Views of primary producers in the Taupo and Rotorua catchments: implications for water quality policy

Paper Presented at the New Zealand Agricultural and Resource Economics Society Conference 25-27 August 2006

Neels Botha and Terry Parminter[1]

1. AgResearch Ltd, Ruakura Research Centre, East street, Private Bag 3123, Hamilton, New Zealand

Summary

Lakes Taupo and Rotorua are important to New Zealand, but declining lake water quality is increasingly becoming a problem. Primary producers are said to be impacting heavily on the lakes' water quality through discharges that reach them through streams and ground water. The paper discusses the results of ongoing social research in the lakes' catchments. Data gathering was through literature reviews, interviews and workshops. The views, farming goals and perceived mediocre to poor adoptability of new environmental practices and technologies by primary producers in the lakes' catchments indicate that policy instruments encouraging voluntary change are unlikely to positively impact on water quality.

Key words

Adoptability; policy instrument; farming goals

Introduction

There are eleven major lakes in the Rotorua catchment of which Lake Rotorua is the largest. The town of Rotorua is on the shores of Lake Rotorua. Nearby and to the west is the town of Taupo that is situated beside the North Island's largest lake, Lake Taupo. These lakes are significant natural features in New Zealand attracting thousands of local and overseas visitors annually because of their pristine water quality, and they are also important from a cultural perspective. The New Zealand Government is keen to protect these lakes and Maori specifically see themselves as the *kaitiaki* (guardians) of the lake waters.

Both Lake Rotorua and Lake Taupo are currently experiencing increasing levels of algal blooms, lake foams, various lake weeds, and decreased water clarity and quality (Rutherford, Pridmore and White, 1989). Nitrogen and other nutrients enter the lakes through ground water and streams, and current land use practices in the Lake Taupo catchment largely affect the amounts of nitrogen entering it, posing a threat to its water quality (Journeaux, 2004). Farming practices in the catchment areas of these lakes contribute approximately 37% of nitrogen levels within Lake Taupo and 66% within Lake Rotorua. Subsequently the lakes may become unsuitable for recreation and human water supply in the longer-term.

Public policies are assumed to be “anything a government chooses to do or not to do” (Dye, 1972) and they set the backdrop within which primary producers operate and make decisions about the environment. Public policies consequently strongly influence land users’ decision making options and choices. Current public policies require land users in both catchments to reduce nitrogen and phosphorus emissions. But available mitigating technologies and practices have to be adoptable or they won’t be used and may cause policy to fail.

Research into the biophysical aspects of nitrogen leaching and studies to better understand the social factors impacting on nitrogen leaching off farms have been ongoing in the Taupo and Rotorua catchments for several years. The overall objective of the research was to ensure high quality ground- and lake water while enhancing economic and social well-being of Maori and non-Maori landholders, communities and policy bodies. This paper reports on a project that investigates the adoptability and suitability of new land management practices and technologies for land users in the catchment areas. The results of the project can assist policy makers and researchers with insights into how the attributes of new technologies influence their uptake by farming communities.

Methods

We used personal semi-structured interviews with Taupo and Rotorua Maori and non-Maori primary producer groups and governing bodies to gather data on the factors that influenced the adoption of new land management technologies and practices. Interviewees (participants) were key informants and identified through contact persons in the catchments. We also used a convergent interviewing technique to investigate attitudes towards new technologies, including views on nitrogen leaching and policy. Overall we covered dairy, sheep and beef farms of Maori and non-Maori land users in both catchments. We also ran workshops with land users to test a scale that measured the adoptability of available land management technologies and to better understand if they will adopt them.
Interviews were audio-taped and later transcribed. We used N*VIVO software to analyse the data. The goals of the research, their input into it and their rights were explained to each participant at the beginning of their interview. They were also asked to sign a research consent form. Participants later received their own copy of the interview and had the opportunity to make changes or withdraw information and to sign off on the content. This served as a data verification (triangulation) technique for the interview data. We also reviewed adoption and extension literature. Data gathering at the workshops were done by taking notes, audio-taping discussions and by participants’ self-recording of adoptability assessments on a pre-designed assessment scale.

