

A regional collaborative extension project to decrease nutrient losses to waterways in the New Zealand dairy industry

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Abstract. The increasingly regulated management of natural resources in New Zealand provides another dimension for agricultural extensionists to consider, alongside the economic and bio-physical dynamics of farming systems. New processes for on-farm learning and system adaptation are needed that address the legal and statutory obligations being imposed on farmers to reflect the values of communities, industry and central government. DairyNZ and private consultants have worked together with the Manawatu-Wanganui Regional Council to assist dairy farmers in that region comply with the regulations while improving on-farm productivity. During 2014-2015, dairy farmers in the Waikawa Catchment were required to apply for landuse consents to reduce the estimated nutrient contamination in the catchment by between 5-15%. The significant changes in farming systems for this catchment target to be addressed needed an extension strategy involving collaboration across organisations to pool their capabilities for the good of the dairy industry, rural communities and future generations.

Keywords: OnePlan, nutrients, farm-plan, catchment-plan, action research.

Introduction

Research approach

During 2014-2015 extension development in the Manawatu-Wanganui Region was dominated by the introduction of the OnePlan to regulate the management of natural resources in the region. The OnePlan required most dairy farmers to apply before 2018 for a landuse consent controlling their on-farm nutrient management.

This paper describes part of the initial pilot study through an Action Learning-Action Research approach that examines how the practice of extension itself adapted to support farmers through the processes of first confronting and then responding to the introduction of these regulations (Zuber-Skerritt 2002). This study has not used an objective external researcher and more classical research methodologies because these would have exacerbated an already politically charged situation. The advantage has been that the insights generated for other extensionists have been from the participants themselves observing, critical reflecting, discussing, and then testing their ideas through further experience within the same context.

In the paper there is some background about the legislative changes associated with nutrient management in New Zealand that brought together the different agencies involved with regulation, industry good and extension, in this region. There is a description of the catchment that was the focus of reflections on collaborative extension. Then there is a review of our activities through a particular model of behaviour change and a description of what was learnt in that process, before conclusions are presented about continuing with collaborative extension to implement regulated nutrient management.

Legislative imperatives addressing water quality in the Manawatu-Wanganui Region

Resource management legislation in New Zealand has been brought together in one document, the Resource Management Act (RMA; New Zealand Government 1991). The RMA identifies roles for central government, regional government and territorial authorities in the development, administration and enforcement of rules governing the management of air, inshore marine areas, soils and water. Regional Councils such as the Manawatu-Whanganui Regional Council have the responsibility of developing regional plans every 6-10 years for their regions. In 2014 the latest regional plan for the Manawatu-Whanganui region became operative (the OnePlan; Manawatu-Wanganui Regional Council 2014). Chapter 5 of the OnePlan prescribes the regionally significant issues for water management within the Region, and sets out the objectives, policies and methods that derive from these issues. These include that 'existing intensive farming landuse activities must be regulated in targeted Water Management Sub-zones to achieve the nitrogen leaching maximums specified' (p. 14) and that 'new intensive farming landuse activities must be regulated throughout the Region to achieve the nitrogen leaching maximums specified' (p. 14).

A table in Chapter 14 of the OnePlan describes the maximum amount of nitrogen that can be leached from different land use classification units (LUC; Hicks & Anthony 2001). The leaching limits decline over time from the first to the 20th year. Leaching limits in the table range from 30 to 2 kg of nitrate nitrogen per hectare. If farmers with intensive farming systems can operate within the leaching limits in the Chapter 14 table they are required to apply to the council for a controlled consent. If they can't achieve the limits, they must apply for a restricted discretionary consent.

The OnePlan consenting requirements affects almost 500 farmers in the Manawatu-Wanganui region, mostly dairy farmers. Identifying the changes needed for each farming system and preparing the documentation in time, required the support of specialists including extension services from a number of regional and national organisations.

