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Causal mapping of ARGOS high country farms and comparisons to sheep/beef and dairy farms

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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. This report focuses on eight case studies involving participating high country farmers.

As part of the ARGOS social objective, causal mapping was used to document how the eight high country farmers described and explained their farming systems, broadly defined to include economic, social and environmental factors. Participants identified the most important factors (among the 41 provided) in the management and performance of their farms and linked these together to form a causal map. They then indicated the strength of these linkages on a scale of 1 (weak) to 10 (strong). Centrality scores, the sum of the weightings of the arrows entering and leaving a factor, indicated the importance of each factor. An overall or group map was produced by taking an average of the key data from each individual farmer map in order to characterise high country farming. As part of identifying the important factors the farmers did a Q-sort and the analysis of the Q-sort data produced two factors.

Centrality scores

- The centrality data showed that at the heart of high country farming were the decision maker, two non-productive factors (family needs and satisfaction), production and financial aspects moderated by weather and climate.

High country group map:

- At the core of the map were farmer decision maker, production, and family needs.
- Farmer decision maker, as a factor, was most influenced by labour, weather and climate, and family needs.
- Production was most influenced by stocking rates and farmer decision maker.
- Family needs was most influenced by farmer decision maker.
- Weather and climate was an important influence on production, and was as important as fertiliser and soil fertility health.

Comparison across high country, dairy and sheep/beef sectors in terms of causal maps:

- There was broad similarity across the three farming sectors in that each of the group maps has the same top five factors within the top six rankings.
- The high country farming system had less emphasis on production and more emphasis on family, soil type and neighbours.
- High country, compared to dairy only, gave more importance to weather and climate, and to off-farm activities.
- High country, compared to sheep/beef only, gave less importance to off-farm product quality.

- Sheep/beef, compared to dairy only, gave more importance to customer requirements and to advisors and consultants.
- Location and time in farm work were more important to high country farmers as a source of satisfaction while farmer decision maker was not an important source of satisfaction.

Comparisons across sectors in terms of map characteristics:

- High country, compared to dairy and sheep/beef, had more factors and lower map density (fewer connections compared to the number of factors).
- Dairy, compared to high country and sheep/beef, had more transmitter factors (arrows going out) and fewer receiver factors (arrows going in).
- Dairy compared to sheep/beef had fewer double arrows.

Q-sort results:

The low numbers of farmers precluded the development of maps for Q-sort types 1 and 2 but the two factors broadly correspond to a production orientation and an environmental orientation, as found in the dairy and sheep/beef studies.

Interpretation

- Farm environmental health is less important to high country farmers because they see nature as robust and healthy, or because they see their farming system as fragile and have learned to work in synergy with the environment.
- The importance given to weather and climate, soil type and topography, neighbours, off-farm activities and family needs is consistent with the particular character of high country farming. High country farmers assigned relatively less importance to production.
- There is evidence that high country causal maps are more complex than those for the sheep/beef and dairy farming.
- Across the high country, sheep/beef and dairy sectors there are some key similarities which show up as eight common elements of pastoral systems and can be illustrated as a map.

Chapter 1
Introduction: Background, Research Objectives and Method

1.1 Background and research objectives

The social research objective of the Agriculture Research Group on Sustainability (ARGOS) research programme is responsible for contributing to the analysis of different farming systems through the examination of the social dynamics of agricultural production. The objective has already developed significant analyses of the positioning of farmers and orchardists relative to society, to the environment and to their economic visions (Hunt et al., 2005, Hunt et al., 2006) as well as of their engagement with their respective industries (Rosin et al., 2007a and Rosin et al., 2007b). One further aspect of this research involves separate studies of each sector using a causal map method. The first study was of kiwifruit management and was completed in 2006 (Fairweather et al., 2006). The causal mapping showed factors important in kiwifruit orcharding and how orchardists think about and manage their orchards. The second study was for the sheep/beef farms (Fairweather et al., 2007) and involved an improved method that introduced an initial ranking of factors using a Q-sort. This process provided an efficient means for farmers to select the important factors for mapping. The third study was for dairy farmers (Fairweather et al., 2008). These prior reports fully document the literature on causal mapping and the development and application of the methods. The present report focuses only on the core results for the high country sector

The main research objective for the causal mapping of the high country farmers was to document how farmers participating in our ARGOS research describe and explain the management of their farm system broadly defined. An additional objective was to compare results for the high country sector with the results from the sheep/beef and dairy sectors.

