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Complementary pathways to sustainability

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with assistance from Dave Lucock, Glen Greer, Peter Carey, Jayson Benge, Henrik Moller, Jon Manhire, Chris Rosin, Catriona MacLeod, and other members of the ARGOS team since its inception in 2003

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Acronyms
anova - analysis of variance

COS - cash orchard surplus = income minus operating expenditure

C & NC feed – cash and non-cash supplements

C & NC Labour – cash and non-cash labour

DM – dry matter (kiwifruit orchardists receive premiums for achieving high levels of DM)

EOS - Economic Orchard Surplus (difference between income and expenditure which has an adjustment for soil P and unpaid labour)

EFS - Economic Farm Surplus (difference between income and expenditure which has an adjustment for unpaid labour)

FWE – Farm Working Expenses

FWE/GFR - Farm Working Expenses divided by Gross Farm Revenue (a measure of the ‘efficiency’ of the farm because it measures the proportion of the revenue that is spent on the workings of the farm.

GOR = Gross Orchard Revenue (income)

Ha – hectares

NFPBT – Net Farm Profit Before Tax

OWE - Orchard Working Expenses

OWE/GOR – Orchard Working Expenses divided by Gross Orchard Revenue (a measure of the ‘efficiency’ of the orchard because it measures the proportion of the revenue that is spent on the workings of the orchard.

PCA – Principal Components Analysis

SU – stock units

Soil variables – AMN – Anaerobic Mineralisable Nitrogen, C – Carbon, K- Potassium, Mg - Magnesium, N – Nitrogen, S - Sulphur

1 Introduction and rationale

The ARGOS programme is a study of New Zealand sheep/beef and dairy farms and kiwifruit orchards that examines the sustainability and resilience of New Zealand's farming - economically, socially and environmentally. In completing ARGOS1, additional and more intractable sustainability concerns (e.g. climate change and carbon emissions, RMA, animal welfare) have been identified by both the preliminary research and through discussion with industry partners, as key emerging pressures on management practices. In such cases, the pathways to enhanced performance are not exclusively organised around market assurance schemes, but are often structured around regulatory responses, eliciting a separate and substantial set of economic, social and environmental impacts in the primary production sector to that studied in ARGOS1. In addition, cross-cultural comparisons among ARGOS participants has demonstrated the often-essential role of differing philosophical approaches to agricultural practice, which affect the mix of concerns (environmental, social and economic) that influence management actions. To account for the broader spectrum of pathways that influence management, ARGOS 2 will examine the characteristics and outcomes of various pathways to sustainability. This will include an in-depth analysis of intensification of production as an example of a type of response to complementary pathways and the impact on sustainability. The results will be reviewed to clarify the relative effectiveness of the various pathways and tools on farmer behaviour, environmental outcomes and meeting stakeholder's expectations.

1.1 ARGOS 1

The work of ARGOS has mainly been involved in two sectors – kiwifruit and sheep/beef. The kiwifruit study has been of 36 orchards at 12 locations - Kerikeri (1), Bay of Plenty (10) and Motueka (1). At each location there are three ARGOS orchards under management systems associated with growing green, gold and organic green kiwifruit. For the sheep/beef study there are 36 farms based at 12 different locations throughout the South Island. At each location there are three farms using conventional, integrated and organic management systems. However, in ARGOS 2.1, we have moved on to study the sustainability of these orchards and farms independent of management system.

Up until 2009 the ARGOS study (ARGOS 1) has been concerned with comparing the difference between management practices associated with audit systems in the kiwifruit, sheep/beef and dairy sectors of New Zealand's agriculture. Now in ARGOS 2.1 we are concentrating on how famers have changed their farming practices and why.

1.2 ARGOS 2.1

1.2.1 Summarising the results from the retrospective interviews: complementary pathways to sustainability

The first part of ARGOS 2.1 has been based on retrospective interviews of ARGOS famers and orchardists which were conducted to find out how they dealt with shocks over their time in farming (Sanne et al., 2011a) and orcharding (Sanne et al., 20011b). This work also revealed the different pathways farmers and orchardists had taken to manage and overcome shocks that had impacted on their farming and orcharding systems.

Sheep/beef farmers are resilient and flexible. The sheep/beef retrospective interviews revealed that ARGOS farmers' responses to shocks - including the impact of Government policy and the lower returns they have been receiving for their animal-based products – resulted in many farmers making changes which gave them greater flexibility to respond to future shocks and diversified their product range. This flexibility is such that ARGOS farms reveal no common patterns of meat production – variability being the norm.

The tenure review process is having a negative impact High Country farmers, mainly due to the length of time taken for individual farms to get through the process (see Hunt et al., 2012). It provides an example of how government policy needs to be clear from the start, consistent and fair to all, and managed in a timely fashion. Long-term policies need to have obtained some consensus between government parties before their implementation.

The single desk marketing organisation ZESPRI has managed a robust kiwifruit industry which has enabled different kinds of people to participate with a sense of satisfaction. However the sustainability of the industry is challenged by the coming together of several challenges – psa, the declining market value of Hayward green kiwifruit and the value of land.

1.2.2 Implementation pathways: changing practices to manage risk and enhance chances of survival

Elements of sheep/beef farmers' pathways to sustainability on-farm included:

- Increasing lambing percentages by breeding genetics.
- Scanning pregnant ewes to better manage nutritional requirements.
- Stocking rate flexibility - destocking at certain times of the year to manage anticipated drought periods, by earlier lambing, faster lamb growth through better feed etc., trading in stock to manage feed availability.
- Keeping greater stocks of silage, baleage and growing feed crops, to have on hand sufficient feed for winter or drought periods.
- Increasing farm size by purchase or lease of land to provide a run-off for summer.
- Adding irrigation, or increasing the area already irrigated.
- Diversification – changing the balance of sheep and cattle, providing dairy support, growing for meat rather than wool, growing contract crops only, animal trading.
- Reducing fuel consumption by employing low till techniques.
- Belt tightening – reducing fertiliser input, reducing costs.
- Focusing on efficiency - seeing farm as a business.

Off-farm elements included:

- Off-farm work. (Female partners often work in their own right and though this may not be to complement the farm's finances, it does this none-the-less.)
- Restructuring of finances. Many wanted to earn sufficient income to help them prepare for succession by investing off-farm.

High country farming is also changing: The retrospective interviews of the High Country farmers illustrated the many different forms of farm ownership available. Farmers can now own or lease land under different arrangements. In anticipation of tenure review taking a certain length of time and resulting in a surplus due to the exchange of high altitude land for freehold rights, those involved had planned ahead by buying land, investing in irrigation and decreasing wether stock. This implementation of strategic planning has left them with hundreds of thousands of dollars of unexpected debt because the tenure review process has taken so much longer than expected. In consequence they have lost faith with Government. As the fine wool market has been through a long period of poor market returns, High Country farmers are taking a particular pathway to sustainability through:

- Diversification - producing both meat (merino lambs and beef) and fine wools, developing a niche market for merino meat.
- Intensification - finishing stock themselves on irrigated and cultivated land, growing their own supplementary feed crops.
- Long term contracts of 3- 5 years for fine wool with companies like Icebreaker, with whom farmers develop personal relationships.

In the Kiwifruit industry ZESPRI leads from the front and orchardists follow: The kiwifruit retrospective interviews were carried out before the discovery of PSA on orchards. Pathways to sustainability have been imposed by ZESPRI as it has responded to what they have viewed as market demands. In return orchardists have responded to these demands with their own pathways. These have included:

- Off-orchard work – which is more readily available in the areas where kiwifruit is grown.
- Response to labour shortage by changing pruning techniques.
- Response to Taste ZESPRI by the development of controversial vine girdling techniques. Some orchardists are not practicing them or now reducing this practice because of concern about the impact on vine health long-term.
- Continued support for the single desk structure of ZESPRI.
- Response to GlobalG.A.P.is now incorporated into practice after initial fears of some orchardists about being restricted to book work. For younger orchardists such audit practices are just part of being a contemporary business.
- Response to KiwiStart is mixed. This was expressed as concern about the quality of early season fruit.

1.2.3 Recommendations

From the analysis of the retrospective interviews it is suggested that:

- Farmers and orchardists want to ‘do the right thing’ and expect in exchange that the ‘right thing’ will be done to them.
- The autonomy of farmers and orchardists should be respected. They need to be given choices not commands, goals and various ways of getting there.
- There is a need a diversity of practices acceptable to orchardists and farmers so they can choose and match their practices to the situation they find themselves in.
- Recommended practices should demonstrate – possibly visually – what a ‘good’ farmer or orchardist someone is. (This is part of establishing a reputation and hence being trusted in the industry community.)
- Where possible industry partners should form personal relationships with farmers and orchardists, keeping them in touch with the quality of their products, promoting loyalty and pride in their product (e.g., Icebreaker).
- There needs to be an awareness of the different seasonal opportunities in contracts dependent on location (e.g., KiwiStart).
- It would be more useful to farmers and orchardists to have contracts that provide continuity over several years (e.g., Icebreaker, and dairy and kiwifruit – minimum payments and top ups later).
- Farmers’ and orchardists’ resilience should be encouraged by supporting their adaptability, flexibility, experimentation, ability to see the feedback loops, breadth of

social and environmental view (awareness of reach of impacts of practices economically, socially and environmentally), and alternative practices.

1.2.4 Findings in the context of New Zealand and international research

There is international interest in the way ARGOS is comparing organic farming with other management practices. This places organic farming in a broader context in which it influences and is influenced by the practices of other management systems to increase the sustainability and resilience of the agricultural sector as a whole (Hunt et al., 2011). The ‘good farming’ approach used by ARGOS researchers, in which it is assumed that farmers have an inherent desire to fit into culturally acceptable ways of practicing farming, is a new way of thinking about farming in comparison to the standard farm management literature (e.g., Hunt, 2010).

1.2.5 This report: review of ARGOS results to clarify the relative effectiveness of the various pathways and tools for promoting change

This present report now examines the complementary pathways (apart from audit) that the ARGOS kiwifruit orchardists and sheep/beef farmers have taken to ensure they have survived through the time of the ARGOS study so far (2003 to 2011). It does this by examining statistically the hard data gathered over the period of ARGOS (2003 to 2010) from all aspects of the ARGOS research. That is it uses farm management, environmental, economic and social data.

ARGOS now has data that covers a reasonable period of time. It was decided that an exploration of how the ARGOS farms and orchards have changed over that time and what that change might be associated with would reveal what pathways farmers and orchardists have taken to survive through the past eight years. Farmers/orchardists may already be doing certain things well as they thought they could, and so be seeking to maintain those things rather than improve on them, so it was realised that the analysis needed to study absolute values over time (variable means) as well as change. The first analysis was of the kiwifruit data as the sheep/beef farming system is rather more complex and a first look at the meat production data showed complete variability over the past few years. That is, farmers were constantly adjusting their systems in terms of how many stock they finished/sold/bought etc. This introduced another way of looking at the data – how variable was it? Were farmers and orchardists constantly adjusting their practices or were they doing the same thing year after year? The obvious analysis was to find whether there were different patterns of practice followed by groups of farmers/orchardists which were resulting in differing outcomes over the time of the ARGOS study so far.

Pathways to sustainability indicate resilience over time. Core variables were chosen to develop groupings of farmers and orchardists that would hold together to form separate indices of resilience associated with intensification, capital value, efficiency and sustainability. Cluster analyses on a reduced number of variables composed from principal components analysis produced different groupings of farmers and orchardists associated with averages, change and variability of the core variables. Further characteristics of these groups were then found by analysis using as many relevant variables from the ARGOS research.

The next chapter outlines the core variables chosen, and the methods used to analyse the data, particularly the statistical techniques. Two further chapters detail the kiwifruit and sheep/beef sector results. The results are then discussed and a conclusion completes the report proper. All the associated tables are located in two Appendices.

2 Method

What follows is a full description of the methods used and the decisions made to analyse this comprehensive ARGOS data set. This is not usual and many readers may wish to skip to the next chapter of the report. It is included because the author wishes to make clear all the decisions that were made in this analysis to indicate that statistical analysis is not the objective exercise it usually purports to be in the scientific literature. All numbers and analyses involve choices made by the data collectors and the analysts of that data, and all analyses need to be interpreted by people who draw on their understanding of the data and its background.

2.1 An index approach?

After discussion at an ARGOS meeting in August, 2011, when people added variables that they thought should be included in the core analysis, it was decided to construct indices of intensification, capital, efficiency and sustainability through using averages, measures of the annual rate of change (slope of regression line per year) and variability for each of the core variables. However when these variables did not work as single indices for the initial sheep/beef analysis, the approach to the kiwifruit data was adjusted - still focusing on these concepts but doing separate analyses for the average, trend and variability data.

2.2 To standardise and if so what to standardise?

At first each variable was adjusted to try to get a measure that was comparable across management systems. This was done by standardising each variable within each management system. However, it was realised that the interest of this research was focused on pathways to resilience and sustainability and therefore any analysis should be independent of management system. Some key questions are which farms were producing enough in a sustainable way to make them resilient, what changes were being made and how consistent were farmers over the years? Therefore there was no need to standardise the variables to remove the effect of management system. In addition, the procedure for Principal Components Analysis (PCA), if based on correlation matrices, did not need to use standardised variables, so the raw variables were the basis of the analyses.

2.3 Measuring variation

At first it was suggested that the Coefficient of Variation[1] (CV) should be used as a measure of variation within each variable. However, this works well in a scientific data set containing measures of physical phenomena, but the ARGOS data set contains financial variables which can cover a wide variation and sometimes occur as a loss – in other words, they had a negative value. This means that sometimes the mean averages out to be a very small figure approaching zero, while the variation can be quite large in comparison, which makes the CV a very large value approaching infinity! Therefore, it was decided to use the standard deviation (s.d.) as a more consistent and useful measure of the variation of a variable in this situation.

[1] CV = s.d./mean

2.4 Choice of kiwifruit variables

A Principal Components Analysis requires a full data set with no missing data. This placed a limit on which variables were available to be chosen as the core variables for the initial PCA analysis and also constrained the number of orchards which could be included.

As measures of 'intensification' the variables used were:

- Economic Orchard Surplus per hectare (EOS/ha),
- Cash Orchard Surplus/ha (COS/ha),
- trays of fruit produced[2], and
- percentage of orchard canopy area producing Green (Hayward) fruit.

Included in ARGOS is a panel of Gold (Hort16a variety) orchards but some of these orchards are also growing Green kiwifruit (Hayward variety). From earlier analyses and interviews the ARGOS team has determined that the orchardists who grow only gold fruit tend to be different from those that grow both gold and green, the latter being more conservative in their practices and in their propensity for risk taking, being more like the orchardists who grow only green fruit. Hence the latter variable, percentage of canopy producing Green fruit, can be thought of as a measure of intensification because a Gold canopy area produces more kiwifruit on average than the same area of Green canopy.

On the advice of Jayson Benge, the ARGOS kiwifruit field research manager, measures of 'capital' used were:

- the canopy area of the orchard, and
- soil resource measured by pH, Olsen P, percentage nitrogen (N%), potassium (K) and sulphur (S).

Kiwifruit production is improved by the addition of potassium and sulphur to the soil so if the soil has a good measure of these soil attributes it can be valued as a capital resource. Equity could also be regarded as a measure of capital but it was only available for about half of the orchards[3] which would have reduced the number of orchards able to be used in the PCA analysis, so this variable was not used as part of the core analysis.

Measures of 'efficiency' were:

- the ratio of the Cash Orchard Expenses to Gross Orchard Revenue (COE/GOR) and
- EOS/tray – the surplus/profit made for each tray of fruit produced.

It did not make sense to have a measure of sustainability in terms of the profit made per orchard because of the different arrangements of the ARGOS orchard ownerships (see footnote about equity below). Some ARGOS orchardists expect to make their living from their orchards but many others do not fit into this type of ownership pattern.

[2] Trays/ha is the standard measure of kiwifruit production and is equivalent to weight of fruit produced because each tray carries a certain number of fruit according to the fruit size, and so each tray has an equivalent weight (approx. 3.5 kg). Hence fruit size is measured by the number of fruit that fit one tray. Therefore the larger a fruit size the smaller the measure, i.e., a fruit of count size 33 is smaller than a fruit of count size 30.

[3] Note that kiwifruit orchards are rather different from sheep/beef farms. Some of the ARGOS orchards are parts of a much larger whole – for example several are part of orchard or farming businesses which produce other things apart from kiwifruit. Some of the ARGOS orchards are just the gold orchard part or the green part of an orchard under single ownership. Thus it does not make sense to have an equity measure for these orchards.

Other variables of interest were:

- dry matter (DM) which is a measure of quality on which a TasteZespri premium is paid
- fruit size.

ZESPRI has decided through its market research (Jaeger et al. 2011) that fruit size is not as important as taste so the premium paid on size is smaller, however, it is still regarded by some as important, and could be regarded as a measure of efficiency or of intensification if an orchardist can get the same number of fruit off an area but the fruit are larger.[4]

After calculating all these additional variables (change, variation), it was found that a lot of the slopes were not significantly different from zero because there was so much variability over the years. Also, some of the data was just based on three dates of measurement spread over this time period (e.g., soils, bird densitites), therefore measuring slopes and variability over these years was not necessarily very meaningful, so these variables were omitted from the analysis of change.

2.5 Choice of sheep/beef key variables

As stated earlier, a Principal Components Analysis requires a full data set with no missing data. This placed a limit on which variables were available to be chosen as the core variables for the initial PCA analysis and also constrained the number of farms which could be included.

The sheep/beef farming system is rather more complex than a kiwifruit orchard and the meat production data showed complete variability over the past few years, with no discernible trend - that is, farmers were constantly adjusting their systems in terms of how many stock they finished/sold/bought etc. So for the sheep/beef analysis, after consultation with Glen Greer (ARGOS collector and analyst of financial data) and Dave Lucock (ARGOS Sheep/beef Field Research Manager), it was decided to form the groups of farmers on 14 key variables.

As measures of 'intensification' the variables used were:

- Economic Farm Surplus per hectare (EFS/ha)
- Net Farm Profit Before Tax per hectare (NFPBT/ha)
- total carcase weight sold per ha (tcws/ha),
- percentage of farm revenue gained from cropping (crop%)

Total carcase weight sold is a measure of production and was used because it is a better measure of meat produced than live weight.

Measures of 'capital' used were:

- effective farm area in hectares
- percentage of equity
- soil resource measured by pH, Olsen P, percentage nitrogen (N%).

Measures of 'efficiency' were:

- the ratio of the Farm Working Expenses compared with Gross Farm Revenue (FWE/GFR)
- Economic Farm Surplus per stock unit (EFS/su)
- Net Farm Profit Before Tax per stock unit (NFPBT/su)

[4] Note, orchardists prune with the goal of obtaining a certain number of buds on a vine, so an increase in fruit size would increase the number of trays produced off a certain area.

- lambing percentage (lb%)

A low FWE/GFR ratio indicates a farmer who is keeping costs down with respect to the total revenue the farm makes. (This is a measure of the efficiency of production.) The profit made per stock unit is another measure of efficiency and a ewe is regarded as more efficient if she is able to produce more lambs.

Measures of sustainability

- Economic Farm Surplus per farm (EFS/f)
- Net Farm Profit Before Tax per farm (NFPBT/f)

The only measures of sustainability that we have available at this stage, apart from some of those above, was that of financial sustainability. Were a farming couple able to make a sufficient living from their farm, whatever its size, for them to have a reasonable standard of living that enabled them to continue farming?

A summary of the slightly different core variables for the kiwifruit and sheep/beef analyses are shown in Table 2.1.

Table 2.1: Summary of core variables used

	Kiwifruit	**Sheep/beef**
Category	**Core variable**	**Core variable**
Intensification	E0S/ha	EFS/ha ($)
	COS/ha	NFPBT/ha ($)
	Trays/ha	Carc wgt/ha
	% Green	Crop %
Capital	Canopy area (ha)	Effective area (ha)
		Equity %
	pH	pH
	Olsen P	Olsen P
	N %	N %
	K	
	S	
Efficiency	COE/GOR	FWE/GFR
	EOS/tray	EFS/su ($)
		NFPBT/su ($)
		Lambing %
Sustainability		EFS/farm ($)
		NFPBT/farm ($)
Others	DM	
	Size	

2.6 Method of analysis

1. Calculation of averages, trends (annual change), and variability

Averages, average annual change and variation as measured by the standard deviation (s.d.), were calculated over the years for which we have data (for kiwifruit: 7 years for financial data, 10 years for production data, 8 years for DM; for sheep/beef: 6 years for financial data – 2002/3 to 2008/9, 4 years for carcase weight - production data – 2006/7 to 2009/10, 6 years for lambing %, 2004/5 to 2009/10). Correlations of each set of variables were determined. Much of the annual change data was not significantly different from zero (i.e., did not indicate that practices or results had changed over the years for which we have measurements).

2. PCA

Separate Principal Components analyses were carried out for each set of variables – averages, trends and variation.

A Principal Components Analysis (PCA) reduces a data set of variables to a lesser number of independent variables which explain most of the variation. This is done by combining variables that are measuring the 'same' thing – that is, they are correlated. If these combined variables are easily interpreted, that is it they can be logically connected, the complexity of an analysis which would have otherwise had many more variables is reduced.

3. Cluster analysis

Cluster analyses were performed on the principal component scores for each analysis. A cluster analysis does the same as a PCA but for the units that make up a variable, in this case the measurements associated with each farm or orchard. Hence from this analysis we obtain groups of farms or orchards that have similar measurements on each Principal Component (PC).

4. Determining the cluster group characteristics

Unbalanced anova analyses were carried out on the original data using the groups determined by the cluster analysis. This showed how these groups played out in real values in the original data, to understand the implications in 'real' life of this grouping (rather than using the combined Principal Component scores which do not have clear meaning).

One issue here was that some of the averages of the financial variables were not significantly different from zero as some orchards suffered losses rather than profits over the years for which this data was collected. As each cluster group average was only calculated for the data in its group any test of whether it was significantly different from zero only involved the variation of the data in that particular group (which may have only had 2 or 3 members) it meant the boundaries of the mean were often very wide because only a few degrees of freedom were involved. An alternative would have been to calculate the overall standard deviation and use that as an estimate of the s.d. of individual clusters/groups but no stats programme appears to do this and there have been so many analyses it would have been to labour intensive to do by hand! As a result in the tables the means that are not significantly different from zero have been bracketed, and are still taken account of in the commentary but less emphasis is placed on them.

5. Finding out how these groups differ in other on and off orchard/farm characteristics

The other collected variables were then analysed across the groups using unbalanced anovas. For the kiwifruit analysis this included eight further financial variables, eight further soil variables, four bird density variables and 100 attitude variables. For the sheep/beef this data included 14 further financial variables, four farm management variables, 21 fertiliser applications, three further soil variables and 100 attitude variables. This number of variables can then be multiplied by three because the mean, annual change and standard deviation (variability) was used for each variable. In addition of course, these variables had been in turn calculated from at least two years and up to 10 years of data.

2.7 Leaving out an outlier in sheep/beef

It was also decided at the August meeting to leave out one of the conventionally managed farms because the cluster analysis was always putting this farm into a group of 1. On investigation this turned out to be farming family which had just been foreclosed on by their bank. Why this has happened was quite apparent in the analysis – this farm had by far the highest FWE/GFR ratio – well over 100%, however, it had the highest average total carcase weight sold/ha and the lowest variation in lambing percentage. The transport costs were exceptionally high because of where the farm was located and that was compounded with the fact that the farmer was trading in stock. Perhaps this farm business is a lesson that farming also happens in a geographical context which has implications beyond the weather and physical attributes of the land.

2.8 Reading the tables

This report is full of a lot of dense information in tables as this is the most concise way of presenting a lot of information. The tables have been placed in two Appendices at the end of this report – Appendix 1 for the kiwifruit results and Appendix 2 for the sheep/beef results.

1. The tables use Duncan's Notation to indicate significant differences between groups. The lower case letters placed as suffixes above means presented in the table indicate whether group means are significantly different at a 5 percent level, if they do not have a suffix in common. If these suffixes are bracketed it means there is a difference at a 10% level of significance.
2. This analysis uses least significant differences (lsds), the equivalent of t-tests. Some would argue that account needs to be taken of the fact that these analyses have used hundreds if not thousands of significance tests over hundreds of variables, and so it would be expected that at least 5% would show significance anyway, as a matter of chance. Account has not been taken of this. The author has choosen instead to make overall sense of the results, so that if one does not fit with what else appears to be happening, it has not been commented on as of importance.
3. Many numbers in the tables are bracketed. This has been used to indicate that this number is not significantly different from zero – that is, the 95% confidence interval for this mean included zero. So, for instance if measuring profit, and the mean is bracketed, it cannot be stated that it is likely that this group is making a profit. If it is an annual trend mean that is bracketed then it can be stated that it is unlikely that there is an average change over time occurring for this group. Similarly, if it is an average of standard deviations (s.d.) as a measure of variability or consistency over time that is bracketed, then it can be stated that it is likely this group has had a consistent level of profit from year to year. However, some of these non-significant means can then be declared to be significantly different by the analysis. This comes about probably because the calculation of the standard error of the differences, and hence the lsd, is a tighter analysis using all the available degrees of freedom for the full data set, whereas the calculation of the confidence interval for a single group mean probably has used only the data used to find that mean. For example, some of the groups have only two members, and the confidence interval for the group mean was calculated using (group mean ± t_1 s.d./$\sqrt{2}$) where the s.d. is just calculated from the two data points, whereas testing the difference between two means used an lsd calculated from all 24 data points (if sheep/beef) or 29 if kiwifruit.
4. Some cells in the tables are highlighted. Yellow indicates the highest significant group mean, while green indicates the lowest mean. In this way, overall patterns can be identified more easily! For example, it can be seen if a group is consistently producing the lowest or the highest values. In a black and white print out of this report these colours show up as lighter and darker for the yellow and the green respectively.

5. The p-value in the last column represents the probability, taken from the anova, of whether the factor group is statistically significant overall, i.e., is there an overall difference between the groups decided by the cluster analysis. Sometimes an individual difference has been found between two groups even though there is not an indication of an overall difference.[5]

The next two chapters report on the results of the kiwifruit and the sheep/beef analyses.

[5] This is a matter of statistical discussion. Some statisticians would say you should not even look for differences unless this value is significant.

3 Results of Kiwifruit Analysis

3.1 Correlations

3.1.1 Correlation of averages

The table from which the following comments are drawn is Table 3.1 which can be found in Appendix 1. It appears that for kiwifruit the canopy area is strongly reflected in the financial statistics – that is the orchard size affects the financial efficiency of an orchard – the larger the orchard, the greater its profit (EOS/ha, COS/ha, EOS/tray) is likely to be, and the lower the EOS/GOR ratio. This is also reflected in the other financial statistics such as the greater the profit, the lower the EOS/GOR ratio.

It is reassuring to see obvious things reflected in this data, such as the average number of trays of fruit produced per ha is related to the average size of fruit produced – the larger the fruit (the more trays/ha, as would be expected. Also, as we know, gold vines produce more fruit per ha, have a higher DM on average and are usually larger, and this is reflected here, i.e., the proportion of an orchard that is green is negatively related to the average number of trays/ha and the DM but positively related to fruit count size. In other words, as the proportion of Gold increased, the number of trays, dry matter and fruit size all increased.

In terms of the soil measurements it would appear that the percentage of N and the soil K are positively correlated and that soil K also correlates with the pH. The soil S measure also correlated with N% and soil K. Annually, orchardists typically apply combinations of fertiliser products with the aim of supplying these nutrients so these results are not surprising.

More intriguing is how COE/GFR correlates negatively with pH and positively with soil S. That is the less that is spent as a proportion of revenue the higher the pH.[6] It would seem that a higher soil S costs an orchard. This is also reflected in the greater the COS the lower the soil S, which could be an indication of the cost of S fertiliser.

It is also intriguing that DM is negatively correlated with fruit count size meaning that the bigger the fruit the higher the DM. The opposite might be expected given that larger fruit might be expected to contain more water due to practices such as the use of N fertiliser.

Fruit DM is negatively correlated with soil pH, which could indicate that DM increases with a lower availability of soil nutrients. However, DM is not correlated with orchard returns, which could have been expected as a premium is paid for high DM fruit.

3.1.2 Correlation of change over time

When looking at the changes orchardists have made over the time (Appendix 1,Table 3.2) of the collection of this data (9 years for financial data, 10 years for production data and 3 years for soil data) it can be seen that lifting DM correlates with lowering profitability and production, and increasing the COE/GOR ratio. The first and last two issues are confounded with the dropping value of kiwifruit over the past few years, whereas the changing production probably reflects that the increased payment for DM means that orchards have focused less on production in order to increase their DM content. It implies that producing higher DM may have either increased an orchard's working expenses or decreased GOR, or both.

[6] If there is a relationship between COE per se and pH, then perhaps orchardists are applying less fertiliser that would otherwise decrease pH as some fertilisers acidify the soil.

Changes in the financial statistics are reflected in the correlations between these variables and their links to changes in production. Increasing production also results in a lowering of the COE/GOR ratio, indicating increased efficiency.

Keeping in mind that the soil measurements of annual change are only based on 3 years of data (2004, 2006 and 2009) an increase in pH is related to a reduction in the COE/GOR ratio, indicating increased efficiency. This result is also a dilemma and possibly related to changing the DM as indicated above, i.e., is the increase in pH due to lower inputs of fertilisers that would otherwise lower pH? Increasing soil K is correlated with a decreasing DM. This is also a curious result as it is known that KF make a heavy drain on soil potassium.

3.1.3 Variability over time

As would be expected variability in one financial measure is reflected in the variability of other financial measures (see Table 3.3). The variability in production is related to the variability of fruit size, but what is surprising is that this does not seem to reflect on the variability of the profitability or the efficiency of the orchard's financial arrangements, which probably indicates some smoothing capacity of the orchardist to maintain financial consistency.

A varying Olsen P measurement is reflected in the variation of soil N, and in a varying DM. A varying DM reflects in the variability of the profit made per tray (EOS/tray) but not on other financial measures.

3.2 Analysis of averages of kiwifruit data

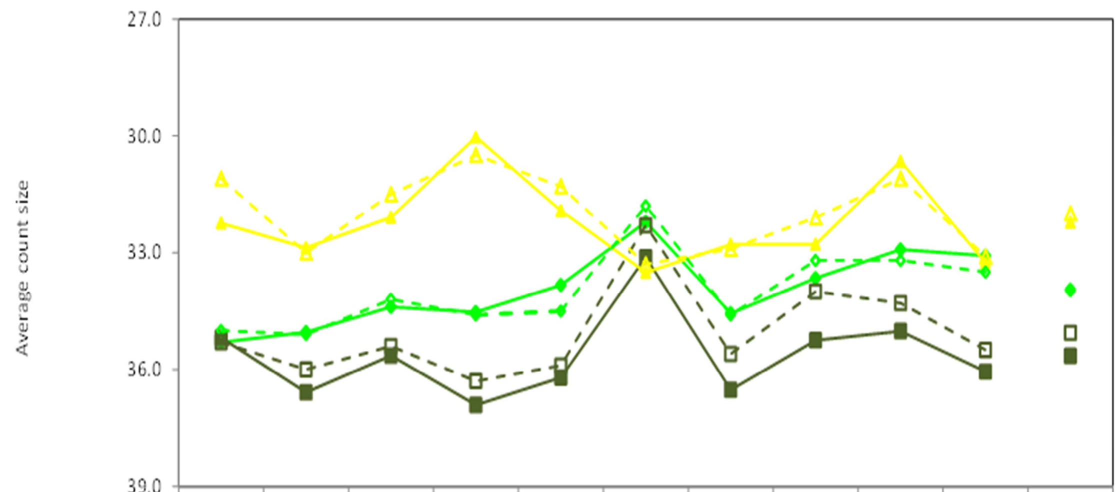
3.2.1 Overall changes over the years of ARGOS

Before analysing the data into groups it is useful to examine the context in which kiwifruit growers have found themselves over the past 8 years and to consider overall responses to that context. The ZESPRI annual report for the year ended 2011 notes that the 2009/10 year was a challenging one and that uncertainty will continue with the psa incursion and the continuing volatility of the exchange rate (ZESPRI, 2011). Figures in the annual report (pp.3-4) show the variability of orchard gate returns (per tray and per ha) with the rather extraordinary increases in payments for Gold fruit eclipsing the more stable but much lower payments for Organic Green and Green fruit in the last two years. (In contrast the ARGOS data is adjusted so that prices are based on those in the year 2009 so that they are more comparable and if ZESPRI had done this the prices returned to orchardists would probably show a decline.)

