

Resilience through change: 'Beyond reasonable drought'

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Abstract. Concerned at declining annual rainfall, increasing erosion and falling profitability, a group of south Marlborough farmers initiated an SFF funded dryland farming project. The project – Beyond Reasonable Drought - explored how farmers could adapt to a changing and variable climate by developing more resilient farming systems. System changes at the Avery family's 'Bonavaree' have increased profitability, biodiversity and leisure time which suggests improved resilience and sustainability of the new system. Behavioural change research investigated the impact of Beyond Reasonable Drought on farmers and rural professionals. Both groups are more aware of dryland farming issues. Farmers have changed farming systems and rural professionals have changed their advice to clients. Doug and Fraser Avery's management skills, personal commitment, and the system changes at Bonavaree were the key factors leading to behavioural change. An extension project that demonstrates practical and achievable outcomes, led by innovative and inspirational farmers, brought about behavioural change.

Key words: sustainability, dryland, climate change, behavioural change

Introduction

The 27,350 ha Starborough Flaxbourne district of South Marlborough is predominantly pastoral farming with some cropping on better soils and an expanding viticultural industry on the river terraces. It is one of the driest regions in New Zealand due to its central location and mountains to the south and east that create a rain shadow. Sunshine hours are high, winters mild and regular droughts are the norm. Rainfall is highly variable with an average annual rainfall of about 560mm; but rainfalls of less than 400 mm are not uncommon (Porteous 2008).

Six years of below average rainfall in the 1990's (average 480 mm) had affected the financial, environmental and emotional sustainability of farms in the district. Concerned at reducing rainfall, increasing erosion and falling profitability, a group of farmers set up a soil conservation group in 2004 (Starborough Flaxbourne Soil Conservation Group - SFSCG). The farmers were concerned at the damage to their loess soils by reduced plant cover and exposure to wind erosion. Erosion was threatening the profitability of their businesses and was also creating a negative impression of the district's farming practices. Support from the New Zealand Landcare Trust and funding from the community and the Sustainable Farming Fund, established a three-year project to investigate sustainable farming options for dryland regions of New Zealand. The SFSCG project aimed to identify farm management options that would allow farmers to maintain production during future droughts and ensure long-term viability. It also highlighted the need for farmers to adapt and to move to more resilient farming systems if they were to survive. An end of project field day – 'Beyond Reasonable Drought' – promoted the project's findings to dryland farmers and rural professionals from many areas of New Zealand.

Bonavaree, the SFSCG monitor farm, is run by the Avery family (Doug and son Fraser). The system changes at Bonavaree, from a ryegrass to a lucerne grazing system, were coupled with a decision-making system that avoided relying on risky periods of feed growth (Avery et al. 2008). This farming system generates more revenue from periods when pasture growth is relatively high and reduces grazing pressure on hill slopes and improving pasture cover. Increased profitability, biodiversity and time for leisure suggest that the resilience and sustainability of the system has improved.

This paper reports on the findings of a review of the SFSCG project undertaken in 2011. It investigates awareness and uptake of project messages and behavioural change among farmers and rural professionals.

Method

Interviews with farmers in the Starborough Flaxbourne community

The review objectives were to investigate the uptake of information and the extent of behavioural change since the start of the SFSCG project of attendees of the Beyond Reasonable Drought field day attendees.

Exploring and discovering the human dimension of sustainable land management issues in the Starborough Flaxbourne area was a critical part of the three year SFSCG project. Ten face-to-face interviews were carried out with farmers or farming couples in the Starborough Flaxbourne district in February 2006; eight months after the SFSCG project started (Nimmo 2006). For the

project review, parts of the 2006 research were repeated to provide an insight into the local community's uptake of information and identify any constraints or barriers to adoption of sustainable land management goals. All of the ten original interviewees were still farming in the district, and seven of these were interviewed for this review. One was unavailable and two others were monitor farmers and management group members, therefore very aware of the SFSCG project and outcomes. Three new farmers were selected. The semi-structured interviews were carried out at the respondent's home over the last two weeks in July 2010, using similar research themes to the 2006 survey. Interviews lasted from one to one and a half hours. The research themes were: farm systems; erosion awareness and management; drought planning and management; lucerne use; and system changes made over the past four years (since the project's inception).