1.2 Method

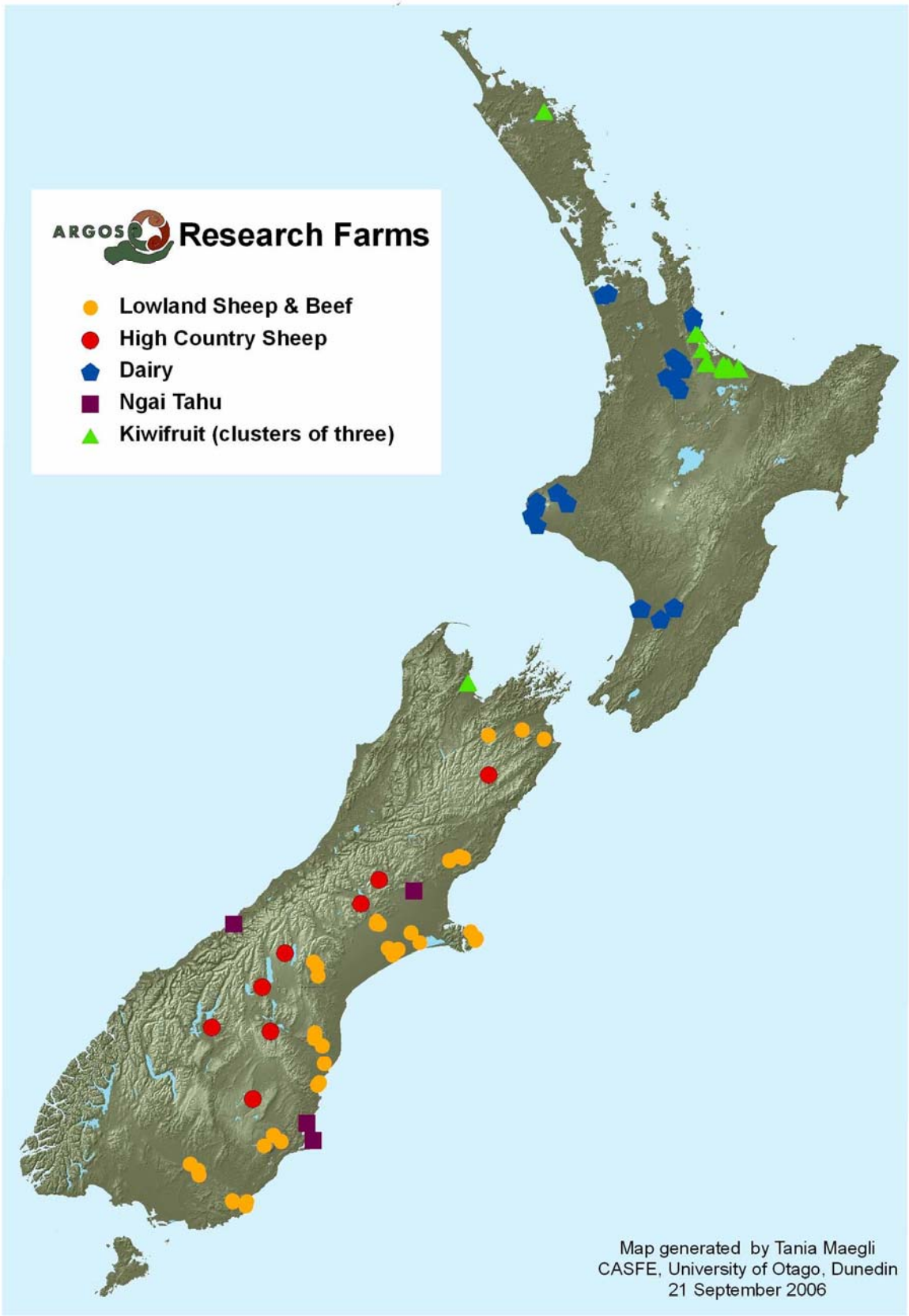
This report does not repeat the detailed account of the method which was provided in the earlier reports. Readers seeking a fuller explanation of the method will need to refer to them. The method used was very similar to the method used for the sheep/beef and dairy studies. The same list of 41 factors used in those studies (as shown in Table 1) was used in this study. A Q-sort was used to allow farmers to identify the important factors prior to using them to make their causal maps. Interviews were conducted in October 2007 using the same interview procedure. The farms were located in the South Island of New Zealand, extending from Marlborough to Otago. Figure 1 shows the farm location map with black circles indicating the location of the high country farms. Data were analysed in the same way as for the sheep/beef and dairy studies.

Table 1: List of factors used in the kiwifruit, sheep/beef and dairy studies

Kiwifruit	Sheep/beef, dairy and high country
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 organisation-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

Note: bolding identifies changes in the wording of the factors used for sheep/beef, dairy and high country.

Figure 1: Location of the high country farms



Chapter 2
High Country Results and Comparisons to Dairy and Sheep/beef Farms

2.1 Introduction

In this chapter, data are presented for the group map for all eight high country farmers. 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 relative importance as it is the sum of the weightings of arrows going into and out from the factor. Centrality therefore reflects both the number of arrows and the weightings of the arrows. The data are presented by first focusing on the group map centrality data then on the group map deriving from these data. The chapter also includes a comparison of the high country causal map results with the dairy and sheep/beef results, and briefly touches on the Q-sort data.

2.2 Centrality data for all eight farmers

When the data for all eight cases had been entered into individual Excel worksheets it was possible to create an equivalent data matrix for the group 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 was a total of 271 separate connections between factors, considerably short of the theoretical maximum of 41 times 40 or 1,640 connections (12 per cent), but still rather too many to represent easily on a single map (see later).

Table 2 shows the average centrality scores in the high country group map. The table shows four groups of centrality scores, with those with the highest scores at the top of the table. These groupings are an attempt to simplify a long list data and to make sense of the higher rated items based on a somewhat arbitrary criterion of taking the top three, then the next four which had somewhat similar scores, followed by the next four scores.

The factor with clearly the highest centrality was farmer decision maker with an average score of 165. Next in order of centrality was family needs with an average of 68, and then quality and quantity of plants and/or livestock, with an average of 55. After these top three factors there was a second tier of four factors with average centrality scores ranging from 41 to 47. These include: satisfaction (47), cash farm income (44), fertiliser and soil fertility/health (42) and weather and climate (41). These factors with high centrality (as shown by having a score of 41 or above which is well over the average of 24) show that at the heart of high country farming is the decision maker, two non-productive factors (family needs and satisfaction) and production and financial aspects moderated by weather and climate.

Table 2: Average centrality scores for all eight high country farms

Factor	
Farmer decision maker	165
Family needs	68
Quality & quantity of production	55
Satisfaction	47
Cash farm income	44
Fertiliser and soil fertility/health	42
Weather/climate	41
Labour	32
Time in farm work	29
Stocking rates	29
Farm working expenses	29
Net profit before tax	26
Water supply and quality	25
Farm environmental health	24
Soil type/ topography	23
Off-farm activities	23
Increasing plant and animal biodiversity	21
This location	21
Farm environment as a place to live	21
Weed and pest management	20
Community	16
Neighbours	15
Marketing or processing organisation	14
Contractors	14
Plant and machinery	13
Stream health	12
Improve equity/land size	12
Customer requirements	11
Future generations/succession	10
Customer satisfaction	9
Information	8
Family history and background	7
Retirement	7
Farmer groups or organisations	7
Exchange rate, macro economy	7
Advisors, consultants	6
Government policies	6
Off-farm product quality	5
Regulations	5
Smallholding/subdivision	3
Off-farm work	1
Average	24

There is a third tier of factors with average centrality ranging from 29 to 32. These include: labour (32), time in farm work (29), stocking rates (29) and farm working expenses (29). The remainder of the factors had centrality scores lower than 26. 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 those of little relevance to high country farming such as off-farm work, smallholding and subdivision. Included here are some factors, such as regulations, government policies and farmer groups or organisations, which suggest that high country farmers see themselves as distant from these factors. Off-farm product quality seems also to be a distant factor for these farmers.