The following analyses (see Table 3.4), like those that follow it, make no distinction between green, organic green and gold kiwifruit orchards. The next table shows the overall average annual change in the variables is analysed in more detail later. Gross Orchard Return/ha (GOR/ha) is the only measure which incorporates returns from the market over which orchardists do not have any control, however, orchardists do of course, have a certain amount of control over how much they produce to send to the market. All other variables can be seen as partial responses to the global market context in which orchardists find themselves. (Other things over which orchardists have no control are the type of base soil resource of their orchard, the weather and other associated climate variables. It is proposed that classifications be studied as part of ARGOS 2.2.) Some components of orchard working expenses such as fuel, sprays and chemicals will be associated with externally driven, rising prices, but this is confounded by the choice orchardists make with regard to how much of these products they use.

For the ARGOS orchards in this sample, the GOR/ha has not changed significantly over time, but the confidence interval indicates the wide variability of this mean. However, when this mean is adjusted to take account of expenses to get a measure of the profit, EOS/ha has not changed for Green and Gold orchards but has dropped for Organic Green. When profit is measured by COS/ha both Green and Organic Green have experienced a drop in profit. At the same time the overall production (trays/ha) has increased, indicating a major response to falling profits is to increase production – to intensify. This is partly indicated by the decrease in the return per tray (EOS/tray) for Organic Green. Over this period the overall soil resource has increased with increases in pH, Olsen P, N % and K. At times this is revealed partly as a result of the increased power of the larger sample size when all 29 orchards are included in the analysis. The only measured element that has not increased is K for Organic Green orchards. This is because it is difficult for organic orchardists to find a good source of K that complies with organic standards. The efficiency of the orchard operation has not changed significantly over the period for all orchards but when organic were considered separately their efficiency had actually become slightly worse. Organic orchardists had actually increased their DM % over the period but the Gold orchardists dropped theirs. The later trend is largely a consequence of high DM early on when the Gold plants were not yet fully mature (See Figure 1). Overall there was no change in size or DM.

Figure 3.1: Average count size of export fruit from ARGOS and industry orchards 2001-2010.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average
ARGOS Green	35.3	35.0	34.4	34.5	33.8	32.2	34.6	33.7	32.9	33.1	34.0
ARGOS Green Organic	35.2	36.6	35.6	36.9	36.2	33.1	36.5	35.3	35.0	36.1	35.7
ARGOS Gold	32.2	32.9	32.1	30.0	31.9	33.5	32.8	32.8	30.7	33.3	32.2
Industry Green	35.0	35.1	34.2	34.6	34.5	31.8	34.6	33.2	33.2	33.5	34.0
Industry Green Organic	35.3	36.0	35.4	36.3	35.9	32.3	35.6	34.0	34.3	35.5	35.1
Industry Gold	31.1	33.0	31.5	30.5	31.3	33.3	32.9	32.1	31.1	33.1	32.0

Source: Jayson Benge.

In terms of orchard expenditure, electricity, pollination and vehicle and fuel costs had increased overall, and contributed to the rise in COE/ha. Expenses due to repairs and maintenance had dropped overall indicating one response to the rising expenditure costs over which orchardists have little control (except to use less of them) is to cut down on repairs and maintenance. There was no indication the overall amounts of fertiliser applied had dropped, but Gold orchardists had reduced their Mg and P applications. Though there is an indication that spray and chemical and fertiliser costs had not changed significantly (which probably means that as these costs rose, orchardists used less), it is apparent that Organic Green orchardists cut their spray and chemical costs, while Green orchardists increased their fertiliser costs. (Analyses of results according to management system are reported in greater detail and are available on the ARGOS website.)

3.2.2 PCA analysis of averages of core variables

For the first analysis (of averages) the data reduced to four Principal Components (Table 3.5) so each orchard in the data set was assigned a score on each of these PCs. In the table the highlighted cells indicate the variables that are a major influence on each principal component. It can be seen that the first principal component, PC1, measures profit and efficiency of production in financial terms, with canopy area now being seen to be associated with financial efficiency. In contrast PC2 measures production, with a negative association with whether an orchard is mainly producing green or gold fruit, a positive emphasis on DM and larger fruit. The third component measures the soil resource except for pH, and the fourth the soil resource associated with pH and soil K. This seems a very satisfactory allocation, easily interpreted across the variables.

3.2.3 Cluster analysis of averages of core variables

A cluster analysis carried out on the four PCs of the 14 averages of the core variables for each orchard (Table 3.6). The 5 cluster solution was chosen because it separated the orchardists into more contrasting and interesting groups. The following descriptions of the groups formed by the cluster analysis are obtained from anovas carried out firstly, on the original core variables from which the PC scores were formed (Table 3.7), secondly on the annual change (Table 3.8) and variation of the core variables (Table 3.9), thirdly, on the other financial and orchard management variables we have collected (Table 3.10), fourthly on the bird intensities calculated from three different periods of observation and counts made on birds on the orchards (Table 3.11), and finally on the attitude data obtained from a survey carried out in 2008 (Table 3.12). The tables summarising the full results of this data can be found in Appendix 1.

Group 1 – poor production, challenging environment
Members: 1A, 5A (2 green)[7]

The measures of the PCs (Table 3.6) indicate that this group has lower productivity and the lowest soil resource in terms of pH and K, compared with the others. Accordingly, looking at the analysis of the averages of the core variables in the PCA (Table 3.7), Group 1 has one of the lower COS/ha, is the most acidic (lowest pH) and has a lower K soil measurement. It has the greatest average canopy area. Both these orchards are in challenging locations – Kerikeri and at a higher altitude in the Bay of Plenty. However, the matching gold orchard (5C, Group 4) is doing very well, but the matching organic orchard (5B, Group 3) is also struggling, possibly due to the high altitude environment, but it is in Group 3 because it has a high soil resource. Group 1 also has one of the more variable COS/ha which is reflected in the high variability of the production (trays/ha) (see Table 3.9).

Group 1 has the lowest expenditure on electricity and fertiliser, and the highest expenditure on pollination (which may be due to location). This group has the lowest density of introduced insectivorous birds which also may be a location effect.

In terms of attitudes this group is one of those that places a high importance on things associated with biodiversity and environmental wellbeing – soil biological activity, having a diversity of native birds, plants and trees, taking responsibility for encouraging birds, enhancing

[7] The orchards are identified by 'cluster' or location – numbers 1 to 12, and then by management system where A represents and orchard growing green kiwifruit, B represents one growing green kiwifruit organically, and C represents one growing Hort 16A or gold kiwifruit.

stream health with trees and shrubs. The two orchardists in this group were most supportive of using trees to make their orchards look attractive and they expect to be orcharding for a long time.[8] They have no debt.

Group 2 - low performing, inefficient, inconsistent and poor soil resource
Members 1C, 6A, 6C, 7A, 7C, 8C, 11A, 11B (3 green, 1 organic green, 4 gold)[9]

According to the cluster analysis this group should have the lowest financial averages in terms of both profit and efficiency, the least soil resource in terms of N%, Olsen P, K and S, and the smallest orchards. The analysis of core variables indicated that indeed Group 2 made on average, the greatest loss per hectare and was the least efficient (highest COE/GFR, greatest loss for each tray of fruit produced), it had the least canopy area, lower N% and K but the highest Olsen P measurement.[10] The lower soil nitrogen appears to be recognised by the orchardists in this Group 2 because this group also has the highest application of N fertiliser.

When considering the trend and variation variables (Tables 3.8 and 3.9), Group 2 had the least change (and the lowest variation) in the soil percentage of N, but the greatest variation in production, efficiency, fruit size and in the amount of S fertiliser applied[11]. This demonstrates that they consistently apply the same amount of N fertiliser each year but that many other factors influence their production and returns.

We know that Cluster 11 (2 orchards in this group) was badly affected by frost in the early years of ARGOS and this may have contributed to the large variation seen in production and fruit size.

Group 3 – high soil resource not matched by financial return and production
Members 2A, 2C, 3A, 3B, 4A, 4B, 4C, 5B (3 green, 3 organic green, 2 gold)

The cluster analysis indicates that Group 3 should have the highest soil resource. Looking at the analysis of the core variables Group 3 does have the highest pH, N, K and S soil measurements. The pH is actually higher than that recommended for kiwifruit (Hill Laboratories (2) & (3), n.d.), but the N and K readings are within the recommended medium range. The S reading is regarded as high. This group has the lowest Olsen P measurement, just making it within the recommended range of 30 to 60. It has lower profit and production figures, and these are supported by a lower DM average.[12] Group 3 orchards are also smaller.

From the analysis of the change and variability variables (Tables 3.8 and 3.9), it can be seen that Group 3 shows the greatest increase in N% and the greatest variability in N% and pH - one probably leading to the other. Group 3 has been lifting its N%, over the time period in which the

[8] Ironically, one of these orchardists has sold his orchard since this survey was carried out in 2008.
[9] One of the orchards in this group could be considered an unusual one to have here because it has been regarded as an exemplar for high production. However, although it is a high producer, our figures show that the soil resource of this orchard is by far the lowest in the group, and that over all the years that ARGOS has been collecting data the applications of all fertilisers (except Mg) have been dropping. Maybe, as this orchardist has looked towards retirement he has been reducing his costs.
[10] All Olsen P group averages are in the medium range (30 – 80) and this is the highest within that. It could be because this group has the smallest proportion of organic orchards and organic orchards usually have a lower Olsen P (Carey et al., 2009).
[11] Variation can presumably come about because of weather events or changes made in orchard practices that may or may not result in consistent change.
[12] Maybe high DM does not come about through a high availability of nutrients, but is partially promoted through a lower availability, putting vines under some stress?

measurements were taken (2004, 2006, 2009),[13] and as shown in the former table, it has the highest average levels of this soil measurement. This change does not appear to be associated with changes in production or financial returns. It has some of the most consistent COS/ha, GOR/ha and efficiency measures as calculated by COE/GOR but as the COS/ha and GOR/ha are low and the efficiency is high (i.e., less efficient) this is not good news because it implies that the practices inbuilt to produce these results are unlikely to change.

Group 3 has the highest phosphate application, and the variation in sulphur application is also high. It ranks highly for all electricity expenses (average, increase and variability), for spray and chemicals costs (average and variability) and fertiliser costs (average and variability), and it has a high variation in pollination costs. Though it has the greatest annual drop in orchard working expenses (OWE/ha), these overall expenses are also very variable. Therefore, it can be seen that this group contribute to building the soil resource, and are working to reduce expenses, but are still not making a profit.

In terms of attitudes, this group consist of 'the pleasers'- it consistently has the highest score for any of the variables which show a difference across any of the groups. The orchardists in this group place importance on environmental and social indicators, they are less likely to change or promote diversity of income sources and are not sure about birds on the orchard, but do see it as landowners' responsibility to encourage birds, they are supporters of planting native trees and have low debt.

The high level of importance and agreement placed on all these variables perhaps indicates that this group like to be thought well of and to socially conform.

Group 4 – the highest producers, spenders and profit makers
Members 3C, 5C, 9C (3 gold)

The cluster analysis suggests that Group 4 should have the highest profit and productivity and be very efficient. The analysis of the core variables indicates that this is so. Group 4 made the most profit (EOS/ha[14], COS/ha, EOS/tray) and produced the most trays/ha, with the highest DM and the largest fruit. Their COS/ha and pH were the most variable. The soil measurements indicate that these orchards fall within the medium recommended ranges for their soil resource.

Group 4 had the highest Gross Orchard Return (GOR/ha), spent more on sprays and chemicals and fertiliser, which contributed to the highest working expenses (COE/ha). However, the group's GOR/ha is the most variable as are their working expenses which are also the most changeable and possibly increasing. This group is maintaining expenditure on electricity. The members of this group are prepared to spend a lot on their orchard but manage to do it in such a way that they make a good return, however, this is averaged over several years, rather than being consistent. In terms of attitudes this group is not concerned about what people think of them. In the survey they claim that environmental values and biodiversity are not important to them and they do not see the orchard as contributing to the environment. (This is a curious aspect of this because we know that one of the orchards is owned by a couple with strong environmental values. However, we know that in the survey they scored anything to do with biodiversity lower than many of the others.) This probably indicates that this group consists of high input orchardists who can make high profits but this is variable possibly because they are

[13] However, the soil results are only based on three measurements and so not too much emphasis should be placed on them.
[14] Even though this was not significantly different from zero, indicating a high variability of the three means of the orhcards in this group. This indicates that these three orchards have very different average annual profits – two were well over $15,000 while one was less than $10,000.

trying things out all the time, taking risks and constantly changing. A high variability can imply adaptability and year to year management, rather than doing the same thing year after year.

Note that these results could just be attributable to these group members all being gold producers as gold fruit naturally has higher DM than green fruit, is a larger producer and has larger fruit, but this study is about pathways to sustainability so is this result saying that given the choice,[15] it would be good idea to produce gold fruit.[16] However, we have to point out that there are nine gold orchards in this data analysis and only three appear in this clustering indicating that the success of Gold is also dependent on the orchardist, management and the site. The next grouping challenges the sustainability of this group.

Group 5 – most efficient, consistent and profitable
Members 6B, 7B, 8B, 9A, 9B, 10A, 10B, 12B (2 green, 6 organic green)

The cluster analysis indicated that this group was making the highest profit, being the most efficient and as having the lowest level of production. The analysis of the core variables indicates that this is so with Group 5 making the most profit (EOS/ha, COS/ha) (alongside Group 4), being the most efficient (lowest COE/GOR, highest EOS/tray) and producing the least trays/ha. However, it also has the lowest average DM and grows the smallest fruit from a lower soil resource in terms of N%, K and S. The pH is higher than recommended (Hill Laboratories (1) and (2), n.d.). The orchards are larger on average than those of Groups 2 and 3.

The analysis of the variability of the core variables indicates that Group 5 has the most consistent and reliable production, fruit size, efficiency and soil pH.

The GOR/ha for the orchards in Group 5 is not higher than that for Groups 2 and 3 which are possibly making a loss, so how is it this group is making a stable profit (COS/ha) over the years of ARGOS? An examination of 'other' variables reveals that this group has the least variation in COE/ha. This is because it is among the groups with the least variation in expenses associated with electricity, spray and chemicals, pollination and fertiliser, but it is the sole group with low variation in all these expenses. The group average is lower for expenditure on spray and chemicals, pollination and fertiliser and together this contributes to the lowest COE/ha overall. The considerably lower expenditure on pollination and spray and chemicals contributes most to this result (and the low expenditure on spray and chemicals could well be because a greater proportion of the orchards in group 5 are organic). All of these results indicate a low intensity production system and this lack of intensification may well be indicated by the highest density of introduced insectivorous birds. The members of this group are the least concerned about issues to do with the family and succession. They are bird friendly but not tree friendly. They focus on a limited number of income sources, probably only growing green kiwifruit, seldom deviate from plans, and do not see their orchard as changing much over the next ten years. This suggests, when taken alongside the low variation in most variables, that the orchardists in this group are probably doing what they have always done and are probably not very adaptable. They probably are looking towards retirement though there was no indication that they were any older than orchardists in the other groups.

One of the orchards in this group - 6B - is the biggest in ARGOS. The members of this group are also mainly based around Te Puke which may result in some sort of efficiency advantage.

[15] The licences to grow Gold fruit are limited.
[16] Keeping in mind that these data were all collected prior to the psa outbreak and its devastating impact on gold vines.

This result is curious and very interesting. This group could be said to be the most sustainable but it is not producing high quality fruit. It is far and away the most efficient, therefore the secret of its success might be in keeping costs low. This success might also be associated with growing organically, as six of the eight members have organic orchards. Does this mean that this group is also resilient or does their success arise from conservatism?

3.2.4 Questions arising

Can the differences between the groups be explained by the differing number of orchards in each group associated with a particular management system or location or the orchard size? Due to their location some orchards may be rewarded by being able to produce fruit early enough to achieve a KiwiStart premium? Maybe the location means that it is easier to produce high DM fruit that achieves a higher premium. Could it be that the cultivar – green or gold - or the management system – organic or integrated – affects the profit able to be made because of the different premium schedules for these different situations? Maybe the size of the orchard affects the efficiency. To answer these questions some further analyses of variance were carried which included a further factor (management system, cluster/location) or a covariate (canopy area) in the original analyses of the key variables to see if the level of probability associated with the differences between the groups changed (see Table 3.13). What this shows is that location played a big part in the level of significance of the differences between the groups for any variables to do with profitability, efficiency and soil, sometimes removing the significance of the differences altogether. This is particularly true for the Olsen P, N% and S measurements. Management system reduced the level of significance for production (as would be expected because organic production in particular would account for some of this) but it increased the level of significance for the difference between the groups for the DM percentage. It removed the difference between the groups for fruit count size entirely.[17] The canopy area reduced the level of significance for one of the efficiency variables – profit/tray.

3.2.5 Discussion and summary

Strategies pertaining to the different groups were:

- Group 1 – on way up by moving on to ‘better’ orchard? One of these orchardists has already sold and moved out of orcharding. The other also has a spray business.
- Group 2 – managed, selling/want to sell, dependent on unpaid labour?
- Group 3 - trying to do the right thing by building up the soil, trying to manage costs but not doing so consistently.[18]
- Group 4 – high investment for high return, constantly innovative, resilient but not sustainable?
- Group 5 – low input (most organic), low expenses, continue to do what they have always done, sustainable but not resilient?

The strategies used by the different groups raise a lot of questions. How much should we be emphasising the role of financial success in resilience and sustainability? People have to earn a living. However, for some of these orchardists the orchard may be more of a hobby, a way of winding down to full retirement by keeping up physical activity (see Hunt, 2009). For them, the orchard could also be seen as a capital investment. Another strategy for making a profit is to keep costs low but does this mean that resources become run down? Does that matter?

[17] For the ARGOS orchards in this analysis, the average gold size was 32.2, green 33.8 and organic green 35.7. (These were all significantly different from each other.)

[18] It could be asked whether these orchardists might be building up their orchards for the future but most of them have been growing kiwifruit for a long time.

Perhaps kiwifruit actually produce high dry matter and larger sized fruit on soils that are not so well fertilised except perhaps for potassium. What about the cost of pruning? How does that balance out with lower returns?

It would seem that to make a living from a kiwifruit orchard an orchardist needs a larger orchard than may have been necessary in the past. But larger orchards need more labour while a smaller orchard may be able to be looked after by a single person except for various tasks at particular times of the year. However, we suspect that this does not necessarily mean that this applies to much larger orchards, just that a few years ago an orchardist could make a living from a two hectare orchard whereas now this might be four hectares. In other words, there are labour implications that come with increasing orchard size.

What would happen in the future if all orchardists followed the pattern of Group 5? Does lifting the game of all orchardists to produce higher quality fruit actually mean that they would become unprofitable? Does it mean that soil resources would be reduced and repairs and maintenance become minimal? How would this affect kiwifruit production?

There are some obvious contradictions in these results. High input orchards are producing high quality fruit and are very profitable; low input orchards are producing lower quality fruit but they are very efficient and reasonably profitable; and another group of orchards are also high input and building up their soil but they are inefficient and have low returns.

It is also apparent that location has a major impact on an orchard business and its soil resources. This has implications for orchard values as a piece of real estate. It may also be that there are efficiencies due to being close to packhouses and services. These could be investigated further in the future by further analysis of the data as part of ARGOS 2.2.

3.3 Analysis of change in kiwifruit data

3.3.1 PCA analysis for annual change

The second PCA analysis (of annual change/trend) reduced to three PCs (Table 3.14).[19] The first PC gives high scores to the orchardists who have increased their financial returns, production and efficiency while dropping their DM. The second PC is a lot weaker and represents mainly changes in Olsen P and fruit size. The third PC represents those who have changed N% in the soil.

3.3.2 Cluster analysis of change

When a cluster analysis was carried out on the three PCs, a grouping of three clusters seemed the most satisfactory (Table 3.15) though it was apparent with later analyses that it did not distinguish between fruit size. One group consisting of the majority of orchardists, did not contain any extreme changes in the core variables. The second group of four orchardists, represented those who had increased their profit, efficiency and production the most while dropping their soil N. The third group represented those who had increased their soil resource as measured by Olsen P and soil N. Further information about these groups follows, built on the information provided by anovas conducted on other variables and presented in Tables 3.15 to 3.21.

[19] pH and K were not included in the analysis as they had very few significant changes over time.

Group 1 – decreasing profits
Members 1A, 1C, 2A, 2C, 3A, 4A, 5B, 5C, 7A, 7B, 8B, 9A, 9B, 9C, 10A, 10B, 11A, 11B, 12B (8 green, 7 organic green, 4 gold)

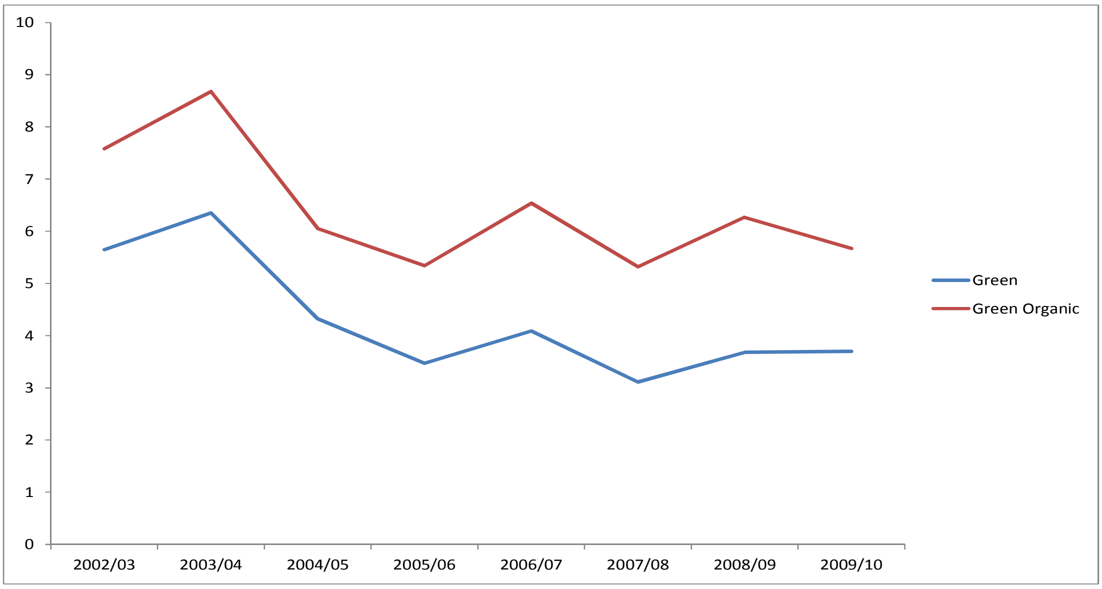
According to the cluster analysis Group 1 has made the least (or the most negative) change in profit, production, efficiency, Olsen P and size while increasing DM. From the analysis of the trend in the individual core variables (see Table ...), it is seen that the profit (EOS/ha and /tray, and COS/ha) did decrease while the production (trays/ha) increased the least (along with Group 3), and that the efficiency and Olsen P measurements probably did not change. While the soil N has probably increased slightly, it has increased less than that of Group 3 and though significantly different from zero possibly would make little difference agronomically. The expected changes in DM and fruit size predicted by the cluster analysis did not show up.

The analysis across the averages of the core variables indicated that Group 1 contained the highest percentage of green orchards and it had the lowest Olsen P. Analysis on the variation of the core variables across this grouping revealed that Group 1 was the least variable in terms of production, DM, size and soil measurements.

Analysis of other variables of interest shows that for Group 1, the majority, GOR has declined and the cost of pollination has increased the least. Along with Group 3, Group 1 places the most importance on various indicators of production and environmental wellbeing.

This group would appear to represent the majority of orchards who are doing much the same as they always have done (consistent) but the returns are decreasing even though production has risen (see Figure 3.2).

Figure 3.2: Orchard Gate Returns (OGR) ($/tray) for Green and Organic Green from 2002/3 season to 2009/10



(Source: Jayson Benge.)

Group 2 – lifting performance but from a low base
Members 4C, 6C, 7C, 8C (4 gold)

According to the cluster analysis Group 2 should represent orchardists who have Increased their profit, production and efficiency and decreased DM. The analysis of the change in the individual core variables shows that members of this group have made the greatest changes, lifting their profit, efficiency and production the most. Along with those in Group 3 they have made the bigger change in Olsen P and as well their DM has dropped the most. From the analysis of the core variable averages, Group 2 has made the greatest loss, and this is reflected in the loss for each tray of fruit produced, so Group 2 is the one that needs to make the greatest change and the evidence here suggests that those in the group are trying to lift their performance. The group do have the highest DM (and so could possibly be able to drop it a bit), but on average contains the smallest orchards and so the orchardists in this group are not able to gain efficiency associated with size. It has the highest average Olsen P. This group is the most variable in terms of production, DM, fruit size and Olsen P but it is the least variable in soil N.

Group 2 has lifted Gross Orchard Revenue (GOR/ha) over time and pollination costs have increased, perhaps indicating that this is one of the ways used to increase production. Unlike Group 1, Group 2 places little importance on indicators of yield, soil and biodiversity. Those in this group do not place as much importance on comparing themselves with other similar orchards and see themselves as impacting on a wider environment than contained within their orchard.

All of these orchards in Group 2 are gold, and therefore we would have expected them to be more profitable. They are in different locations and so this low performance cannot be attributed to climate or altitude. Two of the orchards have changed ownership or management in their time in ARGOS and the changes shown here could be attributed to that.

Group 3 – maintaining profitability, efficiency and consistency
Members 3B, 3C, 4B, 5A, 6A, 6B (2 green, 3 organic green, 1 gold)

From the cluster analysis it would appear that Group 3 has made the greatest change in Olsen P and soil N, while increasing fruit size. Group 3 has increased Olsen P and DM while maintaining efficiency increasing profit and production (but not as much as Group 2). However, this group already makes the most profit and is very efficient in terms of profit made per tray of fruit produced. Their DM was lower than that of Group 2 on average which indicates there was room for improvement. The members of this group have the largest orchards on average.

Group 3 is demonstrates consistency in production, DM and size, however it is the most variable for three of the soil characteristics (pH, Olsen P and N%).

Along with Group 1, Group 3 places the most importance on various indicators of production and environmental wellbeing including biodiversity. Group 3 has the lowest density of introduced birds – in total and in terms of granivorous species. (This could be a locational effect.) The members of this group expect to be working in orcharding longer than the others which perhaps indicates why it is important to them that their children are involved on the orchard and that they are involved in contributing to the local community.

3.3.3 Summary

Overall this analysis of change discriminated between three groups of orchardists. The first represented the majority who, though increasing their production, were facing declining returns. The second was increasing most aspects of their orchard but this was from a low base, while the third group was maintaining its profitability, efficiency and consistency. However, this latter group has the lowest density of insectivorous birds but this could be due to their location in the more northern part of the Bay of Plenty or in the hills above Tauranga.

3.4 Analysis of consistency and variation in kiwifruit data

3.4.1 PCA analysis of variation (standard deviations)

When the core variables were analysed for their variability (s.d.), a PCA reduced the 14 variables to four principal components which explained 69 per cent of their variation (Table 3.22). The first PC represents variability in the COS/ha, and the efficiency variables. The second PC represents variability in production and fruit size (the larger the fruit the greater the number of trays), and the variability in the soil resources of pH and K, indicating how important these two are for the production of kiwifruit. The third PC represents variability in Olsen P and DM. The fourth PC represents variability in EOS/ha and soil N.

The distinctions between the EOS and COS measures of profit are interesting. COS includes paid labour but not unpaid, whereas EOS includes an adjustment for non-cash costs such as unpaid labour and depreciation and also a measure of Olsen P to account for the gains in the soil resource achieved by the use of phosphate fertiliser.

3.4.2 Cluster analysis of variability

The most satisfactory result of a cluster analysis of the above four principal components, was for four cluster groups which effectively separated the variability of all core variables except for soil K (see Table 3.23). The descriptions of these four groups that follow are based on anovas conducted over all the variables of interest that we have collected. The tables showing these results are Tables 3.24 to 3.29.

Group 1 – consistent and reliable
Members 1A, 1C, 2A, 3A, 4B, 5A, 5B, 6A, 7B, 8B, 9A, 9B, 10A, 10B, 12B (7 green, 7 organic green, 1 gold)

The cluster analysis for the variability of the core variables would suggest that this group represents the majority of orchardists, and they are maintaining consistency in their profitability, efficiency and production. This is backed up by the analysis of the variability of the core variables (Table 3.24). This group has the lowest variability for all the core variables which showed differences between the groups. It also has the lowest level of production (with Group 2), the lowest DM and Olsen P on average, the smallest fruit and the greatest efficiency (with Group 3). All the members of the group except one grow green kiwifruit. The group has only been slightly increasing production while increasing its average DM.

The characteristics of Group 1 as consistent and reliable, are also demonstrated in the other results. This group has the least variation in GOR/ha, COE/ha (with Group 4) and has low expenses due to repairs and maintenance and the lowest overall COE/ha. It has the most consistently high scores for the importance placed on different indicators (where there were differences between the groups) and places the most importance on financial and environmental indicators. It places more importance than any of the other groups on birds 9native or introduced) as providing importance services. These attitude scores perhaps indicate that the people in this group are loyal, ‘good’ citizens, wishing to please.

Group 2 – inconsistent:
Members 4C, 6C, 7C, 8C, 11A, 11B (1 green, 1 organic green, 4 gold)

According to the cluster analysis this group should represent the orchards with the greatest variability in COS/ha, efficiency, DM and Olsen P. In the analysis of the variability of the individual core variables this is true for COS/ha, efficiency, DM but also for production and fruit size (which were aspects of PC2 which is not supposed to be well represented in this group). Group 2 also demonstrates the lowest variability for pH and N%. (Frosts at a time early on in the ARGOS programme for Cluster 11 may have contributed to the variability of this group.)

Group 2 has the lowest GOR/ha and profit (however measured). It is the least efficient and has the smallest orchards. It has the most variation in expenses (COE/ha). Its members are increasing their production the most but from a low base. The members of this group do not appear to be concerned about what others think compared with Group 1, placing a lower level of importance on several financial indicators and on most environmental indicators in the survey (though these are still important to them). Ironically, they had the greatest density of introduced birds (particularly of granivorous birds). They probably have more than one source of income. They are aware that their management affects the environment outside of their orchard and they are the least satisfied with their level of viability.

Group 3 – consistent and very profitable
Members 3B, 5C, 6B (2 organic green, 1 gold)

From the cluster analysis Group 3 should demonstrate the lowest variability for COS/ha and efficiency but the highest for EOS/ha[20], DM and N%, and Olsen P. In the analysis of the actual variation of the core variables this cluster does match these expectations except it does not have the highest variability for DM but it is the least variable for fruit size. When this group is compared with the others over the averages of the core variables it has the highest profitability, is the most efficient, and has the largest canopy area. It had the greatest rate of increase of the soil N% and DM. (Orchard 6B is the largest individual orchard in ARGOS. Some others in ARGOS are parts of a large enterprise but only one of the orchards involved in the enterprise is in ARGOS.)

Group 3, is also the most profitable group and with Group 1, the most efficient. It is showing the greatest increase in soil N, and possibly the greatest increase in DM. It has the lowest density of introduced birds (particularly granivorous birds) and its members are satisfied with their level of viability. They place less importance on some financial indicators than Group 1 but are similar for soil and plant health. They do not think it is their responsibility to encourage introduced birds, and perhaps this is reflected in the level of intensification of their orchard.

Group 4 – the high but variable producer:
Members 2C, 3C, 4A, 7A, 9C (2 green, 3 gold)

According to the cluster analysis Group 4 should have the highest variability of production (trays/ha and size), pH and K and lowest for Olsen P and DM. In fact it has only the highest variability for pH, and the lowest for Olsen P. In addition it joins Group 1 as the most consistent in efficiency, has the highest variability in COS/ha and the lowest in soil N%.

This group has the highest level of production and DM and largest fruit. It has the highest and most variable GOR/ha and COR/ha, the highest expenses perhaps partially due to having the highest costs of repairs and maintenance. The group has the lowest equity, and experienced the greatest drop in equity and accordingly the greatest variability of equity, which perhaps indicates its members are keeping up investment in the orchard. (In the survey they admit to having a reasonably high level of debt – 20-40% of equity.) The members of this group place

[20] Note: This demonstrates the need for clarity about how EOS is different from COS.

less importance on the financial indicators of cash surplus/deficit and profit/loss than those in other groups though these are still important to them. They indicate they are less concerned about the health of plants though these are still important to them and they are less concerned about recreation, time for family and friends, family in general and see less connection between their orchard and their own and their family's wellbeing. They disagree that birds provide their orchard with important services but see trees as enhancing stream health.

3.5 Overall findings for kiwifruit

Three groups of orchardists in particular show up together in each of the groupings described above. The first is a group consisting of seven orchardists 7B, 8B, 9A, 9B, 10A, 10B, 12B (2 green, 5 organic green). These people appeared together in Group 5 based on averages, Group 1 based on annual change and Group 1 based on variation. They formed the group demonstrating the most consistent, reliable and profitable results.

