ARGOS

AGRICULTURE RESEARCH GROUP ON SUSTAINABILITY

Research Report: Number 10/01

ISSN 1177-7796 (Print)
ISSN 1177-8512 (Online)

Management and production features of ARGOS farms and differences between production systems

Synthesis Report for ARGOS Objective 1 (Farm Management)

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June 2009

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Acknowledgements

This work was funded by the Foundation for Research, Science and Technology (Contract Number AGRB0301). ARGOS also acknowledges financial assistance for the areas of work reported in this report from; ZESPRI International Ltd, Merino New Zealand Inc., COKA (Certified Organic Kiwifruit Growers Association) and a meat packing company. Also a special thanks to participating farmers/growers who have allowed us to intensively study their farming systems.

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

Executive summary

Farm and Orchard Management, in ARGOS, is studied from a management systems approach with three main areas of study; economic, social and the environment. Economics includes production (both financial and non-financial) through to socio economics of production systems. Social studies the 'people' implications of the systems, motivational drivers, life cycles, whilst the environment objective looks at the impact/implications of the farming system on the environment. Boundaries of the three objectives overlap, leading to overarching research that is a transdisciplinary study of farming systems. It was recognised that generic descriptors, of the farms under study, need to be supplied to the three objectives and this led to a fourth 'sub' objective, the farm/orchard management objective. The role of the management objective includes collecting physical and managerial style data and, where suitable, the preliminary analysis of this data. The main purpose of this synthesis report is to provide an overview of the type of management and production data that have been collected and key differences between production systems (also referred to as 'panels') within each sector. For kiwifruit and dairy, data up to the 2007/08 season is reported.

Characterisation of ARGOS panels

Kiwifruit

ARGOS is studying the three main kiwifruit production systems ("panels") in NZ i.e. 'Hayward' variety grown under integrated management ("Green"), 'Hayward' variety grown as certified organic ("Green Organic") and 'Hort16A' variety grown under integrated management ("Gold"). Like industry, the average production levels of each system have differed with Green consistently producing more and larger fruit than Green Organic. Generally the Gold orchards have on average produced the most and largest fruit but not in every year. Dry matter content, an important and rewarded measure of quality, has generally not differed between Green and Green Organic but has been consistently highest in the sweeter Gold variety.

In terms of the main physical inputs, Organic orchards have not surprisingly used very different fertilisers and sprays because of the greater restrictions they face; Green and Gold orchards have generally used similar inputs. Canopy management, the most time consuming and labour intensive part of growing kiwifruit, has also generally differed between systems due to Organic vines being less vigorous and Gold vines more vigorous than Green. Gold being a different species altogether seems to have naturally different levels of production though we will endeavour to disentangle the impacts of species versus management on production.

The experimental design which ARGOS is using (i.e. matched orchards close together) means that differences in background factors like soil type and climate have been reduced between the kiwifruit systems that have been studied in this project. This gives us good confidence that the production differences between Green and Green Organic (i.e. the same species) are explained largely by management differences. Differences in previous landuse may also account for some of the production differences though many of our orchards have been kiwifruit for some time now. It's plausible that previous landuse may have also stalled the emergence of or lessened differences in some variables between integrated and

In terms of financial attributes, Gold is the most different from an operating perspective due to greater Orchard Gate Return (OGR), a result of higher yields, fruit quality and/or returns per tray, and also because of greater growing costs (mainly due to the greater labour costs required to manage a more vigorous canopy). Despite Green's higher yields, statistically, Green and Green Organic have not been different in terms of total operating revenue and expenditure (per ha). Our ability to detect stronger differences between financial bottom lines may be due to a lack of statistical power in our data and we are currently testing if this is the case.

There was no difference between systems in the amount of unpaid labour used on orchards although the data was highly variable. Although the estimates for paid labour were rather crude, there was some evidence that the Gold orchards were more labour intensive.

In terms of the total energy associated with producing the fruit, there was no significant difference between panels.

In terms of production, the ARGOS panels of orchards are reasonably representative of Industry. Since 2000, the average tray numbers and fruit size have been very similar to industry averages. Average fruit quality (i.e. dry matter) for the ARGOS organic orchards has been very similar to Industry and higher for the integrated orchards. The organic orchards have produced significantly less and smaller fruit than their conventional counterparts. The main driver of this is thought to be the lack of effective budbreak chemicals in organics. Gold orchards have produced significantly larger and higher dry matter fruit than Green but the number of trays has not differed. Gold plants when managed appropriately are more productive. Vine density was found to be the same on orchards so can not be used to explain production differences.

It has been important to characterise production and management of our kiwifruit orchards as this will be crucial to explaining differences in the environmental, economic and social features of orchards. This information may also allow us to identify practices that improve production on orchards (without having any detrimental effects).

Sheep/beef

ARGOS is comparing the following production systems ("panels") in New Zealand's sheep/beef sector: Certified Organic, Integrated and Conventional. The total and effective size of farms within each panel did not differ significantly. However, there was evidence that the Integrated farms had a significantly higher percentage of effective area i.e. 96% vs. 91%. The total number of stock units (sheep or cattle) did not differ between systems. However, per hectare, the organic farms had the least stock units. Organic farms also has a lower lambing % and mating weight compared to Integrated (but not conventional farms). The only energy intensity indicator that was significantly different between the systems was indirect energy, largely because of the influence of inorganic nitrogen fertiliser which organic farms do not apply. Direct and capital energy intensities were similar across all farm management systems, particularly once the variation caused by cropping was removed.

Main management differences were centred round meat marketing, parasite control,soil nutrient inputs and stocking rate.

Meat sale weights were lower for Organic compared with Conventional and Integrated and Organic farmers tended to sell meat later in the season without selling in the winter months. Non Organic farmers sold a greater amount of meat in the summer months and then again in the winter months (obvious contract markets). This suggests that it is more important for the Organic farmers to align animal demand with feed supply.

For internal parasites, Organic farmers used little or no anthelmantic drenches, depending on the markets their lambs were destined for. They used a range of other strategies to decrease the frequency and impact of internal parasites in comparison to other the other farmers who rely more on anthelmantics. .

Organic farmers theoretically have access to all of the macro-nutrient inputs; however they are typically in another form. Organic farmers applied less macro-nutrients than non-organic farmers (with the exception of Ca). Conventional farmers applied less S and Ca than integrated farms.

The organic farms have the lowest stocking rate. This could be a result of a number of factors including the restrictions on fertiliser use (in particular Nitrogen), impact of less effective control of internal parasites etc. Interestingly the integrated systems have a higher stocking rate than the conventional farmers indicating that these farmers are running a system of slightly higher intensity.The ARGOS management data of the Sheep and Beef farms clearly highlight the large variability between systems but also within systems. On some key management variables the variability with in a panel (e.g. organic) is larger than the difference between panels (e.g. between organic and conventional).

Dairy
The dairy sector was added to the ARGOS monitoring programme in 2005 after additional support and funding was provided by Fonterra and the MAF Sustainable Farming Fund. A key driver of this support was the initiative by Fonterra to increase their organic milk supply. Therefore, to determine the impacts of organic production, and given the resources available, a decision was made to compare conventional farms and farms converting to organic.

The main production and management differences were:

- Production of the converting to Organic farms was 90% of the Conventional farms at the start of conversion and this increased to 70% three years later as farmers adapted to new systems with lower stocking rates.
- In regards to fertiliser inputs, the use of N and K were statistically significantly different between organic and conventional farms. In both cases the organic farms uses less. The application of P was strongly related to geographical location but there were no consistent differences between the organic and conventional ARGOS farms.
- Organic farms had significantly less cases of milk fever and a higher somatic cell count. They also had more incidences of lameness and cases of mastitis, although these were not significant.
- Organic farms, were less energy intensive in terms of resource inputs and stock density, had significantly lower greenhouse gas emissions per hectare. However organic and conventional farming systems had almost identical GHG emissions per unit of milk production. Improved productivity and farm management skill are possibly the two biggest opportunities. There is a clear linear relationship between higher productivity per cow and lower GHG emissions per unit of production

It is interesting to note that organic and conventional dairy farms can achieve similar profits even though the production levels are so different. Even more so in an industry that traditionally has been very focused on increasing production (kgMS), sometimes to the detriment of the bottom line.

High country
The High Country part of ARGOS is focused mainly on the merino sector and involves the monitoring and analysis of eight properties throughout the South Island. Like the other ARGOS sectors, regular monitoring is occurring on these properties in order to identify the impacts of different approaches to high country farming.

It is clear that the high country farms are the least intensively managed properties in ARGOS. The extensive nature of high country farming and the vast properties involved has necessitated a case study approach to this sector. The major focus is on environmental monitoring of land cover over long time periods and the ARGOS management objective has a primary role in maintaining a database of changes in management practises over that time.

The 8 properties involved in ARGOS ranged from 4,400 to 40,000 hectares with carrying capacities of 0.31 to 2.01 stock units per hectare. Because of the vast size of the properties, key performance indicators were analysed per stock unit compared with per hectare for the Dairy and Sheep/beef sectors in ARGOS. For instance labour input ranged from 28 minutes per stock unit to 59 minutes per stock unit. The major income stream was Merino wool, followed by meat production.

Barriers to joining the ARGOS programme

Willingness to be involved was an important orchard and farm selection factor. For kiwifruit, 19 orchardists declined to be involved when approached by phone. Reasons including not being able to commit to a long-term project (e.g. under pressure to sell, moving towards retirement), orchard just sold, too busy or thinking about changing production system. Five of the 19 did not specify reasons for not wanting to be involved. For Sheep/beef, out of 76 people interviewed, 1 did not want to be involved due to perceived time constraints and another wanted to be paid for his time and intellectual property. It was apparent, in the early part of selection that there were a limited number of organic sheep/beef properties. Hence organic farmers were approached first and these were matched with conventionally and integrated farms in close geographical proximity to the organic farms, whilst still retaining a distribution of clusters across the South Island.

Summary

The farm management objective of ARGOS has established and maintained a strong network of monitor farms across NZ. Over 100 farms are included in the study and each year detailed management and production information is collected for those farms through regular farmer interviews and questionnaires. The result of this is that there is now a sound understanding of management across all ARGOS farms as well as differences between various production systems within each sector e.g. conventional and organic production. The following table summarises whether differences were found between panels of the Sheep/beef, Kiwifruit and Dairy sectors. This knowledge will be important for explaining the results of other monitoring carried out by ARGOS (i.e. environmental, financial and social) as well as looking for drivers of different production outcomes. The farm management objective will continue to document farm management and production with a focus on exploring relationships between management inputs and production outcomes including many of those summarised in this report.

(Detailed results from the environmental, social, and economic monitoring can be found on the ARGOS website www.argos.org.nz.)

Summary of farm management difference between panels. Y = differences found, N = no differences found.

Variables	Sheep/beef	Kiwifruit	Dairy
Panels	• Organic • Integrated • Conventional	• Organic 'Hayward' • Integrated 'Hayward' • Integrated 'Hort16A'	• Organic • Conventional
Land area	Y	N	Y
Soil management	Y	Y	Y
Pest & disease management	Y	Y	Y
Weed management	Y	Y	Y
Pasture or groundcover management	N	**N/A**	N
Productive intensity(no. of stock units/plants per ha)	Y	N	Y
Productive yield (kg of produce per ha)	Y	Y	Y
Labour (hours per ha)	N	Y	N
Energy indicators - per area - per unit of produce)	Y N	N	**Unknown**
Profitability (per ha)*	N	N	N

1. Overview

1.1 Introduction

The Agricultural Research Group on Sustainability (ARGOS) is an unincorporated joint venture between the AgriBusiness Group, Lincoln University, and the University of Otago. It is funded by the Foundation for Research, Science and Technology (FRST) and various industry stakeholders and commenced in October 2003. ARGOS is a 6 year research project with the aim to model the economic, environmental, and social differences between organic, integrated and conventional systems of production. The aim is to detail the impact of these systems and develop indicators which reflect the interactions across the social, economic and environmental factors. The role of the farm/orchard management objective includes collecting physical and managerial style farm data that are needed for the transdisciplinary modelling in ARGOS.

This synthesis report provides an overview of the management systems that has been studied, the type of management data that have been collected and key differences between production systems within each sector. Further detailed data and results for each sector can be found in Annual Sector Reports prepared by ARGOS for its stakeholders.

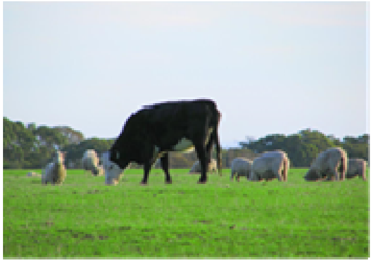
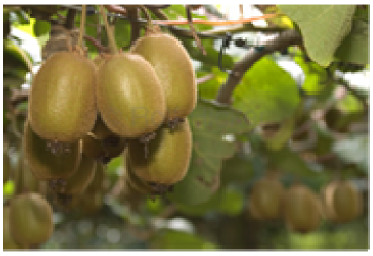
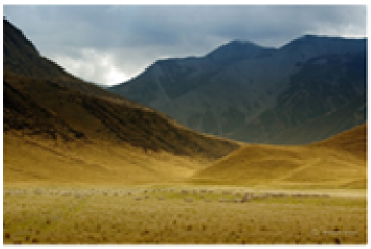
1.2 Sectors, production systems and farms being studied by ARGOS

These are summarised in Table 1. They can broadly be categorized as conventional, integrated and organic. All three types are prevalent for the Sheep/beef sector while only two are for Kiwifruit (i.e. integrated and organic) and two for Dairy (i.e. conventional and organic). Conventional kiwifruit production ceased in the mid 1990s with the introduction of integrated management (specifically the 'KiwiGreen' pest management programmes). Dairy farming in NZ currently does not have an integrated system. The High Country farms in ARGOS are all conventionally managed though at varying levels of intensity while the He Whenua Whakatipu (HWW) study of South Island Maori farms, encompasses a variety of enterprises. A case study approach is being applied to these last two sectors rather than the paneldesign being used in the other sectors.

The general locations of the farms being studied are shown in Figure 1.

Figure 1. Location of farms being studied by ARGOS.

Table 1. Sectors, production systems and farms being study by ARGOS.

Sector	Participating farms
Lowland sheep and cattle 	12 conventional, 12 integrated and 12 organic
Kiwifruit 	12 growing ‘Hayward’ variety under integrated management (”Green”), 12 growing ‘Hayward’ variety under the certified organic programme (”Green Organic”), and 12 growing ‘Hort16A’ variety under integrated management (”Gold”)
High country 	8 farms with different levels of intensity
Dairy 	An adjunct study of 24 dairy farms on the North Island - 12 converting to organic and 12 conventional
Maori landholdings Te Rūnanga o NGĀI TAHU	6 South Island Maori owned land holdings which encompass a variety of enterprises*

* The results of this work are not included in this report.

2.Kiwifruit

2.1 Production systems ('panels')

In the kiwifruit sector, ARGOS is studying the three main production systems present in the Industry (Table 2). Effectively there are two integrated systems (two different varieties) and an organic system.

Twelve clusters of orchards are being studied by ARGOS with each cluster containing one of each orchard type (36 orchards in totals). Ten clusters are in the Bay of Plenty region with one in each of Kerikeri and Motueka (Figure 3). These locations are consistent with the industry distribution of orchards and will potentially allow extrapolation to the wider industry.

Table 2. Kiwifruit production systems being studied by ARGOS.

Panel	Panel name	Management system	Variety	ZESPRI brand name	Photo
A	Green	**Integrated**	Hayward (*Actinidia deliciosa*)	ZESPRI™ GREEN	
B	Green Organic	**Organic**	Hayward (*A. deliciosa*)	ZESPRI™ GREEN ORGANIC	
C	Gold	**Integrated**	Hort16A (*A. chinensis*)	ZESPRI™ GOLD	

The integrated system for kiwifruit is very much based around an integrated pest management system called 'KiwiGreen'. This prescribes the strategies that can be used to control market access pests on kiwifruit crops. In simple terms, growers must demonstrate a need before applying agrichemicals for the control of pests. Prior to KiwiGreen, sprays were applied on more of a calendar basis regardless of the level of pests that may have been present. Specific control measures are outlined in the ZESPRI™ Crop Protection Programmes for export kiwifruit. This comprehensive document is reviewed and updated annually so as to include emerging market access issues. While KiwiGreen does not involve much outside of pest management, other aspects of integrated management (e.g. fertiliser and soil management) must be incorporated into kiwifruit production as part of the GlobalGap assurance programme (see below). A separate KiwiGreen Programme exists for each production system. Certified Organic Kiwifruit growers must also meet the BioGro Organic Standard. The website www.biogro.co.nz lists inputs currently permitted by BioGro.

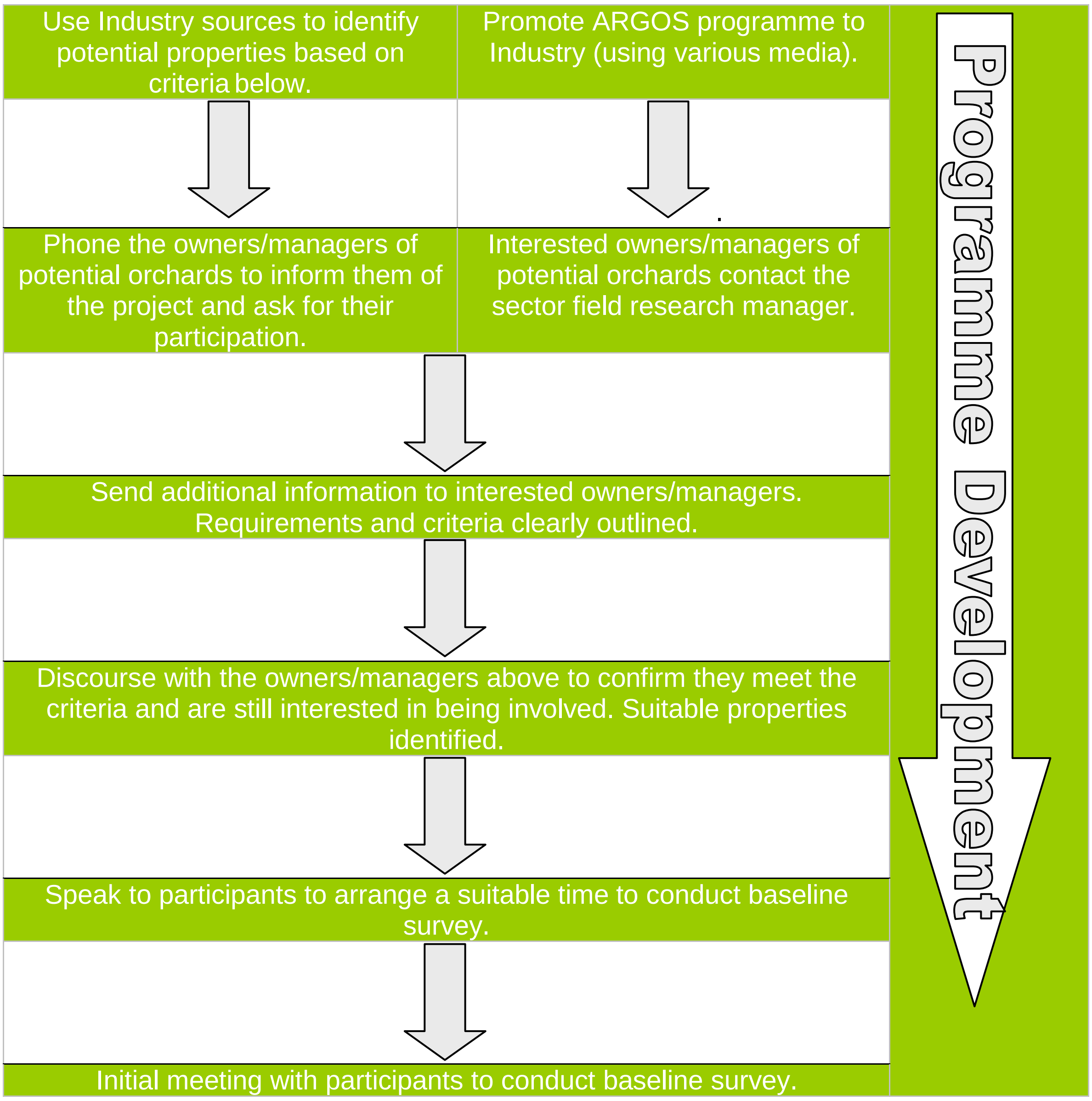
In addition to the KiwiGreen programmes, kiwifruit orchardists must also adhere to GlobalGap requirements. GlobalGAP is a market assurance programme started as an intiative by European retailers in 1997 to ensure Good Agricultural Practices. Itis required for access to many high value markets thoughout the world.

2.2 Orchard selection

The process used to select and recruit orchards is shown in Figure 2. Within clusters, orchards were selected on the basis of being similar in size (canopy hectares), growing structure (i.e. pergola or T-bar), topography, age and management structure i.e. owner operated, managed or leased. The latter two were not always possible to match within clusters. Because of the close proximity of orchards to each other within a cluster, background variables like soil type, altitude and climate were similar.

Willingness to be involved was an important orchard selection factor. While 36 orchardists eventually agreed to be involved, 19 orchardists declined when initially approached by phone (Appendix 1). Reasons including not being able to commit to a long-term project (e.g. under pressure to sell, moving towards retirement), orchard just sold, too busy or thinking about changing production system. Five of the 19 did not specify reasons for not wanting to be involved.

Figure 2. Process used to select and recruit kiwifruit orchards and pastoral farms in the ARGOS programme.



If at any stage above properties are unable to be included, then other properties were sought after and considered. Within clusters, properties were selected on the basis of having similar size (canopy hectares, orchards), growing structure (pergola vs t-bar, orchards), topography, age and management structure (owner-operated, managed or leased). The latter two were not always possible to match within a cluster. Most importantly, willingness to be involved was a factor in property selection. The close proximity of properties to each other within a cluster meant background variables like soil type, climate and altitude were similar.

2.3 Representativeness of ARGOS orchards

Orchard locations

Most of the kiwifruit in NZ is grown in Katikati, Tauranga and Te Puke and for this reason, 10 of the 12 clusters (30 of the 36 orchards) are spread amongst those places (Figure 3, Table 3). There is one cluster in each of the other two major kiwifruit regions i.e. Northland and Nelson. These regions have very contrasting biophysical conditions which will provide outlying information throughout the programme. Clusters also cover a range of altitudes and are spread from just north of Katikati to just south of Te Puke.

