ARGOS

AGRICULTURE RESEARCH GROUP ON SUSTAINABILITY

ARGOS Research Report: Number 07/02

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

Understanding sheep/beef farm management using causal mapping: development and application of a two-stage approach

John Fairweather[2], Lesley Hunt[2],
Chris Rosin[3], Hugh Campbell[3] and Dave Lucock[1]

June, 2007

1. The AgriBusinessGroup
PO Box 4354
Christchurch
www.argos.org.nz

2. Lincoln University
PO Box 84
Lincoln, Canterbury
www.argos.org.nz

3. The University of Otago
PO Box 56
Dunedin
www.argos.org.nz

Contents

List of Tables

List of Figures

Summary

The Agriculture Research Group On Sustainability (ARGOS) is investigating the social, environmental and economic consequences of different management systems in different farming sectors in New Zealand (for more information visit www.argos.org.nz). The sectors being studied include kiwifruit, sheep/beef and dairy, and the systems being studied include conventional, integrated and organic management. Twelve farms under each system are being studied.

As part of the ARGOS social objective, causal mapping was used to document how the participating sheep/beef farmers described and explained the factors involved in their farming systems, broadly defined to include economic, social and environmental factors. Participants identified which factors in the 41 provided were important to the management and performance of their farms and to link these on a map.

All farmers first completed a Q sort of 41 factors to identify the more important ones, then used these to create a map showing the important factors and the causal links between them. The strength of these linkages was also recorded on a 1 – 10 scale with one being weak and ten being strong. Centrality scores indicated the importance of each factor. An overall or group map was produced by taking an average across the individual farm maps and this map characterised the overall farm system. A similar process was used for each of the three management systems being studied, as well as other four other groups of farmers identified from Q-sort analysis.

The overall group map shows that at the core of the map are personal (farmer decision maker and satisfaction) and production factors surrounded by soil, environmental, climatic, family and cost factors. True to the family farm structure of much of New Zealand farming, the map shows the closely integrated role of family in the farming system. And the map is not insular since there are connections extending outwards including other people and related factors especially the marketing or processing organisation along with customers, advisors and sources of information. There is a strong production orientation in the map with some of the strongest connections from farmer decision maker to fertiliser and soil fertility health and to production. However, the environment is also important, reflected in farm environmental health and farm environment as a place to live. The sources of satisfaction (production, farmer decision maker, farm environment as a place to live and family needs) are quite varied and reflect the broad mix of factors at the core of the map.

Farmers create ways through the complexity of farming by developing a strategy or approach that makes sense to them and appears to meet their needs. These different strategies mean that there are distinctive ways that farmers combine and relate factors despite having some core similarities. The results of this research for the panels and the Q-sort types illustrate these different strategies.

The main characteristics of the maps are as follows:

Conventional panel

- There is a very close match between the conventional panel and the overall average.
- Conventional farmers emphasised customer requirements, marketing and processing organisation, and weed and pest management.
- Conventional farmers gave less emphasis to farm environmental health.

- The key theme of the conventional panel is lower emphasis on farm environmental health while weed and pest management, customers and marketing are of greater importance to conventional farmers.

Integrated panel

- Integrated farmers emphasised advisors, farm working expenses and production.
- Integrated farmers had the highest number of low centrality scores including: customer requirements, farm environmental health, fertiliser and soil fertility health, marketing or processing organisation and off-farm product quality.
- The key theme of the integrated panel is an on-farm focus on high quality and quantity of production, managing expenses, meeting family needs and gaining satisfaction.

Organic panel

- Organic farmers emphasised customer requirements, off-farm product quality, farm environmental health, and fertiliser and soil fertility health.
- Organic farmers gave less emphasis to advisors/consultants, farm working expenses, production, and weed and pest management.
- The stronger links involving fertiliser and soil fertility health, farm environmental health and farmer decision maker all show the priority that farmers in the organic panel gave to the health of their farms.
- The key theme of the organic panel map is farm health to achieve off-farm product quality with lower farm working expenses.

The analysis of panel data shows some important differences among the farmers but this approach is not the only way to analyse the data. Q-sort data provides four groups, as follows. (They are presented in order from the smallest to the largest in terms of number of farmers who define the type.)

Q-sort type 2 – Off-farm work (N = 4, 1 organic, 2 integrated and 1 conventional)

- Q-sort type 2 has an off-farm work orientation where the work is related to improving the financial position of the farm.
- Q-sort type 2 gave less emphasis to environment, weather and climate, and satisfaction.
- These farmers are trying to build up their farm financial situation notably by improving their equity.
- They have a map with fewer connections suggesting that their view of farming is less complex compared with other types.
- The key theme of Q-sort type 2 is lower emphasis on environment, production, farmer decision maker and family, and higher emphasis on farm profits to increase equity facilitated by a greater role played by labour and advisors. Customer requirements are unimportant to this type.

Q-sort type 3 – External orientation (N = 5, 2 organic, 1 integrated and 2 conventional)

- Particularly important to Q-sort type 3 are off-farm activities, contractors, fertiliser and soil fertility health, and marketing or processing organisation.
- This type sees markets and customers as paramount and this is paralleled by the importance given to off-farm work and off-farm activities.
- Labour has a strong influence on production. This type of farmer delegates farm work to labour and contractors while they meet off-farm work commitments.
- The key theme of Q-sort type 3 is an external orientation focused on markets, customers, off-farm activities, delegation of work to labour and contractors, and maintaining fertiliser and soil fertility health.

Q-sort type 1 – Conventional, external influences (N = 8, 1 organic, 3 integrated and 4 conventional)

- Q-sort type 1 does not emphasise the farm environment as much as other types and sees the weather and climate, and exchange rate/macro economy, as having a greater influence.
- Results show that Q-sort type 1 has only some subtle differences from the overall average and these farmers believe that that some external factors, over which they have little control, have a greater impact on their farm system.
- Like Q-sort type 2 they have a map with fewer connections suggesting that their view of farming is less complex compared with other types.
- The key theme for Q-sort type 1 is the lack of emphasis on the farm environment and the importance given to three external factors – the weather and the exchange rate/macro-economy.

Q-sort type 4 – Ecological (N = 10, 6 organic, 2 integrated and 2 conventional)

- Q-sort type 4 emphasises farm environmental health, farm environment as a place to live, customer requirements, fertiliser and soil fertility health, satisfaction, and weather and climate. Off-farm product quality is an additional factor on the map.
- Farm environmental health, fertiliser and soil fertility health, family needs and production all have stronger connections to farmer decision maker.
- Farm environmental health is linked strongly to production, and fertiliser and soil fertility health has a strong effect on farm environmental health.
- The link from production to income has less emphasis but financial factors are still very important.
- Q-sort type 4 gets greater satisfaction from meeting family needs, farm environment as a place to live and farm environmental health.
- The key theme of Q-sort type 4 is the importance given to the farm environment, fertiliser and soil fertility health, satisfaction and future generations/succession.

Combined Q-sorts

- Type B (comprising Q-sort types 3 and 4) compared to Type A (comprising Q-sort types 1 and 2) emphasise: an off-farm theme of customer requirements, customer satisfaction and off-farm product quality, a social theme reflected in family needs, future generations/succession and satisfaction, and an environmental theme represented by farm environment as a place to live, farm environmental health and stream health.
- Type B farmers have significantly more connections on their maps and significantly more connections per variable.

Results are discussed to show:

- Differences in sheep/beef farming compared to kiwifruit orcharding.
- Evidence for, and of the nature of, family farming.
- The apparent importance of environmental factors in the causal maps.
- That the combination of Q-sort type 3 and Q-sort type 4 (type B), as opposed to the combination of Q-sort type 1 and Q-sort type 2 (type A), exhibits an eco-cultural approach to farming.
- Sheep/beef farmers exhibit different levels of complexity in their maps: those with complex maps show a holistic approach to farming.
- The possibility that Q-sort types 3 and 4, and Type B (by having more connections) may have different numbers and types of links in their social network.
- That the results are a partial match to earlier research on farmer types.

Acknowledgements

This work was funded by the Foundation for Research, Science and Technology (Contract Number AGRB0301).

Professor Simon Swaffield, Lincoln University, suggested using Q-sort methodology in combination with causal mapping. Associate Professor Henrik Moller, CSAFE, University of Otago, assisted with analysis of the data by suggesting the use of Principal Components Analysis of the variables. Peter Hayes, AERU researcher, suggested a useful reference on factor analysis.

Chapter 1
Introduction: Background and Research Objectives

1.1 Background

The social research objective of the Agriculture Research Group on Sustainability (ARGOS) research programme has already documented important information about farmers and orchardists. For kiwifruit and sheep/beef respectively, Hunt et al. (2005) and Hunt et al. (2006) have summarised the discussion of several topics from interviews with ARGOS participants, including: participants' visions for themselves and their farm or orchard and the constraints to those visions; indicators (as identified by participants) of productivity as well as the financial and environmental wellbeing of farms or orchards; the farm's or orchards' affect on individual, family and community wellbeing; and the factors that ARGOS participants felt they were managing well and those that were difficult. Finally, the reports examine the expectations of farmers and orchardists as a result of their participation in the ARGOS programme. An important finding was that management types shared a large set of core characteristics with bulges toward defining characteristics for each of the management systems. In addition, Read et al. (2005) reported on the analysis of farm sketch maps participants drew in the first interview in order to illustrate the important factors in the management of their farms or orchards. This analysis showed that the design and content of the maps were influenced by the region and landscape in which the farms and orchards are located as well as showing the importance of boundaries, neighbours, organisation of the farm and the orchard, and the mitigation of risk.

These reports from the first interview give a detailed account of many aspects of ARGOS participants' situation, including how they managed their farm or orchard. However, management was one topic among many and the understanding developed, while detailed, was not systematic. Accordingly, a study of kiwifruit management was completed in 2006 (Fairweather et al., 2006) using causal mapping to show factors important in kiwifruit orcharding and how orchardists think about and manage their orchards. The present report covers similar research on sheep/beef farmers.

The 2006 kiwifruit report set out in detail the method and results of the study. It gave a full account of the literature on cognitive mapping relevant to farming, introduced fuzzy cognitive mapping, provided an evaluation of it and described how the mapping method was tested and developed. Considerable effort was put into documenting the results, first for all 36 orchardists, then for each of the three panels. Since the report provides full information about the causal map method, it is not necessary to repeat the information again in this report. Here, emphasis will be given to presentation of the sheep/beef results and their analysis, plus attending to a discussion of their implications. Note, however, that the method used was changed in some important ways in the light of our earlier experience.

The main change in the method was to allow farmers to construct their own causal map from factors written on small cards. This was done to strengthen our claim that the map is a construct of the farmers. The causal map method developed for the kiwifruit research employed a generic map that had the factors in a fixed position but allowed orchardists to draw arrows showing causal connections. Causal mapping can be improved by allowing farmers to create their own map by selecting and moving factors around and then connecting them up. However, there needs to be some initial sorting process to prioritise the factors so that farmers can focus on mapping the important factors in their farming system. Q method was used as a precursor to the mapping since it allows for subjects to prioritise items. It also allows for exploration of the other groupings of farmers.

1.2 Research Objectives

The primary research objective was to document how farmers participating in our ARGOS research describe and explain the management of their farm system broadly defined. The research aimed to develop a full account of such perceptions by identifying the factors that comprise their farm system and by showing how the factors are linked. Accordingly, it allows us to examine the degree and depth of 'systems thinking' by farmers when managing their farms. It does this by employing a modified cognitive mapping method in which farmers portrayed their view of their farm system in the form of a map. The main modifications in the method were to allow for creation of the causal map and to precede the mapping with Q-sorting of factors. A second research objective was to assess the results for any patterns in the way farm systems are seen and understood. Specifically, we shall test the ARGOS null hypothesis that there is no difference in the perceptions of management across the three different management systems under study (conventional, integrated and organic). Meeting this objective also entails consideration of the ways that the panels may be similar. In addition, we shall see if there are other groupings of farmers and test if there are differences in perceptions that flow from these differences. The third objective was to contribute towards some specific social objective aims, namely to identify sites of action for farmers, that is, places where action to achieve sustainability may occur, and perceived constraints on that action. We expect that the different factors involved in management and the linkages between them can contribute to this research objective. A final objective was to contribute to modelling the environmental systems in which farmers operate. By developing farmer-based models this component of the social research can make an important contribution to modelling of interest to ARGOS ecologists and economists, thereby contributing to our transdisciplinary aims.

1.3 Outline of report

In Chapter 2, the causal mapping method is described and attention is given to the refinements in its application in this study. In Chapter 3, the results of the ARGOS study are presented followed by Chapter 4 which includes a summary of the results and provides discussion and interpretation.

Chapter 2
Method: a Refined Two-stage Approach to Causal Mapping

2.1 Introduction

This chapter describes the approach to the research including the modifications to the list of factors used in the interview, an outline of Q methodology, the pre-testing, and the interview procedure. The method used a two-stage approach which uses the Q-sort method as a precursor to the causal mapping. It also describes the different analyses deriving from each part of the methods used. By way of clarifying our terminology, we note that our use of causal mapping involves factors that farmers identify and link to show causal connection in the formation of their causal maps and that Q methodology also uses the same term but with different meanings[1].

2.2 Modifications to the list of factors

The 36 factors used in the kiwifruit study were the starting point for the factors used in the present research. (These factors were derived from 14 open-ended interviews with a variety of farmers near Lincoln University.) There is a trade-off between number of factors and efficiency of research design: more factors would increase the chance that each farmer would have all the key factors they would need but additional factors would make the sorting task more difficult. Accordingly, some attention was given to the number of factors used but with a concern not to significantly increase the total number.

Initial modifications to the list included changing the word orchard to farm, and the three financial factors were changed to reflect the use of these accounting concepts as they are more typically used by sheep/beef farmers. These changes are shown in the list of factors in Table 1 which shows the kiwifruit factors next to the sheep/beef factors. Bolding is used to highlight the changes.

Some new factors were tried out. From discussions with ZESPRI staff during presentation of the causal map results it was clear that customer satisfaction was an important factor and one that was not well represented by customer requirements, so this was added to the list. Some additional environmental factors were needed in order to increase their number since these factors were numerically small compared to economic and social factors. To this end the following were added after suggestions from a key member of the ARGOS environment team: increasing plant and animal biodiversity, water supply and quality, and stream health. The first pre-test showed that we needed to include stocking rates. Some new factors derived from the farmer goals literature were tried out but discarded because they afforded few benefits but added to the total number of factors.

---

[1] The causal mapping factors are more correctly known as variables since they have varying levels of importance in a causal map. We continue to use the term 'factors' since this was how the components of the maps were thought of by participants and was the word used with the participants. The approach used here also includes Q-sort data and analysis. Q-sorting usually refers to items that are sorted and Q methodology focuses on factors that are created by the factor analysis, where a factor is a group of subjects who sort items in a similar way. Since our earlier study used the term 'factor' and this is what we talked to farmers about it seems reasonable to persist with this use of the term. To distinguish these factors from those usually referred to in the Q method, we will refer to the latter as Q-sort types.

Table 1: List of factors used in the kiwifruit study and the present study

Kiwifruit	Sheep/beef
Farmer or grower decision maker	**Farmer decision maker**
Quality and quantity of plants and/or livestock	Quality and quantity of plants and/or livestock
Orchard gate returns	**Cash farm income**
Marketing organization (ZESPRI)	**Marketing/processing organization-produce buyers**
Production expenditure	**Farm working expenses**
Contractors and packhouse	**Contractors**
Cash orchard surplus	**Net profit before tax**
Satisfaction	Satisfaction
Fertiliser and soil fertility	Fertiliser and soil fertility/health
Weed and pest management	Weed and pest management
Labour	Labour
Farm/orchard environmental health	**Farm environmental health**
Post harvest quality	**Off-farm product quality**
Regulation	Regulations
Time in farm work	Time in farm work
Weather/climate	Weather/climate
Farm/orchard environment as place to live	Farm environment as place to live
Improve equity/land size	Improve equity/land size
Plant and machinery	Plant and machinery
This location	This location
Advisors, consultants etc.	Advisors, consultants etc.
Soil type/topography	Soil type/topography
Customer requirements	Customer requirements
Exchange rate, macro economy	Exchange rate, macro economy
Family needs	Family needs
Government policies	Government policies
Information	Information
Off-farm activities	Off-farm activities
Neighbours	Neighbours
Grower groups or orgs	**Farmer groups or organisations**
Off-farm work	Off-farm work
Retirement	Retirement
Future generations	Future generations/succession
Community	Community
Smallholding/subdivision	Smallholding/subdivision
Family history and background	Family history and background
	Customer satisfaction
	Increasing plant and animal biodiversity
	Stocking rates
	Water supply and quality
	Stream health

2.3 Outline of Q methodology

Q-sort methodology, established by William Stephenson in the 1950s (Stephenson, 1953), is a well-established but not mainstream approach to documenting human subjectivity (Stephenson, 1953; Brown, 1980; McKeown and Thomas,1988; Fairweather, and Swaffield, 2000). Generally, it involves sorting items into a Q-sort array which is factor analysed to identify groups of subjects who sort the items in similar ways. In effect, this approach develops a typology across cases. It is unusual in that the analysis focuses on the subjects, not the variables, in the data matrix. The method had been applied in a wide range of disciplines and appears to have increasing popularity in recent years.

Q-sort methodology is well documented by Brown (1980), McKeown and Thomas (1988), and Addams and Proops (2000). New Zealand research using and documenting this method includes Fairweather (2002) and Fairweather and Swaffield (2000, 2002). Generally, Q method provides a quantitative means of documenting or exploring subjective viewpoints about a wide range of phenomena. There are three basic steps in Q method. First, items, usually statements but also photographs, are sorted into the Q-sort distribution in response to a condition of instruction such as: which ones do you most like? Second, the Q-sort data are factor analysed to find groupings of subjects who sort the items in similar ways. This step includes rotation of factors or spreading the variance across factors in order to achieve simple structure. Third, the resulting factor array that represents the group of subjects whose individual Q sorts define it is interpreted to explain why the items have that particular distribution.

Q method took its name from the need to show that it was different from the usual approaches which typically used correlations and Pearson's R. In comparing Q and R techniques, Gorsuch (1983) explains that while the factors from Q and R analyses could be translated one for the other, this applied only to the unrotated factors. Because the configuration of individuals will usually be different from the configuration of variables, the rotated factors need not be the same. Each will rotate to its own simple structure and the factor scores will no longer equal the factor loadings of the other analysis (Gorsuch, 1983: 315). Further, R technique will include information on mean differences between individuals that is excluded from Q technique by virtue of its ipsatised data, that is, each case having the same mean, median and range. Only the R technique has the possibility of finding a general factor. Therefore, if the research need is to find similarity among variables then R technique is indicated but if the research need is to develop a typology across cases then Q technique is indicated.

2.4 Pre-testing the new approach

During September, 2006, three interviews with farmers were conducted in order to test the new approach to causal mapping. The pre-testing showed that the new method worked well. Farmers were able to sort the factors into the Q-sort distribution and this took about 15 minutes. Taking the top-rated factors they then placed them on the A2 paper, moved them around in order to show how they might be related, connected related factors and assigned scores to each arrow. The maps were completed in about 65 minutes.

Pre-testing showed that it was useful to delay drawing in lines until the farmer developed some structuring and ordering of the initially selected factors. At a point chosen by the farmer, lines were drawn in and then more factors added. Only after the lines were drawn were the scores assigned. Each farmer was asked to peruse the remaining piles of sorted factors and to add in any that seemed important in their farming system.

Farmers appeared reluctant to place high importance on farmer decision maker. In the pre-tests it was in the third or fourth column from the right hand side of the Q-sort continuum. In the maps, however, this factor was linked by many lines and, as the analysis will show, had a high centrality score – a measure of its importance. The organic farmer participating in the pre test demonstrated the importance of environmental factors, soil health, quality, customers, and had many bi-directional arrows. In all three pre-tests, there were differences between the factors chosen as most important in the Q-sort compared to the factors that had most importance in the map. Among the top four factors in the Q-sort, there were two, four and three respectively that did not have highest importance as indicated by centrality. In other words, farmers rated some factors as very important in the Q-sort but in their causal map they were not so important. This suggests that the Q-sort data may not simply match the map data.

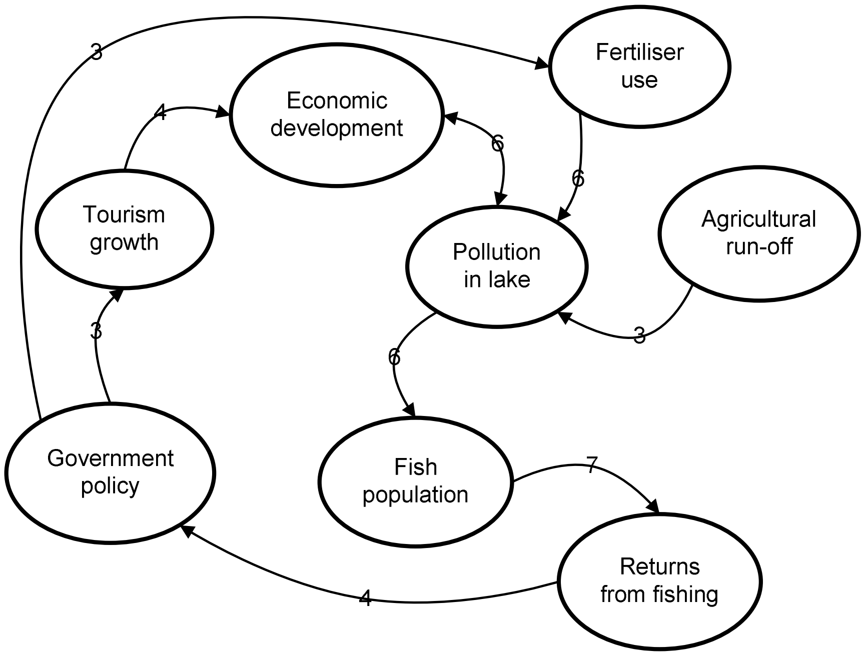
2.5 Interview procedure

Interviews were conducted from October to November 2006. The 34 sheep/beef farmers studied were those enrolled in the ARGOS research. Then farms were located in the South Island of New Zealand, extending from Marlborough in the north to Owaka in the south. They occupied a range of climates and topographies and thus include the full variety of such farms. Figure 1 shows the farm location map.