A group of three orchardists stayed together throughout the three analyses (Group 3 based on averages, Group 1 based on annual change and Group 1 based on variation). They differed from the first group in that basically, they were not as good at making a profit, and this may have been partly due to having smaller orchards – their COS/ha being positive but their resultant EOS/ha not being significantly different from zero, indicating that if their own labour was taken into account they would not be making a profit.[21]

Another group of three orchardists that stayed together were in Group 2 for each analysis. What characterised this group was inefficiency and inconsistency.

Most orchards (except for Group 4 formed from the analysis of averages) are bringing in similar revenue per ha, so what is making the difference? It seems to lie in control of working expenses. The most stably 'successful' orchards are not producing premium fruit through DM or size – in fact they have the lowest DM and smallest fruit – and they are not producing the most. That is they are making the most, they are the most efficient and they are producing the least! So what expenses are they keeping low compared to others? One economy seems to be in terms of canopy area. The smaller orchards appear to be dependent on their own labour and even so are not making ends meet, whereas one group of medium sized orchards (around 5 ha) is doing reasonably well. The largest orchards, however, are not necessarily so successful. These smallest orchards of around 2 ha which used to be very profitable enterprises seem to be no longer so. Other economies are to do with spending less on sprays and chemicals, pollination and generally maintaining lower cash orchard expenses. They are also less variable, maintaining consistency in their returns, expenditure on sprays and chemicals, pollination costs, fertiliser costs and overall cash orchard expenditure. These orchards are also the most hospitable to insectivorous birds.

The average income is stable even though production is increasing[22]. That is, one response to lower prices has been to intensify production. However, only one group (of gold orchards) has markedly increased its volume of production compared to the others, and the equivalent GOR/ha has also increased, but it has not increased its profit and while the only obvious increase in expenditure was in pollination, presumably all other costs must have increased accordingly for this not to show up as profit.

[21] ARGOS has struggled to measure this unpaid component of labour. It is thought that the amount and quality of labour are most important but very difficult to measure.

[22] Annual average change in trays/ha is 401.8, 95% confidence limits (272.5, 531.1).
Annual change in EOS/ha is $-110 (confidence interval, $-1,685, $1,465), COS/ha is $-858 ($-2,381, $664).

The small group of orchards that has the most intensification of production (trays/ha) is also producing the highest profit, Gross Orchard Return, DM and biggest fruit. But these orchardists are also spending the most on the orchard (COE/ha) though it is not clear where the extra expenditure goes, it is increasing and is the most variable, as is income and profit (COS/ha).

One group has the greatest soil resource (capital – pH, N %, K and S) but with the lowest Olsen P and the smallest orchards. This group has the highest expenditure on the fertilisers used to maintain this soil resource but the group members are not doing well financially.

What are the group strategies for sustainability and resilience?

- Group 1 – on way up by moving on to 'better' orchard
- Group 2 – managed, selling/want to sell, dependent on unpaid labour?
- Group 3 - trying to do the right thing by building up the soil, trying to manage costs but not consistently
- Group 4 – high investment for high return, constantly innovative, resilient but not sustainable
- Group 5 – low input (most organic), low expenses, continue to do what they have always done, sustainable but not resilient

What questions arise from this analysis?

- What is the role of financial success in resilience and sustainability?
- Does keeping costs low mean that resources become run down?
- How does the sustainability of an orchard enterprise relate to the size of an orchard? It seems that larger orchards are needed than in past and this has labour implications.
- What of the future? What would happen if all followed pattern of Group 5?
- There are contradictions here – orchards with high input, producing high quality fruit are very profitable; low input orchards producing lower quality fruit and with high efficiency are profitable; whereas high input orchards are producing low returns.

4 Sheep/beef results

4.1 Correlations of core variables

Correlations are useful for finding broad relationships but it must be remembered that this does not imply causality. Also, correlations imply linearity, and while this may be true for some variables, for many we are only considering variables over a particular range of values because outside those values linearity can no longer be assumed. For example, pH is recommended to be between 5.8 and 6.3, and it makes no sense practically for a farmer to try to aim for a pH outside this range as it will not add to pasture growth. Similar limitations are known for soil N, and Olsen P.

Fortunately, the correlations of the averages make some practical sense reinforcing the accuracy of the data (see Appendix 2, Table 4.1). The correlations show the following:

- It is obvious from these correlations and is well known that a farm's profit (per ha, per farm, per SU) is closely related to how much control is exercised over working expenses, particularly as a proportion of revenue (FWE/GFR). This holds over all management systems.
- Profit made per ha is related to the meat produced and cropping is more profitable.
- Less profit is made per ha, the larger the farm (as larger farms are usually more extensive).
- The larger the profit/ha, the more efficient the farm (the lower the FWE/GFR ratio), and the more profit is made per stock unit and per farm.
- However, only the profit measured by EFS is positively related the Olsen P levels and negatively to the % of N. This perhaps indicates that the % of soil N reflects profit levels (the higher the soil N, the lower the profit because of expenditure on N fertiliser), though if so how does this explain the Olsen P levels? Does a high Olsen P indicate good pasture growth and hence indirectly better lamb performance (only at 10% level of significance)?
- The more the cropping going on the lower the soil N, indicating the intensification and higher demands on soil of cropping.
- The more efficient the farm, the higher the pH level. Does this have any significance?
- The more efficient the farm the higher the lambing %.
- The intensification measures are all correlated, as are the efficiency and sustainability measures. Only the capitals do not hang together.
- The different measures of profit are highly correlated – however it is measured, profit is profit!

The correlations of annual trends (Table 4.2) need to be viewed rather sceptically because a correlation can be found for any numbers no matter how small and for most of the individual farm data the values of the trend lines were not significantly different from zero – in other words, there was no significant change over time. The measure of Equity would be the most reliable as 15 of the 24 farms have shown a significant change in their equity over time. FWE/GFR showed 7 significant changes and lambing 8, whereas all the others were somewhere between 2 and 5.

With this in mind it is of interest and significance that increasing equity was associated with decreasing efficiency in terms of FWE/GFR and this is identified with decreasing profits/farm (so not necessarily increasing costs). Though paying off debt is not taken account of in the calculation of profit, presumably a farmer can use profit to pay off debt, hence possibly affecting the following year's financial results. It could also be that as farmers get older and have paid off more debt, they do not push the farm as hard.

All the other relationships do make sense. For example, the greater the effective farm area the less the profit per stock unit (su), which implies the larger areas are more extensively farmed, and changing financial data is reflected in changes in other financial data.

The correlations of the variability of the core variables (Table 4.3) show that:

- The variability of any of the financial results affects the variability of any other financial results.
- The variability of lambing % affects the variability of the financial returns.

It is unclear what to make of the way the lower the variability of the % of N the higher the variability of the cropping %, and the variability of the financial returns. Perhaps it makes sense the other way around – the higher the variability of N, the lower the variability of the returns, indicating a farmer responding to the need for N. This may become clearer when the N application rates are examined.

4.2 Analysis of averages of sheep/beef data

4.2.1 PCA analysis of averages of core variables

Averages of all the core variables were analysed in one PCA in order to obtain PC scores as the measures on which to base the cluster analysis. This gave the results reproduced in Table 4.4. The first Principal Component, PC1, measures profit in terms of Effective Farm Surplus (EFS) – whatever the units. It also measures the percentage of cropping and relates these variables to the soil nitrogen. This may indicate the drain on the soil of the more intensive farming involved in cropping and on the profit of keeping up the soil N, while at the same time increasing the profit. (EFS includes the cost of labour both paid and unpaid, and the value of the change in the feed inventory.)

PC2 measures profit in terms of the Net Farm Profit Before Tax (NFPBT) – whatever the units. It also includes equity, and is balanced out by the effective land area. This makes sense as the level of profit will relate to how much of the mortgage can be paid off and in turn probably to the size of the farm.

PC3 is a measure of the efficiency (FWE/GFR) and the availability of soil nutrients as measured by soil pH. This is related to profit.

PC4 is a measure of the lambing percentage and the meat production/ha, which again seems a logical relationship – so is a measure of production. This production is related also to the Olsen P level.

This PCA analysis does not nicely group the intensification, capital, efficiency and sustainability variables as was hoped when setting up this analysis at first. However, it is a grouping that makes sense.

4.2.2 Cluster analysis of averages of core variables

A cluster analysis using the four PC scores assigned to each farm was executed. The five cluster solution was the first to separate out each of the variables and there was a reasonable scatter of the farms across the clusters (see Table 4.5).

Uunbalanced anovas were used on the original core variables to help describe the clusters. This was also done for annual change and the variation of these core variables, along with all other variables of interest. The results are in the Tables 4.6 to 4.13 and the descriptions of the groups formed by the cluster analysis follows.

However, first it is worth noting how EFS and NFPBT are clearly separated out in different principal component scores and other parts of the analysis when it could be expected for them to be grouped together more. Economic Farm Surplus (EFS) includes the cost of labour – both paid and unpaid and is therefore dependent on how accurate a farmer or farming couple is in telling the ARGOS Field Research Manager what hours they work. It also included the value of the feed inventory – hence the importance of whether it is measured in dry matter (DM) or wet matter. A measure of the soil resource as indicated by the Olsen P measurement is not included in EFS but is included in EOS (for kiwifruit). Net Farm Profit Before Tax (NFPBT) includes depreciation and paid labour but not unpaid labour. It does not include the feed inventory.

Group 1: the low performers – least profitable, most inefficient
8A, 9A, 3B, 2C, 8C, 9C (2 organic, 1 integrated, 3 conventional)

The cluster analysis of the PCAs suggest that this group should consist of farmers with a low EFS (however measured) who are the least efficient. This is confirmed by the anovas of the core variables. Group 1 is in the lowest profit category (EFS/ha, /su, /farm, NFPBT/farm) and is the least efficient. Soil N is being maintained. This group has the most variable Olsen P, soil N and FWE/GFR (efficiency).

These are hard country farms. Belonging to this group could be an indication of the stage of development reached by these farms. At least one farmer in this group likes his farm and stock to look nice and so puts a lot of money into achieving this. Two other farmers have been putting a lot of money into development and one has been put into the hands of a manager over the time of ARGOS, after personal issues within the farm family.

Other variables (see Tables 4.9 to 4.12): This group spent the most on stock and C & NC feed expenses. It has the highest density of all birds – introduced, native, native and introduced insectivorous birds, and granivorous birds.[23] These measurements were the most variable for native and introduced insectivorous birds and the latter were also increasing in density over the measurement times.

Attitudes (Table 4.13): Members of Group 1 watch their bank balance and change in equity, indicating perhaps that they are intent on paying off mortgages. They do not deviate from farm plans often, indicating that they are less adaptable than those in the other groups. They are most aware of how their farm practices impact on the wider world.

Group 2: adaptable risk takers – most profitable, least consistent
4A, 2B, 6B + 6C[24] (1 organic, 2 integrated, 1 conventional)

The cluster analysis suggests that this group should have the highest EFS and they are probably cropping farmers with lower resources of N in their soils. This is confirmed by the analysis of the core variables. Group 2 has the highest EFS (/ha, /su, /farm) and NFPBT/ha, a lower soil N, and the most income comes from cropping. This level of soil N may relate to cropping. It has the lowest average equity which could mean that these farmers are developing

[23] Two of these farms are in the Catlins, one is on Bank's Peninsular, and two are above Outram. Thus location could be reason for the bird intensities. It also indicates that fertile systems have more birds!
[24] 6C was added to this group for later analysis. This farmer does not lamb so could not be included in the initial PCA and cluster analyses but was easily assignable to the cluster groupings.

their farms or buying more land, infrastructure or equipment. The profit of this group makes is the least consistent over the years of all the groups and the profit level is possibly increasing at a greater rate. Olsen P measurements and soil N are the least variable, possibly indicating strict fertiliser maintenance programmes.

All of these farmers except one lease land and this may affect equity. The farmer who is the exception had put a lot of money into developing his farm as a cropping farm as he is getting older. All the others probably enjoy taking risks but for this farer this has happened unintentionally as feels he has been forced to respond and adjust to his changing circumstances and the opportunities that have come his way, such as extending his irrigation potential.

Other variables: This group has the highest expenses related to cropping and these are the most variable.[25] All other expenses are also high, possibly also related to cropping (e.g., vehicles and fuel, weed and pest costs, repairs and maintenance). This group applies the most fertiliser (except for Mg) and at the most variable rates. Some fertiliser applications could be increasing – they are definitely being maintained and not declining. It also has the most variable su/ha, and this would probably be related to how most of these farmers finish stock rather than breed them, so they bring in stock whenever they have the feed to finish them. What stock they do breed from, have the highest lambing and scanning percentages.

The high variability of some variables in this group could indicate a farmer's adaptability. S/he may be responding annually to the context of the time – producing particular crops, finishing stock dependent on the feed available in that particular season and fertilising as indicated by annual soil measurements and cropping needs – rather than consistently doing the same thing year after year.

Attitudes: Yield/ha is most important to the farmers in Group 2 and keeping to budget. Soil, livestock and plant health while still very important, is less important to these farmers than those in the other groups. Biodiversity is less important but these farmers want more birds[26] and are aware of the impact of their farming practices on their community and the wider world. The contribution they make to the community is important. The members of this group are more likely to experiment than those in other groups and they have had fewer years on their farms.

Group 3: the organic conservers – low input, low producers with high equity
2A, 5A, 7A, 12D (4 organic)

According to the cluster analysis this group should have the highest NFPBT, however it is measured and be the lowest producers. This does not seem to be confirmed exactly by the anovas of the core variables. They have lower EFS (/ha and /su), and the lowest production (meat and lambing %). This indicates that if unpaid labour and feed inventory were included the profit would not look so good. Three out of four of these farmers do not employ labour outside of the family. They have higher equity but lower capital in the soil resources as measured by Olsen P and N. This group has made consistent profits over the years.

Two of the farmers are processors – they add value before their products leave the farm gate. Two may not grow cash crops but grow brassicas for feed. One has a farm that is really too small to be profitable but he earns further income off-farm. All these farms are likely to have

[25] This is probably because big numbers are more variable than smaller ones – which implies a log transformation should have been used to analyse this data – though the author was reluctant to do that because of having to back transform! Also, negative numbers do not transform to logs. The other alternative would be to leave out the cropping farms and re-analyse the data which is what is done in Section 4.5.

[26] Though these are cropping farmers so perhaps there are only certain kinds of birds they want more of.

high equity as they are inherited from parents except for one farming couple who are paying of their mortgage quickly. However, even though inherited, this does not mean these farmers are not paying off their fathers!

Other variables: This group has the lowest stock expenses and fertiliser application rates and the highest chargeable and non-chargeable labour. It has the lowest scanning percentage. These things probably relate to their organic status.

Attitudes: The members of this group are not interested in succession. Biodiversity is important to them and they believe that they have a responsibility for encouraging birds on their farms. They have spent fewer years on their current farm and fewer years farming than those in other groups (except Group 2).

Group 4: extensive, low production, high soil resource
10A, 8B, 11C (1 organic, 1 integrated, 1 conventional)

According to the cluster analysis this group should have the lowest profit (NFPBT) but be efficient. This group has the largest farms and hence their farms are the most extensive and this is reflected in the lower production/ha and lambing %, and the lower profit when measured per ha or su (NFPBT/ha, /su). The farms in this group have a high capital value in the soil resource. The only other feature of note is that this group has the most variable NFPBT/su and possibly the biggest annual drop in this value.[27]

Farmers in this group are putting money into development or buying more land. Two have bought more land while another is putting a lot of effort into planting trees and shelter belts.

Other variables: This group has the most change and the largest variation in stock and pasture expenses, fertiliser costs and C &NC labour. Two farmers in this group have sons working on the farm and the other has a younger family who also help. It has the highest vehicle and fuel expenses and the least C & NC labour expenses. Those in this group apply on average the most Ca, Mg, P and S fertilisers per farm and these applications are the most variables. These figures can probably be explained by the fact that these are the largest farms. This group has the highest density for all introduced birds and introduced granivorous birds and is most variable for these two categories of bird density measurement.

Attitudes: The members of this group are probably the ‘most agreeable’, wishing to please group as they scored a lot of the questions more highly than those in other groups. They had the highest scores except for the statements associated with climate change, and feel that farms have a responsibility to encourage birds. They were most concerned about climate change, in a way that limits farmers’ responsibility, and suspicious of technological solutions but were very supportive of planting trees both native and exotic to increase biodiversity and the attractiveness of their farms.

Group 5: the stable, continuous improvers – most efficient, consistent and profitable
11A, 4B, 9B, 10B, 11B, 7C, 12C (1 organic, 4 integrated, 2 conventional)

According to the cluster analysis Group 5 should have the highest production, lambing and Olsen P level. These things are confirmed by the anovas of the core variables. This group is the most profitable as measured by NFPBT, and the most efficient as it has the lowest FWE to GFR ratio, a higher lambing %, and makes the most NFPBT for each stock unit. It is also

[27] What could this mean? The suggestion is that money put into development is recorded as Repairs and Maintenance for tax purposes. It may also represent a fluctuation in market values but if so it would have been expected to show up across all farm groups not just this one.

increasing its efficiency the most and is the most consistent with the least variable profit however it is measured, and has the least variation in FWE/GFR.

Other variables: This group has low expenses and low variation in these expenses. However, it does have the highest pasture expenses but a low variation in these, indicating a consistent input into pasture. The high scanning % reflects the high lambing rate. It has a low density of birds across all categories measured and a low variation in these, implying it consistently has fewer birds than farms in the other groups.

Attitudes: Members of this group felt that gross income was an important financial indicator. They were least concerned about contributing to the local community. They had the most issues with farmers being associated with climate change and had a belief that technological solutions would fix it. They were the least interested in uses for trees and have had the longest time farming.

4.2.3 Overall comments

It is suggested that these groupings may reflect more the class of land (soil type) on which farms are than the farm management. Hence it would be useful in the future to find out the different land use classifications for the ARGOS farms. However, in Group 5 for example, two farms are in the Oamaru area, and there is one in Mid-Canterbury, one in the Catlins, one in Gore, one in Fairlie and one in Waimate, indicating they come from wide ranging geographical locations, many of which are regarded as liable to extreme climate conditions.

It is obvious that these tables are dominated by Group 2 which has the highest cropping percentage. A later analysis (see Section 4.5) has been carried out with the cropping farmers in this group removed. (One of its members was not a cropping farmer.)

4.3 Analysis of annual change of sheep/beef data

4.3.1 PCA analysis of annual change

The PCA of the annual change of the core variables over the period of ARGOS resulted in reducing the data to 5 Principal Components (see Table 4.14). PC1 measures change in profit in terms of both Effective Farm Surplus (EFS) and NFPBT – whatever the units. It also balances this with the change in equity because presumably improving equity decreases profit and change in efficiency (FWE/GFR) because improving efficiency will increase profit. PC2 measures the change in cropping balanced by the change soil nitrogen and pH, indicating the drain cropping is on the soil resource. PC3 is a measure of the change in efficiency in terms of the change in profit made per stock unit. PC4 is a measure of how a change in the lambing % changes the meat production/ha, which again seems a logical relationship – so is a measure of the relationship between lambing and meat production. PC5 measures the change in Olsen P.

4.3.2 Cluster analysis of annual change

A cluster analysis using the five PC scores assigned to each farm resulted in a solution with 5 clusters (see Table 4.15). The 5 cluster solution was the first to separate out each of the variables although there was not a reasonable scatter of the farms across the clusters, two of the groups having just one member. It is clear from Table 4.15, that Clusters 1 and 3, the groups which only have 1 member each, have extreme values of a particular PC.

Unbalanced anovas carried out on the original core 'change' variables help to describe the clusters/groups. This was also done for the average and the variation of these core variables.

The results are in Tables 4.16 to 4.23. The non-lambing farmer has not been placed into a group because it was not clear where this farmer fitted.

What is immediately apparent from Table 4.16 is that the cluster analysis did not discriminate between all the variables, especially Olsen P, pH, FWE/GFR and EFS/farm. It may be that the annual changes were so small and so variable that this was impossible unless the analysis is taken further to more clusters. However, as it was, two of the clusters only had one member, so it is would seem that there is one larger dominant cluster. This also indicates that the sheep/beef farms are very different and it is hard to classify them satisfactorily.

It is also apparent that over the years accounted for here (2003/4 – 2009/10) this group of farmers have not earned any more from their farming (adjusted for 2009 dollar value). The only variables that could be said to have increased annually are the amount of equity and the N status of soils. In other words, there is no evidence of increasing intensification or efficiency but capital may have increased slightly.

Group 1
2B (1 integrated)

This farmer is increasing his profit, decreasing his equity and increasing his efficiency. It looks as if he is improving production and developing his property. He entered ARGOs later when an ARGOS farm was joined with his farm just as he was taking over the family farm from his father. The decreasing equity may be related to the time when he bought the farm from his father. The excessive rate of change may be related to the difference between the first year of data and those following.

Group 2: The productivists
2A, 4A, 5A, 8A, 11A, 3B, 8B, 9B, 10B, 2C, 9C, 12C (5 organic, 4 integrated, 3 conventional)

This group of farmers has increased their lambing percentage and the resultant meat production compared with the other groups. They have possibly increased their profit as measured by EFS but not NFPBT or their equity.

Additional data: The farmers in this group consistently have the lowest costs (with Group 4). They have the highest density of introduced bird spp.

Attitudinal data: Farmers in this group place the most importance on measuring their financial situation by using profit/loss, equity or return on capital statistics. They indicated that they do not care about their neighbours' approval of their farming practices but do care about off-farm quality and are neutral about the relationship between climate change and their farming practices, while believing that technology will help to decrease greenhouse gas emissions. They are very supportive of tree planting for many reasons.

Group 3
11C (1 conventional)
This farmer has dropped in both profit making and efficiency. He is developing a more extensive property in addition to the 'home' farm and this would result in a decreasing intensity of all per hectare results.

Group 4: The investors
7A, 8A, 9A, 12D, 7C, 8C (4 organic, 2 conventional)

This group has increased their equity and N status of their soils. It would appear that they have not changed their levels of profit or production and have the lowest NFPBT/ha or /su, and a decline in lambing percentage.

Additional data: With Group 2, Group 4 has consistently the lowest expenses. The farms in this group have the highest density of introduced insectivorous birds.

Attitudinal data: Group 4 differ a little from Group 2 here. Though they also indicate that it is important to them to measure their financial situation by noticing their equity and return on capital, they are the group that expresses most disagreement about the relationship between farming and climate change issues. They are also supportive of both birds and tree planting.

Group 5: 'On the way up?'
4B, 6B, 11B (3 integrated)

The farmers in this group have increased their profit more than any of the other groups. They are becoming more intensive with high lambing percentage, profit and cropping. They have the most variable profits and soil pH. In fact this group consistently dominates the results with the highest values for all the variables whatever category, except for the attitudinal variables.

Additional data: The farmers in Group 5 have the highest expenses (vehicles and fuel, fertiliser, weeds and pests), the biggest increase in cash cropping, fertiliser, and weeds and pests expenses, and the most variable cash cropping, feed, and weeds and pests expenses. They apply more fertiliser in the form of K, N and S whether measured per ha or su, and the most N per farm, and their applications of N (however measured) and K (kg/su) are the most variable. In addition they have increased the N (kg/ha or su) applied and decreased the S (kg/ha). They have the most variable stock units per ha, and the highest scanning percentages. Their farms have the lowest density of introduced birds and introduced insectivorous birds.

Attitudinal data: The members of this group place less importance on ways of measuring their financial situation – profit/loss, equity and return on capital. They indicate that they do not care what their neighbours think of them and their farming. They are least concerned about planting trees for whatever reason.

4.4 Analysis of variation in sheep/beef data

4.4.1 PCA analysis of variation

Table 4.24 shows the results of the PCA on the variation of the core variables. PC1 measures variation in profit in terms of both Effective Farm Surplus (EFS) whatever the units and NFPBT/farm. However, the variation in efficiency as measured by EFS/su and FWE/GFR is balanced again the other profit measures indicating that a low variation in efficiency is countered by a high variation in EFS/ha or per farm and NFPBT/farm. PC2 is a measure of the change in efficiency in terms of the change in profit made per stock unit, and the NFPBT/ha and the variation in equity. This makes sense as changing a farm's equity will be affected by the NFPBT.[28] PC3 is a measure of the variation of the soil resource and its association with the lambing%, whereas PC4 is a measure of how the variation in the meat production/ha, seems to be associated with variation in Olsen P. This relationship has also occurred elsewhere, indicating the importance of phosphate fertilisers in pastoral farming. PC5 measures the variation in cropping.

[28] This not showing up with EFS as well, probably because of the 'no cash labour' in EFS.

The cluster analysis using the four PC scores assigned to each farm gave a best solution of five clusters/groups (Table 4.25) – though it did not separate out PC4. Again, it did not give a good scatter of farms across the clusters with one cluster having a majority of farms and another having only one member. It is clear from the Table 4.25 that Cluster 2, the one with only one member, has the most extreme value for PC2. Also, overall there seems to be high positive values for each PC but not very low values. Again, there is one large group into which most farmers fitted.[29]

The results from the unbalanced anovas for the original core variables, which help to describe the clusters/gropups, are in Table 4.26. What is immediately apparent is that the cluster analysis did not discriminate between the variables carcase weight and equity. This means that the variations in these variables for most of the farms were very similar. Tables 4.26 to 4.33 are used to provide a greater description of each group.

Group 1 – Greatest variability of soil resource and lambing
2A, 5A, 6B, 12C (2 organic, 1 integrated, 1 conventional)

The farmers in this group had the most variable NFPBT (per ha or su) and efficiency in terms of profit/su and lambing percentage, but the lowest variability in the other measure of efficiency, FWE/GFR. This indicates that they manage their expenses in order to maintain this.

Additional variables: This group had the lowest percentage of sheep, indicating that cropping and/or cattle were also important parts of these farms. The farmers in these groups had the highest expenditure on vehicles and fuel, overheads, C & NC labour and the largest increase in fertiliser and weed and pest expenses.

Attitudinal data: Farmers in this group do not find it important to pay attention to FWE/GFR (even though they maintain a consistent level of this measure of efficiency). They find it important to produce a competitive yield/ha and a mix of products from their farms (the latter an indication of resilience). They are the least interested in birds, possibly because three of them are cropping farmers. They have the highest level of agreement about the relationship between farming emissions and climate change and see the importance of planting trees as carbon sinks.

Group 2 –High variability in equity and efficiency
11C (1 conventional)

This farmer had a very high variability in equity and appeared to make have a large variation in efficiency measure per su. However, this can be explained by the addition to his farm of a more extensive property.

Group 3 – lower variability across most variables – the consistent, reliable farmers
7A, 9A, 10A, 11A, 12D, 3B, 4B, 8B, 9B, 10B, 2C, 7C, 8C (5 organic, 5 integrated, 3 conventional)

These farms were the most consistent across all variables except for soil N. However, there is no indication of why this should be so as the application of N does not appear to have changed, or may have even dropped in contrast with Group 1.

Additional variables: Group 3 has the lowest expenses and the least change in fertiliser costs, and the least variability in cash cropping, repairs and maintenance, C and NC labour and feed

[29] Again, the farmer who does not lamb was not added in to this analysis it was not clear where he fitted.

expenses. The farms in this group have the least variation in introduced insectivorous birds. The farmers have also made the least changes in their application of N (however measured), Ca, P and S (measured per su), and hence have the lowest variation in these fertiliser components as well. This indicates that they probably put on the same fertiliser year after year. (Note that five of them are organic so this impacts on the use of chemical fertiliser.)

Attitudinal data: The members of Group 3 place most importance on profits and financial efficiency (FWE/GFR) as financial indicators, but do not place importance of high yields. They are the least concerned about climate change and dispute its relationship to farming, and do not see their practices as having an effect on the global environment. They are the least likely to experiment.

Group 4 – greatest variability in profit
8A, 2B, 9C (1 organic, 1 integrated, 1 conventional)

These three farmers had the greatest variability in their profit as measured by EFS (/ha, su, farm) and NFPBT/farm, and in the measure of efficiency FWE/GFR. They had the lowest profit (NFPBT/ha, su), the least change in equity and the greatest increase in EFS/su and lambing percentage. Two of these farms have experienced great change over the time of ARGOS, with one farm being combined under the management of a relative and another to being managed with the owner leaving farming.

Additional variables: These farmers have made the greatest changes and have the largest variation in their fertiliser applications of Ca, P and S per su. They have the largest variation in C and NC feed, and have made the biggest change in the percentage of sheep on their farms.

Attitudinal data: The change in the bank balance is the most important financial indicator for this group of farmers. They do not think it is important for the farm to have a mix of productive nad non-productive uses, but are the most bird friendly group. They expect to be farming the longest into the future. (However, since filling in this questionnaire, one farmer had put a manager on his farm!)

Group 5 - variability of cropping and profit per su
4A, 11B (1 organic, 1 integrated)

The two farmers in this group appeared to have a low variability in the efficiency of their farming as measured by FWE/GFR but a high variability of the profit per su. This can probably be explained by the way the two of them manage sheep finishing around their cropping enterprise.

Additional variables: The two farmers in Group 5 have the most expenses related to cash cropping and repairs and maintenance. They have the largest variability in repairs and maintenance and C and NC labour expenses. They have made the least changes in the percentage of sheep on their farms.

Attitudinal variables: These farmers place the least importance on profit/loss as a financial indicator and they are the most likely to experiment. They have the highest awareness of the impact of their farming practices on the global environment, though they are not so keen on introduced birds. They are less interested in trees for practical and aesthetic purposes except for growing them to supply logs/timber.

4.5 Analysis of sheep/beef data excluding cropping farmers

When the first analysis was dominated by the cropping farmers, it was decided to do an analysis without them, as this may be a more representative sample of 'proper' sheep/beef farmers. Also, because the cropping farmers made so much more profit than anyone else, in any statistical analysis the usual larger variation that occurs as numbers get larger could have meant that differences between the non-cropping farmers were being hidden.[30]

4.5.1 Correlations

The correlations of the core variables are shown in Table 4.34. In the comments below the points made earlier when the cropping farmers were included in the analysis have been left if they still hold and amended (in italics) if they do not.

- It is obvious from these correlations and is well known that a farm's profit (per ha, per farm, per SU) is closely related to how much control is exercised over working expenses, particularly as a proportion of revenue (FWE/GFR). This holds over all management systems.
- Profit made per ha is *not* related to the meat produced. *This indicates the importance of what else a farmer does with their income to obtain a profit.*
- The larger the farm the lower the profit (*only NFPBT*) per ha (as larger farms are usually more extensive).
- The larger the profit/ha, the more efficient the farm (the lower the FWE/GFR ratio), and the more profit is made per stock unit and per farm.
- *However, only the profit measured by NFPBT/farm is related the Olsen P levels and in a negative way.*
- The more efficient the farm, the higher the pH level. The pH level is a measure of the availability of soil nutrients and so in a way is a measure of soil efficiency.
- The more efficient the farm the higher the lambing %.
- The intensification and efficiency measures are *not* all correlated (but nearly), but the sustainability measures are. The capitals do not hang together.
- The different measures of profit are *nearly* all highly correlated – *NFPBT is not related to EFS when both measures are per stock unit.*

With this in mind it is of interest and significance that increasing equity (see Table 4.35 – the correlations of annual change) was associated with decreasing efficiency in terms of FWE/GFR and this is identified with decreasing profits (EFS/ha, su, farm, NFPBT/farm). Paying off debt is not taken account of in the profit – only paying interest. Changing financial data is reflected in changes in other financial data.

From the correlations of the variability of the core variables (Table 4.36) it can be see that the variability of any of the financial results affects the variability of any other financial results and the variability of lambing % affects the variability of the financial returns.

[30] Note, this could have been avoided by using log transformations of the data, but this involves back transformation of the results which is rather tedious! Also, it does not deal with negative numbers and so everything has to have a number added to it before undergoing a log transformation so negatives do not occur – requiring yet another manipulation of the data.

4.5.2 PCA analysis of averages of core variables

The Principal Components Analysis of the averages produced four main components (Table 4.37). PC1 measures profit in terms of Effective Farm Surplus (EFS) – whatever the units and associates this with financial efficiency – the ratio of working expenses to gross farm revenue. (EFS includes the cost of labour both paid and unpaid, and the value of the change in the feed inventory.) PC2 measures profit in terms of the Net Farm Profit Before Tax (NFPBT) – whatever the units. It also includes equity, and is balanced out by the effective land area. This makes sense as the level of profit will relate to how much of the mortgage can be paid off and in turn probably to the size of the farm. PC3 is a measure of the lambing % and the meat production/ha, which again seems a logical relationship – so is a measure of production. PC4 is a measure of the soil resource – Olsen P, percentage of nitrogen and the availability of soil nutrients as measured by soil pH.

4.5.3 Cluster analysis of averages of core variables

A cluster analysis using the four PC scores assigned to each farm was carried out. The solution with five clusters was chosen (see Table 4.38).[31] Unbalanced anovas for the rest of the data are used to describe the clusters/groups next (see Tables 4.39 to 4.46).

