 and 2009, the Green Organic orchards in the ARGOS programme produced significantly fewer trays per hectare than the Green and Gold orchards i.e. 5,700 trays / ha vs. 7,600 and 8,300 trays / ha respectively (Figure 5).
- Since 2004, ARGOS Gold orchards on average have produced significantly more trays per hectare than the ARGOS Green orchards i.e. 9,200 versus 8,000 ($P<0.001$).
- Trends in average tray numbers for the ARGOS panels have been very similar to industry trends (Appendix 1).

The increases in tray numbers is likely the result of improved practices and technology transfer. 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). A lack of chemicals particularly budbreak enhancers is a significant factor for less production on Organic orchards.

Figure 5. Average number of export trays for each ARGOS panel between 2001 and 2009.



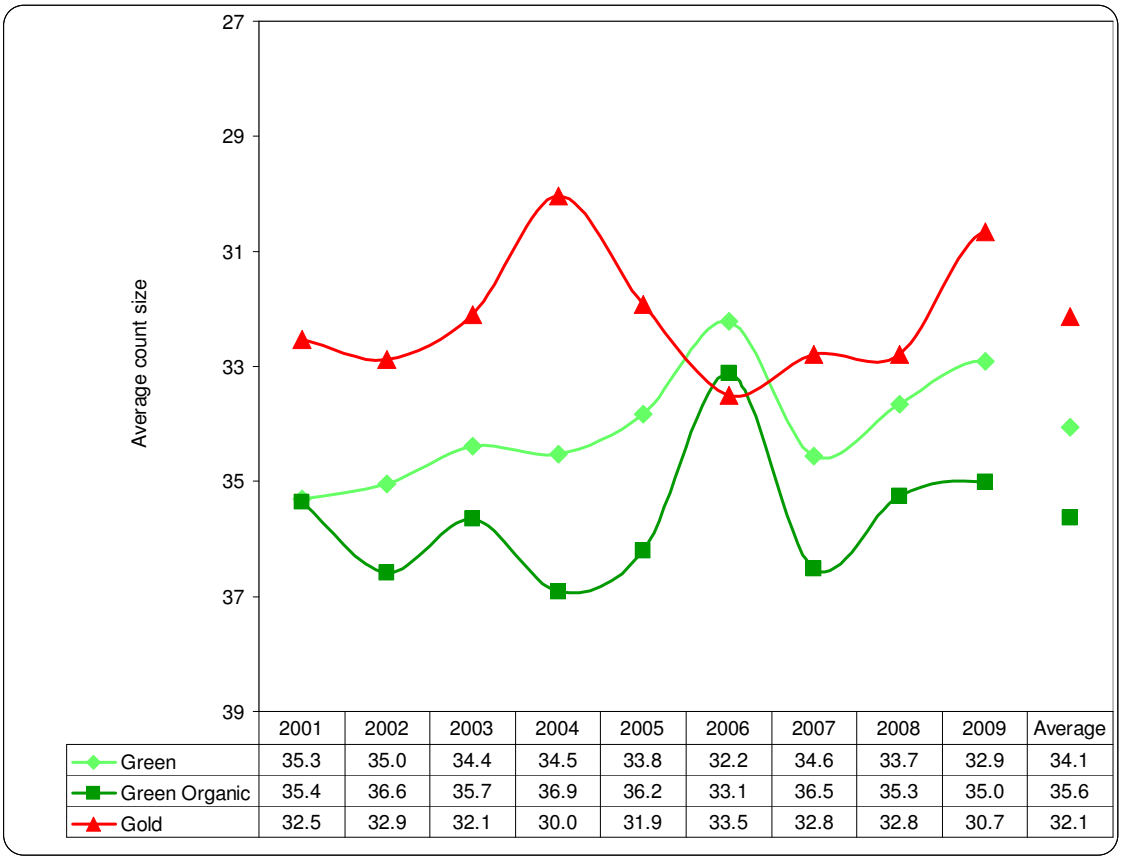
	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Green	7,200	5,700	6,800	7,400	7,400	7,700	8,300	9,200	8,300	7,600
Green Organic	4,600	4,300	4,500	5,600	6,000	5,500	6,800	6,600	7,100	5,700
Gold	5,700	5,400	5,300	9,200	8,700	9,400	9,200	11,500	10,300	8,300

3.3 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 (Appendix 2).
- Overall, ARGOS fruit size increased slightly between 2001 and 2009 (Figure 6).
- Since 2004, the ARGOS Gold orchards have on average produced significantly larger fruit than the ARGOS Green orchards i.e. count size 32.0 versus 33.6 ($P < 0.001$).
- Green Organic orchards in ARGOS have on average produced the smallest fruit (the difference was statistically significant overall). This is probably due in part to differences in fertiliser inputs.
- Managed Gold vines are capable of producing larger fruit which is reflected by the larger average fruit size values for the ARGOS Gold orchards.

Figure 6. Average count size of export fruit for each ARGOS panel between 2001 and 2009.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Green	35.3	35.0	34.4	34.5	33.8	32.2	34.6	33.7	32.9	34.1
Green Organic	35.4	36.6	35.7	36.9	36.2	33.1	36.5	35.3	35.0	35.6
Gold	32.5	32.9	32.1	30.0	31.9	33.5	32.8	32.8	30.7	32.1

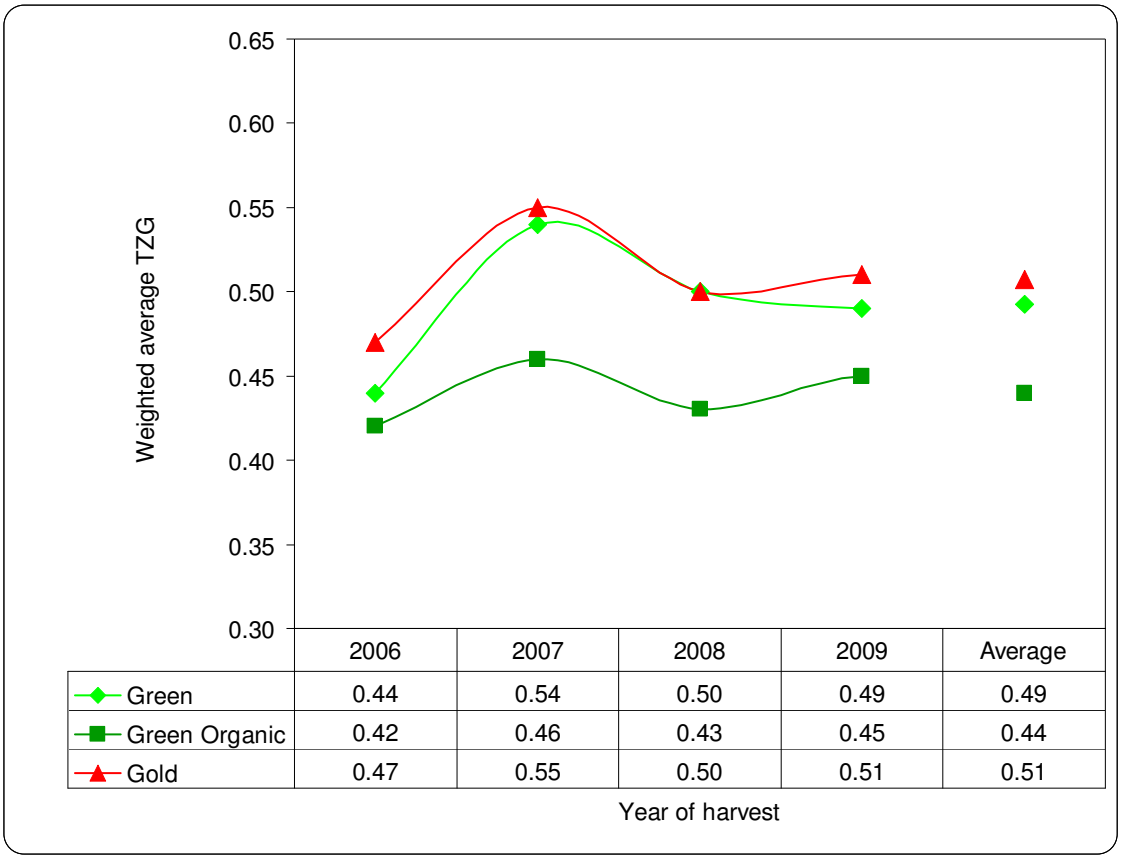
3.4 Dry matter

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

Since 2005, the Industry metric of dry matter has been the Taste ZESPRI Grade (TZG) which is a weighted average that takes into account the variation in a sample of fruit. The average trends for Industry and ARGOS orchards are shown in Figure 7 i.e.

- ARGOS Gold and Green orchards have produced fruit with similar TZG values (not statistically different).
- The ARGOS Organic orchards have consistently produced fruit with lower TZG values than the conventional orchards with the difference being statistically different in 2008 and 2009 (P = 0.06 & P = 0.005 respectively).

Figure 7. ARGOS average TZG values for Green, Green Organic and Gold.



	2006	2007	2008	2009	Average
Green	0.44	0.54	0.50	0.49	0.49
Green Organic	0.42	0.46	0.43	0.45	0.44
Gold	0.47	0.55	0.50	0.51	0.51

* TZG values are weighted averages i.e. for each maturity area, tray equivalents are multiplied by the TZG then all these values are summed with the total divided by the total tray equivalents.

4. Orchard management

4.1 Introduction

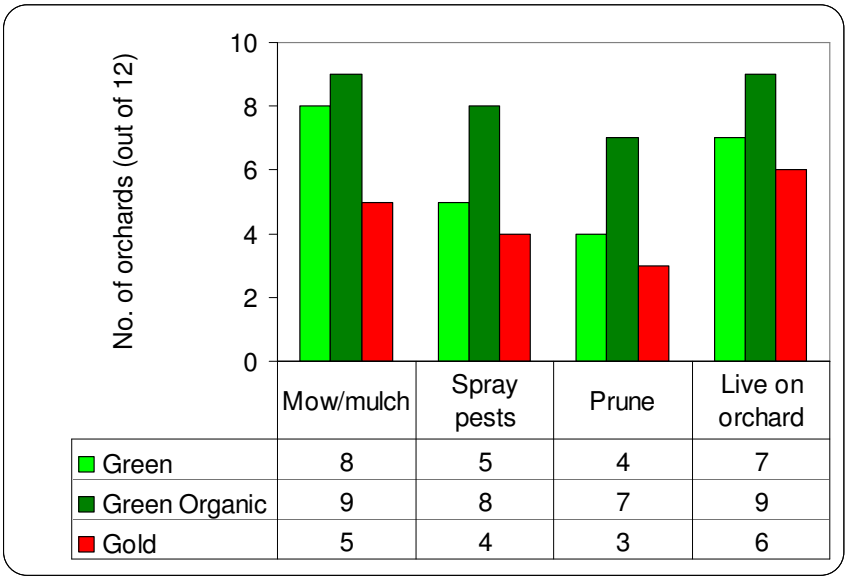
Production outcomes, like those discussed in the previous section, will be driven significantly by management. Understanding differences in management on the ARGOS orchards, between and within production systems, will contribute significantly to understanding differences in production as well as other orchard characteristics (e.g. orchard biodiversity, soil quality, financial performance, farming background and attitudes). Here we discuss the recent management factors and practices on kiwifruit orchards and the differences between production systems. This information has been collected through annual interviews with the orchardists.

4.2 Management structures

Kiwifruit orchardists have a range of management options. These range from having no involvement in the orchard (a leased situation) to having an overseeing role (a managed situation) to having a day-to-day hands-on role (owner-operated). Traditionally, orchards have been owner-operated where the owners (including family) have performed most of the work including mowing, spraying, fertilising and pruning. Across the Industry, there seems to be a decline in the number of owner-operated orchards in favour of managed and leased models.

The majority of ARGOS orchards would tend to fall into the owner-operated category with the owners working full-time on their orchards. A greater proportion of Gold orchards would fall into the managed category though the reasons for this are unclear (it could possibly reflect the owners treating their orchards more as production blocks). Figure 8 shows fewer Gold orchard owners live on their orchards and fewer Gold orchard owners carry out tractor work (i.e. mowing and spraying) and pruning.

Figure 8. Number of kiwifruit orchard owners in the ARGOS programme who mowed, sprayed or pruned significant areas of their orchards (2008/09 season).



	Mow/mulch	Spray pests	Prune	Live on orchard
Green	8	5	4	7
Green Organic	9	8	7	9
Gold	5	4	3	6

4.3 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 were 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.

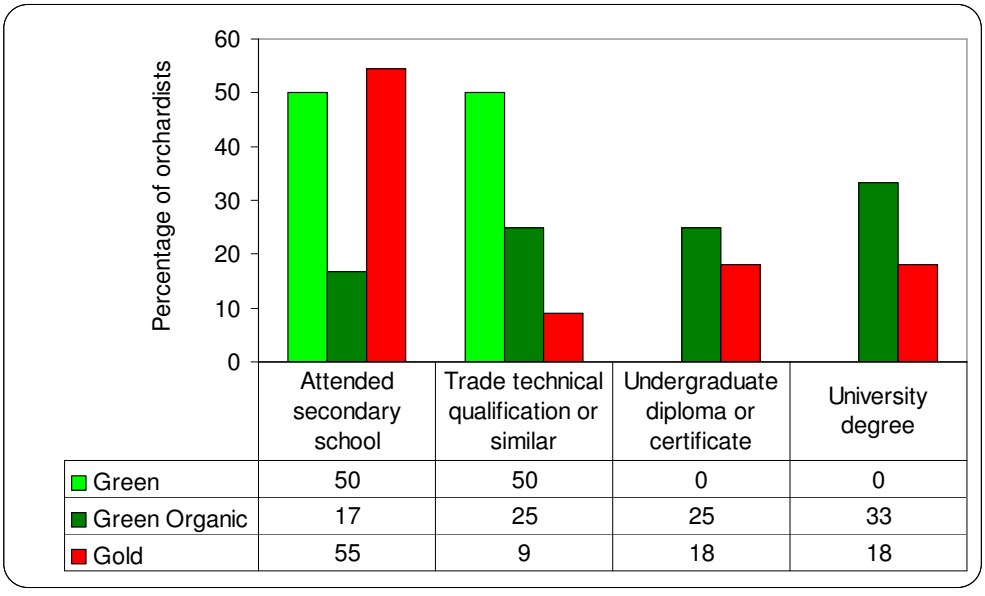
4.4 Orchardist backgrounds

Orchardists' farming experience, level of education and stage of life may have a bearing on their attitude and approach to farming and consequently farming outcomes. Results from a 2008 National Farm Survey deployed by ARGOS showed that the average age and number of years farming did not differ between the three ARGOS panels (Table 1) (Benge, et al., 2009). Green orchardists were found to have been associated with their current orchards for significantly less time than the Gold orchards i.e. 9 versus 20 years. Compared to the broader kiwifruit sector, ARGOS orchardists on average were found to have been farming for 10 fewer years and were younger by 5 years. In terms of education, the Green Organic and Gold panels tended to have a higher level of education (Figure 9).

Table 1. Background information for ARGOS orchardists collected from a 2008 National Farm Survey. Averages for the wider kiwifruit sector are also presented.

	ARGOS				
	Gold	Green	Green Organic	**Average**	**Sector average**
No. of years associated with current farm / orchard	20 a	9 b	14 ab	**14**	**17**
No. of years farming / orcharding	27	21	17	**22**	**32**
No. of years expected to be farming / orcharding	14	14	11	**13**	**14**
Average age	52	57	56	**55**	**60**

Figure 9. Education levels of the ARGOS orchardists.