Figure 1: Location of the sheep/beef farms

All but two interviews occurred at the farm, most usually at the dining table. The ARGOS field manager, Dave Lucock, gave a brief introduction to the overall interview and then handed the interview over to John Fairweather to explain and facilitate the causal mapping. The introduction to causal mapping started with an illustration of a simplified causal map of the factors involved in pollution in a lake (see Figure 2). The example was used to point out that the key features of any causal map included the identification of factors, linkages between factors, and the assigning of numbers to the linkages to indicate the strength of the causal connection. It was also pointed out that some linkages were bi-directional, that is, there were some lines with arrows on each end.

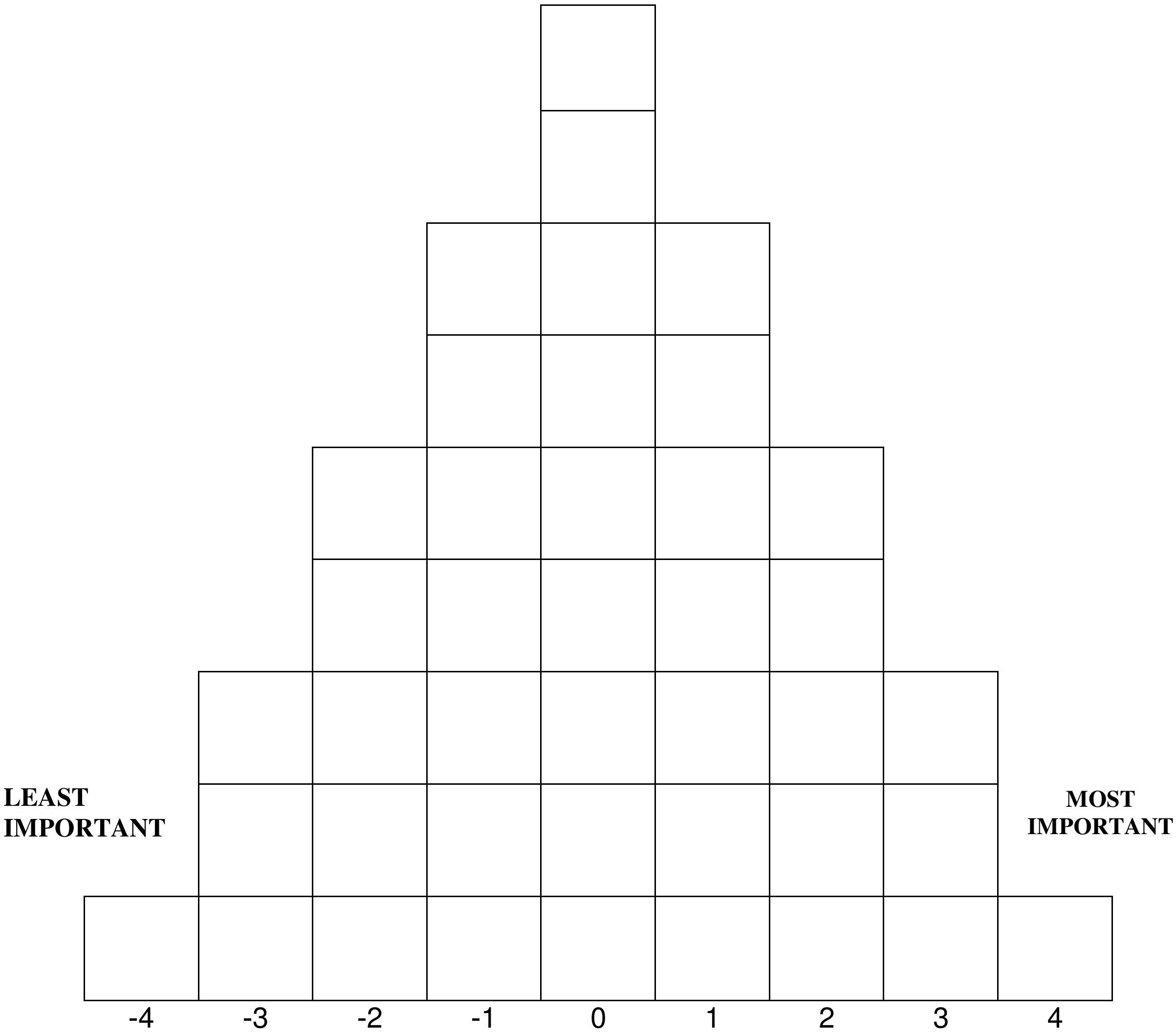
Figure 2: An example of a simple causal map



It was explained that the objective of the interview was for the farmer to prepare a causal map for the farming system, broadly defined. Emphasis was given to thinking about the farm in the broadest sense, (i.e., not just in terms of production), so that all factors should be included, whether social, economic or environmental. The aim was for each farmer to represent his/her farm accurately. To achieve the causal map for their farm, it was explained that there was a three-step process. The first step was to sort the set of 41 possible factors into three piles: one for the factors important in their farming system, one for the factors unimportant in their farming system and the remainder for the factors that were of some importance in their farming system. The second step was to then identify from the first pile of important factors the one that was the most important, then the three that were next on order of importance and so on to form the distribution shown in Figure 3. This part of the interview was in effect a Q-sort of the importance of factors in the farmer's system. The third step was to take some of the important factors and put them on to a blank piece of A2 paper and move them around in preparation for showing how they were connected.

Each farmer was told that there were no right or wrong answers with this process, and that causal mapping was a process designed to allow the farmers as experts to tell us about their farming system. They were also told that the interviewer was not a farm management expert but a sociologist interested in developing methods that allowed us to learn about farming.

Figure 3: The Q-sort distribution



Note: This figure includes the column score which generated the numbers used in the analysis but the scores were not included on the recording sheets.

The first step went smoothly with farmers either making three discrete piles of cards or by making an array of cards so that all were visible but in three groupings. Either way, they generally selected most factors as either very important or of some importance with a smaller number of factors as unimportant. The second step involved working with just the important factors and moving these cards around to put the ones that were more important on the right hand side and those that were less important on the left had side. They then selected the one factor that was most important from those on the right hand side and continued with the remaining important factors, thereby building up their Q-sort distribution of cards. The selected factors were placed in front of the farmer but above their working area. They were ordered in the same way as the distribution shown above. When the important factors were ordered the farmers were asked to consider the unimportant factors. When these were sorted, the farmers were asked to consider the remaining factors, the ones of some importance. As the farmers were Q-sorting the factors, the numbers were recorded on a copy of the distribution shown in Figure 3. They were invited to review their completed sort and make any adjustments that were necessary. With the sorted cards placed above the working area, there was space to introduce the sheet of A2 paper in preparation for the final step.

The third step was the core part of the interview and took most time. Farmers chose cards from the important piles, not necessarily starting with the most important factor. Once the farmer had about four factors on the paper they were given a pen and asked to show the causal connections between these factors. If there were two farmers they were each given a pen. Most farmers talked about their factors and this enabled us to understand what they meant when they made connections. Sometimes it was necessary to ask for more information about their lines to ensure that the line accurately represented what they were saying. For example, they might say that information leads to fertiliser and soil fertility. We asked if this was direct or through something else. Usually they would explain that they would respond to information and that it was them as decision makers that lay between these two factors. If the decision maker factor was not already on the paper the farmer selected it from the piles and included it in their map.

As the farmers talked about their factors the interviewer would reflect back what he was told and used the phrase "I hear you saying that A causes to B, is that right? If so, put the line(s) in". Careful observation of the emerging map was needed because farmers might say that A causes B but put the line in with the arrowhead indicating that B causes A. When this happened, and for some farmers it happened many times, we asked about the causal link by saying "So you are saying that B causes A?" In most cases they modified the line and reversed the direction, but in some cases they went on to explain further what they meant and this clarified the situation. In some of these cases, the farmer realised that there were causes going both ways in which case a double arrowhead was used.

The farmers continued to build up the causal map by adding in factors from the sorted piles. They were asked to continue as long as each factor was an important part of the emerging map of their farming system. Each new factor was considered for what it caused and, in turn, what caused it. Comments or explanations made by the farmers that illustrated something unusual about the linkages between factors were recorded on the data sheet.

The last part of the mapping was assigning numbers to each arrowhead. We explained that the main point with the numbering was to gain a general indication of the importance of the causal connection and to find out if the connection was of high, medium or low strength. After the first few interviews this scale was written on the paper along with numbers to give some options within each of the broad categories. The scale was as follows:

Low: 1, 2 or 3
Medium: 4, 5 or 6
High: 7, 8, 9 or 10.

When the map was finished to the satisfaction of the farmer, the interview was completed with some final questions. These are listed below:

1. Is either of quantity or quality more important to you?
2. What does farm environmental health mean? What does increasing biodiversity mean?
3. What are the important feedbacks to you as decision maker?
4. What are you trying to maximise? Minimise? Heart of your system?

5. To what degree can the system change? How resistant to change is it? What is the main driver of change?
6. What makes for a resilient farm (able to withstand shocks)? Which type of shock (environmental, economic or social) has most impact?
7. What are your main farming goals?
8. What is your level of inputs/ha compared to other farms of a similar type to you (above average, average, below average)?
9. Observe key features of completed map and discuss a summary statement, using double quote marks for the farmer's key summary.
10. Has this process been of any benefit to you? In what way?

Question 3 was designed to check if the farmers had considered the factors which needed to have arrows pointing back to decision maker. Most farmers had overlooked some of these feedback connections and this question led to a few more being added in.

Question 9 was introduced after the first interview and was a good way of getting to the key aspects of the map as the farmer saw it. The quote was written on the map using double quotation marks. If the farmer was unable to state a summary view we discussed the map and developed a summary from joint discussion. In these few cases single quotation marks were used. Question 2 was introduced after interview number 13 when it became apparent the meanings farmers ascribed to the environmental terms was not necessarily the same as others' use of the term.

2.6 Analysis of Q-sort data

The ordering of items in a Q-sort array shows which items are important or salient in some way and provides the quantitative data used for factor analysis. The columns in the Q-sort are routinely assigned numbers with zero for the middle column and, in this case, ranging from -4 for the left hand or unimportant column, to 4 in the right hand or very important column. This numbering is somewhat arbitrary and is deployed merely to provide numbers for the subsequent correlation between all Q-sorts. In this study we can take the scoring to mean a range from one to nine using a scale of positive numbers. In effect, the columns in the middle of the Q-sort, enumerated as zero or close to zero in the data analysis, can be taken to mean some importance since the farmers put most factors into the important and some importance piles at the beginning of their Q sort.

Factor analysis is applied not to variables but to subjects in order to find factors or groups of subjects who sort the items in a similar way. Q method analysis focuses on the emergent factors or types represented by an array of items based on the individual Q sorts of those subjects who load significantly on that factor. The usual research task is to develop a detailed interpretation of the Q-sort type by abductively developing an explanation that fits the order of items on the Q-sort type array. In this study, only a preliminary interpretation has been developed since the main goal was to develop the causal maps.

By its very nature factor analysis is indeterminate in that there are a number of factor solutions which can emerge from the data. As a guide to the optimal total number of factors, Brown (1980) recommends that the unrotated factor matrix is inspected in order to count the number of unrotated factors which have statistically significant loadings. (In this case, over the level of $1/\sqrt{n} * 2.58$, where n=42, or 0.40). This assessment suggests what the upper limit is to the number of factors. Another relevant criterion is the number of significant loaders on each factor. Earlier research (Fairweather, 2002) has shown that when the number approaches ten persons the characteristics of the factor are stable in most situations. That research also showed that factors with fewer significant loadings can be stable. However, factors with only one or two significant loaders, while they can be of interest in some studies, are not always included since it is possible to build interpretations that are derived from only a few people.

The Q data were analysed using the downloadable freeware PQMethod version 2.11. Principle Components factor analysis was used to identify groups of farmers who sorted the items, in this case farming related factors as listed in Table 1, in a similar way. (In addition, centroid factor analysis, which does not use orthogonal factors, was used and similar results were obtained). Inspection of the unrotated factor matrix showed that there were grounds for extracting five factors. However, two, three and four factor solutions were also considered. Varimax rotation was used to enhance the structure of each factor. The preliminary results from the four factor solution showed two factors with low numbers of farmers loading on them but which were easily interpreted. One was made up of farmers whose Q sorts indicated that they had significant off-farm work and the other exhibited a strong off-farm orientation. The other two factors had more farmers loading onto them and they appeared to be less distinctive. This four factor solution provided some winnowing to two small but important groups leaving the majority of farmers as belonging to one of two other groups. The five factor solution had one factor with only one farmer loading on it, and a total of four factors with less then five farmers loading on each. This solution therefore spread out the variance too thinly. The two factor solution did not differentiate the off-farm workers or the off-farm orientation and therefore seemed to collapse what appeared to be important and readily interpretable results. Accordingly, the four factor solution was judged to be the best available.

2.7 Analysis of Map Data

Each map drawn by an individual was reproduced as a digital map using the Microsoft Visio drawing programme, and a copy of this map was returned to the farmer. The map data were entered into an Excel spreadsheet. The spreadsheet consisted of a matrix of 41 by 41 factors whereby the row factor was taken to cause the column factor. All the cells, except the diagonal, were available to be used. This means that in the case of a bidirectional or feedback arrow, one number was entered on one side of the diagonal (X caused Y) and another number entered on the other side of the diagonal (Y caused X). For some bidirectional arrows the weightings were different for each direction.

Characteristics of the matrix were identified by summing column totals (indegree – measuring the combined weight of arrows leading to that factor), and row totals (outdegree – measuring the combined weight of arrows leading away from that factor). These two numbers were added together to provide a measure of the overall importance of that factor in the map or, as it is known in causal mapping, the centrality of the factor. In addition, there were other maps characteristics such as the number of connections, the number of connections per variable, and the number of double arrows.

Centrality is the main measure that this report deals with. We take this to indicate what farmers consider to be important or not important in regards to causal connections between factors in their farming system. In some cases, where a factor has a low centrality score, the factor may still be important for individual farmers. It is possible that in any system some connections with low centrality might play an important role under some particular circumstances.

The map data for each individual map were averaged across the 34 maps to obtain the group map data. The main focus was on the mean scores given to the arrows connecting one factor to another. This provided a description of the group map and the relationship between the factors that the group considered important in managing a farm. Then group map data were analysed by panel, each panel consisting of 11 conventional, 11 integrated and 12 organic orchardists respectively[2], and by Q-sort type. ANOVAs were carried out on these scores using farm location as a blocking factor, and panel as the treatment factor, or just using Q-sort type as the treatment factor[3]. In this way significant differences between the three panels and the four Q-sort types could be identified.

2.8 Conclusion

The new two-stage method appeared to work well and was congenial for farmers to undertake. Initial impressions of the results suggested that there were strong differences between farmers. This promised to yield interesting results.

[2] While the initial panels each had 12 farmers, at the time of interview some farmers were no longer part of the ARGOS study and they had not at this point been replaced.

[3] The balanced nature of the ARGOS design with three panels across 12 locations enables statistical analysis by a 2-way ANOVA, whereas the analysis by Q-sort type (post hoc) is unbalanced across location and hence location cannot be used as a blocking factor.

Chapter 3
Sheep/beef Results

3.1 Introduction

In this chapter, data are presented for the group map for all 34 farmers, followed by the group map data for each panel, then the group map for each Q-sort type. The main task here is to understand group maps, those that are formed from the data from all farmers or from particular breakdowns of the whole group. At this aggregate level we can develop an understanding of the general properties of farming systems, as seen by farmers. One of the main ways we assess maps is by measuring the centrality of factors. Centrality measures a factor's importance as it is the sum of the weightings of arrows going into and out from the factor. Centrality is influenced by both the number of arrows and the weightings of the arrows.

3.2 Group map data for all 34 farmers

When the data for all 34 cases had been entered it was possible to create an equivalent data matrix for the group map by calculating the average score for each cell in the group matrix. These average scores then formed the basis of further calculations. The complete matrix for the group map data shows that for the average group map there were a total of 104 separate connections between factors, considerably short of the theoretical maximum of 41 times 40 or 1,640 connections (seven per cent), but still rather too many to represent easily on a single map (see later).

In this section of the report the data are presented by first focusing on the group map data and then focusing on the group map generated by these data.

Map data

Table 2 shows the core descriptive data derived from the average centrality scores in the sheep/beef group map. These data include the overall average, then the average for the three panels, then the average for the four Q-sort types. The table shows four groups of centrality scores, starting with those with the highest scores at the top. These groupings are an attempt to simplify the data based on a somewhat arbitrary criteria of taking the top three, then the next six which had somewhat similar scores, followed by a break to the next seven scores.

The average centrality for all the factors was 21. The factor with clearly the highest centrality was the decision maker with an average score of 150. Next in order of centrality were quality and quantity of plants and/or livestock, with an average of 82, and satisfaction with an average of 55. After these top three factors there was a second tier of six factors with average centrality scores ranging from 32 to 46. These include: fertiliser and soil fertility/health (46), family needs (42), farm environmental health (40), cash farm income (38), weather and climate (36) and farm working expenses (32). These factors with high centrality (as shown by having a score of 32 or above which is well over the average of 21) show that at the heart of farming is the decision maker, production and satisfaction, followed by fertiliser and soil fertility health, family, weather and financial aspects (represented by cash farm income and farm working expenses).

Table 2: Average centrality for all 34 cases, all panels and all Q-sort types

Factor	All 34	Panels C (11)	I (11)	O (12)	Q-sort types 1 (8)	2 (4)	3 (5)	4 (10)
Farmer decision maker	150	153	156	140	140	136	142	153
Quality & quantity of plants and/or livestock	82	78	96	74	81	64	82	87
Satisfaction	55	43	60	60	33	29	48	70
Fertiliser and soil fertility/health	46	40	39	58	46	21	48	56
Family needs	42	41	50	36	26	32	51	46
Farm environmental health	40	30	27	61	15	18	48	63
Cash farm income	38	34	41	38	36	37	26	49
Weather/climate	36	33	37	38	37	13	35	42
Farm working expenses	32	32	45	19	31	17	36	35
Farm environment as a place to live	25	28	19	28	7	9	20	38
Net profit before tax	24	24	24	24	25	47	27	21
Water supply & quality	22	21	28	16	22	9	15	29
Weed & pest management	21	24	18	20	13	5	52	12
Labour	20	21	24	16	12	29	67	5
Marketing or processing organisation	19	25	11	21	13	13	39	13
Stocking rates	18	15	23	15	19	9	18	16
Off-farm product quality	17	11	9	28	12	0	27	18
Time in farm work	15	16	22	8	18	13	36	3
Customer satisfaction	14	18	6	18	4	2	33	12
Stream health	13	8	11	18	7	0	17	20
Off-farm activities	13	14	14	11	9	5	34	10
Plant and machinery	12	9	12	14	13	7	29	4
Increasing plant & animal biodiversity	12	15	10	10	10	5	0	10
Customer requirements	12	14	8	15	5	0	24	10
Soil type/ topography	11	5	12	16	6	4	22	11
This location	10	8	8	15	10	9	13	15
Off-farm work	9	18	5	4	4	25	29	1
Information	8	5	8	11	5	4	19	9
Improve equity/land size	8	10	8	7	5	27	0	11
Future generations/succession	8	9	5	11	0	9	7	17
Exchange rate, macro economy	7	9	8	6	14	8	0	9
Advisors, consultants	6	5	12	2	3	12	9	1
Neighbours	6	5	5	7	5	7	4	8
Family history & background	6	13	3	3	1	9	12	9
Contractors	6	6	6	4	4	0	15	4
Community	6	4	8	6	1	3	7	9
Retirement	5	6	4	4	0	17	8	3
Government policies	4	5	2	5	5	6	0	5
Regulations	1	2	2	0	2	1	2	1
Farmer groups or organisations	1	1	0	1	1	0	0	1

There is third tier of factors with average centrality ranging from 18 to 25. These include: farm environment as a place to live (25), net profit before tax (24), Water supply and quality (22), weed and pest management (21), labour (20), marketing or processing organisation (19) and stocking rates (18). The remainder of the factors had centrality scores lower than 18. These were often background or contextual factors such as the exchange rate/macro-economy or goals to be achieved such as retirement. It is noteworthy that among the lowest rated factors are social factors such as future generations/succession, neighbours, family history and background, community and farmer groups or organisations.

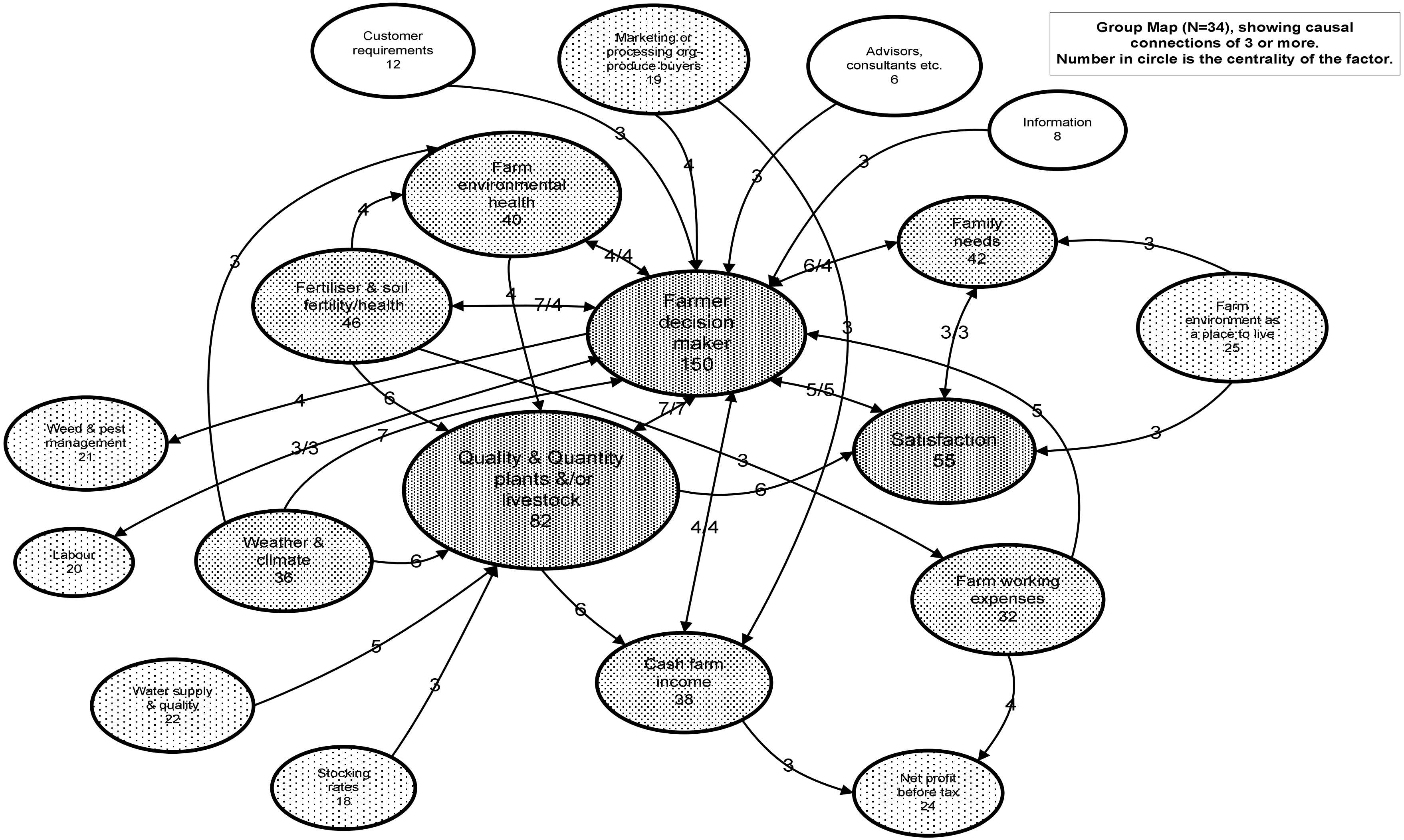
Group map

The centrality scores show which factors are important but they do not show, in detail, how all the factors are linked. To show linkages, we need to use the average data to generate a causal map based on strength of causal connections. However, the full group map has linkages between many factors and is difficult both to present and to interpret. To simplify the group map we tried some arbitrary minimum average connection scores to see at which point the map appeared to show the main causal linkages. Using a score of three was suitable for showing the important connections without getting overwhelmed, and this map is the main one we have chosen to present here. Note that the causal connection score from one to ten was explained to the farmers to indicate that from one to three meant 'low', four to six meant 'medium' and seven to ten meant 'high'. However, these average data do not correspond exactly to this scale. To achieve the same level of meaning as an individual farmer's rating would require all farmers to have linked the same two variables. This was not the case. For example, some farmers did not link quality and quantity of plants and or livestock with cash farm income. Many of those who did linked it with a score of nine or ten. But since not everyone linked it the average score is six.

