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THE DEVELOPMENT OF A MULTI-DISCIPLINED APPROACH FOR DETERMINING NEW ZEALAND DAIRY FARMER ATTITUDES TOWARDS SUSTAINABILITY

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Abstract

In recent years, the concept of sustainability has been a feature in agricultural policy discussions. In this context it is important to understand the rationale of farmer's decisions in relation to the dimensions of sustainability - economic, social, and environmental. The aim of this project was to design a framework to determine the attitudes of individual dairy farmers in terms of financial and environmental management, and social responsibility.

The literature on indicators of sustainability for agriculture were reviewed. Selected indicators identified in the literature were then applied as the three sustainability pillars: economic, social and environmental in a two-stage interview process. Scoping interviews were conducted to finalise relevant indicators before a wider interview process based on the Analytic Hierarchy Process was undertaken.

The results show that social responsibility is a key factor, encompassing both an individual's own work-life balance, but more importantly the positive management of employees. Profitability, evidenced through system resilience and productivity, is also a key driver of a farmers' business. Protecting the environment is a necessity understood by farmers, in terms of both reducing detrimental environmental impact and to a lesser extent enhancing the wider environmental landscape.

Keywords: Agricultural sustainability, dairy farmers' motivations, Analytic Hierarchy Process

Introduction

Traditionally based on sheep and beef farming, New Zealand agriculture has seen major structural changes over time. One of the more recent changes is the conversion of many sheep and beef farms into dairy farms. Dairy production was traditionally based in the North Island, however, most of the recent growth in the dairy industry has taken place in the South Island where farm size, stocking rate and production levels are higher, with 27% of the herds but with 43% of New Zealand's milk solids production (LIC and DairyNZ, 2016). This intensification has been consolidated by a strong position in the processing and marketing sector with the formation in 2001 of Fonterra, a farmer-owned cooperative now owned by about 90% of New Zealand farmers. Fonterra is responsible for almost one third of the world export dairy trade and is ranked as the sixth dairy company in the world (Rabobank, 2017).

In spite of being a highly productive system, the New Zealand dairy sector is confronted by several issues that affect its future sustainability. This includes the lack of cheap and highly nutritive value feed and insufficient quantity of skilled farm labour (Clark et al., 2007). To tackle these problems, the industry has responded in several ways. First, pasture yields have been pushed to their maximum through increasing the amount of nitrogen fertilisers spread on their pasture and through introducing irrigation in the driest regions of the country, primarily Canterbury. Second, to enable economies of scale and the more efficient use of labour, the size of dairy herds have increased considerably over the past few years. This has generated criticism of the industry (Baskaran et al., 2009). Consequently, New Zealand dairy farmers are faced with the challenge of producing adequate quantities of food that enable them to make profit, whilst maintaining a responsibility of care for their highly mobile workforce at the same time protecting their natural resources (Schaller, 1993).

Despite the drive for productivity and consequent intensification of agricultural systems, it has long been established that the behaviour of farmers is not driven solely by the economics of profit maximisation, and that many different values, beliefs and objectives influence their decisions (Gasson, 1973). There is now considerable qualitative evidence that farmers also make land use decisions in response to a variety of non-profit objectives (Cooke et al., 2013). In this context it is important to understand the rationale of farmer's decisions in relation to the dimensions of sustainability - economic, social, and environmental.

The aim of the project reported here was to develop a framework to determine the attitudes of individual dairy farmer towards the economic, social and environmental aspects of decision making in their farming system. This paper summarises the approach to designing that framework, alongside the results from its implementation in the South Island of New Zealand.

Methods

The research had three key phases, literature review, scoping study and in-depth interviews with dairy farmers.

Literature review

The review of literature covered two areas. First, the determination of a definitive list of potentially relevant objectives for New Zealand dairy farmers which could also be considered relevant to the measurement of sustainability. Second, the methods used to identify and determine the value of these objectives to those farmers. In the case of the latter the focus was on the concept of Multi Criteria Decision Making (MCDM) (Keeney and Raiffa, 1976) and the Analytic Hierarchy Process (AHP) (Saaty, 1990).

Selected indicators identified in the literature were then applied as the three sustainability pillars: economic, social and environmental in a two-stage interview process. These interviews were designed to determine attitudes towards financial productivity, social responsibility and environmental management.