Findings

Views about nitrogen entering the lakes

Research participants said that there was a range of sources that contributed to nitrogen in lake water. For discussion purposes we have put them in three categories, viz. farming, human and natural. Regarding farming as a source of nitrogen, they

believed livestock urine and dung were major sources of nitrogen, because they leached easily into groundwater, especially in wet conditions. Livestock that waded into streams or graze on the edge of a lake were regarded as an important source of large quantities of nutrients that could be released directly into the water, and on which algae thrive. In order of importance, participants said that when it came to putting nutrients like nitrogen into the lakes, dairy farming and their effluent ponds were the worst, followed by dry stock farming, and sheep farming. Fertiliser application formed an integral part of any pastoral farming operation. Participants said that most fertiliser was trapped in the soil, and that it therefore did not have a major effect on the water quality of the lakes. But they also indicated that fertiliser could enter the lakes through: storm water runoff; over-application; application directly into waterways, especially by means of aerial sprays; and application on pumice soils which were prone to severe leaching. For example:
"We farm dairy cows on there at 3.5 cows per hectare - so they urinate - that's definitely nitrogen leaching in those urine spots - we know that… definitely female milking cows they are the biggest urine volume"

Participants saw human activities as a major source of nitrogen in the lakes, and that the older traditional type of septic tank would not remove nitrogen or phosphorus from human effluent, aside from plant uptake and scum and solids that settle in the tank. For example:
"So the human impact has got to be probably the major source of nitrogen and phosphorous…"
"I think the biggest polluter of the lake of all is humans and residential. Clearly the worst areas are the ones around the townships"

Volcanic soils generally absorbed phosphorus, but nitrogen was the main nutrient that leached from septic tanks, they explained. There were various residential properties around the lakes, and participants said that some of these still had the older type of septic tank sited as close as five meters from the edge of the lake. They expressed their concern about the continued development of residential subdivisions, especially around Lake Taupo. For example:
"That's been pumping sewer into this lake for years, for like 100 and something years. And all the houses around the lake, their little septic tanks have been pumping nitrogen; you know they're right there; they're 5 metres from the lake"
"I find it a bit difficult to understand why they are letting so much development go on around Lake Taupo, subdivisions etc, etc - to the extent they have. When people are running septic tanks and all those sorts of systems, that's got to be part of the problem too"
"I don't think there should be any more subdivisions going on in Lake Taupo"

Regarding nitrogen leaching from natural causes, they believed that erosion on farms took many forms, e.g. slips, stream bank erosion, and runoff from tilled land. They pointed out that phosphorus attached to soil particles was the main nutrient that got into water because of erosion. Nutrients from geothermal activity particularly in the Rotorua lakes catchment were said to be a significant source of nutrients to the lakes.

Views of research in the catchments

"I think we are all suspicious of research, because what I don't want to be told is I can't do something today and in 10 years' or five years' time they turn around and

say well, we made a mistake. That wasn't what the problem was at all – you could have carried on doing that".
Participants' view was that significant research gaps existed and boards and management committees consequently didn't get a comprehensive view and understanding of the issue. Participants from the Rotorua catchment questioned research results and in general they were viewed as inconclusive. For example they said:
"A lot more research is needed. We need more robust information. People don't mind facing the music if they're confident in the information."
"They don't know how old the phosphate is that's coming out – whether it's new phosphate or old phosphate out of the rock, or whether its nitrogen – they don't really know. A lot of it is guess work". "There are holes in the research all over the place".

Participants viewed the part that farming contributed to nitrogen leaching into Lake Taupo as small in comparison to what urbanisation and nature were responsible for. They believed that findings from research investigations were being used to target farmers, and that a blind eye was being turned to urban nitrogen sources. Investigations were said to be based on theory and not on on-the-ground farming practices that best suited the different geographical locations around the lakes (Roth et al, 2005). For example:
"…they have blocked their mind to the amount of run-off coming from the septic tanks all around"
"I think farming is taking the blame for the big proportion of it. But I don't think we should be taking the blame for a big proportion, maybe we are to blame for some of it. But when we're only 30% of it, there's a big proportion that we're not part of when you've got leaking septic tanks all around the lake and all that sort of thing. Well they've got to tidy up all those things as well, not just try and tidy the farms up. There are more than just the farmers contributing to it"

Participants believed that nitrogen entered the lake mainly via leaching through ground water, and that research results indicated that some of the nitrogen rich waters were between 50 and 100 years old. Lake Taupo participants added that farming had been practiced in the catchment for less than 50 years, and that leaching from their properties had therefore not reached the Lake yet. For example it was said:
"*One of the biggest issues we've got is that we're told that the ground water is taking 50 to 60 years to reach the lake and so the effects of nitrogen leaching that we are seeing right now was created back in the post war days of development out of bush into clover producing hill country using super phosphate"*
"This lake quite clearly has been getting its problems from elsewhere… it hasn't been getting it from the farms because the water hasn't got to the lake yet. This land in 1950 wasn't fertilised. There's only been… 25, 30 years of intensive farming. But to blame the blooms on farming that is 50 years old when the water's 80 to 100 years old - the logic doesn't quite come together, does it?"
"That's a commonly held perception or view that it is such a long time until the water gets to the lake then what we are doing right now is not impacting on water quality for a long time".