A second set of interviews were conducted with Starborough Flaxbourne farmers via telephone. The Marlborough District Council rating database provided the names of owners of rateable properties (50 ha minimum) in the Starborough Flaxbourne area; a total population of 81 properties. Vineyards, farmers already interviewed and SFSCG management group members were excluded (65 contacts) and difficulties finding telephone numbers from the rating base addresses reduced the population to 46 properties. Farmers were randomly selected from this sample of 46 properties. Using a structured questionnaire, ten phone interviews were undertaken over a three week period in late 2010. Interest in the review was very high, and even though it was a busy time of year, refusals were minimal. The length of some interviews (interviews ranged from 20 minutes to over one hour) reflected the respondent's willingness to talk about their farms and this topic. The research themes were: attendance at project events; farm systems; lucerne use; drought management; and changes over the past four years (since the project's inception).

Interviews with farmers and rural professionals from other dryland areas

The 'Beyond Reasonable Drought' day final project field day was held in May 2008, with attendance from over 400 farmer and rural professionals from Hawkes Bay to Central Otago. Field day attendees were encouraged to register and the registration database was kept after the field day for any project updates. Names, email addresses and some phone numbers from the registration database were used for the project review.

Fifteen phone interviews were held with a range of rural professionals who attended the field day and came from Hawkes Bay to Otago, from February to April 2011. The group included regional council staff, tertiary providers, members of the Hawkes Bay Drought Committee, seed merchants, technical/field officers (e.g. from PGGW and CRT), DairyNZ extension staff and representatives from Fish and Game. Ten phone interviews were undertaken during the same time period with farmers randomly selected from the main database in a range of locations from Hawkes Bay to Otago. The research themes were: current role or business; key messages learnt from the field day; changes made to farming systems; and, if and how the field day has influenced current interactions with farmers and others.

All respondents wanted to discuss the role of Doug Avery and/or Doug's personal attributes during the interview process. All comments about Doug and Fraser Avery, Graeme Ogle and Derrick Moot were freely given. The survey instrument did not ask respondents for their opinions of Doug or his role in the project and the interviewer did not probe for respondents' views.

Results

Awareness and perception of project messages

The SFSCG project aimed to: develop a better understanding of the soil properties and processes that create erosion risk; to support families in the development of more sustainable land use options; and to identify, describe and model pastoral farming systems that have superior indications of long term resilience.

All twenty south Marlborough farmer respondents were aware of the project, and have either been to Bonavaree informally, for an organised event (e.g. a field day) or 'had a look' while driving past. As one farmer commented:

I'd go see Doug and he'd say – jump in the truck and I'll show you something.

The SFSCG project raised awareness of dryland farming issues and potential solutions among South Marlborough farmers. They understood that the project was set up to address erosion control and the continual dry summers. South Marlborough farmers specified the value of direct grazing lucerne, preventing overstocking and overgrazing, taking a flexible systems approach to farming and erosion control as the key ideas they learnt from the SFSCG project. The project

gave farmers the opportunity to look at options and decide whether those options fit their current management system, or whether they needed to make a system change. The following comment reflects this.

It has addressed the perception that there is no hope and no other way. We don't always have to look godforsaken and in drought.

Farmers who attended the field day learnt how to incorporate lucerne into a grazing system and how to make profit in the dry. As one North Canterbury farmer commented:

I learnt that there's another way than a pasture based system. I'm carrying less stock and making more money. I'm making the most of what and when the rain falls.

The rural professionals learnt how to utilise lucerne on all areas and not just flats, taking a farming systems approach when looking for options, and recognising the need for change and taking advantage of change. The following comments reflect these ideas.

It was pertinent for us. We'd just been through several big droughts. We were looking for ideas and lessons. I learnt about the principle of re-examining your system due to a changing environment. You can't keep on doing the same things. If it's not working - change it (Hawkes Bay drought committee member).