Scoping study

Seven scoping interviews were conducted with individual dairy farmers across the North and South Island of New Zealand, to determine their attitudes, behaviour and values, in relation to issues affecting production, human resource and environmental management and to finalise the relevant indicators for a wider interview process. Farmers were specifically targeted to represent a range of management structures, farming experience, farm size and farm system to give a good representation of the entire New Zealand Dairy system.

The interviews were based around a series of open-ended questions designed to provide a general appreciation of sustainable farming in New Zealand. The interviews took between 30 minutes and one hour and 20 minutes to complete, the four in the North Island were conducted by phone, the three in the South Island were conducted on farm.

In-depth interviews

The answers provided by the farmers in the scoping study were used to construct the questionnaire for the more in-depth interviews with a wider group of dairy farmers. The purpose of these interviews was to provide insights into the various criteria that are applied by farmer decision makers, often very subtly, as they seek to satisfy competing ends and means and to provide understanding of decision making at the farm level as it affects the wider farm environment, especially of the extent to which this is shaped by economic, social and environmental factors.

A series of 28 interviews were conducted in person with individual dairy farmers across the South Island. Most interviews took approximately one hour and 30 minutes to complete.

Structure of the interview questionnaire

The questionnaires for both the scoping study and in-depth interviews were constructed around a similar format, the former more open-ended and the latter more structured. In both cases, the opening section was designed to record general background information on the farm and farmer. In the case of the scoping study, this was for confirmation purposes – the participants having been purposively selected.

In addition, in order to understand the attitudes and values held by farmers towards issues related to production, people and the environment, each participant in the scoping study was asked to provide and rank their reasons for being farmers and the objectives they set for their business.

In the next three sections of the scoping study, questions were focused on each pillar of sustainability – economic, social and environmental. Participants were asked to describe their economic situation, about their interaction within the farming and non-farming community, and about their management of the environment and the specific environmental issues that they try to manage.

In the in-depth interviews the participants were asked to provide similar information through responding to pre-determined lists generated from the scoping study process.

To conclude this section, participants in both the scoping study and in-depth interviews were asked to allocate 100 points between financial viability of the farm, work-life balance and the farms environmental management in terms of the importance they would give to

each. For the in-depth interview this was in terms of their current situation and in terms of the situation that they envisage for themselves in 10 years' time. For the scoping study this was only in terms of their current situation, but some participants also referred to a future point in time and how the balance would be different.

Analytic Hierarchy Process

The final stage of the in-depth interviews focused on the trade-offs between the three pillars of sustainability using economics, social and environmental objectives, criteria and measurements identified from the literature review and scoping study. This was undertaken using the Analytic Hierarchy Process (AHP). The AHP is a logical Multi-Criteria Decision-Making technique which can be defined as an approach to decision making that involves structuring criteria into a hierarchy. There are four steps. First, organizing the decision problem into a hierarchical model with different levels. The top level is the focus of the challenge. The intermediate levels are equivalent to criteria and sub-criteria. The lowest level comprises the decision alternatives (Saaty, 2008). Second, making pairwise comparisons between the decision alternatives using an AHP ranking scale from 1 (indifference or equal importance) to 9 (extreme preference or absolute importance) (Saaty, 1990). Third, the scores obtained from the pairwise comparison are then used to calculate weights for each alternative. Consistency in the process can be checked through the use of a consistency ratio (Saaty, 2008). Values for the consistency ratio of less than 10% ($CR \leq 0.1$) are considered reliable due to inherent human nature giving rise to occasional inconsistent comparisons (Saaty, 2008). The final step involves the aggregation of the different elements in each level, that is the different alternatives and thence the different attributes to derive composite weightings for the different criteria.

In the in-depth interviews there were two phases to the AHP. Participants were first asked to reflect on their current situation in relation to the decision alternatives, and to identify their most preferred and least preferred levels of these, to some extent the amount of variation they could tolerate over a specified time period. They were then asked to undertake pairwise comparisons between each of the alternatives in turn assuming that each alternative was at its least preferred level.

Results

The main characteristics of the participants and their farms in both the scoping study and in-depth interviews demonstrate a reasonable representation of the dairy industry in New

Zealand. The participants included owners, sharemilkers, farm managers and, in the in-depth interviews, contract milkers. Some farmers had more experience in farming than others. Most had between 10- and 24-years farming, with three quarters having spent less than 10 years on their current farm. There was a range of educational backgrounds, equally split between school leavers, those with a diploma, and those with a degree qualification. Looking to the future, just under half had identified a potential successor, the remainder had not, or it was not relevant to their situation.

