Farmer adoption of pasture renewal practices: the influence of credible information sources

W.YANG[1] and K. RIJSWIJK[2]
[1]*AgResearch Limited, Lincoln Research Centre, Cnr Springs Road & Gerald Street, Private Bag 4749, Christchurch 8140, New Zealand.*
[2]*Wageningen University, Knowledge Technology and Innovation Group, PO Box 8130, 6700EW Wageningen, The Netherlands*
wei.yang@agresearch.co.nz

Abstract
Effective pasture management in the dairy sector is supported by the pasture renewal practices (PRPs) undertaken by farmers. However, the rate and extent of adoption of PRPs by farmers is influenced by their attitudes toward pasture renewal. The aim of this paper was to help the understanding of drivers and barriers that could be derived from the investigation of farmer attitudes to pasture renewal, and to relate credibility of information sources to their perceptions of pasture renewal. A two-step process was applied to existing survey data of dairy farmers in the Waikato and Bay of Plenty regions of New Zealand. First, a factor analysis clustered the dairy farmers into different groups based on their attitudes to pasture renewal. The results show that satisfaction with previous pasture renewal experiences was an important factor affecting farmer adoption. Second, the results from a correlation analysis between the different clusters, indicates that information from local experts and farmers was valued the most by all groups as they were perceived to be the most credible. Motivated farmers also tended to seek guidance from credible publications and websites.

Keywords: pasture renewal, dairy farmers, information credibility, factor analysis

Introduction
New Zealand's temperate climate makes it possible for dairy farmers to gain the benefits of continual pasture growth that provides an inexpensive and sustainable feed supply (Tozer *et al.* 2015). However, grazed pasture systems are dynamic and continually changing in quality and quantity. In addition to the overwhelming impact of climate, factors such as soil type, plant species, fertiliser use and grazing management, as well as pests and weeds, can affect the growth of pasture or cause it to deteriorate over time (Bewsell *et al.* 2008). Pasture renewal practices (PRPs), including full pasture renewal, pasture renovation, undersowing, and crop sequencing are common ways to improve pasture performance (Rijswijk & Brazendale 2016).

The Waikato and Bay of Plenty are New Zealand's major dairying regions, where pasture growth has been constantly threatened by frequent droughts, pests and weeds (Tozer *et al.* 2015). As a result, dairy farmers have been dissatisfied with the performance and persistence of their pastures. Although pasture renewal has been regarded as the key source of nutritious and cost-effective feed (Bewsell *et al.* 2008; Rijswijk & Brazendale 2016), farmers did not believe it would actually improve pasture persistence and performance (Rijswijk & Rhodes 2015). For example, they were concerned that yields of modern cultivars realised in commercial plot trials may not be realised on a farm system scale (Tozer *et al.* 2015).

Many studies have focused on evaluating the benefits of pasture renewal and providing guidance for farmers to carry out good PRPs on their farms (Brazendale *et al.* 2011; Stevens & Knowles 2011). However, literature on the exploration of farmer's adoption behaviour specifically regarding pasture renewal is limited (Belgrave *et al.* 1990; Rijswijk 2013; Rijswijk & Brazendale 2016). The existing literature on adoption generally provides an insight into various factors that influence adoption by land owners (e.g. technology adoption, conservation practices and good environmental practices) (Pannell *et al.* 2006). These factors can be summarised by farmer attitudes to these practices, farm and household characteristics, and other contextual factors such as community and neighbourhood effects (Baumgart-Getz *et al.* 2012; Knowler & Bradshaw 2007).

To facilitate farmer adoption of PRPs, understanding their satisfaction with and attitudes towards the practices is crucial, as well as the influence of the different farmer characteristics on adoption of PRPs. One of the contextual factors for farmer adoption is access to relevant and credible information as indicated by recent studies (Pannell *et al.* 2006; Hansson & Ferguson 2011; Rijswijk 2013; Yang & Sharp 2017). It is also important to know which factors are relevant to a cohort of farmers that will enhance the specialisation of programmes and projects supporting the adoption of PRPs.