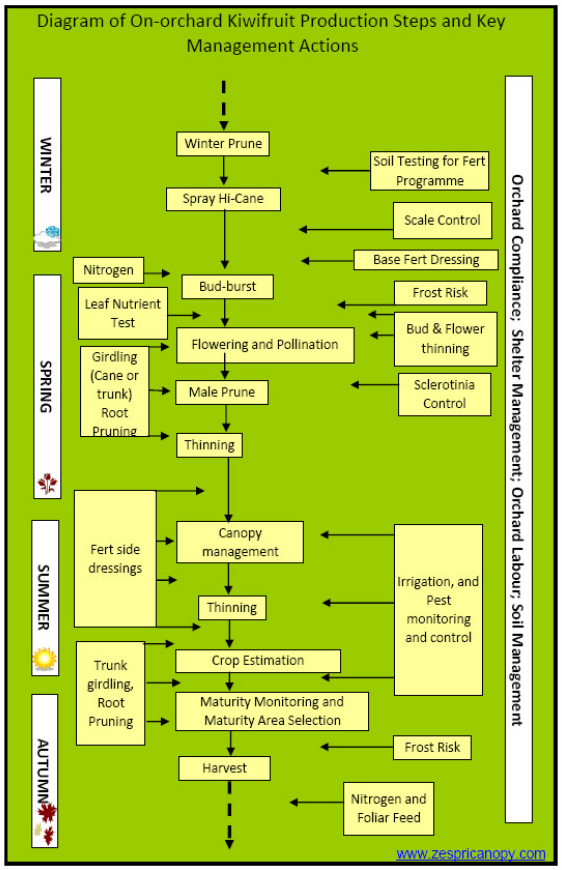


4.5 Orchard practices

4.5.1 Introduction

The main cultural practices carried out on kiwifruit orchards in a production season are summarised in Figure 10. These 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 in this section.

Figure 10. Main kiwifruit orchard practices.

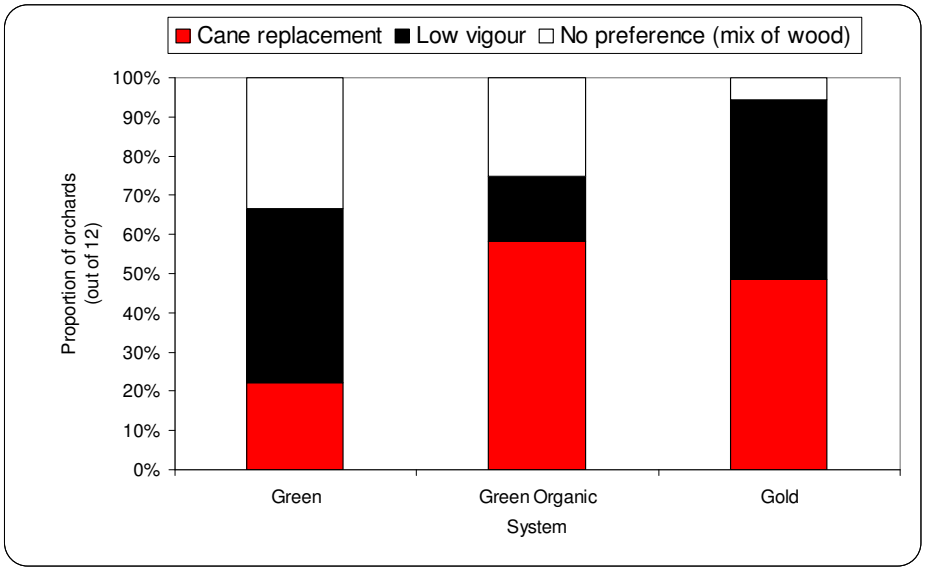


4.5.2 Canopy management

Management of the canopy is the largest annual 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's 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 significantly greater proportion of Organic orchardists in ARGOS, compared to their Green counter parts, that are using replacement canes rather than lower vigour wood (Figure 11, $P < 0.05$). ARGOS's Green and Gold orchards on average have not been significantly different in terms of the numbers using replacement cane versus low vigour.

There doesn't seem to have been much change in wood selection between 2006/07 and 2008/09 with maybe one or two orchards under each production system changing their preference (data not presented). That said, in 2008/09 for Gold there seemed to be a move away from fruiting on spur wood to fruiting on replacement cane in order to minimise damage to fruit from being so close together on canes.

Figure 11. Number of ARGOS orchards (out of 12 for each production system) with each of the different wood preferences. These were verbally communicated to us by the orchardists i.e. no formal assessments were made in the field.



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 (or flowers/buds) in order to optimise fruit numbers, size and quality. Most if not all orchards undertake some level of thinning or culling.

4.5.3 Girdling

Trunk girdling has been used on many horticultural crops around the world for centuries to improve fruit quality, fruit size or fruit numbers. In New Zealand's kiwifruit industry, this innovation has been used commercially since about 2004. Little or no negative impacts have been observed in the short-to-medium term (5 – 10 years) on healthy vines. For this reason, a significant number of orchardists are now trunk girdling and it has very much become standard practice. Some orchardists have yet to girdle for various reasons e.g. they don't believe it's sustainable, the long-term effects are not yet known, the potential risk outweighs the potential benefit, or they don't need to enhance fruit quality or quantity. Furthermore, an important effect of trunk girdling is an increase in return bloom which may be a deterrent for some as additional flowers/fruit may need to be removed in the following season to maintain good fruit size. Greater inputs (e.g. fertiliser, pollination) may also be required to support the extra load. This all comes at a cost. The size of the effects of trunk girdling depends on its timing. Generally, the biggest improvement in fruit size comes from a spring girdle while a summer/autumn girdle is best

Kiwifruit vine with two trunk girdles (Source: Currie and Max, 2007).

for enhancing dry matter. A recent management option has been double trunk girdling (application in spring and again in summer/autumn) to get the best of both worlds.

A main driver for the uptake of trunk girdling has been the recognition that consumers prefer higher dry matter fruit (which equates to a better taste experience). Industry correspondingly pays a dry matter premium to orchardists i.e. up to 40% for Green, 50% for Green Organic and 60% for Gold (in 2007, 2008 and 2009 – ZESPRI Grower Premium Booklets).

Below are the main trends in trunk girdling use on ARGOS orchards.

Overall:

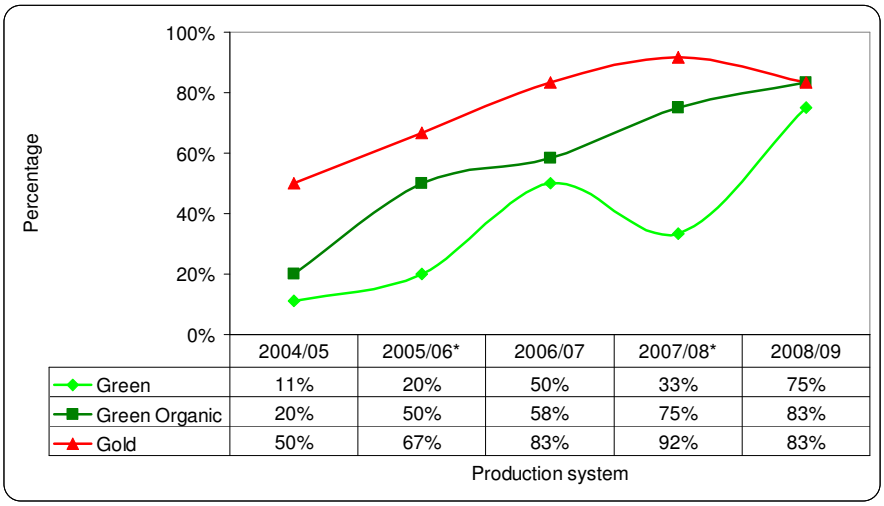
- The percentage of ARGOS orchardists that practice trunk girdling has increased from 27% in 2004/05 to 81% in 2008/09.
- The percentage of ARGOS orchardists that practice double trunk girdling has increased from 0% in 2004/05 to 44% in 2008/09.

Panel differences:

- The percentage of orchardists that have trunk girdled (single or double) has been consistently highest for Gold and consistently lowest for Green, with Green Organic intermediate (Figure 12). However, the differences have not been statistically significant.
- The percentage of orchardists double trunk girdling has not differed much between the three systems with the difference being only one orchardist each season (Figure 13).
- Double trunk girdling started in 2006/07 for conventional and a year later for organic with the percentages for each system increasing ever since (Figure 13).
- There has been a general trend for trunk girdling to replace cane girdling (Figure 14).
- Four orchards (two Green and two Green Organic) have never been trunk girdled for various reasons (Table 2).

Trunk girdling has very much become standard practice for the majority of ARGOS orchardists as they strive to increase orchard gate returns through increased fruit quality and quantity. A small number of orchardists have not yet trunk girdled so it would be interesting to see if they eventually do and note the reasons for change.

Figure 12. Percentages of ARGOS orchards which have trunk girdled (single or double) each season. 12 orchards of each type surveyed.



	2004/05	2005/06*	2006/07	2007/08*	2008/09
Green	11%	20%	50%	33%	75%
Green Organic	20%	50%	58%	75%	83%
Gold	50%	67%	83%	92%	83%

Figure 13. Percentages of ARGOS orchards which have double trunk girdled. 12 orchards of each type surveyed.

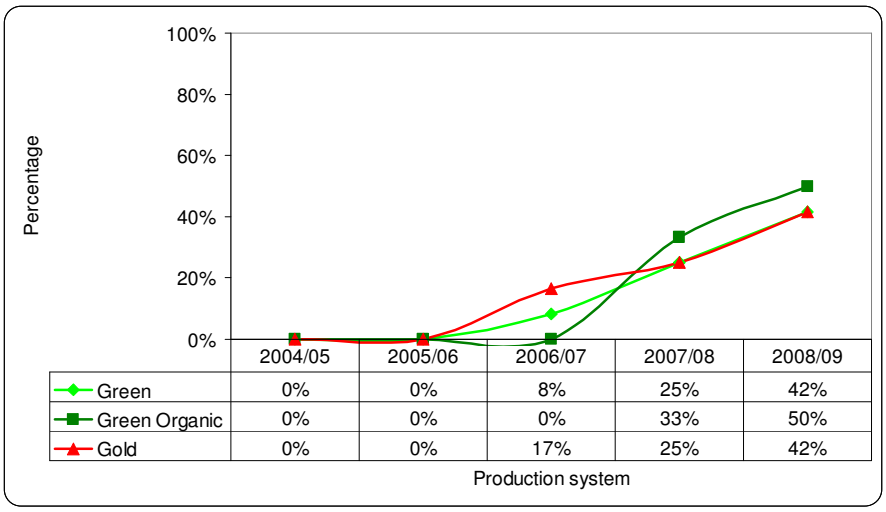


Figure 14. Percentages of ARGOS orchards which have cane and trunk girdled. 12 orchards of each type surveyed.

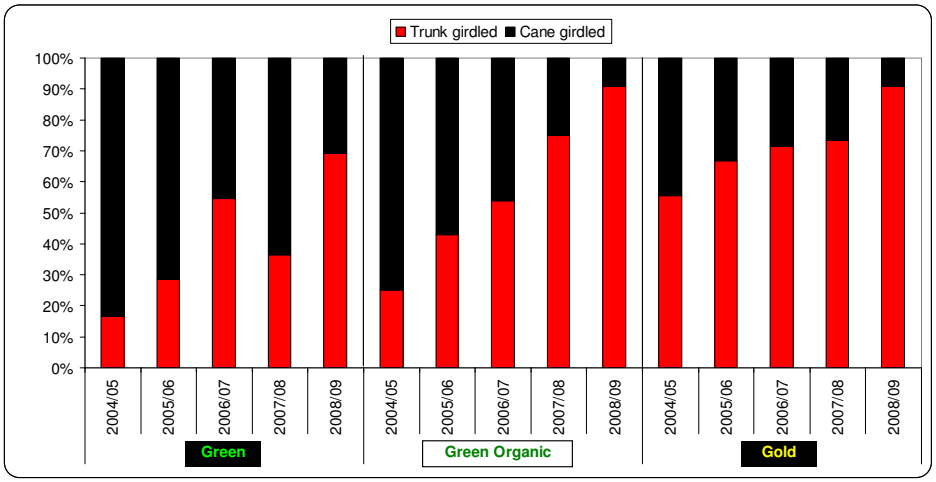


Table 2. ARGOS orchards which have never trunk girdled and the reasons for not doing so.

Property #	Production system	Location	Reasons for not trunk girdling
1	Green	Kerikeri	Has had above average dry matter and believes the risk is not worth it.
2	Green Organic	Kerikeri	Does not believe his vines have the vigour to get away with it.
19	Green	Te Puke	Does not want the increased return bloom effect as there would be a cost in managing this. Also, orchard is late maturing so higher than average dry matter levels obtained anyway.
20	Green Organic	Te Puke	Does not like the idea of trunk girdling.

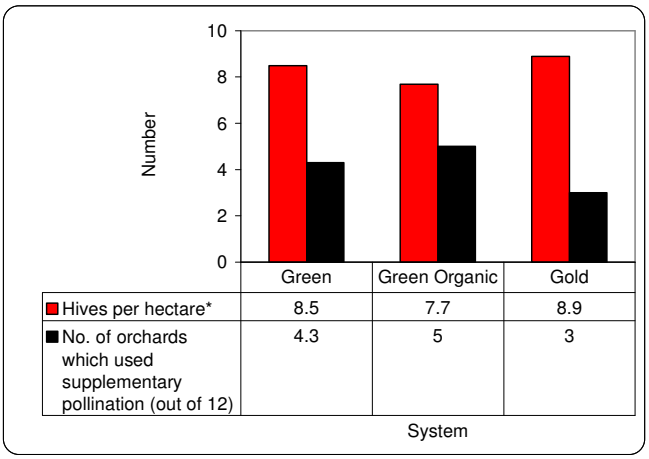
For more information on the technique of trunk girdling, refer to ZESPRI-HortResearch KiwiTech Bulletin No. 36 (Trunk Girdling) by Mike Currie and Shane Max.

4.5.4 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. The average number of hives used in recent years has been about 8.4 to the hectare with about a third of the orchards also using supplementary (artificial) pollination each year (Figure 15). There were no significant differences between production systems.

Figure 15. Average pollination data for Green, Green Organic and Gold orchards in the ARGOS programme. Based on three consecutive growing seasons (2006/07 to 2008/09).

There were no significant differences at the 5% level according to an unbalanced ANOVA for the number of hives and a Kruskal-Wallis test for supplementary pollination.

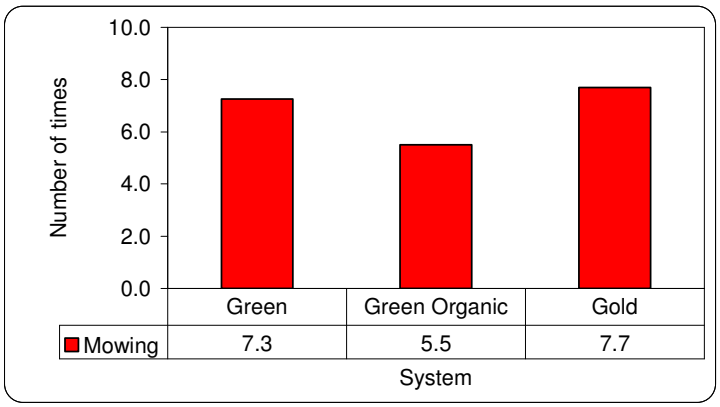


* Average excludes the organic orchard in Kerikeri which does not use hives.