There was also variation in farm size, with farm areas from 150ha to 5,500ha, mean of 442ha, and with a number of mixed-age cows from 220 to 8,500, mean of 973 cows. In the scoping study, the farms on the South Island were, on average, bigger than those in the North, which is consistent with New Zealand dairying in general. All of the production systems defined by DairyNZ were represented, from all grass-based systems, System 1, to a system reliant on imported feed and off-farm grazing, System 5. The majority of the farmers supplied the cooperative Fonterra, but there were also participants supplying private dairy companies.

The number of full-time equivalent staff varied as well, with between two and 54 people working on farm, although on the majority of farms there were less than 10 employees with a mean of just over six staff. The majority of participants in the in-depth interviews employed part time workers, and two thirds employed overseas staff, a significant proportion coming from Asia, but also Oceania and Europe.

Reason for farming and objectives for the farming business

In explaining their reasons for becoming a farmer what emerged from the scoping study participants was the passion for farming and the wider environment, the challenge of the job itself and the satisfaction that it brings. For the owners and sharemilkers there was also the opportunity of running their own business and building up wealth within that. For the managers it was the potential future opportunity for their own business and, to some extent, the autonomy they have in their current role.

Moving on to their objectives, their businesses were mainly driven by profitability and financial performance. They also wanted a system that is productive and resilient long term. For sharemilkers and managers, meeting the owner's objectives was also a high priority. For most participants, there was a strong emphasis on the potential to increase milk production through efficiency gains alongside managing farming expenses.

Social responsibility was seen as a key factor to success. Three main areas emerged as the areas of importance in the scoping study. The participants own work-life balance and social interactions, responsibilities to their employees in terms of their work-life balance and integration into the rural community, and of particular importance to those with a large number of employees, and responsibilities to their livestock with particular emphasis on animal welfare. Success in terms of work-life balance was measured as time spent with family and the time spent away from work in other non-farming activities.

Protecting the environment is a necessity that was understood by the participants in the scoping study and they were conscious of the role they have in managing the environmental impact of their farming activities. For many, one of their objectives was to leave the land in a better shape than when they took it on themselves so that the next generation could also benefit from it as a productive resource. A key current concern for them was the impact of their farm practices on soils and water quality particularly related to nitrate leaching, in part because of the focus of government policy in this area. All participants had taken several measures related to nutrient and water management.

Actively managing for biodiversity was also a consideration. A number of the participants in the scoping study had been actively planting trees and hedges. A key reason was for aesthetics, but they also saw advantages in providing shelter for animals, improving the overall ecosystem and reducing nitrate leaching. A number of the respondents also had native areas on their farm that are actively managed by themselves and/or other organisations with the aim of preserving local biodiversity, with some previously cleared areas also being restored to native planting.

In the in-depth interviews, these reason and objectives were similarly ranked by the participants.

In the allocation of 100 points between financial viability, their own work-life balance, and protection of the environment, financial viability came out as the most important pillar for both the scoping study and in-depth interview participants. According to the scoping study participants, if there is no business, then it becomes harder to focus on the other pillars. There was, however, comment that without due regard to the other pillars the business would not be viable and that to some extent focusing on financial viability would take into account both social and environmental responsibilities. Work-life balance was generally the second most important pillar, followed by environmental management, although there was not too much difference in weighting between the two.

The comment was also made by a number of participants that priorities would and should change over time. It was generally agreed amongst the scoping study participants that, in the long term, equal importance should be given to all three areas, financial, social and environmental. In the in-depth interviews, the overall weighting given to financial viability in the current situation was reduced in favour of increased weightings for work-life balance and environmental management in the future.

Analytic Hierarchy Process

For determining the trade-off between the economic, social and environmental criteria in relation to the attitudes of dairy farmers towards sustainability, our AHP model had four levels (Figure 1). The overriding goal was sustainability split into the economic, social and environmental criteria. These were further subdivided into six decision attributes and nine alternatives for use in the in-depth interviews. These decision attributes and alternatives arose from the findings from the literature review and discussions with the scoping study participants and were reinforced during the first stage of the in-depth interviews.