The purpose of this paper was to identify the factors affecting farmer adoption of PRPs, and specifically, the role of credible information sources in the adoption process. Three questions will be answered: 1) what are

ISSN 2463-2872 (Print) ISSN 2463-2880 (Online)

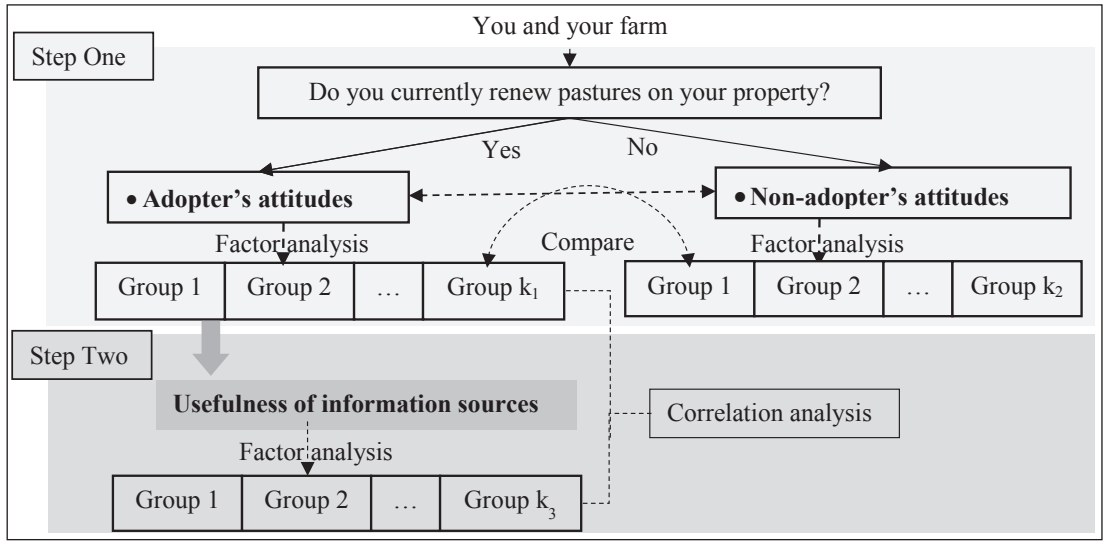

Figure 1 Conceptual analysis framework.

the drivers and barriers to the adoption of PRPs due to farmer attitudes? 2) to what extent are their attitudes homogeneous and 3) which information sources are associated with farmer attitudes to PRPs?

Methods

To understand farmer concerns about pasture renewal, two surveys of dairy farmers in the Waikato and Bay of Plenty regions were conducted in 2010 and 2015 (Rijswijk & Rhodes 2015).These surveys aimed to raise awareness about pasture renewal, to identify barriers to adoption of current PRPs and to establish a dataset that can be used to evaluate interventions.

Using the survey data, Rijswijk & Brazendale (2016) compared farmer confidence, satisfaction, and attitudes to pasture renewal in 2010 and 2015. Results showed farmer perceptions and satisfaction levels associated with their PRPs changed over time, and emphasised the importance of different information sources. Data for this study were drawn from the same dataset as that utilised by Rijswijk & Brazendale (2016), where 1015 useable survey results were available. Rijswijk & Brazendale (2016) presented descriptive results, whereas this study applied a statistical analysis and focused on farmer clusters, according to the link between farmer attitudes and information sources used, and how this affects their choices to adopt PRPs. The original surveys consisted of several sections such as those describing demographic information, farmer attitudes to pasture renewal and satisfaction with their renewal practices, as well as the perceived usefulness of information sources. These sections were also analysed for this study.

A conceptual analysis framework (Figure 1) was used to answer the three questions raised in the previous section. The analysis consists of two steps; step one, questions one and two addressed factors that influence farmer adoption and non-adoption of PRPs. Here, all farmers were categorised into labelled groups based on their attitudes to pasture renewal by using a factor analysis process to check if the categorisation of farmers was consistent across the groups who had renewed pasture recently or in the past 12 months (the 'adopters') and those farmers who had not (the 'non-adopters'); step two, adopters were categorised into information groups based on their perceived usefulness of different information sources about pasture renewal. Lastly, a correlation analysis was used to understand the relationship between information sources and farmer attitudes. R-studio, a free and open source analysis software, was used to analyse the results.

Results

Factors affecting farmer adoption

Approximately 8.9% of dairy farmers had not renewed pastures in the 12 months preceding the surveys (Table 1). The average age of surveyed farmers was 50.7 years, with 88% being male. Owners or owner-operators accounted for 69% of respondents, while 80% had over 15 years of experience. There were no significantly different (P>0.05) characteristics (Table 1) between adopters and non-adopters when comparing the mean values of four variables (age, gender, ownership, and farming experience).