4.5.5 Orchard floor management

Control of the orchard sward in kiwifruit orchards is normally achieved mechanically by mowing. The number of times ARGOS orchards have been mowed in recent years has been relatively constant. Organic orchardists on average have mowed/mulched significantly fewer times than Green and Gold orchardists (Figure 16, $P < 0.05$) suggesting that they can tolerate longer sward.

Figure 16. Average number of times ARGOS orchards have been mowed/mulched fully each year.



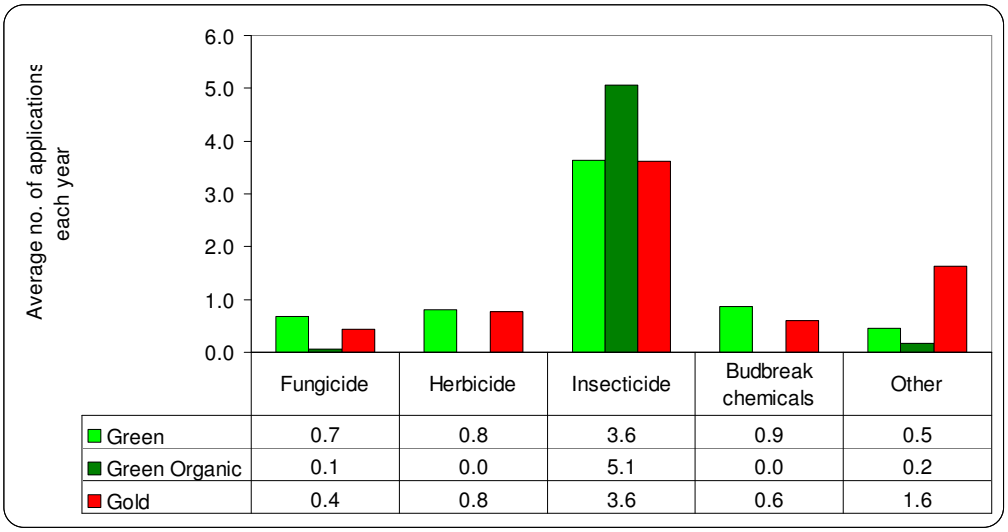
4.5.6 Sprays

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 (Figure 17, Appendix 3) particularly leafroller and armoured scale. In recent years,

On average over the years, organic orchards have applied fewer sprays i.e. 5.3 per year vs. 6.4 for Green and 7.0 for Gold. Gold orchards have received slightly more sprays than Green mainly because of the regular application of fruit sizing chemicals (e.g. “Benefit PZ”). Green Organic orchards have on average had a significantly higher number of insecticide applications (Figure 17, $P < 0.05$) however these have been certified organic with a lower potential environmental risk than conventional sprays (Benge, 2008).

For all three production systems, pre-flowering use of insecticides has generally increased slightly over time (Figure 18). This is likely because of an increasing effort by Industry to promote pre-flowering use of sprays so that any chemical residues on fruit are minimised.

Figure 17. Average number of times major sprays have been applied annually to ARGOS orchards over the 1999/00 to 2008/09 period. ‘Other’ is mainly fruit sizing chemicals. Based on data obtained directly from spray diaries held by ZESPRI.



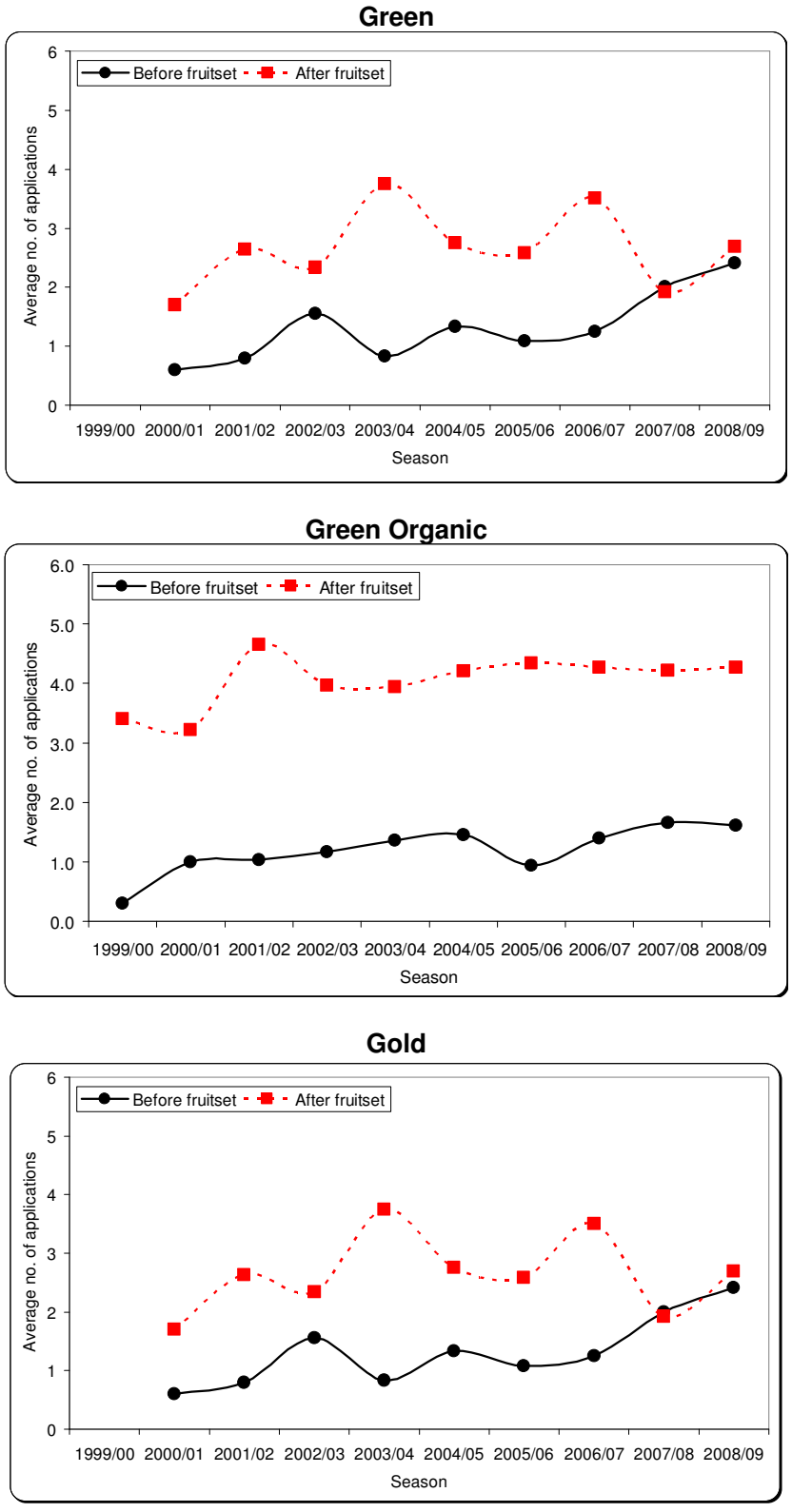
	Fungicide	Herbicide	Insecticide	Budbreak chemicals	Other
Green	0.7	0.8	3.6	0.9	0.5
Green Organic	0.1	0.0	5.1	0.0	0.2
Gold	0.4	0.8	3.6	0.6	1.6

*Certified organic sprays only are permitted on the Green Organic orchards.

The impact of changes to the crop protection programme

In 2007/08 there was a noticeable decrease in post-flowering sprays because commonly used diazinon sprays (for the control of scale insect) were removed from the crop protection programme…a result of market/consumer pressure. Some orchardists substituted mineral oil for diazinon but many were reluctant to do so because of inexperience and/or the potential to mark the fruit skin and make it unsaleable. In the following season, 2008/09, there was an increase in orchardist confidence around the use of mineral oils and hence an increase in the number of post-flowering sprays applied.

Figure 18. Trends in total insecticide use on ARGOS orchards pre- and post-flowering. Based on data obtained directly from spray diaries held by ZESPRI.



4.5.7 Soil nutrition

Trends in the levels of macro-nutrients applied to the soil of ARGOS orchards are shown in Figure 20Figure 20. Average amounts for the 2003/04 to 2008/09 period are shown in Figure 19. On average over the study period and taking into account the variation between orchards, Gold and Green orchards have applied the same amounts of macro-nutrients (i.e. not statistically different).

Over the study period, Organic orchards compared to the conventional orchards have received significantly less nitrogen (N), potassium (K), magnesium (Mg) and sulphur (S) but similar amounts of phosphorus (P) and calcium (Ca). Organic orchards tend to receive large quantities of plant and animal based fertilisers like compost and fish. While the nutritional content of these is small (just a few percent) the large quantities applied (an average of 6 T/ha of compost and 1,200 L/ha of fish annually) means potentially large amount of nutrients are applied. The nutrients in organic fertilisers are likely to be released slowly, potentially over several years.

Lime, Sulphate of Potash (SOP; potassium sulphate), Muriate of Potash (MOP, potassium chloride), and Calcium Ammonium Nitrate (CAN) are the most commonly applied mineral fertilisers for Green and Gold (Table 3). 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 (Carey and Benge, 2009). Organic orchards were also found to contain significantly less P and S though the levels were still acceptable. Differences in the amounts and types of fertilisers used, as discussed here, will contribute significantly to differences in soil quality; other influential factors include orchard history and previous land use.

Figure 19. Average amounts of macro-nutrients applied to soil in kiwifruit orchards in the ARGOS programme for the 2003/04 to 2008/09 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**). Data was obtained from orchardists' fertiliser recommendations with additional information provided by the orchardists.

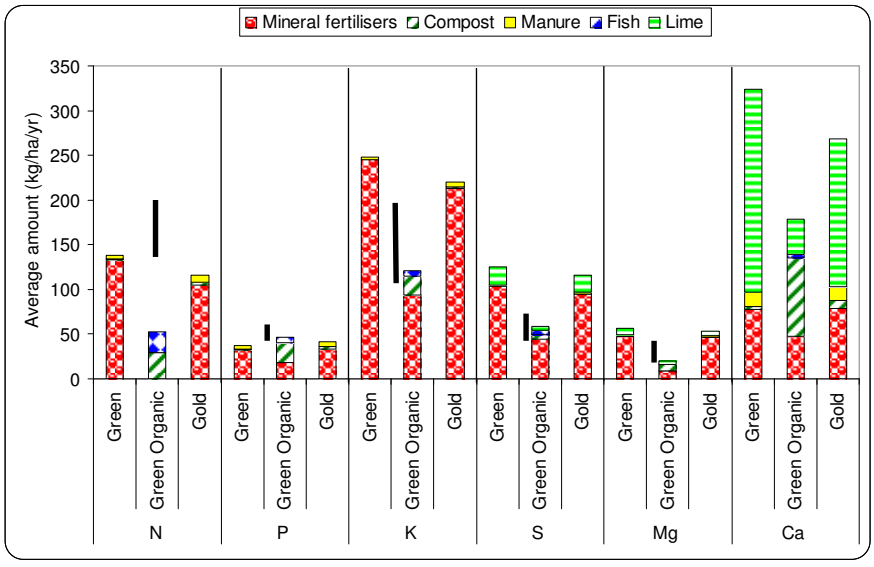
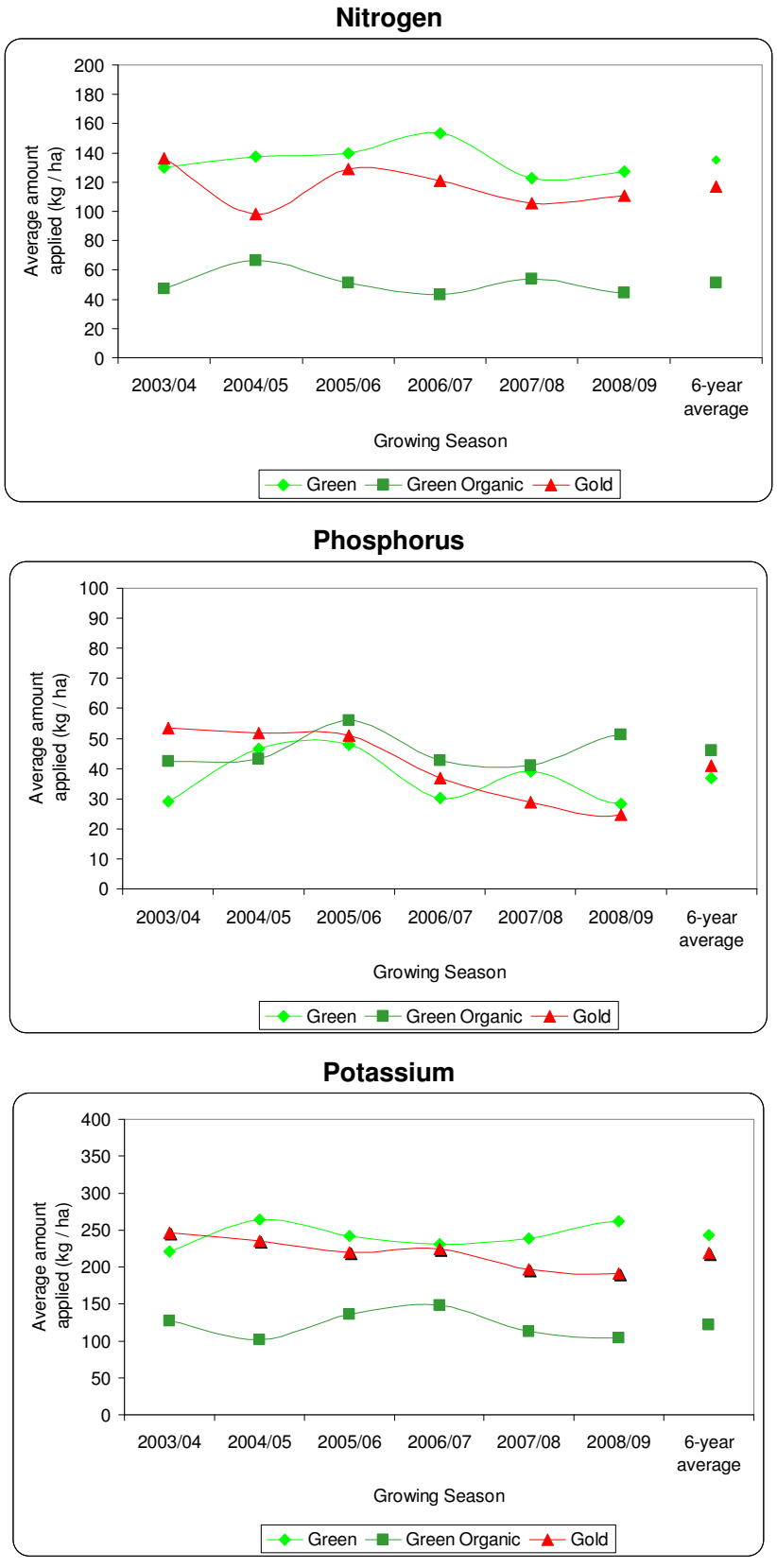
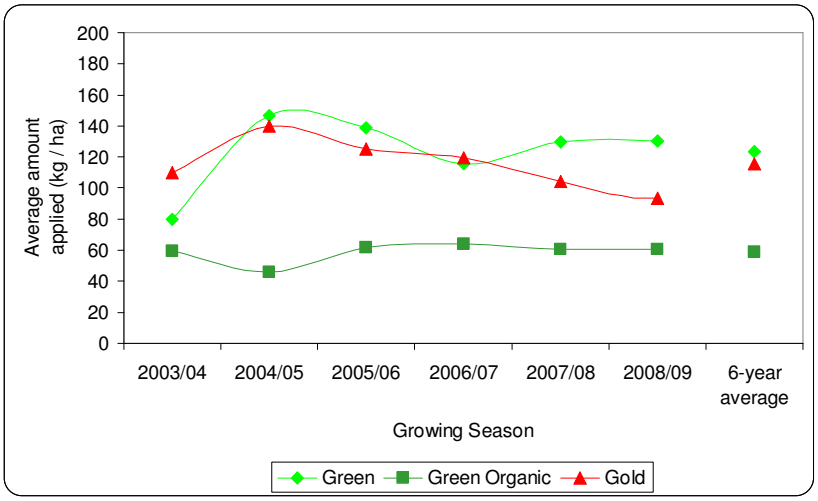