2.3 High country group map

The centrality scores show which factors are important but they do not show, in detail, how the factors are linked. To show linkages, we need to use the average scores from the group matrix 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. Our earlier experience has shown that using connections with a score of three or more was suitable for showing the important connections without getting overwhelmed with connections and this policy was adopted here. The group map is shown in Figure 2. The figure shows some arrows with double arrowheads and two numbers on the line. In such cases, the left hand number applies to the factor furthest to the left.

The map was created by taking the three top-tier factors, shown inside circles with heavy weight lines, and placing them in triangular fashion in the centre of the map. The next tier of four factors, shown inside circles with medium weight lines, was placed around these in order to minimise the number of crossing arrows. Then the next tier of four factors was placed around these factors. Finally, the remaining factors were added in close proximity to the factors to which they are connected. Assessed on the basis of the conventions developed in the earlier studies, the high country group map is more complex in terms of number of factors. This finding is consistent with the data to be presented in Table 4 which shows that the high country group map has more factors than those for the dairy and sheep/beef farms. In order to simplify the map, six factors with connections of three but with centrality scores less than ten, were omitted[1].

At the core of the map are farmer decision maker, quality and quantity of plants and/or livestock (subsequently referred to as production), and family needs. 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, based on the results from the earlier reports, was the high centrality rating of family needs, showing that family considerations are very important to high country farmers. Further, farmer decision maker is dynamically linked with two-way arrows to production and to family needs meaning that these latter two factors have an important bearing on farmer decision maker and it in turn has an important bearing on them. It would seem likely that the importance of family needs to ARGOS high country farmers reflects the high levels of involvement of children in the farm. Cursory examination of ARGOS economic data indicates that many of the ARGOS high country farmers have dependent children or family members working on the farm. This family involvement may reflect greater importance given to succession by high country farmers or may reflect where they are in terms of stages in the farming life cycle.

[1] This policy was not needed, nor applied to, the sheep/beef and dairy maps.

Moving out to consider the next tier of factors, the map shows that farmer decision maker is linked with a bidirectional arrow to fertiliser and soil fertility/health, but with unidirectional arrows to satisfaction, weather and climate, and cash farm income. Most influence is extended to fertiliser and soil fertility health with a score of seven. The other links among these central factors show that production and farm environmental health are influenced by fertiliser and soil fertility health. Satisfaction affects family needs. Weather and climate affects production, farmer decision maker, farm environmental health, soil type and topography, water supply and quality and stocking rates.

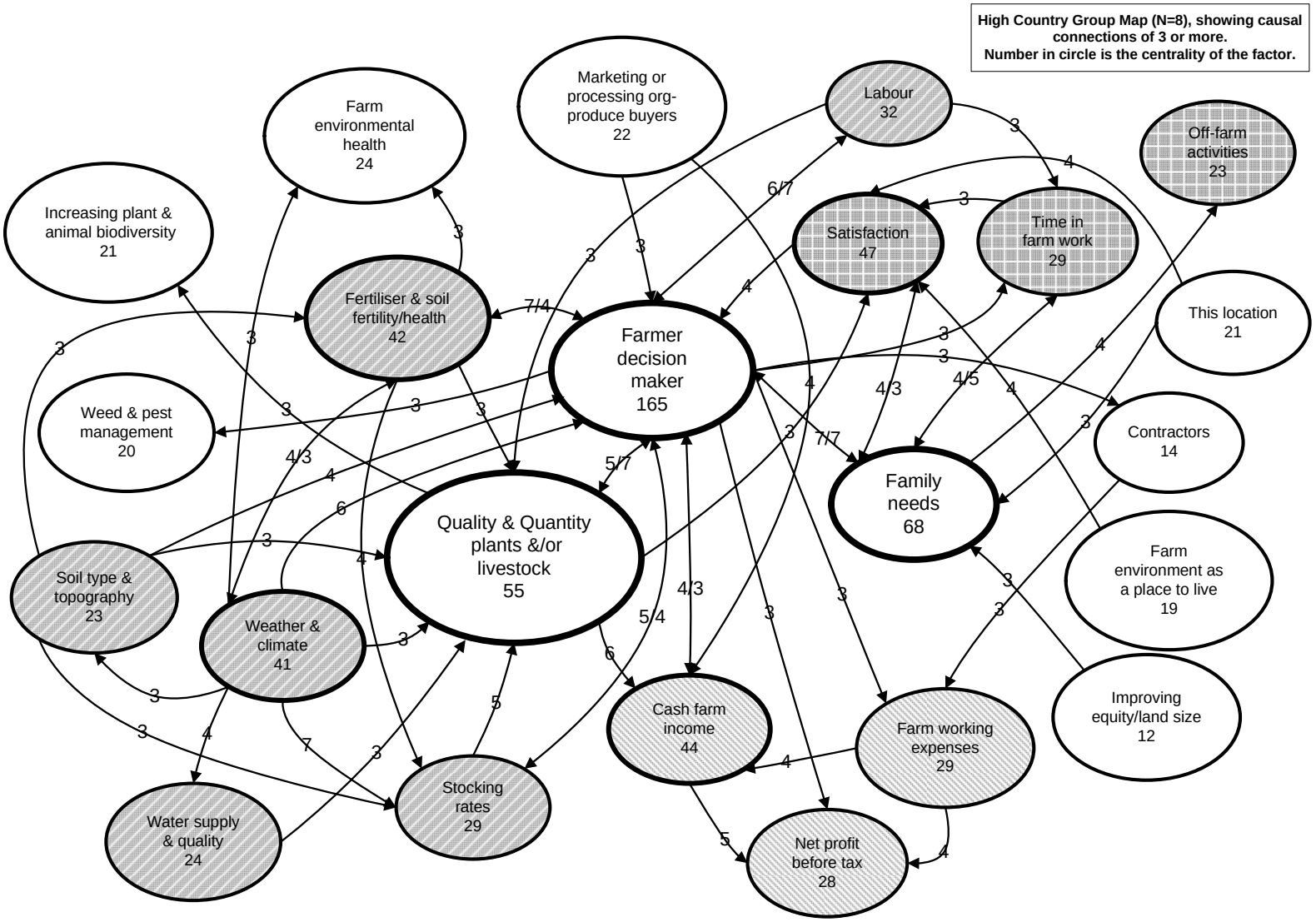
Beyond the factors already mentioned are financial factors and here the main links are from production, decision maker, marketing or processing organisation and farm working expenses to cash farm income. Farm working expenses are largely affected by contractors and farmer decision maker. Net profit before tax is influenced by cash farm income, farmer decision maker and farm working expenses. Another part of the map shows labour, farmer decision maker, and family needs are linked to time in farm work.