The key message I got was that what Doug was doing, wasn't working. He was able to change his farming system to suit the environment rather than trying to change the environment to suit the farm. Doug has changed the way he farms. It's paid massive dividends (technical/field officer).

Adoption of messages and behavioural change

A change to farming systems, using lucerne for grazing and developing drought management strategies are the key behavioural changes evidenced as a result of the SFSCG project.

Farmers in the Starborough Flaxbourne community Farmers in the Starborough Flaxbourne community have made some change to their farming system. All have reduced their stocking rate to increase the flexibility of their farming systems. The capital stocking rate is lower and the variable stocking rate (trading stock) may be higher as stock will be sold when needed to suit feed availability and climate. Some have changed their sheep to cattle ratio (decreasing sheep and increasing cattle), a few have taken on dairy grazers and others have made a system change from less breeding stock to more trading. Increased trading stock or dairy grazing gives increased flexibility.

All farmers interviewed were actively trying to control their erosion by being more aware of their stocking rate and grazing management. They are aware that reducing stocking rate or stock class maintains or increases pasture cover in the dry summer months, as less stock prevents overgrazing. Soils with pasture cover are not exposed to the actions of wind and rain, which has the direct effect of reducing the amount of soil degradation. Farmers are also thinking about what stock they are going to graze where and making stock management decisions earlier in drier years. Some are also thinking about or investigating alternative species for feed and erosion control, for example, tagasaste and different clover varieties.

Other more direct erosion control measures, such as fencing off and/or planting depend on the individual as some *'are doing what they can'* and others *'are doing less'*. If erosion is not perceived as a big problem, is not getting worse and can be managed with the current farming system (pasture cover maintained) the individual may not be taking a lot of direct actions. An individual may do more only when erosion becomes a bigger problem (for example with change in weather), or if cash flow permits. Saltbush was an erosion control and feed management option successfully trialled at Bonavaree. South Marlborough farmers are aware of saltbush but only one has planted since the project. Saltbush and fencing is an expensive option (when plants are used) and district-wide success has been mixed.

Almost all have some lucerne and most have increased their area in lucerne over the past four years and/or are trialling lucerne for grazing, which has increased farming system flexibility. A marked difference has been the change from conservation (making lucerne into hay or silage) to direct feeding of lucerne to young stock and/or ewes and lambs. Increased young stock growth rates means the potential for stock to be sold earlier at a higher price and less stock on-farm over the drier periods.

Farmers are now more confident making drought management decisions and have specific drought strategies. The key components of their drought strategies are planning (develop drought strategies), timeliness (making early, quick decisions) and *'sticking with'* the decision made. Most specified a rainfall pattern that will alert them to the possibility of a drought that leads to instigation of the drought plan. Rainfall timing in spring and/or autumn is critical, whereas a dry summer is *'normal'*. Most make decisions differently now during a drought than

they used to four or five years ago. Flexibility is the key – being more flexible about decisions on which stock to sell and when. All are now running less stock or a stock class that can be easily changed or sold. Many also commented on feeling more confident making drought management decisions - decisions that would have been difficult to make four or five years ago.

We are much better at making decisions. We're more relaxed about ditching things. We're more confident about making decisions and make decisions earlier.

Farmers who attended the Beyond Reasonable Drought field day Almost all farmers interviewed who attended the Beyond Reasonable Drought field day (9 out of 10) have made changes to their farming system since the SFSCG project. Some have changed stock type to increase system flexibility, for example, decreasing sheep numbers and increasing cattle which can be sold if feed becomes scarce. Some have changed lucerne use, from supplementary feed to direct grazing, or have increased the area of lucerne for direct grazing, or introduced lucerne as a component of a dryland pasture grazing mix.

All respondents using lucerne now direct graze their lucerne. Most use it for young stock (for example to finish lambs); one is using for ewe flushing and is mating onto lucerne; and two are also using for a small amount of supplementary feed if a surplus exists after grazing. The exception to this pattern is a high country farmer who grazes after hay and silage cuts have been made, as high protein conservation feed is important in his harsh winter climate.