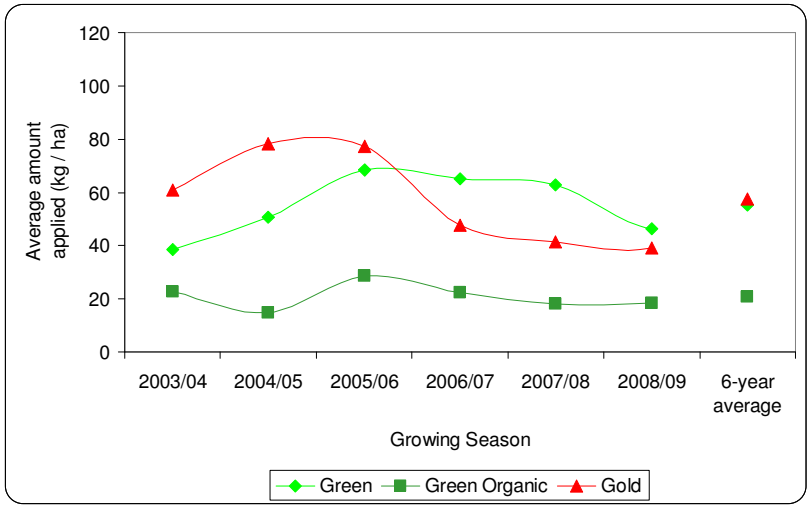
Figure 20. Trends in the average levels of macro-nutrients added to soils in ARGOS kiwifruit orchards between 2003/04 and 2008/09. All types of fertiliser are included. Generally, data was obtained from orchardists' fertiliser recommendations with additional information provided by the orchardists.



Sulphur



Magnesium



Calcium

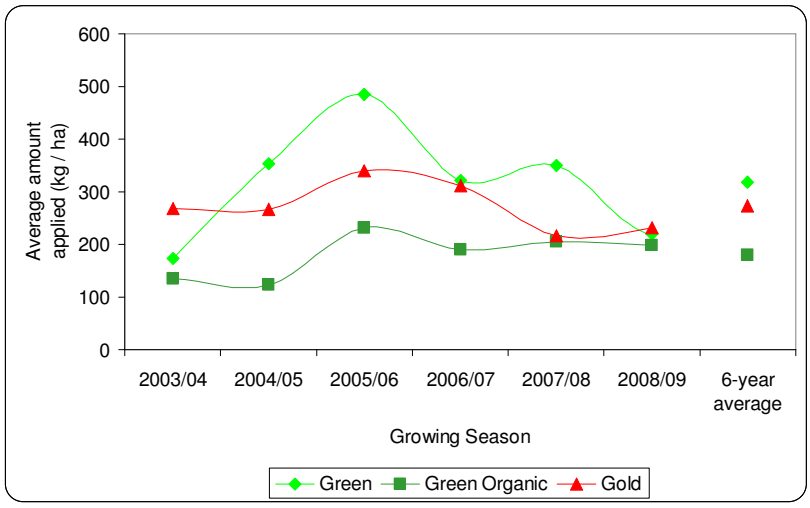


Table 3. Most commonly used mineral fertilisers on Green, Green Organic and Gold orchards in the ARGOS programme. Average rates (kg/ha/yr) for the 2003/04 to 2008/09 period are shown. Generally, data was obtained from orchardists' fertiliser recommendations with additional information provided by the orchardists.

Product	Approx. nutrient content	Green	Green Organic	Gold
Lime	37% Ca	430	70	320
Dolomite	11% Mg, 23% Ca	50	40	50
Gypsum (calcium sulphate)	18% S, 24% Ca	100	20	100
Nitrophoska Blue	12% N, 5% P, 14% K, 6% S	20	0	100
Calcium Ammonium Nitrate (CAN)	27% N, 8% Mg	320	0	190
Urea	46% N	10	0	40
Sulphate of Potash (SOP, potassium sulphate)	40% K, 17% S	250	120	170
Muriate of Potash (MOP, potassium chloride)	50% K	130	30	110
30% Potash Serpentine Super	5% P, 15% K, 6% S, 4% Mg	30	0	110
Patent Kali	25% K, 17% S, 6% Mg	0	70	20
Kieserite	20% S, 15% Mg	70	20	60
Reactive Phosphate Rock (RPR)	12% P	0	110	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.

Correction:
In previous ARGOS reports, the amount of CAN applied to Gold orchards was incorrectly reported to be in excess of 300 kg/ha annually due to a formula error. The correct amounts applied are closer to 200 kg/ha annually.

4.5.8 Other orchard practices

In the last couple of seasons, a third to a half of ARGOS orchards has irrigated to assist vine growth and health. Close to half the orchards have also used some form of frost protection mainly in the form of water. We have not been able to quantify water use on orchards as orchardists generally have not able to provide detail on how often water was applied or how much was applied.

Only one or two orchards have carried out any form of soil cultivation which is a reflection of the good quality soil on which the majority of orchards are grown.

5. Environment

5.1 Introduction

Consumers are becoming increasingly concerned about how their food is produced and the associated impacts. This is being reflected in assurance schemes globally which are beginning to place more emphasis on the environmental impacts of farming. Take for example Tesco's 'Nature's Choice' Integrated Crop Management System which encourages the use of beneficial insects rather than chemicals to control pests (http://www.tescofarming.com/tnc.asp). Orchardists are asked to draw up a farm conservation plan, which guides them in protecting important wildlife and landscapes. Closer to home, GlobalGap contains an 'Environment and Management' section which aims to increase orchardist's awareness of the impacts of orcharding on flora and fauna. Requirements like these are likely to increase and for this reason the kiwifruit industry needs to improve its understanding of the impacts of production. The environment objective of the ARGOS programme aims to clarify the environmental impacts of different production systems which will also assist in the identification and subsequent implementation of more sustainable and resilient farming systems.

5.2 Previous findings

The main findings from ARGOS's environmental monitoring have been reported in detail in previous reports like this as well as other ARGOS publications (many of which can be freely downloaded from www.argos.org.nz). Around two-thirds of all measured variables have revealed a statistically significant difference. The main differences are summarised in the following table.

Figure 21. Overall differences between organic and conventional (i.e. IM) kiwifruit orchards in the ARGOS programme.

	General finding	**Reference**
Soil quality	Generally higher for organic orchards	Carey and Benge, 2009
Invertebrates	Significant differences in the populations of some insects / mites/	Steven and Benge, 2007
Terrestrial vertebrates	More individual birds and a greater number of species	Blackwell, et al., 2005
Orchard habitats	More diverse shelterbelts on organic orchards	Moller, et al., 2007
Aquatic	Not measured (due to lack of waterways on the ARGOS properties)	-

5.3 Findings from the last 12 months

5.3.1 Cicadas

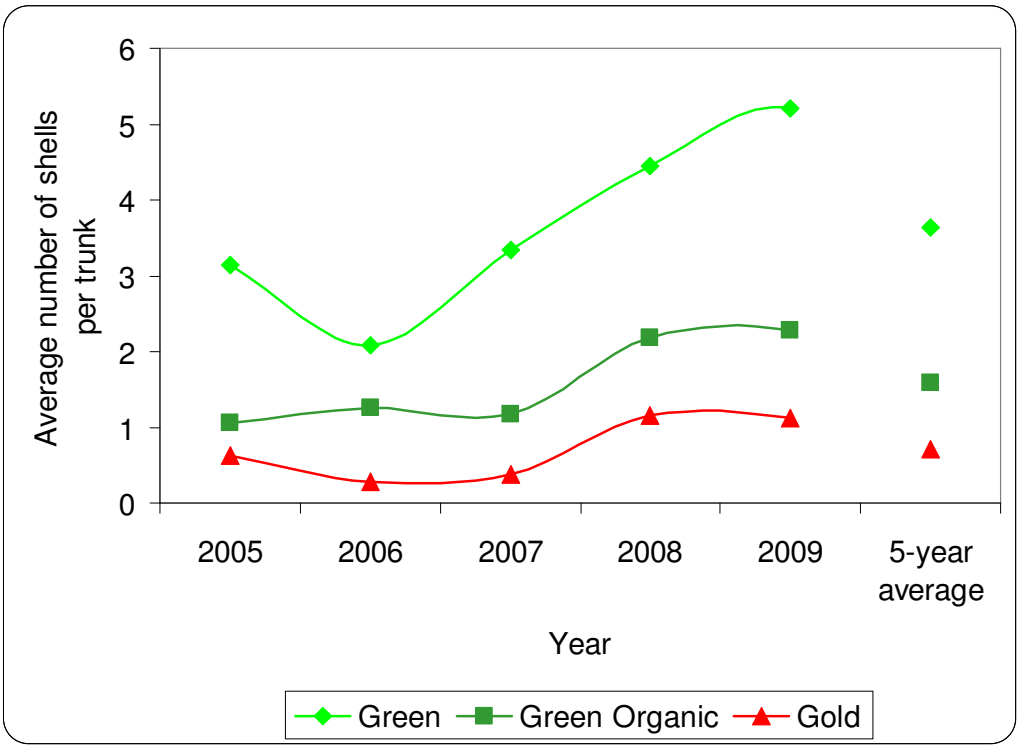
Cicadas were chosen as a potential focal species for ARGOS partly because they are classified as a minor pest (adults can cause fruit marking and the eggs are laid in the vines potentially weakening them) and partly as a potential indicator species (they are highly visible, well known and easy to sample).

The amounts of cicada exuviae (shells) attached to the trunks vines in ARGOS orchards have now been determined over five consecutive years. On average, the most cicada shells have consistently been found in Green orchards with the least consistently found in the Gold orchards (Figure 23).

Two main species are found almost exclusively on NZ's kiwifruit orchards i.e. *Amphipsalta cingulata* (Clapping Cicada) and *A. zelandica* (Chorus Cicada) (Figure 22). The ratio of these on orchards seems to be affected by altitude i.e. the proportion of chorus cicada increases and the proportion of clapping cicada decreases as altitude increases (Figure 24).

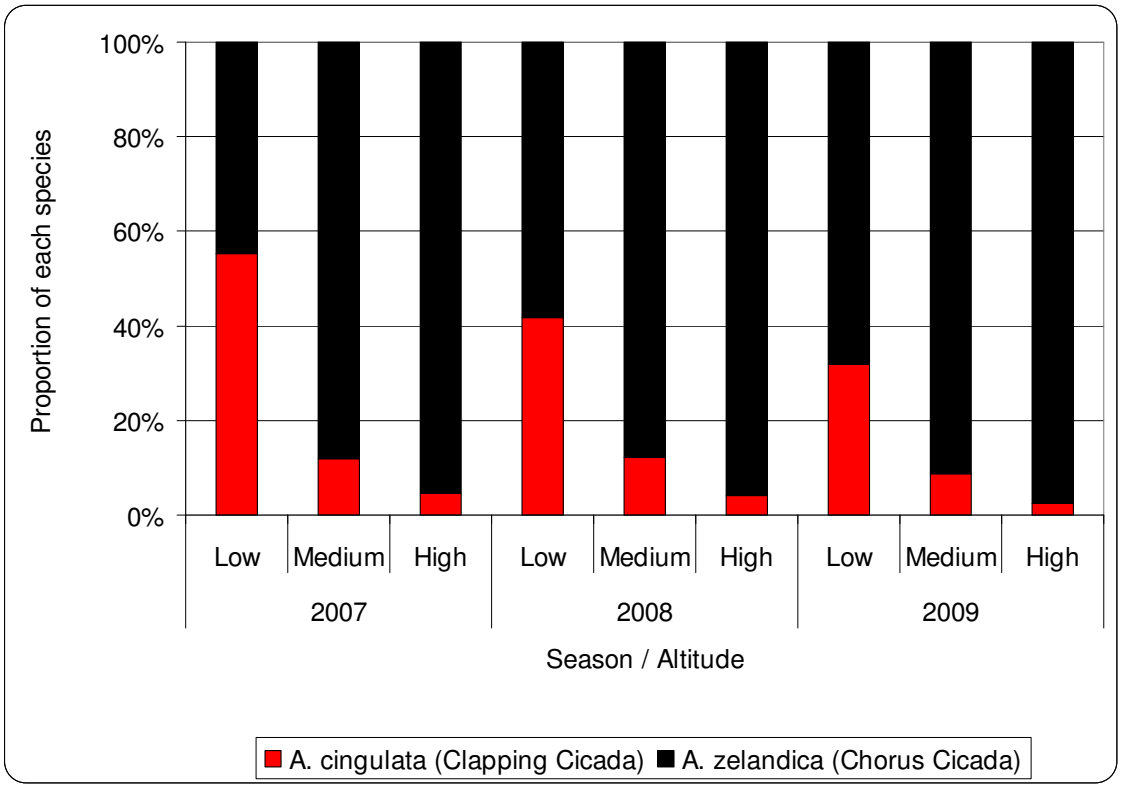
Figure 22. The two main Cicada species found on kiwifruit orchards, *Amphipsalta cingulata* (Clapping Cicada, Left) *and A. zelandica* (Chorus Cicada), can be differentiated rapidly by the colour of their shells.

Figure 23. Trends in the average number of cicada shells 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.

Figure 24. Proportion of the two main cicada species found on ARGOS kiwifruit orchards according to altitude.



5.3.2 Fantail study

In 2008/09, Guinevere Coleman, a Masters student from the University of Otago, surveyed birds on a subset of nine ARGOS orchards with a focus on fantails. Preliminary results are presented here.

Fantail abundance

Preliminary analyses indicate a greater abundance of fantails on the organic orchards. Also, it seems that the numbers on orchards are higher in summer than in winter. Further analyses will be conducted on this data and the final results will be presented in subsequent publications.

Predators

Tracking tunnels and traps were deployed in the nine study orchards to provide an indication of the levels of mammals in the orchards.

Tracking tunnels

Two sets of tracking tunnels were placed in orchards i.e. one set for one night with bait and another for 14 nights unbaited. Preliminary findings are as follows.