The derived group map is shown in Figure 4. The factors in the three tiers are shown in different font sizes and backgrounds to reflect the different centrality scores. There are three factors with no background because they comprise factors which did have a link of three but had low centralities (customer requirements 12, information eight, and advisors/consultants six). The figure shows some arrows with double arrowheads and two numbers on the line. The number nearest to the arrowhead applies to that arrowhead.

The map was created by taking the three top-tier factors and placing them in triangular fashion in the centre of the map. Then the next tier of six factors was placed around these in no particular position but in ways that minimised the number of crossing arrows. Finally, the third tier of six factors was added in closest to the factors that they connected to.

Figure 4: Sheep/beef group map, causal arrows with scores of three or more



There are a number of considerations behind the decision to place farmer decision maker in the centre of the map. W\e know from the centrality score of 150 that there will be many arrows connecting to this factor, therefore it is reasonable to place it in the centre of the map purely from a pragmatic point of view. To further support this policy, the farmers' maps were examined and the actual position of farmer decision maker recorded as centre, internal (near the centre) or edge. Results showed that there were ten farmers who put farmer decision maker on the edge of their map, 21 who put it near the centre, and three who put it in the middle. Clearly, farmers did not uniformly put farmer decision maker in the middle of their map. In part this was because they often selected other factors as their first factor to do their mapping and this factor tended to be put in the middle. For the 21 farmers who put it near the centre it was often a case of putting farmer decision maker with other key factors in order to show important linkages. In these cases farmer decision maker was definitely at the inner core of the map. So the procedure we have followed does not reflect all farmers but does reflect two thirds of them, and certainly best reflects the nature of the centrality data.

Note also that farmers did not accord farmer decision maker as much importance in the Q sort as they did in the causal mapping. For the Q-sort data, the average score, on a one to nine scale, was seven, or on a -4 to 4 scale, +2. This perhaps reflects a natural modesty among farmers but the score suggests that in terms of a simple rating, farmer decision maker was not rated as particularly important among farmers before they made their causal map. The process of causal mapping drew them into highlighting the importance of the farmer decision maker (themselves) in their farming system. This point was acknowledged by some farmers at the end of the interview when they stated that it showed the importance of them as decision makers. In some cases they said they were aware of this before the interview but in some cases they were not. (Also, this indicates the number of connections that have to be via the farmer as decision maker.)

At the core of the map are farmer decision maker, quality and quantity or plants and/or livestock (subsequently referred to as production), and satisfaction. Farmers in a market economy have to produce and sell products and their returns are based on the quantity and quality of production so the importance of this production factor is unexceptional. Perhaps less expected was the high centrality rating of satisfaction, suggesting that quality of life considerations are important to farmers. Further, farmer decision maker is dynamically linked with two-way arrows to production and to satisfaction meaning that these latter two factors have an important bearing on farmer decision maker and it in turn has an important bearing on them. Of the two, it is production that is most important in terms of strength of causal connections, having a score of seven compared to five. There is not quite a perfect interacting circle of factors here because satisfaction does not influence production directly (the score for this connection is zero) but it can have an influence indirectly through farmer decision maker.

Moving out to consider the next tier of factors, the map shows that farmer decision maker is linked with bidirectional arrows to fertiliser and soil fertility/health, farm environmental health and family needs. Thus the farmer decision maker both influences these factors and in turn is influenced by them. Most influence is extended to fertiliser and soil fertility health with a score of seven. Of these three factors, family needs, has the largest influence on farmer decision maker.

The other links among these two top tiers of factors show that production is influenced by fertiliser and soil fertility health and farm environmental health, and that the former influences the latter. Satisfaction affects family needs, as does farmer decision maker, and this latter connection is bi-directional. Beyond these factors mentioned there is weather and climate having an effect on production, farmer decision maker and farm environmental health. In terms of financial factors, among the top two tiers of factors the main links are from production and decision maker to cash farm income. Farm working expenses are largely derived from fertiliser and soil fertility/health and there is an important feedback to farmer decision maker.

The third tier of seven factors has three factors that link to farmer decision maker, including weed and pest management, labour, and marketing or processing organisation/produce buyer. Two of the seven factors, water supply and quality and stocking rates, affect production, and farm environment as a place to live affects both family needs and satisfaction. Finally, net profit before tax is influenced by cash farm income and farm working expenses. Amongst these peripheral factors, only one, labour, has a bidirectional arrow.

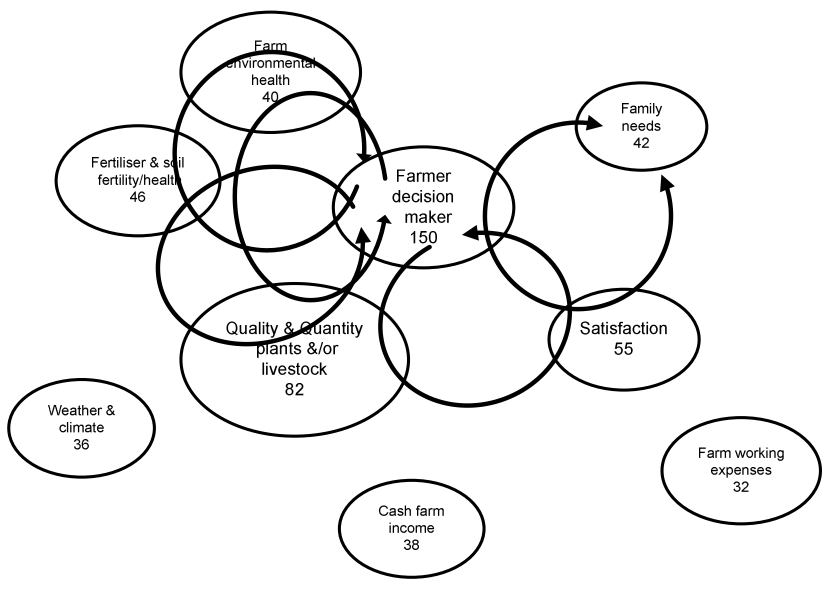
The last factors to be considered are those that, while not having a high centrality, do have connections of three. These include customer requirements, advisors and consultants and information. These all influence farmer decision maker.

Overall then the group causal map is showing that at the core of farming are production, farmer decision maker and satisfaction. Closely linked to these are environmental, family and financial factors, and weather. There are seven two-way arrows, six of which link to farmer decision maker. The remaining one is between family needs and satisfaction.

In terms of key influences on the core factors, family needs and production are the largest influence on farmer decision maker. Farmer decision maker is the largest influence on production, closely followed by fertiliser and soil fertility health and weather. Production is the largest influence on satisfaction. Farmer decision maker is the largest influence on family needs.

One of the advantages of causal mapping is that the maps are representations of dynamic systems. These systems can have patterns of causality that include circuits of causal connection. For the sheep/beef causal map, the circuits involve six core factors with a centrality score of 40 or over at the heart of the map that are all connected to the farmer decision maker by bidirectional arrows. This means that anything that the farmer does to influence any one of these factors will affect adjacent factors and then affect the farmer. There are five such circuits as shown in Figure 5.

Figure 5: Circuits among the top six factors of the group map

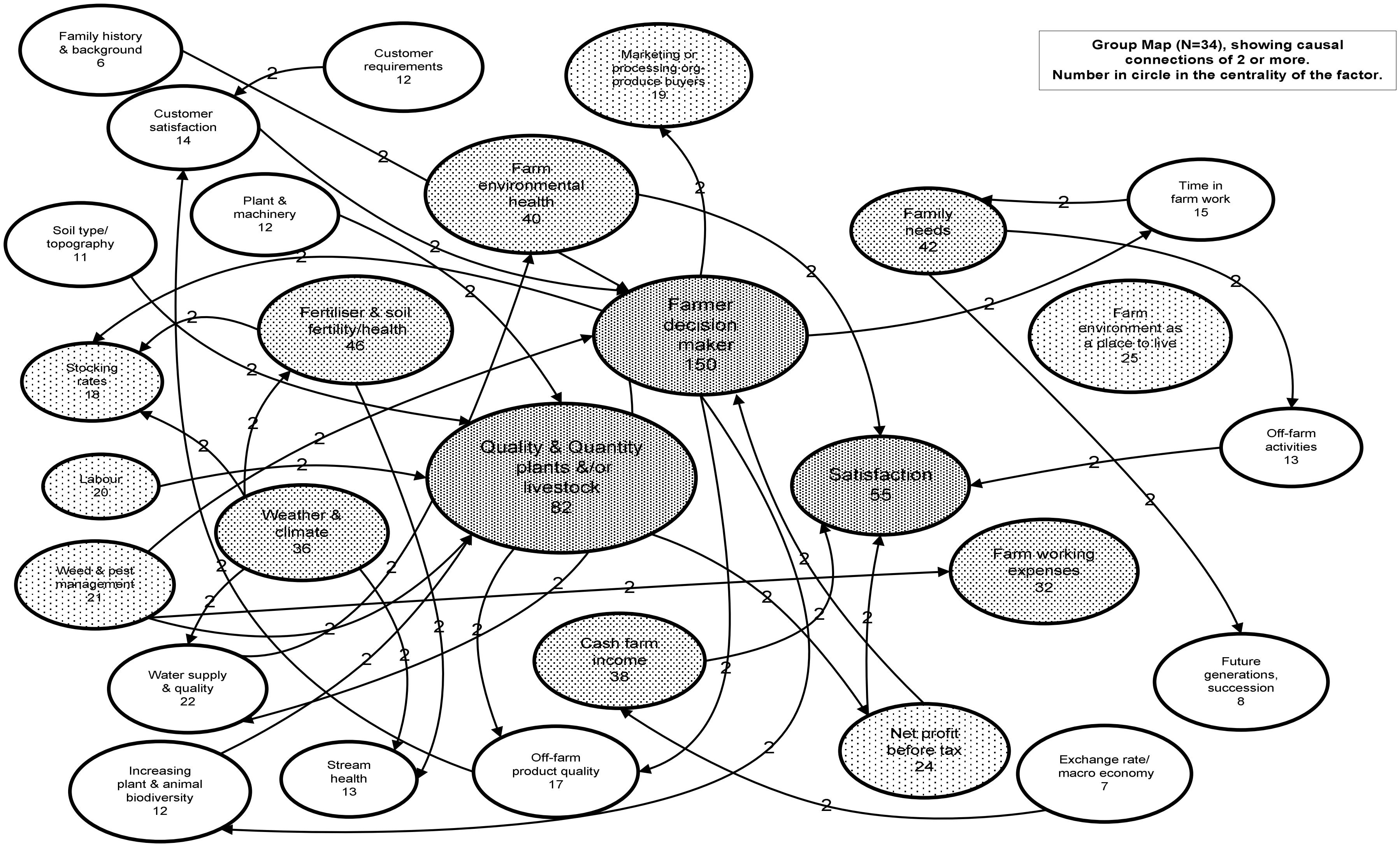


One of the circuits is bidirectional (family needs to farmer decision maker to satisfaction) while the others are unidirectional. These circuits show that changes in any one of the factors near to farmer decision maker can have both a direct effect and an indirect effect on farmer decision maker. Further, a change in one factor can have multiple consequences, with impacts reverberating among the connected factors. These circuits show that farming decision making is complex. Beyond these circuits are others involving two or more factors before returning to farmer decision maker.

The causal map shows that farmers see their system as one oriented to production and satisfaction, with farm and soil health, and family needs, also very important and tightly integrated into the core of the system. The group map also shows the important factor of weather over which farmers have little control.

The group map data presented above show clearly the basic patterns of connection between factors connected at a level of three or more. However, the group map can also show connections that, while not consistently made across the 34 farmers, were made by some farmers so that the average score is less than three. Figure 6 shows the group map with causal connections with a score of two only. It indicates that some additional factors are connected at this level, some of which do not involve the decision maker. However, most of them (21 out of 34) do connect to the top three factors: decision maker, production and satisfaction. Perhaps what is important in these data is the relatively low score of two connecting some factors that might otherwise be thought to be important in sheep/beef farming such as weed and pest management affecting production, or net profit before tax affecting farmer decision maker. We should not conclude that these connections are unimportant. However, they are certainly less important to farmers than all the connections discussed earlier.

Figure 6: Sheep/beef group map, causal arrows with scores of two only



Data from the questions asked after the mapping
Data from the other questions asked at the end of the interview showed some general characteristics of sheep/beef farmers. There was a general emphasis on quality of production. Table 3 shows the importance of either quality of quantity of production. It indicates that 62 per cent of farmers stated that quality of production was more important than quantity of production. Only 15 per cent stated that quantity was more important than quality, while 24 per cent stated both.

Table 3: Importance of either quality or quantity of production

Which factor is more important?	No.	%
Quality	21	62
Quantity	5	14
Both quality and quantity	8	24
	34	100

The question on environment health was only asked of 21 farmers. Table 1.1 in Appendix 1 shows the full text of the responses. There are no obvious groupings in the responses and the quotes seem to cover a single theme. Generally, there was some difficulty in describing environment health and the explanations tend to be tautological, that is, there is good environment health when the farm is healthy. However, as the responses indicate, farmers know that the environment is well when there is absence of problems and positive signs such as good bird life, healthy stock and good water quality. They can tell if farm environmental health is not good if there are signs of ill health, such as unhealthy stock. This sensitivity to the appearance of environmental health is illustrated by the observation reported in The Press (2006) that snow-hit Canterbury farmers were reluctant to enter into the Ballance Farm Environment Awards until they were able to tidy up their farms.

When it comes to the degree of change that farms can undergo, farmers were generally very positive that their farming system can change, that is, was not resistant to change. Table 1.2 in Appendix 1 shows the full statements made in response to this question. Generally, the comments show a positive attitude towards change. Farmers stated that the main driver of change was financial factors. Eighteen farmers mentioned this while nine did not have a response and three said climate.

Farmers also stated what, in their opinion, made for a resilient farm. Table 1.3 in Appendix 1 shows the statements made. The main theme among the responses was financial flexibility expressed in different ways (debt loading, equity, cash reserves etc.). However, the farmers also mentioned being adaptable, being prepared, having the right attitude, diversity, options and environmental health.

In terms of the level of inputs per hectare compared to other farms of a similar type, fifteen farmers stated that it was above average, ten stated it was average, seven stated it was below average and two did not know.

3.3 Group map data for each panel

The assessment of differences between the group maps created for each of the ARGOS management panels involved the identification of significant differences for centrality scores among the panels. To facilitate the analysis, the data from the individual maps were combined into one table that listed the 34 farmers and collated the 41 factors in 41 columns of data. This table is shown in Appendix 2. These data were examined using ANOVA and the results are shown in Table 4[4]. Superscript letters are used to denote statistically significant difference between scores, and bolding is used to show the high centralities.

Table 4: Statistically significant centrality means and map characteristics for each panel

Factors	All 34	Panels C	I	O	Sign.
Advisors, consultants	6.4	5.6	**12.0[a]**	1.7[b]	*
Customer requirements (outlier removed)	10.1	**15.7[a]**	0.2[b]	**14.5[a]**	*
Farm environmental health	39.0	28.5[a]	28.6[a]	**60.0[b]**	*
Farm working expenses	31.1	31.8	**45.4[a]**	16.2[b]	*
Fertiliser and soil fertility/health	44.6	40.1	37.6[a]	**56.2[b]**	*
Marketing or processing organisation	18.8	**27.7[a]**	9.8[b]	18.9	*
Off-farm product quality (LSD=17.46, cf. 17.0)	15.4	12.4	8.4[a]	**25.4[b]**	*
Quality & quantity of plants and/or livestock	81.5	77.0	**97.9[a]**	69.5[b]	*
Weed & pest management (org. outlier removed)	17.6	**24.6[a]**	18.3	9.7[b]	*
Total centrality	862	876	876	834	n .s.
Map density	0.132	0.135	0.114[a]	**0.149[b]**	*
Hierarchy (*10^{-3})	1.95	1.75	1.23[a]	**2.85[b]**	*

Notes: 1.The mean centrality for the overall group of 34 farmers was 21, with a range from 0 to 150.
2. * significance at p<0.05 and ** at p<0.01.

The total centrality score is included to show, in this case, that at the aggregate level there were no differences between panels. There were nine out of the 41 factors with significant differences across the panels. Seven of the differences are between the integrated and the organic panel. Conventional farmers, along with organic farmers, emphasised customer requirements, and they gave a high score to marketing or processing organisation and to weed and pest management. Integrated farmers gave more importance to advisors and consultants, farm working expenses and production. Organic farmers had high centralities for customer requirements, farm environmental health, fertiliser and soil fertility health and off farm product quality.

In addition, the other variables used to characterise the maps showed some differences across panels. The organic panel had significantly higher scores for map density (defined as the total number of connections divided by the square of the number of variables) and for hierarchy (an indication of the structure of the map in terms of whether it is hierarchical or democratic). Ozesmi and Ozesmi (2004) explain that democratic maps are more likely to be more adaptable to local environmental changes because of the high level of integration and dependence. The higher hierarchy score for the organic maps is unexpected. Our maps have very low scores compared to those reported (0.02 to 0.13) and perhaps this makes the organic difference relatively less important. The two map characteristics show that the organic panel has a more complex map and suggests that they see their farm system as more complex.

[4] The numbers may differ slightly from those shown in Table 2 because during the ANOVA some adjustments were made, such as estimating missing data to balance the design and removing outliers, and these adjustments have affected the values.

The above statistically significant differences give us good reason to conclude that the group maps for each panel have some distinctive characteristics. These panel differences were examined in two ways. First, for each factor with a statistically significant difference the connections going into it or out from it were examined to see if the panel map was different from the overall average. Such differences are shown in the following figures in parentheses. Second, it was relevant to look at the panel map more broadly to see what connections were given a higher than average rating. The spreadsheets for the group map data for each panel were examined and each cell with a value of three or more was identified and marked in colour to correspond to the different values ranging from three to nine (the highest value). Then for each panel the marked cells were compared to the overall group data in order to find cells which had a value of two or more in difference. These particular linkages were then added to the overall group map shown earlier to highlight how the panel group maps were different. We do not argue that the specific arrows thus identified are statistically significantly different, however, they give a very good indication of fundamental differences. (It was not possible to do ANOVAs with the arrows data because there were too many cells with zero scores.) The differences at the level of the arrows show how or why the centrality scores were different[5].

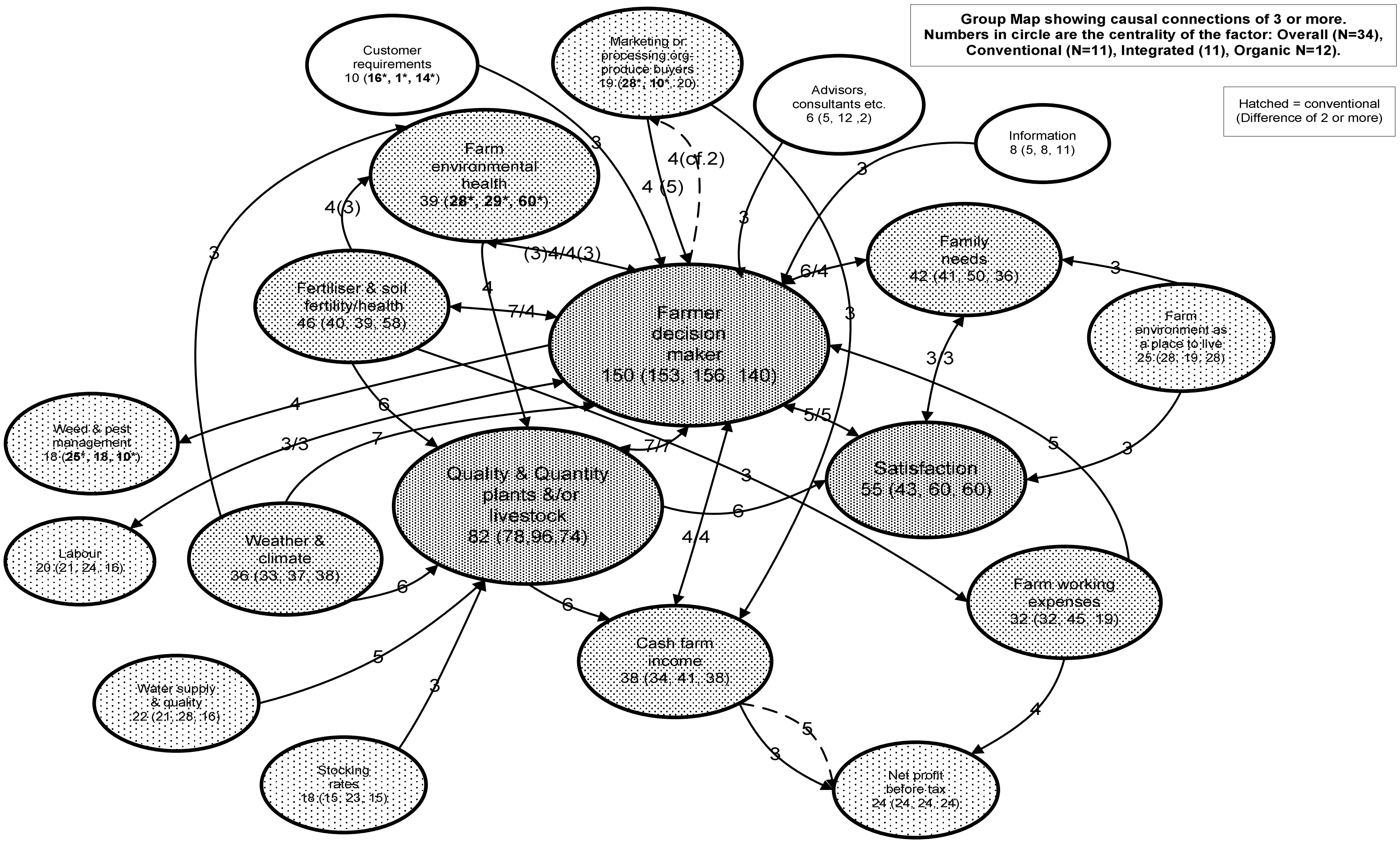
The centrality scores for the overall group and for each of the panel group maps are shown within each circle in the following figures with the significant differences from Table 7 shown in bold. Circles that are new additions for the panel map are shown with hatched lines. Arrows that meet the criterion of being different by two or more are also shown with hatched lines.