Group 1: Inefficient farmers
3B, 7C, 8C, 9C (1 integrated, 3 conventional)

The farmers in Group 1 have low profit levels as measured by EFS but they are reasonably high producers of meat. They have a higher soil N but the lowest pH on average. They are the most inefficient farmers with the highest FWE/GFR, and the least profit (possibly a loss) per farm. Their profit levels have probably not changed or may even be decreasing and they are consistent over time, while their efficiency is declining but variable. However, their equity may be increasing as is their soil N. One farmer has been going through change, developing a deer unit and this could have made him appear less profitable and inefficient.

Additional variables: This group shows quite an extraordinary pattern. It has the highest expenses for stock, pasture and fertiliser, but these are showing little change over time (except for the costs associated with C & NC feed which may be increasing) and therefore also have a low variability. The cost of fertiliser is demonstrated by the amounts applied. These farmers applied more K (tonnes/farm), N (however measured), P (kg/ha and /su) and S (however measured). This indicates that they probably followed a pattern of applying the same amounts of fertiliser each year.

In terms of bird density, this group have the highest measurement of native birds, especially native and introduced insectivorous birds. The native insectivorous birds have shown the greatest increase and variability over the three periods of measurement.

Attitudinal data: The members of this group place the greatest importance on change in bank balance, cash/surplus/deficit, the ratio of working expenses to income and pay attention to good financial returns. (The irony is in this last result because this group is the least efficient with very high expenses.) They place importance on having minimum weeds, production diversity, and pesticide use but least importance on reducing carbon emissions and feel farmers are being

[31] It separated out more variables than the four cluster solution but even so it still did not do it as well as could be expected. It separated out NFPBT/ha, equity, pH, FWE/GFR and NFPBT/su better than the four cluster solution. However, the four cluster solution separated out carcase weight produced and effective area better. With less separation of carcase weight, it might help in finding out how farms that are producing the same amount make different amounts of profit.

asked to assume more than their fair share of responsibility for carbon emissions, and they are not bird-friendly. They do not value having native plants or trees. Overall, this group is the least likely to experiment.

Group 2: organic, low input
2A, 5A, 7A, 8A, 12A (5 organic)

The farmers in this group also have a low EFS (/ha and /su). They produce the least amount of meat per ha and have the lowest Olsen P and soil N. They are possibly however, making a NFPBT profit per stock unit (probably because some add value to their cropping activities by doing some processing on site).

The profit level and soil N of these farmers are unlikely to have changed over the time of ARGOS but their equity has improved by 1 percent. Their lambing percentage is the most variable while other variables are quite consistent over time.

Additional variables: This group has the lowest expenses and the least variation of these expenses. Any changes in expenses indicate a stationary pattern or a slight decline. As befitting their organic status they have very low inputs of traditional fertilisers, with very little variation (and place little importance on pesticide use). The members of this group have used the most supplements and have the lowest stocking rate.

Attitudinal data: This group place the least importance on financial efficiency (FWE/GFR) and are less concerned about paying attention to financial concerns. The members place greater importance on reducing carbon emissions than any of the other groups, though they still feel farmers are being asked to assume more than their fair share of responsibility for climate change. They are the least concerned about farm succession but are most concerned about future generations. They are the most bird and biodiversity friendly group and see the importance of planting trees to encourage biodiversity. The farmers in this group have been associated with their current farm and have been farming for the least number of years.

Group 3: efficient and profitable
11A, 4B (1 organic, 1 integrated)

The two farmers in Group 2 are making the most profit, they are the most efficient and they have the highest equity of all the groups. Their profit level is unlikely to have changed over time or has possibly fallen and their efficiency has declined slightly.

Additional variables: This group has the most expenses associated with cropping and these are showing the largest increase and the most variability. Their fertiliser use does not stand out in any way. They have the greatest supplies of supplements not used.

Attitudinal data: This group is the least agreeable about statements in the survey! The two members place least importance on the indicators of financial performance associated with change in bank balance, actual versus budget income, and cash/surplus/deficit and pay little attention to good financial returns. They are least concerned about weeds, soil biological activity, water quality, the presence of productive and non-productive species, customer requirements, future generations and do not see any importance in planting trees. They do not feel that farmers are being asked to assume too much responsibility for climate change.

Group 4: going through change
2B, 11C (1 integrated, 1 conventional)

The two Group 4 farmers are farming the largest land area and possibly making a loss when measured in terms of NFPBT, however this may possibly be a profit when measured as EFS. Their profit may have risen over time while their equity has probably fallen but their efficiency may well have increased. All of these measurements are highly variable, only their soil N is least variable.

These findings reflect that fact that both these farms have changed over the ARGOS period. One ARGOS farm has become incorporated into another farm and though the measurements here only commenced at the start of this there may well have been a big change from the first year of management when the son took over the farm from his father and later purchased it. The other farmer has brought an extensive land holding inland to complement the original family farm and this will have affected all the results relating to hectares and causing a drop in equity.

Additional variables: This group is notable for the variability of its expenses and having the most change (usually increasing). Their fertiliser applications also reflect this variability. The average use of S per farm is the highest of all the groups. Their stocking rate is the most variable.

Attitudinal data: The two farmers in Group 4 give greatest importance to actual versus budget income and cash/surplus/deficit as indicators of their financial situation. They are least concerned about having a mix of productive uses on their farm. They are quite bird friendly.

Group 5 – high soil resource, consistent and sustainable
9A, 10A, 8B, 9B, 10B, 11B, 2C, 12C (2 organic, 4 integrated, 2 conventional)

The eight farmers in Group 5 are making a profit when measured as NFPBT/ha or per su. They have the highest soil resource as measured by Olsen P, soil N and pH, and are very financially efficient. The profit level of these farmers is unlikely to have changed. Only their soil N is more variable than that of the other groups, while all other variables are consistent over time compared with Group 4.

Additional variables: While Group 2 had the lowest, least variable and least change in farm expenses, Group 5 matches it for the least change and least variable. Farms in this group had the lowest density of native and native and introduced insectivorous species of birds and the greatest drop in native insectivorous birds and the least variation in these birds. In terms of fertiliser use, this group used more Ca (per farm and per ha) than any of the other groups and this use was the most variable. The members of this group used the least K per farm, and the least N fertiliser, however it was measured, with the least variation, indicating that they probably put on similar amounts each year. With Group 1 they applied the most S kg/ha on average. Those in this group used the least DM, wet matter but had the highest stocking rate.

Attitudinal data: The farmers in this group did not place a great importance on the number of different kinds of trees (native or exotic) on their farm, but did place a little importance on planting trees to increase native birds and planting exotic trees to generate carbon credits. They placed the most importance on succession. Along with Group 2 farmers they had on average been the least years farming.

4.6 Discussion of sheep/beef results

4.6.1 The context of sheep/beef farming from 2003-2010

There was no indication overall that any of the core variables used had changed over the period of ARGOS[32] (Table 4.16) with the exception of farm equity which had increased slightly, by nearly one percent, and the percentage of Nitrogen in the soil which had an average of 0.427 and had risen annually by 0.032 for farms without substantial returns from cropping. This demonstrates the very static context in which sheep/beef farmers have operated over the past seven to eight years.

There is no evidence of intensification over the time of the ARGOS measurements. The Net Profit Before Tax/ha (NPBT/ha) had risen overall when cropping farmers were included in the analysis but this became non-significant when they were removed. That is NFPBT/ha had not changed over the period of ARGOS for other than cropping farmers. In terms of capital resources, farm equity averaged 84% - 85% when cropping farms were excluded. As mentioned above, soil N had shown an annual increase of 7% on average. The average efficiency of farms as measured by the Farm Working Expenses to Gross Farm Revenue ratio (FWE/GFR) was 66% (with or without cropping included) and the average lambing percentage was 132.5%. It cannot be stated with any confidence that there was any profit made per stock unit.[33] (For the non-cropping farms there is a 95% chance that the NFPBT/su was between a loss of $18 and a profit of $61, and the EFS/su was between a loss $33 and a profit of $62.) Similarly, the profits made per farm were also so variable it cannot be stated that there was any overall average profit per non-cropping farm whether measured by Effective Farm Surplus (EFS) (between a loss of $144,000 and a profit of $181,000) or NFPBT (between a loss of $48,000 and a profit of $170,000) over the period (in 2009 dollar value. This indicates that many farms were going through tough times, but of course is dependent on what accountants are able to include in the farm expenses!

The separation out of the two analyses, one of which included cropping farmers and the other which excluded them, was a useful exercise. But, just as the analysis with the cropping farmers in produced three outstanding performers whose variability and higher profit meant the power of the other group comparisons was reduced, this also occurred for the analysis without cropping farmers as two farmers emerged far and away more profitable and variable than the rest, again meaning that the analysis was not able to be as discriminating as hoped.

As compared to the kiwifruit analyses, there was little consistency between farmers in terms of groupings across the analyses of averages, change and variation. There were three pairs of farmers who did remain together, but that was all. They were 2A and 5A, 7A and 12D, and 9B and 10B. The first two are both low input organic farmers and make their living not only from their sheep/beef production but also from other organic grain production for baking with some further on-farm processing. 7A and 12D, on the other hand while still being low input farmers they do produce sheep/beef meat only and are consistent reliable producers, and investing in their farms. The other pair, 9B and 10B, are efficient, consistent and profitable farmers, one starting on his career on his father's farm and one finishing it by employing a manager.

4.6.2 Pathways

The most notable aspect of sheep/beef farming would appear to be its diversity which has been difficult to capture in a reasonably concise way. Most of the groupings observed are covered in

[32] The financial data had been converted to 2009 'real' values.

[33] This means that the data were so variable the 95% confidence interval for the mean included zero. That is it cannot be stated with 95% confidence that there was a profit.

the descriptions that follow. As the number of ARGOS farms used in this analysis was only 25 it is difficult to say if this is a proportionally representative sample of New Zealand sheep/beef farmers, so little can be said about the relative sizes of these groups except that some probably represent a larger proportion of farmers than others – as is indicated.

- A very small proportion of low input organic farmers who are only sustainable financially because of their and their family's unpaid labour, their low expenses, and that some of them increase the value of their grain products on-farm through extra processing.

- A small proportion of innovative high risk, highly profitable farmers who vary what they do season by season as they follow the market in cropping and finishing of stock. They are probably very resilient but their dependence on irrigation and high fertiliser and pesticide use (for the non-organic farmers) probably compromises this, though this is challenged by the organic farmer in this analysis of ARGOS farmers, who does not have these inputs, which indicates that there are other ways possible for achieving very profitable farming in these areas.

- A very small proportion of farmers who are consistently very profitable and efficient but who may use entirely different tactics to achieve this. In this analysis one farmer was low input (organic), while the other was a high level producer on irrigated land. They both had high equity. Both were cautious in their preparation for extreme weather events having high supplies of supplements that were not necessarily used.

- The largest proportion and therefore the most common group of farmers, who maintain their soil resource carefully, are stable/consistent, efficient, reliable and make a modest profit. Though this group could be classed as sustainable, they are not necessarily resilient because this habit of consistency – applying the same fertiliser year by year and such like – may mean that they are less adaptable and innovative, surviving through bad times by the common farmer tactic of 'belt tightening' (rather than risk taking), which may well have been what they have been doing through the whole period of the ARGOS programme because it has not been a time of high profits for sheep/beef farming.

- A small proportion of farmers who have been changing by adding to their land area and investing in farm development in less economically focused ways such as through tree planting.

- A reasonably sized proportion of low performing farmers in terms of profitability who have consistently have higher costs than the others and lower production and are hence less efficient. Though some may be consistent and reliable, they are making a loss.

- A very small proportion of extensive pastoral farmers who therefore have a lower rate of production, but also a good soil resource and who are making a meagre living.

5 Discussion and conclusion

5.1 Some obvious pathways

Some pathways are repeated in both the kiwifruit and the sheep/beef sectors. There is the small group of farmers and orchardists who are prepared to invest a lot of capital in their properties, who change and adapt to suit the times by growing different crops, meeting market demands with quality and quantity of product and trying different practices. This group seem to do remarkably well even in difficult times. In contrast there is a group who seem to be investing in their soil resource but are not making a sustainable economic return on their investment. Others are at a stage of expanding the size of their property and/or investing in it but are not getting a return on that investment yet. There is a large group of farmers and orchardists who continue to do what they have always done, who carefully watch their expenditure and manage to make a reasonable living even in the difficult times. Finally there is a group that are not very efficient, spending too much for the amount of return.

However, first it is worth noting how the different ways of measuring profit (EFS and NFPBT in the sheep/beef sector, EOS and COS in the kiwifruit sector) are clearly separated out in different principal component scores and other parts of the analysis when it could be expected for them to be grouped together more. Economic Farm Surplus (EFS) includes the cost of labour – both paid and unpaid and is therefore dependent on how accurate a farmer or farming couple is in telling the ARGOS Field Research Manager what hours they work. It also includes the value of the feed. A measure of the soil resource as indicated by the Olsen P measurement is not included in EFS but is included in EOS (for kiwifruit). Net Farm Profit Before Tax (NFPBT) includes depreciation and paid labour but not unpaid labour. It does not include the feed inventory. Therefore the importance of unpaid labour in both sectors in terms of its contribution to the profitability of the farm or orchard enterprise is made clear. Without unpaid labour many of these enterprises would not survive.

5.2 Intensification

A crucial question for the sustainability and resilience of New Zealand's agricultural resource will be determined by the degree of intensification adopted by farmers, growers and orchardists. In the analysis used for this report the core variables of profit per hectare, production per hectare and percentage of an orchard that produced green kiwifruit or percentage of a sheep/beef farm profit that has come from cropping, and the analysis of change have been included partly as a way of determining whether ARGOS farmers and orchardists have intensified their production over the period of ARGOS data collection.

5.2.1 The question of intensification in the kiwifruit sector

For kiwifruit, in the overall analysis of ARGOS orchards (Table 3.4) it is apparent that there has been an increase in production while there has been no change in profit or Gross Orchard Return. In this time the capital based in the soil resource has increased[34] even though there has been no overall increase in the fertiliser used or in the amount spent on it. Cash Orchard Expenses have increased and this can be accounted for by an increase in electricity, vehicles and fuel and pollination costs. The latter could have contributed to the increased production but could also be attributed to the increasing costs of pollination as a result of the incursion of the varroa mite into bee populations and the increasing cost of managing that and the decrease in

[34] Even though the soil resource has increased it is difficult to know if the amounts of increase involved mean anything in practical terms. For example, do changes in pH of 0.02, and 0.014% in N actually affect the growth of kiwifruit?

the natural occurrence of bees so the need to bring in hives at pollination time. Repairs and maintenance have decreased, probably because this is one way of reducing costs but it could also be that most orchard development has been achieved over this period. What this suggests is that increased production has come about mainly through changing pruning techniques. Unfortunately ARGOS has been unable to obtain accurate labour data or hours worked.

When the data was analysed to look at different groups of orchardists the analysis of the averages of the core variables revealed two contrasting but similarly profitable groups. One was the most intensive (Group 4, Table 3.7) - producing the most trays/ha, the biggest fruit with the highest DM – while the other produced smaller fruit with lower DM. The difference was attributable to the first group of orchards growing only gold fruit whereas the latter group was mainly under organic management and grew only green fruit. There was no indication that either group had changed in any of these variables over time (Table 3.8). There was a hint (at the 10% level of significance) that the first group's 'intensification' was highly variable both in the level of profit and production.

When the analysis was of the annual change in the core variables over the period of ARGOS, the assertions made above were supported (Tables 3.16 – 3.21). The small group that had increased their production the most was lifting it from a low base, and was the only one which had an increasing profit. Another group of six orchardists with the largest orchards on average, was just maintaining their profit through increasing their production and their soil resource (thought the ration C:N was decreasing). The bird density on these orchards had decreased over the time between the two occasions on which this had been measured. The final and largest group was operating at a loss even though their production had increased considerably.

Overall this paints a picture of kiwifruit orchards working hard to try to maintain their profitability by increasing their production, indicating that returns are a major driver of intensification in this sector.

5.2.2 The question of intensification in the sheep/beef sector

The ARGOS sheep/beef farms are so different that it did not seem pertinent to calculate overall averages of change that would be meaningful. However, the average annual changes in the core variables is presented in Table 6.16 and show that there has been no significant change over the period of ARGOS, except that equity has increased on average by nearly 1 percent. In the analysis of averages of the core variables the most intensive group was the one containing the three major cropping farmers (Table 4.6) as would be expected, cropping being a much more intensive practice than the more sheep/beef pastoral farming. These farmers made the highest profit in terms of EFS/ha and had a high level of production in terms of carcase weight. The group with the highest level of production had the highest profit measured as NFPBT/ha only indicating the importance in this measure of unpaid labour – compared to the cropping farmers who probably had both unpaid and paid labour.

In the analysis of annual change for the sheep/beef farmers one small group of three farmers are possibly becoming more intensive. They have the highest profit and lambing percentage and do the most cropping. Their expenses are high and increasing, as is their fertiliser use. One of the consequences of this may be that they have the lowest density of introduced birds, and are not interested in planting trees but as cropping farmers introduced birds may be regarded as a nuisance and trees would only increase this problem. Another large group of 12 farmers have intensified by increasing their meat production and lambing percentage, and they manage by being very efficient, keeping their costs low. This group has highest density of introduced birds and are supportive of tree planting.

When the cropping farmers were removed from the analysis, one of the two groups with the highest level of meat production also had the highest percentage of nitrogen in their soils, but they were the least efficient and possibly farming at a loss. Another small group of two farmers with the highest meat production also had the highest lambing rate was probably the most profitable and efficient. There was no indication of any impact on the soil resource of increased intensification for any of these results.

Overall, while some of the ARGOS sheep/beef farmers may have intensified their meat production through increasing their lambing rates this appears to have had little impact on any other aspects of the farm indicating that profitability may more related to financial management than intensification.

5.3 Further research and analysis for ARGOS 2.2

Location has a major impact on an orchard business and its soil resources. This has implications for orchard values as a piece of real estate. It may also be that there are efficiencies due to being close to packhouses and services. These could be investigated more in the future by further analysis of the data as part of ARGOS 2.2. It has also been suggested that we could look at soil use maps.

Further analyses could be done to see why the groups identified in this report differ. This could be done in terms of adding location, management system and farm size to the analysis and seeing which differences still stand (as in the kiwifruit analysis where this was done just for the variable averages (Table 3.13)).

What questions arise from this analysis?

- What is the role of financial success in resilience and sustainability?
- Does keeping costs low mean that resources become run down?
- How does the sustainability of an orchard enterprise relate to the size of an orchard? It seems that larger orchards are needed than in past and this has labour implications.
- What of the future? What would happen if all orchardists and farmers were consistent and reliable?
- There are contradictions here – orchards with high input, producing high quality fruit are very profitable; low input orchards producing lower quality fruit and with high efficiency are profitable; whereas high input orchards are producing low returns.

5.4 Recommendations and conclusion

When compared to the analysis of the retrospective interviews (van Dungen et a., 2010a, 2010b) this analysis has produced more generalized results because the actual on-farm/orchard practices are not revealed in the same way with quantitative data as with qualitative. We do not know how farmers diversified their products, or managed droughts or even what the effect of drought or snow has been. So in the next sections these two sources of results are brought together to provide an enhanced understanding of the information provided in this report.

5.4.1 Kiwifruit pathways

What strategies have orchardists practiced and are they sustainable and/or resilient?

- Group 1 – on way up by moving on to a ‘better’ orchard, one in a location more suited to kiwifruit growing

- Group 2 – small, were lifestyle orchards expected to make a profit or gain capital value but now not profitable, now possibly managed, selling/want to sell, dependent on unpaid labour
- Group 3 - inefficient and inconsistent - trying to do the right thing by building up the soil, trying to manage costs but not consistently
- Group 4 – high investment for high return, constantly innovative, resilient but not sustainable
- Group 5 – consistent, reliable and profitable - low input (most organic), low expenses, continue to do what they have always done, sustainable but not resilient

What specific ways have kiwifruit orchardists changed or managed to survive?

- Off-orchard work – which is more readily available in the areas where kiwifruit is grown.
- Response to labour shortage by changing pruning techniques.
- Response to Taste ZESPRI by the development of vine girdling techniques.
- Continued support for the single desk structure of ZESPRI.
- Response to GlobalG.A.P.is now incorporated into practice after initial fears of some orchardists about being restricted to book work. For younger orchardists such audit practices are just part of being a contemporary business.

We are aware that the production of kiwifruit is at a crossroads at the moment due to the psa incursion and the lower prices being achieved for green kiwifruit. Therefore these recommendations are very general and some are probably already under consideration by ZESPRI.

Recommendations

- Encourage some amalgamation of orchards to increase the efficiencies associated with size – this has labour implications as it will not be possible for an orchardist to do a lot of the work themselves.
- Efficiency must be balanced with necessary inputs to maintain the soil and capital base.
- Maintain a variety of possibilities so that it is still possible for some orchardists to run a profitable small enterprise.
- Encourage adaptability such as using inputs that are needed rather than application of the same amount each year, such as trying new pruning techniques.
- Producing high dry matter may be a risky business. How could dry matter premiums be managed differently?

5.4.2 Sheep-beef pathways

Sheep/beef farming is practiced in very diverse ways. Most of the results showed considerable variation over the years indicating that managing all the things that impact on a farming enterprise requires continual adjustment and adaptation, there are so many variables and uncertainties. The strategies used by famers over the period of ARGOS could be summarised in the following ways.

- Low input organic farmers - only sustainable financially because of unpaid labour, low expenses, and adding value to their products through on-farm processing.
- Innovative high risk, highly profitable farmers who vary what they do season by season by following the market in cropping and finishing of stock. They are possibly very resilient but their dependence on irrigation and high fertiliser and pesticide use (for the

non-organic farmers) probably compromises this. The inclusion of an organic farmer in this group indicates that there are other ways of achieving very profitable farming.
- Consistent, profitable and efficient farmers with high equity, who are cautious in preparation for extreme weather events with high supplies.
- Stable/consistent, efficient, reliable farmers who make a modest profit and look after their soil resource. They could be sustainable, but not resilient because of their consistency which means they are less adaptable and innovative, surviving through bad times by the common farmer tactic of ‘belt tightening’ (rather than risk taking).
- Investing and changing farmers who have been adding to their land area and investing in farm development.
- Low performing, high cost farmers.
- Extensive pastoral farmers with a lower rate of production, but a good soil resource who are making a meagre living.

The actual techniques that individual sheep/beef farmers practiced included:
- Increasing lambing percentages by breeding genetics.
- Scanning pregnant ewes to better manage nutritional requirements.
- Stocking rate flexibility.
- Keeping greater stocks of silage, baleage and growing feed crops for periods of adversity..
- Increasing farm size by purchase or lease of land to provide a run-off for summer.
- Adding irrigation, or increasing the area already irrigated.
- Diversification.
- Reducing fuel consumption.
- Belt tightening.
- Focusing on efficiency.

Off-farm elements included:
- Off-farm work.
- Restructuring of finances.

Recommendations
- Assist farmers to manage their costs while being more adaptable, e.g, managing fertiliser applications, having run-off properties to manage risk, diversification and risk.
- Encourage openness to other ways of farming – so alternative techniques can be incorporated into existing practices (as in kiwifruit where more conventional orchardists use compost and alternative fertilisers).
- Be supportive of diversity – both in practices and sources of income.
- Support the conditions which would ensure a greater security of income.
- Create an environment in which sheep/beef farming and farmers are valued.

5.4.3 Recommendations that apply to orchardists and farmers:

- Farmers and orchardists want to ‘do the right thing’ and expect in exchange that the ‘right thing’ will be done to them.
- The autonomy of farmers and orchardists should be respected. They need to be given choices not commands, goals and various ways of getting there.
- There is a need a diversity of practices acceptable to orchardists and farmers so they can choose and match their practices to the situation they find themselves in.

- Recommended practices should demonstrate – possibly visually – what a 'good' farmer or orchardist someone is. (This is part of establishing a reputation and hence being trusted in the industry community.)
- Where possible industry partners should form personal relationships with farmers and orchardists, keeping them in touch with the quality of their products, promoting loyalty and pride in their product (e.g., Icebreaker).
- There needs to be an awareness of the different seasonal opportunities in contracts dependent on location (e.g., KiwiStart).
- It would be more useful to farmers and orchardists to have contracts that provide continuity over several years (e.g., Icebreaker, and dairy and kiwifruit – minimum payments and top ups later).
- Farmers' and orchardists' resilience should be encouraged by supporting their adaptability, flexibility, experimentation, ability to see the feedback loops, breadth of social and environmental view (awareness of reach of impacts of practices economically, socially and environmentally), and alternative practices.

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Appendix 1: Tables associated with kiwifruit analysis

Table 3.1: Correlations of averages of core variables

	E0S/ha	COS/ha	Trays/ha	%Gr	Area	pH	Olsen P	N%	K	S	COE/GOR	EOS/tray	DM	Size
E0S/ha	1	0.84 **	ns	Ns	0.68 **	ns	ns	ns	ns	ns	-0.78 **	0.90 **	ns	ns
COS/ha		1	ns	Ns	0.39 *	0.32 (0.09)	ns	ns	ns	-0.46 *	-0.85 **	0.73 **	ns	ns
Trays/ha			1	-0.53 **	ns	ns	ns	ns	ns	ns	ns	ns	ns	-0.80 **
% Green				1	ns	ns	ns	ns	ns	ns	ns	ns	-0.67 **	0.62 **
Effective area					1	ns	ns	ns	ns	ns	-0.49 **	0.65 **	ns	ns
pH						1	ns	ns	0.43 *	ns	-0.40 *	ns	-0.51 **	0.31 0.10
Olsen P							1	-0.33 (0.08)	ns	ns	ns	ns	ns	ns
N%								1	0.49 **	0.72 **	ns	ns	ns	ns
K									1	0.57 **	ns	ns	ns	ns
S										1	0.37 *	-0.35 (0.07)	ns	ns
COE/GOR											1	-0.70 **	ns	ns
EOS/tray												1	ns	ns
DM													1	-0.50 **
Fruit size														1

* p<0.05, ** p<0.01

Table 3.2: Correlations of annual trends of core variables

	E0S/ha	COS/ha	Tr/ha	pH	OlsP	N%	K	COE/GOR	EOS/tr	DM	Size
E0S/ha	1	0.81 **	0.39 *	ns	ns	ns	ns	-0.48 **	0.86 **	-0.42 *	ns
COS/ha		1	0.39 *	ns	ns	ns	ns	-0.73 **	0.73 **	-0.44 *	ns
Trays/ha			1	ns	ns	ns	ns	-0.43 *	0.50 **	-0.53 **	ns
pH				1	ns	ns	ns	-0.48 **	ns	ns	ns
Olsen P					1	ns	ns	ns	ns	ns	ns
N%						1	ns	ns	ns	ns	ns
K							1	ns	ns	-0.42 *	ns
COE/GOR								1	-0.62 **	0.55 **	ns
EOS/tray									1	-0.57 **	ns
DM										1	ns
Size											1

* p<0.05, ** p<0.01

Table 3.3: Table: Correlations of variation (s.d.s) of core variables

	E0S/ha	COS/ha	Tr/ha	pH	OlsP	N%	K	COE/GOR	EOS/tr	DM	Size
E0S/ha	1	Ns	ns	ns	ns	0.33 (0.08)	ns	ns	ns	ns	ns
COS/ha		1	ns	ns	-0.34 (0.07)	ns	ns	0.50**	0.48 **	ns	ns
Trays/ha			1	ns	ns	ns	ns	ns	ns	0.32 (0.09)	0.39 *
pH				1	ns	ns	ns	ns	ns	ns	ns
Olsen P					1	0.38 *	ns	ns	ns	0.55 **	ns
N%						1	ns	ns	ns	ns	ns
K							1	ns	ns	ns	ns
COE/GOR								1	0.64 **	ns	ns
EOS/tray									1	0.41 *	ns
DM										1	ns
Size											1

* p<0.05, ** p<0.01

Table 3.4: Annual change in core variables for all ARGOS orchards

	Variable	Average annual change	95% confidence interval	Significance (Green, Organic Green, Gold)	n
External driver	GOR/ha ($)	153	-1,499, 1,805	n.s. (G, OG, Go)	29
Responses					
Intensification	E0S/ha ($)	-110	-1,685, 1,465	n.s. (G, decrease OG, Go)	29
	COS/ha ($)	-858	-2,381, 664	n.s. (decrease G, decrease OG, Go)	29
	Trays/ha	402	272, 531	Increase (G, OG, Go)	29
Capital	pH	0.020	0.004, 0.035	Increase (n.s. G, n.s. OG, n.s. Go)	29
	Olsen P	1.75	0.54, 2.96	Increase (n.s. G, n.s. OG, n.s. Go)	29
	N%	0.014	0.009, 0.0186	Increase (G, OG, Go)	29
	K	0.020	0.012, 0.027	Increase (G, n.s. OG, Go)	29
Efficiency	COE/GOR	0.010	-0.015, 0.034	n.s. (G, increase OG, Go)	29
	EOS/tray	-0.05	-0.39, 0.30	n.s. (G, decrease OG, Go)	29
Others	DM	-0.011	-0.068, 0.045	n.s. (G, increase OG, decrease Go)	29
	Size	-0.09	-0.21, 0.03	n.s. (G, OG, Go)	29
	Equity %	-6.6	-13.5, 0.4	n.s. (G, OG, Go)	22
Expenses ($/ha)	Electricity	19	4, 34	Increase (n.s. G, n.s. OG, n.s. Go)	27
	Spray & chemicals	-26	-74, 23	n.s.(G, decrease OG, Go)	29
	Pollination	69	25, 114	Increase (n.s. G, n.s. OG, Go)	29
	Fertiliser	51	-17, 120	n.s. (increase G, n.s. OG, Go)	29
	Vehicles and fuel	92	55, 129	Increase (G, OG, Go)	29
	Repairs and maintenance	-144	-245, -44	Decrease (n.s. G, n.s. OG, n.s. Go)	29
	COE	783	125, 1440	Increase (n.s. G, OG, n.s. Go)	29
Fertiliser applied/ha	Mg	-2.1	-5.0, 0.7	n.s. (G, OG, decrease Go)	28
	S	3.3	-1.4, 8.0	n.s. (G, OG, Go)	28
	K	0.9	-6.8, 8.6	n.s. (G, OG, Go)	28
	P	-2.3	-5.4, 0.8	n.s. (G, OG, decrease Go)	28
	N	-1.4	-6.2, 3.3	n.s. (G, OG, Go)	28

Note: 1. Soil measurements are annual change from 2004-9, calculated over three sampling times 2004, 2006 and 2009. (Sulphur was only measured twice.)
2. Fertiliser is an average of 9 years of application, 2003/4 to 2009/10.
3. The numbers in brackets indicate whether this same result holds when management system is considered.

Table 3.5: Rotated Principal Components for averages of core variables[35]

	Variables	PC1	PC2	PC3	PC4
Intensification	E0S/ha	+0.96	+0.17	-0.20	+0.02
	COS/ha	+0.86	+0.18	-0.19	+0.21
	Trays/ha	+0.09	+0.80	-0.09	-0.03
	% Green	-0.3	-0.84	-0.13	+0.04
Capital	Effective area	+0.76	-0.21	+0.15	-0.33
	pH	+0.26	-0.32	-0.02	+0.83
	Olsen P	-0.17	+0.27	-0.60	+0.28
	N%	-0.16	+0.13	+0.84	+0.03
	K	-0.10	+0.08	+0.70	+0.60
	S	-0.31	+0.20	+0.84	+0.00
Efficiency	COE/GOR	-0.87	+0.13	+0.05	-0.20
	EOS/tray	+0.89	-0.03	-0.18	+0.11
Others	DM	+0.06	+0.65	+0.28	-0.41
	Size	0.13	-0.90	-0.02	+0.03
% of variation	79 (total)	31	22	16	10

Table 3.6: Cluster analysis groups of averages of core variables

	Group 1 (n=2)	Group 2 (n=8)	Group 3 (n=8)	Group 4 (n=3)	Group 5 (n=8)
PC1 – financial profit and efficiency	-0.12	-0.78	-0.50	+0.86	+0.99
PC2 – productivity	-0.59	+0.35	-0.27	+1.93	-0.66
PC3 – soil resource – N,P, K, S	-0.03	-0.82	+1.08	+0.35	-0.38
PC4 – sol resource - pH and K	-2.38	-0.09	+0.66	+0.09	-0.04

[35] Rotation of these components using a varimax method, spreads the variation more evenly and often allows for an easier interpretation of the components.