Figure 3. Location of ARGOS kiwifruit orchards.

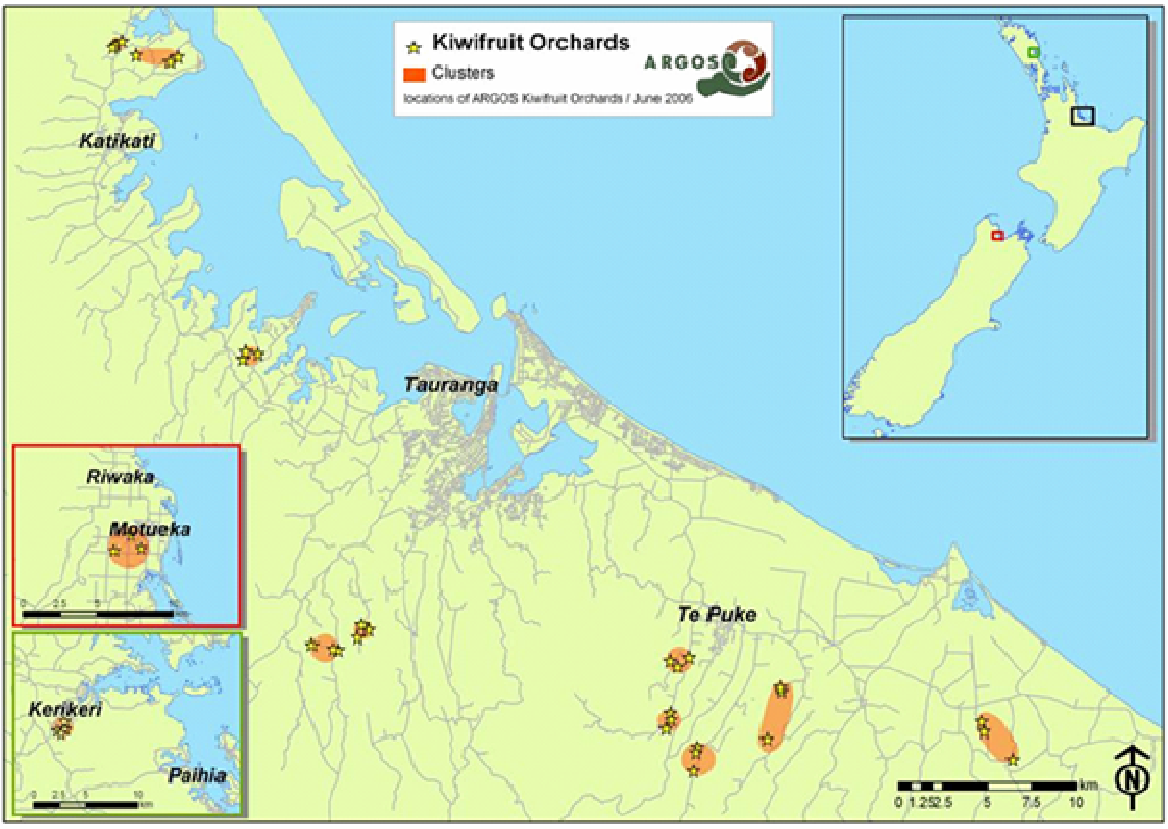


Table 3. Relative amounts of kiwifruit in each of the major kiwifruit growing areas of NZ (Source: ZESPRI Annual Report 2003 – page 38) and the associated number of ARGOS orchards.

	Percentage of kiwifruit area in each region (Industry)	No of ARGOS orchards in each region
Northland	5	3
Bay of Plenty		
- Katikati	13	6
- Tauranga	17	9
- Te Puke	37	15
Nelson	6	3

Growing structures

Most of NZ's kiwifruit crop is grown on pergola structures with the minority on T-bar structures (Table 4). To align with this, most of the recruited ARGOS orchards were on pergola i.e. 10 out of 12 clusters (or 30 out of 36 orchards; ~ 80%). Since the original recruitment, three of the six t-bar orchards (a Te Puke cluster) have converted to pergola as a move to increase production and ease management. Only the three orchards in Motueka remain on T-bar.

Table 4. Percentages of the total canopy hectares of kiwifruit grown on the different training structures in NZ c. 2003 (Source: ZESPRI KPIN database).

	Pergola	Mixed *	T-bar	Unknown
Green	61	16	17	7
Organic Green	62	14	17	6
Gold	83	9	4	4

*proportion of T-bar and pergola unknown

Establishment of Hort16A (Gold) in orchards

The introduction of Gold into the ARGOS orchards began from 1996. Most of the orchards converted a part of their orchard and so the majority also have Green; only four are growing just Gold (Appendix 2). The majority of orchards replaced Green (by grafting) rather than planted new seedlings.

Orchard management structures

The way an orchard is managed could impact significantly on its performance. At the time of recruiting orchards in 2003, most orchards in the Industry were categorised as owner-operated i.e. the owners has significant input into the decision making and day-to-day running of the orchard. A similar proportion of owner-operated orchards (c. 65%) were selected into the ARGOS programme (Table 9). A slightly lower proportion of leased orchards and a slightly higher proportion of managed orchards were recruited into the ARGOS programme.

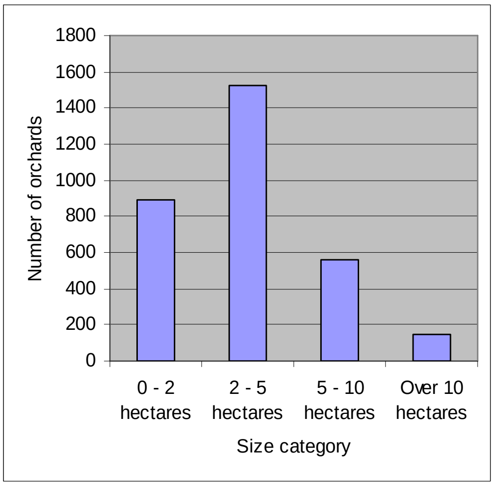
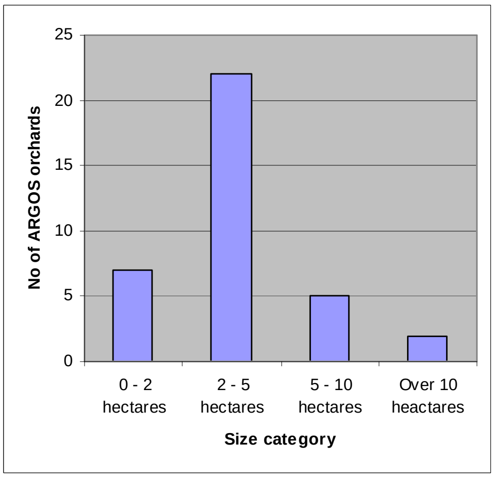
Table 5. The breakdown of how ARGOS orchards are managed relative to Industry c. 2003 (Source: ZESPRI KPIN database).

	Owner-operated	Leased	Managed	Total
Total no of orchards in the Industry	1954	518	530	3002
Proportion of orchards in the Industry	**65**	**17**	**18**	
No of ARGOS orchards	23	3	10	
Proportion of ARGOS orchards	**63**	**9**	**28**	

Orchard size

The average production area of kiwifruit orchards in NZ is only a few canopy hectares – most are 2 – 5 hectares (Figure 4). The size profile of the selected ARGOS orchards was similar to that of Industry with most being 2 – 5 canopy hectares.

Figure 4. Size of orchards in the NZ Kiwifruit Industry c. 2003 (A - Source: ZESPRI Annual Report, 2003 – page 40) and the ARGOS programme (B).

A. Industry	B. ARGOS
	

2.4 Production area

Industry production and financial figures for kiwifruit are often reported in terms of the productive (or 'effective') areas of orchards i.e. canopy hectares. From an ecological point of view, other parts of orchards are important with respect to biodiversity and refugia issues as well as intensification metrics. On average, the organic orchards have a lower ratio of canopy area to total land area (Table 6). This suggests that the integrated orchards are more kiwifruit intense and that the organic orchards are move diverse.

Table 6. Average proportions of kiwifruit canopy area relative to total orchard areas. According to an ANOVA, the Green Organic mean is significantly lower than the other means at the 10% level (P = 0.091).

	Proportion of kiwifruit canopy area to total land area
Green	0.62 a
Green Organic	0.50 b
Gold	0.61 a
LSD	0.10

2.5 Planting density

No significant differences were found in the density of vines between production systems (Table 7). This is therefore unlikely to be a major contributing factor to the production differences between systems which are described below.

Table 7. Average density of vines on ARGOS orchards. The values did not differ significantly at the 5% level (according to an unbalanced ANOVA).

	Females / ha	Males / ha	Total / ha
Green	380	100	520
Green Organic	400	90	480
Gold	450	110	560
F pr	0.313	0.654	0.309

2.6 Production

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 useful for illustrating key production differences between ARGOS orchards and between management systems. With time, we may be able to attain a better understanding of what might be driving these. 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.

Number of trays

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

For ARGOS orchards, the greatest increase in average tray numbers has occurred with Gold (Appendix 3) – a result of younger orchards maturing and established orchards producing very good crops. Appendix 2 shows when Gold was first established in the ARGOS orchards. The overall increases in tray numbers can be attributed to favourable growing conditions and improved and new practices. Girdling (ring-barking) is an example of a new practice which although primarily used to increase fruit quality and size 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 associated labour cost, and potentially reduced fruit size due to a dilution effect.

Between 2001 and 2007, ARGOS Green orchards on average produced about 33% more trays than their Organic counterparts which is similar to the Industry difference of about 31%. This difference, which is statistically significant (
Table 8), is likely to be mainly due to the use of budbreak agents (hydrogen cyanamide) on Green Orchards that enhance production. Such chemicals are not permitted for use on Organic orchards. ARGOS Gold orchards have yielded about 7% more trays on average than their Green counterparts (which is lower than the average Industry difference of about 15% for the same period) although the difference was not statistically significant. A survey conducted in 2005 by ARGOS revealed that Gold compared to Green had a higher density of winter buds and greater budbreak which is consistent with the greater yields (2006 Annual ARGOS Sector Report - Kiwifruit).

The Industry averages, for the 2001 and 2007 seasons, fell within the 95% confidence intervals for the ARGOS orchards (Table 8). This suggests that the ARGOS averages may not be that different to the Industry ones i.e. the ARGOS data is reasonably representative of Industry.

Table 8. Recent average production levels for ARGOS orchards and Industry based on export trays (Class I) submitted into the ZESPRI inventory at harvest. For the 2001 to 2007 period. 95 confidence intervals (CI) are presented. ARGOS values within the same row which have different letters are statistically difference at the 5% level (according to an ANOVA and Duncan's multiple comparison test).

		Green	Green Organic	Gold	F pr
Yield (trays/ha[2])	**ARGOS**	**7,200 a**	**5,400 b**	**7,700 a**	**0.013**
	CI	(6,100 - 8,300)	(4,200 - 6,400)	(6,400 – 8,600)	
	Industry	6,800	5,200	7,800	
Size per tray[3]	ARGOS	**34.3 a**	**35.8 b**	**32.3 c**	**<0.001**
	CI	(33.6 – 35.0)	(35.1 – 36.5)	(31.6 – 32.9)	
	Industry	34.3	35.3	31.9	
Tonnes / ha[4]	ARGOS	**26.0 a**	**19.2 b**	**26.0 a**	**0.024**
	CI	3.9	3.9	3.9	
	Industry	**24.5**	**18.7**	**26.5**	
Dry matter (%)[5]	ARGOS	**17.0 a**	**16.5 b**	**18.1 c**	**<0.001**
	CI	(16.6 – 17.3)	(16.2 – 16.8)	(17.8 – 18.4)	
	Industry	17.0	16.5	18.1	

[1] Industry values are derived from average values each year published in the ZESPRI Kiwiflier (Industry Newsletter). [2] Hectares of kiwifruit canopy. [3] This represents the number of fruit which fit in a single layer tray - the smaller the value the larger the fruit and vice versa. [4] Trays per ha multiplied by average net weight of trays i.e. 3.6 kg for Hayward and 3.4 kg for Hort16A. [5] Averages of the highest results for each maturity area, for the 2002 to 2007 period.

Fruit size

Fruit size is another important measure of orchard production as consumers and markets have preferred sizes. Orchardists strive to maximise trays 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. The Industry averages, for the 2001 to 2007 period, fell within the 95% confidence intervals for the ARGOS orchards (Table 8). This suggests that the ARGOS averages may not be that different to the Industry ones i.e. the ARGOS data is reasonably representative of Industry.

The size of fruit from ARGOS orchards overall increased between 2001 and 2007 for Green and Green Organic with the latter increasing at a slightly greater rate (Appendix 3). Gold fruit size decreased slightly overall.

Compared to Green, Green Organic orchards in ARGOS have on average produced significantly smaller fruit across the 2001 to 2007 period. Research has demonstrated that Hydrogen Cyanamide (HC) can result in significantly larger fruit by improving flower quality (Patterson et al., 1999). The lack of HC in organics is likely to be a strong drive of smaller fruit. Other factors may also contribute to organic fruit being smaller including canopy differences and less readily available nutrients in the soil. If managed appropriately, Gold vines are capable of producing larger fruit which is reflected by the significantly larger average fruit size for ARGOS Gold.

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 (i.e. premiums) offered for Green, Green Organic and Gold were 40%, 50% and 60% respectively (ZESPRI, 2007, ZESPRI, 2008).

For the 2001 to 2007 period, the ARGOS Gold orchards have consistently had higher dry matter levels because it is a naturally sweeter variety. The average dry matter levels have on average been higher in Green than in Green Organic though the differences have been small in recent years. These differences have been statistically significant (Table **8**). Similar differences have been observed at Industry level.

Since about 2004 there has been a slight increase overall in average dry matter levels of fruit from ARGOS orchards which is consistent with Industry trends (Appendix 3). These increases can be attributed to favourable seasonal factors as well as improved practices (e.g. girdling, more effective canopy management, warming of the orchards through adjustments to shelter) impacting on the final dry matter content of fruit.

2.7 Orchard management

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 to understanding differences in production as well as other orchard characteristics (e.g. orchard biodiversity, soil quality, financial performance, social life). Here we discuss the recent management factors and practices on kiwifruit orchards and the differences between production systems.

Management structures and labour use

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). The majority of orchards in the Industry are owner-operated where the owners (including family) tend to perform most of the work including mowing, spraying, fertilising and pruning (Figure 5). Across the Industry, there has been 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 (Table 9). 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 5. Proportion of orchards in the Industry which are owner-operated, managed and leased. These are the results from a telephone survey of 400 randomly selected orchardists (Brunton, 2007).

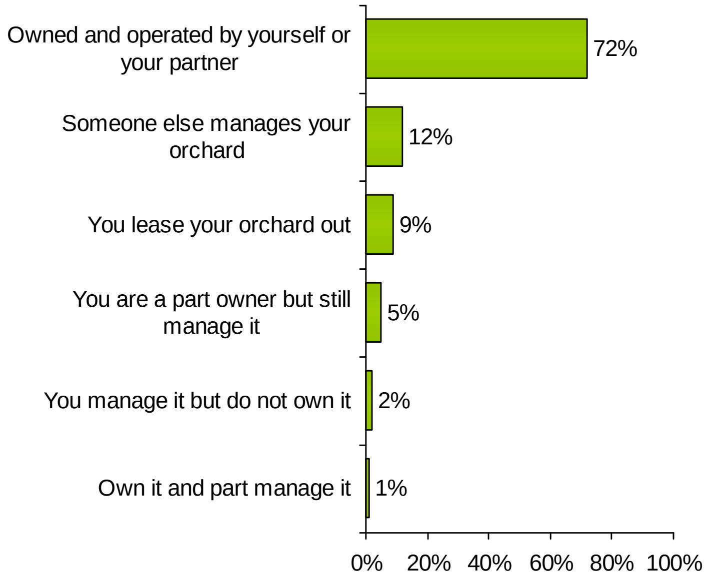


Table 9. Number of owner-operated and managed orchards in the ARGOS programme and the number of orchardists who live off orchard.

	Green	Green Organic	Gold
Owner-operated	9	8	6
Managed	3	4	6
Owners live off orchard	4	2	8

Paid labour

The largest annual cost incurred in growing kiwifruit is cash labour which is primarily used to help with vine and fruit management (i.e. pruning, thinning, girdling and picking). Other labour costs may be incurred for contract mowing, spraying and shelter trimming/mulching.

Quantifying the number of hours paid labour spend on orchards is problematic. The two main reasons for this are:

1) It is difficult for most orchardists to quantify the number of hours they spend actually working on their orchards let alone how much time other people like pruners spend on their orchards. Winter pruning is often invoiced on an area basis rather than hour basis.
2) The operation of kiwifruit orchards is characterised by a high annual dependence on transient contract labour primarily to help with vine management (pruning), shelter trimming and harvesting. Tractor work may also be contracted although many orchardists do this themselves. However, the hours required to carry out activities like winter pruning and picking are not usually recorded because the workers are paid on a contract basis i.e. $ per area/bin.

Because of these significant problems, only crude estimates of time spent working on ARGOS orchards have been obtainable and should be treated circumspectly.

Initially, orchardists were asked to estimate the number of hours spent working on their orchards but the level of wages paid suggested that the number of hours were underestimated (Benge, 2009). Consequently, this approached was abandoned in favour of calculating estimates using cash labour costs presented in orchardists' accounts (these are largely pruning costs but for some orchards will include mowing and spraying hours). The following assumptions were applied in using this approach:

a. The average hourly rate does not differ significantly between production systems.
b. For work that is paid on a per area basis, assume that this works out to be similar hourly pay rate as jobs paid on an hourly rate.
c. Picking – usually paid per bin but assume similar hourly rate to other jobs on the orchard.

Based on the assumptions, and an average cost of approx. $15/hr (which was reported by orchardists to be the hourly rate for summer work), Gold hours were twice as much as Green and Green Organic (Table 10). This difference is due to Gold vines requiring more attention which is consistent with what is generally known about growing the Hort16A variety. Gold orchardists are endeavouring to reduce the vigour of their vines so this difference may close over time.

Table 10. Estimates of average number of hours contractors spent working on orchards in the 2006/07 season. See above text for underlying assumptions. Unbalance ANOVA.

System	Wages (hours/ha)	Picking (hours/ha)
Green	510	150
Green Organic	530	120
Gold	1300	310
F pr.	0.005	<0.001
LSD	315	85

Estimates of paid hours have been supplied here but they are crude. To accurately quantify hours would require timesheets to be completed but this is not really practical. It might be possible to do this with a small number of growers. Nevertheless, there is reasonable evidence that Gold is more labour intensive which is consistent with what is generally known about growing the Hort16A variety which can be more vigorous.

Unpaid labour

The operation of many kiwifruit orchards is characterised by significant amounts of unpaid labour i.e. time the owners (i.e. orchardists) and family spend working on the orchard. Most do not receive a wage and so their financial reward is the orchard profit. Understanding differences in the level of unpaid labour is useful for understanding financial aspects of the operation. For example, an orchardist who carries out a large amount of work on the orchard, unpaid, will have a lower cash wage bill.

Estimates of unpaid labour were obtained as part of the annual management interviews with each orchardist. Hours specifically were not usually provided as orchardists do no record this and was difficult to recollect accurately. Instead, orchardists indicated how many weeks they (and/or family) worked during the year. It was assumed that on average through the course of a year that a week was about 40 hours (based on feedback from several of the growers).

According to our analysis (see Benge, 2009 for more detail), there was no significant difference in the proportion of orchards which used unpaid labour (Table 11; Figure 6). Likewise, the proportion of orchards using unpaid labour did not differ significantly between seasons (Table 11; Figure 7).

Table 11. Significance values for the proportion of unpaid labour used on ARGOS orchards i.e. no significant differences between production systems and seasons. Logistic regression (distribution = binomial, link function = logit).

Fixed term	Wald statistic	d.f.	Wald/d.f.	chi pr
System	1.96	2	0.98	0.375
Season	4.06	5	0.81	0.541
System.Season	19.38	10	1.94	0.036

Figure 6. Average proportion of Green, Green Organic and Gold orchards in the ARGOS programme that used unpaid labour in the 2002/03 to 2007/08 period. Values not significantly different at the 5% level. Logistic regression (distribution = binomial, link function = logit).

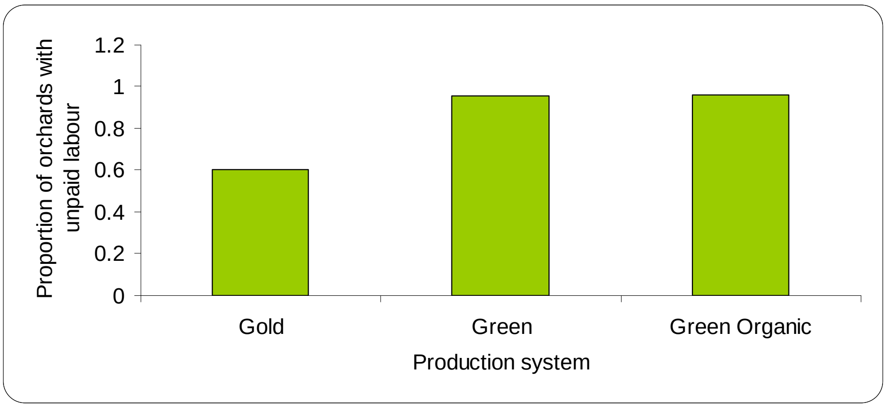
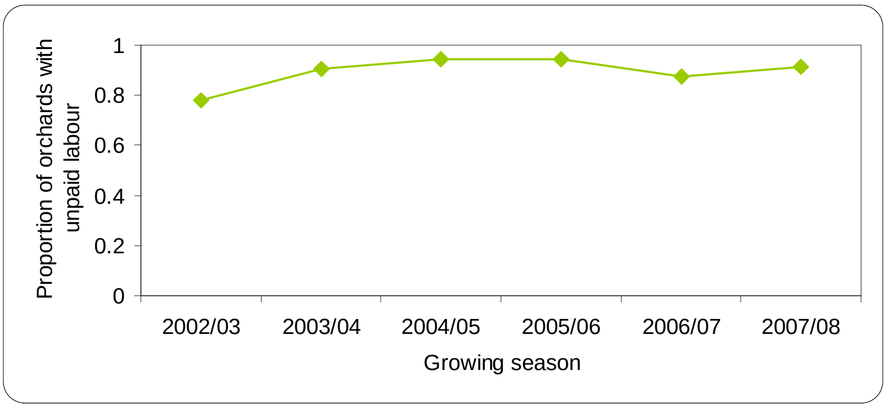


Figure 7. Trend in the average proportions of ARGOS orchards with unpaid labour. Val



According to the ordinary regression (mixed model – REML); no significant difference was found between production systems in the amount of unpaid labour used in a season (Grand Mean = 230 hours/ha) (Table 12; Figure 8). Likewise, no significant difference was found between seasons in the amount of unpaid labour (Table 12; Figure 9). Also, there was no significant interaction effect. There is significant variation within systems which is reflected in large confidence intervals in the graphs below.