All have a specific drought plan, with flexibility and planning the keys to a drought proofed system, for example, selling trading stock or drafting to lower weights. Many have not changed their drought decision-making process since the SFSCG project; however, the key difference is using lucerne to provide feed over a dry period. Lucerne is now part of these farmers' drought proofing toolboxes. The increased flexibility from lucerne is a direct result of the SFSCG project.

Respondents also commented on change amongst their neighbours with more lucerne being planted and more used for direct grazing. All commented that these changes appear successful. One central Otago respondent discussed the impact that the Greenfield agribusiness company has had in their district, as Greenfield's staff attended the field day and were influenced by Doug Avery and the system at Bonavaree. He commented:

I was the only one from around here that came up to the day. Greenfields though has gone to the Avery model. It's in your face – hundreds of acres of lucerne and the main road goes right through the property. You can't miss it. They are traders only, so don't have the winter issues (no growth) as they don't have any stock on. Others around here have seen that and have put in large areas of lucerne. Some are using it for grazing and others are using for cut and carry. The ones grazing are selling less stores and fattening more lambs and getting them away earlier. They have changed the way they are farming.

Doug Avery and the changes at Bonavaree were the key factor leading to change on these properties, as Doug was specified by seven of the nine who changed their system. Derrick Moot (dryland plant specialist, Lincoln) and Graeme Ogle (farming systems specialist) were also mentioned (Note: all names were freely mentioned and not probed for by the interviewer).

Some specific examples:

Doug's field day boosted our confidence to go for it. We've adapted it for our situation as we have a smaller growth period and a later spring (respondent now lambs on and finishes young stock on lucerne, therefore can draft earlier).

The interaction with Doug Avery. The original field day was the stimulus. Doug came to see us with Graeme Ogle. What we're doing now better fits our feed curve – our supply (respondent now direct grazes young stock on lucerne, and is increasing the planted area each year).

It's always a drought here and I always plan for a drought. We just plan for no rain. We slow down the rotation until the next rain and then when it does rain you know you will have some feed with lucerne in no time. We were uneconomic until I visited Doug Avery and I learned how his system worked (central Otago respondent, 400-600mm annual rainfall).

Rural professionals who attended the Beyond Reasonable Drought field day A wide range of rural professionals from Central Otago to Hawkes Bay attended the end of SCSFG project field day. These fifteen respondents all commented on behavioural changes evidenced among their farmer clients since the field day and changes in their own attitudes, knowledge and businesses since the SFSCG project. The following examples illustrate some of the behavioural changes.

Three technical/field officers from rural trading companies were interviewed and are actively working with approximately 390 farmers in Canterbury and Otago. They are now using the project's concepts when working with farmers, such as the idea of a systems change; matching the system to best fit their own environment and the benefits of lucerne as a direct grazing tool.

It's hard to quantify, but what Doug is saying is having an impact. Farmers are taking more notice of what they're growing – rather than just the ryegrass/white clover that their fathers did. Farmers are changing their thinking. It will take conservative farmers longer but it will happen (seed company representative).

The technical field officers have also noticed behavioural change among their farmer clients. The Canterbury respondent with 140 farmers in his client base estimated that 60% have made changes since the field day. The farmers in this area have made changes such as: working towards a system to improve late spring/early summer production by direct grazing lucerne; trialling lucerne in areas traditionally considered marginal (rather than just on the best producing flats); and adopting Doug's idea of moisture transfer through summer fallowing (using ryecorn).

The Central Otago respondent with 50 clients has seen a few making a system change although many are 'thinking about it ... It's the mindset; the fear of stepping into the unknown'. Some others have put in lucerne on a paddock by paddock basis, but he commented that they need larger scale to make the lucerne system work effectively.

One of the Hawkes Bay Regional Council attendees described a recent community initiative he is involved with. As a direct result of the project and the field day, this respondent has worked with his local community to set up the SFF funded Huatokitoki Community Catchment Project. This community project covers 17,000 ha of sheep/beef/arable country, involves 25 farms and was completed in 2012. His comments reflect the role of the Starborough Flaxbourne project and Doug Avery as instigators in the Huatokitoki project.