The economic indicators covered two alternative attributes; productivity, the quantity of milk solids produced, and resilience, the milk payout received. Social indicators covered two attributes; employer work-life balance and employee management, and in both cases two alternatives, leave days and working hours. Environmental indicators covered two attributes; water pollution and habitat/biodiversity, with three alternatives provided, nitrogen loss per hectare, the proportion of paddocks bounded by hedge, and the relative percentage of farm area given over to native habit.

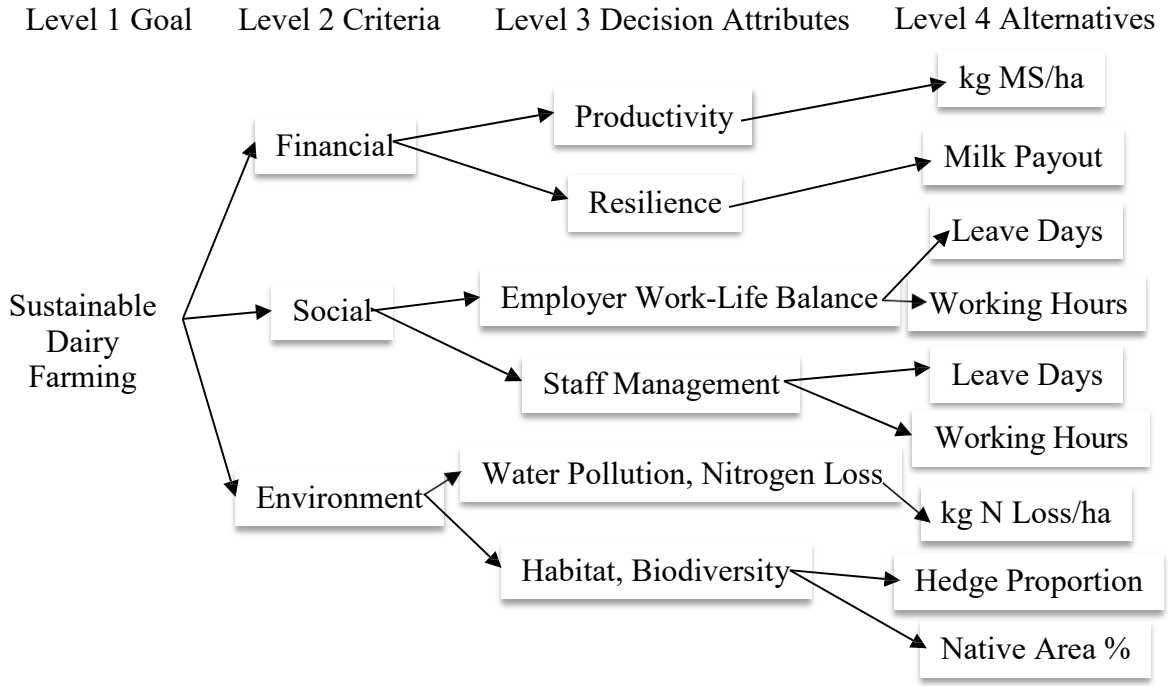

Figure 1 AHP Model: Criteria, Attributes and Alternatives

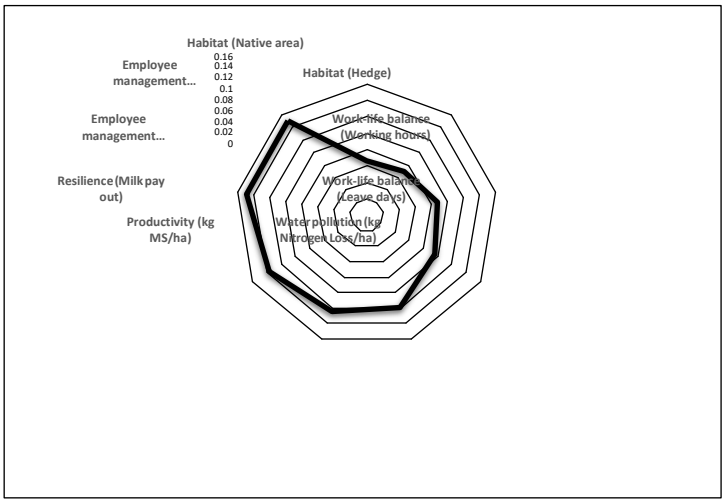

Figure 2: AHP Model: Importance of Alternatives by Mean Score

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Using the pairwise comparison approach of the AHP, numerical weightings were able to be assigned to the different alternatives, attributes and criteria. The AHP results show that for the individual alternatives, employee management in terms of leave days and working hours are critical factors in farm business decisions, alongside milk payout and milk solids produced and managing water pollution from nitrogen loss. Less important, by comparison, are the employers own leave days and working hours and proportion of hedges around paddocks and native areas on the farm (Figure 2).