The mean values of seven attitude questions (Table 1) provide some insights into the drivers and barriers for dairy farmers to adopt PRPs. Answers to these questions were scaled from 1 to 5, where 5 represents 'strongly agree' with the variable description. The average value of each attitude variable could be regarded as an indicator of either a driver or barrier to renewing pastures. Thus, variables with a mean higher than 3 (3 being 'neutral') might be a driver, while those with a value lower than 3 might be a barrier[1]. For example, the adopters were more satisfied with their recent renewal practices (3.24) than the non-adopters (1.93). A t-test was used to test for the differences between the mean farmer attitudes to pasture renewal. Based on the P-value associated with the t-test, adopters and non-adopters attitudes to past experience in pasture renewal, pasture performance, and information accessibility was different. This indicates that these variables may affect farmer choices to renew or not renew.

Farmer attitudes to pasture renewal

Based on the seven questions about farmer attitudes to pasture renewal (Table 1), a factor analysis (Principle Component approach) categorised farmer respondents into three different groups (Table 2), where those in each group share similar attitudes to pasture renewal, labelled as follows:

- Management and investment orientated - these farmers appeared to perceive pasture renewal benefits from the perspective of appropriate farm system, time management and good financial returns. About 40% of farmers were strongly aligned with this group.
- Pasture performance oriented - this group of farmers focused on the performance of pastures. Good pasture performance may motivate them to adopt

Table 1 Overview of different farmer characteristics and attitudes between adopters and non-adopters.

	Variable Description	All farmers (n=1015)		Adopter (n=925)		Non-adopter (n=90)		P-value
		Mean	SD	Mean	SD	Mean	SD	
Farmer characteristic								
Age	Age of farmer, continuous variable.	50.7	10.74	50.71	10.71	50.5	11.1	NS[1]
Gender	Dummy variable equal to 1, if male; otherwise, female.	0.12	0.32	0.11	0.31	0.12	0.44	NS
Ownership	Interviewee's relationship to farm, categorical variables. Coded as 1, owner or owner operator; coded as 2, co-owner; coded as 3, manager; coded as 4, sharemilker; coded as 5, others.	1.75	1.28	1.73	1.27	1.84	1.4	NS
Farming experience	Years of farming experience, categorical variables. Coded as 1, less than 1 year; coded as 2, 1-5 years; coded as 3, 6-10 years; coded as 4, 11-15 years; coded as 5, more than 15 years.	4.69	0.76	4.70	0.74	4.54	0.98	NS
Attitude (Scale 1-5)	Answers were scale coded as ordinal variables with the values from 1 to 5, representing 'strongly disagree', 'disagree', 'neutral', 'agree', and 'strongly agree', respectively.							
Financial return	Convinced of financial return regarding renewed pasture.	3.09	1.51	3.04	1.48	2.99	1.73	NS
Time investment	Renewing pastures justify the time investment required.	2.80	1.42	2.76	1.40	2.62	1.66	NS
Information accessibility	Information can be accessed to ensure the success of PRPs.	2.89	1.43	2.85	1.39	2.14	1.62	P<0.001
Satisfactory experience	Recent experiences of pasture renewal on farm have been satisfactory.	3.29	1.58	3.24	1.51	1.93	1.83	P<0.001
Pasture performance	Happy with current pasture performance.	3.13	1.36	3.18	1.31	2.92	1.76	P<0.001
Suitable farm system	Pasture renewal fits current farm system.	2.54	1.53	2.46	1.51	2.47	1.76	NS
Suitable cultivar	A suitable cultivar was available for the farm/ property.	2.93	1.46	2.88	1.42	2.03	1.62	

[1]NS=not statistically significant. SD=standard deviation of the mean.

[1] Please note: the respondents were able to indicate their attitudes on a scale of 1 to 5. If a lot of respondents chose 1 and 5, the average of 3 gives little indication of actual variation in attitudes.

PRPs. About 21% of dairy farmers were strongly aligned with this group.

- Information and experience oriented - knowledge and experience were highly valued by the farmers in this group. The availability of suitable cultivar was also strongly correlated with this group. About 39% of dairy farmers were strongly aligned with this group.