- On the Green orchards, half as many 1-night baited tunnels were found to contain tracks compared to Green Organic and Gold orchards.
- A noticeable higher proportion of 1-night tunnels were found to contain tracks compared to the 14-night tunnels indicating the bait was successful in attracting mammals.
- There was no obvious pattern in terms of when the 1-night baited traps were used. However, in the December and January rounds, no tracks were found in the 14-night tunnels.
- The most common animal found to leave tracks was the hedgehog (20% of tunnels). Some rats, mice and unknown tracks were also found (each found in <10% of tunnels) (Table 5).

Table 4. Percentage of tracking tunnels in which mammal tracks were found for each orchard type and for each circuit of sampling.

	1 night (baited)	**14 nights (unbaited)**
Orchard type		
Green	21 %	14 %
Green Organic	44 %	13 %
Gold	42 %	15 %
Circuit		
1 (27 Oct – 15 Nov)	55 %	14 %
2 (15 Nov – 2 Dec)	25 %	42 %
3 (2 Dec – 30 Dec)	43 %	0 %
4 (30 Dec – 22 Jan)	22 %	0 %

*A total of 120 tunnels were deployed for each orchard type and 88 for each circuit of sampling.

Table 5. Numbers of tunnels containing tracks from each mammal (out of a total of 352 tunnels).

	Hedgehog	Unknown	Rat	Mice
1-night (baited)	66 (19%)	9 (3%)	27 (8%)	25 (7%)
14-night (unbaited)	29 (8%)	3 (1%)	9 (3%)	8 (2%)

Figure 25. Example of tracks left in tracking tunnels on an ARGOS kiwifruit orchard.

Trapping

The abundance of birds in orchards could be affected by the presence of predators. For this reason, snap traps (large mouse traps) were used to gauge predator species present in the ARGOS kiwifruit orchards. 160 traps were set across 9 orchards (11 – 27 traps per orchard) on 13 consecutive days in the 2009 summer. Only 17 catches were made with the main culprit being rats (9 out of 17) (Table 6). Three mice, two hedgehogs, and three birds were also snared.

Table 6. Animals caught during predator trapping on ARGOS kiwifruit orchards.

	Cluster 3 (Katikati)			**Cluster 4 (Omokoroa)**			**Cluster 7 (Te Puke)**		
Date	**Green**	**Green Organic**	**Gold**	**Green**	**Green Organic**	**Gold**	**Green**	**Green Organic**	**Gold**
27/01/09	*	*	rat x2	*	*	rat	*	rat	*
28/01/09	mouse	*	*	*	*	*	*	*	*
29/01/09	*	*	*	*	rat	*	*	*	*
30/01/09	blackbird	*	*	*	*	*	*	*	sparrow
31/01/09	*	*	*	*	*	*	*	*	*
1/02/09	*	*	*	*	*	*	*	*	*
2/02/09	*	*	mouse	*	rat	*	*	*	*
3/02/09	*	*	*	*	rat	*	*	*	*
4/02/09	myna	rat	*	*	*	*	*	*	*
5/02/09	*	*	*	*	*	*	*	*	*
6/02/09	*	blackbird	mouse	*	hedgehog	*	*	*	*
7/02/09	*	*	*	*	*	hedgehog	*	*	*
8/02/09	*	*	rat	*	*	*	*	*	*

5.3.3 Soil

In 2009 soil fertility was assessed on a subset of 12 ARGOS orchards i.e. four clusters. Other orchards were not able to be sampled as fertiliser was applied prior to sampling (it is hoped that these will be sampled in 2010).

Despite the smaller sample size in 2009, some consistent trends emerged across sample years with respect to differences between production systems (Appendix 4) i.e.

- significantly lower pH for Gold
- significantly higher total base saturation (BS), available nitrogen, calcium and magnesium for Green Organic
- significantly lower organic matter (OM), total carbon and total nitrogen for Green
- greater use of organic inputs on organic orchards will be a key reason for differences

Similarly, consistent differences emerged across years for the two difference areas that were sampled in each orchard (alleyways versus under the leaders) (Appendix 5) i.e.

- olsen P significantly lower in the alleyways
- available nitrogen, total C & N, organic matter and calcium all consistently higher in the alleyway; this is likely due to greater organic matter deposits there and no herbicide

5.4 Environment summary

A number of significant differences have been found between environment factors of the three main kiwifruit production systems. Generally, the greatest difference has been between Organic and the other two systems with fewer and smaller differences detected between Green and Gold. This is not surprising given that the Organic management system is the most distinct of the three with greater restrictions placed on inputs particularly fertiliser and agrichemical use. Gold is a relatively new variety (commercialised in the late 1990's) and its production system has evolved from the system for Green hence there are some management similarities. Future monitoring is planned to see if the differences and similarities we have observed remain or not.

6. Financial performance

6.1 Introduction

Details of ARGOS's economic and farm finance monitoring can be found in Saunders, et al., 2009. Here the main findings are presented. At the farm or orchard level, we have now collected financial accounts for six consecutive years (2002/03 to 2007/08). 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 for kiwifruit are presented below.

6.2 Data availability

The availability of financial data has been a limitation for the economic analyses in all sectors studied by ARGOS particularly the kiwifruit sector. For some orchards, data has not been available at all because of the complexity of operations and inability to isolate income and expenditure for the orchards concerned. Table 7 shows the number of kiwifruit orchards which data was available each year.

Table 7. Number of orchards which financial data was available for each year.

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
All data available/usable	27	29	29	26	21	19
Operating data only available	1	1	1	1	5	3
Data not available	8	6	6	9	10	14

6.3 Production levels

Analysis of the yields over the study period showed highly significant differences amongst the three panels. The highest yields were achieved on Gold orchards (8,700 trays per hectare) while Organic production was lowest (5,200 trays per hectare). Green kiwifruit produced around 7,100 trays per hectare on average. It should be noted that the estimated Gold yield is not the mature yield of the Gold cultivar since most Gold vines were not at full production in the early years of the study.

6.4 Financial indicators

Analysis of orchard-gate returns (OGR) per tray of kiwifruit over the study period showed highly significant differences amongst the three panels. Organic fruit returned the highest average return per tray of $7.18 (in 2007/08 dollars), Gold the median price of $6.18, and Green $4.19 per tray.

Gold orchards had significantly higher (F=.001) revenue and costs than Green and Organic orchards (Figure 26). However, there was insufficient statistical power to detect differences between the Green and Organic panels except with respect to some individual cost categories.

Considerable variation was present between orchards for many of the financial variables. For example, Figure 27 shows the variability in Net Orchard Profit Before Tax (NOPBT) per orchard. This meant we did not have enough statistical power with our sample sizes to detect any significant differences in the "bottom-line" financial variables i.e. Cash Orchard Surplus (COS), NOPBT and Economic Orchard Surplus (EOS) (Figure 26). We therefore can not conclude if there were real differences in the bottom lines of the three production systems (because of the quality of the data available).

Figure 26. Average values of key financial aggregates for ARGOS kiwifruit orchards over six years (Real $2007/08 values).

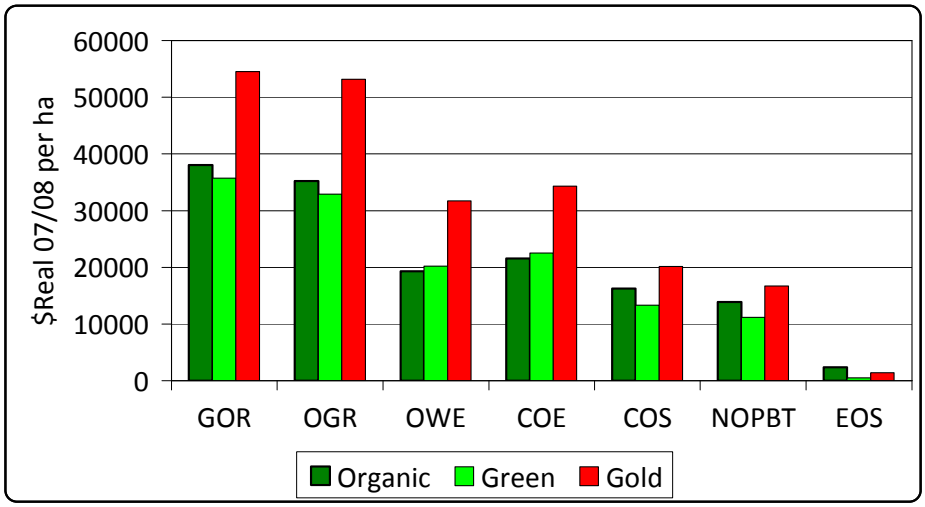
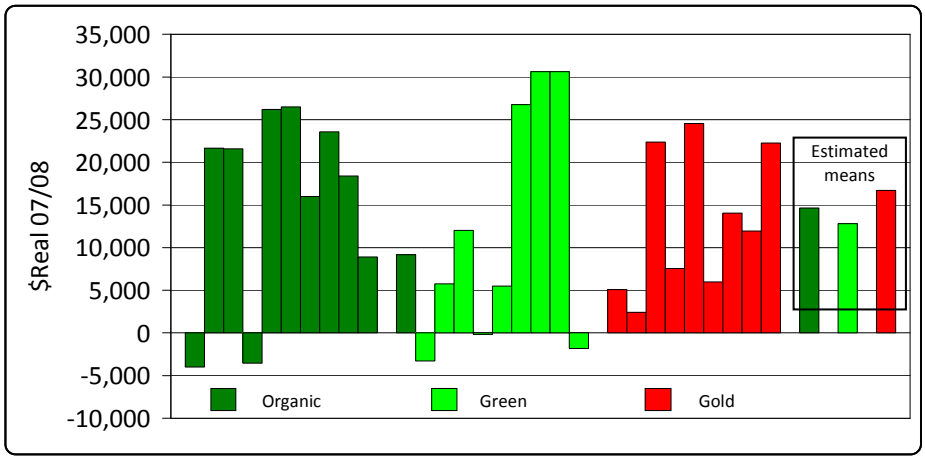


Figure 27. Average Net Orchard Profit Before Tax (NOPBT) per hectare for ARGOS kiwifruit orchards over six years (Real $2007/08 values). Each vertical bar represents an individual orchard.



6.5 Individual cost categories

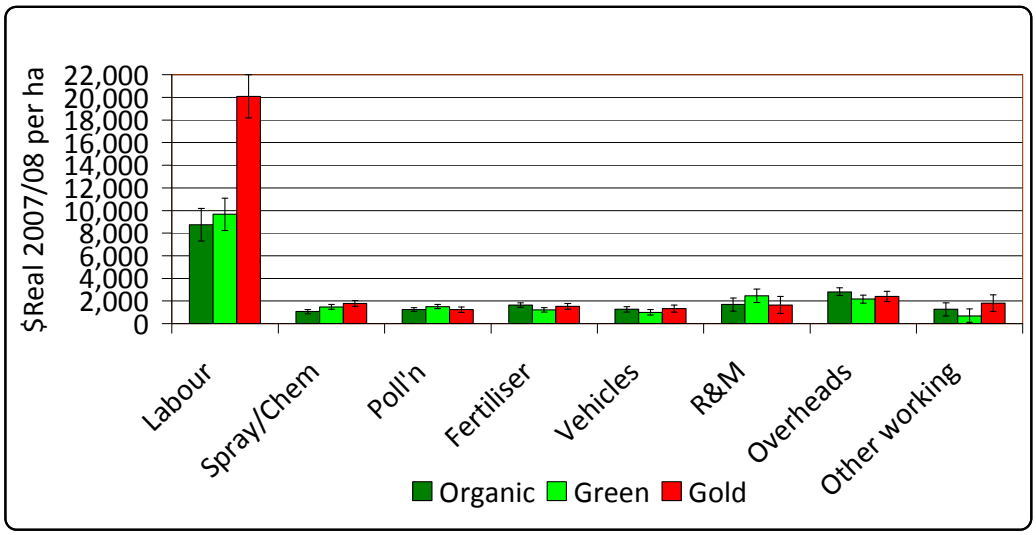
Significant differences were detected in the levels of most individual orchard costs amongst the three panels, but as was the case with the total cost variables, most of these differences were between the Gold and other panels and the analysis was insufficiently powerful to detect differences between the Green and Organic panels.

As Table 8 shows, labour costs were significantly higher on Gold orchards than on other orchards, reflecting the costs of managing the more vigorous and higher yielding Gold vines. Fertiliser expenses were significantly lower on Green orchards than on the higher yielding Gold orchards and on Organic orchards where considerable amounts of organic inputs, particularly compost, is applied. Overhead expenses were higher for Organic than Green and Gold orchards, which may reflect the costs associated with organic certification. Average working expenses over the period are shown in Figure 28.

Table 8. Differences in individual working costs for Green, Organic and Gold orchards.

	Significant		Difference
Cash labour expenses	Yes	(F=<.001)	Gold > (Green, Organic)
Total labour expenses	Yes	(F=<.001)	Gold > (Green, Organic)
Fertiliser expenses	Yes	(F=.01)	(Gold, Organic) > Green
Pollination expenses	Approaching	(F=.068)	Green > (Gold, Organic)
R & M	No	(F=.114)	
Spray and chemical expenses	Yes	(F=<.001)	Gold > Green > Organic
Overhead expenses	Yes	(F=.025)	Organic > (Green, Gold)
Other working expenses	Approaching	(F=.08)	Gold > Green > Organic
Vehicle expenses	No	(F=.157)	

Figure 28. Average values of individual cost categories for ARGOS kiwifruit orchards over six years (Real $2007/08 values).



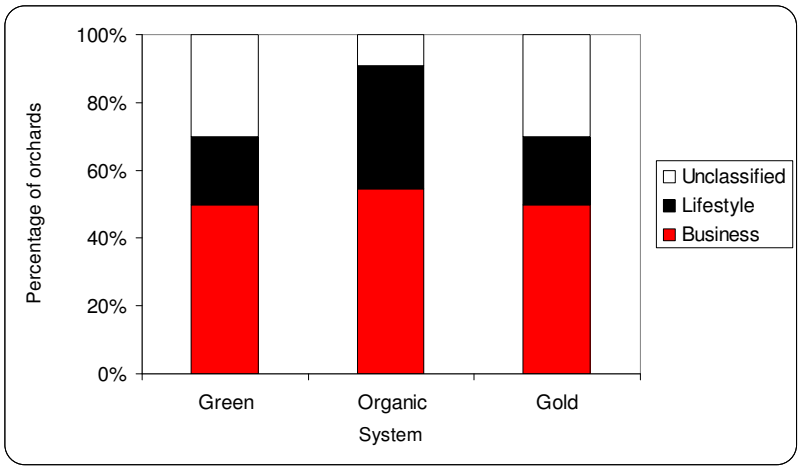
6.6 Other key performance indicators

The ratios of orchard expenditure to revenue were calculated for the kiwifruit panels but as a large number of farms lacked debt servicing data the debt servicing ratio was not. These analyses had low power and so we were not able to detect any significant differences. So again we can't conclude if there were any differences or not because of the lack of sufficiently good quality data.

6.7 Differences between orchardist types

Orchardists were categorised into different types regardless of their production system. This Q-sort analysis was carried out by Social Objective team using causal maps obtained in previous interviews. Two farmer typologies were identified; Type 1 (described as the "business" group) who gave more emphasis to post orchard-gate aspects such as customer satisfaction and requirements and post-harvest quality, and Type 2 (described as the "lifestyle" group) who emphasised family needs off-orchard activities and the orchard environment as a place to live (Fairweather et al, 2009). Of 31 orchards included in the kiwifruit financial analysis; 24 were assigned a Q-sort value. Figure 29 summarises the Q-sort typologies in relation to each management system.