There are nine two-way arrows, six of which link to farmer decision maker. Four of them link farmer decision maker, labour, family needs, satisfaction and time in farm work. Two way arrows indicate link factors in a dynamic relationship indicating that each factor influences the other, and vice versa. The presence of many such connections indicates a more complex, interactive system.

Overall, the group causal map is showing that at the core of high country farming are farmer decision maker and family needs, closely linked to production. In addition to the core, there is a group of production-related factors, a group of financial factors and a group of work-time-satisfaction factors. At the periphery are less important factors that usually have only one arrow.

Two of the three core factors are linked to each other by two-way arrows indicating the dynamic nature of these connections. The three largest causal influences on farmer decision maker are labour, weather and climate, and family needs. Family needs is causally influenced by farmer decision maker, improving equity and land size, location, time in farm work and satisfaction. The production factors, highlighted in diagonal shading, show that production is derived from labour, fertiliser and soil fertility health, soil type and topography, weather and climate, water supply and quality, stocking rates and farmer decision maker. The two largest causal influences on production are stocking rates and farmer decision maker. In this map, weather and climate is as important as fertiliser and soil fertility health as a causal influence on the level of production. Near to the production-related factors are the financial factors, highlighted with grey shading, showing that production has the strongest influence on cash farm income. On the top right of the map, there is a set of linked factors including time in work, off-farm activities and satisfaction, highlighted by cross hatching. These can be seen to relate to the balance between work and family. While labour is a production-related factor, it is also linked to these factors. Surrounding the factors already mentioned are peripheral factors, such as this location and marketing or processing organisation, which tend to influence the core factors. There are exceptions: the following peripheral factors are caused by other factors: increasing plant and animal biodiversity, farm environmental health, off-farm activities, and weed and pest management.

Figure 2: High country group map - causal with scores of three or more



2.4 High country comparisons to dairy and sheep/beef

In comparing centrality scores of high county farmers with dairy and sheep/beef farmers, we start with a summary of centrality scores for the top 12 factors for high country farmers compared to the equivalent scores for dairy and sheep/beef (as shown in Table 3). The table includes the additional factor of farm environmental health to show the lower score and ranking it received in the high country map compared to dairy and sheep/beef. The table shows that some of the factors receive quite different scores from farmers in the different sectors. Some of the centrality scores are similar for dairy and sheep/beef but different to high country. However, all three sectors have the same top five factors within the top six rankings. Beyond the top five factors, there were some differences in rankings, with both dairy and sheep/beef giving lower centrality scores compared to high country for labour, time in farm work and stocking rates.

Table 3: Comparison of high country, dairy and sheep/beef top-ranked factors

Factor	High Country		Dairy		Sheep-beef	
	Centrality Score	Rank	Centrality Score	Rank	Centrality Score	Rank
Farmer decision maker	165	1	129	1	150	1
Family needs	68	2	42	5	42	5
Quality & quantity of production	55	3	81	2	82	2
Satisfaction	47	4	52	3	55	3
Cash farm income	44	5	38	6	38	7
Fertiliser and soil fertility/health	42	6	50	4	46	4
Weather/climate	41	7	23	11	36	8
Labour	32	8	14	18	20	14
Time in farm work	29	9	18	16	15	18
Stocking rates	29	10	21	13	18	16
Farm working expenses	29	11	30	8	32	9
Net profit before tax	26	12	28	9	24	11
Farm environmental health	24	14	35	7	40	6

It is useful to study these comparisons further by conducting a one-way analysis of variance of the underlying data.

Table 4 lists ten of the 41 factors and five map characteristics for which there were statistically significant differences across sectors. For four factors there were statistically significant differences when high country farmers were compared to both dairy and to sheep/beef farmers. These include quality and quantity of production, family needs, soil type/topography and neighbours.

In the analysis that follows we present the results from the table along with comparisons to each of the ARGOS panels (representing distinctive management systems) in the sheep/beef and dairy sectors. In this way we can check if significant differences between high country and other sectors are driven by the sectors as a whole of by particular management systems within the latter two[2].

The high country centrality score for quality and quantity of production was much lower (55) than that for dairy (81) and sheep/beef (82). However, the scores given by organic sheep/beef farmers were not significantly different from the high country scores, showing that, in the sheep/beef sector, this difference was driven more by the integrated and conventional farmers.

The high country centrality score for family needs was higher (68) compared to dairy (37) and sheep/beef (39). When this was explored further it was found that the integrated sheep/beef farmers did not demonstrate this difference to the same extent as the organic and conventional farmers. Similarly, soil type and topography (23) was more important to high country compared to both dairy (7) and sheep/beef farmers (12). When explored it was found that these differences were driven by the lack of importance placed on soil type and topography by organic dairy farmers and conventional sheep/beef farmers. Last, neighbours were more important to high country farmers than to dairy or sheep/beef farmers (15 compared to 3 and 6). When explored further it was found that these differences were indicative of the lower emphasis given to neighbours by conventional dairy farmers and integrated sheep/beef farmers.

These results are showing that overall, when comparing sectors, the farming system for high country farmers is less concerned with production and more concerned with family needs, soil type and typography and neighbours. However, when taking into account management systems within sectors, it was found that high country farmers and organic sheep/beef farmers placed a similar lower importance on quality and quantity of production, and high country farmers, organic dairy farmers, and organic and conventional sheep/beef farmers place a greater importance on neighbours. These refinements in the results are showing that high country farmers share some similarities in centrality scores with organic farmers[3].