Things were dire for us in Hawkes Bay at the time. We knew we had to do things differently. The Starborough Flaxbourne project created the profile for a project like this – a systems review at farm level. It raised awareness that we needed to do something. After Doug Avery it was easier to get people to understand what we were trying to achieve. I'd say – 'look at what Doug's already done. This guy's already doing it on the ground and he's very successful'. It was a huge advantage for us.

Beyond Reasonable Drought and the Starborough Flaxbourne project has had an impact on the training and farm operation at Taratahi Agricultural Training Centre, near Masterton. All first year students are now exposed to the information from the field day and changes made include growing and using lucerne on all their farms and dairy units (following the Doug Avery model), and the field day influencing their decision to run less cows on their dairy unit. Regular public on-farm field days expose the wider farming community to new farming methods demonstrated at Taratahi: 'We like to think we are influencing farms around us and that our students will take what they have learned into their future farming roles'.

Discussion

The resilience of Bonavaree and the Avery family has been increased by the farm system changes developed through the SFSCG project – resilience through change. Doug often uses the term 'resilience' and commented how he and the farm had little resilience before the project. He described his concept of resilience as:

The ability to handle the broad set of events that may challenge my business or life and have the skill set and knowledge to mitigate these as best possible, and get things back to happy again. It's about having realistic visions and expectations and managing these in a way that you have reserves in the tank kept from good times to help you through the tough. This thinking is spread over soils, plants, animals, bank accounts and human endurance. We have become so unbelievably powerful and so quickly.

Doug's concept of resilience is reflected in the literature. The concept of resilience was adapted from ecology (Holling 1973), and is defined as 'the capacity of a system to absorb disturbance and still retain its basic function and structure' (Walker and Salt 2006, p. xiii). Other researchers have applied this concept to farming systems (Crawford et al. 2007; Darnhofer et al. 2010). The concept of a resilient New Zealand dairy farm system was developed by Rusito et al. (2011). They proposed (p. 8) that:

Resilience is the capacity of a farming system to not only adapt to change in the environment but also take advantage of opportunities created by a disturbance while maintaining productive capacity in face of variability in production, financial and market related factors.

A resilient dairy farm has been described as profitable, sustainable and able to withstand variability (Crawford et al. 2007) and able to maximise efficiency regardless of favourable or unfavourable market conditions (Rusito et al. 2011).

A study of dryland farmers in the Huatokitoki catchment, Hawkes Bay, identified individual strategies that farmers use to increase their resilience (Gray et al. 2011). The Huatokitoki study divided the resilience strategies into the risk, recovery, revenue and rest phases developed in

the SFSCG project (Avery et al. 2008). Farmers in the Huatokitoki 'believed they were resilient because they had survived several years of drought' (p.20) and Gray et al. further commented that 'the portfolio of strategies that a farmer adopts are more important than individual strategies to develop a resilient farm system' (p.20).

Strong local farmer leadership was one of the key factors leading to success of the SFSCG and uptake of project messages. Strong farmer leadership was evidenced by the farmer management group members' involvement, and particularly, in Doug Avery's personal management skills and commitment as group chairman and monitor farmer. Strong local leadership was also a success factor in all thirteen New Zealand environmental case studies reviewed by Giera et al. (2007). The authors summarised the leadership role that farmers play as:

demonstrating best practice on their own farms; by organising and chairing meetings to discuss issues, by allowing their farms to be used for demonstrations; by speaking out about issues for the well-being of the industry and by supporting land-care initiatives' (p.34).

The importance of farmer leadership was also reported during a review of the Upper Taieri catchment project, Otago, when nearly all respondents (> 90%) agreed or strongly agreed in the importance of farmers to be leaders in developing future water management systems (Tyson et al. 2011).