A sensitivity analysis was conducted using factor analysis to see if the categorisation of the groups was consistent across adopters and non-adopters (Table 2). Comparing the grouping results of the two subsets to those for all farmers, there was no significant differences in categorisation between the adopters and all farmers, but this was not the case for non-adopters. Thus, the categorisation for all farmers and adopters could not be utilised for non-adopters. Considering the limited number of non-adopters (90), more data may help categorisation for non-adopters and the understanding of their attitudes.

Perceived usefulness of information sources

Adopters were able to rate different information sources, such as on-farm consultants, contractors, scientists and internet. According to the ratings (scale 1-7) of information sources given by adopters, farmers were categorised into five groups (Table 3) using factor analysis; group labels were based on farmer evaluation of the usefulness of the information sources:

- Local social networks: adopters in this group valued information and knowledge about pasture renewal from their local social networks, including farmers in the same district, farmer discussion groups and DairyNZ staff. Farmer discussion groups and DairyNZ staff are regionally oriented. The average rating from all adopters was 4.21. About 27% of farmers were categorised in this group.
- Publications and websites: this group of farmers regarded different types of publications and internet information most useful but the average rating score of 2.95 was low. Although a substitution effect between mail publication and websites was expected, farmers tended to value both sources, with 21% of farmers strongly aligned with this group.
- Contractors and fertiliser representatives: this group of farmers believe the most useful information came from contractors and fertiliser representatives, with 20% of farmers identifying strongly with this group. The average rating of the information sources in this group was 2.95.
- Seed companies: information from seed retailers and companies (including company catalogues) rated highly with farmers in this group scoring 4.65. About 19% of adopters were strongly aligned with this group.
- Experts: farmers in this group had confidence (highest score of 4.88) in the knowledge and information obtained from experts including scientists, researchers and on-farm consultants. About 13% of farmers were strongly aligned with this group.

Correlation analysis was used to identify if the classifications described in Tables 2 and 3 were related to each other. Adopters' scores for each of the different groups were estimated so that correlation analysis could be performed to identify if scores in one group (of attitude factors) was related to those in other groups (of information sources).

Limited correlation relationships existed between the groups (Table 4). All three attitude groups were

Table 2 Factor analysis of farmer attitudes to PRPs.

	All farmers			Adopters			Non-adopters		
	Group 1	**Group 2**	**Group 3**	**Group 1**	**Group 2**	**Group 3**	**Group 1**	**Group 2**	**Group 3**
	Management & investment orientated	Pasture performance orientated	Experience & information orientated	Management & investment orientated	Pasture performance orientated	Experience & information orientated	Investment orientated	Farm system & pasture oriented	Experience & information orientated
Financial return	0.85	0.09	0.32	0.87	0.09	0.30	0.87	0.28	0.33
Time investment	0.85	0.13	0.36	0.83	0.14	0.40	0.88	0.31	0.24
Information accessibility	0.46	0.16	0.67	0.44	0.18	0.68	0.49	0.16	0.58
Satisfactory experience	0.28	0.00	0.84	0.32	0.04	0.81	0.23	0.14	0.85
Pasture performance	0.16	0.96	0.07	0.14	0.96	0.05	0.22	0.93	0.15
Suitable farm system	0.65	0.40	0.32	0.60	0.41	0.40	0.25	0.78	0.23
Suitable cultivar	0.29	0.14	0.83	0.25	0.13	0.85	0.29	0.31	0.81
Proportion identified	40%	21%	39%	40%	21%	39%	37%	34%	28%
Method	**Principal Component analysis, Varimax rotation[1]**								
Sample size	n=1015			n=925			n=90		
Test for choosing three factors	Chi-square=771.39, P value<0.001			Chi-square=534.12, P value<0.001			Chi-square=323.81, P value<0.001		
Total variance explained by factors	92.64%			91.04%			93.17%		

Note: shaded cells have loading on factors >0.5, indicating the threshold value for including the attitude as a key component in the group.

[1]See Schmitt & Sass (2011) for information on the Varimax rotation.

Table 3 Factor analysis of adopter satisfaction with information sources.