[2] Location was omitted from these analyses because the dairy, sheep/beef and high country farms were in different locations. Hence, the data can be considered to be averaged over location.

[3] The standard approach is to look between sectors and check for components, such as management system, which drive the observed differences. Alternatively, one could look between management systems and see how much the sector would drive the observed differences. This approach was tried and only a few statistically significant differences were found and these appeared to be less important than those reported above.

Table 4: Significantly different centrality scores and map characteristics across high country, dairy and sheep/beef farms

	HC	Dairy	S/B	Significant differences (P-value)		
				HC cf. Dairy	HC cf. S/B	Dairy cf. S/B
	N = 8	N = 20	N = 31			
Factor						
Quality and quantity of production	55	81	82	0.015	0.008	
Family needs	68	42	42	0.010	0.011	
Weather/climate	41	23	36	0.017		0.010
Off-farm activities	23	8	13	0.035		
Off-farm product quality	5	8	17		0.030 T	
Soil type/topography	23	7	12	0.007	0.046	
Customer requirements	11	4	12			0.049
Neighbours	15	3	6	0.012	0.038	
Farmer groups or organisations	7	1	1		0.046	
Advisors, consultants	6	1	6			0.035 T
Map characteristic						
Total number of factors	30.4	21.5	21.7	0.000	0.000	
No. of transmitter variables	7.6	1.4	4.1	0.042 T		0.000T
No. of receiver variables	2.1	5.6	1.8	0.012 T		0.000T
Density	0.08	0.13	0.13	0.008	0.002	
Number of double arrows	18.1	7.4	11.6			0.042T

Notes:
1. T indicates that Tamahane's T2 was used where variances were unequal, otherwise LSD (equivalent to a multiple t-test) was used.
2. The number of double arrows is 18.1 which is more than the nine referred to earlier where the high country map is described. This is because the map does not include all possible connections.

For some factors there were statistically significant differences when high country farmers were compared to either dairy or to sheep/beef farmers. Weather and climate was more important to high country farmers compared to dairy farmers, and more important to sheep/beef farmers compared to dairy farmers. Off-farm activities were more important to high country farmers compared to dairy farmers only. Off-farm product quality was more important to sheep/beef farmers compared to high country farmers only. There were no panel-specific drivers of these results. Customer requirements were more important to sheep/beef farmers compared to dairy farmers only. When this was explored further it was found that the difference was due to the greater importance placed on customer requirements by organic sheep/beef farmers than by organic dairy farmers. Farmer groups and organisations was more important to high country farmers than to sheep/beef farmers. Advisors and consultants were more important to sheep/beef farmers than to dairy farmers perhaps because dairy farmers have greater access to 'free' advisors, such as consulting officers employed by Dexcel. For these latter three results some of the centrality scores are very low indicating that for some sectors these factors are not particularly important within the farming system as a whole.

Some of the map characteristics showed differences across farming sectors. The total number of factors was higher for high country farmers compared to dairy and sheep/beef. The number of connections per factor, however, showed no significant differences. In addition, map density (calculated from the ratio of the number of connections to the number

of factors) was lower for high country farmers compared to dairy and sheep/beef. Although high country farmers had a similar number of connections between factors in comparison to the other sectors, they had relatively more factors than connections and therefore fewer causal connections per factor. Further investigation found that the higher density of the organic dairy farmers' maps was driving the difference between dairy and high country, and the higher density of the organic and conventional sheep/beef farmers was driving the difference between high country and sheep/beef. These refined analyses are showing a pattern of organic farms having higher density. This means that organic farmers have more connections per factor than others indicating that they see their systems as more complex.

The other significant comparisons show that dairy farm maps, when compared to both high country and sheep/beef farms, had fewer transmitter factors (that is, factors that only had outward arrows) and more receiver factors (that is, factors that had only inward arrows). Further exploration found that these results were due to the low number of transmitter factors on organic dairy farmers' maps and the very high number of receiver factors on conventional dairy farmers' maps[4]. These results are showing that organic dairy farmers are less likely to see that factors only influence other factors. In contrast, conventional dairy farmers saw more factors as influenced by other factors. (It also possible that the organic farmers saw both inward **and** outward arrows on factors viewed as only transmitters by others, thus limiting the number of purely transmitting variables.) The low number of transmitter factors indicates that conventional dairy farmers saw their farm system in a passive way, and high country farmers, with a higher number of transmitter factors, saw their systems as more active.

In terms of other map characteristics, dairy maps had fewer double arrows compared to the sheep/beef map. The high country map has a high number of double arrows but not at a level which is statistically significant. In part, this finding reflects the small number of high country cases and the high variability of the data. This finding is consistent with the earlier observation of the nine double arrows shown on the high country causal map when compared with six for the dairy causal map and seven for the sheep/beef causal map. While the higher number of double arrows for the high country map is not statistically significant, it is suggestive that high country maps are more complex.

Table 5 compares the sources of satisfaction across high country, dairy and sheep/beef farms. The table shows that while there are some overlaps in the sources of satisfaction, these occur more across dairy and sheep/beef. Location and time in farm work are more important to high country farmers while farmer decision maker is not an important source of satisfaction.

Table 5: Comparison of sources satisfaction across the three sectors

Link to satisfaction	High country	Dairy	Sheep/beef
This location	4	2	1
Time in farm work	3	2	1
Production	3	6	6
Family needs	4	5	3
Farm environment as a place to live	4	4	3
Farmer decision maker	2	4	5
Net profit before tax	2	3	2

[4] A low number of transmitter factors on organic dairy maps was not found in the earlier dairy analysis because location was included in that analysis and this meant that the results were different.

2.5 Q-sort analysis for high country

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 Q-sort data suggested that up to six factors could be used in the analysis. Since there were only eight cases this result is indicating that there is wide variability in the data and that there may not be viable factor analysis solutions for the small number of cases. In order to simplify this phase of the research and to make it easy to compare to results from the sheep/beef and dairy studies, however, a two factor solution was examined. The small number of cases means that it is not possible to examine the centrality scores and map characteristics to see if in fact there are statistically significant differences between types. Further, the two factors found had five farmers loading on factor 1 and three farmers loading on factor 2 and with such low numbers the average data gave very low scores for particular connections between factors. For example, for factor 1, the highest average score was only five and for factor 2 it was only three.