Conventional panel. Figure 7 shows the conventional panel map. The centrality scores of this panel generally are similar to the overall average; however farm environmental health is low, while customer requirements, marketing or processing organisation, and weed and pest management are high. There are only two additional connections with a score difference of two or more compared to the overall group map. There is a link of four rather than two between farmer decision maker and marketing or processing organisation/produce buyers, and there is a link of five rather than three between cash farm income and net profit before tax. Score differences of one occur for the link between marketing and processing organisation and farmer decision maker (five not four), between farm environmental health and farmer decision maker (three not four in each direction), and from fertiliser and soil fertility health to farm environmental health (three not four).

These data show that there is a very close match between the conventional panel and the overall average. It shows that they believe that they have more influence over marketing or processing organisations, possibly because they are not locked into contracts, and these organisations influence them slightly more. The key theme of the conventional panel is lower emphasis on farm environmental health while weed and pest management, customers and marketing are of greater importance to conventional farmers.

[5] Note that when comparing maps, an average connection on one map may be the product of few connections at higher weightings, or the product of many connections at low weightings. However, most farmers used high scores rather than low scores so it is unlikely that former combination occurred.

Figure 7: Conventional panel group map

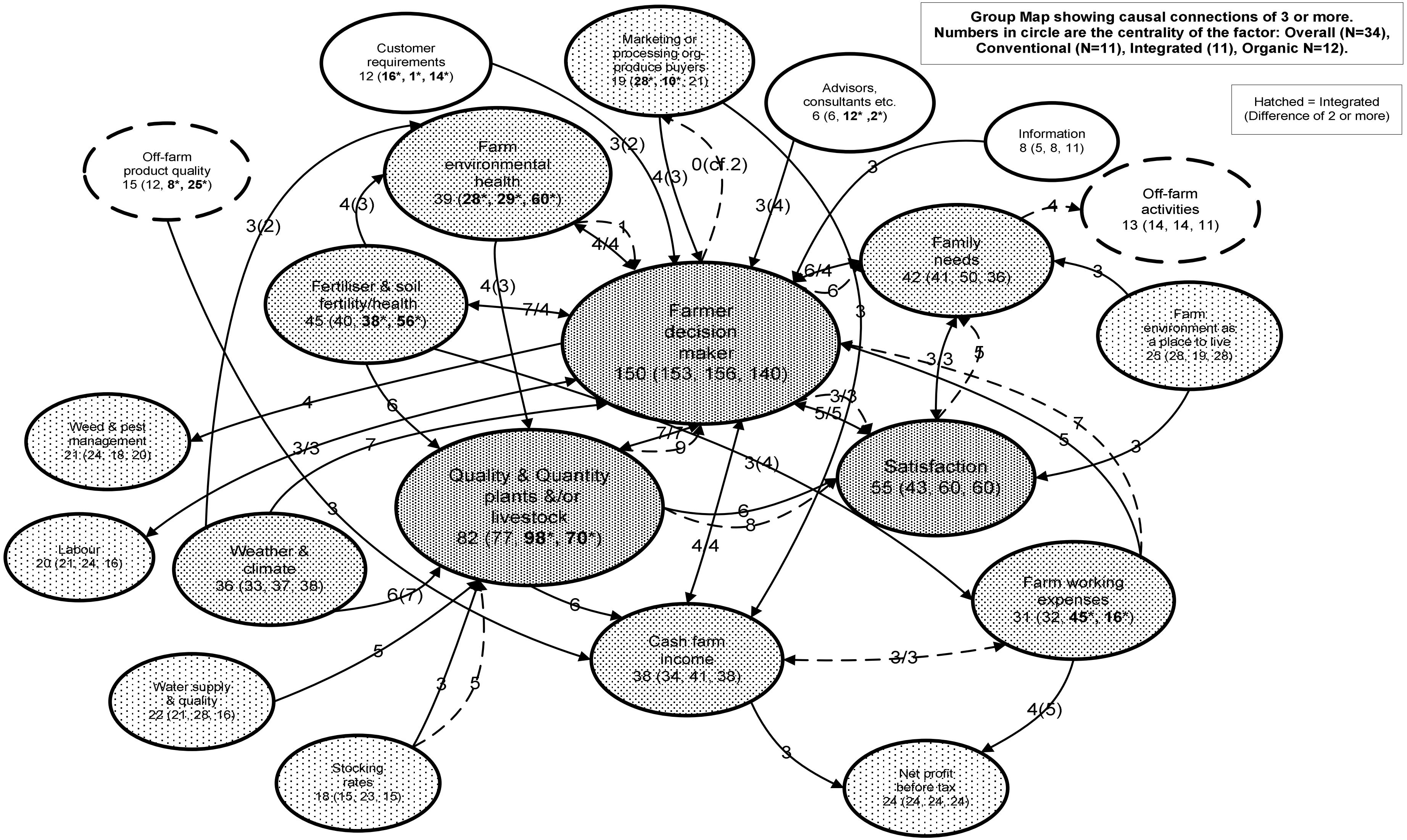


Integrated panel. Figure 8 shows the integrated panel map and it has many differences when compared to the overall map. Off-farm activities is an additional factor, connected by four from family needs, and off-farm product quality is an additional factor connected by three to cash farm income. There are significantly high centralities for quality and quantity of production, farm working expenses and advisors/consultants and significantly low scores for customer requirements, farm environmental health, fertiliser and soil fertility health, marketing or processing organisation and off-farm product quality. In terms of particular connections with scores of two or more difference, satisfaction influences family needs at five not three. Cash farm income is linked by a two-way arrow to farm working expenses at three for each arrow not one for each arrow. Production is linked to satisfaction by eight not six. The remaining differences relate to farmer decision maker. First, there is a connection of zero rather than two between farmer decision maker and marketing or processing organisation/produce buyers. Then farm environmental health is linked by one rather than four to farmer decision maker, production is linked by nine rather than seven, and farm working expenses is connected by seven rather than five. Satisfaction is linked by three rather than five. From farmer decision maker to family needs the connection is six rather than four.

Each connection to or from the factors with statistically significant scores was examined. Customer requirements affect farmer decision maker with a score of two not three, fertiliser and soil fertility health affects farm environmental health with three not four, advisors/consultants affect farmer decision maker with four not three, and marketing or processing organisation affects farmer decision maker with three not four.

These data are showing that off-farm activities, while not having a higher centrality for integrated farmers, are connected to family needs at a stronger level. Both satisfaction and farmer decision maker appear to be meeting family needs more. Along with this strong family orientation is a stronger, two-way link between cash farm income and farm working expenses, and a stronger link (7 cf. 5) from expenses to decision making. Similarly, production is more strongly linked to farmer decision maker. This score on nine is very high and means that this link was consistently given a high rating by all integrated farmers. These results are suggesting that integrated farmers have a strong focus on production and expenditure. Noticeable are the two linkages with lower scores than the overall average: the link of one from farm environmental health to farmer decision maker, and the zero link to marketing and processing organisation. The lower emphasis on environment is reflected in the lower centrality for farm environment as a place to live but this difference in not statistically significant. The lower score between marketing and processing organisation and farmer decision maker may reflect the contract between them. From the farmer's point of view, the link is unproblematic and relatively unimportant. Further, it may be that producing to an integrated standard gives the farmers greater assurance about environmental health. Integrated farmers have a wide variety of techniques at their disposal to address environmental and fertiliser issues. The low centrality score for off-farm product quality noted above in Table 7, and shown in the figure as a new factor, may reflect that while integrated farmers keenly seek to produce to a demanding specification, the motivation for this lies in meeting the contract by focusing on the farm rather than a concern for markets off farm. The key theme of the integrated panel is high quality and quantity of production, managing expenses, meeting family needs and gaining satisfaction. This is a very on-farm focus.

Figure 8: Integrated panel group map

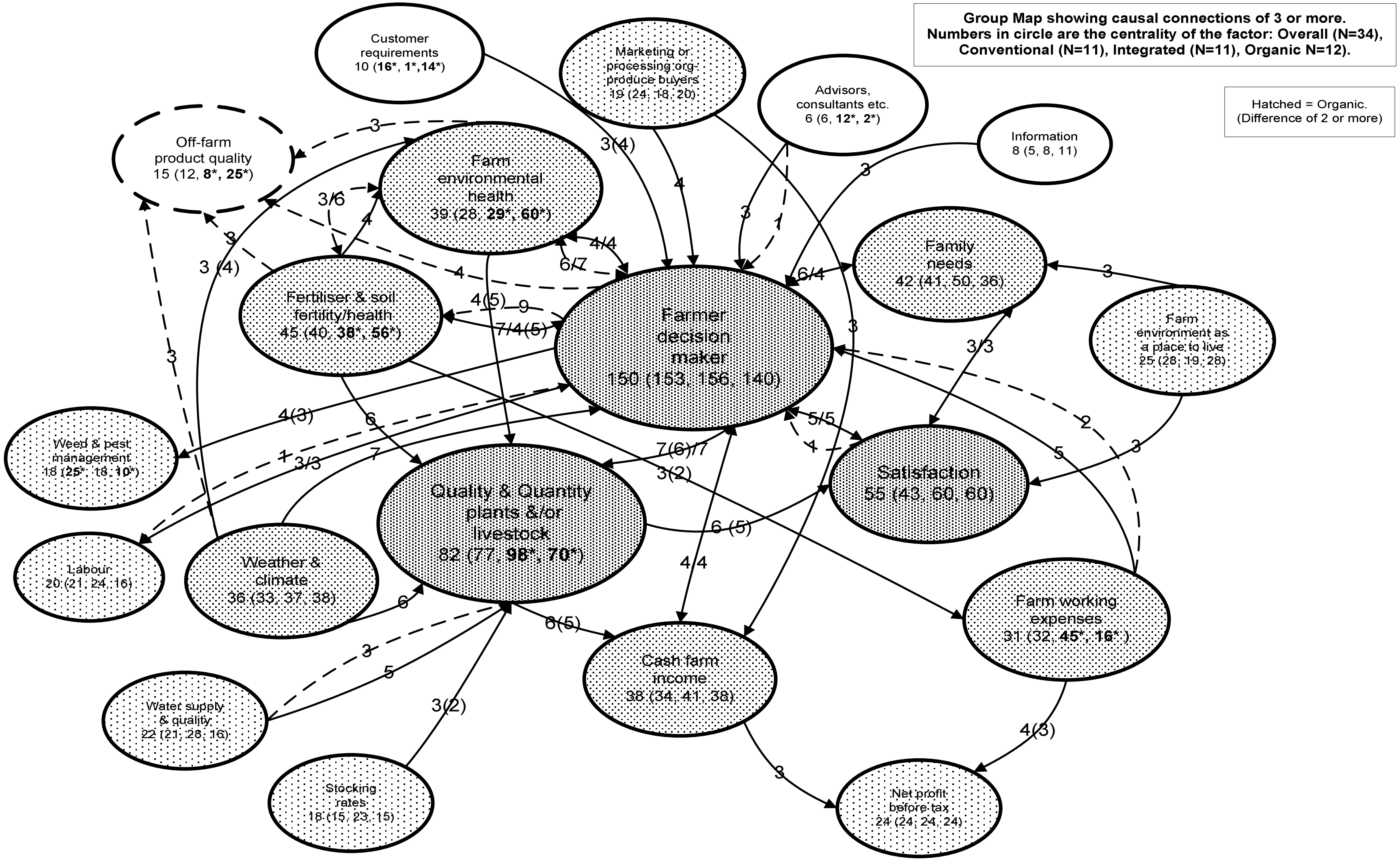


Organic panel. Figure 9 shows the organic panel map and it too has many differences when compared to the overall map. There are high centralities for farm environmental health, fertiliser and soil fertility health and off-farm product quality (an additional factor). There are low centralities for advisors/consultants, farm working expenses, quality and quantity of production, and weed and pest management. In terms of connections between factors, off-farm product quality has four connections. There are connections from farm environmental health (3), farmer decision maker (4), fertiliser and soil fertility health (3) and weather and climate (3). There are differences in the relationship between farm environmental health and fertiliser and soil fertility health with a bidirectional arrow and a link of six not four to farm environmental health, and a link of three not one to fertiliser and soil fertility health. Water supply and quality is less important in its connection to production at three not five. The remaining differences involve links to farmer decision maker. There is a link from farmer decision maker to labour at one not three. Farm working expenses is at two not five, satisfaction is linked at one not five, and similarly, advisors and consultants is linked at one not three. Finally, the farmer decision maker links with farm environmental health and fertiliser and soil fertility health are stronger. Notably there is a link of nine not seven from farmer decision maker to fertiliser and soil fertility health, and this shows that the organic farmers consistently emphasised this link.

The organic panel map has many connections with a difference of one. Weather and climate is linked to farm environmental health at four not three, farm environmental health is linked to production at five not four, fertiliser and soil fertility health is linked to farm working expenses at two not three, stocking rates is linked to production at two not three, production is linked to cash farm income at five not six and production is linked to satisfaction at five not six. For farmer decision maker, customer requirements is linked at four not three, fertiliser and soil fertility health at five not four, and weed and pest management at three not four. Farmer decision maker in linked to production at six not seven.

These data are showing that off-farm product quality is important to farmers in the organic panel and they see this as being derived from a number of factors. They also emphasise customer requirements. The low link from farmer decision maker to labour is hard to interpret. It could be because farmers in the organic panel do not employ many workers and this issue is not very relevant. In effect they do much of this work themselves. Perhaps it reflects the occurrence of WOOFERS on organic farms and these workers are self motivated and unpaid and therefore do not emerge as an issue in terms of worker-employee relationships. Or perhaps it reflects the low supply of workers with the right skills. The lower link from farm working expenses to farmer decision maker may reflect the lower cost structure of organic farming or at least the lower perceived cost of organic farming. Satisfaction is weakly linked to farmer decision maker (one rather than five) perhaps because they are more attuned to the state of their farm environment and this influences them as decision makers (seven rather than four) more than satisfaction per se. The low link from advisors/consultants to farmer decision maker reflects the lack of readily available advice about organic farming, and it may reflect the fact that many organic farmers have had to learn without the aid of farm advisors. The lower centrality for weed and pest management reflects the more positive way organic farmers view alternative species. Finally, the stronger links involving fertiliser and soil fertility health, farm environmental health and farmer decision maker all show the priority that farmers in the organic panel gave to the health and environment of their farms. This healthy environment is integral to their decision making. They also give less attention to production. The key theme of the organic panel map is farm health to achieve off-farm product quality with lower farm working expenses.

Figure 9: Organic panel group map



3.4 Group Data for Each Q-sort type

The Q-sort data provided the basis for an examination of groups of farmers based on how they rated the importance of the factors. The factor analysis result that gave four Q-sort types was the best solution in terms of readily interpretable types with reasonable numbers of farmers being associated with each type. This section of the report examines the data for the four Q-sort types and develops a preliminary interpretation of each type. It then presents the group map for each type, that is, the map generated by selecting those farmers who comprise each Q-sort type. It concludes by showing an amalgam of types to reduce the number to two: a combination of Q-sort types 1 and 2, and a combination of Q-sort types 3 and 4.

Table 5 shows the number of farmers who loaded significantly on each factor. Q-sort types 2 and 3 had four and five significant loaders respectively. While these are small groups they are interesting and readily interpretable in that the Q-type array shows clearly what characterises each group. Q-sort types 1 and 4 had eight and ten significant loaders respectively. The Q-sort types are based on results from 27 out of the 34 farmers studied. It also shows that there were seven multiple loaders, farmers who loaded significantly on more than one factor. These typically occur in Q method research and in this case the proportion is relatively low. The focus on cases that load on one Q-sort type is a characteristic of Q method research and is done to ensure that the types are based on good exemplars. Given that the focus of Q method is on the nature of the types this procedure is not problematic. The fact that some farmers have characteristics common to two types does not weaken claims about the types themselves. The data from the seven farmers with loadings on more than one factor were not used until the latter section on combined types.

The table shows that Q-sort type 1 has mainly conventional and integrated farmers, Q-sort types 2 and 3 have a mixture, while Q-sort type 4 has mainly organic farmers. These results will be shown to fit the character of the Q-sort type interpretations.

It is usual in Q-sort analysis to examine the type arrays, those factors that make up the underlying or prototypical characteristics of each Q-sort type. However, before presenting these data, it is necessary to examine the centrality scores and map characteristics to see if in fact there are differences in the maps for each type.

Table 5: **Numbers of significant loaders on each Q-sort type**

	Q-sort type					
	1	**2**	**3**	**4**	**Multiple loaders**	**Total**
Conventional	4	1	2	2	2	
Integrated	3	2	1	2	3	
Organic	1	1	2	6	2	
Subtotal	8	4	5	10	7	34

Table 6 shows the statistically significant centrality scores for the four Q-sort types, each score being an average for the Q-sort type. Bolding is used to show the highest scores. Clearly, there are a number of differences across the types, often between pairs of types. Looking at each type shows that Q-sort type 1 gives most importance to exchange rate/macro economy and to weather/climate. Q-sort type 2 gives more importance to improving equity/land size and net profit before tax. Q-sort type 3 emphasises contractors, fertiliser and soil fertility health, marketing or processing organisation and off-farm activities (defined as sporting or cultural activities). Finally, Q-sort type 4 emphasises a number of factors, including: customer requirements, farm environment as a place to live, farm environmental health, fertiliser and soil fertility health, future generations/succession, increasing biodiversity, and satisfaction. Note that some of the centrality scores are low so some caution is needed in taking the factors for which there are significant differences as being definitively important for those Q-sort types[6]. Just because they are significantly different does not mean that the difference is critically important. As before, these differences between Q-sort types give a preliminary indication of possible map differences and so they prepare the way to show more subtle differences at the level of individual connections between factors on the respective maps.

Table 6: Statistically significant differences in centrality scores and map characteristics for Q-sort types

Factor	Total (27)	Q-sort type 1 (8)	2 (4)	3 (5)	4 (10)	Sign.
Contractors	5.3	3.5^{a}	0.0	**15.0^{b}**	4.1^{a}	*,*
Customer requirements	9.5	5.4	0.0^{a}	23.6	**9.5^{b}**	*
Exchange rate, macro economy	8.6	**13.6^{a}**	8.2	0.0b	9.0	*
Farm environment as a place to live	21.1	6.7^{a}	9.0^{a}	20.2	**37.7^{b}**	**,**
Farm environmental health	39.2	15.4^{a}	17.5^{a}	48.2	**62.5^{b}**	**,**
Fertiliser and soil fertility/health	46.1	46.2	20.5^{a}	**47.6^{b}**	**55.5^{b}**	*,*
Future generations/succession	8.8	0.0^{a}	8.5	7.2	**16.7^{b}**	*
Improve equity/land size	9.6	5.0^{a}	**26.5^{b}**	0.0^{a}	11.4	*,*
Increasing plant & animal biodiversity	7.3	9.5	5.2	0.0^{a}	**10.0^{b}**	*
Marketing or processing organisation	17.5	12.5^{a}	13.2^{a}	**38.6^{b}**	12.6^{a}	*,*,**
Net profit before tax	27.2	25.1	**47.0^{a}**	27.0	21.1^{b}	*
Off-farm activities	13.4	9.4^{a}	4.8^{a}	**33.6^{b}**	10.0^{a}	**,**,**
Satisfaction	48.7	33.1^{a}	28.5^{a}	48.4	**69.5^{b}**	*,*
Stream health	12.7	7.2	0.0^{a}	17.0	**20.0^{b}**	*
Weather/climate	34.8	**36.7^{a}**	12.7^{b}	34.8	**42.1^{a}**	**,*
Number of connections		**50^{a}**	**47^{a}**	**74^{b}**	63	*
Centrality for decision maker/ total centrality		**0.201^{a}**	**0.204^{a}**	0.136^{b}	0.169	**
Q-sort score for decision maker		4	3	1	2	

Notes 1: * significance at p<0.05 and ** at p<0.01.

2. Some a versus b contrasts might have different levels of significance. For example, Q-sort type 1 versus Q-sort type 3 would have a different level of significance than Q-sort type 3 versus Q-sort type 4 because of different numbers in each Q-sort group.

In addition, the other variable used to characterise the maps show differences across Q-sort types for the average number of connections. There were most connections for Q-sort type 3 (74) compared to Q-sort type 1 (50) and Q-sort type 2 (47). Q-sort type 4 had 63 connections. Clearly, farmers in Q-sort type 3 see their farm system as more complex not in terms of number of factors but in how they are connected.

[6] Analysis was carried out using SPSS and this makes observation of outliers and normality of data more difficult to determine.