Respondents recognized that a successful monitor farmer was the key to demonstrating successful system changes. It was suggested that a successful monitor farmer should be: organised; focussed; scientific; able and willing to keep regular accurate records; prepared to share farm and financial information; willing and prepared to take part in all dimensions of the project; and motivated to make it work to get the most benefit for the community, not just for self-interest. Doug was described as organised, committed, enthusiastic, receptive to new ideas and a man with a vision and a detailed plan who wants to succeed and be a good farmer. Doug's business skills and attention to detail ensured that he was a successful monitor farmer and his ability to communicate his ideas ensured the project's outcomes were available to a wide audience.

Doug is an inspirational and enthusiastic innovator and motivator, and is comfortable with change. His enthusiasm, commitment and willingness to share information with others has ensured that the message is widespread. Doug's inspirational messages of working with natural forces and working on what you can change, continue to be shared with an urban and rural, national and international audience, via a wide range of media. Doug's post-project contribution and enthusiasm continues and Doug and Fraser host many individuals, groups and field days to share their learning journey. Mentoring other farmers, running dryland plant trials, writing a regular blog on thoughts and progress, and the recent addition (April 2013) of a face book page, are all examples of his ongoing contribution and commitment.

Community participation in and ownership of the process are other factors that lead to the uptake of the project's messages. Leadership and direction from the farmer management group and support from the New Zealand Landcare Trust ensured project direction and goal setting was driven by the community. The community planned and owned the Beyond Reasonable Drought field day for example, and saw it as an opportunity to showcase their community. Ownership of the research process has been noted by other researchers as key factors in promoting behaviour change. A review of the Aorere (Golden Bay) and Rai (Marlborough) 'Farmers as Leaders' project discovered that dairy farmers taking ownership of their own environmental performance lead to an increased adoption of project messages and behavioural change (Robertson 2012). Similarly, stakeholder and community engagement and leadership and partnership are two key factors suggested as critical for New Zealand integrated catchment projects to achieve their objectives (Feeney et al. 2010).

Trust and belief in people involved was another key factor in the success of the Beyond Reasonable Drought field day and SFSCG project. Farmers learn from providers they trust. A British study described the strong relationship that farmers had developed with their vets, which was built on mutual trust and shared interest (Fisher 2013). This relationship enabled effective information sharing about Tb control and farmers then acted upon this information.

Farmers respect and trust Doug Avery, can identify with him, believe in him and Bonavaree's financial accounts backed up the system changes evidenced. Farmers also trust, respect and understand Derrick Moot (lucerne and dryland plant specialist, Lincoln). Graeme Ogle (farming systems specialist) helped Doug design his new profitable farming system. Farmers trust Graeme Ogle's advice; particularly those in the high country who have worked with him before. The successes at Bonavaree have increased interest in lucerne, and Derrick Moot has noted a

significant increase in invitations to speak about dryland pastures and lucerne grazing at farmer field days and conferences, and is also involved in other SFF projects. He attributes this increase to the SFSCG project and commented that 'people have read and heard about Bonavaree and are taking up the challenge of adopting and adapting their systems'.

Many farmers and rural professionals came specifically to the Beyond Reasonable Drought field day to learn about lucerne and how to incorporate it into their farming system. Similar ideas were discovered by Rhodes, Willis and Smith (2000) during a study with New Zealand North Island hill country sheep and beef farmers. They commented that the farmers did not automatically attend field days, but selected specialist field days and were prepared to travel long distances to attend them.

The Beyond Reasonable Drought field day provided a highly effective learning medium and social opportunity, which has translated into behavioural change. Farmers had the opportunity to interact, learn from each other and gain new knowledge. Farmers often work alone in isolated environments, and the field day provided an opportunity to get together and talk with farmers from other parts of the country. Many farmers were 'feeling stressed and overwhelmed' from continual drought. The field day was positive and upbeat and many commented on feeling inspired and 'having lifted spirits'. Social interaction provides an opportunity for collaborative learning, which is the active process of learning from others (Allen et al. 2002). The authors also commented that active collaborative learning leads to ownership of outcomes, new ideas and perceptions and which can lead to improved understanding and behaviour change.