Returning to the Q-sort data themselves, it is possible to characterise each Q-sort type in terms of distinguishing items and the overall type array. Table 6 shows the distinguishing items which have a statistically significant difference score. Q-sort type 1 gave more emphasis to family needs, farmer decision maker, income and fertiliser while Q-sort type 2 gave more emphasis to this location and farm environmental health.

Table 6: Distinguishing items for Q-sort type 1

Factor	Type 1	Type 2
Family needs	4**	1
Farmer decision maker	3**	-2
Cash farm income	2**	-1
Fertiliser and soil fertility health	2*	1
Farm working expenses	1**	-1
Stocking rates	1**	0
Soil type and topography	1**	-1
This location	1**	4
Improve equity/land size	0**	-3
Increase plant and animal biodiversity	0*	1
Farm environmental health	0**	3
Time in farm work	0*	1
Plant and machinery	0*	-2
Exchange rate/macro-economy	0*	1
Regulations	-1*	-3
Stream health	-1**	1
Off-farm activities	-1**	0
Government policies	-2*	0
Community	-2**	0
Off-farm work	-3**	-4

Note: * significant difference between Type 1 and Type 2 at $p<0.05$ and ** at $p<0.01$.

The type array for Q-sort type 1 confirms these characteristics. Table 7 shows the top nine factors and their corresponding Z scores derived from the Q-sort raw scores ranging from -4 to 4. The top factor is family needs followed by farmer decision maker then quality and quantity of production. In contrast, Table 7 indicates that Q-sort type 2 gave more emphasises to this location, the farm environment and satisfaction. These results show some

similarity to those for dairy and sheep/beef in that one Q-sort type emphasised production while the other emphasised the environment.

Table 7: Highly rated factors for Q-sort type 1

Factor	Z score
Family needs	2.4
Farmer decision maker	1.7
Quality and quantity of production	1.3
Satisfaction	1.3
Cash farm income	1.3
Net profit before tax	1.2
Weather/climate	1.2
Fertiliser and soil fertility health	1.2
Farm working expenses	1.2

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

Factor	Z score
This location	1.9
Farm environmental health	1.9
Satisfaction	1.5
Quality and quantity of production	1.5
Weather and climate	1.4
Water supply and quality	1.1
Farm environment as a place to live	1.0
Net profit before tax	0.9
Labour	0.8

2.6 Conclusion

This chapter has presented results on the overall group map for high country farming. The centrality data were useful in their own terms and for preparing a group map. The high country group map results were then compared with those from the earlier studies of the dairy and sheep/beef farms to show some key differences across sectors. The Q-sort data were only of modest value in this study.

Chapter 3
Key Findings and Discussion

3.1 Summary of results

Centrality scores

- The centrality data showed that at the heart of high country farming were the decision maker, two non-productive factors (family needs and satisfaction), production and financial aspects moderated by weather and climate.

High country group map:

- At the core of the map were farmer decision maker, production, and family needs.
- Farmer decision maker, as a factor, was most influenced by labour, weather and climate, and family needs.
- Production was most influenced by stocking rates and farmer decision maker.
- Family needs was most influenced by farmer decision maker.
- Weather and climate was an important influence on production, and was as important as fertiliser and soil fertility health.

Comparison across high country, dairy and sheep/beef sectors in terms of causal maps:

- There was broad similarity across the three farming sectors in that each of the group maps has the same top five factors within the top six rankings.
- The high country farming system had less emphasis on production and more emphasis on family, soil type and neighbours.
- High country, compared to dairy only, gave more importance to weather and climate, and to off-farm activities.
- High country, compared to sheep/beef only, gave less importance to off-farm product quality.
- Sheep/beef, compared to dairy only, gave more importance to customer requirements and to advisors and consultants.
- Location and time in farm work were more important to high country farmers as a source of satisfaction while farmer decision maker was not an important source of satisfaction.

Comparisons across sectors in terms of map characteristics:

- High country, compared to dairy and sheep/beef, had more factors and lower map density (fewer connections compared to the number of factors).
- Dairy, compared to high country and sheep/beef, had more transmitter factors (arrows going out) and fewer receiver factors (arrows going in).
- Dairy compared to sheep/beef had fewer double arrows.

Q-sort results:

The low numbers of farmers precluded the development of maps for Q-sort types 1 and 2 but the two types broadly correspond to a production orientation and an environmental orientation, as found in the dairy and sheep/beef studies.

3.2 Discussion and Interpretation of Results

In the following discussion most attention is given to comparative assessments of the results rather than on the particular characteristics of the high country results. However, the latter is covered to some degree in the first point.

1. Particular characteristics of the high country results

a. Unique sources of satisfaction for high country farmers. This research has identified two distinctive sources of satisfaction for high country farmers, including this location and time in farm work. Clearly, these farmers are drawn to and value the unique high country environment. Further, it is only on the high country map that farmer decision maker has a low level of connection to satisfaction. It has a score of only two so does not make it on the map whereas for sheep/beef and for dairy it was four. This difference partly explains why satisfaction has lower centrality for high country (47) compared to sheep/beef (55) and dairy (52). Therefore, for high country farmers satisfaction is gained more from varied sources and less directly from farmer decision maker.

b. Government policies received a centrality score of six. This score is very low and similar to sheep/beef (4) and dairy (3) and seems at odds with the current level of attention being given to tenure review of high country farms. Four ARGOS high country farms have been involved with tenure review. Perhaps this low score reflects that the high country farmers put aside government policies when they were asked to think about their farming system. This consideration seems at odds with the strong feeling by some farmers that government policy in the form of land tenure review is having major effects on what they farm and how they farm. This result suggests that high country farmers do not place their farm system within a political context. The result also suggests that high country farmers may be idealising their view of their farm system and portraying it as they would prefer it to be functioning – without overt interference from government.

2. High country factors with statistically significant scores

a. Weather and climate: high country 41 and dairy 23.

Weather and climate was rated highly by high country farmers compared to dairy farmers because in high country farming this factor has a high level of influence on farming operations. High country farming occurs in relatively dry areas with short growing seasons and extreme seasonal temperature variation. The normal level of climatic variability has a large impact.

b. Soil type and topography: high country 23, sheep/beef 12 and dairy 7.