Current approaches to agricultural extension in New Zealand

During the late 1980s the public extension services provided by the Ministry of Agriculture and Fisheries in New Zealand were privatised. Since then organisations providing an industry-good such as DairyNZ have continued to provide extension services as have some private farm consultants (Parminter 2011a). Less than 20% of farmers have contact with farm consultants and they have mainly been involved in providing business advice to farmers to increase their profitability (Botha et al. 2006). The farm consultants in that study had a low level of interest in contributing to environmental decision making on farms, except where compliance issues were involved. Since the 1980s many of the papers in New Zealand written about agricultural extension have continued to build on the principles of technology transfer (Lissaman et al. 2013) although there has been some interest in co-learning and collaboration (Allen et al. 2002). In order to adapt to new natural resource issues it has been suggested that new models of doing extension are needed (Botha et al. 2006). For some researchers that has meant looking at individual models of extension (Manjala 2006), for others it has been a social model of extension (Turner et al. 2013). Both individual and social models have been integrated for Australian and New Zealand policy makers by Vanclay and Leach (2011), and Parminter (2011b) respectively.

DairyNZ is an 'industry-good' organisation owned by institutions within the dairy industry and funded in part by farmer levies to 'support on-farm change, create on-farm opportunities, build capability and mitigate risk to achieve the industry's strategic objectives. This is being done through research, development, engagement and leadership' (DairyNZ 2015, p. 2). DairyNZ has regional offices and employs about 40 consulting officers throughout New Zealand charged with implementing the strategy and addressing the needs of about 1300 dairy farmers. The dairy industry's strategy until 2020 has been for the industry to be globally and locally competitive and to act responsibly towards the environment, staff, communities and the nation.

Establishing the Collaborative Extension Project

As an example of this strategy in action DairyNZ has worked with the Manawatu-Wanganui Regional Council to put in place a pilot project that could assist farmers to make farming system changes and create opportunities for industry development within nutrient-limit constraints. The purpose of the pilot project was to build an alignment between regional council staff, DairyNZ consulting officers and private farm consultants so that a uniform approach was in place to assist farmers in obtaining their consents from the Regional Council. The pilot project focussed upon farmers in three catchments including the Waikawa Stream Catchment.

Waikawa Stream Catchment

The Waikawa Stream Catchment (which is where this study is focussed) contains two rural villages – Manakau in the middle, and Waikawa Beach along the seaside (Figure 1). They have permanent populations of just over 400 and 50 people respectively (Brown, pers comm. 2015). The Waikawa Stream is just over 18km long, from the headwaters in the Tararua Ranges to the western shore line of the Manawatu-Wanganui Region. The catchment has two main streams, the Waikawa Stream on the northern side of Manakau and the Manakau Stream to the south of Manakau. The Manakau Stream joins the Waikawa Stream about 1.3km before it reaches the Waikawa Beach settlement in an area called Huritini in Table 1. In the catchment there are seven dairy farms and over 200 rural lifestyle blocks. The catchment is about 8,000 ha and dairy farms make up about 24% of the landuse in the catchment (Horizons 2015).

Water testing the Waikawa Stream

The regional council has water testing sites in the upper catchment of the Waikawa Stream at North Manakau Rd, in the middle of the catchment at the Manakau Stream at Manakau itself and then below their confluence and just above the beach settlement at Huritini. In 2012 the

Waikawa Catchment was monitored for soluble inorganic nitrogen levels (SIN), providing a measure of all the inorganic nitrogen compounds in the waterway, including nitrite, nitrate and ammoniacal nitrogen (a measure of the amount of ammonia). The same sites were monitored for dissolved reactive phosphorus to measure soluble phosphorus compounds readily taken up by plants and algae. There were not expected to be discharges from point sources in the catchment but there were potential sources of nutrient contamination from septic tanks, road runoff and agricultural activities.

Figure 1. Map of the Waikawa catchment on the west coast of the Manawatu-Wanganui region



Source: LINZ

The catchment has targets for nutrients set below the point at which nuisance growth of plants and algae were likely to occur. Having too many nuisance water plants and algae growing in a waterway can reduce the diversity of aquatic insects, cause large fluctuations in oxygen, and make the water more acid. These changes in water quality can harm aquatic communities, block irrigation intakes and reduce recreational enjoyment.

In 2012 nitrogen results at the top of the Waikawa Catchment near the forest park were well within the target figures. In the middle of the catchment they were twice the target and in the lower catchment they were four times the target (Table 1). Since 2012, catchment loads of soluble inorganic nitrogen have been becoming less each year, although below Manakau they are still above the target (Clark personal communication, July 2015). Phosphorus results were lowest at the top of the catchment and twice the target in the rest of the catchment.