Table 3.7: Characteristics of the groups from the cluster analysis of the averages of core variables

	Variable Average	Group 1: Poor producers (n=2)	Group 2: Inefficient, inconsistent (n=8)	Group 3: High soils, poor return (n=8)	Group 4: High producers and profit (n=3)	Group 5: Most efficient, consistent and profitable (n=8)	Overall average	p[36]
Intensification	E0S/ha ($)	(390)	(-4,336[b])	(-3,860[b])	(15,585[a])	12,942[a]	(2,948)	0.000
	COS/ha ($)	(6,209[b])	13,113[b]	13,226[b]	27,499[a]	26,481[a]	17,844	0.001
	Trays/ha	6,529[bc]	8,060[b]	6,922[bc]	10,480[a]	6,460[c]	7,450	0.004
	% Green	100	75	89	0	100	80	*
Capital	Effective area (ha)	6.1[a]	2.1[c]	2.6[bc]	4.6[ab]	4.8[a]	3.5	0.002
	pH	6.28[c]	6.51[bc]	6.70[a]	6.54	6.66[ab]	6.59	0.027
	Olsen P	39.3	50.5[a]	32.9[b]	42.4	40.2	41.2	0.127
	N%	0.484	0.435[b]	0.588[a]	0.507	0.429[b]	0.486	0.004
	K	0.52[c]	0.68[c]	0.99[a]	0.93[ab]	0.75[bc]	0.80	0.001
	S	17.6	12.6[bc]	31.7[a]	22.7[ab]	8.8[c]	18.2	0.001
Efficiency	COE/GOR	0.69[ab]	0.75[a]	0.62[ab]	0.56[bc]	0.38[c]	0.59	0.000
	EOS/tray ($)	(0.01)	(-0.44[b])	(-0.81[b])	1.58[a]	1.96[a]	(0.36)	0.003
Others	DM %	17.55	17.03	16.93[b]	17.92[a]	16.81[b]	17.07	0.165
	Size	34.4[ab]	33.3[bc]	34.0[ab]	31.8[c]	35.2[a]	33.9	0.009

Note:

    * Not normally distributed.

    Bracketed numbers are not significantly different from zero.

[36] This means that the 'treatment' factor ('group') in the anova had this level of significance, i.e., it is a measure of the probability of non-significance of all possible 9 comparisons between each group.

Table 3.8: Characteristics of the groups from cluster analysis of averages of core variables, in terms of annual trend/change of core variables

	Variable Annual change	Group 1: Poor producers (n=2)	Group 2: Inefficient, inconsistent (n=8)	Group 3: High soils, poor return (n=8)	Group 4: High producers and profit (n=3)	Group 5: Most efficient, consistent and profitable (n=8)	Overall average	P
Capital	N%	(0.006 (b))	(0.007 b)	0.022 a	(0.021 (a))	(0.012 (b))	0.014	0.095
Others	DM %	(0.097)	(-0.068 (b))	(-0.043)	(-0.079)	(0.075 (a))	(-0.011)	0.205

Note: 1. Superscripts in brackets denote differences at the 10% level of significance.
2. Only variables where significant differences occurred are presented in this table.
3. In the analysis of trend only variables that had eight or more significant regression measurements of slope were included.
4. Numbers in brackets are not significantly different from zero.

Table 3.9: Characteristics of the groups from cluster analysis of averages, in terms of variation (s.d.) of core variables

	Variable: Standard deviation	Group 1: Poor producers (n=2)	Group 2: Inefficient, inconsistent (n=8)	Group 3: High soils, poor return (n=8)	Group 4: High producers and profit (n=3)	Group 5: Most efficient, consistent and profitable (n=8)	Overall average	P
Intensification	E0S/ha ($)	34,300	34,300	25,800(b)	61,600 (a)	47,700	38,500	0.335
	COS/ha ($)	(5,300) b	12,300 (a)	8,300 b	(16,000 a)	7,900 b	9,900	0.027
	Trays/ha	(1235 b)	2688 a	2115	2610 (a)	1448 b	2,080	0.040
Capital	pH	(0.14)	0.13 (a)	0.16 a	0.18 a	0.08 b	0.13	0.028
	N%	(0.020 (b))	0.032 b	0.059 a	(0.060 (a))	0.037 (b)	0.043	0.095
	K	(0.08)	0.07 (b)	0.12 (a)	(0.12)	0.08 (b)	0.09	0.255
Efficiency	COE/GOR	(0.14)	0.27 a	0.14 b	(0.13 (b))	0.09 b	0.16	0.057
Others	Size	(2.24)	2.21 a	1.83	1.55 (b)	1.61 b	1.87	0.188

Note:

1. Superscripts in brackets denote differences at the 10% level of significance.
2. Brackets indicate averages that are not significantly different from zero.
3. It is the smallest groups (1 and 4) that are more likely to have a s.d. that is not significantly different from zero. This is simply because they are so small (one or two degrees of freedom) that the t-value used to calculate the confidence interval will be quite large. It also indicates the strong possibility that these values may in fact show no variation at all.

Table 3.10: Other variables to add to descriptions of groups clustered from averages of core variables

	Variable	Group 1: Poor producers (n=2)	Group 2: Inefficient, inconsistent (n=8)	Group 3: High soils, poor return (n=8)	Group 4: High producers and profit (n=3)	Group 5: Most efficient, consistent and profitable (n=8)	Overall average	P
Financial Income $	GOR/ha Av	(30,700[(c)])		42,200[b]	70,100[a]	43,800[b]	44,700	0.000
	GOR/ha s.d.	(5,100 [b])	12,800[a]	8,000 [b]	(14,800[a])	8,300 [b]	9,900	0.026
Financial expenditure $/ha	Electricity Av	(44 [b])	344 [a]	338 [a]	(139)	208	262	0.091
	Electricity annual change	(-3)	22	50 [a]	(-2 [b])	(0 [b])	19	0.083
	Electricity s.d.	(17 [b])	101 [b]	193 [a]	(91 [(b)])	78 [b]	111	0.063
	Spray & Chemicals Av	1,203	1,580 [a]	1,857 [a]	2,04 1 [a]	975 [b]	1,511	0.023
	Spray & Chemicals s.d.	(350)	544 [a]	494 [a]	421	219 [b]	415	0.042
	Pollination Av	1,942 [a]	1,278 [b]	1,526	1,263	1,182 [b]	1,364	0.090
	Pollination s.d.	(309)	411	509 [a]	260	189 [b]	354	0.107
	Fertiliser Av	(699 [c])	1,381 [bc]	2,006 [a]	1,735[ab]	1,428 [bc]	1,556	0.030
	Fertiliser s.d.	(252 [b])	478 [b]	844 [a]	(366 [b])	367 [b]	521	0.014
	COE/ha Av	(20,486[bc])	28,110[b]	25,030[b]	38,092[a]	16,344[c]	24,521	0.000
	COE/ha annual change	(1,039)	(1,487 [(a)])	(-150 [b])	(2,213 [a])	(411)	782	0.188
	COE/ha s.d.	(2,892 [bc])	5,834 [ab]	3,940 [bc]	8,671 [a]	2,943 [c]	4,605	0.004
Soils	C% Average	6.2	5.3 [b]	6. 8 [a]	5.9	5.0 [b]	5.76	0.014
	C% Annual change	(0.046 [(b)])	(0.042 [b])	0.196 [a]	0.264 [a]	0.099 [(b)]	0.124	0.041
	C% s.d.	0.254 [bc]	0.424	0.593 [ab]	0.708 [a]	0.283 [c]	0.450	0.039
	C/N average	12.90 [a]	12.23 [ab]	11.54 [c]	11.80	11.83 [bc]	11.931	0.046
	AMN/N average	1.95	1.91	1.50 [b]	1.65	2.31 [a]	1.884	0.149
	AMN/N s.d.	0.54 [a]	0.15 [b]	0.19 [(b)]	0.28	0.33	0.251	0.168
Fertiliser applied (kg/ha)	Sulphur s.d.		58.4[a] [63.8 [a]]	33.0 [b]	(41.0)	28.7 [b]	41.7	0.029 [0.009]
	Phosphate Av		36.2 [b]	65.8 [a]	37.8 [b]	33.7 [b]	44.4	0.003
	Nitrogen Av		122.3 [a]	100.0	97.2	69.2 [b]	97.2	0.171

Note: Empty cells indicate data only available for one orchard for this variable.

Table 3.11: Characteristics of the groups from cluster analysis of averages, in terms bird densities

	Variable	Group 1: Poor producers (n=2)	Group 2: Inefficient, inconsistent (n=8)	Group 3: High soils, poor return (n=8)	Group 4: High producers and profit (n=3)	Group 5: Most efficient, consistent and profitable (n=8)	Overall average	p
Bird density[37]	Introduced: all	(7.8 (b))	11.5	11.2	8.8 (b)	13.7 (a)	11.5	0.195
	Introduced: insectivores	(4.6 b)	8.6	9.1 (a)	6.7 (b)	10.8 a	8.9	0.179

Table 3.12: Characteristics of the groups from cluster analysis of averages, in terms attitude variables (from 2008 survey)[38]

	Variable	Group 1: Poor producers (n=2)	Group 2: Inefficient, inconsistent (n=8)	Group 3: High soils, poor return (n=8)	Group 4: High producers and profit (n=3)	Group 5: Most efficient, consistent and profitable (n=8)	Overall average	p
Importance of financial indicators	B1k: Don't monitor	[1.0]	2.7	4.0 a	1.0 b	2.5	2.91	0.203
Importance of production indicators	B2d: Minimum weeds	6.0 (a)	4.3	5.4 a	4.3	3.4 b	4.52	0.223
	B2g: Good mixture of productive uses	6.0 (a)	5.3 a	5.4 a	2.7 b	5.4 a	5.11	0.209
Importance of environmental indicators	B3b: Soil biological activity	7.0 a	5.9 b	6.6 a	6.7 (a)	6.8 a	6.50	0.105
	B3c: Soil health	7.0 (a)	6.3 b	6.8 (a)	7.0 (a)	6.9 a	6.71	0.146
	B3e: Biodiversity	6.0 (a)	4.8 (b)	6.1 a	3.7 b	5.3 (a)	5.32	0.077
	B3f: Native bird spp.	6.5 a	4.6	5.9 a	3.7 b	5.1	5.14	0.143
	B3h: Native plant spp.	6.5 a	3.9 b	5.5 a	3.7 b	3.9 b	4.52	0.058
	B3i: Plants or trees	6.5 a	3.7 c	5.4 ab	4.0 (bc)	4.4 (bc)	4.63	0.117
	B3l: Water budgeting	4.5	4.6	5.8 a	3.3 b	4.4	4.74	0.303
	B3o: Energy use	5.0	5.1	5.7 a	4.0 b	5.8 a	5.32	0.169
	B3p: Carbon stored	5.5	4.2	5.7 a	3.0 b	5.0	4.78	0.209

[37] See MacLeod et al. (in press) for a full description of the research from which this data is taken.
[38] For full report see Fairweather et al. (2009).

Importance of social indicators	B4b: Time for community activities	5.5	4.0 [b]	5.2 [(a)]	6.0 [a]	5.0	4.96	0.192
	B4e: Connection to place	5.5 [(a)]	5.0 [(a)]	5.1 [a]	5.0	3.6 [b]	4.68	0.182
	B4h: Orchard contributing to community	5.5 [(a)]	5.1 [(a)]	5.4 [a]	3.3 [b]	4.9 [(a)]	4.96	0.229
	B4m: Orchard workers are treated well	6.5	6.0 [b]	6.7 [a]	6.0 [(b)]	6.3	6.31	0.112
	B4n: Scope for farm succession		5.7	6.5 [a]	5.7	4.1 [b]	5.37	0.037
Consideration/implementation of approaches to management	C1e: Focus on limited no. income sources	6.5 [(a)]	4.9 [b]	6.1 [a]	5.7	6.0 [a]	5.75	0.114
	C1g: Seldom deviate from farm plans	(5.0)	3.6 [b]	5.1 [a]	3.3 [b]	4.7 [(a)]	4.41	0.048
	C2: Orchard different in 10 years?	6.5 [a]	5.4 [(a)]	5.0	5.0	4.1 [b]	4.96	0.193
Agreement with connections of management to -	D1b: wellbeing of local community	6.0 [a]	5.1 [a]	5.5 [a]	3.0 [b]	4.8 [a]	4.96	0.042
	D1c: wellbeing of nation and world	6.0 [a]	5.0 [(a)]	5.6 [a]	3.3 [b]	5.1 [a]	5.11	0.091
Agreement with management affects -	D2a: productive areas	6.5	4.9 [b]	6.0 [(a)]	5.7	6.6 [a]	5.89	0.121
Importance of farming factors	F1e: environmental health	7.0 [a]	6.4 [a]	6.5 [a]	5.0 [b]	6.5 [a]	6.36	0.014
	F1f: future generations/succession	3.0 [b]	4.3 [(b)]	6.0 [a]	4.3	4.1 [b]	4.64	0.145
Agreement with statements about emissions trading	G1a: NZ farmers contribute to climate change ...	3.5	4.1 [a]	3.9 [a]	1.3 [b]	3.6 [(a)]	3.57	0.268
Agreement with statements about native bird diversity and farm management	H1A: would not like more birds on farm	(1.5[(b)])	3.3	4.8[a]	(3.7)	2.4[b]	3.36	0.166
	H1Ac: Birds provide important services ...	(4.5)	5.3[a]	4.2	(2.3[b])	4.1	4.30	0.276
	H1Ad: Not responsibility as land owner to encourage birds ...	1.0[b]	3.0[(b)]	2.1[b]	5.0[a]	3.0[(b)]	2.82	0.066
Agreement with statements about introduced bird diversity and farm management	H1Ba: would not like more birds on farm	(1.5[b])	3.0[b]	4.2	6.3[a]	3.0[b]	3.6	0.059
	H1Bc: Birds provide important services ...	(4.5)	5.1[a]	4.0	2.3[b]	4.1	4.20	0.339

	H1Bd: Not responsibility as land owner to encourage birds ...	(2.0[b])	2.4[b]	2.8[b]	6.0[a]	3.4[b]	3.20	0.020
Importance of native trees and shrubs	I1Aa: Generating carbon credits	(4.0)	4.0[a]	4.4[a]	(2.3)	1.9[b]	3.35	0.092
	I1Ad: Enhancing stream health ...	(5.0)	4.1	5.5[a]	(4.3)	2.3[b]	4.23	0.128
	I1Ae: Enhancing shelter for stock/fruit	(3.5)	5.4[a]	5.2[a]	(2.3[b])	4.1	4.56	0.179
	I1Af: Managing erosion	(4.0)	5.3[a]	4.9[(a)]	(2.7[(b)])	2.7[b]	4.15	0.166
	I1Ag: making orchard look attractive	6.0[a]	5.0[a]	5.5[a]	(2.0[c])	4.1[ab]	4.64	0.014
Importance of exotic trees and shrubs	I1Ba: Generating carbon credits	(4.0)	4.0[a]	3.3	(2.3)	1.9[b]	3.00	0.236
	I1Bd: Enhancing stream health ...	(5.0[a])	3.7[(a)]	5.0[a]	(4.3[(a)])	(1.6[b])	3.78	0.084
	I1Be: Enhancing shelter for stock/fruit	(3.5[b])	6.3[a]	5.3	6.3[(a)]	5.3	5.56	0.223
	I1Bg: making orchard look attractive	6.0[a]	4.7[(a)]	5.0[(a)]	(2.7[b])	4.0	4.44	0.182
Background information	J6: Level of debt (high to low)		5.1[ab]	4.1[bc]	(3.3[c])	5.7[a]	4.76	0.013
	J10: How many years expect to be in orcharding[39]	35 [a]	14 [b]	13 [b]	17 [b]	7 [b]	13.7	0.004

Note: Square brackets indicate that this group was not included in the analysis because only one of the group responded to this question in the survey.

[39] The irony is that one of these orchardists left orcharding in 2010.

Table 3.13: The impact of management system, orchard size and location on the differences between the groups of the averages of the core variables

	Variable	Significance of differences between groups			
	Average	No additional factor	Factor: location	Factor: management system	Covariate: canopy area
Intensification	E0S/ha ($)	0.000	0.070	0.001	0.007
	COS/ha ($)	0.001	0.098	0.003	0.003
	Trays/ha	0.004	0.004	0.042	0.006
Capital	Effective area (ha)	0.002	0.003	0.003	n.a.
	pH	0.027	0.070	0.020	0.015
	Olsen P	0.127	0.555	0.220	0.128
	N%	0.004	0.713	0.002	0.006
	K	0.001	0.157	0.002	<0.001
	S	0.001	0.751	<0.001	0.001
Efficiency	COE/GOR	0.000	0.083	0.002	0.002
	EOS/tray ($)	0.003	0.317	0.005	0.041
Others	DM %	0.165	0.130	0.072	0.192
	Size	0.009	0.019	0.677	0.018

Table 0.1: Principal Components of annual change of core variables

	Variables	PC1	PC2	PC3
Intensification	E0S/ha	0.85	-0.12	0.20
	COS/ha	0.87	-0.01	0.30
	Trays/ha	0.65	-0.01	-0.14
Capital	Olsen P	0.12	0.77	-0.09
	N%	0.02	0.16	0.86
Efficiency	COE/GOR	-0.79	-0.14	0.03
	EOS/tray	0.91	0.12	0.00
Others	DM	-0.70	0.41	0.34
	Size	-0.12	-0.68	0.36
% of variation explained	70	43	14	13

Table 3.15: Cluster analysis groups formed on principal component scores of annual change of core variables

	Group		
Representing the annual change in:	1 (n=19)	2 (n=4)	3 (n=6)
PC1 – profit, efficiency, DM	-0.4	+1.7	+0.1
PC2 – Olsen P and fruit size	-0.4	+0.2	+1.2
PC3 - soil N%	-0.2	-0.9	+1.1

Table 3.16: Characteristics of the groups from cluster analysis, using annual change in core variables

	Annual change of variable:	Group 1: Decreasing profits (n=19)	Group 2: Lifting performance from a low base (n=4)	Group 3: Maintaining profits and efficiency (n=6)	Overall average	p-value
Intensification	E0S/ha ($)	-2,000[c]	4,800 [a]	(2,600 [ab])	(-110)	0.001
	COS/ha ($)	-2,300 [b]	(3,600 [a])	(800)	(-858)	0.008
	Trays/ha	340 [b]	870 [a]	285 [b]	(402)	0.007
Capital	Olsen P	(0.40 [b])	(4.70 [a])	4.04 [a]	1.75	0.003
	N%	0.012 [b]	0.005 [b]	0.027[a]	0.014	0.004
Efficiency	COE/GOR	(0.022 [a])	(-0.063 [b])	(0.020 [a])	(0.010)	0.048
	EOS/tray ($)	-0.44 [c]	(1.39 [a])	(0.25 [b])	(-0.05)	0.000
Others	DM	(0.001 [b])	-0.263 [c]	(0.116 [a])	(-0.011)	0.000
	Size	(-0.032)	(-0.154)	(-0.241)	(-0.092)	0.341

Note: Numbers in brackets are not significantly different from zero.

Table 3.17: Characteristics of the groups from cluster analysis of annual change of core variables, in terms of averages of core variables (Are orchardists who are not changing already at a high level of intensification, capital and efficiency?)

	Average of variable:	Group 1: Decreasing profits (n=19)	Group 2: Lifting performance from a low base (n=4)	Group 3: Maintaining profits and efficiency (n=6)	Overall average	p-value
Intensification	E0S/ha ($)	(3,508 [(a)])	(-7,184 [b])	(7,930 [a])	(2,948)	0.115
	% Green	86 [a]	43 [b]	83 [(a)]	80	0.080
Capital	Effective area (ha)*	3.4 [b]	1.3 [c]	5.1 [a]	3.48	0.006
	Olsen P*	40.8 [b]	53.2 [a]	34.5 [(b)]	41.2	0.091
Efficiency	EOS/tray ($)	(0.65 [a])	(-1.94 [b])	(0.97 [a])	(0.36)	0.012
Others	DM	16.9 [(b)]	18.0 [a]	17.0 [b]	17.1	0.017

Note:
* Variances not homogeneous.
Numbers in brackets are not significantly different from zero.

Table 3.18: Characteristics of the groups from the cluster analysis on change, using the variation (s.d.) of core variables

	Variation (s.d.) of variable:	Group 1: Decreasing profits (n=19)	Group 2: Lifting performance from a low base (n=4)	Group 3: Maintaining profits and efficiency (n=6)	Overall average	p-value
Intensification	Trays/ha	1,860 [b]	3,522 [a]	1,813 [b]	2,080	0.002
Capital	pH	0.114 [b]	0.149	0.176 [a]	0.132	0.086
	Olsen P	6.59 [b]	(14.14 [a])	13.10 [a]	8.98	0.020
	N%	0.037 [b]	0.030 [b]	0.070 [a]	0.043	0.012
Efficiency	EOS/tray	1.69 [(b)]	(2.79 [(a)])	1.45 [(b)]	1.79	0.172
Others	DM	0.64 [b]	1.06 [a]	0.78 [b]	0.73	0.001
	Size	1.70 [b]	2.63 [a]	1.91 [b]	1.87	0.008

Table 3.19: Other variables to add to descriptions of groups clustered from annual change of core variables

	Variable	Group 1: Decreasing profits (n=19)	Group 2: Lifting performance from a low base (n=4)	Group 3: Maintaining profits and efficiency (n=6)	Overall average	p-value
Financial - income	GOR/ha annual change ($)	-1,565[b]	(4,840 [a])	(2,467 [a])	(152)	0.005
Financial – expenses	Pollination Cost/ha annual change ($)	(43 [b])	(194 [a])	71	69	0.058
Soils	C% Annual change	0.120 [(a)]	0.001 [b]	0.215 [a]	0.1236	0.047
	C/N Annual change	-0.042 [a]	-0.098	-0.209 [b]	-0.0841	0.017
	C/N s.d.	0.38 [b]	0.54	0.72 [a]	0.471	0.016
Fertiliser applied (kg/ha)	S s.d.	37.2 [b]	64.3 [a]	26.8 [b] [39.3]	39.3	0.015 [0.111]

Note: The square brackets show the values for s.d of S when the outlier is included.

Table 3.20: Bird density

	Variable	Group 1: Decreasing profits (n=19)	Group 2: Lifting performance from a low base (n=4)	Group 3: Maintaining profits and efficiency (n=6)	Overall average	p-value
Bird density[40]	Introduced: all	12.3 [a]	12.9 [a]	8.1 [b]	11.5	0.046
	Introduced insectivores	9.1	10.8 [(a)]	7.0 [(b)]	8.9	0.227
	Introduced granivorous	3.1 [a]	2.0	1.0 [b]	2.5	0.018

[40] See MacLeod et al. (in press) for a full description of the research from which this data is taken.

Table 3.21: Attitude variables (from 2008 survey)

	Variable	Group 1: Decreasing profits (n=19)	Group 2: Lifting performance from a low base (n=4)	Group 3: Maintaining profits and efficiency (n=6)	Overall average	p-value
Importance of production indicators	B2b: Yields/ha cf similar orchards	6.6 [a]	5.0 [b]	6.2 [a]	6.32	0.007
	B2g: Mixture productive activities	5.6 [a]	3.0 [b]	4.6	5.11	0.065
Importance of environmental indicators	B3b: Soil biological activity	6.5 [a]	5.3 [b]	7.0 [a]	6.50	0.003
	B3c: Soil health	6.7 [a]	6.0 [b]	7.0 [a]	6.71	0.022
	B3f: Native bird spp.	5.3 [a]	3.0 [b]	5.7 [a]	5.14	0.034
	B3g: Bird spp.	5.0 [(a)]	3.3 [b]	5.5 [a]	5.93	0.119
	B3i: Plant or tree spp.	4.8 [a]	2.7 [b]	5.2 [a]	4.63	0.068
Importance of social indicators	B4a: Children involved in orchard	3.4 [b]		5.2 [a]	4.00	0.049
	B4g: Orcharding contributes to local customs/traditions	3.8 [(b)]	2.0 [b]	5.5 [a]	3.96	0.043
Agreement with what management affects -	D2a: Productive areas	6.2 [a]	(3.7 [b])	6.2 [a]	5.89	0.005
Background information	J10: No. of years in future expect to be orcharding	11 [b]	15	24.0[a]	13.7	0.026

Table 3.22: Rotated Principal Components for variation of core variables[41]

	Variables	PC1	PC2	PC3	PC4
Intensification	E0S/ha	0.18	0.06	0.04	0.75
	COS/ha	0.76	0.12	-0.35	0.17
	Trays/ha	0.33	0.66	0.23	-0.19
Capital	pH	-0.07	0.77	-0.05	0.33
	Olsen P	-0.24	0.07	0.83	0.21
	N%	-0.24	0.07	0.32	0.73
	K	-0.30	0.58	0.14	0.11
Efficiency	COE/GOR	0.82	-0.13	-0.04	-0.17
	EOS/tray	0.87	-0.05	0.26	0.08
Others	DM	0.25	0.27	0.82	0.03
	Size	0.00	0.59	0.19	-0.47
% of variation explained	69	23	21	14	11

Table 3.23: Cluster analysis groups of variation of core variables

	Group			
Represents variability of	1 (n=15)	2 (n=6)	3 (n=3)	4 (n=5)
PC1 – profit (COS) and efficiency	-0.48	+1.19	-0.57	+0.36
PC2 – production, pH and K	-0.43	+0.32	-0.24	+1.03
PC3 – Olsen P and DM	-0.24	+0.87	+0.94	-0.89
PC4 – profit (EOS) and N%	-0.36	-0.77	+2.08	+0.74

[41] Rotation of these components using a varimax method, spreads the variation more evenly and often allows for an easier interpretation of the components.

Table 3.24: Characteristics of the groups from cluster analysis of the variation of core variables

	Variable: Variation (s.d.)	Group 1: Consistent and reliable (n=15)	Group 2: Inconsistent (n=6)	Group 3: Consistent and profitable (n=3)	Group 4: High but variable (n=5)	Overall average	p-value
Intensification	E0S/ha ($)	27,400[c]	31,100 [bc]	(82,700 [a])	54,100 [ab]	38,500	0.003
	COS/ha ($)	7,900 [b]	12,000 [a]	(6,000 [b])	15,800 [a]	9,900	0.002
	Trays/ha	1,620 [b]	3,1987 [a]	(1,868 [b])	2,257	2,080	0.003
Capital	pH	0.109 [b]	0.118 [b]	0.160	0.202 [a]	0.132	0.016
	Olsen P	7.62 [b]	(11.27)	17.38 [a]	5.27 [b]	8.98	0.040
	N%	0.034 [b]	0.032 [b]	0.010 [a]	0.048 [b]	0.043	0.000
	K	0.089	0.081	0.111	0.109	0.093	0.750
Efficiency	COE/GOR	0.130 [b]	0.307 [a]	(0.072 [b])	0.140 [b]	0.162	0.014
	EOS/tray ($)	1.21 [b]	3.17 [a]	(1.88 [(b)])	1.81 [b]	1.79	0.003
Others	DM	0.643 [b]	0.919 [a]	0.794	0.698	0.725	0.067
	Size	1.74 [b]	2.34 [a]	1.38 [b]	1.99	1.87	0.063

Table 3.25: Characteristics of the groups from cluster analysis of variation of core variables, in terms of averages of core variables (Are orchardists who are the most consistent already at a high level of intensification, capital and efficiency?)

	Average	Group 1: Consistent and reliable (n=15)	Group 2: Inconsistent (n=6)	Group 3: Consistent and profitable (n=3)	Group 4: High but variable (n=5)	Overall average	p-value
Intensification	E0S/ha ($)*	(2,989 [b])	-8,093 [c]	18,189 [a]	(6,932 [ab])	2,948	0.004
	COS/ha	17,207 [(b)]	12,038 [b]	27,489 [a]	20,933	17,844	0.144
	Trays/ha*	6,965 [b]	6,855 [b]	7,815	9,400 [a]	7,450	0.044
	% Green*	99[a]	62 [b]	67	51 [b]	80	0.018
Capital	Effective area (ha)	3.6 [b]	1.8 [c]	6.2 [a]	3.3 [bc]	3.48	0.009
	Olsen P	37.0 [b]	52.7 [a]	43.6	38.4 [(b)]	41.2	0.097
Efficiency	COE/GOR	0.57 [b]	0.75 [a]	0.42 [b]	0.56 [(b)]	0.59	0.057
	EOS/tray ($)*	(0.53 [b])	(-1.36 [c])	2.30 [a(b)]	(0.73 [ab])	(0.36)	0.013
Others	DM	16.77 [b]	17.40 [(a)]	17.05	17.58 [a]	17.07	0.094
	Size	34.54 [a]	33.38	34.02	32.59 [b]	33.91	0.081

Note: * Variances not homogeneous
Numbers in brackets are not significantly different from zero.

Table 3.26: Characteristics of the groups from cluster analysis of variation of core variables, in terms of annual trend/change of core variables

	Variable: Annual change (slope)	Group 1: Consistent and reliable (n=15)	Group 2: Inconsistent (n=6)	Group 3: Consistent and profitable (n=3)	Group 4: High but variable (n=5)	Overall average	p-value
Intensification	Trays/ha	283 [b]	745 [a]	(500)	(288 [b])	402	0.023
Capital	N%	0.011 [bc]	(0.006 [c])	0.036 [a]	0.018 [b]	0.014	0.001
Others	DM	0.050 [a]	(-0.173 [b])	(0.084 [a])	(-0.057 [(b)])	(-0.011)	0.004

Note: Numbers in brackets are not significantly different from zero.

Table 3.27: Characteristics of the groups from cluster analysis of variation of core variables, in terms of other variables

	Variable	Group 1: Consistent and reliable (n=15)	Group 2: Inconsistent (n=6)	Group 3: Consistent and profitable (n=3)	Group 4: High but variable (n=5)	Overall average	p-value
Financial – income ($)	GOR/ha average	40,700[bc]	38,700[c]	53,200[ab]	59,100[a]	44,700	0.004
	GOR/ha variation	7,681[c]	12,298[ab]	7,335[bc]	15,212[a]	9,899	0.004
Financial – expenses ($)	Repairs & Maintenance average	1,669[b]	1,463[b]	944[b]	3,098[a]	1,798	0.010
	Pollination costs/ha annual change ($)	(30[b])	(155[a])	(42)	(99)	69	0.141
	COE/ha average	21,825[b]	25,489	(22,745)	32,516[a]	24,521	0.090
	COE/ha variation	3,451[b]	6,618[a]	4,048	5,984[b]	4,605	0.043
Other	Equity % average	84[a]	91[a]	92[(a)]	(42[b])	83	0.150
	Equity % annual change	(-5.3[b])	(-2.8[b])	(0.7[b])	(-32.7[a])	(-6.6)	0.082
	Equity % variation	(21.4[b])	4.8[b]	(11.6[b])	(120.0[a])	25.0	0.055
Soils	C% Annual change	0.092[bc]	0.037[c]	0.344[a]	0.191[ab]	0.1236	0.002
	C% s.d.	0.33[b]	0.44[b]	0.90[a]	0.53[b]	0.450	0.003
	C/N s.d.	0.49	0.43	0.75[a]	0.31[b]	0.471	0.159
	AMN/N annual change	-0.069[b]	0.005	-0.091[b]	0.033[a]	-0.0384	0.041
Fertiliser applied (kg/ha)	S s.d.	32.0[b] [37.0]	53.0[a]	(19.6[b])	53.8[a]	39.3	0.016 [0.114]

Note: 1. A lot of variables are significant at the 10% level.
2. Equity data is only available for a limited number of orchards (12, 6, 2, 2 respectively).
3. The square brackets for S, s.d., are the values when the outlier is included.

Table 3.28: Characteristics of the groups from cluster analysis of variation of core variables, in terms of bird density

	Variable	Group 1: Consistent and reliable (n=15)	Group 2: Inconsistent (n=6)	Group 3: Consistent and profitable (n=3)	Group 4: High but variable (n=5)	Overall average	p-value
Bird density[42]	Introduced: all	11.9 (a)	13.5 a	7.5 b	10.5	11.5	0.150
	Introduced granivorous	2.8 (a)	3.2 a	0.8 b	1.9	2.54	0.134

Table 3.29: Characteristics of the groups from cluster analysis of variation of core variables, in terms of attitude variables (from 2008 survey)

	Variable	Group 1: Consistent and reliable (n=15)	Group 2: Inconsistent (n=6)	Group 3: Consistent and profitable (n=3)	Group 4: High but variable (n=5)	Overall average	p-value
Importance of financial indicators	B1a: Gross income	6.9 a	6.0 b	6.0 b	6.6 (a)	6.57	0.012
	B1b: Working expenses	6.8 a	6.8 ab	5.7 c	6.2 (b)c	6.57	0.008
	B1c: Change in bank balance	6.0 a	4.2 b	5.3	5.6 (a)	5.54	0.059
	B1e: Cash surplus/deficit	6.9 a	6.8 a	6.7 (a)	6.0 b	6.68	0.012
	B1f: Net profit/loss	6.8 a	6.4	6.0 (b)	6.0 b	6.50	0.060
	B1h: Ration working expenses to gross income	6.5 a	5.4 b	5.0 b	6.0	6.07	0.002
Importance of production indicators	B2a:Health of stock and/or plants	6.9 a	6.8 a	7.0 a	6.2 b	6.79	0.002
	B2b: Yield/ha cf similar farmers	6.7 a	5.2 b	6.0	6.4 a	6.32	0.002
Importance of environmental indicators	B3b: Soil biological activity	6.7 a	5.6 b	6.7 a	6.6 a	6.50	0.019
	B3c: Soil health	6.9 a	6.2 b	7.0 a	6.6	6.71	0.064
	B3d: Health of livestock and/or plants	6.9 a	6.8 (a)	7.0 a	6.4 b	6.82	0.041
	B3f: Native bird spp.	5.7 a	3.8 b	4.0 (b)	5.6 (a)	5.14	0.054
	B3g: Bird spp.	5.3 a	3.8 b	3.7 (b)	5.6 (a)	4.93	0.064

[42] See MacLeod et al. (in press) for a full description of the research from which this data is taken.