The results show that high country farmers gave a much greater importance to soil type and topography than those in the other sectors. The large and varied nature of the topography of high country farms is reflected in the greater importance of this factor in high country farming. In many cases high country farms lack good quality soils so soil type has a large influence on production.

c. Neighbours: high country 15, sheep/beef 6 and dairy 3.

While relatively low in centrality score, neighbours received a higher score from high country farmers compared to sheep/beef and dairy. Perhaps this result is a product of the isolated nature of high country farming, and with neighbours a long way off, more importance is given to them. It remains the case that a high country farmer's neighbours are a source of help

when a crisis occurs. Further, since the high country farms are large, it is likely that there are relatively fewer neighbours compared to low country farms. Perhaps also, neighbours rated so low in sheep/beef and dairy because management practice is more likely to impact on a neighbour in some way so this relationship is potentially more problematic. Many high country operations would have little immediate bearing on neighbours.

d. Off-farm activities: high country 23 and dairy 8.
Perhaps strangely, it is high country farmers compared to dairy farmers only who placed more emphasis on off-farm activities when it would appear that these would be harder to pursue in more remote locations. Perhaps off-farm activities are more taken for granted for dairy farmers since they are closer at hand, and therefore are given less importance.

e. Quality and quantity of production: high country 55, dairy 81, sheep/beef 82.
Off-farm product quality: high country 5 and sheep/beef 17.
High country farmers do not appear to be as production or marketing oriented as other farmers. They gave less emphasis to production and gave a very low centrality score to off-farm product quality. Perhaps they believe that they cannot influence production very much in their extensive pastoral system. It may be that for high country farmers production is tightly constrained by weather and soil type and that they have learned not to emphasise production.

f. Family needs: high country 68, dairy 37, sheep/beef 39.
Family needs were more important to high country farmers perhaps reinforced by their sense of isolation and the need to be more aware of family requirements for education, friendship and social activity, which are more taken for granted for sheep/beef and dairy farmers.

Overall, these results suggest a picture of farming which reflects our notions of traditional family farming in which family and social factors, such as off-farm work and neighbours, are important. Less emphasis is given to production and more to weather and soil as critical factors influencing production.

3. High country factors with distinctive but not statistically significant scores
a. Farm environmental health: high country 24, sheep/beef 40, dairy 35.
High country farmers did have farm environmental health on their group map but the centrality score of 24 was lower than that for dairy at 35 and for sheep/beef at 40, although the difference was not statistically significant. The level for high country is similar to that for kiwifruit where the centrality was 20. On balance then there is marginal evidence that high country farmers rated the environment as a less important aspect of their management compared to dairy and sheep/beef. Assuming that it is lower, how can we account for it? We suggested in the kiwifruit report that the low rating to orchard environmental health may have been due to widespread use and acceptance of the Kiwigreen system which meant, from the orchardists' point of view, that the environment was taken care of. For these orchardists the management system being used protects the environment. In a similar way, but perhaps for different reasons, high country farmers see environmental health as a less important part of their farming system. High country farming is not intensive and the large scale of the farming operation makes it difficult for farmers to have an obvious impact. They may even think that they are hard pressed to have an impact on the environment. Since nature is seen as robust, it can be seen as healthy. Alternatively, what the lower score for farm environmental health may be indicating is that high country farmers see their extensive pastoral farming system as fragile and unforgiving of mistakes and have learnt to work in synergy with the environment. Because this is embedded in their farming style they have not rated farm environmental health as high.

b. Labour: high country 32, sheep/beef 20, dairy 14.
Labour for high country has a centrality of 32 compared to 20 for sheep/beef and 14 for dairy. Again, this difference was not statistically significant. In both the latter causal maps this factor is linked to farmer decision maker only while in the high country map it is also linked to time in farm work. Further, it is only on the high country map that the factor of contractors is present, albeit with a low centrality of 14. Clearly, the scale of high country farms demands greater use of either farm labour or contractors and this is reflected in the maps.

4. Higher complexity in high country maps?
The total number of factors used by high country farmers in their maps was higher than the number used by dairy or sheep/beef farmers. In the causal map there are more factors, and, using the same criteria across sectors, this map omitted some factors that were included for sheep/beef and dairy in order to make the map easier to follow. On this criterion of number of factors, high country maps are more complex.

However, the high country map density was lower than that of the other sectors while there was no significant difference in the number of connections. As map density is calculated from the ratio of the number of connections to the number of factors squared, high country maps had more factors with a similar number of connections compared to the dairy and sheep/beef maps. This indicates that, while high country farmers recognised a greater number of factors that played a role in their farm systems, they used a relatively fewer connections. The results also suggest that there may be a limit to the number of connections that a farmer is able to make as the number of factors increases. Given that the average number of factors for the high country causal map was 30 compared to 22 for sheep/beef and dairy, then these maps were already more complex just with the factors alone. It is reasonable to suggest that under such circumstances, relatively fewer connections would be made.

In terms of double arrows, the high country maps had more but the difference was not statistically significant. The data show that two high country farmers had six double arrows, while four had 24 or more. This high variability among a small number of cases militated against finding a statistical difference.

High country farms have large and diverse environments which traverse a broad range of landscapes and altitudes. In making their maps represent this landscape they would be more likely to include more factors than the other sectors. But does this increased number of factors lead to greater complexity of the farm system? The results show that there were relatively fewer connections between factors indicating that at this level the maps were less complex on this dimension but in terms of number of factors they were more complex.