Views of changes to policy and farming practices

Because of policy changes, the farming environment in the Taupo and Rotorua catchments areas have been clearly changing and we recorded a variety of responses to those changes. Participants clearly viewed the lakes as a "tourism Mecca" and as "a piece of heaven". For example, for Maori who are the *kaitiaki* of the land and the lake waters, their priority was to ensure that the land was looked after so that it would continue to provide benefits to future generations. They said that there was no common view among Maori about how to respond to policy changes, and they seemed to be getting conflicting information about how to best address the issues they faced. Local government manage environmental issues and resource management, mainly through Regional Councils which are established for every catchment in New Zealand. Currently Maori say that they have not received clear guidelines from regional councils, but they realised that new regulations would at some time be put in place. Because they didn't know how to respond appropriately there was a widespread sense of uncertainty. For example:
"That's what I'm waiting for: some clear direction as to what we are supposed to be doing. And I think that's what probably a lot of people are doing. At the moment a lot of people are just farming and some of them are increasing their stock units because they are frightened that they are going to be told to cut back, so they are increasing them as high as they can so if they are told to cut back, they can cut back and they're still profitable".

Some participants believed they run a risk of being required to improve even further when new regulations come into place. For example:
"The guy that's been farming conservatively fencing off blocks of bush is well, frozen in the status quo. The guy that's been hard core polluting, well he may be allowed to stay at that same level".

There were two main responses, i.e. simply carry on farming as in the past, and wait and see; push production up as quickly as possible, before "capping" rules came into play. Participants said that they would co-operate with Regional Councils if they viewed the coming restrictions as fair and based on good science. Most participants were confident that the discussions and negotiations between regional councils and Maori as the *Tangata Whenua* (people of the land) of large areas of the catchment areas would provide both parties with greater clarity and time to make adjustments.
"They're all running scared about the fact that their economics are going to change through legislation and that's what's occupying their minds".

If these negotiations were not satisfactory the Environment Court could be asked to help resolve the issue. All the participants anticipated that restrictions would be enforced on their farming practices. Participants from the Lake Taupo catchment particularly expressed serious concerns about restrictions, because it meant significant costs to their farming enterprises in the form of lost opportunity.

Current on-farm environmental practices

All the participants have implemented some environmentally friendly on-farm practices and technologies over the years. These included riparian strips, decreased fertiliser use, erosion prevention, nutrient budgeting, destocking and shelterbelts. For example:
"…the other thing we do is nutrient budgeting. Making sure we're not wasting it".

Many of those were implemented for other reasons than protecting the environment, but have had positive environmental effects non-the-less.
"Things like direct drilling: we do that because it's cheaper. There's economic reason behind it, not just for leaching".

All the participating farm managers and consultants said that they were considering introducing a number of additional practices on their properties when they received more concrete guidelines from the regional councils. However, most of the participants said that they did not want to do anything new about nitrogen leaching at that time. For example:
"They are also waiting in the wings and saying what are these new technologies and what's the cost and what's the benefit".

These potential practices included: developing feed pads outside the catchment areas for wintering of livestock; retiring more areas, in some cases significant areas for horticultural use like blueberries; putting in detention dams; trialling Eco-N fertilisers; downsizing dairy cow herds and replacing them with high performing sheep.

Farming objectives

The farming objectives of primary producers highlighted what they wanted to achieve in future. None of the interviewees had objectives that directly addressed water quality in the lakes, but most interviewees talked about the importance of long-term profitability and sustainability. Financial viability seemed high on the agenda, for example it was said:
""You can't be green if you're in the red. If you are fighting for survival you can't be green – that's the way."
"Its (reducing nitrogen) important but farmers still got to survive".
"Our accountant says you don't spend money on anything that either isn't going to make life easier or make more money".

Most interviewees had well-developed long-term visions and strategies in place for realising their objectives. Achieving these objectives required significant capital expenditure, and participants varied greatly in terms of their ability to fund the activities that would help them most to achieve their objectives.

The adoptability of available technologies and practices

Available technologies were identified with leading scientists and included: excluding nitrogen in winter; changing stock class ratios; direct drilling or no-till cropping, the use of Dicyandiamide (DCD); low protein feeds; wintering standoff feed pads; and stock class management to prevent pugging. Views by workshop participants were, with very small exceptions, similar for Rotorua and Taupo. We found that the exclusion of nitrogen in winter and the use of direct drilling/no-till cropping for re-grassing and re-cropping were fully accepted and used. Similarly, the implementation of stock management to reduce pugging was widely used by land users particularly in the Lake Rotorua catchment. These practices were implemented for economic reasons rather than emission control.