	Mean Score	**Group 1** Local social network	**Group 2** Publication & website	**Group 3** Contractor & Fertiliser rep	**Group 4** Seed company	**Group 5** Expert
On-farm consultant	4.96	0.09	0.06	0.02	0.07	0.97
DairyNZ staff	3.68	0.72	0.26	0.22	-0.05	0.18
Other farmers in the same district	4.75	0.77	0.02	0.14	0.02	-0.02
Farmer discussion group	4.21	0.85	0.07	0.09	0.04	0.02
Seed merchant/ retailer	4.76	0.12	-0.01	0.19	0.79	0.18
Catalogues from seed merchants/ seed companies	4.54	0.0.04	0.18	0.09	0.85	-0.08
Researchers/ scientists	4.79	0.26	0.34	0.30	0.23	0.78
Contractors	3.46	0.17	0.04	0.82	0.15	-0.01
Fertiliser reps	3.11	0.18	0.16	0.81	0.11	0.05
DairyNZ website	2.99	0.46	0.57	0.21	0.07	0.08
Other websites	2.56	-0.07	0.79	0.11	-0.07	0.01
Publication	3.29	0.21	0.73	-0.02	0.23	0.04
Proportion explained		27%	21%	20%	19%	13%
Method	Principal component analysis, Varimax rotation					
Sample size	n=925					
Test for choosing three factors	Chi-square=771.39, P value<0.001					
Total variance explained by factors	92.64%					

Note: shaded cells have loading on factors >0.5, indicating the threshold value for including the attitude as a key component in the group.

Table 4 Correlation analysis between attitudes and information sources.

Attitude group / Information group	**Management & investment**	**Pasture performance**	**Experience & information**
Local social network	0.21**	0.14***	0.14*
Publication & website	0.50	-0.02	0.15***
Contractor & Fertiliser reps.	-0.02	-0.01	0.01
Seed company	0.01	0.18**	0.06
Expert	0.08	0.09	-0.02

***= P<0.01, **=P<0.05,*P<0.1 represent statistical significance at 1, 5 and 10% levels, respectively.

correlated to local social network. The "Pasture performance" group was correlated with seed companies, while the "Experience and information" group was correlated with those who found relevant publications and websites most useful for guiding pasture renewal.

Discussion

Factor and correlation analyses were used to gain insights about adoption process around PRPs of dairy farmers in the Waikato and Bay of Plenty regions, using previous survey data.

The first question posed for this study was to gain an understanding of the drivers and barriers to the adoption of PRPs. The results showed that dairy farmers who had renewed pasture held a different attitude to pasture renewal than those who did not. The adopters may be motivated by a satisfactory pasture renewal experience, while the non-adopters were disappointed having had an unsuccessful renewal experience. The non-adopters also showed lower satisfaction level with pasture performance and information accessibility compared to adopters. Intuitively, accessibility to information and pasture performance could be seen as typical drivers for adopters but barriers for non-adopters.

The diversity of farmer attitudes to pasture renewal, presents challenges to design projects and programmes that are tailored to the requirements of every farmer. The factor analysis process enabled farmers to be categorised into different groups, each with a different focus. In group one, farmers were motivated by good investment in time and money as well as suitable farm system management, while in group two, farmers were focused on pasture performance that could determine the uptake of PRPs. In group three, information and knowledge could help farmers make decisions. Hence, the flow of useful information and good communication of a successful experience may motivate farmers to adopt or improve PRPs. However, the categorisation was not consistent across adopters and non-adopters. Therefore, support programmes for pasture renewal should design facilitating strategies that fit both adopters and non-adopters requirements. This answered the second question posed for this study referring to homogeneity or otherwise of farmer attitudes to pasture renewal: the attitudes of farmers were not only different between adopters and non-adopters (based on the different drivers or barriers), but also within these two sets of farmers, three different groups could be identified.

Dairy farmers showed different levels of satisfaction with the information sources (the third question posed for this study) for pasture renewal. The credibility of information from local social networks was also confirmed by the correlation analysis (Table 4) with all three attitude groups correlated to a local information source. This result could provide a starting point for future supporting programmes suggesting essential information and knowledge of pasture renewal should be locally oriented and spread through farmer interactions. Information from seed companies and retailers was valued by the farmers who focused on pasture performance, while information and experience oriented farmers tend to obtain knowledge from related publications and websites. Thus, to increase the adoption rate of pasture renewal, future projects should include seed companies and retailers exploring and understanding farmer requirements as pasture performance was identified as a barrier to farmer adoption. Relevant information, such as the selection of suitable cultivars, could be specified and provided via publications and websites, while considering the needs of the "Experience and information orientated group" (Group 3).