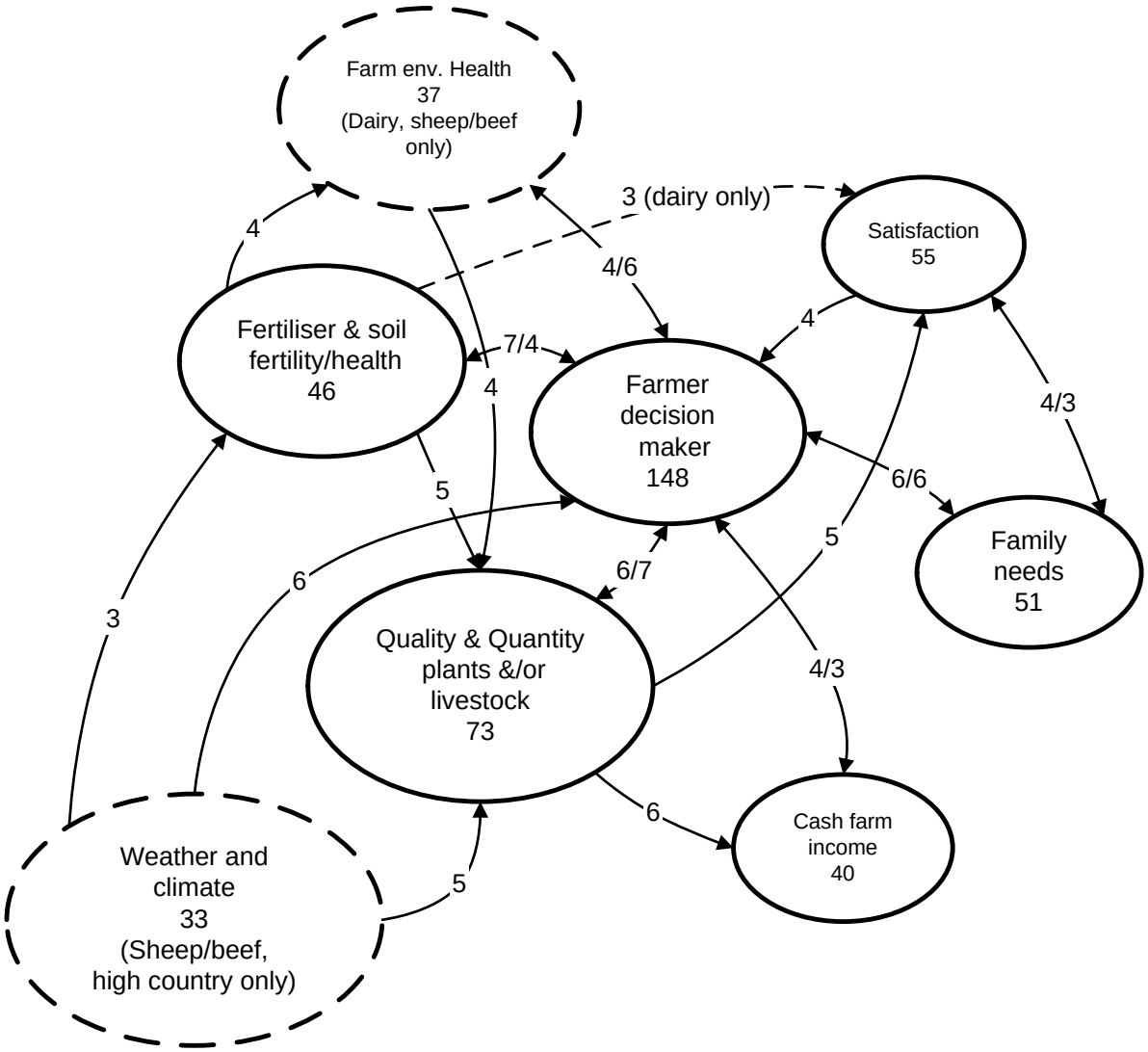
5. Character of dairy farming highlighted by comparisons. The other significant comparisons show that dairy farm maps had fewer transmitter factors, that is, factors that only had outward arrows, and more receiver factors, that is, more inward arrows. They also had fewer double arrows. This could mean that dairy farmers have a greater awareness of the factors that impact on their farming system but do not see feedbacks operating between factors. Further work would need to be done comparing transmitter factors with receiver factors if this were to be explained further.

6. Some similarity between high country and organic sheep/beef farming.
The high country centrality score for quality and quantity of production was much lower (55) than that for dairy (81) and sheep/beef (82). However, the scores given by organic sheep/beef farmers were not significantly different from the high country scores, showing that, in the sheep/beef sector, this difference was driven more by the integrated and conventional farmers. These results are showing that high country farmers and organic sheep/beef farmers attach a similar, and lower, level of importance to quality and quantity of production compared to other farmer types in the other sectors.

This suggestion of similarity between organic farming and high country farming is not supported by comparison of map characteristics. High country farmers used more factors in their maps compared to sheep/beef and dairy but this characteristic was not shared by organic sheep/beef or dairy farmers. In fact, converting dairy farmers had slightly fewer factors. Also in contrast was map density: this was much lower for high country farmers but sheep/beef organic farmers and converting dairy farmers had greater map density. In addition, the latter had more connections per factor.

7. Common elements of pastoral systems. While the analysis has emphasised differences across farm sectors, it is still the case that the three pastoral systems have the same top five factors within the top six ratings. In addition, weather and climate was seventh for high country, eleventh for dairy ad eighth for sheep/beef. Farm environmental health was the sixth factor for sheep/beef and the seventh factor for dairy. So including weather and climate and farm environmental health allows us to consider the top eight factors among most of the maps. Figure 3 below shows how these eight factors are related.

Figure 3: The eight key factors in pastoral systems as exhibited by high country, dairy and sheep/beef farm causal maps (averaged data)



The farmer decision maker is the most important factor. This factor is connected to all other factors and five of these seven links are bidirectional. Next in order of importance is production which is central to the productive side of the farm system being causally influenced by fertiliser and soil fertility health and weather and climate, and, in turn, causally influencing cash farm income. However, these other productive factors are less important than satisfaction and family needs. Satisfaction is achieved from production and meeting family needs. Family needs has a direct influence on farmer decision maker. This summary map is showing how farmers negotiate between productive and family factors. Less important than the factors already mentioned is farm environmental health which has a modest centrality score for dairy and sheep/beef only. Farm environmental health is influenced by fertiliser and soil fertility health and the decisions made by the farmer. Its main causal influence is on quality and quantity of production. Note that farm environmental health is not strongly influenced by quality and quantity of production: in fact the average connection is two for each of sheep/beef and dairy and zero for high country. Finally, weather and climate is the factor with the lowest average centrality score among these eight factors. It has a strong link to farmer decision maker and production.

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