	B3h: No. native plant or tree spp.	5.1 [a]	3.6 [(b)]	2.7 [b]	5.0 [a]	4.52	0.057
	B3i: No. plant or tree spp.	5.1 [a]	3.4 [b]	3.7	5.2 [(a)]	4.63	0.128
	B3n: Pesticide use	6.7 [a]	5.2 [b]	6.3 [a]	5.4 [(b)]	6.08	0.001
Importance of social indicators	B4c: Time for family and friends	6.5 [a]	5.8 [bc]	6.7 [a(b)]	5.2 [c]	6.18	0.002
	B4d: Time for recreation ...	6.3 [a]	5.2 [bc]	6.0 [ab]	4.6 [c]	5.75	0.001
Consideration or implementation of approach to management	C1e: Focus on limited no. income sources	6.1 [a]	4.6 [b]	6.3 [a]	5.6	5.75	0.035
Agreement with connections of management to:	D1a: wellbeing of self and family	6.3 [a]	5.8	6.7 [(a)]	5.2 [b]	6.07	0.148
Agreement with management affects:-	D2a: productive areas	6.5 [a]	4.2 [b]	5.7 [(a)]	5.8 [a]	5.89	0.004
Importance of farming factors	F1a: Customer requirements	6.6 [a]	6.2	6.3	5.6 [b]	6.32	0.120
	F1c: Family needs	6.7 [a]	6.0	6.7 [a]	5.2 [b]	6.29	0.023
	F1e: environmental health	6.7 [a]	6.4 [a]	6.3 [(a)]	5.4 [b]	6.36	0.011
Agreement with statements about emissions trading	G1d: Technological solutions needed	5.8 [a]	5.0	4.5	3.8 [b]	5.15	0.164
Agreement with statements about native bird diversity and farm management	H1Ac: Birds provide important services ...	4.9[a]	4.4	4.0	2.6[b]	4.30	0.140
Agreement with statements about introduced bird diversity and farm management	H1Bc: Birds provide important services ...	4.8[a]	4.4	4.0	2.4[b]	4.20	0.105
	H1Bd: Not responsibility as land owner to encourage birds ...	3.2	2.4[b]	5.0[a]	3.0	3.20	0.241
Importance of exotic trees and shrubs	I1Bd: Enhancing stream health by planting ...	3.0[b]	3.8	3.5	5.6[a]	3.78	0.174
Background information	J6: Level of debt (high to low)	5.2[a]	4.8	5.3	3.6[b]	4.81	0.134
	J7: Satisfaction with level of economic viability	4.0 [(b)]	3.0 [b]	6.0 [a]	4.8	4.22	0.109

Appendix 2: Tables associated with sheep/beef analysis

Table 4.1: Correlations of averages of core variables

	NFPBT /ha	EFS /ha	Carc wgt/ha	Crop %	Equity	OlsP	N%	pH	Eff Area	FEW /GFR	NFPBT/su	EFS/su	Lambing%	NFPBT/farm	EFS/farm
NPBT/ha	1	0.57 **	0.45 *	0.48 *	0.36 (0.09)	ns	ns	ns	-0.52 **	-0.68 **	0.89 **	0.48 *	0.54 **	0.83 **	0.45 *
EFS/ha		1	0.50 *	0.67 **	ns	0.42 *	-0.47 *	ns	ns	-0.49 *	0.39 (0.06)	0.96 **	0.37 (0.08)	0.66 **	0.94 **
Carc wgt/ha			1	Ns	ns	0.35 (0.09)	ns	ns	ns	ns	ns	0.49 *	0.70 **	0.52 **	0.45 *
Crop %				1	ns	ns	-0.61 **	ns	ns	ns	0.44 *	0.66 **	ns	0.37 (0.08)	0.64 **
Equity					1	ns	ns	ns	ns	ns	0.44 *	ns	ns	0.34 (0.10)	-0.38 (0.07)
Olsen P						1	ns	ns	ns	ns	ns	0.38 (0.06)	ns	ns	Ns
N%							1	ns	ns	ns	ns	-0.40 (0.05)	ns	ns	-0.49 *
pH								1	ns	-0.48 *	Ns	ns	ns	ns	ns
Eff Area									1	ns	-0.58 **	ns	ns	ns	ns
FWE/GFR										1	-0.56 **	-0.47 *	-0.44 *	-0.70 **	-0.53 **
NFPBT/su											1	0.38 (0.07)	0.58 **	0.82 **	ns
EFS/su												1	0.42 *	0.64 **	0.93 **
Lambing%													1	0.61 **	ns
NFPBT/farm														1	0.63 **
EFS/farm															1

* p<0.05, ** p<0.01

Table 4.2: Correlations of annual trends of core variables

	NFPBT ha	EFS /ha	Carc wgt/ha	Crop %	Equity	OlsP	N%	pH	Eff Area	FWE/GFR	NFPBT/su	EFS/su	Lambing%	NFPBT/farm	EFS/farm
NPBT/ha	1	0.88 **	ns	Ns	ns	ns	ns	ns	-0.52 **	-0.80 **	0.80 **	0.85 **	ns	0.86 **	0.79 **
EFS/ha		1	ns	Ns	0.47 *	ns	-0.35 (0.09)	ns	ns	-0.87 **	0.48 *	0.82 **	ns	0.89 **	0.91 **
Carc wgt/ha			1	Ns	ns	ns	ns	ns	ns	ns	ns	0.49 *	ns	ns	ns
Crop %				1	ns	ns	-0.39 (0.06)	ns	ns	ns	ns	ns	ns	ns	ns
Equity					1	ns	ns	ns	ns	0.52 **	0.44 *	-0.57 **	ns	-0.57 **	-0.65 **
Olsen P						1	ns	ns	ns	ns	ns	ns	ns	ns	ns
N%							1	0.39 (0.06)	ns	ns	ns	ns	ns	ns	ns
pH								1	ns	ns	ns	ns	ns	ns	ns
Eff Area									1	ns	-0.57 **	ns	ns	ns	ns
FWE/GFR										1	-0.44 *	-0.76 **	ns	-0.96 **	-0.94 **
NFPBT/su											1	0.70 **	ns	0.53 **	0.44 *
EFS/su												1	ns	0.87 **	0.85 **
Lambing%													1	ns	ns
NFPBT/farm														1	0.97 **
EFS/farm															1

* p<0.05, ** p<0.01

Table 4.3: Correlations of variation (s.d.) of core variables

	NFPBT /ha	EFS /ha	Carc wgt/ha	Crop %	Equity	OlsP	N%	pH	Eff Area	FEW /GFR	NFPBT/su	EFS/su	Lambing %	NFPBT/farm	EFS/farm
NPBT/ha	1	0.66 **	ns	ns	0.53 *	ns	-0.47 *	ns	ns	ns	0.85 **	0.77 **	0.45 *	0.56 **	0.47 *
EFS/ha		1	ns	ns	Ns	ns	-0.41 *	ns	ns	ns	ns	0.78 **	0.57 **	0.60 **	0.69 **
Carc wgt/ha			1	ns	Ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Crop %				1	Ns	ns	-0.44 *	ns	ns	ns	ns	0.40 (0.05)	ns	ns	ns
Equity					1	ns	ns	ns	ns	ns	0.66 **	0.43 *	ns	0.41 *	-0.40 (0.05)
Olsen P						1	ns	ns	ns	ns	ns	ns	ns	ns	ns
N%							1	-0.40 (0.05)	ns	ns	ns	-0.60 **	-0.58 **	ns	ns
pH								1	ns	ns	ns	ns	ns	ns	ns
Eff Area									1	ns	0.52 **	ns	ns	ns	ns
FWE/GFR										1	ns	ns	ns	0.39 (0.06)	0.41 *
NFPBT/su											1	0.62 **	ns	0.35 (0.10)	ns
EFS/su												1	0.52 *	0.61 **	0.69 **
Lambing%													1	ns	ns
NFPBT/farm														1	0.93 **
EFS/farm															1

* p<0.05, ** p<0.01

Table 4.4: PCA analysis of averages of core variables

		PC Score			
	Variable	1	2	3	4
Intensification	EFS/ha ($)	0.82	-0.04	0.37	0.33
	NFPBT/ha ($)	0.34	0.69	0.44	0.32
	Crop %	0.81	0.31	-0.18	-0.02
	Carc wgt/ha	0.09	0.19	-0.03	0.85
Capital	Equity %	-0.43	0.67	0.28	0.03
	Effective area (ha)	-0.00	-0.79	0.08	0.01
	Olsen P	-0.03	-0.37	0.15	0.52
	N %	-0.69	-0.20	0.19	0.30
	pH	-0.08	0.07	0.77	-0.06
Efficiency	FWE/GFR	-0.32	-0.23	-0.76	-0.22
	EFS/su ($)	0.80	-0.10	0.35	0.37
	NFPBT/su ($)	0.23	0.81	0.34	0.24
	Lambing %	0.18	0.41	0.09	0.76
Sustainability	EFS/farm ($)	0.84	-0.13	0.37	0.24
	NFPBT/farm ($)	0.33	0.52	0.54	0.43
Variance explained	Total+77%	25	20	16	16

Extraction method: PCA with a Varimax rotation.

Table 4.5: Cluster analysis of averages of core variables

	Cluster				
PC Factor	1 (n=6)	2 (n=3)	3 (n=4)	4 (n=3)	5 (n=7)
1 – EFS, cropping & N	-0.74	+1.97	-0.07	-0.10	-0.13
2 – NFPBT, equity & area	-0.25	-0.33	+0.99	-1.60	+0.47
3 – efficiency & pH	-0.83	-0.41	-0.16	+0.82	+0.63
4 – production, lambing & Olsen P	+0.06	+0.21	-1.55	-0.35	+0.90

Note: These values are standardised (mean 0, s.d. 1), and so a high positive number is more of a measurement of a top ranking in this principal component, while a negative number is a measurement of a lower ranking.

Table 4.6: Characteristics of the groups from the cluster analysis of the averages of core variables

Average	Variable	Group 1 (n=6)	Group 2 (n=4)	Group 3 (n=4)	Group 4 (n=3)	Group 5 (n=7)	Outlier omitted from all analyses	Average	P- value
Intensity	EFS/ha ($)	(-162 ^{c})	446 ^{a}	-158 ^{c}	(39 ^{bc})	(86 ^{b})	-136	(37.4)	0.000
	NFPBT/ha ($)	(-30 ^{b})	(281 ^{a})	(162)	(-53 ^{b})	321 ^{a}	-301	153.2	0.008
	Crop %*	0 ^{b}	54 ^{a}	15 ^{b}	0 ^{b}	5 ^{b}	0	0.1	0.002
	Carc wgt/ha	134 ^{bc}	200 ^{ab}	91 ^{c}	108 ^{c}	202 ^{a}	1641	154.5	0.009
Capital	Equity %	83 ^{a}	69 ^{b}	92 ^{a}	78	90 ^{a}	61	83.6	0.011
	Effective area* (ha)	483 ^{b}	454 ^{b}	261 ^{b}	1074 ^{a}	372 ^{b}	325 to 615	482.7	0.002
	Olsen P	21.0 ^{a}	26.6 ^{a}	11.0 ^{b}	23.6 ^{a}	21.7 ^{a}	17.9	20.82	0.029
	N %	0.47 ^{a}	0.29 ^{b}	0.34 ^{b}	0.46 ^{a}	0.44 ^{a}	0.54	0.408	0.002
	pH	5.82 $^{(b)}$	5.90	5.92	6.00	6.00 $^{(a)}$	5.56	5.92	0.355
Efficiency	FWE/GFR*	0.84 ^{a}	0.64 ^{bc}	0.68 ^{ab}	0.64 ^{bc}	0.49 ^{c}	0.97	0.655	0.004
	EFS/su ($)	-17.04 ^{c}	42.33 ^{a}	(-22.03 ^{c})	(1.39 ^{bc})	(6.45 ^{b})	-19.88	(1.18)	0.000
	NFPBT/su* ($)	(-4.79 ^{bc})	21.94 ^{ab}	(18.18 ^{ab})	(-19.91 ^{c})	28.09 ^{a}	-48.44	(11.19)	0.025
	Lambing %	128 ^{b}	133	119 ^{b}	119 ^{b}	149 ^{a}	119	132.5	0.003
Sustainability	EFS/farm ($)	(-69,766 ^{c})	171,665 ^{a}	-35,505 ^{bc}	(39,088 ^{b})	(38,975 ^{b})	-62,041	(21,506)	0.000
	NFPBT*/farm ($)	-13,738 ^{c}	92,995 ^{ab}	32,170 ^{bc}	9,330 ^{bc}	111,552 ^{a}	-143,104	51,128	0.003

Note: 1. Carc wgt/ha = Net carcase weight sold kg/ha

2. The superscripts indicate whether values are statistically significantly different at the 5% level of significance. Superscripts that are different indicate a significant difference. If there is a superscript in common between two values then they are not significantly different.[43]

3. Values in brackets indicate a mean that is not significantly different from zero.[44] For example, a profit value in brackets indicates that this group has probably not made a profit or a loss.

4. Variances not homogeneous – because of the larger values in Group 5, these values dominate the variance calculation meaning that the s.e.d. is large and therefore will not pick up differences between the other groups as accurately. This issue is remedied later when the data is analysed without the cropping farmers.

[43] These differences are tested using an lsd - least significant difference. Because each of the groups has a different number of measurements in its mean, each lsd for comparison between two means will be different. Hence, it is difficult to report them in a table.

[44] The question then becomes, can you have a significant difference between two variables when they themselves are not significantly different from zero. It could be argued that this is possible because the analysis of the differences is actually more powerful, using all the values in the data not just those involved in each separate mean.

Table 4.7: Characteristics of groups from cluster analysis of averages of core variables, in terms of annual trend/change of core variables

Annual change (trend)	Variable	Group 1: low performers (n=6)	Group 2: profitable, inconsistent, adaptable (n=4)	Group 3: organic conservers (n=4)	Group 4: extensive (n=3)	Group 5: efficient, consistent, profitable (n=7)	Average	P value
Intensification	*EFS/ha ($)	(-35)^{b}	(114)^{a}	(-2)^{b}	(-8)^{b}	(-14)^{b}	(4.8)	0.010
	*NFPBT/ha ($)	(-26)^{b}	(86)^{a}	(-21)^{b}	(-62)^{b}	(-7)^{b}	(-5.2)	0.028
Capital	*N %	0.027^{a}	(-0.003)^{b}	(0.002)^{b}	(0.020)	(0.016)	0.014	0.055
Efficiency	*FWE/GFR	(0.026)^{a}	(-0.085)^{b}	(0.009)	(0.002)	(0.013)^{a}	(-0.0021)	0.179
	*EFS/su ($)	(-0.41)^{b}	(12.00)^{a}	(-0.83)^{b}	(-3.47)^{b}	(1.51)^{b}	(1.769)	0.043
	*NFPBT/su ($)	(-0.45)^{a}	(9.13)^{a}	(-2.84)	(-20.16)^{b}	3.37^{a}	(-0.600)	0.055
Sustainability	*EFS/farm ($)	(-12,789^{b})	(70,394)^{a}	(552)^{b}	(4,898)^{b}	(-4,553)^{b}	(7,911)	0.034
	*NFPBT/farm ($)	-10,169^{b}	(52,021)^{a}	(-3,958)^{b}	(-6,441)^{b}	(-2,559)^{b}	(3,917)	0.085

Note: * Variances not homogeneous due to the dominance of large values in Group 2, reducing the chance of finding significant differences between the other groups. This is remedied later by analysing the data without the cropping farmers in Group 2.

Table 4.8: Characteristics of groups from cluster analysis of averages of core variables, in terms of variation of core variables

Variation (s.d.)	Variable	Group 1: low performers (n=6)	Group 2: profitable, inconsistent, adaptable (n=4)	Group 3: organic conservers (n=4)	Group 4: extensive (n=3)	Group 5: efficient, consistent, profitable (n=7)	Average	P value
Intensification	EFS/ha ($)	174^{b}	380^{a}	111^{b}	(123^{b})	131^{b}	179.0	0.003
	*NFPBT/ha ($)	160	330^{a}	157	(308)	116^{b}	193	0.154
	*Crop %	(0.3^{b})	5.5^{a}	(3.1)	0.0	(3.0)	2.39	0.207
Capital	Olsen P	4.36^{a}	1.89^{b}	2.77	4.14	2.88	3.224	0.235
	N %	0.060^{a}	(0.022^{b})	0.026^{b}	(0.046)	0.058^{a}	0.0454	0.052
Efficiency	*FWE/GFR	0.226^{a}	(0.143)	0.161	0.105^{b}	0.077^{b}	0.1427	0.042
	*EFS/su ($)	16.89^{b}	37.25^{a}	15.40^{b}	(17.46^{b})	11.66^{b}	18.58	0.005
	*NFPBT/su ($)	15.97^{b}	34.32	20.66	(61.51^{a})	12.99^{b}	24.63	0.215
Sustainability	EFS/farm ($)	77,296^{b}	150,980^{a}	25,668^{c}	(67,335^{bc})	48,485^{bc}	71,324	0.000
	NFPBT/farm ($)	75,586^{b}	127,374^{a}	35,490^{b}	77,551	44,965^{b}	68,849	0.006

Note: * Variance not homogeneous

Table 4.9: Financial return and expenses ($) analysed across groups formed from averages

	Variable	Group 1: low performers (n=6)	Group 2: profitable, inconsistent, adaptable (n=4)	Group 3: organic conservers (n=4)	Group 4: extensive (n=3)	Group 5: efficient, consistent, profitable (n=7)	Outlier	Average	P value
Income GFR/ha	*Average	651 [b]	2,551[a]	(829 [b])	(678 [b])	932 [b]	852	1,083	0.001
	*Annual change	(-19 [b])	(162 [a])	(-18 [b])	(50 [(b)])	(-23 [b])	-237	(19)	0.005
	*Variability (s.d.)	139 [b]	624 [a]	168 [b]	(414)	126 [b]	533	255	0.016
GFR/farm	*Average	322,153[bc]	925,479[a]	180,225[(c)]	460,961[b]	337,395[bc]	303,001	420,849	0.000
	*Annual change	-3,210 [b]	98,891 [a]	-5,157 [b]	5,000 [b]	-6,030 [b]	-61,071	13,686	0.000
	Variability (s.d.)	69,933 [b]	208,840 [a]	37,003 [b]	72,098 [b]	44,191 [b]	146,499	80,358	0.000
Expenses FWE/ha	*Average	521 [b]	1,615 [a]	496 [b]	(452 [b])	457 [b]	713	672	0.001
	*Variability (s.d.)	107 [(b)]	(316 [a])	55 [(b)]	(370 [a])	54 [b]	351	151	0.096
FWE/farm	*Average	256,704 [b]	575,850 [a]	114,837 [b]	290,885[b]	164,704 [b]	258,393	263,690	0.001
	*Annual change	(5,134 [b])	(29,299 [a])	(-1,962 [b])	(4,391 [b])	(1,051 [b])	-31,282	(6,695)	0.051
	*Variability (s.d.)	45,795 [b]	96,351 [a]	13, 330 [b]	36,438 [b]	19,994 [b]	76,897	40,115	0.004
Stock expenses/ha	Average	39[a]	26	13 [b]	29	32	28	29.4	0.349
	Annual change	(-1.83)	(-2.25)	(-0.82)	(3.34 [a])	(-1.91 [b])	-3	(-1.11)	0.277
	*Variation (s.d.)	9.51 [b]	8.26 [b]	5.95 [b]	35.40 [a]	6.14 [b]	17	10.96	0.030
Cash cropping/ha	*Average	0 [b]	773 [a]	7 [b]	0 [b]	12 [b]	0	(133.32)	0.000
	*Annual change	(0 [b])	(60 [a])	(-1 [b])	(0 [b])	(3 [b])	0	(10.72)	0.002
	*Variation (s.d.)	0 [b]	228 [a]	3 [b]	0 [b]	12 [b]	0	(42.08)	0.000
Pasture/ha	*Average	76 [(a)]	42 [b]	42 [b]	83 [(a)]	78 [a]	11	66.53	0.079
	Annual change	(-4 [b])	12 [a]	(-3 [b])	(9 [a])	(1)	-3	(1.92)	0.040

	*Variation (s.d.)	25[b]	44	19[b]	72[a]	25[b]	15	33.12	0.063
Vehicle & fuel/ha	Average	69[b]	155[a]	73[b]	42[b]	66[b]	35	79.86	0.050
Repairs and Maintenance/ha	Average	56[b]	111[a]	59[(b)]	59[(b)]	42[b]	55	61.96	0.104
	*Annual change	(0[(b)])	(-2[(b)])	(-1[(b)])	(11[a])	(-3[b])	-17	(0.11)	0.247
Other /ha	*Average	42[(b)]	105[a]	75	38[(b)]	34[b]	244	55.09	0.174
	*Variation (s.d.)	(33)	(56[a])	(20)	(26)	8[b]	208	26.55	0.138
Overheads/ha	Average	59	102[a]	83	42[b]	64	113	69.69	0.249
C & NC labour/ha	*Average	333	469[a]	479[a]	223[b]	393	347	383.90	0.194
	*Variation (s.d.)	60[(b)]	91	67	177[a]	41[b]	115	75.19	0.238
C & NC Feed/ha	Annual change	(4.47[a])	(-18.69[b])	(5.70[a])	(0.02[(a)])	(-0.59[a])	3	(-0.88)	0.057
Fertiliser/ha	*Average	74[b]	261[a]	32[b]	98[b]	78[b]	9	102.03	0.035
	*Annual change	(-5[b])	(22[a])	(-4[b])	(15)	(0[b])	-3	(3.75)	0.043
	*Variation (s.d.)	33[b]	80	21[b]	103[a]	23[b]	15	44.79	0.063
Weeds & Pests/ha	*Average	13[b]	170[a]	1[b]	8[b]	18[b]	1	37.96	0.010
	*Variation (s.d.)	5[b]	39[a]	1[b]	8[b]	8[b]	1	11.30	0.005

Note: * Non-homogeneous variances (probably because of group 2's larger variation) and so again, the significance of the differences could be a bit deflated.

Table 4.10: Characteristics of groups formed from averages in terms of bird density (measurements over three years: 2004-5, 2007-8, 2009-2010)

[45]Density of:	Variable	Group 1: low performers (n=6)	Group 2: profitable, inconsistent, adaptable (n=4)	Group 3: organic conservers (n=4)	Group 4: extensive (n=3)	Group 5: efficient, consistent, profitable (n=7)	Average	P value
All introduced spp.	Average	9.18 [a]	7.81	7.64	9.01 [a]	6.34 [b]	7.845	0.044
	Variation (s.d.)	3.72	2.09 [b]	2.92 [(b)]	5.41 [a]	2.52 [b]	3.176	0.144
Native spp.	*Average	1.89 [a]	0.84	1.72	0.68 [(b)]	0.75 [b]	1.202	0.174
	*Variation (s.d.)	1.13	0.71	1.72 [a]	0.31 [(b)]	0.39 [b]	0.841	0.239
Native – insectivorous spp.	*Average	1.50 [a]	0.11 [b]	0.03 [b]	0.02 [b]	0.30 [b]	0.488	0.039
	*Variation (s.d.)	1.23 [a]	0.15 [b]	0.03 [b]	0.02 [b]	0.24 [b]	0.411	0.053
Introduced - insectivorous spp.	Average	2.25 [a]	0.98 [b]	1.17 [b]	1.83	1.22 [b]	1.507	0.060
	Annual change	0.36 [a]	0.12 [b]	0.16 [(b)]	0.05 [b]	0.05 [b]	0.158	0.021
	*Variation (s.d.)	1.18 [a]	0.50 [b]	0.47 [b]	0.91	0.52 [b]	0.719	0.103
Introduced – granivorous spp.	Average	6.93 [a]	6.82 [(a)]	6.46	7.18 [a]	5.12 [b]	6.338	0.154
	Variation (s.d.)	3.10	2.14 [b]	2.96	4.99 [a]	2.39 [b]	2.946	0.256

Note: * Variances not homogeneous.

[45] See MacLeod et al. (in press) for a full description of the research from which this data is taken.

Table 4.11: Characteristics of groups formed from averages in terms of fertiliser applied and additional soil measurements

	Variable	Group 1: low performers (n=6)	Group 2: profitable, inconsistent, adaptable (n=4)	Group 3: organic conservers (n=4)	Group 4: extensive (n=3)	Group 5: efficient, consistent, profitable (n=7)	Average	P value
Ca tons/farm	*Average	26.3 ^{bc}	38.2 ^{b}	6.6 ^{c}	(84.2 ^{a})	28.2 ^{bc}	33.28	0.002
	Variation (s.d.)	31.5 ^{b}	36.7 ^{b}	5.4 ^{c}	76.7 ^{a}	23.1 ^{bc}	31.22	0.000
Ca kg/ha	Average	62.5	110.0 ^{a}	(34.7 ^{b})	(88.2)	82.9	74.96	0.175
	Variation (s.d.)	73.3	106.5 ^{a}	25.8 ^{b}	(85.3)	75.7	73.11	0.252
K tons/farm	*Annual change	(-0.40 ^{b})	(0.40 ^{a})	(-0.08 $^{(b)}$)	(0.09 $^{(a)}$)	(0.02 $^{(a)}$)	-(0.031)	0.044
K kg/ha	*Average	1.72	(4.36 ^{a})	(0.45 ^{b})	(0.19 ^{b})	1.06 ^{b}	1.564	0.156
	*Annual change	(-0.70 ^{b})	(1.13 ^{a})	(-0.19 ^{b})	(0.07)	(-0.17 ^{b})	(-0.059)	0.037
K kg/su	*Average	0.18 $^{(b)}$	(0.50 ^{a})	(0.05 ^{b})	(0.03 ^{b})	0.12 ^{b}	0.177	0.180
	*Annual change	(-0.075 ^{b})	(0.195 ^{a})	(-0.025 ^{b})	(0.009 $^{(b)}$)	(-0.010 ^{b})	(0.0078)	0.045
Mg tons/farm	*Average	(1.38 $^{(b)}$)	(3.73)	(0.44 ^{b})	(8.11 ^{a})	(1.38 ^{b})	2.454	0.226
	*Annual change	(-0.48)	(0.22 ^{a})	(0.06 $^{(a)}$)	(-2.33 ^{b})	(-0.01 ^{a})	(-0.368)	0.247
	*Variation (s.d.)	(2.83 ^{b})	(7.89)	(0.71 ^{b})	(20.10 ^{a})	2.36 ^{b}	5.340	0.162
Mg kg/ha	*Annual change	(-0.97 $^{(a)}$)	(0.02 $^{(a)}$)	(0.12 ^{a})	(-5.84 ^{b})	(0.08 ^{a})	(-0.926)	0.304
	*Variation (s.d.)	(5.83 ^{b})	(21.49)	(2.13 ^{b})	(44.44 ^{a})	7.95 ^{b}	13.27	0.174
N tons/farm	*Average	(2.9 ^{b})	(22.0 ^{a})	0.0 ^{b}	(1.0 ^{b})	(1.7 ^{b})	(5.04)	0.028
	*Annual change	(-0.31 ^{b})	(4.05 $^{a)}$	0.00 $^{(b)}$	(-0.02) $^{(b)}$	(-0.26) ^{b}	(0.518)	0.160
	*Variation (s.d.)	(2.04 ^{b})	(11.14 ^{a})	(0.00 ^{b})	(1.08 ^{b})	1.12 ^{b}	2.83	0.082
N kg/ha	*Average	(5.4 ^{b})	(73.8 ^{a})	(0.0 ^{b})	(1.9 ^{b})	(4.5 ^{b})	(15.18)	0.023
	*Annual change	(-0.9 ^{b})	(11.0 ^{a})	0.0 ^{b}	(-0.6 ^{b})	(-0.7 ^{b})	(1.30)	0.083
	*Variation (s.d.)	(4.5 ^{b})	(33.0 ^{a})	(0.0 ^{b})	(3.3 ^{b})	3.2 ^{b}	7.96	0.019

N kg/su	*Average	(0.54 [b])	(8.56 [a])	0.00 [b]	(0.15 [b])	(0.55 [b])	(1.740)	0.019
	*Annual change	(-0.04 [b])	(2.58 [a])	(0.00 [b])	(-0.02 [b])	(0.01 [b])	(0.419)	0.033
	*Variation (s.d.)	(0.40 [b])	(8.54 [a])	0.00 [b]	(0.20 [b])	0.37 [b]	(1.657)	0.014
P tons/farm	*Average	5.61	8.60 [a]	(0.96 [b])	(9.66 [a])	5.51	5.810	0.161
	Variation (s.d.)	4.04 [a]	4.82 [a]	(1.09 [b])	(4.53 [a])	3.68 [(a)]	3.633	0.131
P kg/ha	Average	12.1 [bc]	25.0 [a]	3.1 [c]	(9.6 [bc])	15.3 [ab]	13.37	0.017
P kg/su	Average	(1.50 [b])	3.18 [a]	0.41 [b]	(1.22 [b])	1.68 [(b)]	1.616	0.061
S tons/farm	*Average	(4.23 [b])	(12.43 [a])	(0.40 [b])	(13.46 [a])	6.05	6.642	0.038
	Annual change	(-0.22)	(0.91[a])	(0.01)	(0.51)	(-0.89 [b])	(-0.098)	0.191
	*Variation (s.d.)	3.51 [b]	(11.33 [a])	(0.42 [b])	(8.35)	4.26[b]	5.122	0.066
S kg/ha	*Average	(10.10 [bc])	(35.46 [a])	(1.09 [c])	(12.58 [bc])	18.59 [b]	15.611	0.012
	Variation (s.d.)	9.50 [b]	(28.67 [a])	(1.29 [b])	(8.53 [(b)])	15.49	12.955	0.098
S kg/su	Average	(1.38 [bc])	4.09 [a]	(0.16 [c])	(1.68 [(b)])	1.99[b(c)]	1.845	0.028
	Variation (s.d.)	(2.15)	3.41 [a]	(0.21 [b])	(1.03)	1.64	1.748	0.324
Soils	C% average	5.5 [a]	3.3 [c]	3.9 [bc]	5.4 [a]	4.8 [ab]	4.65	0.006
	C% Annual change	(0.053 [a])	-0.126 [b]	(-0.010)	(0.041)	(0.022)	(0.0022)	0.310
	C/N Annual change	-0.54 [b]	-0.31	(-0.10 [a])	(-0.42)	-0.30	(-0.345)	0.210

Table 4.12: Characteristics of groups formed from averages in terms of other farm management variables

	Variable	Group 1: low performers (n=6)	Group 2: profitable, inconsistent, adaptable (n=4)	Group 3: organic conservers (n=4)	Group 4: extensive (n=3)	Group 5: efficient, consistent, profitable (n=7)	Average	P value
SU/ha	Annual change	(-0.11)	(0.47[a])	(0.09)	(-0.63 [b])	(-0.22[(b)])	(-0.079)	0.195
	*Variation	1.55 [b]	(5.67 [a])	(0.85 [b])	(1.82 [b])	1.26 [b]	2.068	0.007

	(s.d.)							
% Sheep	*Annual change	(0.7[a])	(-2.6[b])	(0.1[(a)])	(0.2[(a)])	(-0.07)	(-0.005)	0.096
Scanning %	Average	152	168[a]	130[b]	Don't scan	161[(a)]	154.9	0.186

Table 4.13: Characteristics of groups formed from averages in terms of attitude variables (from 2008 survey)[46]

	Variable	Group 1: low performers (n=6)	Group 2: profitable, inconsistent, adaptable (n=4)	Group 3: organic conservers (n=4)	Group 4: extensive (n=3)	Group 5: efficient, consistent, profitable (n=7)	Average	P-value
Importance of financial indicators	B1a: Gross income	5.6	5.0[b]	6.0	6.7[a]	6.7[a]	6.00	0.085
	B1c: Change in bank balance	5.8[a]	4.8	4.2[(b)]	4.3	4.2[b]	4.17	0.219
	B1d: Actual vs budget income	4.8	5.8[a]	4.8	5.0	3.0[b]	4.50	0.276
	B1g: Changes in equity	6.4[a]	6.0[(a)]	4.8[(b)]	5.7	4.2[b]	5.32	0.096
Importance of production indicators	B2b: Yield/ha	5.4	6.2[a]	4.0[b]	4.3[(b)]	4.3[b]	4.86	0.149
Importance of environmental indicators	B3c: Soil health	6.4	5.8[b]	6.8[(a)]	7.0[a]	6.7[(a)]	6.50	0.169
	B3d*: Health of livestock & plants	7.0[a]	6.5[b]	6.8	7.0[(a)]	7.0[a]	6.86	0.134
	B3g*: No. of bird spp.	5.0[(b)]	3.7[c]	5.8[ab]	6.3[a]	4.3[(b)c]	4.95	0.029
	B3h*: No. of native plants or tree spp.	4.6[b]		6.0[a]	5.7[(a)]	4.5[b]	5.06	0.036
	B3i: No. of plants or tree spp.	4.8[b]	5.0	6.2[a]	5.7	5.0[(b)]	5.29	0.250
	B3k*: Presence of prod. & non-prod. spp.	5.8[a]	4.0[b]	6.0[a]	5.7[a]	4.8	5.29	0.062
	B3m: Nutrient budgeting	4.2	4.8	3.0[b]	5.7[a]	4.2	4.35	0.225
	B3p: Carbon stored	4.2	4.8[a]	4.8[a]	4.7	2.7[b]	4.05	0.132

46 For full report see Fairweather et al. (2009). Note that not all farmers filled in the survey therefore two of the groups are a little smaller than the original ones.