Table 12. Output from mixed model analysis (REML) for amount (hours per canopy hectare) of unpaid labour used in a year on ARGOS kiwifruit orchards. No significant differences between production systems and seasons.

Fixed term	Wald statistic	d.f.	Wald/d.f.	chi pr
System	0.71	2	0.36	0.700
Season	6.35	5	1.27	0.273
System.Season	17.68	10	1.77	0.061

Figure 8. Average no. of hours per canopy hectare of unpaid labour used on Green, Green Organic and Gold orchards in the ARGOS programme. Error bars represent 95% confidence intervals. Back-transformed values presented.

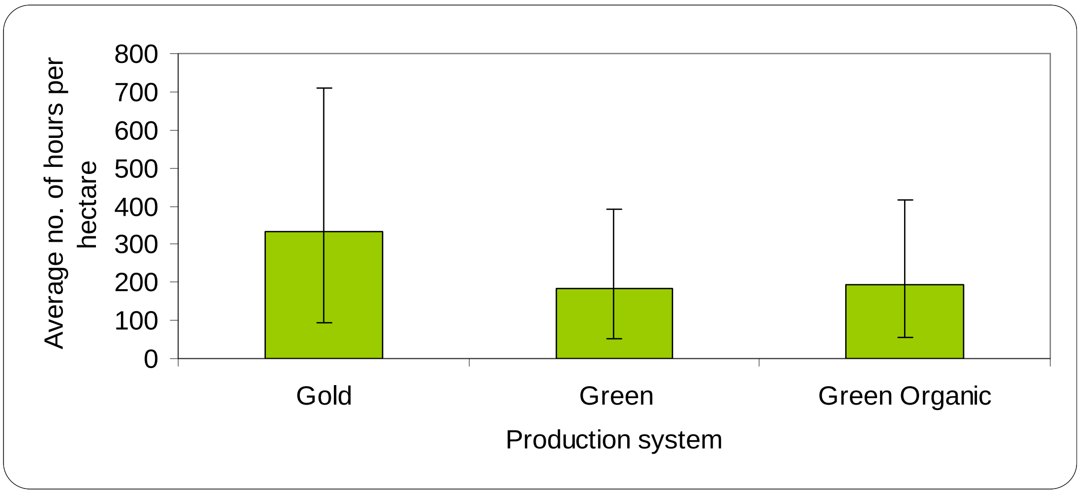
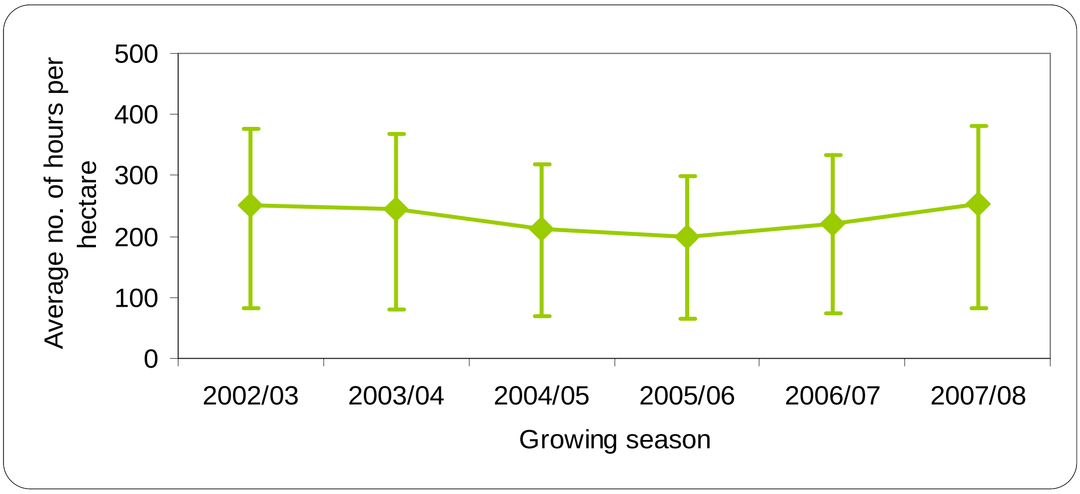


Figure 9. Trend in the average no. of hours per canopy hectare of unpaid labour used on ARGOS orchards. Error bars represent 95% confidence intervals. Back-transformed values presented.



Overall, the average level of unpaid labour in terms of hours/ha did not differ significantly between production systems. That said, there was significant variation in the number of hours per canopy hectare.

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 1980s. Nearly all of the orchards were previously dairy farms with the others having a tobacco (the Motueka orchards) or cropping history.

Orchard practices

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

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

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

Canopy and crop management

Management of the canopy is the largest undertaking on a kiwifruit orchard and for this reason the greatest regular cost. Probably the biggest difference between production systems occurs with the winter pruning of canopy. Winter pruning is the task of replacing last season fruiting wood with new wood to carry the next season's crop. As organic vines are generally of lower vigour, getting complete canopy fill can be an issue especially at wider plant spacing 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 vigorous cane on organic orchards to ensure vines don't "runt out". This is evidenced by significantly more Organic orchardists in ARGOS (Table 13) who are targeting replacement canes rather than lower vigour wood (Green vs Green Organic, P=0.077, Fishers Exact Test, One-tailed).

Table 13. Number of ARGOS orchards with a preference for each major type of pruning system in the 2006/07 season.

	Green	Green Organic	Gold
Low vigour	6	2	7
Replacement cane	3	7	4
Mixed (no preference)	3	3	1

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

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

Trunk girdling
Trunk girdling of vines can often enhance fruit dry matter levels and is now common practice in the Industry because of the potential incentives offered for high dry matter fruit. ARGOS orchardists who were previously reluctant to trunk girdle are now doing so because they feel they have too much to lose financially from not maximising fruit dry matter. The main trends in the use of this tool have been as follows.

Figure 10. Kiwifruit vine with two trunk girdles.

Overall -

- The percentage of ARGOS orchards trunk girdling has increased from 27% in 04/05 to 81% in 08/09.
- The percentage of ARGOS orchards double trunk girdling has increased from 0% in 04/05 to 44% in 08/09.

Panel differences (illustrated in Appendix 4) -

- The percentage of orchards which have trunk girdling (single or double) has been consistently highest for Gold and consistently lowest for Green, with Green Organic intermediate.
- The percentage of orchards double trunk girdling has not differed much between the three systems with the difference being only one orchard each season.
- Double trunk girdling started in 2006/07 for conventional and a year later for organic with the percentages for each system increasing ever since.
- For Green Organic and Gold, trunk girdling has replaced cane girdling. This trend is not so apparent for Green.

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 their conventional neighbours and may not benefit from this situation.

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

Orchard floor management
Control of the orchard sward in kiwifruit orchards is normally achieved mechanically by mowing on average 5 – 8 times a season. The number of times ARGOS orchards have been mowed in recent years has been relatively constant. Organic orchardists on average have tended to mow less often than Green and Gold orchardists suggesting that they can tolerate longer sward.

Crop protection

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

Soil nutrition

The levels of macronutrients (i.e. N,P,K,S,Mg) applied to the soil in ARGOS kiwifruit orchards were estimated using the fertiliser information provided by orchardists. Typically, orchardists pay for someone to analyse the soil fertility and provide fertiliser recommendations. These often list the amounts of macronutrients added. For some products, like composts, the nutrient content was not available and so estimates were used based on published and industry data.

In recent years, Green and Gold orchards have generally applied similar amounts of N,P,K,Mg and S in mineral form (Figure 11). This is not surprising given that research on the nutritional requirements of the newer Gold variety is limited and so the recommendations for Green tend to form the basis. Due to the restriction of inputs, Organic orchards have tended to apply less nutrients in quickly available form particularly nitrogen. Instead, Organic orchards tend to receive large quantities of plant and animal based fertilisers like compost and fish (Table 14). While the nutritional content of these is small (just a few percent) the large quantities applied means potentially large amount of nutrients are applied. The nutrients in organic fertilisers are likely to be released slowly, potentially over several years. Organic inputs like composts are likely to provide other benefits to the soil like increased organic matter and water holding capacity.

Figure 11. Average amounts of nutrients applied to kiwifruit orchards in the ARGOS programme for the 2003/04 to 2006/07 period. The black vertical lines represent suggested annual fertiliser requirements for maintaining yields on established Hayward kiwifruit vines for a 8,000 trays/ha crop published at www.hortnet.co.nz.

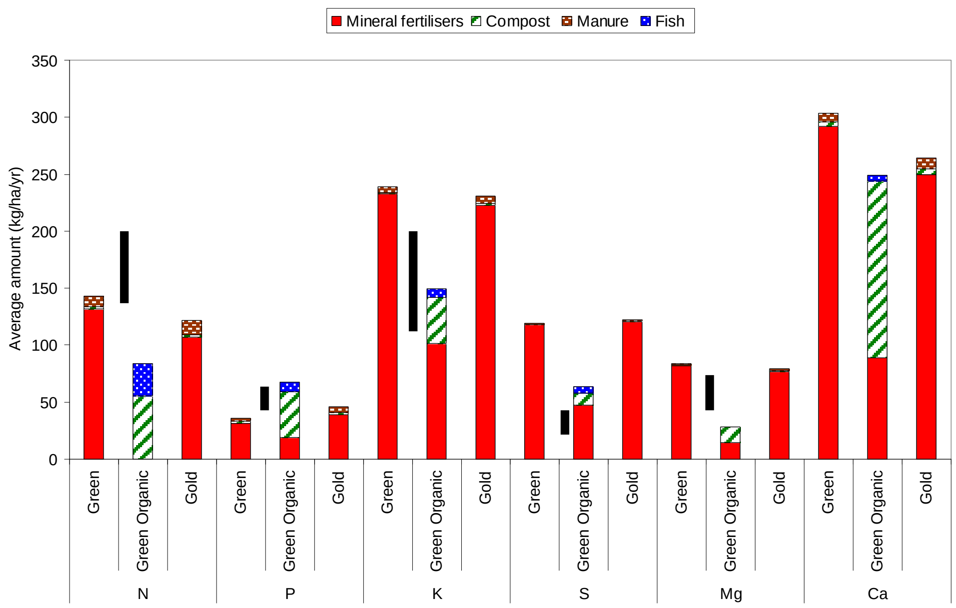


Table 14. Average amounts of organic fertilisers applied annually to kiwifruit orchards in the ARGOS programme for the 2003/04 to 2006/07 period (rounded to the nearest 100).

	Green	Green Organic	Gold
Compost (kg/ha)	200	6,600	300
Manure (kg/ha)	600	0	800
Average of Fish (L/ha)	0	1,000	0

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 () Sop is also commonly applied to Organic orchards as are RPR and Patent Kali.

Table 15. Most commonly used mineral fertilisers on Green, Green Organic and Gold orchards in the ARGOS programme. Average rates (kg/ha/yr) for the 2003/04 to 2006/07 period are shown (rounded to the nearest 50).

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

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

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. 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.

Other practices

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

2.8 Species Influence

For the kiwifruit sector, we were forced to include the Hort16A species (“Gold”) due to a lack of Hayward orchards converting to organic; the original idea was to compare integrated management, organic and converting Hayward. While this provides an opportunity for us to identify the impacts of growing what has become a valuable crop in Hort16A, it makes it challenging for us to isolate the influence of management from the influence of species. Table 16 and Table 17 have therefore been created to help us understand the key species and plant differences so that we can better divine management impacts. Compared to

Green, Green Organic vines tend to be less vigorous and fruitful while Gold is a more vigorous and fruitful species altogether.

Table 16. Main differences in the growth and behaviour of Organic Hayward compared to Conventional Hayward, and the associated management implications or compensations. These are based on industry data and observations.

		Purported organic differences	ARGOS results	Management implications / compensation
Production	Cropload (fruit number)	Inconsistent flower and fruit numbers from year to year due to lack of an effective budbreak agent. Other factors are likely to contribute but not well understood.	Consistent with this.	Differences in canopy management – more wood may be tied down in the winter. Trunk Girdling is providing more reliable return bloom (flower numbers in the following season) but comes at the cost of more poor quality flowers that require thinning.
	Fruit size	Smaller. Contributing factors thought to be lower nutrition availability (especially N), wood quality, weather and pollination	Consistent with this.	More fruit removed during thinning. Greater need for markets willing to pay for smaller fruit.
	Dry matter %	Consistently lower for the organic orchards.	Consistent with this.	Seasonal influences due to later vine development can influence dry matter in some years.
Vine/fruit characteristics	Fruit physical characteristics	No difference.	Not measured.	
	Phenology i.e. the timing of budbreak, flowering, shoot growth	Events generally occur 2 - 4 weeks later than conventional Hayward.	Not measured.	Later management practices. Shorter growing season in which to meet fruit size and dry matter targets
	Flowering	Prolonged flowering produces more variable flowering and flower quality i.e. more multiples. Later flowering often encounters poorer weather.	Not measured.	More thinning. May not get the best hive quality as can get "hand me downs" from the earlier flowering conventional orchards.
	Vine vigour	Less vigorous.	Not measured.	Low vigour systems are used less because they are considered incompatible with organics although this may stem from poor understanding of the appropriate wood type to target. Some organic growers are moving towards low vigour because it may deliver larger and better quality fruit because of less canopy which would otherwise be present in a replacement cane system.
	Nutritional requirements	No difference in nutrient requirements but mineral fertilisers restricted particularly N.	Consistent with this.	Greater emphasis placed on enhancing soil biology and organic fertilisers to make soil nutrients more available.
	Crop protection	No fungal problems - thought to be due to greater natural protection. Scale pressure generally higher.	Not measured.	No fungicides applied. Greater use of oils for scale requires good operation and timing. Better suited to a grower doing own spraying than reliance on contractor.
	Fruit storage quality	Less storage problems which may be due to better postharvest management rather than any inherent fruit quality differences. Historically, a few selected facilities have packed organic fruit.	Not measured.	Some lines may be stored for longer which increases risk of quality problems and fruit loss.

* Thanks to Shane Max of ZESPRI and Ross Haycock of CropLink for their input.

Table 17. Main differences in the growth and behaviour of conventional Hort16A compared to conventional Hayward, and the associated management implications or compensations.

		Purported Hort16A differences	ARGOS results	Management implications / compensation
Production	Cropload (fruit number)	Higher.	Consistent with this.	Stronger growing structures required to carry extra fruit.
	Fruit size	Naturally smaller than Hayward but managed appropriately can be larger.	Consistent for managed situations.	Tray size is 3.4kg v 3.6kg for Hayward. Fruit size is very sensitive to biostimulants therefore widely used but at the expense of dry matter.
	Dry matter %	Higher.	Consistent with this.	Industry is failing to provide enough high DM fruit to meet market requirements.
Vine/fruit characteristics	Fruit physical characteristics	Golden fleshed, sensitive skin, no hair and pronounced beak at distal end of fruit (a source of physical damage).	-	More prone to physical damage and so greater care and less speed is required during picking and grading, thus more expensive. Smaller window in day to pick fruit so picking often occurs into the night. Skin more prone to spray damage so greater care required to ensure spraying occurs in the optimum conditions.
	Phenology i.e. the timing of budbreak, shoot growth and flowering	Events for conventional Hort16A generally occur 3 – 4 weeks earlier than conventional Hayward.	Not measured.	Earlier management practices. Higher frequency of frost protection required. Harvesting is generally started and completed before Hayward.
	Vine vigour	More vigorous and characterized by both primary and secondary growth during the vegetative phase. Hayward has a greater degree of apical dominance and does not exhibit secondary growth from primary shoots. Vegetative growth and extension of long canes continues for a longer period into late summer than is characteristic for Hayward.	Not measured.	Greater need for summer canopy management and thus greater cost. Various growing systems being trialled to find a lower cost way of growing.
	Nutritional requirements	Little scientific knowledge on optimum requirements for Hort16A. No obvious difference in the amounts of macronutrients applied.	Consistent with this.	The amount of N applied to Hort16A may have declined in recent years to avoid stimulating too much unwanted canopy growth.
	Crop protection	Earlier budbreak and flowering on Hort16A exposes fruit for longer to invasion by scale crawlers. Only one scale species can develop on Hort16A fruit (Greedy scale) so less scale pressure on Hort16A. Less susceptible to Sclerotinia rot. More susceptible to on vine and storage rots.	Not measured.	Budbreak applications occur earlier on Hort16A so don't get same problems of spray drift anxiety because weather is better. Also, there is much less Hort16A to spray in the Industry. Hayward sprays applied later when conditions can be more marginal. Earlier flowering may coincide with preflowering sprays on Hayward which may create issues of bee poisoning.

		Hort16A is slightly less susceptible to leafroller attack.		There may be less need to spray for leafroller.
	Fruit storage quality	More prone to storage problems. Shortage storage life and greater level of fruit loss.	Not measured.	Different storage requirements i.e. higher storage temperature (1.5 v 0°C). Most fruit picked before fully mature and conditioned at 5-10°C to allow fruit to colour up. This may predispose fruit to more storage problems.

2.9 Financial performance

At the farm or orchard level, we have now collected financial accounts for five consecutive years (2002/03 to 2006/07). Each year's data have been analysed to provide information to ARGOS farmers and to compare the performance of these farms with regional and industry benchmarks. These data are also being analysed to determine trends over time, as well as systematic differences amongst farms. The results to date are presented below.

ARGOS has used a similar template to that used by the Ministry of Agriculture and Fisheries (MAF) for presenting its financial data so that comparisons can be made if required. More detailed MAF Farm Monitoring data can be downloaded from the MAF Website (**www.maf.govt.nz**).

The majority of the Gold orchards also have Green kiwifruit. The results here for Gold pertain to the four orchards which grow only Gold as financial data for the mixed orchards were not available by variety.

Production

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

Orchard gate revenue (OGR) per ha

Despite the consistently higher average yield of Green compared to Green Organic, the average OGR/ha has been slightly higher for Green Organic (Figure 12) though the difference has not been significantly different. The lower yields of Green Organic have been offset by the higher OGRs/tray which on average have been 50% higher between 2002/03 and 2006/07; this difference is consistent with the average Industry differential of 50% between 2002 and 2007 (ZESPRI, 2008). The average OGR/ha for Gold has been higher than both Green and Green Organic because of higher yields and/or tray returns.

Orchard working expenses (OWE) per ha

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

Cash operating surplus (COS) per ha

The average COS/ha has been higher for Green Organic compared to Green which reflects the higher average revenue and lower expenses for Green Organic. The averages however have not been significantly different. The average COS/ha for Gold has not differed from that of the other systems however this is based on data from 4 of the 12 Gold orchards being studied. We propose to analyse this data in a different way to try and draw in the Gold orchards which also have Green but which don't have separate data for each variety.

Orchard equity

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

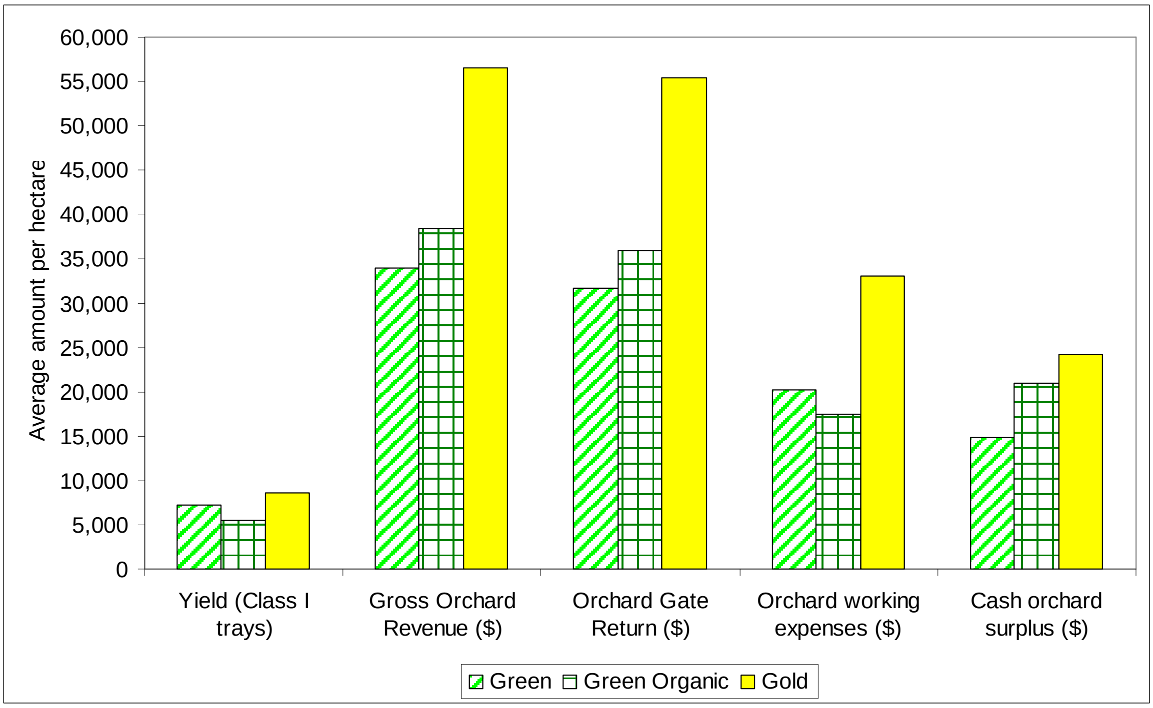
Relationships between expenditure and revenue

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

Summary

On the whole, Gold is the most different system in terms of operating performance due to greater OGR (a result of higher yields and/or returns per tray) and also greater growing costs (mainly due to the greater labour costs required to manage a more vigorous canopy). Despite Green's higher yields, statistically, Green and Green Organic have not been different in terms of total revenue and total expenditure (per ha). Variability in the financial data and small sample size (i.e. statistical power) may be limiting our ability to detect significant differences and this is something we are currently exploring.