Table 1. Measured nitrogen and phosphorus loads compared to regional council targets for waterways in 2012

Monitoring Site	Nitrogen target load (tonnes/year)	Measured nitrogen (tonnes/year)	Phosphorus target load (tonnes/year)	Measured Phosphorus (tonnes/year)
North Manakau	8.1	4.5	0.5	0.5
Manakau	2.0	4.6	0.1	0.2
Huritini	10.0	43.7	0.6	1.2

Source: Roygard & Clark 2012

Methodology for collaborative extension

Extension strategies for achieving social and individual behaviour change can be guided by a number of different models. These have been summarised by an author in previous publications (e.g. Parminter 2013; Parminter 2010; also see Prochaska and Velicer's transtheoretical model from 1997). The key elements these publications identified were:

- a mix of resources being available to provide both relationship building and technical support during the introduction and implementation phases of an extension strategy.
- segmentation of farmers based on their recognised stages of behaviour change so that different extension interventions can be matched to support each stage.
- establishing a process of on-going feedback and learning throughout implementation of the strategy so that it can be adapted to meet changing conditions and needs.

The strategy for this project was not designed to specifically address the theoretical elements listed above. Instead the project was developed around an approach for delivering on-farm and catchment results that reflected behaviour change principles known to the managers in the regional council and DairyNZ (Parminter & Neild 2013). In doing so they intuitively addressed those elements above, so that these now provide a useful lens for retrospectively reviewing the content of the strategy and its implementation. The project interventions can be considered under five headings that relate to a stages of change framework (Figure 2):

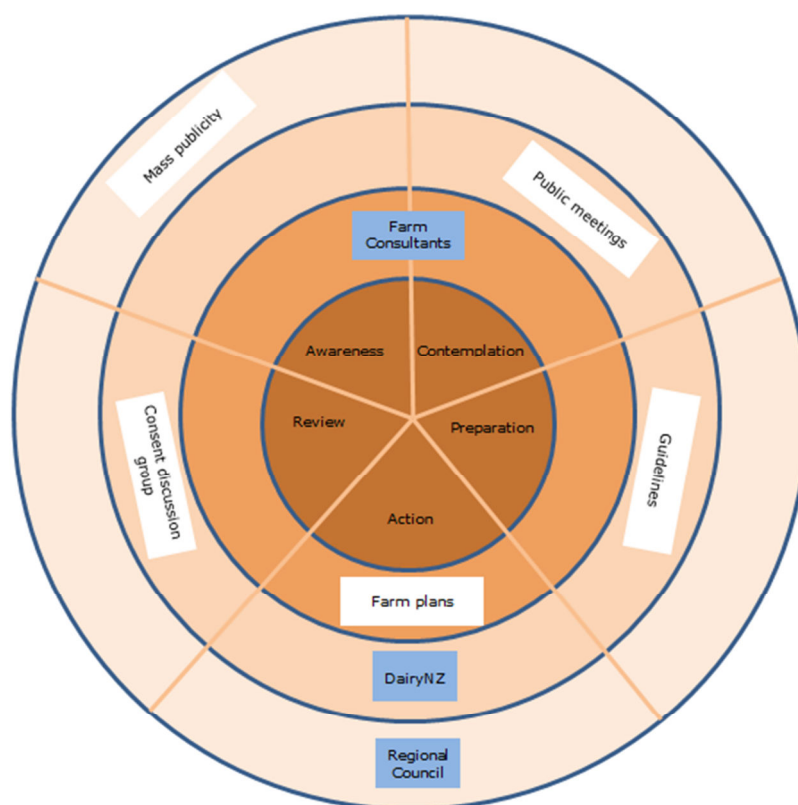
- Awareness stage. During 2010 to 2014 the farmers in the region began to notice that the OnePlan existed and that it contained rules that could affect them. Mass publicity about the OnePlan from a number of agencies was encouraged by the council and farmer lobby groups. Not all of this information was supportive of the position being taken by council staff on natural resource management and in general the information during this stage tended to dramatise the underlying conflicts in the situation rather than being technical (Federated Farmers 2012; The New Zealand Farmers Weekly 2013). The information was not specific to Waikawa Catchment, and was widely and readily available at low cost.
- Contemplation stage. In 2014, when farmers recognised that all the dairy farms in the Waikawa Catchment were included in the One Plan provisions, the council and DairyNZ staff held a public meeting in the catchment specifically for dairy farmers to explain how they could be affected and the opportunities provided for them in the pilot project. The information was associated with respected farming leaders and industry experts to assist in building farmer confidence in the information being conveyed.
- Preparation stage. At this stage farmers started to make plans to involve themselves in the consenting process and needed to know the level of resources required in order for them to become involved and the sorts of benefits possible for them. For farmers in this stage, DairyNZ provided a comprehensive manual and additional guidelines.
- Action stage. Throughout 2014 farmers worked with their local consultants to select and customise a set of management practices suitable for their dairy system.
- Review stage. Was later in 2014, when farmers began growing in confidence in what they were doing, the changes that each of them were making was reinforced by their peers. For this DairyNZ established a local discussion group specifically for consented dairy farmers.