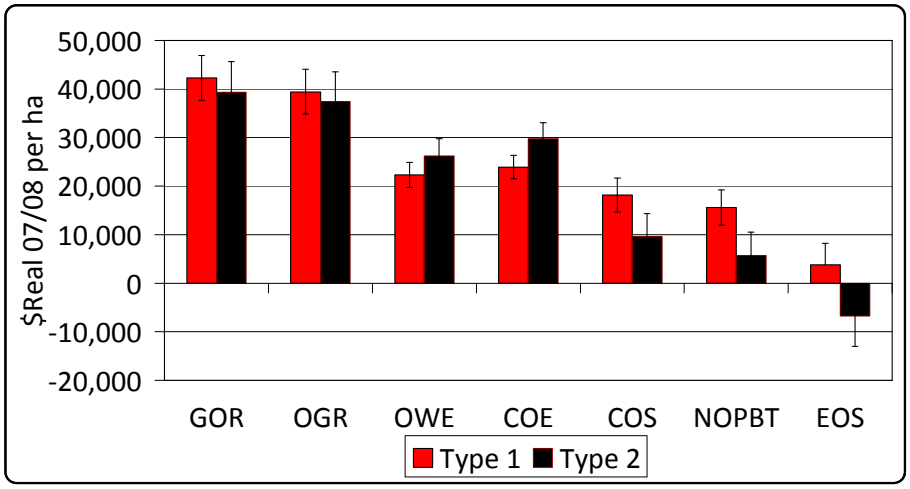
Figure 29. Percentages of ARGOS orchardists who were classified as having a relatively stronger "business" focus or a relatively stronger "lifestyle" focus.



Investigation of the interaction between management system and orchardist typology via an ANOVA that included both of these variables as treatments did not identify any significant differences. Nor did it enhance the power of the analysis sufficiently to allow us to accept the null hypothesis that there is no difference between management panels with respect to profitability indicators.

There was insufficient statistical powerful to detect significant differences between Types 1 and 2 in either Gross Orchard Revenue (GOR) or the Orchard Gate Return (OGR) (power = 25 percent). However, Type 1 (business) orchardists had significantly lower costs and significantly greater "bottom-lines" (COS, NOPBT and EOS) than Type 2 (lifestyle) orchardists (Figure 30).

Figure 30. Kiwifruit major financial aggregates by Q-sort type over six years (Real $2007/08 values). All three management systems included. Type 1 has stronger business focus and Type 2 has a stronger lifestyle focus.



6.8 Financial summary

Due to the considerable variation between orchards, and our modest sample size, we did not have enough statistical power to conclude if there were any differences or not in "bottom-line" financial variables between ARGOS panels. That said we did detect differences in some individual cost categories. We also found differences in the costs and bottom-lines of orchardists with a stronger business focus versus those with a stronger life-style focus. This work highlights the difficulty in getting a sufficient amount of good comparable financial data for orchards.

7. Social

7.1 Introduction

The ARGOS social research team has used various quantitative and qualitative methods to examine the social dimensions of orchard and farm management (Table 9). The results from most of these have been presented in previous ARGOS reports particularly Rosin, et al., 2007. Here we focus on new findings from the last 12 months particularly from a 2008 national survey of farmers' attitudes and opinions to farm management and sustainability.

Table 9. Interviews and questionnaires which have been deployed by ARGOS's Social Objective.

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

7.2 National farm survey

The following is taken directly from a recent report (Benge, et al., 2009) submitted to ZESPRI. For further detail refer to the full report.

Introduction

At the end of 2008, a National Farm Survey (postal questionnaire) was deployed to gauge opinions to key elements of farm management and sustainability. Such information is valuable for industry as it provides an indication of what orchardists' priorities are and the importance they place on sustainability issues like biodiversity and climate change. It could also help to explain different orcharding outcomes. Potentially, industry can use this knowledge to inform strategies aimed at providing more sustainable kiwifruit production.

The questionnaire was sent to the 36 kiwifruit orchardists (three panels of 12 Green, 12 Green Organic and 12 Gold) participating in the ARGOS research programme. The same questionnaire was also sent out to randomly selected producers in the Horticulture sector (as well as other sectors). However, there was a low response rate to this (20% vs. 32% in 2005) suggesting people are become fatigued by surveys. Responses were received from only 19 kiwifruit orchardists (18 integrated and 1 organic). This combined with the 33 ARGOS responses (3 did not respond) provided a total 52 responses on which the main findings here are based.

The following discussion of the survey consists of two main sections. First, the overall attitudes of all the orchardists are presented and within that, key differences between Green, Green Organic and Gold orchardists (from the ARGOS programme) are identified. Secondly, the survey data is used to segregate orchardists first based on the level of their focus on production and second on their level of focus on orchard tidiness irrespective of their

production system. In addition, the associated outcomes of these different orientations are explored using other orchard data collected by ARGOS. This provides an insight into how orchardists' intentions play out in practice.

Main findings

Overall attitudes

Although there is a growing concern globally amongst consumers about the environmental impacts of food production, orchardists currently don't feel that issues like biodiversity and reduction of greenhouse gas emissions are high priorities. Orchardists' placed much stronger importance on maximising production and financial outcomes, as well as plant health, and soil health and fertility (which presumably they associate with production). Orchardists saw broader environmental indicators (e.g. biodiversity, number of birds) as slightly important at best. They also agreed slightly that farmers were being asked to bear too much responsibility for emissions and that technological solutions are required to mitigate this. All of this means that care needs to be exercised when developing policies which look to enhance broader sustainability of orchards like biodiversity and emission reduction. On the positive side, the lack of great negativity as a whole to environmental questions (some individuals were negative) may signal an open mindedness to environmental initiatives.

Orchardists identified the social aspects of orcharding to be important particularly those to do with them and their families; the wellbeing of staff was important too. This reflects that the lifestyle and wellbeing of the community is important in addition to making a living. Community participation was low but this is a reflection of the lifecycle stage of the orchardists rather than anything else. Orchardists placed a lot of importance on customer requirements/satisfaction (an acknowledgement that this is crucial for repeatedly selling their fruit at good prices) as well as on family needs and personal satisfactions. Succession was only slightly important.

Recently ARGOS has been exploring the use of bird symbols to market production as environmentally friendly. However, this survey showed that orchardists expressed little enthusiasm for participating in such a scheme. This may highlight a disconnection in values between the market and the producers. If consumers do value such factors then producers will need to be convinced of this.

An interesting finding from this work was that the ARGOS orchardists, in comparison to the other survey participants, seemed to provide more positive responses to questions relating to enhancing biodiversity in orchards. A possible explanation for this is that involvement in the ARGOS project has raised their awareness of and sensitivity to biodiversity concerns. This suggests that the broader population may be come more sympathetic of sustainability issues as exposure to them increases.

Orchardists' backgrounds for the three ARGOS panels were similar. They did not differ significantly in their age, the number of years they had been farming, the number of years they planned to farm, or in terms of how satisfied they were with their current level of economic viability. The only difference was that the ARGOS Gold orchardists had a significantly greater level of debt (20 – 40%) compared to the Green and Green Organic orchardists (0 – 20%).

There were very few differences between the ARGOS panels i.e., between the Green, Green Organic and Gold orchardists. They placed equal importance on all the financial and social indicators and on different management strategies and they expected the same levels of changes to their orchards. There were no differences in the level of social or environmental connectivity, with the level of community participation or with attachment to place. Views on emission trading did not differ nor did the importance of a range of other important orcharding goals (i.e. customer requirements/satisfaction, family needs,

satisfaction, stream health, orchard as a place to live, orchard health and succession). There was no difference in the importance they placed on trees and shrubs. The main differences were Green placing more importance on having a tidy orchard and Gold being less positive to broader biodiversity and birds.
The lack of differences between panels implies policies around enhancing orchard sustainability are likely to receive similar responses from orchardists under each production system. The exception might be a greater resistance from Gold orchardists to any policies enhancing broader biodiversity and birds on orchards.

Linking attitudes to outcomes
Analysis of the survey data enabled the segregation of orchardists based on their relative of focus on production and on orchard tidiness (regardless of whether they were Green, Green Organic of Gold). The group focused on higher production was able to be further segregated into three groups i.e., 'focused enthusiasts', 'good orchardists' and 'tidy orchardists'. The outcomes of these groups were compared to provide some insight into how orchardists' attitudes play out in practice.

Overall there were clear differences between the financial and production outcomes depending on the level of focus on production. But generally there were few differences in the environmental outcomes. The level of focus on tidiness didn't seem to affect the overall outcomes on orchards. These findings imply that environmental outcomes of orcharding are largely not affected by the level of focus on production or orchard tidiness.

7.3 Economic focus, breadths of view and innovativeness

In 2009, Lesley Hunt from ARGOS's social research team constructed some indices of economic focus, breadths of view and innovativeness. This was achieved using previously collected interview and questionnaire data (the details of the methodology used to construct these indices will be presented in future reports).

All three ARGOS panels were shown to be equally strongly focused on the economics of their operations (Table 10). This was born out in the previous section. Gold tended to have a narrower social breadth of view meaning they had less focus on the social impacts of their orcharding outside of their families. There was no significant difference between panels in their environmental breadth of view. By their own assessment, Gold and Green Organic orchardists indicated that they were more likely to be innovative than Green orchardists.

Table 10. Economic focus, breadths of view (BoV) and innovativeness of orchardists. *Note, a negative value does not mean a negative view just that it is lower than a positive value.*

Index	Green (n=9)	Gold (n=12)	Green Organic (n=10)
Economic Focus	+0.71	+0.55	+0.51
Social BoV	+0.50 ^{A}	-0.25 ^{Bb}	+0.39 ^{a}
Environmental BoV	+0.30	-0.05	+0.43
Innovation likelihood	-0.74 ^{B}	+0.08 ^{A}	+0.05 ^{A}

*Upper case letters signify differences at the 5% level, and lower case at the 10% level.

8. Overall summary

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

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

	Green & Gold	**Green Organic**
Management	These two systems have a lot of similarities particularly in terms of soil management and crop protection. The biggest difference between the two is probably 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 (as long as they are "natural"). 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, when managed accordingly, is a more fruitful species that produces sweeter fruit and so yield and fruit dry matter content (the industry measure of sweetness) can exceed that of Hayward.	Green Organic orchards have produced significantly less than their conventional counterparts (c. 30%). This is probably due largely to the use of budbreak agents in Green. Nutrition, particularly a lack of soluble N, is also likely to contribute to lower Organic yields.
Environment	Generally, kiwifruit orchard environments appear healthy regardless of whether they are Green, Green Organic or Gold. Environmentally, Green and Gold have had a lot more similarities than differences particularly with respect to soil quality and terrestrial biology (e.g. birds, orchard floor vegetation). There have been some noticeable differences like Green consistently having more cicadas.	Green Organic has had the most different environmental outcomes. This is not surprising given organic management is the most distinctive. Organic orchards have tended to rank higher on a number of measured environmental indicators e.g. greater bird diversity, more earthworms, and higher soil quality.
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.	We have not been able to conclude if there are any statistically significant differences in the bottom-lines of the three production systems due to considerable variation in the financial data.

Social	ARGOS previously reported that kiwifruit orchardists, regardless of production system, to have a common set of social characteristics e.g. they are all focussed on production and financial outcomes. Green orchardists were considered more content with their situation, were confident about their current practices, and didn't see as much need to experiment. Gold orchardists on the other hand were considered more proactive and adventurous and enjoy the challenge of growing Gold. Recent survey data has shown little difference between the attitudes of the panels to management strategies, environmental, social and financial indicators. Perhaps the main differences were that Green place more importance on having a tidy orchard and Gold were less positive to broader biodiversity and birds.	Green Organic orchardists appeared to be the most distinctive. They tended to treat the environmental and biological processes on their orchards as elements of a wider landscape. Optimisation of these processes was considered important to orchard health and production as well as the wellbeing of family, community and the environment. Green Organic (and Gold) orchardists seem to be more innovative than Green orchardists.

9. References

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ZESPRI, 2008. Grower Premiums - Harvest 2008.

10. List of ARGOS reports and resources

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

ARGOS Stakeholder Reports

Kiwifruit

- ARGOS Annual Kiwifruit Sector Report, October 2008 by Jayson Benge
- ARGOS Annual Kiwifruit Sector Report, October 2007 by Jayson Benge
- ARGOS Annual Kiwifruit Sector Report, October 2006 by Jayson Benge
- ARGOS Annual Kiwifruit Sector Report, September 2005 by Jayson Benge

Sheep / Beef

- ARGOS Annual Sheep/Beef Sector Report, October 2008 by Dave Lucock
- ARGOS Annual Sheep/Beef Sector Report, September 2007 by Dave Lucock
- ARGOS Annual Sheep/Beef Sector Report, September 2006 by Dave Lucock
- ARGOS Annual Sheep/Beef Sector Report, September 2005 by Dave Lucock

High Country

- ARGOS Annual High Country Sector Report, November 2008 by Dave Lucock and David Norton
- ARGOS Annual High Country Sector Report, September 2007 by Dave Lucock, David Norton, Diane Sage and Mark Stevenson

Dairy

- ARGOS Annual Dairy Sector Report, October 2008 by Dave Lucock

ARGOS Research Reports

- 09/03 New Zealand Farmer Attitude and Opinion Survey 2008: Management systems and farming sustainability, by John Fairweather, Lesley Hunt, Chris Rosin, Henrik Moller and Solis Norton
- 09/02 New Zealand Farmer and Orchardist Attitude and Opinion Survey 2008: Characteristics of organic, modified conventional (integrated) and organic management, and of the sheep/beef, horticulture and dairy sectors, by John Fairweather, Lesley Hunt, Jayson Benge, Hugh Campbell, Glen Greer, Dave Lucock, Jon Manhire, Sarah Meadows, Henrik Moller, Chris Rosin, Caroline Saunders and Yuki Fukuda
- 09/01 Kiwifruit causal mapping in 2008: Comparisons to 2005 and to other sectors, by John Fairweather, Lesley Hunt, Chris Rosin, Jayson Benge and Hugh Campbell
- 08/04 Soil Properties on ARGOS Dairy and Sheep & Beef Farms 2007, by Peter Carey, Dave Lucock and Jayson Benge
- 08/03 Linking farmer wellbeing and environmentally sustainable land use: a comparison between converting organic and conventional dairy farmers, by Belinda Mortlock and Lesley Hunt
- 08/02 Causal mapping of ARGOS high country farms and comparisons to sheep/beef and dairy farms, by John Fairweather, Lesley Hunt, Dave Lucock, Chris Rosin
- 08/01 Causal mapping of ARGOS dairy farms and comparisons to sheep/beef farms, by John Fairweather, Lesley Hunt, Chris Rosin and Hugh Campbell
- 07/14 Tran disciplinary synthesis, by ARGOS
- 07/13 Social Objective Synthesis Report: Differentiation among Participant Farmers/Orchardists in the ARGOS Research Programme, by Chris Rosin, Lesley Hunt, John Fairweather and Hugh Campbell
- 07/12 Environmental indicators from alternative farm management systems: Signposts for different pathways to sustainable primary production in New Zealand?, by Tanja Maegli, Sarah Richards, Sarah Meadows, Peter Carey, Marion Johnson, Monica Peters, Katherine Dixon, Jayson Benge, Henrik Moller, Grant Blackwell, Florian Weller, David Lucock, David Norton, Chris Perley and Catriona MacLeod.
- 07/11 Economics Objective Synthesis Report, by Caroline Saunders, Glen Greer, Eva Zellman
- 07/10 Sustainability Monitoring Report of Case Study Farms in the He Whenua Whakatipu Research Objective, by John Reid, Tim Jenkins and Martin Emanuelsson