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



2.10 Energy use

The energy associated with production was quantified for the 2003/04 season. The average values are presented in Appendix 5. The full results were presented to ZESPRI (Barber and Benge, 2006)

> The only kiwifruit energy indicator that was statistically significantly different (at the 5% level) between management systems was fertiliser use. This is largely because of the influence of high energy inorganic nitrogen fertiliser, of which organic orchards do not apply any. Agrichemical use was not significantly different due to the high use of biological control agents and oils on the Organic orchards in substitution for the lower volumes but more energy intensive conventional agrichemical applications used in the Green and Gold orchards.

None of the orchard management systems had significantly different total energy indicators. On average, Green Organic had the lowest energy intensity at 36,000 MJ/ha, with the Green and Gold panels being on average 17% and 29% higher. However the order reversed when expressed per unit of fruit. Gold orchards had the best (lowest) energy productivity at 4,670 MJ/1,000 trays (with a 95% confidence interval of ± 1,240); Green and Green Organic orchards were 9% and 58% higher. Removing the use of a helicopter for frost protection from one Gold orchard further improves the energy productivity of the Gold orchards to 4,310 MJ/1,000 trays.

2.11 Summary

This section has documented the key production and management features of the kiwifruit production systems (Green, Green Organic and Gold) being studied by ARGOS with a particular emphasis on the most recent growing season (2006/07). Not surprisingly, there have been significant differences in production between the systems which have been in part driven by differences in key orchard practices. This current knowledge along with future data collected by ARGOS will be used alongside the environmental, social and economic features of these systems to help identify pathways for sustainable kiwifruit production. A future focus for ARGOS's orchard management objective will be to explore relationships between the management inputs and production outcomes described in this report.

3. Sheep/beef

3.1 Production systems

The ARGOS sheep/beef farms are spread across the South Island reflecting the main MAF sheep/beef farm classes with 12 clusters of 3 farms representing the following management systems ("Panels"):

- Certified Organic Production
- Integrated – complying with a quality assurance programme that involves production under some management constraints to produce animals for a targeted market specification
- Conventional

Conventional farms use contemporary land management practices. The certified organic farmers comply with either the BioGro or AsureQuality organic production standards – both of these standards align with the world organic body, IFOAM, organic standard norms. 'Integrated' is used to indicate systems that follow specific market based audit schemes that restricts/controls the use of certain inputs. Farms following 'integrated' management practises tend to be much more product specification focused and are audited on certain management practices depending on the market the sell into.

3.2 Farm selection

The process used to select and recruit farms was the same as for the ARGOS kiwifruit orchards as shown in figure 2.. It was apparent, in the early part of selection that there were a limited number of organic sheep/beef properties and these were approached first and subsequently matched with conventional and integrated farms that were in close geographical proximity to the organic farms, whilst still retaining a distribution of clusters across the South Island. Out of 76 people interviewed, 1 did not want to be involved due to perceived time constraints and another wanted to be paid for his time and intellectual property.
Additional selection criteria to minimise cluster and panel variations included:

- Non organic farms had to be clients of the meat packing company partner in this project.
- Similar size
- A typical farming business for the area
- Selection of farms in a cluster within the MAF farm class

Farms were chosen to align align with the main MAF Farm Monitoring farm classes to assist with broader extropolation of the ARGOS results. . Table 18 shows the number of ARGOS farms in each of the MAF monitoring classes, whilst Table 19 illustrates similarities between ARGOS and MAF monitoring farms.

Table 18. Relating clusters of ARGOS sheep/beef farms to MAF Farm monitoring types.

Cluster Number	Location	MAF Farm Monitoring Type	Code
1	Marlborourgh,	Dryland hill sheep/beef farms	MFM1
2	North Canterbury	Dryland hill sheep/beef farms	MFM1
3	Canterbury, Banks Peninsula	Dryland hill country, low rainfall	MFM1
4	Canterbury, Selwyn	Irrigated, intensive mixed arable	MFM7
5	Canterbury, Highbank/Methven	Dryland mixed cropping farms	MFM2
6	Canterbury, Ashburton, North East	Irrigated, intensive stock production	MFM7
7	Canterbury/Nth Otago, McKenzie	Dryland, intensified extensive	MFM3
8	Otago, Outram	Hill country, dryland, intensive	MFM3
9	South Otago, Owaka	Dryland rolling hill	MFM5
10	Western Southland, Gore	Dryland rolling hill	MFM5
11	North Otago, Oamaru	Dryland rolling hill	MFM3
12	South Canterbury, Waihaorunga	Dryland rolling hill	MFM3

3.3 Physical characteristics of farms

The ARGOS Sheep/Beef farms cover a total of 14,346 hectares, carrying 119,000 stock units, in twelve locations from Blenheim to Gore. Farm sizes range from 145 to 1370 hectares, with a mean size of 340 hectares. Rainfall ranges from approximately 400 to 1100 mm/yr. The farms have similar overarching farming strategies in that their management is based around pastoral based systems with varying degrees of cropping. Cropping types range from fodder to cereal to small seeds production, mainly in mid Canterbury to predominantly fodder crops in Southland. Livestock production on most farms is predominantly lamb sales with 2 farmers mainly bull beef.

An overview of the farms under each production system is presented in Table 19. Total farm hectares, effective hectares, sheep stock units (SU), cattle SU, and the proportion of sheep SU to total SU were not statistically different between systems. The statistically significant differences were:

- Stock units per hectare was least on the organic farms.
- The mating weight and lambing percentage for organic farms was significantly less than the integrated farms (but not the conventional farms).
- Integrated farms had the highest percentage of effective area (at 10% significance level) although the difference was small i.e. only 5% (96 vs. 91%).

Table 19. Average features of ARGOS sheep/beef farms under different management systems for the 2004/05 to 2007/08 period. Unless stated otherwise, means are predicted values from unbalanced ANOVA. Where values are significantly different at the 5% level, values with a row with the same letter are not significantly different.

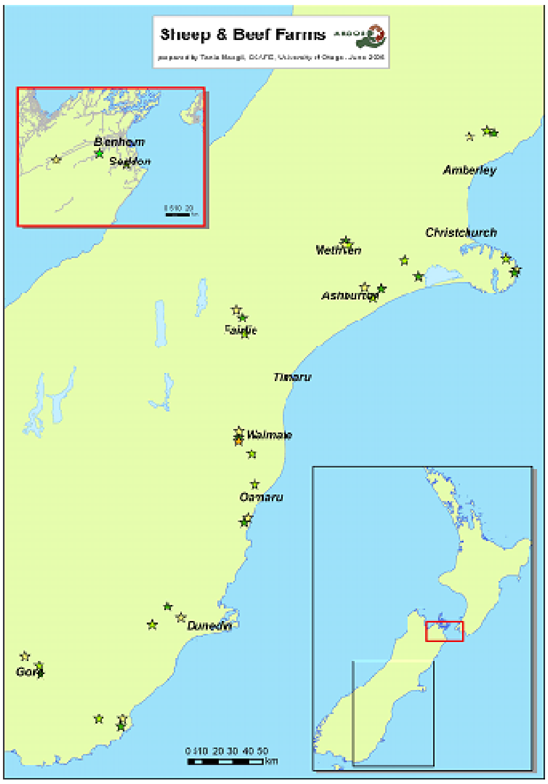
	Organic[2]	Integrated	Conventional	Overall average	Significance	MAF
Total farm hectares[1]	358	400	468	409	ns	
Effective hectares[1]	325	387	430	381	ns	519
% effective area[3]	91 a	96 b	92 a	93	0.054[4]	
Sheep stock units (SU)	2383	3404	2987	2924	ns	3573
Cattle SU[1]	758	731	1130	873	ns	937
% sheep SU to total SU	78	78	73	76	ns	79
SU / ha	8 a	12 b	11 b	10	0.006	9
Lambing %	123 a	141 b	130 ab	131	0.079	129
Mating weight (kg)	63 a	70 b	67 ab	67	0.003	

[1] Data log-transformed prior to analysis. Back-transformed values presented here. [2] In cluster 12, original organic farm replaced. Data for new organic farm only included here. [3] Actual means presented. [4] Data analysed using non-parametric test (Kruskal-Wallis one-way analysis of variance); Chi-square p-value presented.

3.4 Farm locations

The ARGOS sheep/beef farms are distribution through the South Island of New Zealand, mainly along the eastern side (Figure 13).

Figure 13. Location of ARGOS Sheep/Beef Farms.



3.5 Farm production

The quantification of production outcomes on the AGOS sheep and beef farms has proven to be complex with large variability between farms. This is a reflection of the many management options available to the sheep and beef farmers like the ratio of sheep to cattle, the extent of livestock trading and the extent of cropping. However, ARGOS has completed a detailed analysis of all stock sold including store stock as well as meat company killing sheets, and some of the variables in these datasets can be used for comparing management systems, in particular overall meat production, mean carcass weights and occurrence of meat quality defects.

Meat production

Initial analyses through to the net output in kilograms per hectare is shown in Table 20 below and indicates the variability between panels over 3 years. Reasons for this variability include changes to stock policy (market forces, climate, general fine tuning etc) and land size (buying, selling) at the farm level.

Table 20. Net kilograms of meat exported per hectare from Sheep/Beef properties in the ARGOS project

	2006/07	2007/08	2008/09	Average all years
Organic	39	75	104	73
Integrated	143	109	147	133
Conventional	82	169	61	104

Three years of meat sales (**Figure 14**) suggests some subtle differences between panels with the Organic panel sending lambs later than the other two management panels, but appear to have sold the bulk of meat before the winter.

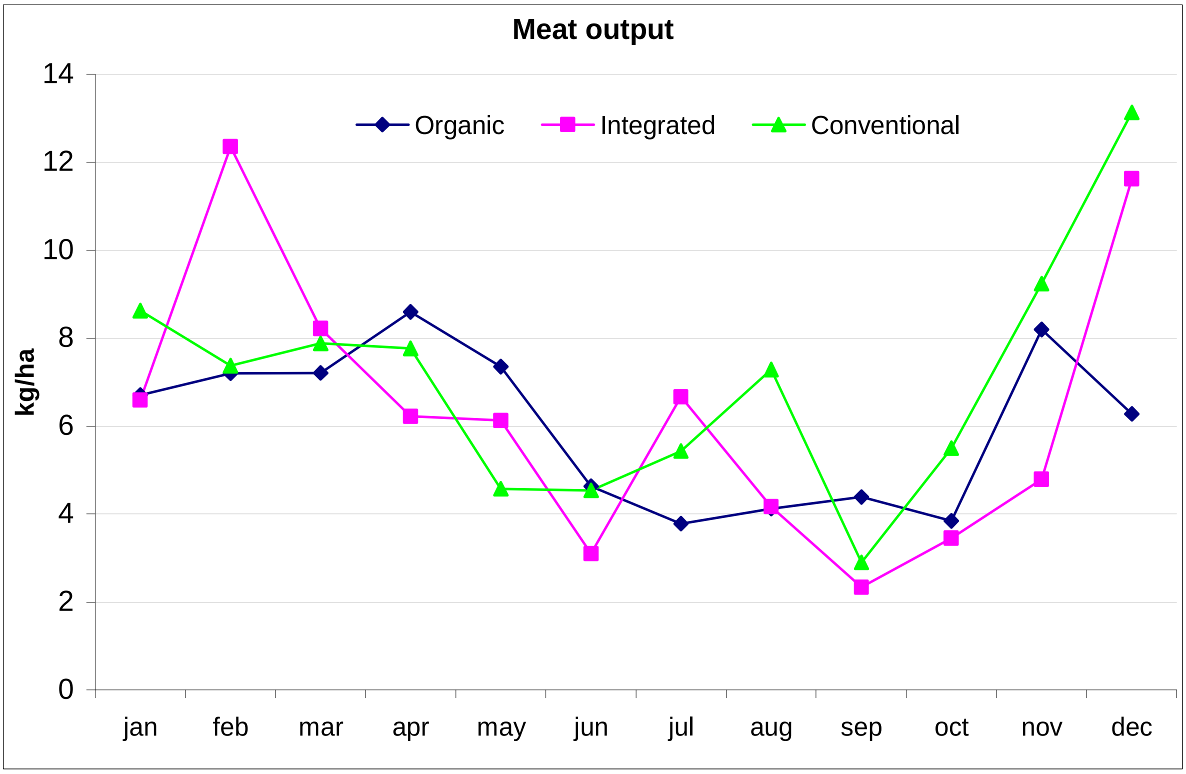


Figure 14. Three years of meat output per month data for Organic, Integrated and Conventional farms in ARGOS

This is less subtle when lamb meat only is assessed. **Figure 15** shows a more level lamb meat output line than the other 2 panels suggesting that Organic farmers destocked their cattle pre-winter. The Integrated panel appear to farm to the grass market with the majority of their sales through the spring to autumn period.

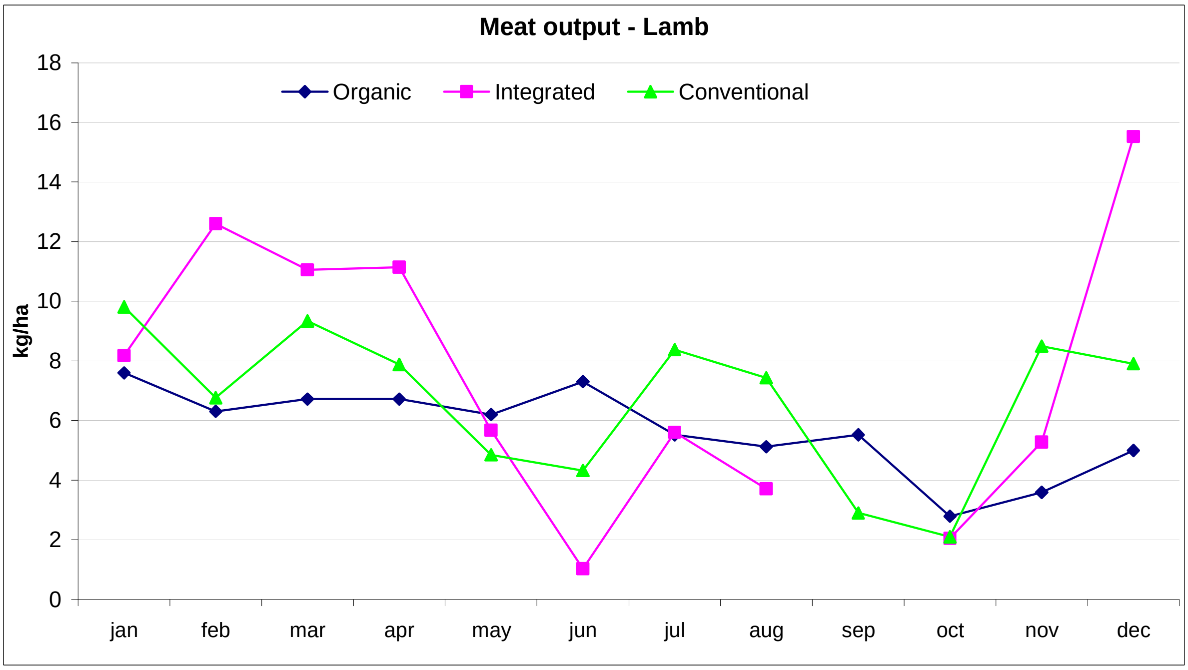


Figure 15. Three years of Lamb meat output per month for Organic, Integrated and Conventional farms in ARGOS

Average lamb weights

The organic lamb carcass weight is on average 1.2 kilograms lower than integrated farmers and 1.8 kilograms lower than the conventional counterparts. The results are not surprising as the organic farmers in general have lower growth rates and the integrated farmers have tighter contract specifications on carcass weight.

Table 21. Average lamb carcass weight (kg) for ARGOS sheep/beef farms.

	05/06	06/07
Organic	16.0	16.0
Integrated	17.2	17.2
Conventional	17.8	17.7
P	<0.001	
LSD (5%, max)	0.67	

Lamb quality defects

The analysis of the killing sheet data also provided an opportunity to observe whether there are any trends in relation to the frequency of diseases recorded at the time of slaughter. The diseases that are recorded can be grouped into 2 main groups:

1. Respiratory diseases – Pneumonia and Pleurisy, which can become infectious (within body) and contagious (from one body to another).
2. Inflammatory diseases – Pyogenic lesions and Peritonitis that are not contagious.

Ten percent of lamb carcasses (from a total of 90,000 lambs) were identified as having some type of a disease. Not all of these diseases have a negative impact on carcass quality, i.e. not all of the carcasses were downgraded. However, working on the theory that for every clinical sign of disease there are an increased number of sub-clinical diseases, any disease will impact negatively on the efficiency of lamb production, e.g. through decreased growth rates.

Preliminary studies show that as each killing season progresses there is an increase in diseases such as: Pneumonia, Pleurisy, Pyogenic lesions and Peritonitis. Additionally the results suggest that mixed cropping farms have an increased incidence of respiratory disease compared with pastoral farms.

An initial analysis does not suggest any linkage between respiratory and inflammatory disease levels, though there could have been commonality in the respect that they can be linked to farm management practices, geography (including soil type and pasture cover) and climate.

3.6 Farm management

An annual visit and survey is undertaken with all the farmers and includes establishing an understanding of approaches to farm management, any changes in management practice and where possible an assessment of the relative impact of the management practice.

Parasite management

Internal and to a lesser extent external parasite can have a very significant impact on animal productivity so insights into management practices is important. Management strategies by ARGOS farmers varied according to their management style, and their philosophy towards chemical inputs. For internal parasites, Organic farmers used little or no drenches, depending on the markets their lambs were destined for. They used other strategies to decrease the impact of worms such as:

- Utilising other classes of stock to 'vacuum' potential worm burdens.
- Creating paddocks with very low worm burdens; this may be through:
    - Grazing ex silage or hay paddocks with lambs
    - Growing fodder crops (typically Brassica crops) to finish lambs on.
- Sending lambs off the property at a lower weight as shown in Table 21
- Those that had the option of a single drench did so at the perceivable optimal time.
- Decreased the stocking rate to decrease the worm burden
- Grazed pastures to a higher residual.

Non organic farmers mainly used anthelmantics to manage intestinal parasites and used some of the practices listed above, to varying degrees, to reduce their use of anthelmantics.

The release of an ecto-parasiticide has given organic farmers that can show a requirement to treat- an effective control for external parasites. Organic farmers tend to use shearing as another strategy to minimise the impact.

Table 22 shows internal and external parasites that farmers in ARGOS regarded as their greatest threat to their farming business. In total 17 farmers regarded round worms as their greatest threat, whilst tapeworm was relatively easier to control. Round intestinal worms are of the Trichostrongyloid family, and include Nematodirus, Ostertagia, Haemonchus contortus, Dictyocaulus arnfeldi. Twelve farmers based their decision to drench on visual assessments, 4 farmers drench to a calendar system (eg once every 4 weeks) and 8 monitored first to see if drenching was necessary.

Table 22. Parasite threats to production for the ARGOS sheep/beef farms.

		Organic	Integrated	Conventional
Which internal parasites are your greatest threat?	Round worms	4	4	9
	Tapeworms	1		
	None			1
	Resistant worms		1	
	Don't know	3	2	1
Do you faecal egg count?	Yes	7	6	3
	No	2	5	6
Which external parasites are your greatest threat?	Fly	4	6	5
	Lice	6	4	5
What is your basis for decision to drench	Visual	1	3	8
	Calendar		2	1
	Monitor	3	2	3

Human dimensions - management style

There are a range of possible processes that could be used to assist farmers to systematically review their farming operations, identify areas for improvement, plan appropriate actions and implement these. A review of the potential value and effectiveness of various planning processes has been undertaken to establish their potential for facilitating the adoption of best management practices identified by ARGOS and the establishment of more sustainable farming systems. A further analysis of the differences between ARGOS farms and their approaches to business planning and operation are outlined in the Social Objective synthesis report.

Farm labour

The amount, type and source of labour inputs on sheep/beef farms vary greatly between farms and have changed significantly overtime. Table 23 describes the number of hours worked to manage the farm workload. This includes the number of hours worked by paid and unpaid workers. The total hours required to manage the farm from a ‘labour only’ perspective are presented along with the labour hours per 100 hectares and labour hours per 1000 stock units. The number of hours that contractors spend on the farm is then added and this is broken down to a weekly basis. It should be noted that this only includes the ‘number of hours’ that contractors worked and does not include work that they did on a per hectare basis. Labour plus contractor hours were then added together to arrive at the total hours spent working per 100 hectares and per 1000 stock units.

Table 23. Labour, contractor and total hours worked (on average) comparing farms under different management systems and all ARGOS farms.

Farm Labour	Organic	Integrated	Conventional	All Argos farms
Total farm area	383	493	496	453
Labour hours/week	37	37	34	36
Labour hours/week/100ha	12	10	8	10
Labour hours/week/1000s.u	20	9	9	13
Contractors-Hours /year	40	97	38	58
Contractors-Hours /week	0.8	1.9	0.7	1.1
Total (Labour + Contractor)-hours/week	38	39	35	37
Total hours/week/100ha	12	10	8	11
Total hours/week/1000s.u	20	10	9	13

It should also be noted that the figures used were derived from estimates only. However, it is still a constructive way to assist in the analysis of an important part of the farm system.