The ratio of the centrality for farmer decision maker to total centrality is also shown in the table and this ratio provides additional information about the importance of farmer decision maker in the map. Q-sorts 1 and 2 have the highest ratios and this is consistent with the score that each type gave to farmer decision maker during the Q sort. The last row of the table shows the Q-sort score for farmer decision maker. These two lines of data show good compatibility between the Q-sort data and the causal map data. Overall, these data are showing that Q-sort types 1 and 2 give more importance to farmer decision maker and, even though they have maps with fewer connections, farmer decision maker plays a more dominant role in the map.

The following presentation starts with Q-sort types 2 and 3 because they are both small groups with very distinctive qualities and are easier to interpret. It then returns to Q-sort types 1 and 4. This order of presentation works from the smallest factors to the largest.

Q-sort type 2 – Off-farm work

Before presenting the maps for each Q-sort type it is necessary to first characterise each type by referring to Q-sort data. The main Q-sort result is the array of items, in this case factors, that make up the prototype for that Q-sort type. It is central to characterising the type. In addition, type arrays can be compared by examining the distinguishing items, the factors which received a significantly different score compared to all other types.

Table 7 shows the scores for the factors that were statistically significant compared to the other types. Q-sort type 2 gives more emphasis to off-farm work, improving equity or land size and time in farm work. These results illustrate the off-farm work orientation of Q-sort type 2. Unusually, time in farm work is moderately important because these farmers have less time to put into farm work. Advisors/consultants has some importance with a score of one perhaps because this type is not averse to seeking guidance on farming since they are not in such a hands-on position. Exchange rate/macro economy has some importance as does weather and climate but the latter is less important compared to all other types. Production is less important with a zero score, unlike the other three types. Retirement also has a zero score while all other types rate it lower. (On the Q-sort scale the zero score corresponds to the middle pile which still has some importance, at a level of five on a one to nine scale.) Customer requirements are unimportant. This type has an off-farm work orientation where the work is related to improving the financial position of the farm. These farmers are trying to build up their farm financial situation notably by improving their equity. Inspection of the cases loading on this factor shows that they all have significant off-farm work, to the extent that their off-farm work is a major activity in comparison to the farm.

Table 7: Distinguishing items for Q-sort type 2

Factor	Q type1	Q type 2	Q type 3	Q type 4
Off-farm work	-4	**3****	0	-3
Improve equity/land size	-2	**2****	-1	0
Time in farm work	0	**2****	-1	-3
Advisors, consultants etc.	-1	**1***	-1	-3
Exchange rate, macro economy	2	**1***	-3	-1
Weather/climate	3	**1***	2	2
Quality & quantity of plants and/or livestock	3	**0****	2	2
Retirement	-3	**0****	-2	-2
Customer requirements	0	**-2****	2	1

Note: * significance at p<0.05 and ** at p<0.01.

The type array for Q-sort type 2 confirms this interpretation. Table 8 shows the top eight factors and their corresponding Z scores derived from the Q-sort raw scores ranging from -4 to 4. High among these highly rated factors is off-farm work and financial considerations. Also present are family needs and satisfaction. Thus the off-farm work type emphasises the financial need to improve the farm's finances but with a view to meeting family needs from which they get satisfaction.

Table 8: Highly rated factors for Q-sort type 2

Factor	Z score
Family needs	2.5
Net profit before tax	1.7
Off-farm work	1.3
Farmer decision maker	1.3
Labour	1.2
Improve equity/land size	1.2
Cash farm income	1.1
Satisfaction	1.0
Time in farm work	0.9

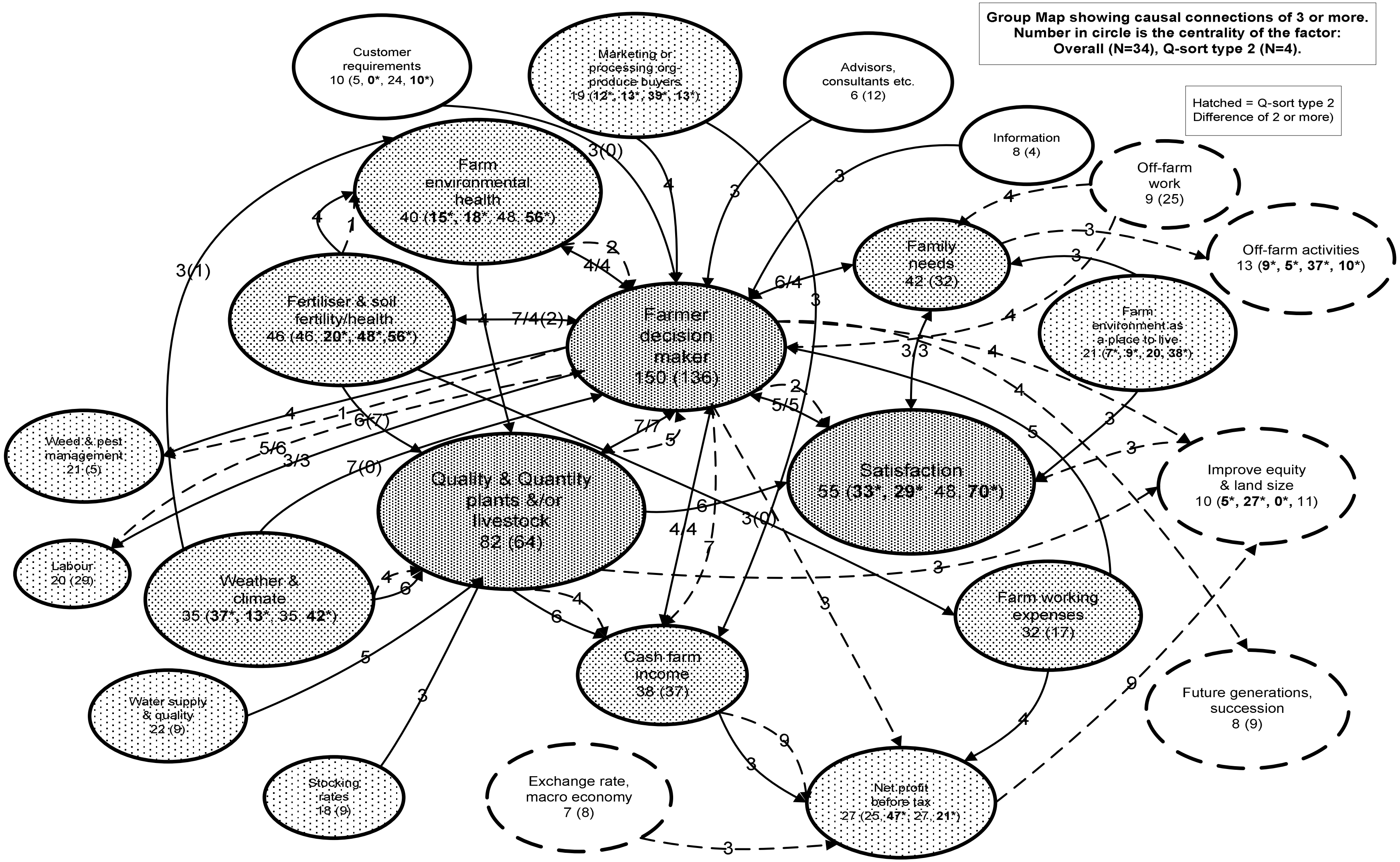
We can also draw from other data available from the other questions asked during the interview to add to the interpretation of Q-sort type 2. While overall there were 62 per cent of farmers who stated that quality of production was more important than quantity, and only 15 per cent who said quantity was most important, among Q-sort type 2 there was one half who said quantity was most important. In addition, two of them said their main farming goals were to improve equity.

Figure 10 shows the causal map for Q-sort type 2 based on average data for the four cases. The map shows the additional factors of off-farm work, off-farm activities, improving equity, future generations/succession and exchange rate/macro economy. Three of these correspond with the distinguishing items shown in the table above. The centrality data (included in the circles in the figure) show that improving equity/land size and net profit have a high score. A number of factors have a lower centrality score, including customer requirements, farm environmental health, fertiliser and soil fertility health, weather and climate, satisfaction, farm environment as a place to live and off-farm activities. Four of these are in the two top-tier factors. Most of the additional connections relate to the additional factors. Further, some of the connections to farmer decision maker from nearby factors are reduced in strength. There are stronger connections to labour. Production is less strongly connected to cash farm income, the latter being influenced by the exchange rate.

It is unusual that off-farm activities has a low centrality but appears as an additional factor because the link from family needs is three not two as it is for the overall average. Perhaps the simpler character of this map, it has a low number of connections, meant that these farmers used fewer arrows to off-farm activities and these coalesced on the link from family needs to off-farm activities, thus producing the average of three.

The results of the connections to or from a factor with statistically different centralities support the off-farm work characterisation. Customer requirements to farmer decision maker is at zero not three, fertiliser and soil fertility health to production is seven not six, to farm working expenses is zero not three. Weather and climate to farmer decision maker is zero not seven, and to farm environmental health is one not three. The map clearly shows the key theme of lower emphasis on environment, production, farmer decision maker and family, and the higher emphasis on farm profits to increase equity facilitated by a greater role played by labour and advisors. Customer requirements are unimportant to this type.

Figure 10: Group map for Q-sort type 2



Q-sort type 3 – External orientation

The data in Table 9 show that Q-sort type 3 has a strong external orientation with particular attention given to markets and customers. These factors receive high scores which are in sharp contrast to the other Q-sort types. Family needs is important but not as much as for types 2 and 4. Off-farm product quality is marginally more important compared to Q-sort type 4. Of all types, Q-sort type 3 gives least emphasis to farmer decision maker. While off-farm work appeals to Q-sort type 2 it is not important to Q-sort types 1 or 4 and has only some importance for Q-sort type 3. Off-farm activities has some importance, consistent with the off-farm orientation of this type. Perhaps there is interest in off-farm, non farm work activities. Farm working expenses has least importance. The other types do not rate contractors as important but Q-sort type 3 sees them as having some importance. Finally, Q-sort type 3 discounts the three external factors of location, exchange rate, macro economy/government policies presumably because they take full responsibility for their farm performance, a feature that is mirrored by Q-sort type 4.

Table 9: Distinguishing items for Q-sort type 3

Factor	**Q type1**	**Q type 2**	**Q type 3**	**Q type 4**
Marketing or processing organisation/produce buyers	1	0	**4****	0
Customer satisfaction	-1	-1	**3****	0
Family needs	1	4	**3***	4
Customer requirements	0	-2	**2****	1
Off-farm product quality	-1	-2	**1***	1
Farmer decision maker	4	3	**1***	2
Off-farm activities	-1	-1	**0***	0
Off-farm work	-4	3	**0****	-3
Farm working expenses	2	1	**0***	1
Contractors	-2	-3	**0****	-2
This location	1	1	**-1***	0
Exchange rate, macro economy	2	1	**-3****	-1
Government policies	0	0	**-4****	-3

Note: * significance at p<0.05 and ** at p<0.01.

The type array for Q-sort type 3 fits this interpretation. Table 10 shows the highest rated factors for Q-sort type 3. The two highest items include the key external factors of marketing or processing organisation and customer satisfaction. While not as highly rated, customer requirements is among the top seven factors. Also important is labour and this corresponds to the emphasis on contractors noted above suggesting that these are farms which are large and employ either or both contractors and labour, or that the farmer delegates work to these two sources. They are not driven solely by markets since family needs are important as is farm environmental health. Note that farmer decision maker has a Z score of 0.6 and it is 16th in the list, thus it is not as important to Q-sort type 3 as all the other types.

Table 10: Highly rated factors for Q-sort type 3

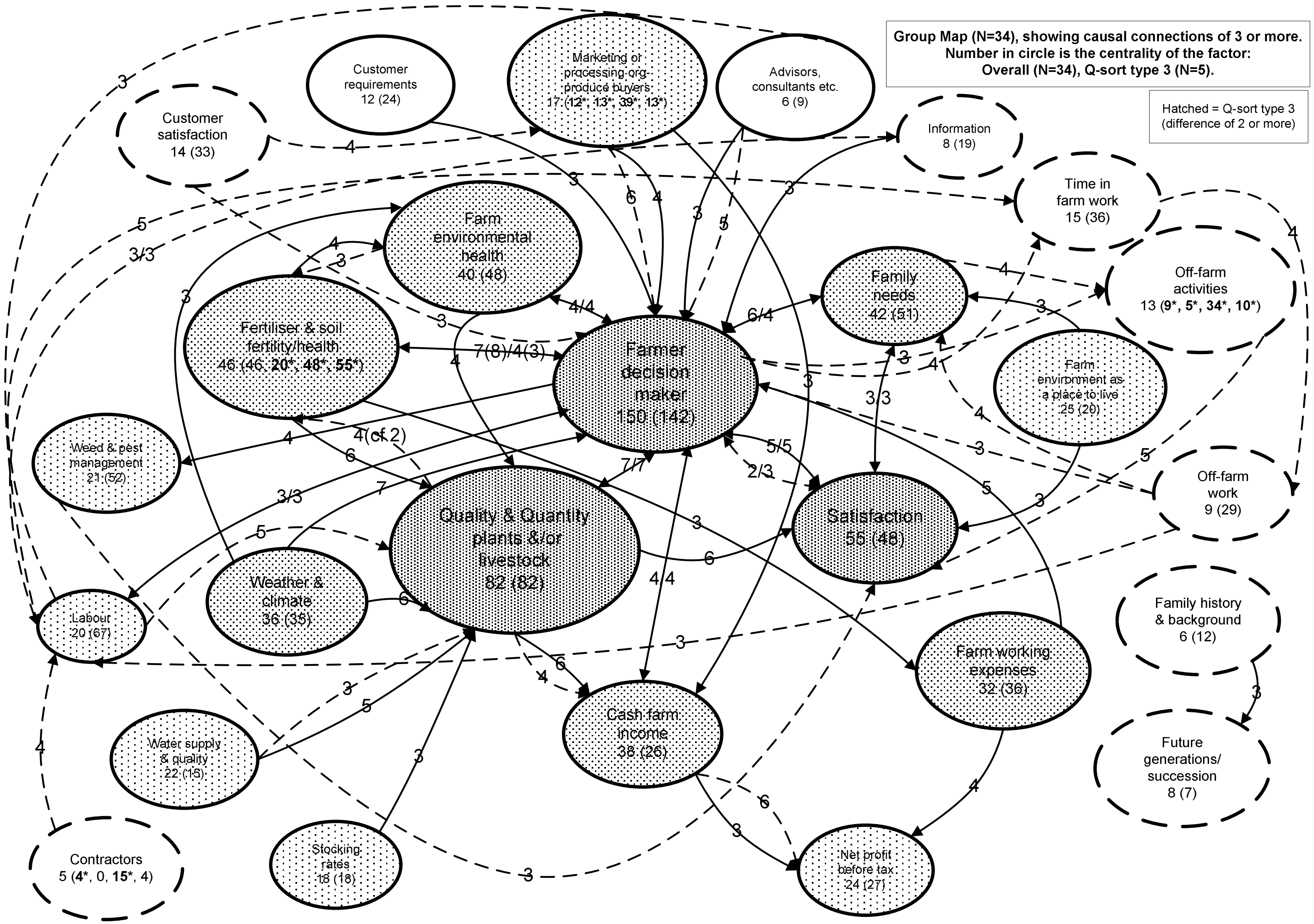
Factor	Z score
Marketing or processing organisation/buyers	1.5
Customer satisfaction	1.4
Labour	1.2
Family needs	1.1
Farm environmental health	1.1
Quality and quantity of plants and/or livestock	1.0
Satisfaction	0.9
Customer requirements	0.9
Weather/climate	0.8

Data from the other questions show that, of the five farmers in Q-sort type 3, four stated that their level of inputs was above average while the fifth stated that he did not know. Further, in their summation of the key characteristics of their causal map three of these five farmers mentioned off-farm work, marketing and customers, and off-farm activities respectively.

Figure 11 shows the causal map for Q-sort type 3 based on average data for the five cases. The map shows ten additional factors, four of which correspond to the distinguishing factors in the earlier table. The additional factors relate to customers, advisors and information, off-farm work and activities, family history and future generations, and contractors. The centrality data show that the statistically significant differences occur for marketing and processing organisation, off-farm activities, contractors, and fertiliser and soil fertility health. In contrast to Q-sort type 2, the top two tier factors retain their importance but, in addition, this type sees markets and customers as paramount and this external orientation is paralleled by the importance given to off-farm work and off-farm activities. The off-farm work is not linked to increasing equity. Most of the additional connections relate to the additional factors and some of these connect to farmer decision maker. Labour has a strong influence (five) on production. This type of farmer delegates farm work to labour and contractors while they meet off-farm commitments. This makes time in farm work an important factor which is affected by labour and contractors. Within the top two tier factors, there are a few differences compared to the overall group map for the 34 farmers. Satisfaction is not so strongly linked to farmer decision maker, production is less strongly linked to cash farm income, and fertiliser and soil fertility health is influenced by both production and farm environmental health. There are few links that are different by only one. Farmer decision maker to fertiliser and soil fertility health is eight not seven, and from fertiliser and soil fertility health to farmer decision maker is three not four.

The key theme of Q-sort type 3 is an external orientation focused on markets, customers, off-farm activities, delegation of work to labour and contractors, and maintaining fertiliser and soil fertility health. This type does not accept that external factors over which they have little control play a significant part in their farm system. They give unexceptional scores to farm environmental health and farm environment as a place to live. The map is dominated by a large number of additional factors.

Figure 11: Group map for Q-sort type 3



Q-sort type 1 – Conventional, external influences

Returning to Q-sort type 1, which was one of the largest types in terms of number of loaders, Table 11 shows the distinguishing items and indicates that this type emphasises farmer decision maker more than the other types. They also see the external factors of weather/climate and exchange rate/macro economy as important. Family needs has some importance but is notable for being lower than all other types. Less important than the other types is future generations/succession and retirement.

Table 11: Distinguishing items for Q-sort type 1

Factor	Q type1	Q type 2	Q type 3	Q type 4
Farmer decision maker	**4****	3	1	2
Weather/climate	**3***	1	2	2
Exchange rate/macro economy	**2***	1	-3	-1
Family needs	**1***	4	3	4
Future generations/succession	**-2****	-1	-1	1
Retirement	**-3****	0	-2	-2

Note: * significance at $p<0.05$ and ** at $p<0.01$

Table 12 throws a little more light on the character of Q-sort type 1. The highly-rated factors confirm the importance of farmer decision maker and the other factors suggest a traditional approach to farming with emphasis on fertiliser, weather and production along with key financial factors, and including the exchange rate as a reasonably important factor. These factors are associated with satisfaction.

Table 12: Highly rated factors for Q-sort type 1

Factor	Z score
Farmer decision maker	2.2
Fertiliser and soil fertility health	1.9
Weather/climate	1.8
Quality and quantity of plants and/or livestock	1.5
Net profit before tax	1.2
Exchange rate, macro economy	1.0
Cash farm income	0.9
Satisfaction	0.9
Farm working expenses	0.8

Figure 12 shows the causal map for Q-sort type 1 based on average data for the eight cases. The map shows that exchange rate/macro economy and this location are the only additional factors. The centrality scores are similar to the overall average for all 34 farmers and most of those that are different are lower. The centrality scores for exchange rate/macro economy and for weather/climate are significantly higher. Farm environmental health is very low at 15 compared to 40, as is farm environment as a place to live (seven compared to 25).

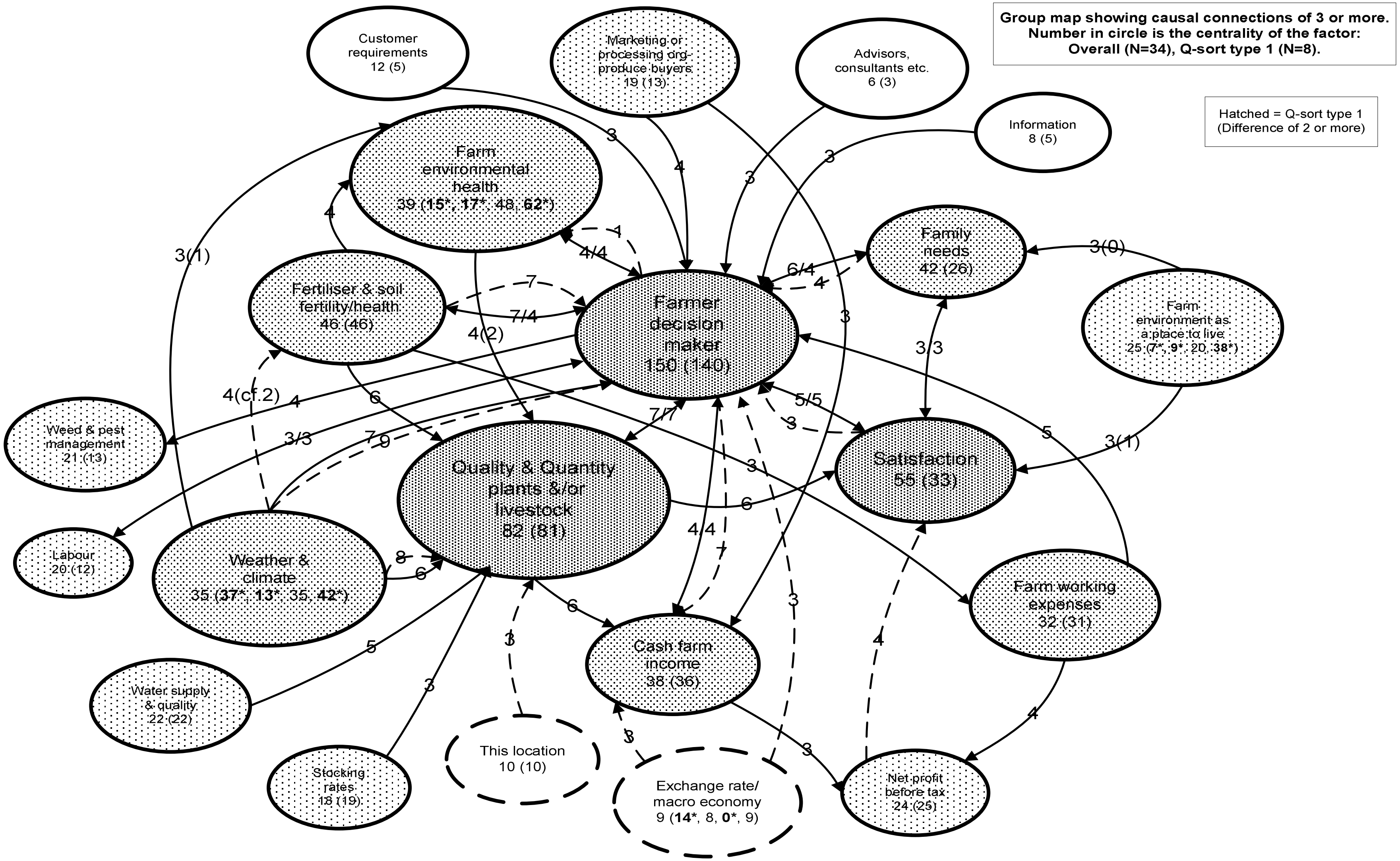
What is unusual about Q-sort type 1 is that while the Q-sort data show that farmer decision maker was the most important factor unlike all other Q sort types (see Table 11), the map data has farmer decision maker with a centrality of 140 - less then the overall average of

150. It seems that Q-sort type 1 did not get drawn into making many connections to or from farmer decision maker while they were developing their map. This is confirmed by the data on the total number of connections on the maps. Q-sort type 1 has a low number of connections at 50 compared to 47 for Q-sort type 2, 74 for Q-sort type 3 and 63 for Q-sort type 4. Further, the data on the ratio of centrality of decision maker to total centrality show that this is high for this type in keeping with the Q-sort results.