- 07/09 Management and Production Features of ARGOS farms and Differences between Production systems, by Jayson Benge, Dave Lucock, Martin Emanuelsson, Jon Manhire
- 07/08 New Zealand Farmer and Grower Attitude and Opinion Survey: Kiwifruit Sector, by John Fairweather, Lesley Hunt, Andrew Cook, Chris Rosin, Jayson Benge and Hugh Campbell
- 07/07 New Zealand Farmer and Grower Attitude and Opinion Survey: Analysis by Sector and Management System, by John Fairweather, Lesley Hunt, Andrew Cook, Chris Rosin, Hugh Campbell
- 07/06 There are Audits, and There are Audits: Response of New Zealand Kiwifruit Orchardists to the Implementation of Supermarket Initiated Audit Schemes, by Chris Rosin, Lesley Hunt, Hugh Campbell and John Fairweather
- 07/05 Becoming the Audited: Response of New Zealand Sheep/Beef Farmers to the Introduction of Supermarket Initiated Audit Schemes, by Chris Rosin, Lesley Hunt, Hugh Campbell and John Fairweather
- 07/04 Applicability of Performance Indicators to Farms and Orchards, by Caroline Saunders, Eva Zellman, William Kaye-Blake
- 07/03 The Representativeness of ARGOS Panels and Between Panel Comparisons, John Fairweather, Lesley Hunt, Andrew Cook, Chris Rosin, Hugh Campbell
- 07/02 Understanding sheep/beef farm management using causal mapping: development and application of a two-stage approach, by John Fairweather, Lesley Hunt, Chris Rosin, Hugh Campbell and Dave Lucock
- 07/01 Soil Properties on ARGOS Dairy and Sheep & Beef Farms 2005-6, by Peter Carey, Dave Lucock and Amanda Phillips, May 2007
- 06/10 New Zealand Farmers and Wetlands, by Carmen McLeod, Lesley Hunt, Chris Rosin, John Fairweather, Andrew Cook, Hugh Campbell, November 2006
- 06/09 Understanding kiwifruit management using causal mapping, by John Fairweather, Lesley Hunt, Chris Rosin, Hugh Campbell, Jayson Benge and Mike Watts, September 2006
- 06/08 Kiwifruit energy budgets to be published, Andrew Barber and Jayson Benge
- 06/07 Total Energy Indicators: Benchmarking Organic, Integrated and Conventional Sheep and Beef Farms, by Andrew Barber and Dave Lucock, September 2006
- 06/06 to be published
- 06/05 Prevalence and diversity of non-forage herbaceous plants on sheep/beef pastures in the South Island, by Grant Blackwell, Dave Lucock, Henrik Moller, Richard Hill, Jon Manhire and Martin Emanuelsson
- 06/04 to be published
- 06/03 Cleaner streams and improved stream health on North Island dairy and South Island sheep/beef farms, by Grant Blackwell, Mark Haggerty, Suzanne Burns, Louise Davidson, Gaia Gnanalingam and Henrik Moller, June 2006
- 06/02 Weed survey to be published, Henrik Moller et al
- 06/01 Understanding Approaches to Sheep/Beef Production in New Zealand: Report on First Qualitative Interviews of ARGOS Sheep/Beef Participants, by Lesley Hunt, Chris Rosin, Marion Read, John Fairweather, Hugh Campbell, February 2006
- 05/10 Sketch Maps: Features and Issues Important for the Management of ARGOS Orchards and Farms, by Marion Read, Lesley Hunt and John Fairweather, July 2005
- 05/09 to be published
- 05/08 to be published
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- Working Paper 1: Social Dimensions of Sustainable Agriculture: a Rationale for Social Research in ARGOS by Hugh Campbell, John Fairweather, Lesley Hunt, Carmen McLeod and Chris Rosin
- Working Paper 2: Social Research Compendium: Key Questions on Social Dimensions of Agricultural Sustainability (The Corpse) by Hugh Campbell, John Fairweather, Lesley Hunt, Carmen McLeod and Chris Rosin
- Working Paper 3: Economics Rationale for ARGOS by Caroline Saunders and Martin Emanuelsson
- Working Paper 4: He Whenua Whakatipu Rationale for ARGOS by John Reid
- Working Paper 5: Scoping Report for monitoring and evaluation processes within ARGOS by Esther Water (Members only)
- Working Paper 6: Environmental Monitoring and Research for Improved Resilience on ARGOS Farms by Henrik Moller, Alex Wearing, Andrea Pearson, Chris Perley, David Steven, Grant Blackwell, Jeff Reid and Marion Johnson

Research Notes

1. Background to the ARGOS Programme
2. Transdisciplinary Research
3. Cicadas in Kiwfruit Orchards
4. Market Developments for NZ Agricultural Produce
5. Spiders in Kiwifruit orchards
6. Organic Kiwifruit Survey 2003
7. Analysis of ZESPRI's Organic Kiwifruit Databases
8. Types of Kiwifruit Orchardist
9. First Kiwifruit Interview: Individual and Orchard Vision
10. Sketch Map Results : Kiwifruit Sector
11. Sketch Map Results: Sheep/Beef Sector
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
38. Audits and Sheep/Beef Farm Management
39. Quality Assurance Programmes in Kiwifruit Production
40. High Country Woody Weeds
41. The Relevance of Performance Indicators Used for Non-Agribusinesses to Kiwifruit Orchards
42. The Relevance of Performance Indicators Used for Non-Agribusinesses to Sheep and Beef Farms
43. Common elements of pastoral farming systems as shown by causal mapping
44. Differences in soil quality within kiwifruit orchards
45. Differences in soil quality between organic and conventional kiwifruit orchards
46. Strong production focus shown in kiwifruit causal mapping

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- A Transdisciplinary Approach to Promoting Biodiversity on NZ Dairy Farms, by Yuki Fukuda, Henrik Moller & Bruce Burns

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

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

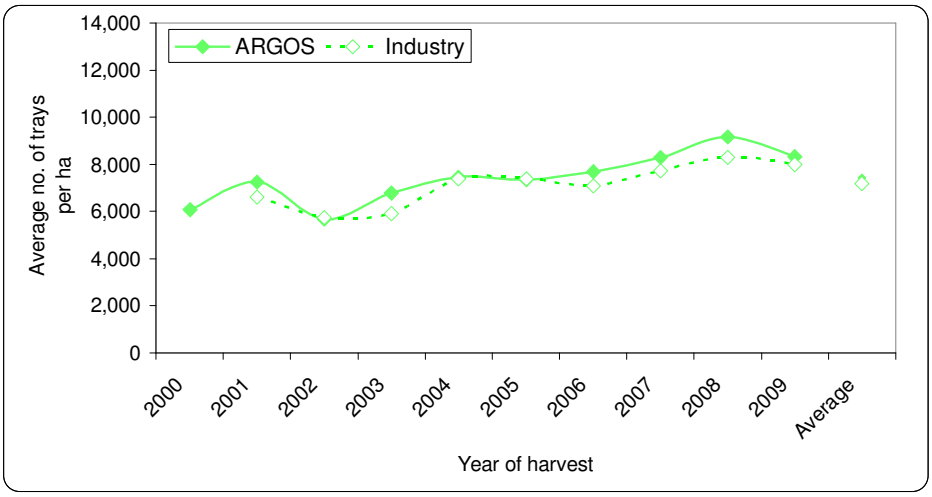
Posters from Kiwi2006: International Kiwifruit Symposium - February 2006

1. Soil Biota Poster
2. Birds Poster

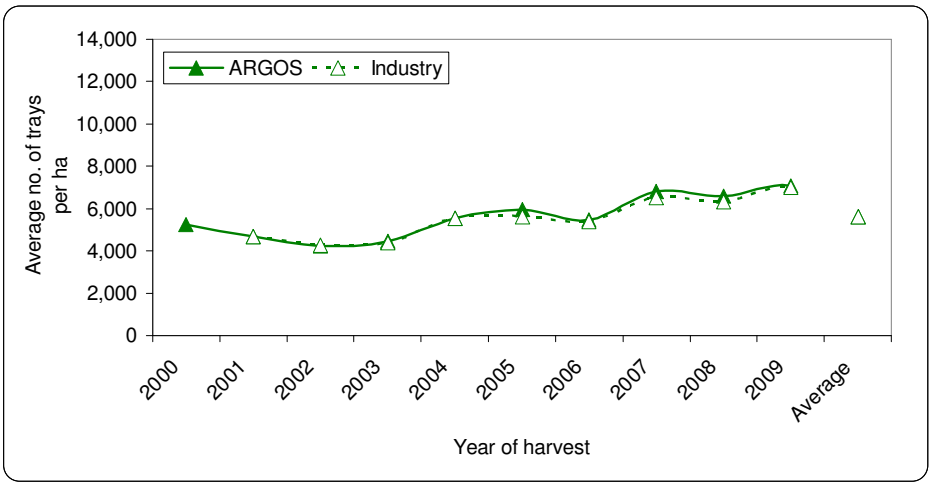
Appendices

Appendix 1. Trends in average tray numbers (Class I Submit) for ARGOS orchards (solid lines + solid symbols) and for Industry (dashed lines + open symbols). Industry data sourced from ZESPRI Kiwifliers.

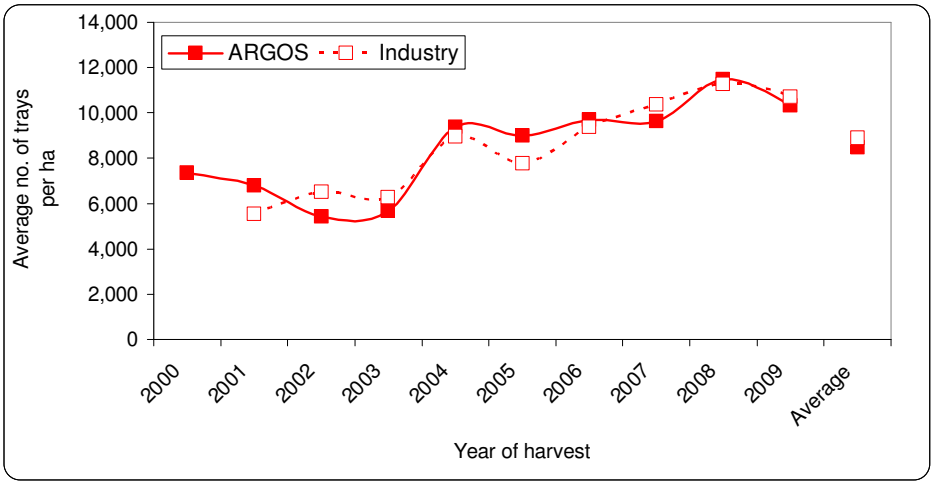
Green



Green Organic

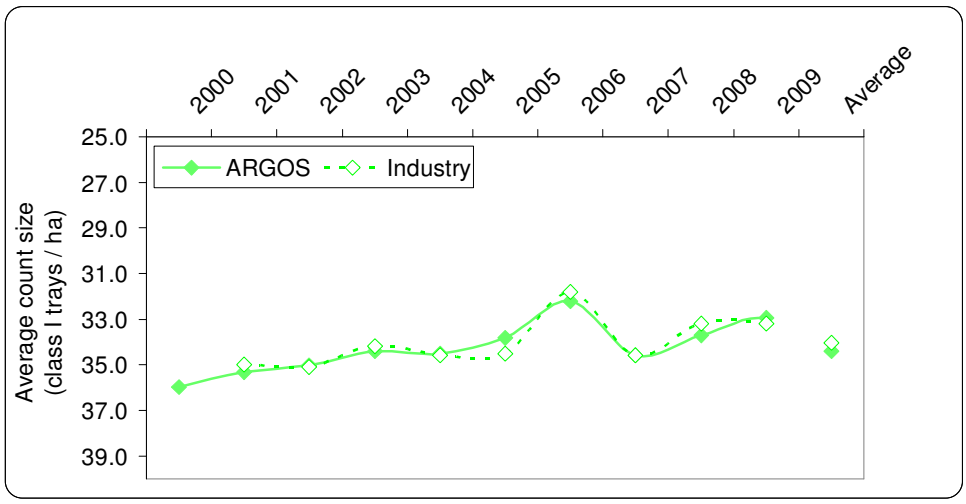


Gold

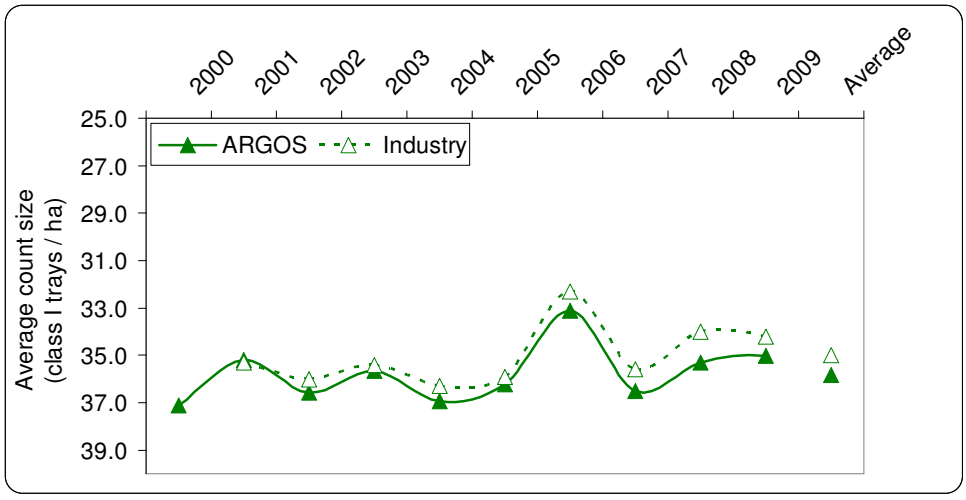


Appendix 2. Trends in average fruit size (Class I Submit) for ARGOS orchards (solid lines + solid symbols) and for Industry (dashed lines + open symbols). Industry data sourced from ZESPRI Kiwifliers. The lower the count size, the bigger the fruit and vice versa.