The following part of the paper describes the activities in each of these stages in more detail.

Mass communication

While the OnePlan was being introduced, the regional council employed their own farm advisory staff to work with farmers in the region. In anticipation of the release of the OnePlan, Farmer groups had become quite agitated about the possible policies and rules that it could contain. Farmer lobby groups organised resistance to its introduction. This included the farmers in the Waikawa Catchment. The regional council staff met with these farmer groups and provided written material for agricultural magazines and newspapers about the policies and rules in the OnePlan (The NZ Farmers Weekly 2013). The articles described the purpose of these provisions and how farmers could be affected by them. During this time the council's science staff also provided technical information to land owners and farmer lobby groups to assist them to take an evidence-based approach to presenting their arguments for and against the OnePlan to the public and the council.

Responding to pressure from the dairy farmers in the region, DairyNZ met with the Manawatu-Wanganui Regional Council and initiated a collaborative extension project with selected local farm consultants. Ten consultants were selected that were established in the region, widely known by farmers, experienced in whole farm systems, and accredited by the industry in nutrient management (Fertiliser Association 2002).

Figure 2. Extension activities matched to the stages of change segments of farmers

Public meetings

The seven dairy farmers in the Waikawa catchment were encouraged by DairyNZ to attend an initial meeting where the OnePlan could be explained by people from both DairyNZ and the regional council. At the meeting the farmers in the Waikawa catchment were able to voice their concerns and discuss the policies, rules and consenting processes with people knowledgeable about the detail in the OnePlan.

The OnePlan and nutrient budgeting required the use of Overseer® decision support software. The content of the farm plans and how the Overseer® results would be used in it was also a point of contention with the farmers and this needed additional explanation at the meeting. At the end of the meeting there was an opportunity for farmers to sign on and join the pilot project. All seven farmers in the Waikawa Catchment agreed to participate.

Guidelines

It was recognised during the public meetings across the region that the amount of information being presented was a bit overwhelming for people in the audiences to take in at those events. Therefore a comprehensive manual was developed by the DairyNZ and the Manawatu-Wanganui Regional Council that outlined the roles and responsibilities of all the parties involved in the consenting processes. This helped to align the expectations of farmers with what was actually going to be happening. In addition, information on mitigation practices to reduce nitrogen losses and environmental checklists were also made available to them. Using these resources the farmers could consider the likely actions that would be required on their farms before they were visited by farm consultants.

Actions

Each farmer working with their nominated consultant was responsible for preparing a nutrient management plan for their property to support their consent application. The applications had to be submitted before the end of 2015 and had the potential to be granted for periods of up to 25 years. Consents were granted at the discretion of council staff depending on the information contained in the nutrient management plan. The discretion of staff was restricted to only those matters described in the OnePlan. Preparing nutrient management plans involved the following steps:

Step 1: Soil and Land Use Capability (LUC) maps at 1:7,000 scale, for each farm were developed by trained pedologists on contract to the council for this project and provided to each farmer.

Step 2: Using the maps, DairyNZ staff met with the farmers on their properties and established a baseline description of the farms for the 2012/13 season. The baseline was then used as a starting point for each farm to be able to quantify and report on the commitments and subsequent environmental improvements to be achieved on each farm.

Step 3: The farmer with their farm consultant agreed on a set of on-farm mitigation practices. Each set of mitigation practices was modelled through Overseer[®] to ensure that sufficient reduction in nutrient losses was being accumulated on each farm to achieve the desired catchment scale reduction in nutrient levels. A secondary document was prepared by the farm consultants for the on-farm discussions that highlighted both the management and financial considerations of all the farm mitigation options being considered.