While weather and climate has a centrality score similar to the overall score based on the original data, it has, along with Q-sort type 4, a statistically significant higher score when compared to Q-sort type 2. The map also shows that from weather and climate there is an additional arrow to fertiliser and soil fertility health, plus two arrows with greater weight to farmer decision maker and production. These arrows show that weather and climate is seen as having a stronger influence on key parts of the system. The link between fertiliser and soil fertility health and farmer decision maker has a weighting of seven rather than four. The link from family needs to farmer decision maker is lower at four not six. Farmer decision maker affects cash farm income very strongly at seven compared to four. Satisfaction has less influence on farmer decision maker (three compared to five) and satisfaction is more strongly influenced by net profit (four compared to two). There are three connections with a difference of two or more. Farm environmental health affects production by two not four. Farm environment as a place to live affects family needs at zero not three, and satisfaction at one not three. These results suggest that Q-sort type 1 farmers have some subtle differences from the overall average and believe that that some external factors, over which they have little control, have a greater impact on their farm system.

The emphasis given to exchange rate is more typical of farmers who are commodity producers, facing less movable international prices, rather than niche producers who are more able to adjust their prices in response to exchange rate changes. They see that the changes in the exchange rate have a direct bearing on their viability. They see themselves as directly influencing cash farm income. The map suggests that these farmers have a less nuanced view of their farm system and may be less attached to their farm. (There is a hint in the list of cases that these farmers are less attached – two are moving, one is a manager). Six out of the eight Q-sort type 1 farmers are located in inland locations near Blenheim, Methven and Fairlie. Such locations are more likely to experience climatic extremes – drought, frost, etc. – and thus explain to some extent the emphasis on weather in this type. The Q-sort data show that this type gives most emphasis to farmer decision maker and least emphasis to family needs and future generations/succession but these distinctions did not show up on the maps with statistically different centrality scores. The key theme for Q-sot type 1 is the lack of emphasis on the farm environment and the importance given to two external factor - the weather and climate, and the exchange rate/macro economy.

Figure 12: Group map for Q-sort type 1



Q-sort type 4 – Ecological

Finally, we can consider Q-sort type 4. Table 13 shows that the farm environment as a place to live is important while future generations/succession is more important compared to all other types. Some importance is given to off-farm product quality while improving equity is not very important. As noted above, there is less emphasis given to government policies and exchange rate/macro economy and even less to advisors or consultants.

Table 13: Distinguishing items for Q-sort type 4

Factor	Q type1	Q type 2	Q type 3	Q type 4
Farm environment as a place to live	0	1	1	**3****
Future generations /succession	-2	-1	-1	**1****
Off-farm product quality	-1	-2	1	**1***
Improve equity/land size	-2	2	-1	**0***
Exchange rate/macro economy	2	1	-3	**-1***
Government policies	0	0	-4	**-1****
Advisors, consultants etc.	-1	1	-1	**-3****

Note: * significance at p<0.05 and ** at p<0.01

The type array for Q-sort type 4 (Table 14) shows that family needs is most important with emphasis also on fertiliser and soil fertility health. The environment generally is ahead of production, and decision maker is relatively less important. There is only one financial factor in this top nine.

Table 14: Highly rated factors for Q-sort type 4

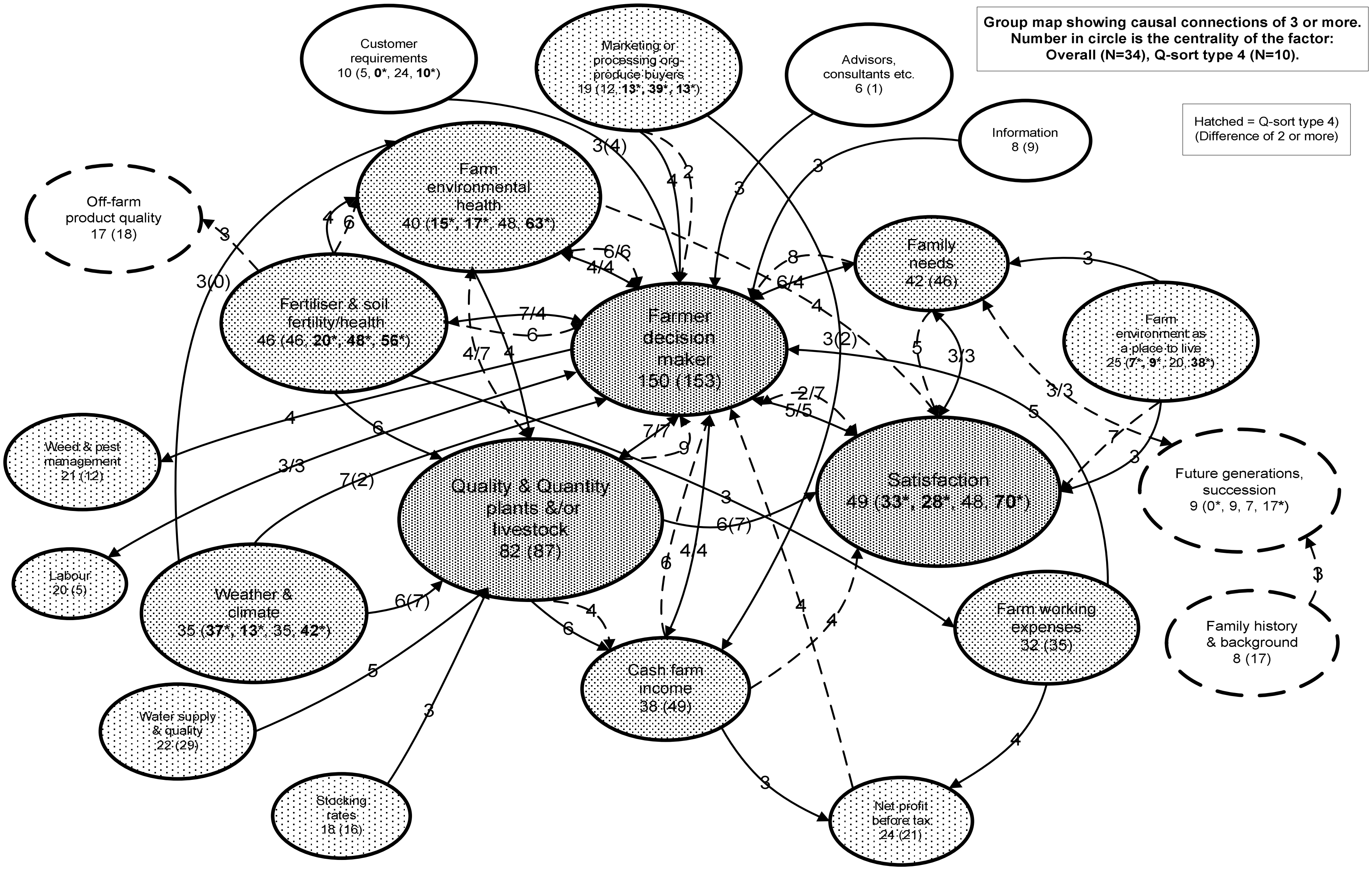
Factor	Z score
Family needs	1.9
Fertiliser and soil fertility health	1.7
Farm environment as a place to live	1.4
Satisfaction	1.4
Farm environmental health	1.4
Weather/climate	1.2
Quality and quantity of plants and/or livestock	1.2
Farmer decision maker	1.2
Cash farm income	1.0

Figure 13 shows the causal map for Q-sort type 4 based on average data for the ten cases. The map shows the additional factors of off-farm product quality, future generations/succession and family history and background. The significant centrality scores include the two environmental factors, future generations/succession, customer requirements, marketing and processing organisation, fertiliser and soil fertility health, satisfaction, and weather and climate. The additional arrows reflect these centrality scores but most of them relate to factors in the top two tiers. In terms of influences on farmer decision maker, farm environmental health, fertiliser and soil fertility health, family needs and production all have stronger connections. In contrast, satisfaction has a lower influence on farmer decision maker. Farm environmental health is linked to production more strongly and there is reverse link here too. Fertiliser and soil fertility health has a strong effect of farm environmental health. Income is not seen as so strongly deriving from production but financial factors are very important: cash farm income to farmer decision maker, and to satisfaction, are higher.

Links with a difference of one occur for customer requirements to farmer decision maker (four not three) and from marketing or processing organisation to cash farm income (two not three). Weather and climate has mixed effects: to farm environmental health it is zero not three, to farmer decision maker it is two not seven but to production is seven not six.

These farmers believe that production per se is less important as an influence on cash farm income. They pay attention to net farm profit. For Q-sort type 4 there is greater satisfaction from meeting family needs, and from farm environment as a place to live and from farm environmental health. Clearly, this type of farmer emphasises the environment in their farming system, and gets satisfaction from this emphasis. They include future generations and succession. The distinctive theme of this type is the importance given to farm environment, fertiliser and soil fertility health, satisfaction and future generations/succession, showing that they are satisfied living on the farm and have some stake in the future. The map data correspond well with the Q-sort data although the latter show that this type emphasises family needs more than the map indicates. There is an overall theme of emphasising the farm environment hence the word ecological in the title.

Figure 13: Group map for Q-sort type 4



Comparing Q-sort types 1 and 4

The tables above show very well the character of each of Q-sort types 2 and 3 but are not so good at characterising Q-sort types 1 and 4. Additional data shown in Table 15 help compare these two types. The table shows the factors which have greatest differences in the scores. The table makes clear that the first two external factors of exchange rate and government policies are rated as more important by Q-sort type 1, and this type sees weed and pest management as a key part of farming. They do not rate advisors very highly but they give this factor a higher rating than Q-sort type 4, as they do farmer decision maker and net profit before tax. Thus, they emphasise profit before lifestyle. Q-sort type 4 in contrast emphasises family and environmental factors more. Perhaps their emphasis on farm environment as a place to live means that they rate farm environmental health and stream health more highly.

Table 15: Descending array of differences between Q-sort type 1 and type 4 (Z scores)

Factor	Type 1	Type 4	Difference
Exchange rate, macro economy	0.9	-0.4	1.3
Government policies	0.0	-1.2	1.2
Weed and pest management	0.6	-0.6	1.2
Advisors, consultants etc.	-0.4	-1.5	1.1
Farmer decision maker	2.2	1.2	1.0
Net profit before tax	1.2	0.3	0.9
Stream health	-0.8	0.0	-0.8
Off-farm product quality	-0.7	0.3	-1.0
Farm environmental health	0.4	1.4	-1.0
Family history and background	-1.6	-0.4	-1.2
Family needs	0.5	1.9	-1.4
Farm environment as a place to live	-0.2	1.4	-1.6
Future generations/succession	-1.5	0.8	-2.3

Organic panel compared to Q-sort type 4 - Ecological

The results presented so far show that the organic panel and Q-sort type 4 are similar. Both appear to have a strong environmental orientation. It remains necessary to compare these two results and see in what ways they are similar and different. The first point to note on the comparison of the two causal maps is that they both have the additional factor of off-farm product quality. The organic panel has a higher centrality at 25 compared to 18 for Q-sort type 4. The are four connecting arrows for the organic panel, from farm environmental health, weather and climate and farmer decision maker as well as the common one of fertiliser and soil fertility health. Q-sort type 4 has future generations/succession as an additional factor and it is linked to family needs. Off-farm product quality is important for both but less so for Q-sort type 4 because this type has been diminished on this point by the organic farmers in Q-sort type 3 who also emphasise this factor. The same applies to marketing and processing organisation.

Some of the additional connections in each map correspond well. These include the link between farmer decision maker and farm environmental health. In both cases each of the two links is stronger than in the overall causal map. The link from fertiliser and soil fertility health to farm environmental health is strong in both cases. The link from satisfaction to farmer decision maker is low in both cases but Q-sort type 4 has a stronger link from farmer decision maker to satisfaction, and a higher centrality score for satisfaction.

A number of connections in each map match the other but do not show up because they did not exceed the overall average by two or more and therefore do not always appear on the maps. Table 16 shows these connections and has bolded scores for those which are different by two from the overall average. These data suggest that the two maps in question are more similar than it appears. For all factors listed the general trend is followed by both the organic average and the Q-sort 4 average.

Table 16: Connections that have similar weights for the organic panel and Q-sort type 4 - Ecological

Connection	Overall average	Organic average	Q-sort type 4 average
Farmer decision maker to labour	3	**1**	2
Quality and quantity to cash farm income	6	5	**4**
Cash farm income to farmer decision maker	4	5	**6**
Net profit before tax to farmer decision maker	2	3	**4**
Farm environmental health to satisfaction	2	3	**4**
Farm working expenses to farmer decision maker	5	**2**	4
Fertiliser and soil fertility health to farmer decision maker	4	5	**6**
Farmer decision maker to satisfaction	5	6	**7**

In contrast, a number of connections run in opposite ways when the maps are compared and it is here that some differences can be seen. Table 17 shows these connections.

Table 17: Connections that have dissimilar weights for the organic panel and Q-sort type 4 - farm environment, satisfaction, future

Connection	Overall average	Organic average	Q-sort type 4 average
Farmer decision maker to fertiliser and soil fertility health	7	**9**	7
Quality and quantity to farmer decision maker	7	6	**9**
Family needs to farmer decision maker	6	5	**8**

The main focus should be on the significant differences in centrality scores. For both the organic panel and for Q-sort type 4 there is correspondence in the higher values for customer requirements, farm environmental health and for fertiliser and soil fertility health. The organic panel also emphasise off-farm product quality but give significantly lower scores for production, weed and pest management and expenses. The theme here is customers, product quality, good fertiliser and environmental health at low expense. Q-sort type 4 farmers give distinctive emphasis to weather/climate, satisfaction, future generations and farm environment as a place to live. The theme here is satisfaction from living on the farm with an orientation to the future.

3.5 Combination of Q-sort types

The Q-sort data have yielded interpretable types of farmers with considerable detail but the depth of results brings both advantages and disadvantages. On the one hand the types are clearly characterised but on the other hand the number of types makes it more onerous to comprehend the essential findings. For policy and other purposes it may be more useful to have some basic core findings that draw from the Q-sort type results but simplify them somewhat. One way to do this is to combine Q-sort types 1 and 2 and combine Q-sort types

3 and 4. The main justification for this simplification lies in the basic similarity between these pairs. Q-sort types 1 and 2 have a lower number of statistically different centrality scores and they tend not to have higher than average centrality scores. On the other hand, Q-sort types 3 and 4 are similar in that they have an external orientation and give high scores to environmental factors even though these are not statistically significant in the case of Q-sort type 3.

Table 18 shows the statistically significant centrality scores for the combined types. These data comprise the 27 farmers with significant loading on one Q-sort type, plus four other cases where the farmer loaded on Q-sort types 3 and 4. Thus the combined types include a total of 31 out of the 34 farmers studied. To simplify the notation we refer to Q-sort types 1 and 2 as Type A and to Q-sort types 3 and 4 as Type B. Overall, the results show that type B had higher centrality scores for all the listed factors and, accordingly, their total centrality is high and significantly different. Type B gives emphasis to three distinct themes. First, they emphasise an off-farm theme of customer requirements, customer satisfaction and off-farm product quality. Second, they emphasise a social theme reflected in family needs, future generations/succession and satisfaction. Third, they emphasise an environmental theme through farm environment as a place to live, farm environmental health and stream health.

Table 18: Significant centrality scores and map characteristics for combined Q-sort types

Factor	All 34	Combined Q-sort type 1&2 Type A (12)	Combined Q-sort type 3&4 Type B (19)
Customer requirements	9.5	3.6	17.2**
Customer satisfaction	12.7	3.2	18.7**
Family needs	39.1	28.2	47.8*
Farm environment as a place to live	21.1	7.6	31.9**
Farm environmental health	39.2	16.0	57.7**
Future generations/succession	8.8	2.8	13.5*
Off-farm product quality	16.6	7.9	23.2*
Satisfaction	48.7	31.6	62.5**
Stream health	12.7	4.8	19.0*
Total centrality	855	686	999**
Number of connections		49	64**
Number of connections per variable		2.4	3.0*
Centrality for decision maker/ total centrality		0.202**	0.162

Note: * significance at p<0.05 and ** at p<0.01.

In addition, there were three significantly different map characteristics. Type B had a greater number of connections per map (67 cf. 49**), and the number of connections per variable was higher (3.0 cf. 2.4*). In addition, for Type A the centrality of farmer decision maker was a larger proportion of the total centrality.

It must be noted that some of the centrality scores, while showing significant differences, are still low. For example, future generations/succession at 13.5 indicates that the factor is still not very important.

Six out of the 12 Type A farms are located exclusively in inland locations near Blenheim, Methven and Fairlie and, as suggested earlier, may be related to the higher incidence of drought and frost in these locations.

It is possible that the higher number of connections in some maps was derived from the fact that if two people created the map it is likely that they put in more connections. This possibility was examined by assessing the presence of farm couples for Type A and Type B, the latter having more connections per map. The data showed that farm couples occurred with the same frequency in each type.

3.6 Conclusion

This chapter has presented results on the overall group map for sheep/beef farming. It gave a detailed analysis of that map before examining group maps for the panels and for the Q-sort types. For the latter there were two sets of data, one to characterise the Q-sort types and the other to characterise the maps for each type. There was not a strong correlation between the Q-sort types and the centrality data for each type. Thus the map data do not neatly correspond to the Q-sort data for each of the Q-sort types. For example, Q-sort type 3 has marketing or processing organisation as the most important factor but the map data show this factor has a modest but above average centrality score of 39. Clearly, the mapping process meant that the causal connections made other factors more important in terms of centrality. However, the patterns are similar: the score of 39 mentioned above is more than twice as high as the centrality score for the other three Q-sort types (all at 13). This observation suggests that there is an advantage in grouping farmers based on the Q-sort data rather than the centrality data because the former are based on a simpler assessment of importance. Putting it another way, without the Q-sort types we might not have been able to make the distinctions by relying on the centrality data alone. When farmers made their causal maps, the mapping process itself meant that certain key factors dominated those linkages, particularly for farmer decision maker, and this means that the derived centrality data have swamped or masked the differentiations that may exist between types of farmers.

In addition to the analyses presented in this chapter, the centrality data and the Q-sort data were analysed using Principal Components Analysis. The data were standardised. The centrality data across management system results showed a difference across the third PC in which organic is different from both the others. This PC emphasises positively off-farm work, family needs, community, advisors/consultants, family history, farmer as decision maker, and time in farm work. It has a negative emphases on farm environmental health, stream health and off-farm product quality. These latter findings are broadly similar to the results in Table 7 showing the distinctive centralities for the organic panel.

PCA for the Q-sort data found organic was significantly different from integrated and conventional on the first PC (13% of the variation). This PC has positive emphases on off-farm product quality, stream health, customer requirements, customer satisfaction, and farm environmental health, with negative emphases on profit, equity, cash flow and advisors.

Across the four Q-sort groups the centrality data showed some differences across PC2, PC3 and PC5 that reinforced the choice of the four groups. This was even more apparent using the Q-sort data, with differences across the first three PCs. Across the two Q-sort groups (1&2 combined and 3&4 combined), using the centrality data there were differences for the first and third PC, however there were no differences when the Q-sort data was used, suggesting that four groups rather than two is the better approach.

Our analyses of the centrality and Q-sort data show that they are not easily reducible to simpler constructs. For the factor analysis or PCA, when the data are summarised by four or five factors, these are only describing a modest proportion of the variability (62 per cent for the Q-sort data and 50 per cent for the centrality data).

Location effects were found but they were, in the main, unsurprising. Labour, weed and pest management, fertiliser/soil fertility health and government policies had locational effects. We would expect the former ones to be affected by location but the result for government policies is hard to fathom.

Chapter 4
Key Findings and Discussion

4.1 Introduction

This conclusion provides a summary of our research approach and the results. It then interprets the results on a number of dimensions. It concludes with a discussion of some limitations of the research.

4.2 Summary of approach

This research had four objectives. The first was to document how farmers participating in our ARGOS research described and explained the management of their farm system. The second research objective was to assess the results for any patterns in the way farm systems are seen and understood. The third objective was to contribute towards some specific social objective aims, namely to identify sites of action for farmers - that is, places where action to achieve sustainability may occur - and perceived constraints on that action. The final objective was to contribute to modelling the environmental systems in which farmers operate.

The refinement of causal mapping applied in this research followed our earlier work on kiwifruit orchardists. In response to some problems we encountered with the kiwifruit research, the method was developed into a two-stage approach whereby farmers first completed a Q sort of the factors and this prepared the way for them to work with the most important factors in making their own causal map on an A2 piece of paper. Farmers moved the cards around to create their map with many causal connections, in some cases in two directions, each one weighted with a number from one to ten to show the strength of causal connection.

The data were used to prepare a group causal map for all 34 farmers by focusing mainly on the centrality of the factors. This map showed the key factors and their inter-relationships and demonstrated the fundamental nature of sheep/beef farming. After working with the data for all 34 farmers, attention was given to the group map for each of the three panels. Then the Q-sort data were analysed using standard Q-methodology factor analysis to identify four groups of farmers. Maps were prepared for each Q-sort type. Finally, the Q-sort types were combined into two types.