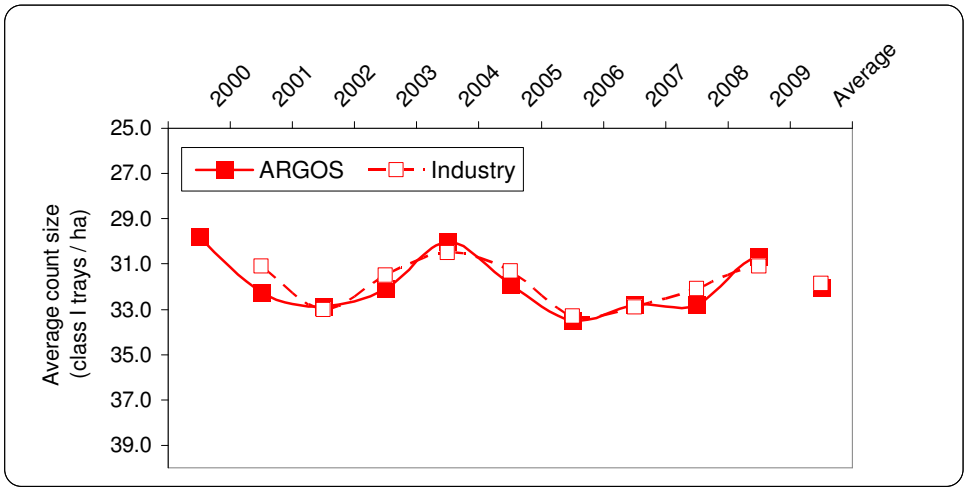
Green



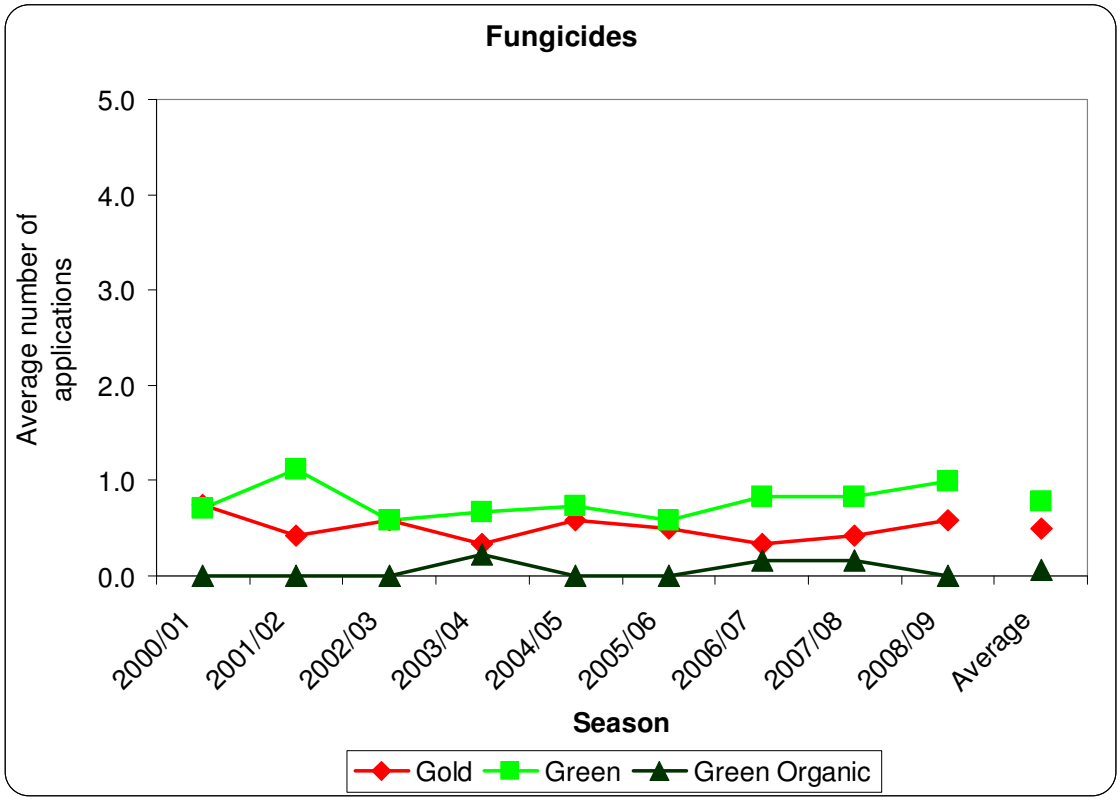
Green Organic

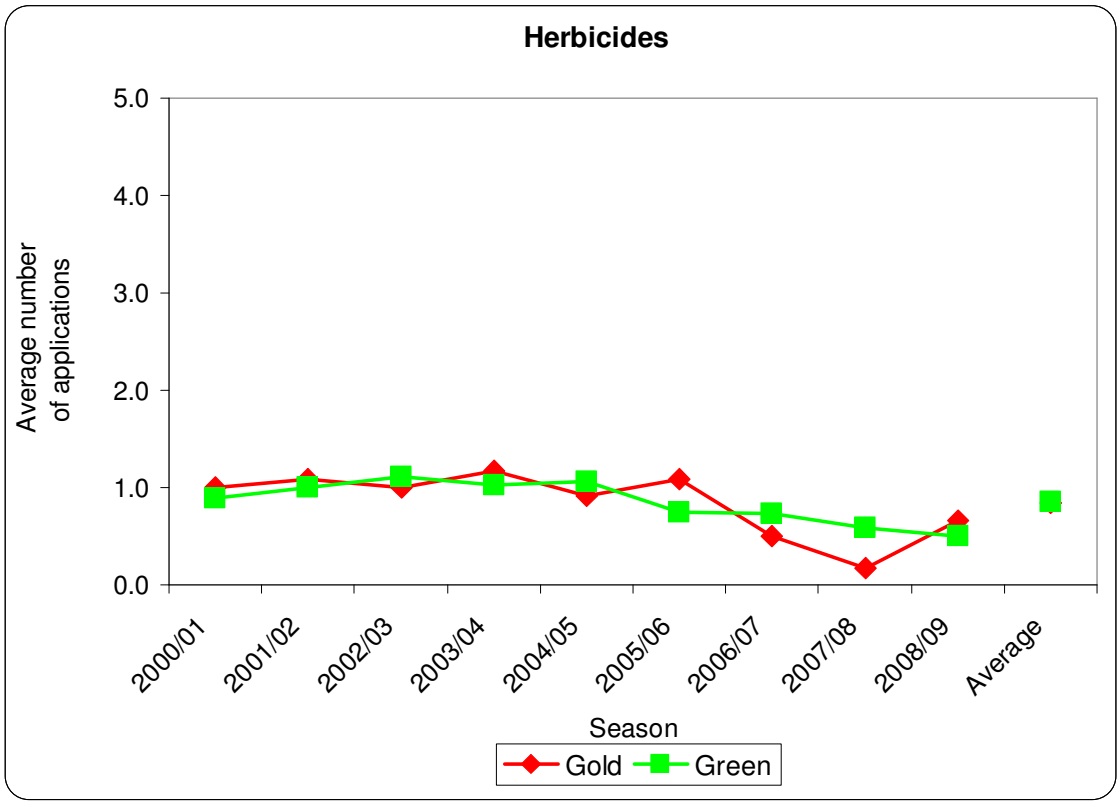


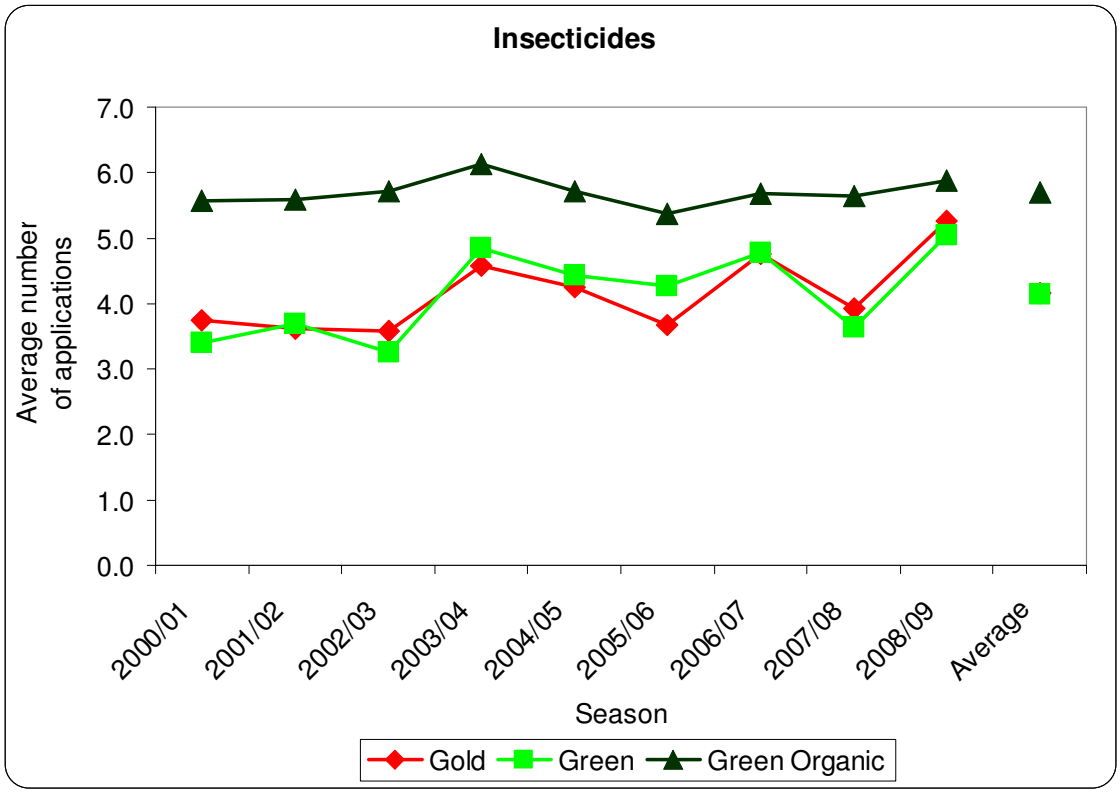
Gold

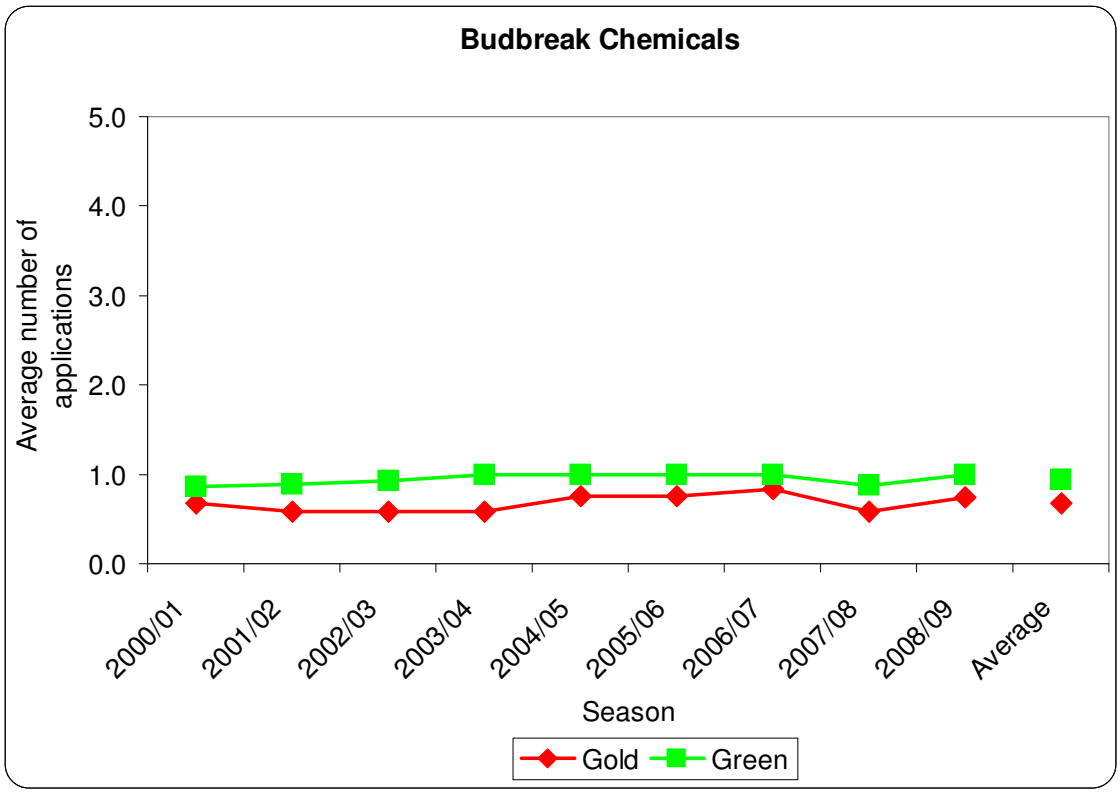


Appendix 3. Trends in the average number of sprays applied to orchards in the ARGOS programme. *All sprays applied to organic orchards are certified organic and have lower potential toxicity.*






Insecticides
Average number of applications
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
Average
Season
Gold
Green
Green Organic


Budbreak Chemicals
Average number of applications
5.0
4.0
3.0
2.0
1.0
0.0
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
Average
Season
Gold
Green

Appendix 4. Significant differences between production systems each year for soil chemistry measures.

Greater/less than signs indicate the direction of difference. Letters together within a bracket are not significantly different. A = Green, B = Green Organic, C = Gold. NS = no significant differences. Consistent differences across all three years are in bold. 5% significance level used.

	Year		
	2004	**2006**	**2009**
No. of clusters sampled	*All 12*	*All 12*	*Four out of 12*
pH	**C** < A < B	**C** < A < B	**C** < (A,B)
P retention	A < (B,C)	A < B	-
Olsen-P	B < (A,C)	B < A < C	A < C
Resin-P	(A,C) < B	(A,B) < C	-
Total BS	**C < A < B**	**C < A < B**	**C < A < B**
CEC	(A,C) < B	A < (C,B)	A < (C,B)
Available nitrogen	**(A,C) < B**	**(A,C) < B**	**(A,C) < B**
OM	**A** < (B,C)	**A** < C < B	**A** < (B,C)
Total C	**A** < (B,C)	**A** < C < B	**A** < (B,C)
Total N	**A** < C	**A** < (B,C)	**A** < (B,C)
C:N ratio	C < B	C < B	NS
Calcium	C < A < **B**	(A,C) < **B**	(A,C) < **B**
Magnesium	(A,C) < **B**	A < C < **B**	(A,C) < **B**
Potassium	NS	A < C < B	NS
Organic S	C < B	A < B < C	-
Sulphate-S	B < (A,C)	B < A < C	-

* Data analysed by ANOVA with cluster as blocks and production system as treatment. Duncan's multiple comparison tests used to identify differences.

Appendix 5. Significant differences between sample areas each year for soil chemistry measures.

Greater/less than signs indicate the direction of difference. Letters together within a bracket are not significantly different. BR = between-row (alleyways), WR = within-rows (under the leaders). NS = no significant differences. Consistent differences across all three years are in bold. 5% significance level used.

	Year		
	2004	**2006**	**2009**
No. of clusters sampled	*All 12*	*All 12*	*Four out of 12*
pH	NS	NS	NS
P retention	NS	NS	-
Olsen-P	**BR < WR**	**BR < WR**	**BR < WR**
Resin-P	NS	NS	-
Total BS	NS	**BR > WR**	**BR > WR**
CEC	NS	**BR > WR**	**BR > WR**
Available nitrogen	**BR > WR**	**BR > WR**	**BR > WR**
OM	**BR > WR**	**BR > WR**	**BR > WR**
Total C	**BR > WR**	**BR > WR**	**BR > WR**
Total N	**BR > WR**	**BR > WR**	**BR > WR**
C:N ratio	NS	BR < WR	NS
Calcium	**BR > WR**	**BR > WR**	**BR > WR**
Magnesium	NS	NS	NS
Potassium	NS	BR > WR	NS
Organic S	NS	NS	-
Sulphate-S	NS	BR < WR	-

* Data analysed by ANOVA with cluster/orchard block as blocks and production system * sample area as treatment. Duncan's multiple comparison tests used to identify differences.