Conclusion

This study contributes to the adoption literature of New Zealand by providing a quantitative framework for analysing farmer attitudes, where previous studies have mostly been qualitative. This framework could be used for other studies that focus on the adoption of other farm practices or technologies. This study identified that farmers thought highly of information from local experts and contacts, consistent with the results of Yang & Sharp (2017). This indicates the importance of local connections to farmer adoption, which could be further explored in combination with regional and spatial differences in future research.

ACKNOWLEDGEMENTS

We acknowledge the Pasture Improvement Leadership Group, and in particular Cameron Ludemann and Sally Peel from DairyNZ, for providing the data from the two surveys. We would also like to thank for David Hume and Sue Zydenbos from AgResearch and two anonymous reviewers for their valuable comments.

REFERENCES

Baumgart-Getz, A.; Prokopy, L.S.; Floress, K. 2012. Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management 96*: 17-25.

Belgrave, B.R.; Watt, P.C.; Brock, J.L.; Wewala, S.; Sedcole, J.R. 1990. A survey of farmer knowledge and use of pasture cultivars in New Zealand. *New Zealand Journal of Agricultural Research 33*: 199-211.

Bergtold, J.S.; Duffy, P.A.; Hite, D.; Raper, R.L. 2012. Demographic and management factors affecting the adoption and perceived yield benefit of winter cover crops in the southeast. *Journal of Agricultural and Applied Economics 44*: 99-116.

Bewsell, D.; Botha, N.; Brown, M.; Fraser, T.; Wilson, J. 2008. Understanding pasture renewal in New Zealand. *Report on market research for the Pasture Renewal Charitable Trust.* AgResearch Ltd., New Zealand. 75 pp.

Brazendale, R.; Bryant, J. R.; Lambert, M.G.; Holmes, C.W.; Fraser, T.J. 2011. Pasture persistence: how much is it worth. *Grassland Research and Practice Series 15*: 3-6.

Hansson, H.; Ferguson, R. 2011. Factors influencing the strategic decision to further develop dairy production - A study of farmers in central Sweden. *Livestock Science 135*: 110-123.

Knowler, D.; Bradshaw, B. 2007. Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy 32*: 25-48.

Pannell, D.J.; Marshall, G.R.; Barr, N.; Curtis, A.; Vanclay, F.; Wilkinson, R. 2006. Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture 46*: 1407-1424.

Rijswijk, K. 2013. Interactions between players in the field of pasture renewal. *Proceedings of the New Zealand Grassland Association 75*: 221-222.

Rijswijk, K.; Brazendale. R. 2016. Pasture renewal practices, experiences and attitudes: a comparison over time. *Proceedings of the New Zealand Grassland Association 78*: 51-56.

Rijswijk, K.; Rhodes, H. 2015. Pasture renewal in the Waikato and Bay of Plenty regions: a comparison between 2010 and 2015 farmer surveys. Client report prepared for DairyNZ by AgResearch Ltd., New Zealand. 43 pp.

Rolfe, J.; Gregg, D. 2015. Factors affecting adoption of improved management practices in the pastoral industry in Great Barrier Reef catchments. *Journal of Environmental Management 157*: 182-193.

Schmitt, T.A.; Sass, D.A. 2011. Rotation criteria and hypothesis testing for exploratory factor analysis: Implications for factor pattern loadings and interfactor correlations. *Educational and Psychological Measurement 71*: 95-113.

Stevens, D.R.; Knowles, I. 2011. Identifying the need for pasture renewal and valuing the contribution of renewal on a dairy farm-Telford Dairy, a case study. *Grassland Research and Practice Series 15*: 211-216.

Tozer, K.N.; Rennie, G.M.; King, W.M.; Mapp, N.R.; Aalders, L.T.; Bell, N.L.; Wilson, D.J.; Cameron, C.A.; Greenfield, R.M. 2015. Pasture renewal on Bay of Plenty and Waikato dairy farms: impacts on pasture performance post-establishment. *New Zealand Journal of Agricultural Research 58*: 241-258.

Yang, W.; Sharp, B. 2017. Spatial dependence and determinants of dairy farmers' adoption of best management practices for water protection in New Zealand. *Environmental Management 59*: 594-603.