4.3 Summary of results

The main characteristics of the maps are as follows:

Group map

The overall group map shows that sheep/beef farming involves the management and response to a wide variety of factors, including economic, environment and social ones. At the core of the map are personal (farmer decision maker and satisfaction) and production factors surrounded by soil, environmental, climatic, family and cost factors. True to the family farm structure of much of New Zealand farming, the map shows the closely integrated role of family in the farming system. And the map is not insular since there are connections extending outwards including other people and related factors, especially the marketing or processing organisation along with customers, advisors and sources of information. There is a strong production orientation in the map with some of the strongest connections from farmer decision maker to fertiliser and soil fertility health and to production. However, the environment is also important, reflected in farm environmental health and farm environment as a place to live. The sources of satisfaction (production, farmer decision maker, farm environment as a place to live and family needs) are quite varied and reflect the broad mix of factors at the core of the map.

Other data rounded out the general findings. Most sheep/beef farmers reported that quality of production, rather than quantity of production, was most important. A modest majority stated that their farms were above average in terms of level of inputs per hectare. Farm environmental health was defined most often in terms of its negation, that is, the farmer can know when it is not good from signs of ill health. The farmers expressed a flexible attitude to change on their farms. Farmers also stated that a resilient farm had financial flexibility or was adaptable in other ways.

Many of the core factors in the map are connected with bidirectional arrows so they are in a dynamic and complex relationship with each other. Changes in one factor would necessitate changes in nearby factors. These sheep/beef farmers are juggling many factors in the day-to-day and longer-term planning and management of their farms. It is because of this complexity of factors shown at the generic level for all 34 farmers that farmers create ways through the complexity by developing a strategy or approach that makes sense to them and appears to meet their needs. These different strategies mean that there are distinctive ways that farmers combine and relate factors despite having some core similarities. The results of this research for the panels and the Q-sort types illustrate these different strategies.

Conventional panel

- There is a very close match between the conventional panel and the overall average.
- Conventional farmers emphasised customer requirements, marketing and processing organisation, and weed and pest management.
- Conventional farmers gave less emphasis to farm environmental health.
- The key theme of the conventional panel is lower emphasis on farm environmental health while weed and pest management, customers and marketing are of greater importance to conventional farmers.

Integrated panel

- Integrated farmers emphasised advisors, farm working expenses and production.
- Integrated farmers had the highest number of low centrality scores including: customer requirements, farm environmental health, fertiliser and soil fertility health, marketing or processing organisation and off-farm product quality.
- The key theme of the integrated panel is an on-farm focus on high quality and quantity of production, managing expenses, meeting family needs and gaining satisfaction.

Organic panel

- Organic farmers emphasised customer requirements, off-farm product quality, farm environmental health, and fertiliser and soil fertility health.
- Organic farmers gave less emphasis to advisors/consultants, farm working expenses, production, and weed and pest management.
- The stronger links involving fertiliser and soil fertility health, farm environmental health and farmer decision maker all show the priority that farmers in the organic panel gave to the health of their farms.
- The key theme of the organic panel map is farm health to achieve off-farm product quality with lower farm working expenses.

The analysis of panel data shows some important differences among the farmers but this approach is not the only way to analyse the data. Q-sort data provides four groups, as follows. (They are presented in order from the smallest to the largest in terms of number of farmers who define the type.)

Q-sort type 2 – Off-farm work (N = 4, 1 organic, 2 integrated and 1 conventional)

- Q-sort type 2 has an off-farm work orientation where the work is related to improving the financial position of the farm.
- Q-sort type 2 gave less emphasis to environment, weather and climate, and satisfaction.
- These farmers are trying to build up their farm financial situation notably by improving their equity.
- They have a map with fewer connections suggesting that their view of farming is less complex compared with other types.
- The key theme of Q-sort type 2 is lower emphasis on environment, production, farmer decision maker and family, and higher emphasis on farm profits to increase equity facilitated by a greater role played by labour and advisors. Customer requirements are unimportant to this type.

Q-sort type 3 – External orientation (N = 5, 2 organic, 1 integrated and 2 conventional)

- Particularly important to Q-sort type 3 are off-farm activities, contractors, fertiliser and soil fertility health, and marketing or processing organisation.
- This type sees markets and customers as paramount and this is paralleled by the importance given to off-farm work and off-farm activities.
- Labour has a strong influence on production. This type of farmer delegates farm work to labour and contractors while they meet off-farm work commitments.
- The key theme of Q-sort type 3 is an external orientation focused on markets, customers, off-farm activities, delegation of work to labour and contractors, and maintaining fertiliser and soil fertility health.

Q-sort type 1 – Conventional, external influences (N = 8, 1 organic, 3 integrated and four conventional)

- Q-sort type 1 does not emphasise the farm environment as much as other types and sees the weather and climate, and exchange rate/macro economy, as having a greater influence.
- Results show that Q-sort type 1 has only some subtle differences from the overall average and these farmers believe that that some external factors, over which they have little control, have a greater impact on their farm system.
- Like Q-sort type 2 they have a map with fewer connections suggesting that their view of farming is less complex compared with other types.
- The key theme for Q-sort type 1 is the lack of emphasis on the farm environment and the importance given to three external factors – the weather and the exchange rate/macro-economy.

Q-sort type 4 – Ecological (N = 10, 6 organic, 2 integrated and 2 conventional)

- Q-sort type 4 emphasises farm environmental health, farm environment as a place to live, customer requirements, fertiliser and soil fertility health, satisfaction, and weather and climate. Off-farm product quality is an additional factor on the map.
- Farm environmental health, fertiliser and soil fertility health, family needs and production all have stronger connections to farmer decision maker.
- Farm environmental health is linked strongly to production, and fertiliser and soil fertility health has a strong effect on farm environmental health.
- The link from production to income has less emphasis but financial factors are still very important.

- Q-sort type 4 gets greater satisfaction from meeting family needs, farm environment as a place to live and farm environmental health.
- The key theme of Q-sort type 4 is the importance given to the farm environment, fertiliser and soil fertility health, satisfaction and future generations/succession.

Combined Q-sorts

- Type B (comprising Q-sort types 3 and 4) compared to Type A (comprising Q-sort types 1 and 2) emphasise: an off-farm theme of customer requirements, customer satisfaction and off-farm product quality, a social theme reflected in family needs, future generations/succession and satisfaction, and an environmental theme represented by farm environment as a place to live, farm environmental health and stream health.
- Type B farmers have significantly more connections on their maps and significantly more connections per variable.

4.4 Discussion and Interpretation of Results

The first two objectives of this research have been fully met. For the first research objective, the aim was to develop an account of farmers' perception of the sheep/beef farm management system by identifying the factors that comprise the system and by showing how the factors were linked. This objective has been achieved with the development of the group map for sheep/beef farming. The second objective was to examine different patterns among the farmers and this has been achieved by examining panel data and by examining Q-sort types. The third and fourth objectives have yet to be met. The third was to identify sites of action - that is, places where action to achieve sustainability may occur - and perceived constraints on that action. This objective is addressed partly in the discussion below. The final objective was to contribute to modelling the environmental systems in which farmers operate. This objective has been partly met by the maps but more work is needed to develop dynamic models.

Meta analysis worked well. While each sheep/beef farm is unique, there was sufficient similarity in the relevance of the factors and how they were connected that patterns emerged and the resulting group map represents sheep/beef farming generally. There were consistencies in the ratings of factors such that a relatively small number of factors were important in many of the maps. A group map was able to be produced which mainly showed the common causal connections among the key factors. While there were some significantly different causal connections for each panel and Q-sort type, these are still outnumbered by the common causal connections indicating that there is much that was similar across the panels and Q-sort types.

The results have included details relating to the three panels and the four Q-sort types. The former are useful for showing differences derived from participation in a management system. But such participation is not necessarily the best way to understand approaches to farming. We know from earlier research (Fairweather, 1999; Darnhofer et al., 2005) that organic farmers include those who are philosophically committed and those who are pragmatically committed to organic farming. Each type of orientation can have a different expression of organic farming, that is, it can manifest in different ways. Similarly, there may be conventional farmers who practise farming utilising organic production methods but they have not gone so far as to become certified. Consequently, the panels may contain farmers who do not necessarily consistently reflect the management system they are using. This may be an important factor in explaining why some of the early ARGOS tests of the null hypothesis have not found any significant differences across panels. The Q-sort data have provided a more grounded grouping of farmers, that is, groupings that are based on factors that the farmers have chosen to emphasise. These particular results show that the formal management system does not precisely correspond to the Q-sort types, but there are some consistencies in the results. For example, Q-sort type 4 (and similarly Type B) have a majority of organic farmers, but some integrated and conventional ones as well.

The discussion covers a number of topics indicated by the subheadings below. In some cases the discussion is of a preliminary nature but is appropriate for a report which has as its principle focus the presentation and analysis of causal map data.

Location effects. The results showed some interesting location effects. Six out of the eight Q-sort type 1 farmers, and six out of 12 type A farmers, were located in inland locations near Blenheim, Methven and Fairlie. Such locations are more likely to experience climatic extremes such as drought, frost, etc. As suggested earlier, this location effect is consistent with the emphasis that Q-sort type 1 gave to weather, although similar emphasis was given to weather by Q-sort type 4. Some of the other characteristics of farmers in both Q-sort type 1 and in type A is that they had fewer connections in their maps and give more importance to farmer decision maker in their maps. With fewer connections their maps are simpler. What we do not know at this stage is whether the rigours of the climate and the location mean that the farmers are forced to view their systems as less complex, or whether the farmers who have chosen to live in these regions inherently see their farming system as less complex. Climatic rigour, it could be argued, would make the farm system more complex since some of the farming fundamentals would change season by season. On the other hand, the climate may limit the range of options farmers have and this makes for a simpler system. But this link from the environment to the farmer is not consistent with the fact that these farmers gave more emphasis to decision making. Again, it is not clear if weather limits the role of decision making or requires a greater role for it.

Confirmation of core similarities across panels. Earlier research by the ARGOS social team (Hunt et al., 2005; Hunt et al., 2006), has found that the different management system panels share a core of similar characteristics. That is, while the interview data showed that there were distinctive characteristics associated with each panel, there was a common core of shared beliefs about farming. The results from the causal maps also reinforce this view. While we have emphasised the differences across panels and across Q-sort types, it is still the case that the maps have many factors which had similar levels of importance to the farmers.

Preliminary comparison to kiwifruit. The results of the kiwifruit study showed that the kiwifruit group map reflected an overall productive orientation typical of orchardists. The centrality data showed that the most important factors in this case were decision maker, quality and quantity or production, ZESPRI, financial factors and satisfaction, mainly derived from the former factors. This held across all panels indicating that the growers were not particularly eco-centric or ecosystem oriented, but took a very production focused approach to their orcharding system. Unlike the results from the kiwifruit research, the sheep/beef farmers did engage with and incorporate farm environmental processes and family strongly into their causal maps.

The kiwifruit group map showed a greater role for key oganisations with which orchardists interact, including ZESPRI, contractors and packhouse, and kiwifruit groups or organisations. Sheep/beef farmers did acknowledge the role of marketing or processing organisation, although this link was not strong (four compared to seven), and they did not have noticeable links to farmer groups or organisations.

The role of the family in sheep/beef farming. There are complex interactions among the central factors in the map and one of these is family needs. Thus, any change in family situation, such as a birth or a death, could affect family needs and this, in turn, has a major influence on farmer decision maker. The other key factors influence farmer decision maker which in turn affect family needs. This result supports the claim that sheep/beef farming in many cases has a strong family farm characteristic. This claim entails the view that what is distinctive in farming is that family factors can have a direct influence on the conduct of farm management. Family needs can influence the way the farm business is conducted, not just as a rationale for farming to make a return to support a family, which is typical for people in other businesses. However, the results also show that some family-related factors are not very important on sheep/beef farms. For example, future generations/succession has an overall centrality of eight in scores that range from zero to 150. Family history and background has a centrality of six. One Q-sort type did give more emphasis to future generations and succession but it was still a lower rated factor. The findings show that while sheep/beef farming overall still has a family character it does not in terms of succession.

The Q-sort results show that among the different types there is variable importance attached to family. Q-sort type 1 has the lowest score for the importance of family needs at one compared to either three or four for the other three types. While future generations/succession is not generally important, for Q-sort 1 it has the lowest score of -2.

These results are in line with the commonly expressed view of ARGOS farmers, and other New Zealand farmers, that they do not expect their children to continue in farming but they would, if the child were interested, strongly support them in such a career. This conditional commitment to farming succession is relatively new and in contrast to earlier times, typically before the 1980s when farmers had stronger expectations about farm succession, paralleled by stronger recognition and support for farming from the general public.

The results also show that the traditional family farming values or characteristics, such as succession, customer requirements, farm environment as a place to live (Q-sort type 4) and customer requirements and off-farm product quality (organic), are supported most by organic farming.

Character of integrated farming. The group causal map for integrated farming shows that customer requirements and marketing and processing organisation have relatively low centrality. We would assume that integrated farmers are very customer oriented because the rationale for integrated farming is usually expressed in terms of market need. Perhaps what is happening is that in terms of explaining why they have adopted integrated farming, such explanation necessarily would involve reference to customers and processing organisation. However, when formulating the maps these considerations were outweighed by on-farm factors (production, sales, family needs). Integrated farmers have a contract to deliver certain quality of stock at specified times and this requires careful management of stocking rates and feed supply. Achieving this rigorous requirement could be a source of satisfaction. This on-farm focus is different to that of the organic panel map which has distinctive changes in the central factors (on farm) but maintains importance of customer requirements and off-farm product quality. One implication of this finding is that encouraging farmers to adopt integrated management may work best by appealing to on-farm benefits rather than off-farm consequences.

Role of environmental factors. Among the important factors in the overall group map were farm environmental health and fertiliser and soil fertility health. Slightly less central was farm environment as a place to live. The first two are closely linked to farmer decision maker and to production. The connection between farm environmental health and production is interesting: farmers were saying, in response to enquiries about farm environmental health, that it is important because when it "goes bad" it adversely affects production. Farmers are also aware of the environmental effects of fertiliser applications as indicated by a causal link from fertiliser and soil fertility health to farm environmental health.

The emphasis on environmental factors is interesting because it did not come up in pre-testing. These pre-test interviews were open ended discussions about what factors were important in the farming system broadly defined. The environmental factors were added because we thought they might still have some role to play in the causal mapping. It is fair to say that increasing plant and animal biodiversity did not rate very highly and there is considerable scope for this concept to be developed and communicated to farmers. Its most frequent meaning in discussion was one of productive biodiversity.

Perhaps these farmers give the appearance of concern for the environment with the relatively high centrality for farm environmental health and farm environment as a place to live but in reality may not fully appreciate their ecosystem. After all, as the map shows, farm environmental health is linked to production and farmers are aware of the negative impacts of poor environmental health. Further, they are living on their land so they would express concern for the farm environment as a place to live. However, the maps show that some factors are not strongly linked to farm environmental health such as stocking rates and water supply. Similarly, there were low connections between farm decision maker and stocking rates and water supply. The low scores for these factors suggest that there are some blind spots in farmers' thinking about environmental issues. Also, as noted earlier, increasing plant and animal biodiversity was often interpreted as productive biodiversity such as changing stock genetics. This observation implies that farmers may profess concern for their environment but may not be strongly ecological in their thinking. They may not be so ecologically literate as other observers or researchers of farm systems. It may also be the case that farmers have difficulty in understanding the terminology and concepts that are currently popular in ecology.

Combined types. While it has been useful to analyse the Q-sort data into four types, we have also used a simpler analysis of two groups, Type A and Type B. Type A maps have fewer connections and give less emphasis to the environment. Type B maps have more connections and emphasise satisfaction, external factors, the environment and family. From the 34 farmers studied Type A comprises 12 farmers and type B comprises 19 farmers with three not fitting any group. Type A includes five conventional, five integrated and two organic farmers, while Type B includes four conventional, five integrated and ten organic farmers. Theirs is an eco-cultural approach, one that emphasises environment and family. They have a more profound view of their systems and this manifests wherever they focus their attention, whether it be family, environment or production.

The defining characteristics of Type B suggest that these characteristics may be social indicators of eco-cultural resilience. Production is still important, as it is for all types. There are more sources of satisfaction and this could imply greater wellbeing. We are raising the possibility that farmers with a more complex map may be better able to handle shocks in the future but this suggestion is by no means proven by the data presented here.

Sheep/beef farming as a complex system. The group map results also raise a very important question about the complexity of sheep/beef farming systems. Is sheep/beef farming a complex system? Galmiche-Tejeda (2004) argues that farmers think holistically and in terms of complex systems of relationships and therefore recommends that research methods be used in ways that are appropriate to this reality. Our results show that sheep/beef farmers do think about their farming system as complex systems because they include economic, environmental and social factors, and include them all in the central part of their farm map. However, farmers in the organic panel and Q-sorts types 3 and 4, and Type B, have more connections in their maps. The results suggest that that there is differentiation among farmers in their appreciation of farm complexity. We conclude that while sheep/beef farmers are dealing with a complex system some of them perceive it to be more complex than others. It is more likely that organic farmers and Type B farmers fall into this category. As suggested above these farmers may be exhibiting eco-cultural resilience.

Perhaps what is happening in our data is not so much measurement of complex systems but that farmers did as we asked them. We asked them to consider what factors were involved in their farming system broadly defined and they have obliged us with a map which shows this. While this is true, the results still show the depth of thinking by farmers and how they have different ways of working through the complexity of the system. Importantly, the results show differentiation in the degree of complexity, and greater complexity is associated with environment not production. Further, while the farmers could have chosen only a few factors to use in their maps, they typically used many factors.

Complex farm systems are not necessarily holistic ones. The issue of holistic farming systems has been given some characteristics by Jay (2007). She compares the Ballance Farm Environment Award with the Dairy Excellence Award and points out that the latter, while considering environmental factors, takes them to be subservient to the system of production. The means of addressing environmental issues are divorced from production (Jay, 2007: 273). Putting it another way, she states that the problems of production are viewed separately from the system that produces them. In contrast, farmers entering the Ballance Farm Environment Award tend to have a more holistic view of farming. They see the farm as part of a locality and region, acknowledge that farm practices can have wide impacts beyond the farm, and see the soil and water as integral to farming not just as factors of production. In short, they take a holistic not a fragmented approach, show awareness of the farm as an organic whole, have multiple values and attach importance to intergenerational factors. This reflects environmental care and long-term stewardship.

These latter attributes correspond with those expressed by Q-sort type 4 and are well represented in its title of Ecological. Farmers in this type emphasised a number of environmental factors in combination with satisfaction, farm environment as place to live and future generations/succession. Q-sort type 3 has some of these characteristics too. Consequently, combined Type B demonstrates these characteristics with the emphasis given to customers, family and environment. The results are suggesting that we are able to differentiate the ARGOS farmers in terms of the holistic extent of their approach to management. However, the results are limited at this stage because we have not examined holism in great detail.

Social networks. Q-sort types 3 and 4, or Type B farmers, have more connections in their map. There is a theme of greater off-farm orientation whether it is for customer satisfaction and off-farm activities, or for customer requirements and off-farm product quality. These two results suggest that these types may have more connections to people. Causal mapping is not the most appropriate way to assess social network connections and at best they are suggestive. This suggestion is very tentative because the earlier qualitative interview results indicated that organic sheep/beef farmers believed they were isolated. Would such connections be part of their strategy of farming which they maintain in the course of doing their farming? Is this an example of higher social capital engaged in their approach to farming? If they indeed do have more connections, what is the character of these links? Do they manage to maintain close contact with them all or are they weakened in some way because of their number?

In contrast, Q-sort type 1 farmers have fewer connections and while they are oriented off farm to the extent of focusing on consumers, their vision is not as broad. Further, they rely more on decision making to achieve their goals. Perhaps they are a product of past events in primary production in which survival has relied upon stubborn independence. Q-sort type 2 farmers are unusual in that they appear to have strong off-farm links but this may be only because they have to emphasise off-farm work since that is the decisive characteristic of their farm. Their centrality for off-farm activities is lowest at five.

Does the greater connectedness of Q-sort types 3 and 4, or Type B, generate resilience? It may be that degree of connectedness is a measure of ecological literacy and with better measurement these farmers are better able to manage the whole farm environment.

Granovetter (1983) evaluates empirical evidence relevant to his ideas that seemingly weak ties can have strong social effects. He proposes that when people within networks relate to acquaintances they are less socially involved and the resulting ties are weak, and when people relate to close friends the ties are strong. People with few weak ties are isolated from information from distant parts of their social system. It follows that such people are insulated from the latest ideas, are not so likely to get good labour market information, are less likely to become involved in a political movement (because they are less likely to get beyond their clique), and new ideas spread among them slowly. He applies his theory to individuals, the spread of ideas, and to social organisation and reviews research which addresses the issues showing, with qualifications, that the core theory has merit. Since weak ties allow people to gain information from distant locations they can innovate. People with many strong ties are well supported by these close connections and have less opportunity or need to innovate. Not all weak ties are useful just those that bridge between network segments.

Let us apply these concepts to farming. If there are farmers with more weak ties it is likely that they can be expected to be more innovative. Conversely, farmers with strong ties are more likely to have notions of how to farm or to innovate strongly prescribed by the people in their network. In a recent study of organic farming networks, Reider (2007) concludes that in the absence of knowledge on organic farming, organic farmer to farmer linkages are very important. Her study suggests that organic farmer information networks are likely to be more diffuse compared to conventional farmers since there are fewer farmers nearby. These may constitute weak links. It seems likely that organic farmers have a higher proportion of farmer sources as information because there are fewer formal information sources, have greater distance in their links because they seek advice from distant organic farms engaged in the same land use, and have more linkages because how to farm is not so obvious. In addition, it may be that they may have more linkages because they are systems thinkers, that is, regardless of what they do, they think and behave more holistically. Finally, they are faced with the difficult problem of producing outside of the prevailing local norms. Under these circumstances it is more likely that they would seek guidance from further afield.

Farmer types. Earlier work on farmer types (Fairweather and Keating, 1994) advanced the interpretation of New Zealand's primary production history as one of moving from an emphasis on production up to the 1980s, followed by an emphasis on careful marketing of primary produce in the wake of agricultural reforms in the 1980s. The results also indicated another, newer type: one that emphasised environment and family. This interpretation of New Zealand's primary production history has been supported recently by Valentine et al. (2007) in their review of land management and extension in New Zealand. They describe the four phases in the history of New Zealand's land management as: (1) the pioneer phase, (2) the production phase (3) the economic phase and (4) the ecological phase. Their history focuses on the macro level rather than on farmer response and this would explain why the last two phases do not distinguish the post-1984 marketing phase. Results from the present study found that most farmers reported that quality of production was more important than quantity. This suggests that the historic emphasis on production is definitely not a popular option at the present time, at least among sheep/beef farmers.