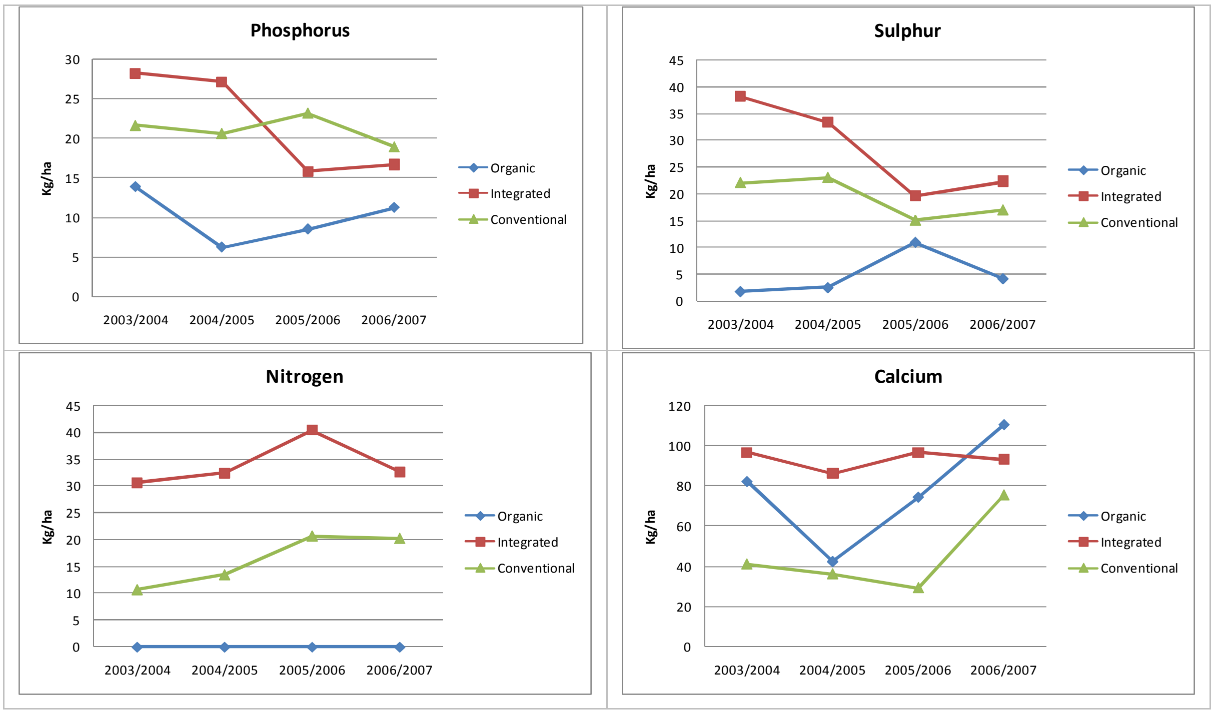
One third of ARGOS sheep/beef farms employ fulltime labour and the balance have a diverse range of systems in place to manage their workload. This ranges from part time labour to contractors doing some or almost all farm work. Managing the workload can have a financial impact on the profitability of the farm and there is often a balance required between how much time the farm owner can spend working on the farm and social and long term economic consequences if not enough time is spent away from farm work. Therefore, the system that farmers adopt to manage their workload, is one that requires careful consideration.

Fertiliser inputs

Surveys of the timing, volume and types of fertiliser have been undertaken in 2004, 2005, 2006 and 2007. Tonnage, type of fertiliser purchased, and the application rate has been broken down to a nutrient per hectare basis for each of the four years. Figure 16 shows trends in the average kilograms of macronutrients (nitrogen, phosphate, potassium, sulphur, calcium and magnesium) applied on the ARGOS farms while Table 24 shows the results from statistical analyses.

Organic farmers theoretically have access to all of the macro-nutrient inputs; however they are typically in another form. Organic farmers applied less macro-nutrients than non-organic farmers (with the exception of Ca). Conventional applied less S and Ca than integrated farms.

Figure 16. Fertiliser input per hectare on the ARGOS sheep/beef farms, from 2003 to 2007



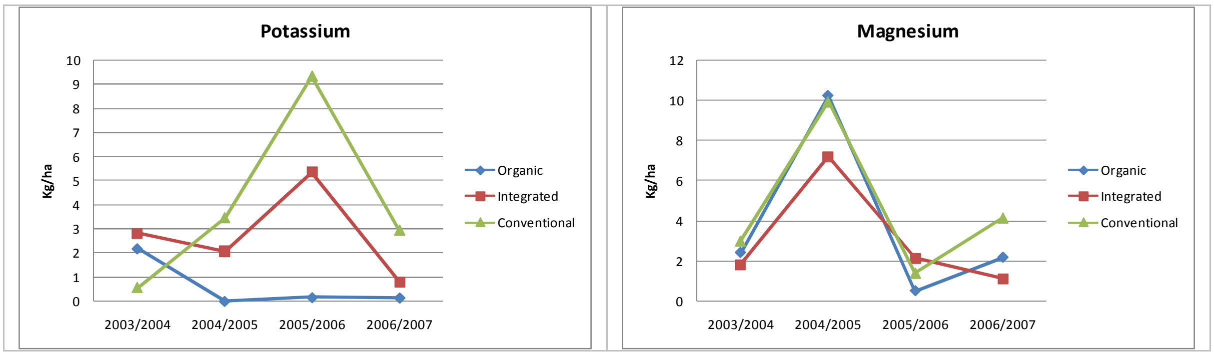


Table 24. Average amounts (kg/ha) of macro-nutrients applied annually to ARGOS sheep and beef farms for the 2003/04 to 2006/07 period. Values are predicted averages from statistical models. Within each column, values with the same letter are not significantly different at the 95% level.

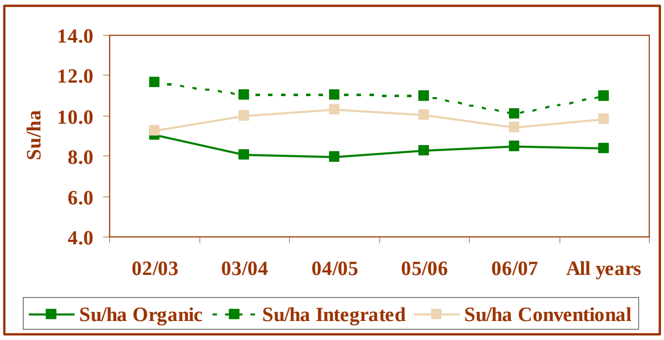
	N[1]	K[1]	Mg[2]	P[3]	S[3]	Ca[3]
Organic	0	0.7	1.2	10.2 a	5.1 a	78 a b
Conventional	14.6 a	4.1 a	0.4 a	22.0 b	19.9 b	49 a
Integrated	13.2 a	1.5 a	0.6 a	23.2 b	29.7 c	87 b
P (Mgmt)	0.849	0.173	0.194	0.022	<0.01	0.063
LSD	3.0	4.5	2.75	9.78	8.26	33.08

1. Only conventional and organic included in analysis. Log transformation required prior to analysis. REML applied (fixed model = management system; random model = cluster).
2. Only conventional and organic included in analysis. Log transformation required prior to analysis. ANOVA applied (treatment = management system; block = cluster).
3. All three systems included. ANOVA applied (treatment = management system; block = cluster). No transformation required.

Stocking rate

The organic farms have the lowest stocking rate. This could be a result of a number of factors including the restrictions on fertiliser use (in particular Nitrogen), impact of less effective control of internal parasites etc. Interestingly the integrated systems have a higher stocking rate than the conventional farmers indicating that these farmers are running a system of slightly higher intensity.

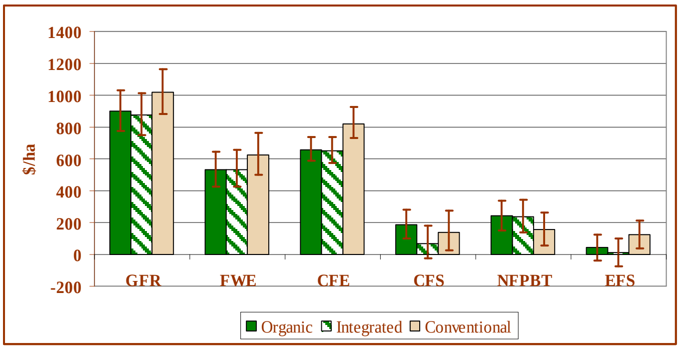
Figure 17. Trends in stocking rates for ARGOS sheep/beef farms.



3.7 Financial performance

The graph below provides a snapshot of the financial performance of the 3 management systems being studied. For further details please refer to the Economics Objective Synthesis report (www.argos.org.nz).

Figure 18. Financial aggregates for ARGOS sheep/beef farms for the 2006/07 year.



3.8 Energy use

There are several key drivers for wanting to improve our knowledge on energy efficiency and related climate change issues:

1. To improve profitability - identifying ways to enhance overall energy efficiency and decrease energy input costs (particularly as energy costs continue to soar)
2. Market access issues – the amount of energy required to produce and transport food (food miles) is emerging as a potentially significant issue in relation to access of some markets e.g., European Union.
3. To identify possible strategies for farmers to respond to regulatory signals for improvements in energy efficiency

An energy audit of ARGOS sheep/beef farms was carried out for the 2003/04 season. Sheep and beef farms are extremely complex and unlike dairy farms or kiwifruit orchards, where there is just one dominant output, a large number of livestock and crop mixes need to be taken into account. The analysis does not take cropping outputs into account.

Total energy use, including not only fuel but the energy embodied in the manufacture of all farm inputs, particularly nitrogen fertiliser, is an important measure of a farms overall sustainability. Benchmarking performance can highlight areas for improvement (particularly around irrigation efficiency and tillage practices) as well as gaining a better understanding of the on-farm environmental impact compared to other parts of the food chain, for example, transport and processing.

- Direct energy is that energy used directly by the operation and is most easily recognised as energy e.g. diesel, petrol and electricity.
- Indirect energy is that energy which is embodied in agrichemicals and fertilisers. Indirect energy is calculated using previously determined coefficients. For example, the production of nitrogen fertiliser requires large quantities of energy for its synthesis from natural gas which must be included in a farms overall energy use in order to determine the true total energy input.
- Capital energy is that energy in structural material form, such as machinery, fences and buildings.

It is important to know the total energy use (the sum of the direct, indirect and capital energy) to get a true picture of the energy flows in and out of the farm. This data is then available for comparing farm performance between similar farms and between growing systems e.g. conventional versus organic or internationally between countries.

Energy intensity

This is measured as the energy input per hectare, per stock unit or per dollar of revenue. The average organic farm had the lowest energy intensity, with the integrated and conventional farms being higher. The only indicator that was significantly different between the systems was indirect energy, largely because of the influence of inorganic nitrogen fertiliser which organic farms do not apply. Direct and capital energy intensities were similar across all farm management systems, particularly once the variation caused by cropping was removed.

Table 25. Energy intensity values for ARGOS sheep/beef farms excluding a high input/output cluster (cropping cluster).

Indicator	Average, 95% confidence interval and (median)		
	Organic	Integrated	Conventional
Total energy MJ/ha	2,650 ± 990 (2,300)	4,590 ± 1,780 (3,970)	3,740 ± 1,780 (3,540)
Total energy MJ/s.u.	370 ± 170 (240)	410 ± 140 (360)	340 ± 200 (260)
MJ/$	4.1 ± 1.5 (3.6)	5.8 ± 1.6 (4.8)	5.2 ± 1.7 (5.0)

Energy productivity

This is measured as energy use per tonne of wool and per tonne of sheep carcass weight. Wool production, based on a share of the farm revenue is allocated almost the same proportion of energy inputs across all the farm management systems being between 11 and 12%. Table 26 shows that while organic farms have the best energy productivity it is not significantly different from the other two farming systems. Organics median value however is almost half the median integrated and conventional farms.

The significantly lower sheep productivity on the organic farms results in them having very similar energy productivity as the integrated farms and 34% higher than the conventional farms.

Table 26. Energy productivity values for ARGOS sheep/beef farms.

Indicator	Average, 95% confidence interval and (median)		
	Organic	Integrated	Conventional
Total energy MJ/t wool	11,170 ± 3,860 (7,870)	15,680 ± 3,680 (14,240)	15,780 ± 5,830 (14,220)
Total energy MJ/t sheep carcass weight	16,000 ± 5,010 (14,180)	15,600 ± 4,270 (14,740)	11,300 ± 4,410 (10,450)

Overall the energy input per hectare is lower on organic farms compared with integrated and conventional systems, however on a produce output basis, all three management systems are very similar.

3.9 Summary

This section has documented the key production and management features and results for the three sheep and beef management systems researched in the ARGOS sheep and beef sector. In relation to production – the diverse range of farm enterprises does make it difficult to obtain accurate comparative production results however some are identified and these show differences between panels. This includes the results from the energy comparison. Core farm management activities such as lambing, shearing and grazing management are similar across all ARGOS farming panels, however there are differences in relation to how farmers in the different panels manage parasites, weeds and soil health as well as how much labour is used are identified. These differences tended to be The ARGOS management data of the Sheep and Beef farms clearly highlights the large variability between systems but also within systems. On some key management variables the variability within a panel e.g. organic is larger than the difference between panels (e.g. between organic and conventional. For the purpose of understanding key successful management practises within the sector and the represented managed systems it may therefore be prudent to try and gain further insights through case studies, or, a combination of statistical analysis of the broader range of ARGOS results.

4. Dairy

4.1 Introduction

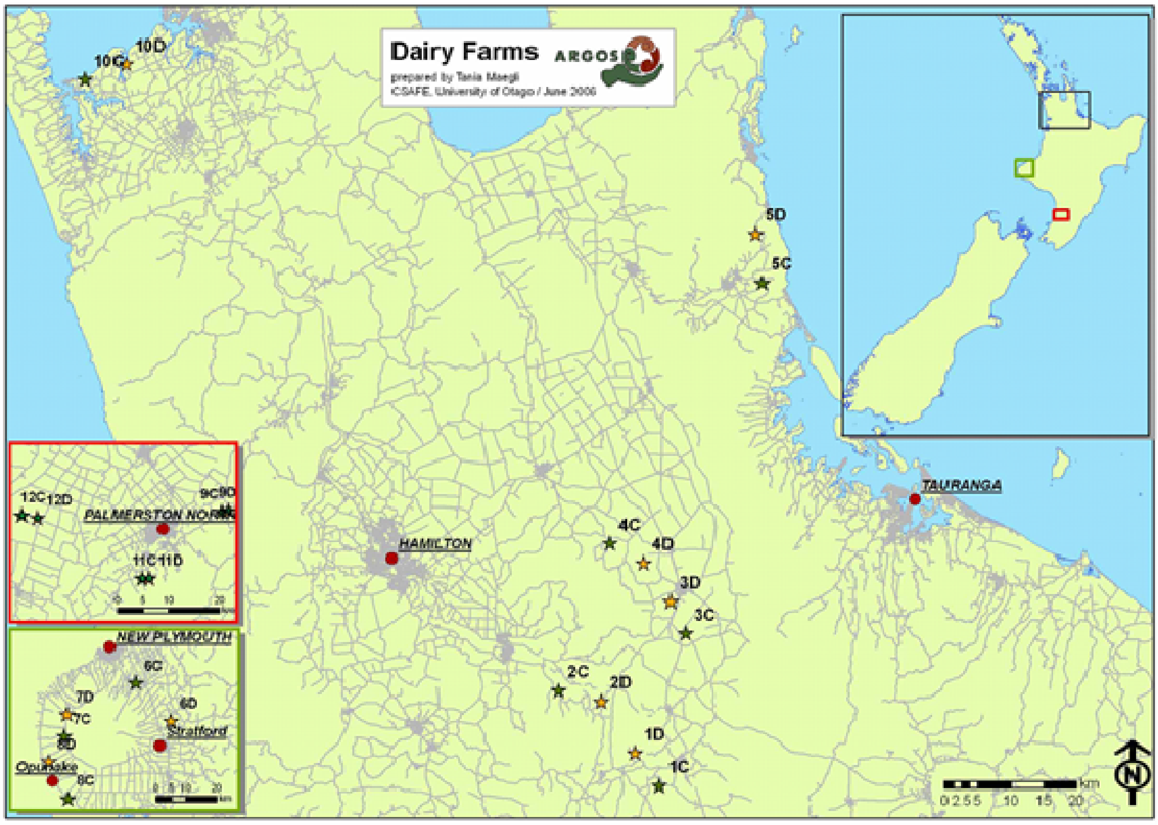
The dairy sector was added to the ARGOS monitoring programme in 2005 after additional support and funding was provided by Fonterra and the MAF Sustainable Farming Fund. A key driver of this support was the initiative by Fonterra to increase their organic milk supply.

The dairy section of ARGOS was designed to compare conventional farms and farms converting to organic. Essentially such a comparison is a BACI (Before-After-Control-Impact) that will allow us to better identify the consequences of organic management.

The comparison started in 2005/06 with the recruitment of twelve pairs of conventional and converting farms. One pair is located in South Auckland, four in Waikato, one in Waihi, three in Taranaki and three in the Manawatu.

As in the sheep/beef sector, conventional dairy farms use contemporary land management practices and are established as the control group. Dairy farms converting to organic were chosen so that before and after data would be collected as dairy farms went through the conversion process. ARGOS dairy farms must be certified to the New Zealand Food Safety Authority Technical Rules for Organic Production (www.nzfsa.govt.nz), administered through either AgriQuality Ltd or Bio-Gro New Zealand. This standard has been negotiated by governments around the world and allows access into overseas markets.

Figure 19. Location of ARGOS dairy farms in NZ.

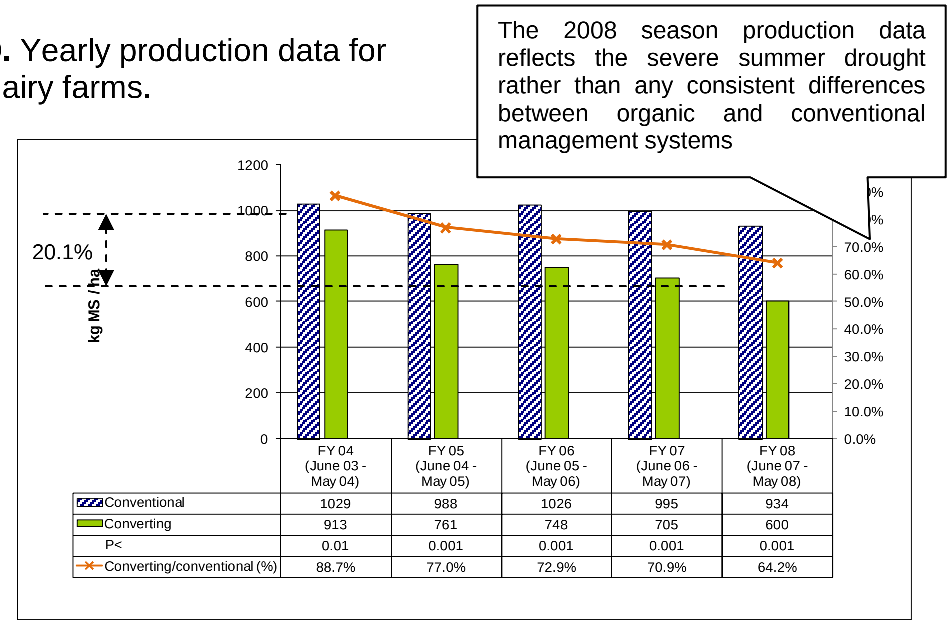


4.2 Farm production

Milk yield

ARGOS now has production data for four full years. The severe drought of the 07/08 season is evident in the graph below and it appears as though organic has suffered more than the conventional counterpart. The 2008 season is thus of little value in the comparison of management systems under normal circumstances. However, if we look at the monthly chart (Figure 21) it appears as though the difference between organic and conventional management systems remains similar to the 06/07 season up until the drought is having an impact in January. The reasons for this are uncertain at this stage but a survey has been deployed to assess the severity of the drought in different regions as well as the success of various management responses before, during and after the drought.

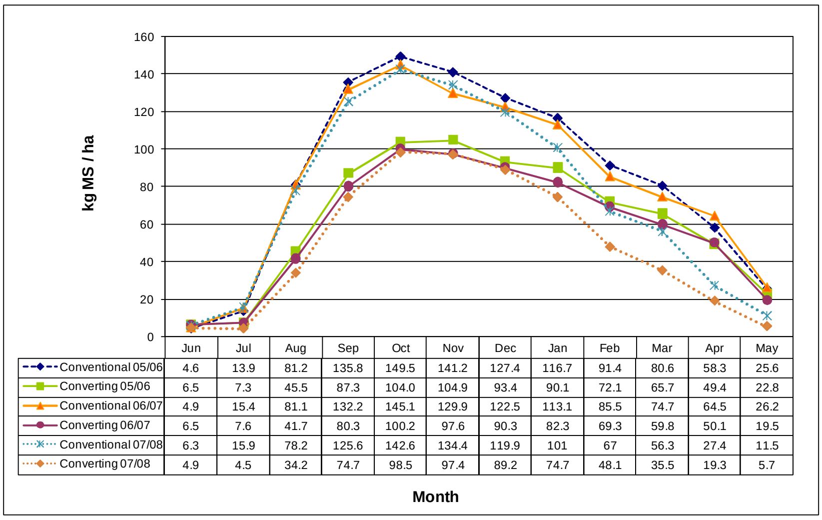
Figure 20. Yearly production data for ARGOS dairy farms.



	FY 04 (June 03 - May 04)	FY 05 (June 04 - May 05)	FY 06 (June 05 - May 06)	FY 07 (June 06 - May 07)	FY 08 (June 07 - May 08)
Conventional	1029	988	1026	995	934
Converting	913	761	748	705	600
P<	0.01	0.001	0.001	0.001	0.001
Converting/conventional (%)	88.7%	77.0%	72.9%	70.9%	64.2%

If we compare the difference between the management systems in 03/04 with the difference in 06/07 the decrease in production for the organic farms during the conversion period is 20.1%, with a baseline to their conventional counterparts (see graph above).

Figure 21. Monthly production data for ARGOS dairy farms.