Step 4: The farm consultant then used the mitigations and associated analysis and baseline modelling to complete a nutrient management plan for the farm, which formed the basis of the consent application to council.

Step 5: The nutrient management plan and consent application for each farm was lodged with the council and once approved, a consent was granted. The consent enabled existing dairy farmers to continue dairying over the specified time period, as long as the nutrient reductions are being achieved each year. Every year farmers are required to update their nutrient budgets so that the variations in their nutrient losses can be monitored.

The council and DairyNZ established a behavioural scale for evaluating the responses of farmers. It worked on a three colour system – green, yellow and red. Farmers in the green category understood their responsibilities and worked with the team through steps 1-5 in order to submit their consent application. Farmers that were unwilling to make sufficient practice change were in the orange category. These farmers would receive an additional visit by council farm advisory staff to talk through their social responsibility to implement the OnePlan. Farmers who were not prepared to engage with the process at all were visited by council staff and as well as their social responsibilities were warned about the negative consequences for them of continued non-compliance. All the farmers in the Waikawa catchment fitted the green category.

In the pilot project, steps 1-5 above had no cost for farmers. Since then, farmers have had to pay \$1,500 for steps 1-2, \$3,500 for steps 3-5 and just under \$1,000 to process their landuse consent application.

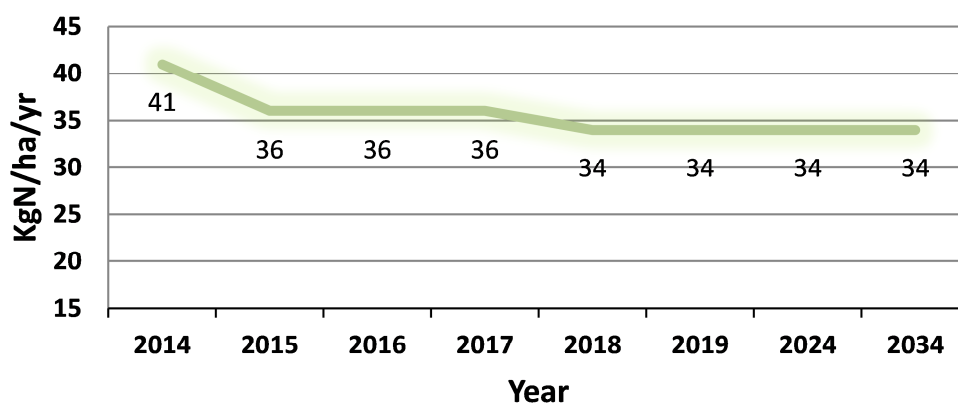
Review

At the time that their consents were being submitted, the seven Waikawa farms ranged in nitrogen loss rates from 22-42 kgN/ha/yr. The consent applications showed how the different farmers would be reducing these by between 0-18% over a 20 year period (an average of 8%). The trajectory for one farm taken from their consent is shown in Figure 3 as an example. The actual amounts and the rates of reduction depended on the type of farming systems involved, their rigidity to modification and their starting points (Parminter 2015).

After the consent applications had been submitted and were approved by the council, a 'post-consent support group' was provided for the Waikawa farmers modelled along discussion group lines. The objective of the discussion group was to provide farmers with the confidence that they could learn about implementing their selected environmental practices and continue to farm profitably within their environmental constraints (Parminter & Ridsdale 2015). The discussion group has focussed on practical on-farm solutions to address problems raised by farmers. Farmers have been able to learn from each other and from invited experts.

The discussion group has been provided with information by the council on their results from water quality monitoring. These showed that in the Waikawa stream some parameters such as *e-coli* have started improving as livestock have been fenced out. It has been too early for other nutrient changes in the catchment to be measured by the science team at Manawatu-Wanganui Regional Council and it could take another 5 years or so before they can be detected.

Collectively, after allowing for 50% attenuation, the dairy farms in the catchment may have reduced the future nitrogen load at Hirutini by about 2.5 tonnes per annum, although this will take a number of years to establish.

Figure 3. Nitrogen leaching trajectory as shown on a dairy farm consent

Coordination and collaboration

The agricultural extension needed for policy implementation in the Manawatu-Wanganui Region can only be delivered by staff from the relevant organisations working together. The regional council has the statutory responsibility for catchment management and needs to be included along with DairyNZ to provide an industry perspective. DairyNZ has a mandate from farmers to develop the changes in farming practices that have been needed in the farm plans. Farm consultants were included to provide independence and a client focus in preparing the landuse consents. Environmental organisations were considered for the project, but were not able to make any technical or mandated contributions to the project.