Conclusion

This review has identified the importance of strong local farmer leadership and community ownership of projects to achieve outcomes. Support and guidance from individuals or an organisation that the community trusts and respects will give community members the skills and confidence to undertake projects of this scale. The benefits of the changed farming system were demonstrated in a clear and practical manner and on-going back-up support is still available. The change to a lucerne grazing system is achievable and, if successful, a good financial outcome is the reward. Trust and belief in Doug Avery and the providers, and a clear understanding of the steps to take, were key factors in farmers willing to trial new technology.

Project review such as this are essential in understanding the key factors that lead to success and for lessons that can be applied to other projects.

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References

- Allen W, Kilvington M and Horn C 2002, 'Using participatory and learning-based approaches for environmental management to help achieve constructive behaviour change', Landcare Research Contract Report: LC0102/057, Ministry for the Environment, Wellington, New Zealand.
- Avery D, Avery F, Ogle GI, Wills BJ and Moot DJ 2008, 'Adapting farm systems to a drier future'. *Proceedings New Zealand Grasslands Association*, 70: 13-18.
- Crawford A, McCall D, Mason W and Paine M 2007, 'Industry adaptation – challenges when building resilient farming systems'. in *Meeting the Challenges for Pasture-Based Dairying: Proceedings of the Australasian Dairy Science Symposium*, September 2007.
- Darnhofer I, Fairweather J, and Moller H 2010, 'Assessing a farm's sustainability: insights from resilience thinking', *International Journal of Agricultural Sustainability*, 8(3): 186-198.
- Giera N, Menzies S, Buchan D and Anstey C 2007, 'Bridging the gap between environmental knowledge and research, and desired environmental outcomes to achieve sustainable land management. Phase Two Report', MAF Policy, Wellington, New Zealand.
- Fisher R 2013, 'A gentleman's handshake: The role of social capital and trust in transforming information into usable knowledge', *Journal of Rural Studies*, 13: 31-22.
- Feeney C, Allen W, Lees A and Drury M 2010, 'Integrated Catchment Management – a review of literature and practice', Ministry for the Environment, Wellington, New Zealand.
- Holling CS 1973, 'Resilience and stability of ecological systems' *Annual Review of Ecology and Systematics*, 4: 1-23.
- Gray DI, Reid JI and Horne DJ 2011, 'The management of risk in a dryland environment', *Proceedings of New Zealand Grasslands Association*, 73: 13-22.
- Nimmo K 2006, 'Rediscovering the 'Green and Gold' in Starborough Flaxbourne', Unpublished report as part of the Sustainable Farming Fund funded project #05/132.

- Ogle G 2006, 'Starborough Flaxbourne Soil Conservation Group Farm systems Research', Unpublished report as part of the Sustainable Farming Fund funded project #05/132.
- Porteous A 2008, 'Variability and trends in the climate of South Marlborough', in P Wardle and H Collins (Eds.), *Beyond reasonable drought. adapting dryland farming to climate change*, Hamilton, New Zealand: New Zealand Landcare Trust, pp. 7-9.
- Rhodes T, Willis B and Smith W 2000, 'Impediments to Optimising the Economic and Environmental Performance of Agriculture. Volume One: A study of Issues Affecting North Island Hill Country Farmers', MAF Policy, Wellington, New Zealand.
- Robertson J 2012, 'Aorere and Rai project review', New Zealand Landcare Trust, Hamilton, New Zealand.
- Rusito B, Shadbolt NM, Gray DI and Olubode-Awasola F 2011, 'Resilience of New Zealand dairy farms in a turbulent environment: Definition and measurement', in *Proceedings of the International Food and Agribusiness Management Association 21st Annual World Symposium, 20 - 21 June 2011*, IFAMA: Frankfurt, pp. 1 - 25.
- Tyson B, Edgar N and Robertson J 2011, 'Facilitating collaborative efforts to redesign community managed water systems', *Applied Environmental Education & Communication*, 10: 211-218.
- Walker B and Salt D 2006, *Resilience thinking. sustaining ecosystems and people in a changing world*, Island Press, USA.