	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Conventional 05/06	4.6	13.9	81.2	135.8	149.5	141.2	127.4	116.7	91.4	80.6	58.3	25.6
Converting 05/06	6.5	7.3	45.5	87.3	104.0	104.9	93.4	90.1	72.1	65.7	49.4	22.8
Conventional 06/07	4.9	15.4	81.1	132.2	145.1	129.9	122.5	113.1	85.5	74.7	64.5	26.2
Converting 06/07	6.5	7.6	41.7	80.3	100.2	97.6	90.3	82.3	69.3	59.8	50.1	19.5
Conventional 07/08	6.3	15.9	78.2	125.6	142.6	134.4	119.9	101	67	56.3	27.4	11.5
Converting 07/08	4.9	4.5	34.2	74.7	98.5	97.4	89.2	74.7	48.1	35.5	19.3	5.7

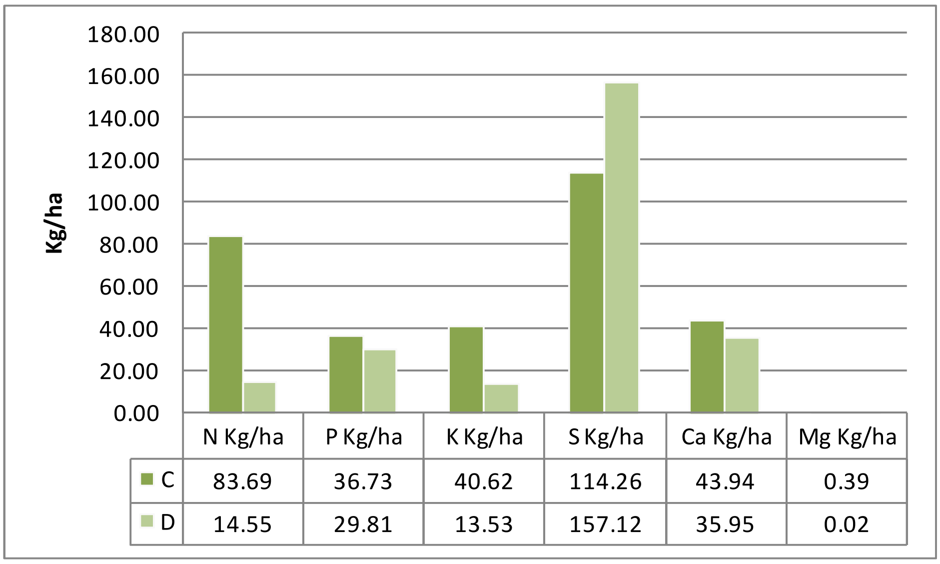
4.3 Farm management

ARGOS collects information on management practices for each farm. Below are some summaries of that data for the 2006/07 season.

<u>Fertiliser inputs</u>

The use of N and K were statistically significantly different between organic and conventional farms. In both cases the organic farms uses less. The application of P was strongly related to geographical location but there were no consistent differences between the organic and conventional ARGOS farms.

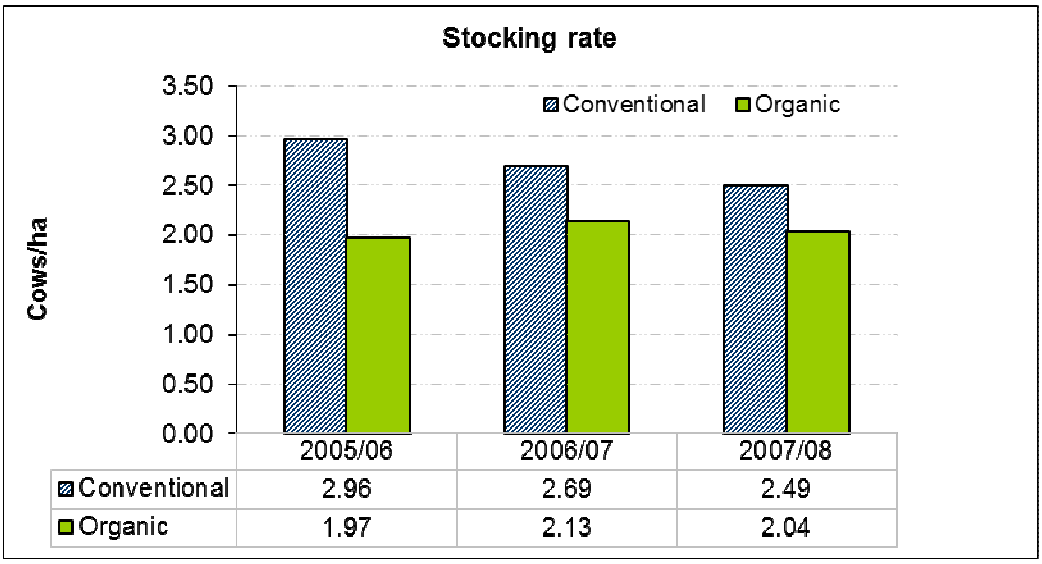
Figure 22. Fertiliser inputs for ARGOS dairy farms.



<u>Stocking rate</u>

The difference in stocking rate is statistically significant with organic having 0.67 cows less per hectare (maximum cows milked per ha (milking platform)).

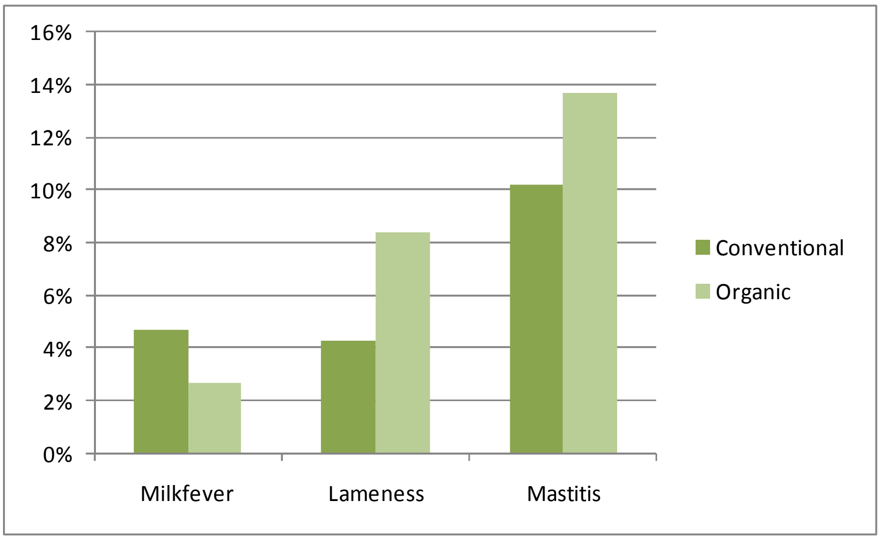
Figure 23. Stocking rate for ARGOS dairy farms.



Animal health

The three major cow health issues reported by the farmers in 06/07 were Mastitis, Lameness and Milkfever. The graph below depicts the percentage of cows that suffered from these health issues. Milkfever is statistically significantly different between organic and conventional farms, while Lameness and Mastitis is not (the difference in average values as per graph below is a product of some outliers rather than a consistent difference between the management systems).

Figure 24 Animal health figures for ARGOS dairy farms.



As to why there is a statistically significant difference in the percentage of cows with milkfever between organic and conventional is unclear. A multitude of factors can contribute to this cow health benefit of organic farming. These could include;

- Less common in lower yielding cows
- Less common in leaner cows
- Later calving – more pasture in diet

Somatic cell count

The somatic cell count for the 06/07 season is significantly higher for the organic systems. This is expected due to restriction in the use of antibiotics.

Figure 25. Somatic cell counts for ARGOS dairy farms.

	2005/06	2006/07
Conventional	188315	158821
Organic	228413	246663
P	0.0115	0.001

Internal parasites

For the 06/07 season the following products were used for internal parasites by the organic farmers. Cider vinegar and Eprinex were the most popular treatments and Eprinex is also the only product used extensively by conventional dairy farms.

Table 27. Internal parasite treatments for organic dairy farms

Number of farms	Product
4	Cider vinegar
2	Herbal health tonic
1 calf	Dectomax
1	Earthwise
4	Eprinex
1	wormwood
1	Diatomatus earth (sort of lick)
1	Vermis (Homeopathic)

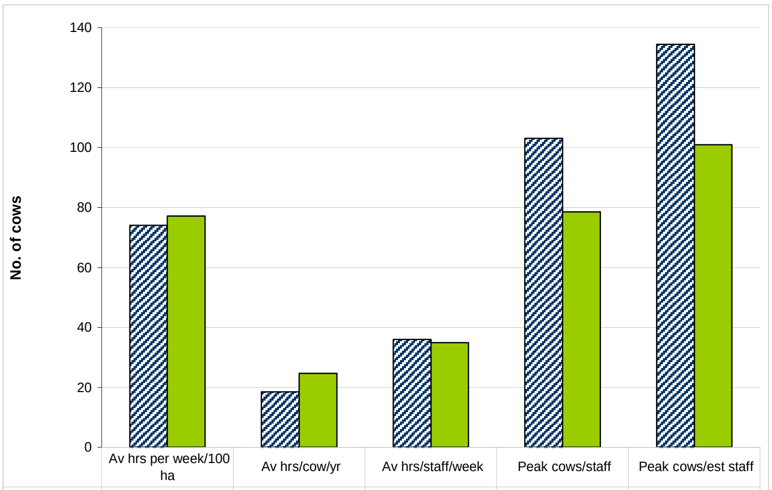
External parasites

The treatment for external parasites was limited to the use of oil on calves and one farmer treated heifers with Elemental Sulphur.

4.4 Labour

Total hours worked to manage each property were averaged out over the 2006/2007 and 2007/2008 seasons. There were no significant differences between organic and conventional in hours worked per 100 hectares and the number of hours worked per week per staff member. However some differences emerged with staff hours per cow and became significant ($p= 0.028$) for number of cows milked per staff member and bordered significance ($p= 0.067$) for number of cows milked per estimated staff member. Peak cows per staff member includes all staff that work on the property, whilst peak cows per estimated cows excludes casual staff such as relief milkers.

Figure 26. Hours worked to manage the farm workload (average 2006/2007 and 2007/2008).



	Av hrs per week/100 ha	Av hrs/cow/yr	Av hrs/staff/week	Peak cows/staff	Peak cows/est staff
Conventional	74.0	18.4	35.9	103	134
Organic	77.1	24.6	34.8	78	101

4.5 Energy - carbon footprint

As with the Sheep/beef sector, there are a number of key drivers to understand the carbon footprint of the farm business. A carbon footprint is "the total set of GHG (greenhouse gas) emissions caused directly and indirectly by an individual, organization, event or product" (UK Carbon Trust 2008). These are broken down further to energy components; namely:

- Direct energy is that energy used directly by the operation and is most easily recognised as energy e.g. diesel, petrol and electricity.

- Indirect energy is that energy which is embodied in agrichemicals and fertilisers. Indirect energy is calculated using previously determined coefficients. For example, the production of nitrogen fertiliser requires large quantities of energy for its synthesis from natural gas which must be included in a farms overall energy use in order to determine the true total energy input.

- Capital energy is that energy in structural material form, such as machinery, fences and buildings.

- Methane cows lose about 10% of their metabolisable energy intake (MEI) as methane (CH4) gas. The gas is produced during digestion in the main stomach (rumen) and is belched out through the mouth.

- Nitrous oxide one of the three greenhouse gases, nitrous oxide comes mainly from dung, urine and nitrogenous fertilisers.

Figure 27 shows typical on-farm green house gas emission profiles for both Organic and Conventional farms in ARGOS.

Organic **Conventional**

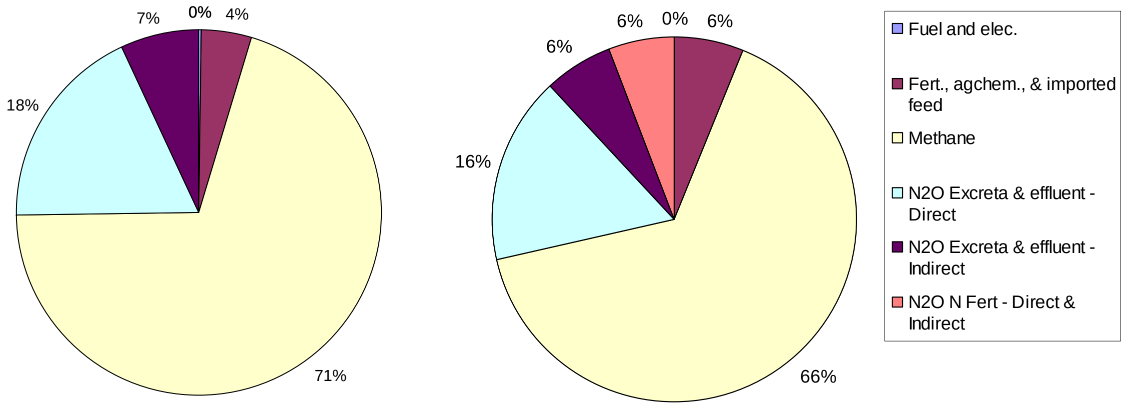


Figure 27 On-farm GHG Emission Profile

4.6 On-farm Greenhouse Gas Emissions from 23 Surveyed Organic and Conventional NZ Dairy Farms

Introduction

The following section consists of a supplementary report by Andrew Barber of AgriLINK, based on on-farm greenhouse gas emissions from 23 surveyed organic and conventional NZ dairy farms. Information in this report is derived from dairy farms involved in ARGOS.

The project surveyed and established the carbon footprint of 23 dairy farms from around the Waikato, Taranaki and the Manawatu. Thirteen farms used organic production practices. The average greenhouse gas (GHG) emissions from these organic farms have been compared to the 10 conventional farms using the same methodology and emissions modeling based on Overseer and a Life Cycle Assessment resource use emissions database. The system boundary is through to the farm gate.

Previous studies that compared organic and conventional farms had mixed results with two studies showing GHG emissions per unit of production was between 8% and 11% higher in organic systems while another study showed organically produced milk with 14% lower emissions than conventional farming.

Findings

Variation between farms highlights the enormous potential from applying good GHG management practices where the lowest GHG emitting organic farm, per unit of production, was 24% lower than the highest GHG emitting farm and 12% lower than the average organic farm. The best performing conventional farm had 33% lower emissions than the highest farm per unit of production, and 21% lower than the average conventional farm. In all cases the highest and lowest emitting production systems were in the respective bottom or top quarter of production per cow.

Organic farms, which were less intensive in terms of resource inputs and stock density, had significantly lower greenhouse gas emissions per hectare. However organic and conventional farming systems had almost identical GHG emissions per unit of milk production (Figure 28 following page).

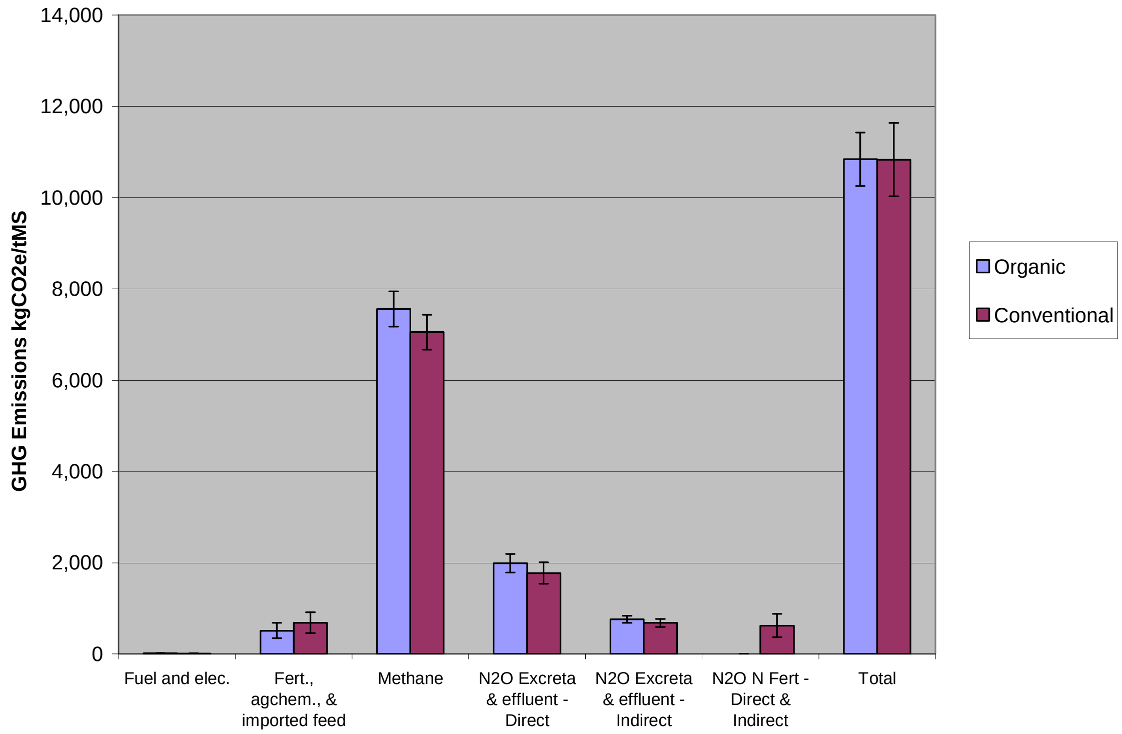


Figure 28 GHG Emissions per Tonne of Milk Solids

Production of milk solids per hectare was much lower on organic farms at 585 kgMS/ha compared to 982 kgMS/ha on conventional farms. GHG emissions per unit of production were almost identical (0.3% difference) at 10,865 kgCO_2e/tMS and 10,835 kgCO_2e/tMS for organic and conventional systems respectively. Organic farms had statistically significantly lower GHG emissions per hectare than conventional farms, driven predominantly by their lower stocking rate of 1.6 cows/ha compared to 2.6 cows/ha on the conventional farms.
Lower resource use GHG emissions on the organic farms were offset by lower production per cow resulting in almost identical emissions per unit of production. Not surprisingly there is a strong relationship between production per cow and GHG emissions per unit of production (Figure 29), clearly increased production comes at the price of only a small marginal increase in GHG emissions. Analysing the production systems separately (not shown) shows an even stronger relationship.

GHG mitigation strategies were investigated including animal productivity, the use of feed pads to restrict winter grazing, nitrification inhibitors, better utilisation of farm dairy effluent, dung beetles, the use of the antibiotic monensin, and supplementary feeding with oil and cereal grain. On their own none of these strategies is going to result in dramatically lower on-farm GHG emissions. However where appropriately used many will not only lower GHG emissions but will also improve farm profitability.

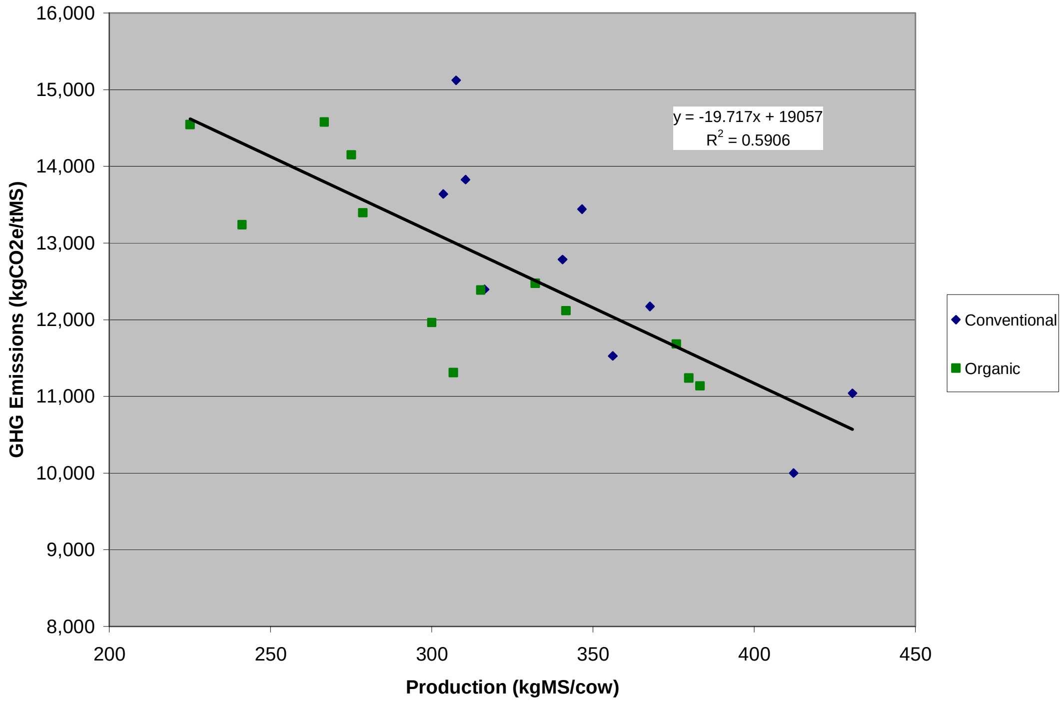


Figure 29 GHG Emissions per Tonne of Milk Solids vs. Cow Productivity

Discussion

More important than the absolute GHG emissions is how the emissions can be reduced in the future. While a range of strategies were investigated there is no “silver bullet” that will dramatically lower on-farm GHG emissions. Modeling showed that a combination of improved productivity and the use of a nitrification inhibitor lowered emissions by approximately 12%. Both these strategies, where appropriately used, not only lower GHG emissions but also improve farm profitability.

Improved productivity and farm management skill are possibly the two biggest opportunities. There is a clear linear relationship between higher productivity per cow and lower GHG emissions per unit of production (Figure 29).

While this project did not look beyond the farm gate other studies have shown that farmers' own and control most of the life cycle GHG emissions (around 85%). This empowers farmers to make changes that will be reflected in a noticeably lower carbon footprint of the final consumer product

4.7 Financial performance

For this report the 05-06 and the 06-07 accounts were analysed. The 06/07 season is the first year where all the organic farmers have received their full premium (20%).Table 28 details the financial variables for this season. Some general observations from the analysis are;

1. There is very little difference in operating profit between organic and conventional farmers in the ARGOS program. The average and the median operating profit are slightly higher for the organic farms but this is not a statistically significant difference.
2. The revenue is higher for the conventional farms, but again the difference is not statistically significant.
3. The lower operating expenses of the organic farms more than compensate for the lower revenue figures.

4. Variation within management systems is larger than the variation between management systems (see graph below).

Figure 30 below clearly illustrates point 4 above as well as how conventional and organic farms seem to achieve similar levels of profitability a very different levels of production.

Figure 30. Production levels and profitability scatter plot for ARGOS dairy farms (2006/07).