The project brought together a range of skill sets with the different individuals that became part of the team. These included aspects of resource-consent assessment, stream ecology, nutrient science, farm management, farm systems design, event management, technical writing, agricultural extension, and project management. All of these skill sets needed to be coordinated across the organisations so that the intent to collaborate was enhanced throughout the project (Fraser et al. 2014).

The farmers had a central and unique role in this project. Their role was unlike those in other studies that have explored collaboration with farmers as part of a process for developing, adapting and adopting farming practices (Hamilton 1998). In this project, farmers were compelled by legislation to apply for a resource consent and to cooperate with the relevant learning about and selecting least-cost options for their farming systems to achieve future profitability within the environmental constraints of their consent application (Parminter & Ridsdale 2015). Throughout the process, submitting consent applications remained the responsibility of individual farmers and was never the responsibility of any of the collaborating agencies.

Afterwards, the participating farmers have said about the project:

DairyNZ's role in putting together the project was great because otherwise we would have been fighting the beauracracy of the [Regional Council] ourselves.

[DairyNZ] coordinator assisted the whole process, they gave it a point of focus. By having them involved we were able to have a good process.

... then it was up to the consultants and the farmers to put it all together – they did all the hard work.

Overall it has been more user friendly than we thought it was going to be – more positive – although in the end the actual application was developed by you [consultant] and me [farmer].

Conclusions

The policy problem being addressed in this project was socially defined through public engagement in the OnePlan development process. It needed an integrated social as well as a technical response involving a number of industry agencies working with farmers in the Waikawa Catchment. It would not have been enough to have developed a technical solution

without the industry and the affected farmers being part of that development. In this project farm consultants have been resourced to work with separate farm businesses and describe the policy problem as it affected individual farmers. The consultants were then able to suggest and adapt a range of farming practices so that farmers have been able to take their part in a collective response with each landowner making their contribution to the catchment target.

Extension principles and best practice have been important to the collaborating parties in the project. Although the team did not follow an extension prescription, retrospective reflection has highlighted that by following heuristics and 'rules of thumb' the various components of recognised practice-change frameworks have been brought together in an integrated extension delivery. The practice-change framework can now be applied more directly in other catchments within the region to enhance the process of farmers applying for landuse consents more directly.

Acknowledgments

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Before beginning work with Ravensdown Fertilise Co-operative Ltd, and during the life of the project described in this paper, Jessica Hughes was working as a farm advisor with the Manawatu-Wanganui Regional Council. Jessica appreciates the support of her employers – past and present for her contribution to this paper.