There are two recent studies of farmer types that can be compared to the results presented in this report. A study of Californian farmers (Brodt at al., 2006) used Q methodology and found three main types of farmers. The authors concluded that their results strongly resemble those from other parts of the world, in particular the earlier New Zealand findings. A study of British farmers and their possible movement towards post-productivism found that productionism was still strong (Burton and Wilson, 2006). While they considered four types of farmers (the agricultural producer, the agribusinessman, the conservationist and the diversifier) they argued that farmers have some aspects of each type in their self concept although their evidence shows that the first three types are positively valued while the diversifier is seen as the other. The business roles 'permeate across the spectrum of farming self-concepts' (Burton and Wilson: 109) and this view is compatible with the results here which show that the different types still value and include key economic concepts in their view of farming. Table 19 below shows how the results from all of the three studies mentioned above and the present study align. The table shows a theme of broad similarity across the four studies for each of three broad areas. The first theme is a production oriented type and this theme is represented consistently across the studies although the present study can only point to the integrated management panel as showing some aspects that fit here. The production emphasis only shows up in the integrated panel with a higher centrality for production. None of the Q-sort types expresses a strong production orientation. There is only a hint of productionism in Q-sort type 1: production is slightly more important in the Q-sort results but when asked which was more important, quality or quantity of production, six farmers said quality and the remaining two said both. The second theme is some alternative to a production emphasis and it manifests in slightly different ways in each study. Flexible Strategists sought to maximise returns by paying attention to careful marketing of farm products rather than production per se. Networking Entrepreneurs show less interest in earning a living from the farm and have more interest in off-farm activities and social interaction. Diversifiers seek to make income from on-farm diversification schemes. This second theme is reflected in Q-sort types 2 and 3, both of which emphasise off-farm connections, work or activities.

Table 19: Alignment of studies of farmer types

Earlier work: Fairweather and Keating (1994)	California: Brodt et al. (2006)	UK: Burton and Wilson (2006)	Present study
Dedicated Producer	Production Maximisers	Agricultural producer Agribusinessperson	Integrated management
Flexible Strategist	Networking Entrepreneurs	Diversifier	Q-sort type 3 – External Q-sort type 2 – Off-farm work
Environmentalist	Environmental Stewards	Conservationist	Organic management Q-sort type 4 – Ecological

The third theme includes environment, conservation or ecological ideas. The environmentalist was distinguishable by the importance given to environmental awareness and conservation. Environmental Stewards emphasised environmental stewardship. The conservationist were creating new wildlife habitats and had conservation schemes on their farms. In the present study, organic farmers and Q-sort type 4 farmers emphasised the farm environment and its quality.

For the present study, Q-sort 1 does not fit the themes across the research, and neither does conventional farming. Perhaps for some sectors, New Zealand farmers' adaptation to more-market policies has been complete and farmers now have a market focus while elsewhere there is a type which adheres to the productionist approach, possibly aided by government policies or subsidies.

We know that one of the responses to restructuring in New Zealand primary production was an increase in off-farm work by either the farm man or farm woman (Fairweather, 1999; Taylor and Little, 1995) and this explains the presence of the off-farm work type in the present results. ARGOS farm survey results show that among sheep/beef farmers in 2005 there were 35 per cent of farms which had significant off-farm income in the last year (Fairweather et al., 2007). According to these data, there should be 11 ARGOS sheep/beef farmers with off-farm work. The four reported here is lower than this amount.

4.5 Limitations and future research

For research on the Q-sort types, we have not yet examined other social objective data in order to corroborate, explicate or elaborate on the results. One obvious need is to examine the questionnaire data from the national survey which each ARGOS farmer also filled out. The questionnaire covered a wide range of attitudes and included demographic data. This analysis would add to our understanding of Q-sort types.

The use of causal mapping as used in this research has had to limit the total number of factors used to represent the main aspects of sheep/beef farming in order to keep the sorting and mapping tasks manageable. This practical consideration means that some detail in individual factors is lost. This is a major limitation. We do not know what details of meaning that can be attached to such factors as fertiliser and soil fertility health or to quality and quantity or production, for example. Some of these more complex factors could be the subject of further research which could usefully include causal mapping that focused just on the factors that are involved in the management of that factor.

While a number of environmental factors were used in the mapping, there was an indication during the mapping process that some farmers who were not particularly responsive to them even though they appeared to be environmentally oriented farmers. Many farmers did not understand the concept ‘biodiversity’ even though they may have been increasing the variety of species on their farm. Some caution is needed in interpreting the causal map results as definitive indications of the environmental orientation of a farmer.

The research presented here also has not linked these results to those from the qualitative research completed to date. A preliminary assessment of farmers’ happiness and engagement with the environment was made and it was found that most farmers judged to have high ratings on these variables were in Type B.

Further work is needed to explore whether the Q-sort types have explanatory value in terms of other results in the ARGOS research programme, particularly the ecological and economic performance of the farms.

The results have suggested that farmers give the appearance of being concerned for the environment. There remains the possibility of enhancing their knowledge of the environment and this could be the subject of future research which could more directly question farmers about this topic. Action research may lead to better environmental management.

The decision maker factor can dominate the mapping process, so mapping could be tried without emphasising the links through this factor. It may be best to explore this by dropping decision maker out completely. This might show up the important relationships among other factors. It would also mean that the system is de-humanised.

The discussion of social networks brings the focus squarely on the links beyond the farm. The causal mapping has made a good beginning at documenting these links and how they vary by management system and by Q-sort type. Future research could examine these networks more thoroughly in order to more definitely assess the precise nature of the connections and what effects they have on farm management. Needed in this kind of research are methods which accurately document the nature and character of such connections. Such a focus could also be part of more general surveying of farmers in New Zealand.

References

Addams, H. and Proops J. (2000), Social Discourse and Environmental Policy: An Application of Q Methodology. Edward Elgar: Cheltenham, UK.

Brodt, S., Klonsky, K. and Tourte, L. (2006), Farmer goals and management styles: Implications for advancing biologically based agriculture. Agricultural Systems 89:90-105.

Brown, S. (1980), Political Subjectivity. Applications of Q Method in Political Science. Yale University Press: New Haven.

Darnhofer, I., Schneeberger W..and Freyer B. (2005), Converting or not converting to organic farming in Austria: Farmer types and their rational. Agriculture and Human Values 22:39-52.

McKeown and Thomas (1988), Q Method. Sage: Newbury Park.

Fairweather, John R. (1995), "Dilemmas and Decisions Over On or Off-Farm Work". Rural Society 5(1): 6-19.

Fairweather, J.R., (1999) “Understanding How Farmers Choose Between Organic and Conventional Production: Results from New Zealand and Policy Implications”. Agriculture and Human Values 16(1):51-63.

Fairweather, J.R. (2002), “Factor Stability, Number of Significant Loadings and Interpretation: Results from Three Case Studies and Suggested Guidelines”. Operant Subjectivity 25(1):37-58.

Fairweather, John R. and Norah C. Keating (1994), "Goals and Management Styles of New Zealand Farmers". Agricultural Systems 44(2)181-200.

Fairweather, J.R. and Swaffield, S. R. (2000), “Q Method Using Photographs to Study Perceptions of the Environment in New Zealand”. Chapter 7, Pp. 131-158 in H. Addams and J. Proops (eds.) Social Discourses and Environmental Policy: Application of Q Methodology. Edward Elgar, Cheltenham, UK.

Fairweather, J.R. and Swaffield, S. R. (2002), “Visitors’ and Locals’ Experiences of Rotorua New Zealand: An Interpretative Study Using Photographs of Landscapes and Q Method”. International Journal of Tourism Research 4(4):283-297.

Fairweather, John, Lesley Hunt, Chris Rosin, Hugh Campbell, Jayson Benge and Michael J. Watts (2006), Understanding kiwifruit management using causal mapping. ARGOS Research Report No. 06/09.

Fairweather, John, Lesley Hunt, Andrew Cook, Chris Rosin and Hugh Campbell (2007), New Zealand farmer and grower attitude and opinion survey: Sustainability in primary production. ARGOS Research Report No. 07/0X.

Galmiche-Tejeda, A. (2004). Who is interdisciplinary? Two views, two goals, professionals and farmers. Interdisciplinary Science Reviews 29 (1):77-95.

Gorsuch, R. L (1983), Factor Analysis. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

Granovetter, M. (1983), The strength of weak ties: a network theory revisited. Sociological Theory 1: 201-233.

Hunt, Lesley, Chris Rosin, Carmen McLeod, Marion Read, John Fairweather, Hugh Campbell (2005), Understanding Approaches to Kiwifruit Production in New Zealand: Report on First Qualitative Interviews of ARGOS Kiwifruit Participants. ARGOS Research Report No. 05/01.

Hunt, Lesley, Chris Rosin, Marion Read, John Fairweather, Hugh Campbell (2006), Understanding Approaches to Sheep/Beef Production in New Zealand: Report on First Qualitative Interviews of ARGOS Sheep/Beef Participants. ARGOS Research Report No. 06/01.

Jay, M. (2007), The political economy of productivist agriculture: New Zealand dairy discourses. Food Policy :266-279.

Ozesmi, U. and Ozesmi, S.L. (2004) Ecological models based on people's knowledge: a multi-step fuzzy cognitive mapping approach. Ecological Modelling 176: 43-64.

Read, Marion, Hunt, Lesley and Fairweather, John (2005), Sketch Maps: Features and Issues Important for the Management of ARGOS Orchards and Farms. ARGOS Research Report 05/07.

Reider, R. (2006), Growing Organically? Human Networks and the Quest to Expand Organic Agriculture in New Zealand. AERU Research Report No. 293, Lincoln University, New Zealand.

Stephenson, W. (1953), The Study of Behavior. Chicago: University of Chicago Press.

Taylor, N and Little, H. (1995), Means of Survival: a study of off-farm employment in New Zealand. Taylor Baines and Associates, Christchurch.

The Press, (2006), Snow-hit farmers reluctant to enter awards. 17 November.

Valentine, I., Hurley, E., Reid, J. and Allen, W. (2007), Principles and processes for effecting change in environmental management in New Zealand. Journal of Environment Management 82: 311-318.

Appendix 1: Responses to questions asked after causal mapping

Table 1.1: Response to: What does good environment health mean?

(The farm) looks good, good stock health, plant health, streams, bird life, aesthetics (no balage wrap)
Healthy soil, plants and animals
Comes back to worms, parasites etc. on stock; if under stress get lice then flies.
Soil health, then whole farm, trees, plants, make sure they are all fit and happy.
Soil microbes working properly; without that you have nothing.
Sprays, chemicals, fertilisers, (not) burning plastic, increasing biodiversity, almost like organic.
Soil activity, bird life, stream health, beautification
Not polluting farm, environment, rivers, what's going down the rivers, dumping chemicals
Having a sustainable environment that can tell by health of animals and by water quality.
Good ecosystem, environmentally OK, leave farm in better or no worse state, not to create environment that is going backwards e.g. creeks all muddied.
Covers all the soil, pastures and health of stock; bird life, trees. Signs are when things are not well, if see things dying.
The total thing, everything below ground and above. Close to natural process as possible, indicate from plant and animal health.
Health of soil, birds, insects can live on land because no poisons, weed free, good quality water in stream.
Don't know; having birds and trees plus water quality right. Sell animals with no DDT.
No pollutants. Start from soil biology. Sign? Any living organism, from small to large, not healthy
Everything, good soils, water quality, plant health which equals fertiliser and good stock; trees, birds enhancing the environment.
Lot to do with fertiliser, soil, balance, looking to the future
Sustainable is one thing it means. Not degrading it in quest for greater production. Enhancing what nature's given us. Urea has negative effect on soil biota.
Should leave farm in better condition. If water quality poor stock do not do so well, therefore cash farm income low, not just physical farm but personality, e.g., lack of communication among staff, intrinsic (qualities).
So we can be here in 100 years, Sustainable, shown by insects, birds, wildlife, animals are all good indication.

Table 1.2: Response to: To what degree can your farm change?

Easily change but not quickly
Not locked in
Could change, changing breeds.
Very open to change, but dictated by weather.
Yes, flexible, moved from crop to stock.
Yes, quite easily.
Depends on time, can change types of crops quite easily, could be dairy or vineyard.
Could all change e.g., irrigation and grapes
Lot of change lately
Sold all sheep with five minutes consultation.
Can change
Easily changed
Open
Not locked in
It is like something moving with its own momentum; takes big knocks to move it off course.
Difficult to change system.
Certainly can change
Flexible
Easy to change
Change tomorrow if want
Always flexibility.
Reasonably flexible
Set in many ways.
System is fluid, flexible, need to dealing with nature. Could easily change.
Could change dramatically
Done most of the change, don't know how much further it can go; probably locked in, no going back, been there,
Yes, but there are principles I will not go past, have made changes,
Easy to change
Could in principle change everything
Fairly flexible
Not locked in
Wide open to change
Can change, done it!
Reasonably easy to change

Table 1.3: Response to: What makes for a resilient farm?

Have a plan B alternative, ready to make these decisions
Farming to the condition of the area, not trying to beat the system, farm to strengths, e.g., mix of soil types.
Stocking rates and breed, topography gives variety.
Debt loading
Being well prepared, thinking ahead
Having fertiliser up to spec., can drop expenses if need to; soil health and quality e.g., if snow have quality feed.
A fertile farm.
Financial backing, the size and diversity of a corporate.
Better equity, flexible management system
Equity
Debt, willing to move with times, not traditional, flexibility to adjust to market.
Financial resilience by ability to borrow if you need, or have cash available.
Diversity of crops, soil types, mental horsepower and physical labour
Size
Farm environmental health.
Attitude of farmer, having things in place to have options when something happens. Have other food supplies (silage).
Not too encumbered to ride ups and downs. A farming system that can cope with variations in climate.
Don't push to limit, variation in options.
Family history and background and net profit before tax
Farm environmental health. If up to scratch, better able to bounce back from any outside influence.
Net profit, weather/climate, environmental health, stock quality, not pushing too much.
Scale, good cash position.
Well established family farm with equity. For this place having stocking rates not too high.
Being farmed in harmony with nature; need to prevent change and have pre-emptive, proactive management.
Lack of debt plus environmental health, if farm is strong it can handle shocks eg no fertiliser for five years, could handle it. System did not collapses with snow and lost 15% of ewes.
Having a system that can take shocks
Attitude of people running it, including vision, objectives, ruthlessness, degree of risk management.
Financial security, decision making , recognise shocks and make right decision
Monetary independence, financial strength, being diverse
Diversity in crops and source of income
Not being totally dependent on weather plus diversity of income.
Cash farm income, doing what you do well, good livestock, water.
Plant and animal biodiversity i.e., breeding animal to handle climate.

Appendix 2: Centrality scores (means) by panel

Code	Weed & pest mgmt	Weather/climate	Water supply & quality	Advisors, consultants	Time in farm work	This location	Stream health	Stocking rates	Satisfaction	Soil type/ topography	Smallholding/subdiv	Retirement	Regulations	Quality & quantity	Plant and machinery	Off-farm work	Off-farm prod quality	Off-farm activities	Net profit b4 tax	Neighbours	Mktg or proc org	Labour	Information	Increasing p&a bd	Imprv equity/land size	Government policies	Future gens/succession	Fert and soil fert/health	Farmer groups or orgs	Farmer DM	Farm wkg expenses	Farm env health	Fm env to live	Family needs	Family hist & b'grd	Ex'ge rate, macro econ	Customer satisfaction	Customer requirements	Contractors	Community	Cash farm income
1C	12	30	31	5	0	5	0	16	14	0	0	0	12	46	36	35	0	7	14	13	14	17	5	37	0	28	0	83	8	188	43	24	0	10	0	31	12	12	24	8	42
2C	47	59	0	7	34	13	0	35	36	0	0	0	0	73	0	0	31	38	23	0	21	0	0	110	26	23	42	32	0	154	44	64	95	96	20	21	26	40	27	0	17
3C	0	48	39	0	0	0	0	9	70	27	0	0	0	75	0	0	21	0	22	26	38	0	23	0	48	0	31	28	7	184	31	28	47	77	38	0	23	24	0	15	59
5C	17	56	17	0	26	14	0	0	32	0	0	0	0	75	0	0	0	37	49	0	17	0	10	0	0	0	0	35	0	126	25	0	0	29	0	19	0	0	0	0	0
6C	35	0	24	13	0	0	0	0	53	4	0	0	0	77	0	0	0	0	16	0	21	0	0	21	0	0	0	30	0	148	47	22	28	50	0	0	37	0	0	0	18
7C	18	29	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	16	0	47	0	0	0	0	0	0	30	0	95	35	15	12	4	0	8	0	16	0	0	59
8C	36	27	24	0	0	0	0	0	89	0	0	14	11	99	0	27	32	35	33	0	48	51	8	0	0	0	0	55	0	142	74	47	25	56	0	0	50	16	0	0	35
9C	39	39	0	23	79	27	0	60	18	26	0	0	0	112	50	96	0	31	22	9	33	93	0	0	0	0	7	54	0	193	32	0	8	72	54	0	26	24	16	21	70
10C	0	0	0	0	39	0	0	0	60	0	0	51	0	44	0	42	0	0	48	0	0	42	0	0	33	0	0	28	0	125	23	30	25	31	0	17	0	0	0	0	40
11C	48	40	54	9	0	10	54	18	59	0	0	0	0	113	11	0	38	10	20	0	22	25	0	0	0	0	20	56	0	240	0	58	30	28	30	0	29	18	0	0	0
12C	12	38	45	0	0	16	37	31	41	0	0	0	0	108	0	0	0	0	0	10	13	0	5	0	0	0	0	14	0	91	0	43	35	0	0	0	0	0	0	0	37
1B	0	46	37	0	56	0	0	49	45	0	0	0	0	105	23	0	26	14	0	0	0	42	0	0	0	0	0	34	0	158	13	0	0	53	0	0	19	7	4	0	41
2B	29	48	36	7	82	0	30	32	45	13	0	24	0	84	0	10	7	48	41	12	17	23	0	0	0	0	21	39	0	140	73	70	18	85	6	0	0	8	23	12	27
3B	21	17	4	29	0	0	0	30	29	0	0	0	0	100	6	25	0	0	47	0	23	32	16	0	33	16	15	24	0	151	17	0	0	13	0	0	8	0	0	0	36
4B	15	10	17	0	0	0	0	25	28	23	0	0	6	45	0	0	9	0	9	0	17	0	4	8	4	0	19	22	0	78	34	23	30	47	6	0	8	4	0	0	25
5B	32	40	0	0	25	21	0	24	50	20	0	0	0	130	17	0	31	0	42	0	0	0	5	12	13	0	0	72	0	127	76	9	0	26	0	19	0	0	0	0	67
6B	30	39	32	9	0	0	0	0	63	0	0	20	0	102	0	0	0	0	17	23	0	64	0	0	0	0	0	45	0	123	23	24	13	71	0	0	7	7	0	0	56
7B	0	52	58	31	0	0	31	0	148	24	0	0	7	80	39	0	0	35	0	0	0	35	21	20	0	0	0	48	0	310	73	39	62	60	0	0	0	0	6	63	36
8B	21	67	62	0	0	30	47	0	135	0	0	0	0	133	0	0	0	23	20	0	0	22	41	26	0	0	0	64	0	156	78	83	40	48	0	37	0	0	24	0	53
9B	14	20	44	21	39	25	0	29	38	31	0	0	7	79	29	0	0	17	32	0	9	36	6	0	27	0	0	34	0	205	52	0	0	58	9	16	0	0	0	0	39
10B	0	5	5	12	12	14	0	5	25	0	0	5	4	59	22	6	0	12	38	18	0	15	0	21	14	7	0	6	0	100	27	0	11	41	12	13	0	0	0	13	38
11B	41	60	16	24	33	0	14	63	59	18	0	0	0	135	0	16	30	10	20	0	59	0	0	26	0	0	0	44	0	172	28	47	34	49	0	0	20	58	10	0	36
2A	25	9	16	0	19	0	13	0	0	7	0	0	0	25	5	10	29	0	0	0	21	45	24	0	0	0	8	32	0	112	0	124	0	0	0	0	57	0	5	0	0
3A	46	38	27	0	0	0	39	69	102	0	0	0	0	56	0	0	21	0	0	0	27	0	9	29	0	0	7	69	0	107	17	42	6	0	0	0	26	37	0	0	0
4A	130	51	0	17	0	40	42	0	90	64	0	0	0	88	88	0	67	54	39	0	74	124	64	0	0	0	0	58	0	123	0	0	50	40	0	0	30	70	31	0	0
5A	0	41	0	0	43	13	0	0	81	36	0	0	0	95	44	0	71	0	0	0	45	0	0	0	0	0	0	58	0	166	0	56	41	51	0	0	41	18	0	0	68
6A	35	20	38	0	0	0	22	0	37	5	0	0	0	72	0	0	0	0	30	0	0	0	0	16	0	0	19	18	0	142	43	70	4	0	18	0	14	7	0	0	30
7A	0	36	0	0	0	0	21	0	45	0	0	0	0	62	0	0	38	0	48	18	0	0	6	27	0	8	0	68	0	133	0	32	8	30	0	16	0	8	0	0	0
8A	0	57	34	0	0	47	48	64	90	31	0	14	0	83	21	0	0	38	9	0	0	0	0	0	32	0	0	77	0	114	30	109	66	43	0	0	0	0	12	0	73
9A	0	35	24	0	0	37	29	0	50	0	0	0	0	73	0	0	0	0	0	0	23	0	0	23	7	10	46	67	0	160	23	73	54	52	0	0	0	0	0	0	64
10A	0	30	24	0	0	20	0	0	55	9	0	0	0	82	0	0	28	0	0	0	0	0	16	0	7	0	32	85	6	141	26	61	40	42	0	16	0	17	5	11	79
11A	0	29	28	5	0	21	0	0	0	17	0	13	0	54	0	26	0	7	55	8	30	27	0	0	26	0	19	24	0	168	0	40	0	44	23	3	0	0	0	0	35
12D	0	37	0	0	0	0	0	41	45	0	0	0	0	84	0	11	29	0	25	0	0	0	9	27	0	0	0	40	0	143	40	54	24	42	0	0	9	7	0	0	37
12A	0	77	0	0	29	3	0	0	126	18	0	18	0	109	10	0	58	29	76	57	26	0	0	0	16	42	0	98	0	172	49	66	42	85	0	37	34	18	0	62	71