Importance of social indicators	B4g: Contribute to local traditions	3.2	5.2 [a]	3.7	5.0 [a]	2.7 [b]	3.80	0.080
	B4h: Orchard contributing to community	4.2	5.5 [a]	4.3	4.7	2.8 [b]	4.15	0.246
	B4m*: Workers treated well	6.4 [ab]	5.8 [c]	6.0 [bc]	7.0 [a]	6.0 [bc]	6.16	0.014
	B4n*: Scope for farm succession	6.0 [a]	6.0 [a]	4.2 [b]	7.0 [a]	5.7 [(b)]	5.73	0.063
Consideration/ implementation of approaches to management	C1g: Seldom deviate from farm plans	5.5 [a]	3.2 [b]	4.2	3.0 [b]	4.5	4.19	0.118
Agreement with connections of management to -	D1b*: wellbeing of local community	4.6 [(a)]	5.0 [a]	4.5 [(a)]	4.7 [(a)]	2.8 [b]	4.18	0.146
	D1c: wellbeing of nation and world	5.2 [a]	5.0 [a]	3.8	4.3	2.7 [b]	4.09	0.142
Importance of farming factors	F1f: future generations/succession	5.8	6.2 [(a)]	4.2 [b]	7.0 [a]	4.7 [b]	5.45	0.137
Agreement with statements about emissions trading	G1b: NZ farmers should take responsibility only ...	5.8	5.0	6.5 [a]	4.0 [b]	6.7 [a]	5.76	0.108
	G1d*: Technological solutions needed ...	5.8	5.0	4.0 [b]	5.0	6.5 [a]	5.38	0.319
	G1e*: Higher market returns will balance costs ...	2.4 [(b)]	4.8 [a]	2.8	1.0 [b]	3.5 [(a)]	3.00	0.115
Agreement with bird diversity & farm management	H1Ac: Would not like more native birds on farm	4.0	3.2 [b]	5.5 [a]	6.0 [a]	4.6	4.57	0.098
	H1Ad: Not responsibility to encourage native birds	3.8 [a]	4.8 [a]	1.2 [b]	1.0 [b]	3.4 [a]	3.00	0.006
	H1Bc: Would not like more introduced birds...	4.0	2.7 [b]	5.5 [a]	5.7 [a]	4.5	4.48	0.151
	H1Bd: Not responsibility to encourage introduced birds	3.8 [b]	6.0 [a]	1.2 [c]	1.7 [c]	3.7 [b]	3.29	0.000
Importance of planting native trees/shrubs on farm	I1Ab: To increase native bird diversity & abundance	5.2 [a]	2.8 [b]	4.8 [(a)]	5.7 [a]	2.7 [b]		0.046
	I1Ac: To increase insect diversity & abundance	4.8 [ab]	3.0 [bc]	4.8 [ab]	5.7 [a]	2.2 [c]		0.024
	I1Af: To manage erosion	5.2 [a]	4.2	4.2	4.7	2.6 [b]	4.10	0.288
	I1Ah*: To provide fodder for stock	3.0 [a]	4.0 [a]	3.5 [a]	2.3	1.0 [b]	2.64	0.037

	I1Ai: To provide logs & timber	3.0	3.5 [(a)]	4.0 [a]	2.7	1.3 [b]	2.77	0.174
Importance of planting exotic trees/shrubs on farm	I1Bb: To increase native bird diversity & abundance	5.2 [a]	3.0 [(b)]	4.8 [a]	5.7 [a]	2.2 [b]	4.00	0.016
	I1Bc: To increase insect diversity & abundance	4.8 [ab]	3.0 [bc]	4.8 [ab]	5.7 [a]	1.7 [c]	3.76	0.005
	I1Bf: To manage erosion	5.2 [a]	3.0	4.2 [(a)]	4.7 [a]	1.8 [b]	3.68	0.074
	I1Bg*: To make farm look attractive	5.8 [a]	4.0	5.0	6.3 [a]	3.7 [b]	4.86	0.096
	I1Bh*: To provide fodder for stock	3.2 [a]	3.3 [(a)]	3.5 [a]	2.3	1.0 [b]	2.52	0.108
Background information	J8: How many years ... associated with current farm?	26	18 [bc]	16 [c]	45 [a]	36 [ab]	28.1	0.037
	J9: How many years farming?	30 [(a)]	17 [b]	18 [b]	33 [(a)]	37 [a]	27.5	0.051

Table 4.14: PCA analysis of annual change in core variables

	Variable	PC Score				
	Annual change of:	1	2	3	4	5
Intensification	EFS/ha ($)	0.92	-0.13	0.08	-0.08	0.07
	NFPBT/ha ($)	0.84	-0.08	0.48	-0.05	0.03
	Crop %	0.02	-0.75	0.36	-0.22	0.23
	Carc wgt/ha	-0.10	0.06	0.26	0.69	-0.48
Capital	Equity	-0.63	0.06	0.49	-0.20	-0.36
	Olsen P	0.13	0.17	0.09	0.04	0.87
	N %	-0.28	0.75	0.06	-0.19	0.27
	pH	0.00	0.64	0.18	-0.18	0.13
Efficiency	FWE/GFR	-0.94	0.03	-0.03	0.21	0.01
	EFS/su ($)	0.88	-0.03	0.26	0.18	0.21
	NFPBT/su ($)	0.48	0.06	0.83	0.09	0.11
	Lambing %	-0.06	-0.24	-0.12	0.82	0.22
Sustainability	EFS/farm ($)	0.98	-0.07	-0.03	-0.03	0.03
	NFPBT/farm ($)	0.98	-0.06	0.08	-0.03	0.01
Variance explained	Total+85%	42	12	11	10	10

Extraction method: PCA with a Varimax rotation.

Table 4.15: Cluster analysis of annual change in core variables

PC Factor	Group 1 (n=1)	Group 2 (n=12)	Group 3 (n=1)	Group 4 (n=6)	Group 5 (n=3)
1 – balance between profit, equity and efficiency	+4.3	-0.2	-0.6	-0.2	-0.0
2 – balance between profit and soil resource	-0.1	+0.3	-0.8	+0.5	-1.8
3 – change in profit/su	-0.3	+0.1	-4.0	+0.1	+0.7
4 – relationship between lambing and meat production	+0.1	+0.7	-0.3	-1.1	-0.3
5 – change in Olsen P	+0.2	+0.1	-0.1	-0.5	+0.7

Note: These values are standardised (mean 0, s.d. 1), and so a high positive number is more of a measurement of a top ranking in this principal component, while a negative number is a measurement of a lower ranking.

Table 4.16: Characteristics of the groups from the cluster analysis of annual change of core variables

Annual change	Variable	Group 1 (n=1)	Group 2 (n=12)	Group 3 (n=1)	Group 4 (n=6)	Group 5 (n=3)	Average[47] (n=21)	P- value
Intensity	EFS/ha ($)	271	(-15 (b))	-54	(-13 (b))	(45 (a))	(-6)	0.132
	NFPBT/ha ($)	228	(-20 b)	-175	(-10 b)	(44 a)	(-8)	0.015
	Crop %	0.0	(0.1 b)	0	(0.0 b)	(3.9 a)	(0.0)	0.001
	Carc wgt/ha	-19	(14 a)	-36	(-22 b)	(-30 b)	(-2)	0.011
Capital	Equity %	-8.2	(0.3 b)	-3.6	2.2 a	(0.7)	0.9	0.140
	Olsen P	0.54	(-0.11)	-1.50	(-1.02)	(-0.38)	(-0.41)	0.499
	N %	-0.006	0.016 a	0.005	0.025 a	(-0.008 b)	0.015	0.037
	pH	-0.025	(-0.006)	-0.046	(0.004)	(-0.039)	(-0.008)	0.515
Efficiency	FWE/GFR	-0.321	(0.020)	0.028	(0.000)	(0.001)	(0.011)	0.407
	EFS/su ($)	32.55	(1.27 a)	-11.50	(-2.19 b)	(4.78 a)	(0.78)	0.014
	NFPBT/su ($)	27.70	(0.75 b)	-58.17	(-1.54 b)	6.01 a	(0.85)	0.014
	Lambing %	0.1	3.0 a	4.6	-4.6 b	(3.7 a)	(0.9)	0.002
Sustainability	EFS/farm ($)	210,112	(-1,451)	-5606	(-5,642)	(8,604)	(1,212)	0.472
	NFPBT/farm ($)	176,162	(-5,101 b)	-21,235	(-4,247)	(9,207 a)	(2,813)	0.106

Note: As Groups 1 and 3 consist of only one member, they cannot be analysed for differences compared to the other groups.

Table 4.17: Characteristics of the groups from cluster analysis of annual change of core variables, in terms of averages of core variables

Average	Variable	Group 1 (n=1)	Group 2 (n=12)	Group 3 (n=1)	Group 4 (n=6)	Group 5 (n=3)	Average	P value
Intensification	NFPBT/ha ($)	52	174	-328	(58 b)	374 a	169.3	0.100
	Crop %	1	(12)	0	(0 b)	(34 a)	11.6	0.135
Efficiency	NFPBT/su ($)	5.19	14.12	-79.57	(5.95 b)	33.92 a	14.61	0.116
	Lambing %	130	130 b	107	130 b	156 a	133.8	0.031

[47] Not including Groups 1 and 3.

Table 4.18: Characteristics of the groups from cluster analysis of annual change of core variables, in terms of variation of core variables

Variation (s.d.)	Variable	Group 1 (n=1)	Group 2: Productivists (n=12)	Group 3 (n=1)	Group 4: Investors (n=6)	Group 5: On the up (n=3)	Average (excluding Groups 1 & 3)	P value
Intensification	EFS/ha ($)	283	153 [(b)]	197	118 [b]	(300 [a])	164.3	0.111
	NFPBT/ha ($)	239	151 [(b)]	724	115 [b]	280 [a]	158.8	0.108
	Crop %	0	(1.7 [b])	0	(0.3 [b])	(8.3 [a])	2.22	0.004
Capital	pH	0.171	0.161 [a]	0.106	0.076 [b]	(0.197 [a])	0.1419	0.050
Efficiency	EFS/su ($)	33.99	15.97	40.41	11.16 [b]	(26.35 [a])	16.08	0.135
	NFPBT/su ($)	29.22	16.79	167.11	12.94 [b]	(26.28 [a])	17.05	0.135

Table 4.19: Characteristics of groups formed from annual change in terms of financial expenses

	Variable	Group 1 (n=1)	Group 2: Productivists (n=12)	Group 3 (n=1)	Group 4: Investors (n=6)	Group 5: On the up (n=3)	Average (excluding Groups 1 & 3)	P value
Income GFR/ha	*Average	583	967 [b]	854	686 [b]	(1,821 [a])	1,008	0.106
	*Annual change	208	(-28 [(b)])	177	-14 [b]	(102 [a])	(-5)	0.018
Expenses FWE/ha	Annual change	-19	(0 [b])	197	(-6 [b])	(50[a])	(6)	0.072
Cash cropping	Annual change	6.24	(1.79 [b])	0	(-0.03 [b])	(46.32[a])	(7.63)	0.015
	Variation (s.d.)	6.2	(25.34 [b])	0	(0.30 [b])	(141.68 [a])	(34.80)	0.088
Feed	Variation (s.d.)	13.07	23.75 [b]	197.55	17.81 [b]	(54.31 [a])	26.42	0.054
Vehicles & fuel	Average	44.28	72.50 [b]	53.95	54.15 [b]	(148.36 [a])	78.09	0.049
Fertiliser	Average	28.82	62.05 [b]	127.05	85.15	(192.49 [a])	87.29	0.101
	Annual change	-2.23	(-2.03 [b])	47.97	(-3.21 [b])	(14.86 [a])	(0.04)	0.047
Weeds & Pests	Average	3.77	10.96 [b]	18.99	(8.75 [b])	(128.49 [a])	(27.12)	0.011
	Annual change	0.15	(-0.91 [b])	3.60	(0.05 [b])	(10.71 [a])	(1.03)	0.012
	Variation (s.d.)	4.18	5.59 [b]	20.44	(4.05 [b])	(36.83 [a])	9.61	0.007

Note: All of these had non-homogeneous variances (probably because of group 2's larger variation) and so again, the significance of the differences could be a bit reduced as there is unlikely to be any chance of differences between Group 5 and Groups 2 and 4 showing.

Table 4.20: Characteristics of groups formed from annual change in terms of bird density (measurements over three years: 2004-5, 2007-8, 2009-2010)

[48]Density of:	Variable	Group 1 (n=1)	Group 2: Productivists (n=12)	Group 3 (n=1)	Group 4: Investors (n=6)	Group 5: On the up (n=3)	Average	P value
All introduced spp.	Variation (s.d.)	1.49	3.85[a]	2.91	3.37	(1.21 [b])	3.337	0.118
Introduced - insectivorous spp.	Average	1.21	1.43 [(b)]	1.75	2.12 [a]	0.81 [b]	1.540	0.075

Table 4.21: Characteristics of groups formed from annual change in terms of fertiliser applied and additional soil measurements

	Variable	Group 1 (n=1)	Group 2 Productivists (n=12)	Group 3 (n=1)	Group 4: Investors (n=6)	Group 5: On the up (n=3)	Average	P value
K kg/ha	Average	0.07	0.90 [b]	0.18	(0.90 [b])	(3.26 [a])	1.239	0.061
K kg/su	Average	0.009	0.09 [b]	0.027	(0.10 [b])	(0.38 [a])	0.134	0.019
	Variation (s.d.)	0.02	(0.18 [b])	0.05	(0.20 [(b)])	0.61 [a]	0.251	0.085
N tons/farm	Average*	2.47	0.83 [b]	2.28	(2.60 [b])	(13.57 [a])	(3.157)	0.035
	Variation* (s.d.)	2.78	0.66 [b]	2.65	(1.64)	(4.35 [a])	1.469	0.084
N kg/ha	Average*	6.4	1.8 [b]	5.1	(5.2 [b])	(60.6 [a])	(11.20)	0.033
	Annual change*	-3.8	(-0.3 [b])	-1.8	(-1.0 [b])	(4.3 [a])	(0.15)	0.056
	Variation* (s.d.)	9.4	1.8 [b]	9.4	(3.6 [b])	(18.5 [a])	(4.67)	0.039
N kg/su	Average*	0.67	0.18 [b]	0.34	(0.54 [b])	(6.66 [a])	(1.210)	0.025
	Annual change*	-0.40	(-0.01 [b])	-0.08	(-0.02 [b])	(1.53 [a])	(0.207)	0.034
	Variation* (s.d.)	0.99	0.15 [b]	0.52	(0.33 [b]	(5.80 [a])	(1.009)	0.027
S kg/ha	Average	12.4	13.5 [(b)]	18.5	(6.0 [b])	(28.2 [a])	13.45	0.048
	Annual change	1.5	(-0.7 [b])	-4.7	(-0.5 [b])	(-5.0 [a])	(-1.26)	0.053
S kg/su	Average*	1.5	1.7	2.1	(0.6 [b])	3.3 [a]	1.63	0.057
Soils	C% Annual change	-0.16	(0.006 [b])	-0.02	0.122 [a]	-0.181 [c]	(0.012)	0.003

Note: * variances not homogeneous. Differences may be masked by the larger values of Group 4.

[48] See MacLeod et al. (in press) for a full description of the research from which this data is taken.

Table 4.22: Characteristics of groups formed from annual change in terms of other farm management variables

	Variable	Group 1 (n=1)	Group 2 Productivists (n=12)	Group 3 (n=1)	Group 4 Investors (n=6)	Group 5 On the up (n=3)	P value
SU/ha	Variation (s.d.)	12.1	1.32 [b]	6.9	(1.49 [(b)])	4.10[a]	0.130
Scanning %	Average	151	153 [b]	Don't scan	144 [b]	183 [a]	0.015

Table 4.23: Characteristics of groups formed from annual change in terms of attitude variables (from 2008 survey)[49]

	Variable	Group 1 (n=1)	Group 2 Productivists (n=10)	Group 3 (n=1)	Group 4 Investors (n=6)	Group 5 On the up (n=3)	Average (excluding Groups 1 & 3)	P value
Importance of financial indicators	B1f:Net profit/loss	6	5.9[a]	6	6.2 [(a)]	(4.3 [b])	5.74	0.087
	B1g: Changes in equity	6	5.4 [a]	7	5.8 [a]	(3.0 [b])	5.16	0.020
	B1i: Return on capital	6	4.0	4	5.3 [a]	(2.3 [b])	4.16	0.054
Importance of environmental indicators	B3o: Energy use	2	4.6 [(a)]	6	3.3 [b]	5.7 [a]	4.37	0.050
Importance of social indicators	B4i: Neighbours approve ...	4	3.1 [b]	7	4.0	5.7 [a]	3.83	0.109
	B4k: Neighbours consider me a good farmer	4	3.2 [b]	7	4.5	6.0 [a]	4.11	0.089
Importance of farming factors	F1g: Off-farm product quality	6	6.4 [a]	7	6.5 [a]	(4.0 [b])	6.05	0.032
Agreement with statements about emissions trading	G1a: NZ farmers contribute to climate change ...	3	4.0 [a]	2	1.8 [b]	1.7 [(b)]	2.95	0.040
	G1d: Technological solutions needed ...	3	6.1 [a]	7	4.0 [b]	6.0	5.39	0.078
Agreement with bird diversity & farm management	H1Ba: Would not like more birds on farm	2	2.5 [b]	1	5.3 [a]	5.0 [(a)]	3.79	0.032
Importance of planting native trees/shrubs on farm	I1Ab: To increase native bird diversity & abundance	3	4.7 [a]	7	4.5 [a]	(1.3 [b])	4.11	0.011
	I1Ac: To increase insect diversity & abundance	3	4.2 [a]	7	4.5 [a]	(1.3 [b])	3.84	0.035
	I1Ad: To enhance stream health	2	4.6 [a]	7	4.3 [a]	1.0 [b]	4.11	0.047
	I1Ag: To make farm look attractive	4	5.6 [a]	7	5.5 [a]	(3.0 [b])	5.16	0.002
Importance of planting exotic trees/shrubs on farm	I1Bg: To make farm look attractive	4	5.1 [a]	7	5.5 [a]	(2.5 [b])	4.94	0.060

[49] For full report see Fairweather et al. (2009). Note that not all farmers filled in the survey therefore two of the groups are a little smaller than the original ones.

Table 4.24: PCA analysis of variation of core variables

	Variable	PC Score				
	Variation (s.d.) of:	1	2	3	4	5
Intensification	EFS/ha ($)	0.65	0.25	0.42	0.35	0.12
	NFPBT/ha ($)	0.31	0.83	0.34	0.04	-0.01
	Crop %	-0.04	0.01	0.21	0.14	0.89
	Carc wgt/ha	0.04	0.05	-0.11	0.82	0.21
Capital	Equity	0.20	0.82	-0.35	0.10	0.03
	Olsen P	-0.06	0.06	-0.34	-0.60	0.47
	N %	-0.10	-0.27	-0.79	0.04	-0.32
	pH	-0.16	-0.09	0.66	0.04	-0.08
Efficiency	FWE/GFR	0.73	-0.11	-0.02	-0.43	0.01
	EFS/su ($)	-0.54	0.58	0.41	0.15	0.25
	NFPBT/su ($)	0.06	0.95	0.12	-0.05	0.01
	Lambing %	0.42	0.10	0.62	-0.02	0.14
Sustainability	EFS/farm ($)	0.90	0.15	-0.02	0.20	-0.06
	NFPBT/farm ($)	0.86	0.34	-0.04	0.01	-0.10
% of variance explained	Total 79%	22	21	16	10	9

Extraction method: PCA with a Varimax rotation.

Table 4.25: Cluster analysis of variation of core variables

PC Factor	Group 1 (n=4)	Group 2 (n=1)	Group 3 (n=13)	Group 4 (n=3)	Group 5 (n=2)
1 – variation in profit moderated by efficiency	-0.3	-0.4	-0.3	1.8	-0.2
2 – variability of equity and efficiency	0.0	4.2	-0.3	-0.4	0.2
3 – variability of soil resource and lambing %	1.7	0.0	-0.5	0.1	-0.2
4 – variability of meat production & Olsen P	0.0	-0.4	0.0	-0.4	1.0
5 – variation in cropping	0.0	-0.5	-0.3	-0.1	2.6

Note: These values are standardised (mean 0, s.d. 1), and so a high positive number is more of a measurement of a top ranking in this principal component, while a negative number is a measurement of a lower ranking.

Table 4.26: Characteristics of the groups from the cluster analysis of the variation of core variables

Variation (s.d.)	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=13) Consistent and reliable	Group 4 (n=3) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average (excluding Group 2)	P-value
Intensity	*EFS/ha ($)	(240)	197	112 [b]	282 [a]	(232)	170	0.064
	*NFPBT/ha ($)	(272 [a])	724	122 [b]	199	155	162	0.110
	*Crop %	(3.7 [b])	0	(0.7 [c])	(0.9 [bc])	(11.3 [a])	2.3	0.000
	Carc wgt/ha	43	55	47	(45)	(79)	49.1	0.439
Capital	Equity %	(4.5)	(21.9)	(6.8)	(7.0)	(10.4)	6.72	0.406
	Olsen P	2.15	3.73	3.38	3.36	(4.28)	3.232	0.615
	N %	0.016 [b]	0.018	0.062 [a]	0.042	(0.026 [b])	0.0480	0.002
	pH	0.25 [a]	0.11	0.12 [b]	0.14 [(b)]	(0.12 [(b)])	0.143	0.031
Efficiency	FWE/GFR	(0.12 [b])	0.13	0.13 [b]	0.31 [a]	(0.09 [b])	0.146	0.004
	*EFS/su ($)	(23.08 [a])	40.4	10.49 [b]	27.81 [a]	(29.73 [a])	16.89	0.003
	NFPBT/su ($)	26.17 [a]	167	12.57 [b]	21.31 [(a)]	(25.58 [a])	17.60	0.012
	Lambing %	14 [a]	10	8 [b]	(12)	10	9.8	0.118
Sustainability	EFS/farm ($)	(51,639 [b])	95,957	52,154 [b]	(144,280 [a])	(72,717 [(b)])	66,493	0.014
	NFPBT/farm ($)	(57,285 [(b)])	105,715	56,949 [b]	(114,074 [a])	(45,061 [(b)])	63,719	0.150

Note:

1. As Group 2 consists of only one member, it cannot be analysed for differences compared to the other groups.
2. The bracketed values are not significantly different from zero. Even variation can be not significantly different from zero. What this means is that there is no evidence of variation over the years.
3. Variances not homogeneous.

Table 4.27: Characteristics of the groups from cluster analysis of variability of core variables, in terms of averages of core variables

Average	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=13) Consistent and reliable	Group 4 (n=3) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average	P value
Intensification	NFPBT/ha ($)	(355[a])	-328	138 [(b)]	(-21 [b])	(228)	164	0.090
	Crop %*	(31 [a(b)])	0	(2 [c])	(0 [bc])	(44 [a])	11.1	0.015
Capital	N %	0.32 [b]	0.38	0.45 [a]	0.42	(0.40)	0.417	0.145
Efficiency	NFPBT/su ($)	(27.87 [a])	-80	11.94	(-3.24 [b])	(27.56 [(a)])	14.19	0.109

Table 4.28: Characteristics of the groups from cluster analysis of variability of core variables, in terms of annual trend/change of core variables

Annual change	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=13) Consistent and reliable	Group 4 (n=3) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average (excluding Group 2)	P value
Intensification	*Crop %	(0.1[b])	0	(0.2 [b])	(0.2 [b])	(3.6 [a])	(0.51)	0.002
Capital	Equity %	(1.4 [a])	0.0	(1.1 [a])	(-3.3 [b])	(0.9 [(a)])	(0.51)	0.051
	N%	(-0.002[b])	0.009	0.023 [a]	(0.011)	(-0.005 [b])	0.014	0.028
	pH	(-0.053 [b])	-0.092	(0.008 [a])	(-0.010)	(-0.050)	(-0.009)	0.199
Efficiency	*EFS/su ($)	(2.21)	-11.50	(0.41 [b])	(10.96 [a])	(0.97)	(2.229)	0.201
	Lambing %	6 [a]	5	(-1 [b])	(5 [a])	(-1 [(b)])	(0.9)	0.031

Note: *Variances not homogeneous.

Table 4.29: Characteristics of groups formed from variation in terms of financial expenses

$	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=13) Consistent and reliable	Group 4 (n=3) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average	P value
Income GRF/ha	*Average	(1,683[a])	854	734[b]	625[bc]	(1,805[a(c)])	989	0.035
	*Variation (s.d.)	(357[a])	1052	117[b]	180	(545[a])	208	0.030
GFR/farm	*Variation (s.d.)	(75,134)	111,721	49,890[b]	(188,814[(a)])	(152,146[a])	73,175	0.083
FWE/ha	*Average	(1,009[a])	658	438	(475[b])	(1,142[(a)])	611	0.072
	*Annual change	(38[a])	197	(-5[b])	(16)	(-15[(b)])	(5)	0.163
	*Variation (s.d.)	(135[(b)])	1,000	62[b]	(96[b])	(317[a])	103	0.035
FWE/farm	*Annual change	(7,596[(b)])	17,616	(1,095[b])	(-3,258[b])	(26,956[a])	(4,034)	0.072
	*Variation (s.d.)	(29,248[(b)])	47.347	30,515[b]	29,967[(b)]	(84,305[a])	35,100	0.180
Cash cropping	Variation* (s.d.)	(87.72)	0	(4.24[b])	(2.08[b])	(162.43[a])	(33.51)	0.062
Vehicle & fuel	Average*	(137.11[a])	53.94	50.74[b]	(90.02)	(103.10)	76.56	0.031
Repairs and maintenance	Average*	(85.41[ab])	92.54	44.46[c]	(37.32[bc])	(125.01[a])	58.25	0.014
	Variation (s.d.)	26.31[(b)]	159.75	16.75[b]	(13.21)[b]	45.79[a]	20.64	0.013
Overheads	Average	106.35[a]	50.81	57.43[b]	54.46[(b)]	(97.03)	69.52	0.097
C & NC labour	Average	594.99[a]	298.15	314.19[c]	(315.12[bc])	(549.10[ab])	386.73	0.004
	Variation* (s.d.)	78.47	429.08	44.20[b]	(53.52[b])	(136.03[a])	60.05	0.032
C & NC Feed	Variation (s.d.)	(64.48)	77.93	33.61[b]	(89.07[a])	(37.46)	47.14	0.148
Fertiliser	Annual change*	(10.94[a])	47.97	(-2.92[b])	(-4.66[(b)])	(3.43)	(-0.06)	0.069
Weeds & Pests	Annual change*	(7.04[a])	3.60	(-0.32)	(-0.59[b])	(-0.28)	(0.99)	0.223

Note: * Most of these with a large value for Group 5 had non-homogeneous variances (probably because of group 5's larger variation) and so again, the significance of the differences could be a bit reduced.

Table 4.30: Characteristics of groups formed from variation in bird density (measurements over three years: 2004-5, 2007-8, 2009-2010)

[50]Density of:	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=13) Consistent and reliable	Group 4 (n=3) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average	P value
Introduced - insectivorous spp.	Annual change	(0.19 [(b)])	-0.06	0.13 [b]	(0.42 [a])	(0.14 [(b)])	0.182	0.100
	Variation (sd.)	(0.47 [b])	0.29	0.74 [(b)]	(1.32 [a])	(0.52)	0.752	0.197

Table 4.31: Characteristics of groups formed from variation in terms of fertiliser applied and additional soil measurements

Fertiliser applied:	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=13) Consistent and reliable	Group 4 (n=3) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average	P value
Ca kg/su	Annual change*	(3.0 [(a)])	14.5	(-0.5 [b])	(5.3[a])	(0.5 [(b)])	(1.04)	0.030
	Variation* (s.d.)	(14.7)	50.2	6.6 [b]	(22.3 [a])	(13.6)	10.85	0.106
K tons/farm	Annual change	(0.089 [a])	0.155	(-0.056 [(a)])	(-0.481 [b])	(-0.143)	(-0.0954)	0.160
K kg/ha	Annual change	(0.42 [a])	0.10	(-0.14 [(a)])	(-0.96 [b])	(-0.68 [(b)])	(-0.198)	0.073
K kg/su	Annual change	(0.064 [a])	0.027	(-0.007 [(a)])	(-0.111 [b])	(-0.092 [(b)])	(-0.0159)	0.068
N tons/farm	Annual change	(0.74 [a])	-0.23	(-0.22 [b])	(-0.63 [b])	(0.00)	(-0.079)	0.084
N kg/ha	Annual change*	(3.53 [a])	-1.81	(-0.74 [b])	(-1.75 [b])	(0.02)	(-0.033)	0.115
N kg/su	Annual change*	(1.13 [a])	-0.08	(-0.01 [b])	(-0.17 [(b)])	(0.03)	(0.179)	0.194
P tons/farm	Variation (s.d.)	(1.15 [b])	2.95	4.13 [a]	(4.35 [a])	(2.56)	3.477	0.070
P kg/su	Annual change*	(0.03)	-0.15	(-0.04 [b])	(0.64 [a])	(0.22)	(0.087)	0.195
	Variation* (s.d.)	(0.95 [(b)])	0.54	0.96 [b]	(3.08 [a])	(2.31)	0.367	0.166
S kg/su	Annual change*	(0.06 [(b)])	-0.07	(-0.02 [b])	(0.95 [a])	(0.28)	(0.151)	0.100
	Variation* (s.d.)	(1.02 [(b)])	1.59	0.91 [b]	(3.68 [a])	4.05 [a]	(1.601)	0.063
Soils								
C%	Average	3.6 [b]	4.2	5.1 [a]	5.0	4.3	4.7	0.151
	Annual change	-0.119 [b]	-0.015	0.086 [a]	(-0.094 [b])	(-0.131 [b])	(0.0043)	0.004
AMN/N	Average	31.1 [b]	32.1	35.8 [a]	34.5	(34.3)	34.6	0.199
	Variation (s.d.)	4.5 [b]	3.7	8.6 [a]	9.8 [a]	(9.0)	8.0	0.132

Note: * variances not homogeneous.

[50] See MacLeod et al. (in press) for a full description of the research from which this data is taken.