References

- Allen, WJ, Kilvington, MJ, Nixon, C & Yeabsley, J 2002, *Sustainable development extension*. MAF Technical Paper 02/03. ISSN 1171-4662. ISBN 0 478 07663 0.
- Botha, N, Coutts, J & Roth H 2006, 'The role of agricultural consultants in the New Zealand Research, Development and Extension system', *Proceedings of the New Zealand Agricultural and Resource Economics Society Annual Conference*, available from <http://purl.umn.edu/> [July 2015].
- Brown, J 2015, personal communication with Waikawa Beach Ratepayers Committee.
- DairyNZ 2015, DairyNZ Annual report 2014/15. The summary, p2. <http://www.dairynz.co.nz/> [March 2016].
- Federated Farmers 2012, Government report confirms Horizons 'Farmergeddon'. <http://www.fedfarm.org.nz/> [July 2015].
- Fertiliser Association 2002, New training course enhances fertiliser knowledge. Media news release. <http://www.fertiliser.org.nz/> [March 2016].
- Hamilton, G 1998, 'Co-learning tools: powerful instruments of change in Southern Queensland, Australia'. In *Facilitating Sustainable Agriculture: Participatory learning and adaptive management in times of environmental uncertainty*, ed. NG Röling & MAE Wagemakers, Cambridge University Press, United Kingdom, pp. 172-190.
- Hicks, D & Anthony, T (eds.) 2001, *Soil Conservation Technical Handbook*, Ministry for the Environment, Wellington, New Zealand.
- Horizons 2015, *Waikawa Stream and Manakau Stream faecal source tracking report*. Manawatu-Wanganui Regional Council Report/EXT/1460, Palmerston North, New Zealand.
- Lissaman, WJ, Casey, M & RowathJS 2013, 'Innovation and technology uptake on farm', *Proceedings of the New Zealand Grassland Association*, vol. 75, pp.27-32.
- Manawatu-Wanganui Regional Council 2014, *One Plan. The consolidated regional policy statement, regional plan and regional coastal plan for the Manawatu-Wanganui region*. Horizons Regional Council', Palmerston North, New Zealand.
- Manjala, T 2006, *Good to great extension: influencing on farm change at pace and scale*, Report to Nuffield New Zealand.
- Parminter, TG 2010, A description of voluntary policy methods for natural resource management. *Proceedings of the NZ Agricultural and Resource Economics Society annual conference*, available from <http://ageconsearch.umn.edu/> [July 2015].
- Parminter, TG 2011^a, 'Past and present history of extension in New Zealand', in *Shaping change: natural resource management, agriculture and the role of extension*, ed J Jennings, R Packham, D Woodside, Australasian-Pacific Extension Network (APEN), Australia, pp. 20-21.
- Parminter, TG 2011^b, 'Opportunities for utilising voluntary policy methods in natural resource statutory planning', *Extension Farming Systems Journal*, vol. 7, no. 2, pp. 115-117.
- Parminter, TG 2013, *Of my own free will: voluntary approaches to environmental policy*. LAP Lambert Academic Publishing, Saarbrücken, Germany.
- Parminter, TG 2015, 'Selecting farm practices and preparing farm plans to apply for land-use consents in the Manawatu-Wanganui region', *Proceedings of the 77th Annual Grassland Conference*, vol. 77, pp. 275-279.
- Parminter, TG & Max, S 2004, 'A learning model of technology transfer for the kiwifruit industry', in *Proceedings of the New Zealand Agricultural and Resource Economics Society*, available from <http://purl.umn.edu/> [July 2015].

- Parminter TG & Neild J 2013, Just knowing: tacit knowledge. *Extension Farming Systems Journal*, vol. 9, no. 1, pp. 231-239. <http://www.apen.org.au/> [July 2015].
- Parminter, TG & Ridsdale, S 2015, 'Adapting Manawatu dairy farms to regional council catchment targets'. in: *Moving farm systems to improved attenuation*, eds L.D. Currie and L.L Burkitt, Occasional Report No. 28. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. <http://flrc.massey.ac.nz/> [July 2015].
- Prochaska, JO & Velicer, WF 1997, 'The transtheoretical model of health behaviour change', *American Journal of Health Promotion*, vol. 12, pp. 11-12.
- Roygard, J & Clark, M 2012, 'Supplementary statement by Jon Roygard and Maree Clark on nutrient load scenarios and methodology'. Evidence before the Environment Court in the matter of appeals under clause 14 of the First Schedule to the Resource Management Act 1991 concerning proposed One Plan for the Manawatu-Wanganui Region, <http://www.horizons.govt.nz/assets/one-plan-publications-and-reports/SWQ-Technical-New-Approach-to-evidence-Jon-Roygard-and-Maree-Clark-20120224.pdf> [July 2015].
- The New Zealand Farmers Weekly 2013, 'The One Plan will provide wriggle room for farmers', March 4th, 2013, p. 24.
- Fraser, C, Fenemor, A, Turner, J, & Allen W 2014. 'The Wheel of Water Research Programme. Designing collaborative catchment decision-making processes using a WaterWheel- reflections from two case studies', Document number C1205601, Research Report for Ministry of Business, Innovation and Employment, Wellington, New Zealand.
- Turner, JA, Rijswijk, K, Williams, T, Barnard, T & Klerkx, L 2013, 'Challenges to effective interaction in the New Zealand agricultural research and extension system: an innovation systems analysis', *Extension Farming Systems Journal*, vol. 9 no. 1, pp. 89-98.
- Vanclay, F & Leach, G 2011, 'Enabling change in rural and regional Australia', in *Shaping change: natural resource management, agriculture and the role of extension*, eds J Jennings, R Packham, D Woodside, Australasian-Pacific Extension Network (APEN), Australia, pp. 20-21.
- Zuber-Skerritt, O 2002, A model for designing action learning and action research programs. *The Learning Organization*, vol. 9 no. 4, pp. 14 -149.