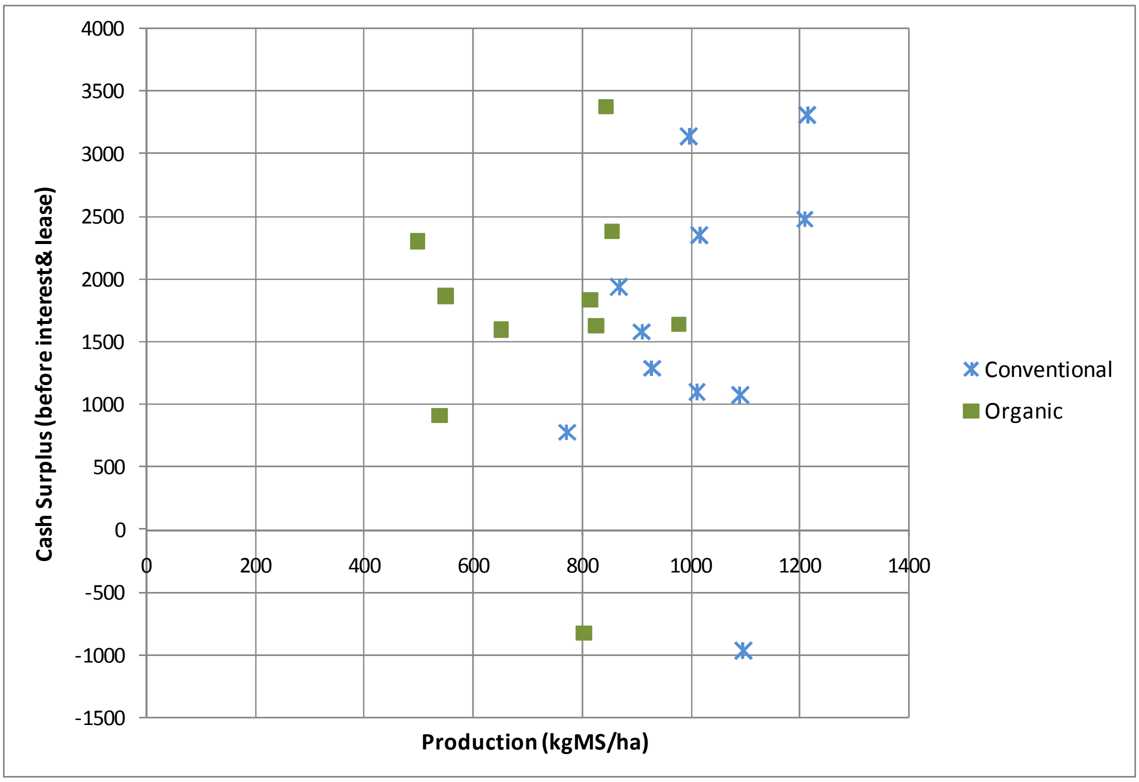


Table 28. Average financial data for ARGOS dairy farms (per ha), for the 2006/07 year.

	Conventional Average	Conventional Median	Organic Average	Organic Median	P
Cows milked	3.00	2.92	2.35	2.26	0.01
REVENUE					
Milksolids - base payout	4156	4111	3694	3849	ns
Net milk solids income	4133	4109	3661	3821	ns
Gross stock income	479	385	562	418	
Less: Cattle Purchases	602	328	409	75	
Other dairy income	70	19	63	11	
Non Dairy Farm Income	99	78	106	111	ns
Cash Farm Income	**4276**	**4452**	**4103**	**4173**	**ns**
EXPENDITURE					
Labour Expenses					
Permanent wages	349	268	539	565	
Casual wages	57	16	32	6	ns
ACC	31	17	23	24	ns
Ag.contracting (not crop/cult.)	281	269	155	142	0.014
Stock Expenses					
Animal health	47	42	51	38	
Feed - purchased (all types)	219	233	223	199	
Feed (grazing)	149	102	43	26	
Feed Hay and Silage	272	254	129	151	
Feed -fodder crops	13				
Seed	3	0	0	0	
Fertiliser & lime excl N	2	0	0	0	
Fertiliser N	1	0	0	0	
Contract cultivation	6	0	2	0	
Weed and pest	1	0	0	0	
Total-fodder crops		0	2	0	
Pasture renovation	423				
Seed	17	5	9	5	
Fertiliser & lime excl N	310	352	280	277	ns
Fertiliser N	58	16	0	0	
Contract cultivation	16	10	11	0	
Weed and pest	21	10	6	1	
Total Pasture renovation		494	306	315	ns
Other expenses					
Electricity	92	93	90	98	ns
Freight	26	16	34	19	
Vehicle costs (including fuel)	169	181	198	174	ns
R & M farm	255	238	295	196	
Overheads					
Rates (including water rates)	77	83	90	76	ns
Communication costs	27	23	19	16	
Insurance	5	0	2	0	
Accountancy	41	34	30	29	0.018
Legal and consultancy	17	13	5	0	
Other admin	34	30	46	47	ns
Run-off lease	34	33	32	32	ns
Other dairy	13	5	88	20	
Non dairy	0	0	0	0	
FARM WORKING EXPENSES	**2631**	**2592**	**2433**	**1968**	**ns**
OPERATING PROFIT	**1645**	**1859**	**1670**	**2205**	

4.8 Summary

It is interesting to note that organic and conventional dairy farms can achieve similar profits even though the production levels are so different. Even more so in an industry that traditionally has been very focused on increasing production (kgMS), sometimes to the detriment of the bottom line.

The ARGOS dairy farms have been monitored throughout the organic conversion period and are now (2008/09) into their 2^{nd} or 3^{rd} year of fully certified production. Anecdotal evidence of organic conversion suggests that after 5 years or so the new system starts to come together and the production levels become stable and possibly increase. It will be exciting to see if this is true for the ARGOS farms over the next few years.

5. High country

5.1 Introduction

The High Country part of ARGOS is focused on the merino sector and involves the monitoring and analysis of eight properties from Marlborough to Maniototo in the South Island. The properties range from 4,400 to 40,000 ha, with carrying capacities of 0.5 to 2.0 stock units per hectare. The properties are mainly farmed for fine wool with additional income streams from meat and tourism. The vast size of these properties and the absence of any significant differentiating market audit systems (at the time the project was established) makes them unique to other sectors currently under study in ARGOS; hence a case study approach has been adopted.

A major output from the ARGOS High Country programme is in providing information that can be used to enhance the existing Zque sustainability assurance programme that allows the industry and individual merino growers to report on the sustainability of the systems in which merino wool is grown. This provides the market and other stakeholders with an assurance that the farming system that New Zealand Merino wool is produced in has a high level of sustainability and environmental integrity. The information from ARGOS also provides information that can be used to respond to regulatory and market demands for information on the environmental performance and impact of High Country farms.

The project also assists in identifying management strategies that can be used to lift the environmental and financial performance of any less sustainable farming operations so that they can successfully meet market demands for sustainably produced products.

This report section presents some general descriptions of farm management on these properties.

Table 29. Characteristics of ARGOS high country farms.

Farm ID	Freehold Area (ha)	Leasehold Area (ha)	Total Farm Area (ha)	SU	SU/ha	Breed
HC1			19,360	12,320	0.64	Merino
HC2	1,604	38,395	39,999	28,340	0.71	Merino
HC3	3,870	530	4,400	4,559	0.55	Merino
HC4	9,156	0	9,156	18,384	2.01	Merino, Crossbred
HC5	595	19,004	19,599	6,165	0.31	Merino, Crossbred
HC6		14,607	14,607	13,202	0.90	Merino, Halfbred, Angus
HC7	251	11,327	11,578	9,865	0.85	Merino
HC8	10,705	28,128	38,833	19,946	0.51	Merino

5.2 Farm production

Much like the low-land sheep and beef farms, the production outcome for the ARGOS high country farms is highly variable and complex (Table 30). The classic measure of production outcomes for high country merino farmers are wool quantity and quality. However, a modern high country framing enterprise may involve cross breeds and half breeds, meat production and tourism, as well conservation efforts. As a consequence, farm profitability is the most appropriate measure of the final production outcomes, whereas wool production is at best indicative.

Table 30. Wool production for the ARGOS high country farms (2006/2007).

Farm ID	Weight of wool sold (kg)	Microns	Wool/SU (kg/SU)
HC1	47,480	Ewes 18.9, Hoggets, 17.3, Wethers 18.9	5.0
HC2	138,000		4.87
HC3	12,532		2.75
HC4	51,524		2.80
HC5	27,650	Ewes 19, E.hgts 17.7	4.48
HC6	Unknown	Halfbred hgts - 22.5, Merino hgts - 16, Halfbred ewes - 23.5, Merino ewes - 18	Unknown
HC7	41,714		4.23
HC8	81,307		4.08

5.3 Farm management

High Country farming represents the least intensively managed properties in the ARGOS programme. Labour and management practices are generally more important than external inputs such as fertiliser and agrichemicals. This section describes some of these aspects on the ARGOS properties.

<u>Labour</u>

All of the ARGOS high country properties employ varying amounts of labour. This ranges from part time unpaid labour (family members) to fulltime staff. Managing the workload can have an impact on the profitability of the business and there is often a balance required between how much time the farm owner can spend working on the farm and social and long term economic consequences. Therefore, the system that farmers adopt to manage their workload is one that requires careful consideration.

As the table below details, paid fulltime labour and unpaid management labour are dominating. “Unpaid Manager” is slightly misleading as this is usually the farm owner and family, i.e. they are paid for the work through the profit of the business and property value increases.

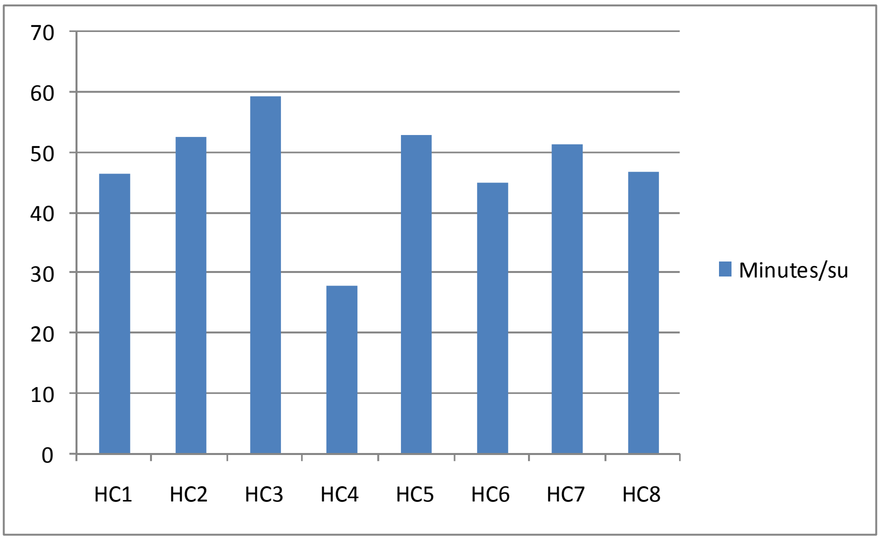
The total number of labour hours per stock unit is surprisingly similar cross the properties, with only property number 4 being significantly lower.

Table 31. Labour input over the 2006/07 season (hours) for the ARGOS high country farms.

Farm ID	Other unpaid	Paid casual	Paid fulltime	Paid part time	Unpaid Manager	Total
HC1	613		5,743		3,203	9,558
HC2			24,909			24,909
HC3	730			659	3,129	4,518
HC4			8,587			8,587
HC5	782	27	1,758		2,868	5,435
HC6	78		5,051	1,811	2,939	9,880
HC7			5,642		2,821	8,463

HC8			12,945		2,671	15,616

Figure 31. Labour input over the 2006/07 season (minutes/SU) for the ARGOS high country farms.



Fertiliser

The majority of fertilisers use on the high country farms are applied on cultivated paddocks and on crops, in particular Nitrogen. Phosphate is applied on oversown tussock land as well as on the cultivated paddocks and crops. The other elements are usually a secondary input and part of the choice of fertiliser mix. The table below details the fertiliser applied as N, P, K, S and Ca nutrient inputs on a per stock unit basis. The table include nutrient inputs for maintenance, cropping, feed conservation and any development work.

Table 32. Fertiliser use in 2006/07 for the ARGOS high country farms, per stock unit (SU).

Farm ID	Kg N/su	Kg P/su	Kg K/su	Kg S/su	Kg Ca/su
HC1	0.77	1.88	0.55	6.48	5.17
HC2	0.00	0.25	0.00	2.33	0.55
HC3	0.00	0.44	0.00	1.85	0.98
HC5	1.16	1.43	0.21	4.14	2.84
HC6	0.22	1.08	0.05	3.08	1.71
HC8	0.01	1.60	0.00	7.51	4.06

Parasite management

Parasite management is traditionally an important aspect of high country farming and has become even more so with recent consumer concerns regarding residues in the wool as well as other management practises aimed at reducing the effects of parasites. All farms reported treatment of lice and all but two were concerned about flystrike (Table 33). Similarly, all farms treated for internal parasites (Table 34).

Table 33. External parasite threats for the ARGOS high country farms.

Farm ID	Greatest threat	Secondary threat
HC1	Lice	
HC2	Lice	
HC3	Flystrike	Lice
HC4	Lice	Flystrike
HC5	Flystrike	Lice
HC6	Lice	Flystrike
HC7	Flystrike	Lice

Table 34. Internal parasite management for the ARGOS high country farms.

Farm ID	Greatest threat	Faecal egg count	Drench resistant parasites	Basis for decision to drench
HC1		Yes		Vet advise & reduction tests
HC2	Nematodirus	Yes		Eye appraisal and convenience as area is too vast to muster
HC3	Lungworms	No		Experience
HC4	Nematodirus	No	Don't know	Brought in lambs get Matrix
HC5	Worms that were from bought in lambs	Yes	Haven't identified any - need to do a test.	Partially egg count.
HC6		Yes	Yes	Calendar
HC	Worms in general	No		Observation
HC8	Nematodirus	Occasionally	None that are known	Preventative

Feed management

The general approach to feed management in the high country is similar across the farms. The lower and/or cultivated land is used for wintering and lambing while the hills are summer country and in general for Ewes and large lambs or ewes after weaning. However, there is some leeway for adjusting the feed management as the table below indicates.

Table 35. Feed management for the 2006/07 season for the ARGOS high country farms.

		Grazing strategy			
Farm ID	Post mating mobs	Lambing	Lambing to weaning	Lambs at weaning	Ewes at weaning
HC1	Wintered in mobs of 500 - 1000. Grain was fed to ewes with twins	Set stocked by end September - 300 to 600 per paddock/block. All on oversown country (flats and downs). Nothing in paddocks.	Everything stayed setstocked due to the wet weather	Lambs weaned and sexed 2 to 3 days before the sale. Half breeds run as mobs of heavies and lights	Set stocked in 4/5 blocks. Sale ewes stay on oversown country.
HC2	Set stocked	Set stocked. Terminals start a little earlier	Set stocked onto fresh blocks	Not sexed till 3 to 4 weeks later. Set stocked. A milk draft goes before weaning and terminals are drafted to works at 16 kg	Extensive runoff. Big mobs. Lighter ones drafted off (300) and looked after on easier block, where they stay through to mid/late April.
HC3	No change in mobs post mating. 3 blocks are rotated through over winter (6 weeks each).	Lamb set stocked in blocks. CFA mob separate.	Stay in lambing mobs & go on to clean pasture post tailing.	Lambs shuffled round on clean blocks. Terminals sold store.	Put on drier native blocks. Tidy up lambing blocks.
HC4	Merinos on hill - not fed at all. Crossbreds stay on flat and may get a bit of feed off-shears. Will feed lighter stock more.	Setstock and shed Crossbreds. Setstock and leave Merinos. Lamb twins separate.	Mob up as soon as tailed - rotate Crossbreds around flat. Leave Merinos alone.	Not sexed. Weaned backed to same paddocks.	Ewes go to summer country. Culls sold when possible
HC5	Mob M.A ewes up again. 2ths separate. Preferential feeding first trimester. Maintenance second trimester. Increasing plane third trimester	Set stocked till tailing. Lamb in different mating types. Twining ewes on dry most sheltered blocks.	Same mobs as lambing. Surplus feed went to 2ths and terminal sired ewes. Twins stayed on the better country	Works lambs to cultivated paddocks. Rest to hill	Ewes head up and clean up lambing blocks and higher top dressed blocks.
HC6	Merino, half breeds, drys went to flats/finishing farm	Set stocked	Set stocked	Sexed. Milk draft (800). Rest went to flats/ finishing farm.	Crutched, dipped, culls go to flats
HC7	Set stocked in 3 mobs: 2ths, M.A and light condition ewes	Set stocked	Everything is set stocked except the terminal mob which is shuffled around	Some on hill. Some on irrigated country under pivot. All go to saved pasture	Culls taken out & fattened & sold to works. Rest go to the summer country
HC8	2 ths in 1 mob, MA in 1 mob. At scanning mobs are increased because of singles and twins.	Drought in Autumn meant feed plane was decreasing right through till lambing	All ewes were setstocked. The ewes with twins were set stocked 2/3 the rate of ewes with singles	Lambs are not sexed. They are jetted and put onto a lax rotation on the best available feed	Ewes on summer country Feb to April.

Table 36. Supplement use (wet tonnes) in 2006/07 for the ARGOS high country farms.

Farm ID	Hay		Baleage		Silage		Straw		Grain	
	05/06	06/07	05/06	06/07	05/06	06/07	05/06	06/07	05/06	06/07
HC1	1,024	1,229			2,545	2,545			24.7	
HC2	10.24	137	60	356.7						
HC3					1,400	1,400				
HC4		220		50	0	6,400				
HC5		39			455	606	12.94			
HC6	219.5	457	500	750	636	1,009				
HC7					606	636				
HC8	54.88	73.2								

5.4 Financial Performance

In this section the financial summary is presented on a per hectare basis for both Ministry of Agriculture (MAF), and Meat and Wool New Zealand (MWNZ) for South Island High Country Properties.

Figure 32 shows:

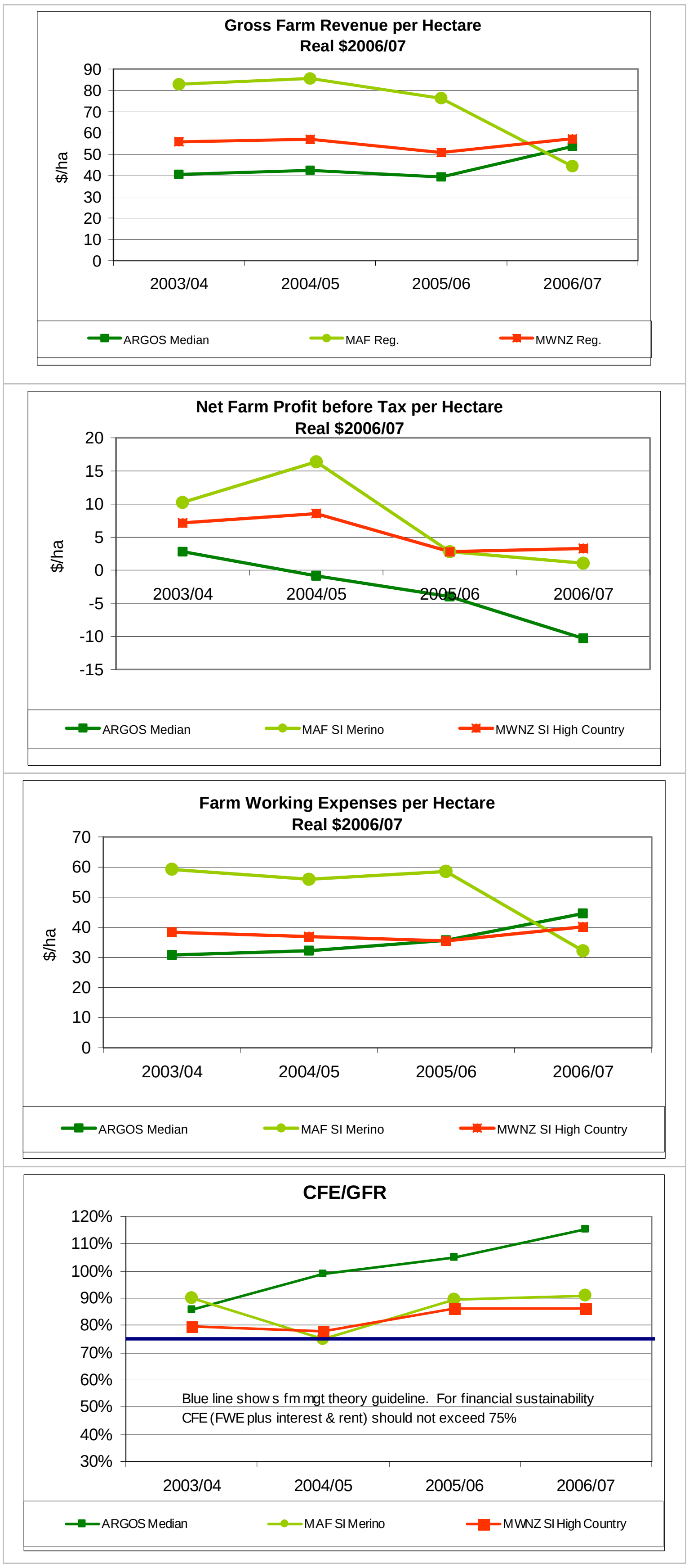
- Gross Farm Revenue
- Farm Working Expenses
- Net Farm Profit Before Tax
- Cash Farm Expenses as a percentage of Gross Farm Revenue

It is clear that the profitability is not great for high country farmers and what is worse, the trend is down.

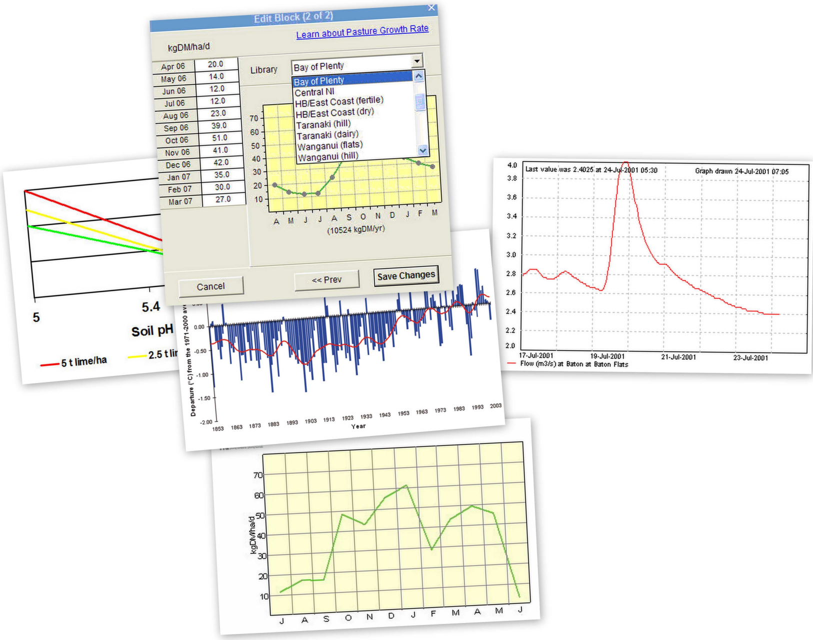
5.5 Summary

It is clear that the high country farms are the least intensively managed properties in ARGOS. The extensive nature and scale of high country farming as well as an absence of differences in market audit systems necessitated a case study approach to this sector. The major focus is on environmental monitoring of land cover over long time periods and the ARGOS management objective (as described in this section) has a primary role in maintaining a database of changes in management practises over that time.