Table 4.32: Characteristics of groups formed from variation in terms of other farm management variables

	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=13) Consistent and reliable	Group 4 (n=3) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average	P value
% Sheep	Average	58[b]	37	79 [a]	82 [a]	90 [a]	76.8	0.026
	*Annual change	(-1.4 [(b)])	0.0	(-0.4)	(1.4 [a])	(-2.4 [b])	(-0.01)	0.160

Table 4.33: Characteristics of groups formed from variation in terms of attitude variables (from 2008 survey)[51]

	Variable	Group 1 (n=4) Efficiency & pH very variable	Group 2 (n=1) High equity & efficiency	Group 3 (n=12) Consistent and reliable	Group 4 (n=2) Greatest variability in profit & efficiency	Group 5 (n=2) Variability of cropping & profit/su	Average (excluding Group 2)	P value
Importance of financial indicators	B1c: Change in bank balance	5.0	5	4.3[b]	6.5 [a]	(5.0)	4.75	0.132
	B1f: Net profit/loss	6.0 [a]	6	6.1 [a]	5.0	(4.0 [b)])	5.75	0.097
	B1h: Ratio of working expenses to gross income	4.8 [b]	5	6.2 [a]	6.0	6.5 [(a)]	5.90	0.100
Importance of production indicators	B2a: Health stock/plants	7.0 [a]	7	7.0 [a]	6.5 [b]	7.0 [a]	6.95	0.014
	B2e: Volume production at maximum	6.2 [a]	5	4.3 [b]	4.0 [(b)]	(5.5)	4.80	0.078
	B2g: Good mixture production	6.5 [a]	4	5.8 [a]	4.0 [b]	6.0 [a]	5.80	0.037
	B2i: Reducing carbon emissions	4.8 [(a)]	4	3.2 [b]	(5.5 [a])	(4.5)	3.85	0.077
Consideration/ implementation of	C1a: Adopt proven practices ...	4.5 [(a)]	4	4.8 [a]	(4.5)	(2.5 [b])	4.50	0.140

[51] For full report see Fairweather et al. (2009). Note that not all farmers filled in the survey therefore two of the groups are a little smaller than the original ones.

approaches to management	C1b: Pay close attention to changes ...	6.0 [a]	7	6.0 [a]	(4.5 [b])	(5.5 [(a)])	5.80	0.018
	C2: How different will farm be in 10 years ...	3.2 [b]	5	4.8 [a]	(5.5 [(a)])	(5.5 [(a)])	4.65	0.112
Agreement with management affects -	D2c: environment on a global scale	3.5	5	3.1 [b]	(2.0 [b])	(5.5 [a])	3.30	0.120
Agreement with statements about emissions trading	G1a: NZ farmers contribute to climate change ...	4.8 [a]	2	2.2 [b]	(4.0)	(3.0)	2.95	0.098
	G1e: Higher market returns will balance costs ...	5.0 [a]	1	1.8 [b]	(5.0 [a])	5.0 [a]	3.10	0.001
Agreement with bird diversity & farm management	H1Ae: Interested in participating in native bird tick accreditation	(3.0 [b])	6	3.0 [b]	6.5 [a]	6.5 [a]	3.82	0.024
	H1Ba: Would not like more introduced birds...	4.0	1	3.5 [(b)]	(1.5 [b])	6.5 [a]	3.70	0.189
	H1Bd: Not responsibility to encourage introduced birds	(2.0 [b])	1	3.2 [(b)]	(3.5)	(5.5 [a])	3.26	0.182
	H1Be: Interested in participating in bird tick accreditation	3.3 [b]	6	2.9 [b]	6.5 [a]	6.5 [a]	3.82	0.010
	H1Bf: Some birds cause damage ...	5.7 [a]	5	5.2 [a]	1.0 [b]	6.5 [a]	5.00	0.047
Importance of planting native trees/shrubs on farm	I1Aa: To generate carbon credits	4.8 [a]	1	2.6 [b]	(2.0 [(b)])	(2.0 [(b)])	2.95	0.112
	I1Ae: To enhance shelter for stock	5.5 [(a)]	7	6.4 [a]	6.5 [a]	(3.5 [b])	5.95	0.025
	I1Ag: To make farm look attractive	4.5	7	5.6 [a]	(5.0)	(3.5 [b])	5.10	0.124
Importance of planting exotic trees/shrubs on farm	I1Be: To enhance shelter for stock	(4.0 [b])	7	6.4 [a]	6.5 [(a)]	(3.5 [b])	5.74	0.033
	I1Bi: To provide logs/timber	(3.3)	1	3.7	(1.5 [b])	6.0 [a]	3.63	0.194
Information	J10: How many years in future do you expect to be farming?	10 [b]	20	12 [b]	(25 [a])	-	13.1	0.059

Table 4.34: Correlations of averages of core variables (without cropping)

	EFS /ha	NFPBT /ha	Carc wgt/ha	Equity %	Eff Area	OlsP	N%	pH	FWE/GFR	EFS/su	NFPBT/su	Lambing%	EFS/farm	NFPBT/farm
EFS/ha	1	0.52 *	Ns	ns	ns	ns	ns	Ns	-0.76 **	0.95 **	Ns	0.45 *	0.92 **	0.66 **
NFPBT/ha		1	Ns	0.56 **	-0.50 *	ns	ns	0.38 (0.09)	-0.75 *	0.46 *	0.91 **	0.55 **	0.39 (0.08)	0.82 **
Carc wgt/ha			1	Ns	ns	ns	ns	Ns	ns	0.41 (0.06)	ns	0.70 **	ns	0.41 (0.06)
Equity %				1	-0.40 (0.08)	ns	ns	Ns	ns	0.44 *	0.61 **	ns	ns	0.54 *
Eff Area					1	ns	ns	Ns	ns	Ns	-0.57 **	ns	ns	ns
Olsen P						1	ns	Ns	ns	Ns	Ns	ns	ns	-0.49 *
N%							1	Ns	ns	Ns	ns	ns	ns	ns
pH								1	-0.48 *	Ns	ns	ns	ns	ns
FWE/GFR									1	-0.71 **	-0.57 **	-0.44 *	-0.73 **	-0.74 **
EFS/su										1	ns	0.54 *	0.88 **	0.68 **
NFPBT/su											1	0.58 **	ns	0.81 **
Lambing%												1	0.37 (0.10)	0.61 **
EFS/farm													1	0.60 **
NFPBT/farm														1

* p<0.05, ** p<0.01

Table 4.35: Correlations of annual trends of core variables (without cropping)

	EFS /ha	NFPBT /ha	Carc wgt /ha	Equity %	OlsP	N%	pH	FWE/GFR	EFS/su	NFPBT/su	Lambing%	EFS/farm	NFPBT/farm
EFS/ha	1	0.86 **	Ns	-0.58 **	ns	ns	Ns	-0.94 **	0.81 **	0.47 *	Ns	0.96 **	0.93 **
NFPBT/ha		1	Ns	ns	ns	ns	Ns	-0.85 **	0.85 **	0.81 **	Ns	0.81 **	0.88 **
Carc wgt/ha			1	ns	ns	ns	ns	ns	ns	ns	0.61 **	ns	ns
Equity %				1	ns	ns	ns	0.54 *	-0.62 **	ns	Ns	-0.70 **	-0.60 **
Olsen P					1	ns	ns	ns	ns	ns	Ns	ns	ns
N%						1	0.40 (0.08)	ns	ns	ns	Ns	ns	ns
pH							1	ns	ns	ns	Ns	ns	ns
FWE/GFR								1	-0.78 **	-0.44 *	Ns	-0.95 **	-0.96 **
EFS/su									1	0.71 **	Ns	0.87 **	0.88 **
NFPBT/su										1	Ns	0.42 (0.06)	0.52 *
Lambing%											1	ns	ns
EFS/farm												1	0.98 **
NFPBT/farm													1

* p<0.05, ** p<0.01

Table 4.36: Correlations of variation (s.d.) of core variables (without cropping)

	EFS/ha	NFPBT/ha	Carc wgt/ha	Equity %	OlsP	N%	pH	FWE/GFR	EFS/su	NFPBT/su	Lambing%	EFS/farm	NFPBT/farm
EFS/ha	1	0.44 *	Ns	ns	ns	ns	ns	-0.62 **	0.64 **	0.47 *	Ns	0.72 **	0.57 **
NFPBT/ha		1	Ns	0.68 **	ns	-0.39 (0.08)	ns	ns	0.75 **	0.95 **	Ns	ns	0.47 *
Carc wgt/ha			1	ns	ns	ns	ns	ns	ns	ns	Ns	ns	ns
Equity %				1	ns	ns	ns	ns	0.51 *	ns	Ns	0.45 *	0.50 *
Olsen P					1	ns	ns	ns	ns	ns	Ns	ns	ns
N%						1	ns	ns	-0.46 *	-0.38 (0.09)	-0.54 *	ns	ns
pH							1	ns	ns	ns	Ns	ns	ns
FWE/GFR								1	0.50 *	-0.44 *	Ns	-0.63 **	0.56 **
EFS/su									1	0.70 **	Ns	0.61 **	0.56 **
NFPBT/su										1	Ns	ns	ns
Lambing%											1	ns	ns
EFS/farm												1	0.93 **
NFPBT/farm													1

* p<0.05, ** p<0.01

Table 4.37: PCA analysis of averages of core variables (without cropping)

		PC Score			
	Variable	1	2	3	4
Intensification	EFS/ha ($)	0.95	0.03	0.15	0.06
	NFPBT/ha ($)	0.48	0.80	0.17	0.03
	Carc wgt/ha	0.21	0.15	0.81	0.22
Capital	Equity	-0.04	0.79	0.03	-0.05
	Effective area (ha)	0.29	-0.76	-0.10	0.08
	Olsen P	0.18	-0.24	0.08	0.74
	N %	-0.22	-0.01	0.21	0.72
	pH	0.29	0.46	-0.40	0.55
Efficiency	FWE/GFR	-0.83	-0.39	0.00	-0.06
	EFS/su ($)	0.92	0.00	0.28	0.13
	NFPBT/su ($)	0.30	0.85	0.23	-0.08
	Lambing %	0.36	0.36	0.74	0.06
Sustainability	EFS/farm ($)	0.95	-0.10	0.12	-0.13
	NFPBT/farm ($)	0.64	0.60	0.30	-0.02
Variance explained	Total+80%	32	25	12	10

Extraction method: PCA with a Varimax rotation.

Table 4.38: Cluster analysis of averages of core variables (without cropping)

	Cluster				
PC Factor	1 (n=6)	2 (n=3)	3 (n=4)	4 (n=3)	5 (n=7)
1 – EFS and efficiency	-1.4	-0.5	+1.2	+0.9	+0.5
2 – NFPBT balanced by area	-0.3	+0.6	+0.2	-2.2	+0.3
3 – Production	0.9	-0.8	+1.6	-0.3	-0.2
4 – Soil resource	+0.5	-1.1	-1.0	-0.2	+0.8

Note: These values are standardised (mean 0, s.d. 1), and so a high positive number is more of a measurement of a top ranking in this principal component, while a negative number is a measurement of a lower ranking.

Table 4.39: Characteristics of the groups from the cluster analysis of the averages of core variables (without cropping)

Average	Variable	Group 1 (n=4) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=8) High soil resource, consistent and sustainable	Average	P- value
Intensity	EFS/ha ($)	(-234^{b})	(-155^{b})	(205^{a})	(68^{a})	(52^{a})	(-35.68)	0.000
	NFPBT/ha ($)	(-35^{bc})	(121)	282^{ab}	(-137^{c})	231^{a}	(124.08)	0.078
	Carc wgt/ha	171^{a}	93^{b}	(230^{a})	149	145	146.0	0.065
Capital	*Equity %	82^{b}	91^{ab}	95^{a}	60^{c}	88^{ab}	85.4	0.001
	Effective area (ha)	429^{b}	310^{b}	(552)	1082^{a}	501^{b}	502.1	0.075
	Olsen P	23.4^{ab}	11.1^{bc}	(15.1^{b})	24.1^{ab}	23.8^{a}	19.91	0.001
	N %	0.49^{a}	0.35^{b}	(0.38)	0.35^{b}	0.47^{a}	0.427	0.017
	pH	5.78^{b}	5.91	5.81	5.84	6.05^{a}	5.92	0.102
Efficiency	*FWE/GFR	0.89^{a}	0.70	0.50^{b}	0.65	0.55^{b}	0.656	0.018
	EFS/su ($)	(-22.86^{c})	(-22.34^{c})	(21.81^{a})	(3.39^{ab})	(3.34^{b})	(-6.00)	0.000
	*NFPBT/su ($)	(-3.65)	(12.80^{a})	(31.82^{a})	(-37.19^{b})	18.43^{a}	(8.86)	0.046
	*Lambing %	133^{b}	120^{b}	(162^{a})	(118^{b})	135^{b}	132.2	0.021
Sustainability	EFS/farm ($)	(-96,388^{d})	(-43,072^{c})	112,592^{a}	(77,421^{a})	19,424^{b}	(-3,118)	0.000
	*NFPBT/farm ($)	(-15,680^{c})	(21,630^{bc})	(155,870^{a})	(-35,050^{c})	76,077^{ab}	42,652	0.002

Notes:
1. Carc wgt/ha = Net carcase weight sold kg/ha.
2. The superscripts indicate whether values are statistically significantly different at the 5% level of significance. Superscripts that are different indicate a significant difference. If there is a superscript in common between two values then they are not significantly different.[52]
3. Values in brackets indicate a mean that is not significantly different from zero.[53] For example, a profit value in brackets indicates that this group has probably not made a profit or a loss, which means that the members of the group have quite variable data for this particular variable. When Group 3 has a large mean which is not significantly different from zero, it tells us how different these two farms are for this variable. For example, one farmer is a low input farmer (extensive, organic) and the other is high input (on Canterbury Plains, irrigated) – hence the difference in lambing %, carcase weight, area, Olsen P and N %.[54]
4. * Variance not homogeneous.

[52] These differences are tested using an lsd - least significant difference. Because each of the groups has a different number of measurements in its mean, each lsd for comparison between two means will be different. Hence it is difficult to report them in a table.
[53] See earlier footnote.
[54] It could be asked how does the clustering work if these two disparate farms are put together? It looks as if the clustering has been driven by the financial data – as these two farms make so much more than the others.

Table 4.40: Characteristics of the groups from cluster analysis of averages of core variables, in terms of annual trend/change of core variables (without cropping)

Annual change (trend)	Variable	Group 1 (n=4) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=8) High soil resource, consistent and sustainable	Average	P- value
Intensification	EFS/ha ($)	(-53 [b])	(-6 [b])	(-22 [(b)])	(109 [a])	(0 [b])	(-3.27)	0.121
Capital	*Equity %	(1.4 [a])	1.0 [a]	(1.8 [a])	(-5.9 [b])	(0.0 [a])	(0.20)	0.011
	N %	0.027 [a]	(0.005 [b])	(0.003)	(-0.000 [(b)])	0.024 [a]	0.0318	0.081
Efficiency	FWE/GFR	(0.032 [a])	(0.011 [a])	0.010 [a]	(-0.146 [b])	(0.007 [a])	(-0.0015)	0.088
Sustainability	*EFS/farm ($)	(-18,844[b])	(-1,829[b])	(-12,403[b])	(102,253[a])	(2,903[b])	(5,638)	0.029
	NFPBT/farm ($)	(-11,022[b])	(-4,571[b])	(-7,340[b])	(77,463[a])	(-1,403[b])	(2,956)	0.089

Note: * Variation not homogeneous. Again the variation is dominated by the larger figures for two farms (Group 4) which make the analysis of differences not as tight as it would otherwise be.

Table 4.41: Characteristics of the groups from cluster analysis of averages of core variables, in terms of variation of core variables (without cropping)

Variation (s.d.)	Variable	Group 1 (n=4) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=8) High soil resource, consistent and sustainable	Average	P- value
Intensification	EFS/ha ($)	193	130	(128)	(240 [a])	112 [b]	145.5	0.155
	*NFPBT/ha ($)	145 [b]	155 [b]	(137 [b])	(482 [a])	121 [b]	169.7	0.009
	*Carcase weight/ha	61 [a]	29 [b]	(71 [a])	(40)	44	46.0	0.092
Capital	Equity %	9 [b]	3 [b]	(5 [b])	(18 [a])	7 [b]	7.2	0.003
	N %	0.057 [(a)]	0.027 [b]	0.048	(0.030 [b])	0.066 [a]	0.0498	0.042
Efficiency	FWE/GFR	0.227 [a]	0.182	(0.083)	(0.244 [a])	0.092 [b]	0.1526	0.038
	EFS/su ($)	13.80 [bc]	18.92 [b]	(11.39 [bc])	(37.20 [a])	10.50 [c]	15.76	0.002
	*NFPBT/su ($)	14.76 [b]	20.43 [b]	(14.18 [b])	(98.17 [a])	12.16 [b]	23.01	0.009
	Lambing %	8	13 [a]	(8)	(9)	8 [b]	9.2	0.273
Sustainability	*EFS/farm ($)	73,086 [b]	(41,155 [b])	(72,699 [b])	(157,326 [a])	45,797 [b]	63,169	0.017
	NFPBT/farm ($)	62,420 [b]	43,269 [b]	(77,724 [(b)])	(145,399 [a])	51,962 [b]	63,236	0.022

Note: * Variance not homogeneous.

Table 4.42: Characteristics of groups formed from averages in terms of financial expenses (without cropping)

$	Variable	Group 1 (n=4) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=8) High soil resource, consistent and sustainable	Average	P-value
Income GFR/ha	Annual change	(-2 ^{b})	(-23 ^{b})	(-23 ^{b})	(192 ^{a})	(-25 ^{b})	(1)	0.000
	*Variation (s.d.)	104 ^{b}	169 ^{b}	(129 ^{b})	(643 ^{a})	132 ^{b}	184	0.013
GFR/farm	Average	308,563^{bc}	198,068^{c}	(508,257^{a})	484,762^{ab}	329,871^{b}	326,172	0.010
	*Annual change	(-5,113 ^{b})	(-8,673^{b})	(-13,212 ^{b})	(86,090 ^{a})	(1,450 ^{b})	(4,454)	0.012
	Variation (s.d.)	53,039 ^{b}	47,325 ^{b}	(72,857 ^{b})	(146,323 ^{a})	48,379 ^{b}	60,675	0.019
Expenses FWE/ha	*Annual change	(25)	(-4^{b})	(2 $^{(b)}$)	(89 ^{a})	(-6 ^{b})	(10)	0.129
	*Variation (s.d.)	109 ^{b}	60 ^{b}	(55 ^{b})	(511 ^{a})	63 ^{b}	113	0.057
FWE/farm	Average	263,717^{a}	131,115^{b}	(251,860)	(288,674$^{(a)}$)	184,439	203,192	0.171
Stock expenses	*Average	56.90^{a}	13.40 ^{c}	15.21 ^{bc}	(37.46 ^{ab})	28.04 ^{bc}	29.73	0.001
	*Annual change	(-0.87 ^{b})	(-0.84 ^{b})	(-0.23)	(5.50 ^{a})	(-2.61 ^{b})	(-0.86)	0.112
	*Variation (s.d.)	9.21 ^{b}	(5.55 ^{b})	3.90 ^{b}	(36.60 ^{a})	10.62 ^{b}	10.98	0.172
Cash cropping	*Average	0.00 ^{b}	(5.41 ^{b})	(34.01 ^{a})	(3.10 ^{b})	(1.57 ^{b})	(5.42)	0.071
	*Annual change	0.00 ^{b}	(-0.46 ^{b})	(5.48 ^{a})	(3.12)	(0.91)	(1.05)	0.160
	*Variation (s.d.)	0.00 ^{b}	(2.37 ^{b})	(26.00 ^{a})	(3.12)	(1.36 ^{b})	(5.00)	0.186
Feed	*Variation (s.d.)	23.27 ^{b}	20.14 ^{b}	(27.07 ^{b})	(105.31 ^{a})	22.24 ^{b}	30.31	0.097
Pasture	*Average	96.59 ^{a}	44.62 ^{c}	42.19 ^{bc}	(58.72)	80.88 ^{ab}	69.44	0.029
	Annual change	(1.69 ^{b})	(-4.57 ^{b})	-3.16 ^{b}	(16.27 ^{a})	(-0.66 ^{b})	(0.23)	0.058
Repairs and Maintenance	*Annual change	(1.56)	(-1.13 ^{b})	(1.06)	(16.26 ^{a})	(-3.67 ^{b})	(0.28)	0.127
	*Variation (s.d.)	23.26 ^{b}	20.07 ^{b}	(9.09 ^{b})	(82.72 ^{a})	20.33 ^{b}	25.70	0.138

C & NC labour	*Variation (s.d.)	62.91[b]	58.38[b]	(22.11[b])	(230.14[a])	52.96[b]	70.08	0.081
C & NC feed	Annual change	(15.88[a])	(3.69)	(-2.70)	(-14.59[b])	(-2.66[b])	(1.24)	0.032
Fertiliser	Average	94.31[a]	42.22[b]	(52.26)	(77.93)	73.26	68.32	0.291
	*Annual change	(1.18[b])	(-5.56[b])	(-3.81[b])	(22.87[a])	(-1.92[b])	(-0.02)	0.071
	*Variation (s.d.)	24.30[b]	26.20[b]	(27.40)	(115.31[a])	30.49[b]	36.07	0.156
Weeds & Pests	Variation (s.d.)	7.94	0.88[b]	(6.95)	(12.31[a])	5.46	5.64	0.160

Note: * Non-homogeneous variance (probably because of group 2's larger variation) and so again, the significance of the differences could be reduced.

Table 4.43: Characteristics of groups formed from averages in terms of bird density (measurements over three years: 2004-5, 2007-8, 2009-2010)

[55]Density of:	Variable	Group 1 (n=4) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=8) High soil resource, consistent and sustainable	Average	P-value
Native spp.	*Average	(2.27[a])	(1.48)	(0.54)	(0.70)	0.89[b]	1.239	0.209
Native – insectivorous spp.	*Average	(1.82[a])	(0.06[b])	(0.17[b])	(0.09[b])	(0.42[b])	0.546	0.059
	*Annual change	(0.116[a])	(-0.003)	(-0.021)	(-0.033)	(-0.114[b])	(-0.0274)	0.175
	*Variation (s.d.)	(1.55[a])	(0.04[b])	(0.06[b])	(0.10[b])	(0.35[b])	0.450	0.046
Introduced - insectivorous spp.	Average	2.57[a]	1.53	0.85[b]	(0.148)	(1.35[b])	1.592	0.091

Note: * Variance not homogeneous.

[55] See MacLeod et al. (in press) for a full description of the research from which this data is taken.

Table 4.44: Characteristics of groups formed from averages in terms of fertiliser applied and additional soil measurements

	Variable	Group 1 (n=4) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=8) High soil resource, consistent and sustainable	Average	P- value
Ca tons/farm	Average	16 ^{b}	(15 ^{b})	18	(44)	52 ^{a}	32.5	0.125
	Annual change	(2.3 $^{(b)}$)	(0.3 ^{b})	(-4.8 ^{b})	(11.6 ^{a})	(-1.0 ^{b})	(0.74)	0.044
	Variation (s.d.)	19.0 $^{(b)}$	(14.4 ^{b})	(14.0 $^{(a)}$)	(38.0)	47.1 ^{a}	29.92	0.136
Ca kg/ha	*Average	47.2 ^{b}	(46.2 ^{b})	33.4 ^{b}	(52.0 $^{(b)}$)	103.0 ^{a}	67.36	0.046
	*Variation (s.d.)	64.8	(40.3 ^{b})	(24.9 ^{b})	(31.7 $^{(b)}$)	98.8 ^{a}	64.94	0.083
K tons/farm	*Average	(1.08 ^{a})	(0.47)	(0.43)	(0.17 $^{(b)}$)	(0.19 ^{b})	0.447	0.151
N tons/farm	*Average	(4.9 ^{a})	(0.0 ^{b})	(2.2)	2.4[56]	(0.8 ^{b})	1.67	0.028
	*Annual change	(-0.5 ^{b})	(0.0 ^{a})	(-0.3)	(-0.7 ^{b})	(-0.1 ^{a})	-0.24	0.066
	*Variation (s.d.)	(3.3 ^{a})	(0.0 ^{b})	(1.4)	2.7 ^{a}	(0.6 ^{b})	1.24	0.013
N kg/ha	*Average	10.3 ^{a}	(0.0 ^{b})	(4.3 $^{(b)}$)	(5.8)	(1.8 ^{b})	3.61	0.005
	*Annual change	(-1.7 ^{b})	(0.0 ^{a})	(-0.5 ^{a})	(-2.8 ^{b})	(-0.4 ^{a})	-0.79	0.017
	*Variation (s.d.)	7.6 ^{a}	(0.0 ^{b})	(2.6 ^{b})	9.4 ^{a}	(1.8 ^{b})	3.26	0.000
N kg/su	*Average	1.07 ^{a}	(0.00 ^{b})	(0.70)	(0.51)	(0.18 ^{b})	0.390	0.009
	*Annual change	(-0.03 ^{a})	(0.00 ^{a})	(0.03 ^{a})	(-0.24 ^{b})	(-0.02 ^{a})	(-0.032)	0.028
	*Variation (s.d.)	0.72 ^{a}	(0.00 ^{b})	(0.53 ^{a})	(0.75 ^{a})	0.14 ^{b}	0.313	0.001
P tons/farm	Variation (s.d.)	4.5 ^{a}	1.3 ^{b}	(5.5 ^{a})	(4.4 $^{(a)}$)	3.7 ^{a}	3.51	0.080
P kg/ha	Average	18.1 ^{a}	3.1 ^{b}	(15.3 ^{a})	11.6	11.2 $^{(a)}$	11.03	0.053
P kg/su	Average	(2.3 ^{a})	0.4 ^{b}	(2.1 $^{(a)}$)	1.2	1.2 $^{(b)}$	1.30	0.100
	*Variation (s.d.)	(2.7 ^{a})	0.5 ^{b}	(1.2)	(0.8)	1.0 $^{(b)}$	1.20	0.316
S tons/farm	Average	6.9	0.3 ^{b}	(4.9)	(11.6 ^{a})	6.9 $^{(a)}$	5.61	0.188
	Annual change	(-0.2 $^{(b)}$)	(0.0 $^{(b)}$)	(-0.3 $^{(b)}$)	(1.6 ^{a})	(-0.7 ^{b})	(-0.18)	0.151
	*Variation (s.d.)	4.6 ^{b}	(0.4 ^{c})	(2.8 ^{b})	(10.1 ^{a})	4.9 ^{b}	4.06	0.001
S kg/ha	Average	16.9 ^{a}	(0.9 ^{b})	(9.5)	(15.4 $^{(a)}$)	15.4 ^{a}	11.68	0.087
S kg/su	*Average	(2.3 ^{a})	(0.1 ^{b})	(1.5)	(1.8)	1.7 $^{(a)}$	1.40	0.226
Soils	C% average	5.7 ^{a}	4.2 ^{c}	(4.1)	(3.9 ^{bc})	5.4 ^{ab}	4.9	0.052
	AMN/N Annual change	-2.32	-2.42	(-2.70)	(-0.92 ^{a})	-3.32 ^{b}	-2.63	0.214

Note: * Variance not homogeneous.

[56] For once these two farms agree. They apply similar amounts of N per farm and their variation over the years is significant.

Table 4.45: Characteristics of groups formed from averages in terms of other farm management variables

	Variable	Group 1 (n=4) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=8) High soil resource, consistent and sustainable	Average	P-value
*Total DM used[57] tonnes/farm	Average	(52 b)	(214a)	191	(240(a))	521 b	121.6	0.069
*Total wet matter used tonnes/farm	Average	(105(b))	(558a)	(439)	(538)	127b	294.4	0.167
Total supplements not used[58] tonnes/farm	Average	(142 b)	(131b)	(366a)	(218)	74 b	141.8	0.012
SU/ha	Average	10.6	8.0 b	8.0	(9.5)	11.5 a	9.99	0.237
	Variation (s.d.)	(1.9 b)	1.1 b	(0.9 b)	(5.4 a)	1.1 b	1.63	0.002
*Scanning %	Average	142 (b)	139 (b)	Don't scan	Don't scan	161 (a)	149.8	0.077

* Variance not homogeneous.

[57] Over 3 seasons – 2007/8, 2008/9 and 2009/10.
[58] Over 6 seasons 2004/5 to 2009/10.

Table 4.46: Characteristics of groups formed from averages in terms of attitude variables (from 2008 survey)[59]

	Variable	Group 1 (n=3) Inefficient	Group 2 (n=5) Organic – low input	Group 3 (n=2) Efficient & profitable	Group 4 (n=2) Going thru' change	Group 5 (n=7) High soil resource, consistent and sustainable	Average	P-value
Importance of financial indicators	B1c: Change in bank balance	5.3[a]	4.8 (a)	3.0 b	5.5 (a)	4.7 (a)	4.74	0.256
	B1d: Actual vs budget income	5.0 (a)	4.2	1.5 b	6.0 a	4.6 (a)	4.57	0.288
	B1e*:Cash surplus/deficit	6.7 a	6.2 a	3.5 b	6.5 a	5.7 (a)	5.84	0.153
	B1h: Ratio working expenses to income	7.0 a	5.4 b	6.0	5.5	5.9	5.89	0.267
Importance of production indicators	B2a: Health stock/plants	7.0 a [60]	7.0 a	7.0 a	6.5 b	7.0 a	6.95	0.049
	B2d: Minimum weeds	6.3 a	5.8 ab	4.5 c	5.0 bc	6.0 ab	5.74	0.040
	B2g*: good mixture productive uses	6.7 a	5.6 (a)	6.0 (a)	4.0 b	5.6 (a)	5.63	0.112
	B2i: Reducing carbon emissions	2.3 b	5.0 a	3.5	4.0	3.7	3.84	0.231
Importance of environmental indicators	B3b*: Soil biological activity	6.3 (a)	6.8 a	5.5 b	-	6.7 a	6.53	0.042
	B3h*: No. native plant/tree spp.	4.3 b	5.8 a	5.0	-	4.6 b	4.94	0.048
	B3i: No. plant/tree spp.	5.3	6.0 a	5.5	-	4.6 b	5.24	0.109
	B3j*: Water quality in streams ...	6.7 a	6.6 a	4.0 b	5.5	6.4 a	6.16	0.154
	B3k*: Presence of prod. & non-prod. spp.	5.0 (b)	6.2 a	4.0 c	4.5 bc	5.6 ab	5.37	0.031
	B3n*: Pesticide use	5.0 a	1.0 c	2.5 (b)	3.5 (b)	3.8 b	3.27	0.039
Importance of social indicators	B4n: Scope for farm succession	5.7	4.4 b	6.0	6.5 (a)	6.3 a	5.68	0.183
Consideration/ implementation of approaches to management	C1a: Adopt proven practices ...	6.3 a	3.6 b	4.5 b	4.5 b	4.4 b	4.53	0.013
	C1c*: Pay close attention to ... good financial returns ...	7.0 a	5.2 b	4.5 b	6.5	5.4 (b)	5.43	0.124
Importance of farming factors	F1a: Customer requirements	6.0	6.4 a	5.0 b	6.0	6.7 a	6.26	0.142
	F1g*: Future generations/succession	5.3 bc	6.8 a	5.0 c	6.5 ab	6.9 a	6.37	0.011
Agreement with statements	G1c*: Farmers being asked to assume	7.0 a	6.2 a	3.5 b	6.5 (a)	5.6	5.84	0.168

[59] For full report see Fairweather et al. (2009). Note that not all farmers filled in the survey therefore two of the groups are a little smaller than the original ones.
[60] Note: a value of 7 is the maximum possible score so it implies that in this group there is no variation so the test is simply whether the Group 4 values are significantly different from 7.

about emissions trading	more than their fair share ...							
Agreement with bird diversity & farm management	H1Ab: Native birds help farm cope ...	1.3 [b]	3.6 [a]	3.5 [(a)]	4.0 [a]	3.0 [(a)]	3.05	0.100
	H1Ad*: Not responsibility to encourage native birds	4.3 [a]	1.2 [b]	2.0	3.5	3.3 [a]	2.78	0.096
	H1Ae: Interested in native bird tick mkt accreditation	1.0 [b] [61]	4.8 [a]	3.0	6.0 [a]	4.2 [(a)]	4.00	0.118
	H1Bb: Introduced birds help farms cope ...	1.3 [b]	3.6 [a]	3.5 [(a)]	4.0 [a]	3.3 [a]	3.16	0.171
	H1Bd*: Not responsibility to encourage introduced birds	4.3 [a]	1.2 [b]	3.0	3.5 [(a)]	3.6 [a]	3.00	0.052
	H1Be: Interested in bird tick mkt accreditation	1.0 [b]	4.8 [a]	3.0	6.0 [a]	3.7 [(a)]	3.82	0.097
Importance of planting native trees/shrubs on farm to:	I1Aab: Increase native bird diversity & abundance	4.0	5.0 [a]	1.5 [b]	5.0 [(a)]	4.4 [a]	4.79	0.207
	I1Ac*: Increase insect diversity & abundance	4.0	4.8 [a]	1.5 [b]	5.0 [(a)]	3.9	4.00	0.300
Importance of planting exotic trees/shrubs on farm to:	I1Ba: Generate carbon credits	3.0	3.8	1.5 [b]	2.0 [(b)]	4.4 [a]	3.50	0.207
	I1Bb*: To increase native bird diversity & abundance	4.0	5.0 [a]	1.5 [b]	5.0 [(a)]	4.0	4.11	0.305
Background information	J8*: How many years ... associated with current farm?	26	17 [b]	48 [a]	34	32	28.9	0.187
	J9*: How many years farming?	32	19 [b]	48 [a]	26 [(b)]	29 [b]	27.4	0.072

Note: *Variances not homogeneous

[61] 1 is the lowest score so this means that a group with an average of one has no variation and so the statistical test becomes a test of whether the means of the other groups are different from 1.