An important part of the AHP is to check for consistency in responses. This requires a consistency ratio to be calculated for each participant. In four cases, the consistency ratio equalled 0.10. For the rest of the participants the consistency ratio was below this. This indicates that all participants were reasonably consistent in their responses.

When aggregated to the attribute level, employee management clearly outweighs the other five attributes, which are weighted reasonably similarly. At this level, employer work-life balance encompassing both leave days and working hours is weighted slightly above the two economic attributes, resilience and productivity and two environmental attributes, water pollution and habitat.

When aggregated to the criteria level, the social criteria encompassing both employee management and employer work-life balance amounts to almost half of the overall weighting, with the remaining weighting almost equally split between the economic and environmental criteria.

Discussion

The AHP is one of the most popular Multi Criteria Decision Making instruments for structuring decisions and prioritizing criteria, in this instance enhancing the understanding of the economic, social and environmental drivers of dairy farmers' decision making through a process involving the active participation of the individual decision makers themselves. The approach centres on the generation of hierarchies which link high end goals, in this case sustainability, with measurable attributes and alternatives.

The attributes and alternatives used were selected through a review of the literature and scoping study with individual dairy farmers. The challenge was to be comprehensive whilst recognising the trade-off between the potential number of criteria, their attributes and alternatives and the number of pairwise comparisons the dairy farmers would be able to mentally calculate accurately during the process to ensure consistency of response.

The advantages of the AHP is that it is easy to use and scalable, allowing decision makers to compare alternatives with relative ease, and thus weight attributes and criteria accordingly. In the interpretation of the data, areas of importance for the decision maker can emerge quite clearly. However, it can be time constraining in terms of the number of pairwise comparisons required, and the outcome is dependent on the choice of the attributes and alternatives for the chosen criteria.

In this study, the attributes and alternatives were not exhaustive in terms of capturing all possible factors that may influence the decision making of dairy farmers in New Zealand, and to some extent reflect current immediate concerns that are heavily influenced by increasing regulatory requirements, employee management and nitrogen loss. In addition, the number of alternatives associated with each attribute differs, such that some are represented by two alternatives whilst others are only represented by one alternative. In aggregating to the criteria level, there are four alternatives for the social criteria, three for the environmental criteria, and two for the economic criteria. This may be considered to have influenced the higher weighting given to the social criteria, although consistency in responses for each individual participant suggests this not to be the case.

Conclusion

In a series of interviews with individual dairy farmers in New Zealand, an AHP model was developed to determine attitudes towards the economic, social and environmental aspects of decision making in their farming system.

The participants of the study can be considered as representative of the major dairy farming systems and farm ownership structures, and in terms of stage of life, and as such the interviews have merit in providing both an overview and useful insights towards farmers' behaviour concerning key economic, environmental and social drivers.

The study found that for the majority of participants, social responsibility in terms of employee management and their own work-life balance is a key driver in decision making. Those respondents with a large workforce were particularly conscious of their responsibilities towards their employees, and for all participants' management of their employees and their own time in terms of work-life balance and social interactions within and outside the business are seen as crucial to business performance.

Productivity and financial performance are also important aspects of their system. The financial return forms the basis of many businesses and can drive everything else, as with a good financial situation decision makers can focus on other issues.

Environmental management was also important to the decision makers. There was a particular emphasis on nitrogen loss, unsurprising given the current regulatory requirements related to this issue.

For individuals, motivations and priorities do differ between business type and size and stage of life, leading to different emphases on financial priorities, social responsibilities and environmental management. Nevertheless, all participants indicated that financial viability, and social and environmental responsibility are important components of their decision making, with due regard given to all criteria.

The results show that although profitability is considered a key driver of a farmers' business, social responsibility is also seen by the participants as a key factor to success, alongside the necessity of protecting the environment.

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