Figure 32. Financial indicators for ARGOS high country farms for the 2006/07 financial year.



6. Farm management indicators



6.1 Introduction

Farmers assess the performance of their farms using a variety of measures or indicators. Some of the key measures of management and production, specific to each sector, are presented in Table 37 and briefly described below.

6.2 Kiwifruit

Preharvest, kiwifruit growers often gauge their potential production by inspecting selected areas of their orchard i.e. monitor bays. They are particularly interested in the number of winter buds and resulting flower buds and fruit that develop in those areas. These numbers are a function of the number and quality of canes tied down in the winter (climate is also a big driver of production). Consequently, growers will often target canes of a particular quality to tie down.

The amount and quality of kiwifruit removed from each orchard is the ultimate measure of management and production for orchardists. Growers get a lot of satisfaction from producing good crops. The number of export trays produced, the size of that fruit and the amount of dry matter in that fruit are the main production measures. Growers may also refer to reject rate especially in a year when a significant amount of their fruit does not meet export standards.

6.3 Sheep/beef

Sheep farmers tend to gauge the success early in the production year by lambing percentage and lamb survival rates in combination with current lamb prices (either through existing contracts or through following the lamb schedule prices that are published on a weekly basis).

As the season progress the farmers generally assess the lamb growth rates through a variety of indicators such as feed quality, disease rates, and weather.

The main post season measure of financial success is “Cash surplus/deficit”, as depicted in Table 38.

6.4 Dairy

Dairy farmers try to optimize their total kilograms of milksolids production relative to their farming inputs. They will typically relate to quantitative performance indicators such as kilograms of milksolids per hectare or per cow and cows per hectare (stocking rate).

The projected payout is another key indicator the farmers tend to use to gauge their earnings and adjust their management (expenditure).

To reach their targets dairy farmers will monitor cow condition score and pasture cover throughout the year as well as number of cows unable to get in calf (empty rate) and midpoint calving date earlier in the season.

6.5 High Country

Maximizing the value of their wool clip is typically the key focus of the high country farmer. The micron wool count and kilograms of wool produced per sheep stock unit are the main performance indicators. The diversification into cross breed sheep is leading to production/management indicators similar to down country sheep/beef farmers.

Table 37. Important measures and indicators used by farmers to assess management and production. These may be referred to on a total farm basis or per hectare or stock unit basis.

	Kiwifruit	Sheep/beef			Dairy	High country	
		Sheep	*Beef*	*Cropping*			
Land area	Effective hectares ("canopy hectares")	Effective hectares	Effective hectares	Effective hectares	Effective hectares	Effective hectares Carrying capacity	
Climate	Winter chilling e.g. no. of hours below 7°C. This is important but growers don't measure it.	Rainfall Temperature Wind	Rainfall Temperature Wind	Rainfall Temperature Wind	Rainfall Temperature	Rainfall Time under snow	
Pasture		o Pasture quantity/quality o Soil fertility	o Pasture quantity/quality o Soil fertility	Soil fertility	o Pasture quantity/quality o Round speed o Soil fertility	o Pasture quantity/quality o Soil fertility	
Animal potential		o Sheep stocking rate o Sheep:Cattle o Scanning rate (%) o Lambing rate (%)	o Cattle stocking rate o Sheep:Cattle o Calving rate (%) o Empty rate (%)		o Number of cows o Empty Rate (%) o Mean lactation days o Calving intensity	o Number of sheep o Sheep:Cattle o Scanning rate (%) o Lambing rate (%)	o Number of cattle o Sheep:Cattle o Calving rate (%) o Empty rate (%)
Cropping potential	o Average pieces of wood per bay o Cane spacing (cm) o Cane quality (colour/size) o Winter bud density (no./m2 or no./piece of wood) o Flower bud density (no./m2) o Fruit density (no./m2) o Fruit to flower ratio o Fruit size	o Feed conservation (Hay, silage etc)	Feed conservation	Feed conservation	Feed conservation	Feed conservation	
Harvest	o Tray numbers o Fruit size o Dry matter content (%) o Reject rate (%)	o No. of lambs o Lamb weight (kg) o Wool (kg)	o No. of cattle o Cattle weight (kg)	o Yield (tons) o Quality	o Milk production (kg milk solids)	o Wool quality (microns) o Wool quantity (kg) o Meat weight	

Table 38. Financial measures monitored by farmers (ARGOS National Farm Survey 2008).

Level of importance	Conventional	Integrated	Organic	All sectors overall means
Gross income	5.69	5.96	5.50	5.80
Working expenses	5.91	5.85	6.0	6.0
Change in bank balance over the year	4.85	4.63	4.93	4.90
Actual income versus budget income	4.78	5.0	5.0	4.7
Cash surplus/deficit (income minus all cash expenses; the cash available for tax, drawings and reinvestment)	5.63	6.07	6.15	6.0
Net profit/loss (income minus all cash expenses and depreciation; the taxable component of income)	5.72	6.04	5.93	5.90
Changes in equity	4.58	5.07	5.0	4.90
The ratio of working expenses to gross income	5.06	4.89	5.54	5.20
Return on capital	3.97	4.70	4.06	4.40
Money is available to cover cash needs	5.69	5.56	5.50	5.70
I don’t monitor financial performance because it just follows on from physical management	3.79	3.83	3.21	3.20

7. Comparisons of management systems and sectors

7.1 Summary of management differences.

These are summarised below.

Table 39. Summary of farm management difference between panels.

Variables	Sheep/beef	Kiwifruit	Dairy
Panels		Organic 'Hayward' (ORGANIC) Integrated 'Hayward' (GREEN) Integrated 'Hort16A' (GOLD)	
Land area	Y	No significant difference in productive areas. Orchards are relatively small entities i.e. Most have less than 5 hectares of canopy.	Y
Soil management	Y	Organic panel relies on compost, compost/poultry manure blends, and liquid fish fertilisers. The integrated panels apply similar amounts and types of salt fertilisers.	Y
Pest & disease management	Y	Mineral oils and Bts form the basis of pest control in the organic panel. Integrated panels also use these but other chemicals are also available. Hydrogen cyanamide use for budbreak on the integrated panels is an important point of difference.	Y
Weed management	Y	Glyphosate commonly used within rows in the integrated panels. Organic orchards must rely on mechanical controls.	Y
Pasture or groundcover management	N	N/A	N
Labour	N	No clear differences in the amounts of unpaid labour but some evidence that Gold utilises significantly more paid labour (probably as a consequence of this variety being more vigorous and requiring more pruning). This gap is likely to close as growers adapt to reduce vine vigour	N
Energy indicators	Y	No significant difference in total energy indicators.	N
Profitability	N	No differences detected in the financial bottom lines but this may be a result of a lack of power in the data. This is being investigated.	N

7.2 Comparison on sector intensity

The intensity of the sectors being studied by ARGOS are shown in Table 40. Kiwifruit is regarded as the most intense sector and sheep/beef the least intense according to common input, financial and production indicators.

Table 40. Some indicators of intensity for agricultural sectors being studied by ARGOS. The values are approximate for conventional ARGOS farms in each sector. Sheep/Beef and Kiwifruit are averages for the 2002-05 period while High Country and Dairy are averages for just 2004/05.

	Increasing intensity →			
	High country	*Sheep/beef*	*Dairy*	*'Hayward' Kiwifruit*
Effective area (ha)	20,000	350	115	3.6
Production (per ha)	< 6 kg wool / ha	300 kg carcass / ha	1000 kg milk solids / ha	23,200 kg fruit / ha
Working expenses ($/ha)	<80	500	3,300	19,100
Gross Farm Revenue ($/ha)	<100	800	4,000	37,100
Stock Units (SU)	< 2	12	30	N/A
N (kg/ha)	< 1	5	110	130

7.3 Summary

The farm management objective of ARGOS has established and maintained a strong network of monitor farms across NZ. Over 100 farms are included in the study and each year we have collected detailed management and production information for those farms through regular farmer interviews and questionnaires. The result of this is that we now have a good understanding of management across all our farms as well as the differences between various production systems within each sector e.g. conventional and organic production. This knowledge is important for explaining the results of other monitoring carried out by ARGOS (i.e. environmental, financial and social) as well as for looking for drivers of different production outcomes. We will continue to document farm management and production with a focus on exploring relationships between management inputs and production outcomes including many of those summarised in this report.

The first 5 years of the ARGOS programme for the farm management objective has been dominated by establishing and maintaining relationships with farmers, and facilitating and carrying out field surveys to collect management data (as well as social, economic and environmental data). A future focus for the objective will be to interrogate this data with an emphasis on identifying relationships between farm inputs and outputs.

8. References

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

Benge, J., 2009. ARGOnoteS 18: Labour Use on ARGOS Kiwifruit Orchards.

Patterson, K. J., Snelgar, W. P., Richardson, A. C. and McPherson, H. G., 1999. Flower quality and fruit size of Hayward kiwifruit. Acta Horticulturae. 498: 143 – 150.

Appendix 1. Reasons orchardists declined to be involved in the ARGOS programme when approached by phone at the beginning of 2004.

Reason	No. of orchards
Orchard recently sold	3
Exiting orcharding (retiring)	2
Under pressure from council to sell orchard	1
Too busy	2
Annually reviews a change in production system i.e. away from organic	2
Changing growing structure (i.e. from T-bar to Pergola)	1
Does not want distractions or too many people visiting the orchard	2
No financial benefit from being involved	1
Did not really want to be involved (reason not specified)	5
TOTAL	19

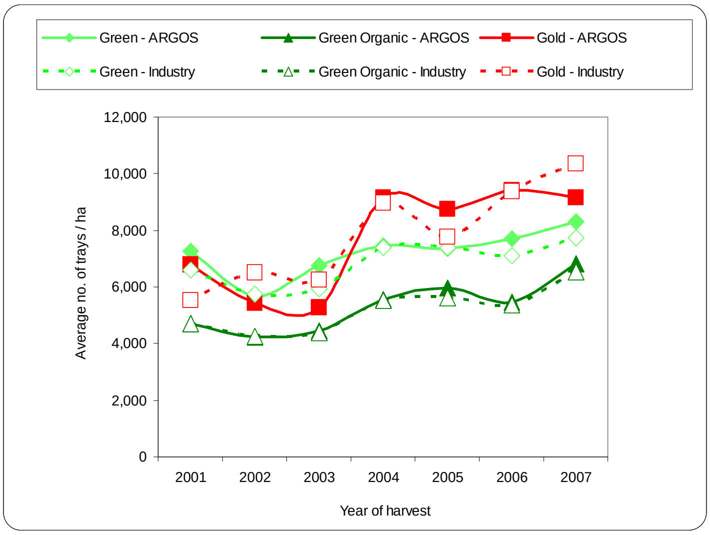
Appendix 2. Establishment of Gold in ARGOS kiwifruit orchards.

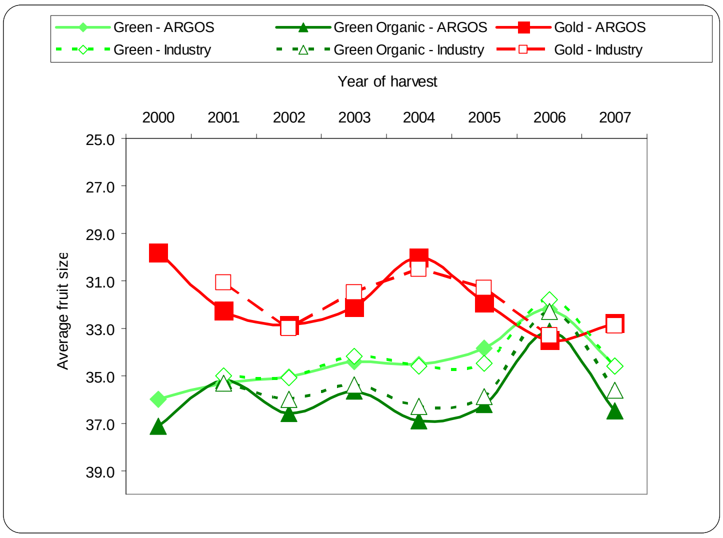
ARGOS ID	Year orchard Established*	Year Gold introduced	Method of introduction	Total hectares of Gold	Total hectares of Green
3	1983	1997	Grafted	1.0	3.7
6	1981	1999 - 2000	Grafted	1.8	2.4
9	1982	1997 - 2002	Grafted & seedlings	6.6	0
12	1983	2000	Grafted	0.9	1.0
15	1983	1998	Grafted	4.6	0
18	1985	2000	Grafted	0.5	1.5
21	1998	1998	Seedlings	2.5	0
24	1975	1997	Grafted	1.2	1.8
27	1981	1997	Grafted	2.7	0
30	1983	1997 - 2004	Grafted & seedlings	1.8	5.0
33	1983	1997 - 1998	Grafted	2.0	4.0
36	1983	1996	Grafted	1.0	0

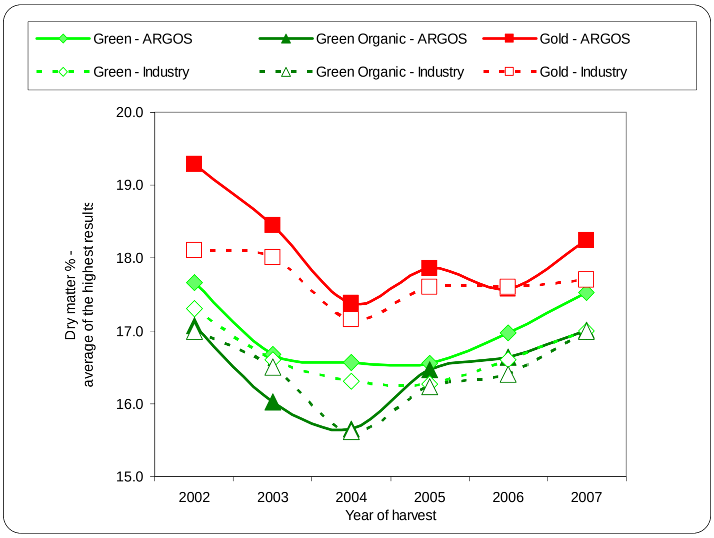
* Estimates provided by orchardists.

Appendix 3. Recent trends in average production levels on ARGOS orchards and for Industry.

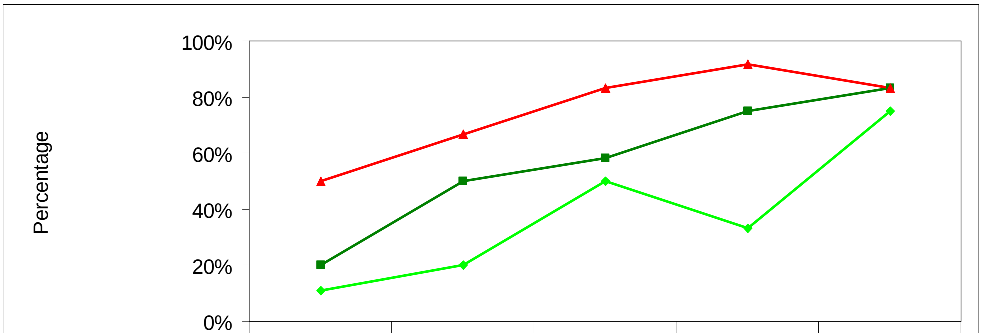
Top graph: Trays/ha. Middle graph: Fruit size (the smaller the fruit count value i.e. number of fruit in the same sized tray, the larger the fruit. Bottom graph: Average dry matter levels (based on the highest samples submitted from each maturity area within each orchard).





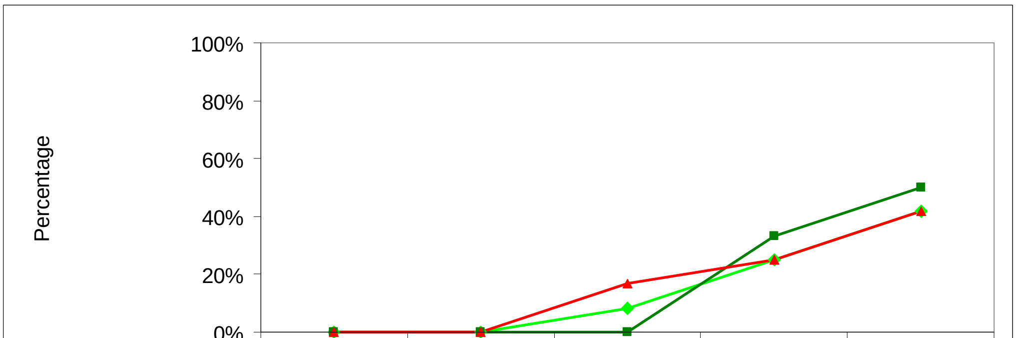


Appendix 4 Percentages of ARGOS orchards which have single or double trunk girdled (top graph), double trunk girdled (middle graph), and cane and trunk girdled (bottom graph). 12 orchards of each type surveyed.



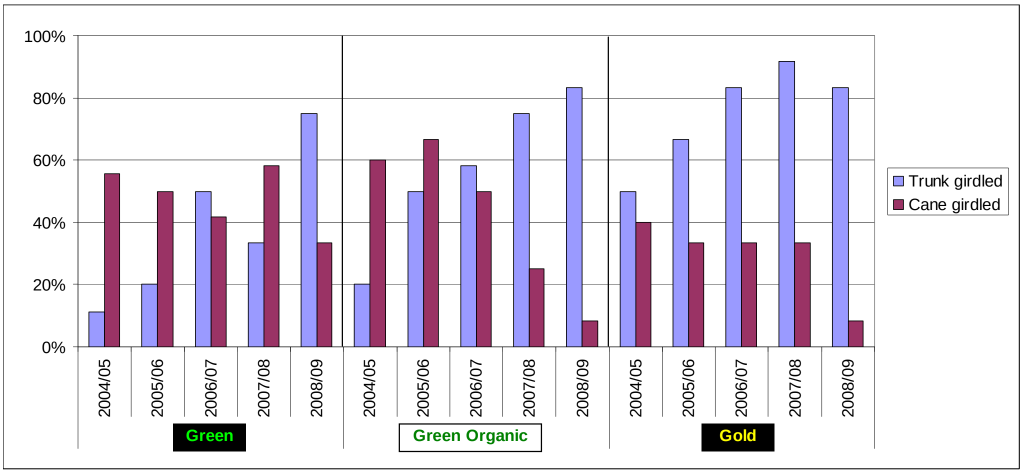
	2004/05	2005/06	2006/07	2007/08	2008/09
Green	11%	20%	50%	33%	75%
Green Organic	20%	50%	58%	75%	83%
Gold	50%	67%	83%	92%	83%

Production system



	2004/05	2005/06	2006/07	2007/08	2008/09
Green	0%	0%	8%	25%	42%
Green Organic	0%	0%	0%	33%	50%
Gold	0%	0%	17%	25%	42%

Production system


100%
80%
60%
40%
20%
0%
2004/05
2005/06
2006/07
2007/08
2008/09
Green
Green Organic
Gold
Trunk girdled
Cane girdled

Appendix 5. Energy indicators for kiwifruit for the 2003/04 production season (Barber and Benge, 2006).

Total Energy Productivity (MJ/1,000 trays)

	Orchard Management		
	Green	**Green Organic**	**Gold**
Direct Energy Inputs			
Diesel	932	1,563	426
Petrol	25	153	264
Oil	8	86	16
Contractors (diesel)	1,035	1,024	983
Total Diesel Equivalent	2,000	2,826	1,689
Electricity	117	1,087	398
Sub Total	**2,117**	**3,913**	**2,087**
Indirect Energy Inputs			
Nitrogen	970	0	732
Phosphorous	56	28	63
Potassium	277	183	236
Sulphur	42	48	53
Magnesium	43	12	30
Lime	26	8	41
Compost & Other	18	267	30
Agrichemicals			
Fungicide	9.0	0.0	3.4
Fungicide - inorganic	0.0	0.0	4.6
Herbicide	34.3	0.0	53.5
Insecticide	152.1	0.0	54.6
Plant Growth Regulator	319.9	0.0	202.3
Biological Control Agent	5.4	138.7	9.6
Oil	0.0	163.0	0.0
Other	1.2	1.9	0.7
Sub Total	**1,955**	**851**	**1,514**
Capital Energy Inputs			
Vehicles	514	1,438	491
Implements	121	446	166
Buildings	126	335	94
Growing structure - Steel	141	209	222
Growing structure - Wood	45	76	39
PVC	0	17	12
PE	52	104	41
Sub Total	**999**	**2,626**	**1,064**
TOTAL	**5,070**	**7,390**	**4,666**

Total Energy Intensity (MJ/ha)

	Orchard Management		
	Green	**Green Organic**	**Gold**
Direct Energy Inputs			
Diesel	8,326	8,010	4,522
Petrol	209	810	2,491
Oil	79	362	95
Contractors (diesel)	8,048	5,062	10,647
Total Diesel Equivalent	16,662	14,245	17,755
Electricity	1,161	5,296	3,292
Sub Total	**17,823**	**19,541**	**21,047**
Indirect Energy Inputs			
Nitrogen	8,258	0	7,488
Phosphorous	471	172	639
Potassium	2,315	836	2,176
Sulphur	382	222	506
Magnesium	380	63	287
Lime	187	26	343
Compost & Other	119	1,260	177
Agrichemicals			
Fungicide	77.1	0.0	34.5
Fungicide - inorganic	0.0	0.0	49.8
Herbicide	265.5	0.0	573.7
Insecticide	1,131.2	0.0	481.9
Plant Growth Regulator	2,729.4	0.0	2,167.5
Biological Control Agent	51.3	951.1	78.4
Oil	0.0	800.2	0.0
Other	8.3	13.5	7.9
Sub Total	**16,374**	**4,343**	**15,012**
Capital Energy Inputs			
Vehicles	4,492	6,474	5,519
Implements	1,059	2,144	1,988
Buildings	1,041	1,510	707
Growing structure - Steel	1,154	1,161	1,759
Growing structure - Wood	379	352	340
PVC	0	63	142
PE	419	413	409
Sub Total	**8,544**	**12,117**	**10,864**
TOTAL	**42,741**	**36,001**	**46,923**