The other technologies and practices i.e. changing stock class ratios, use of DCD, low protein feeds, and wintering standoff feed pads were not adoptable in their

current form. The reasons why participants rejected these technologies and practices were cost, poor fit with current farming systems and not believing that they actually reduce emissions.

Discussion

Available technologies

There are a range of technologies and best management practices available to intercept or remove contaminants before entering waterways and manage contaminants at source. The first set generally requires a change in infrastructure design and construction and the second set require a change in a specific management practice on-farm to achieve a desired environmental outcome. According to Burggraaf, Lambert, Power and Botha (2005) the first set consists of effluent ponds, grass buffer strips, wetlands, denitrification walls and absorbent materials to capture nutrients from overland flows and drains. The second set consists of a set of farm dairy effluent management practices; nutrient budgeting, using nitrification inhibitors, establishing optimum Olsen P values; excluding stock from streams, using stand-off pads during winter; changing feed management reducing treading damage, and feeding pasture supplements along fence lines. For assessing the adoptability at the workshops we asked a prominent scientist to choose land management technologies and practices from the list that are useful or available for use.

Suitability and adoptability of available technologies

Guerin and Guerin (1994) have highlighted the importance of innovation characteristics in their major review of innovation adoption in Australian agriculture. Pannell (2005) has indicated that innovations need to be 'adoptable', otherwise farmers will ignore them. Innovations that are 'adoptable' are those that are useful or suitable for use by land users. The notion of using innovation characteristics to assess the adoptability of innovations comes from the theory of perceived attributes and is a useful point of departure (Nutley et al 2002; Clarke 1996; Rogers & Scott, 1997).

Other authors like Cary, Webb and Barr (2001) and Vanclay (1992) have also described key considerations that primary producers take into account when making adoption decisions. First, the innovation must have some relative advantage over an existing innovation or the status quo, i.e. it must better than what it supersedes. Second, it is important the innovation be compatible (called congruence by Vanclay 1992) with existing needs, values, past experiences and practices. Third, the innovation should not be complex (called intellectual outlay by Vanclay 1992). Fourth, the innovation must have trialability (called divisibility by Vanclay, 1992), i.e. able to be experimented with on a limited basis. Fifth, the innovation must offer observable/visible results (Rogers, 1995). Vanclay (1992) also discusses other factors that influence adoption, i.e. economics and implementation costs, risk and uncertainty, conflicting information, loss of flexibility, and physical and social infrastructure.

It is those innovations that are perceived by individuals as having greater relative advantage, compatibility, trialability and observability, and less complexity that are most suitable and will be adopted more rapidly than other innovations (Rogers and

Scott, 1997). Cary et al (2001) categorised natural resource management (NRM) practices in terms of attributes that had been found to be important in determining whether management practices were readily adopted or not. From their list of sustainable practices only one comprised all the attributes they believed to be important for adoption, i.e. being widely applicable, having high relative advantage to the landholder, low complexity, high compatibility, high trialability and observability. The complexity of many of the environmental topics, skills required to manage environmental problems, newness of and unfamiliarity with some of the topics and a lack of easy-to-use cost effective monitoring tools were identified by Botha and Blackett (2005) as important challenges to dairy farmers.
In terms of our interviews, participants in both catchments said that primary producers already use six practices to protect water quality in nearby waterways, i.e. riparian strips, decreased fertiliser use, erosion prevention, nutrient budgeting, destocking and shelter belts. That these practices are being used so widely and are now accepted farming practices suggests that they meet the required characteristics of adoptability described above.

All main waterways on properties within the Lake Taupo catchment, which include main creeks and wetlands, were fenced off in the early 1980s with the support of the Waikato Valley Authority, which is now the Waikato Regional Council.
In the Rotorua catchment, participants reported that they have now completely fenced their stock out of all natural waterways and most of them reported a decrease in the amount of fertiliser being applied on their properties. One interviewee in the Rotorua catchment area indicated that they have switched the aerial application of urea from aeroplane to helicopter, because it was more accurate and lessened the risk of urea entering waterways. A number of participants have begun re-grassing by means of direct drilling. It was said to be cheaper than conventional methods and also stopped phosphate carrying topsoil from being washed away and getting into waterways and the lakes. A small number of farm managers and their consultants were saving money by using Overseer (a computer program) for nutrient budgeting. This also helped to ensure that more urea than required was not applied to the land.

On some farm blocks urea was no longer being applied during winter months. Some farm managers said that they have decreased their breeding cow numbers and increased their ewe numbers, while others tended to trade their heavier cattle before wintering, ensuring that only younger cattle would be on the farm over the winter period. Grazing more cows off the farm during winter was becoming a common practise for the majority of farm managers. However, in a small number of instances participants were concerned that putting in wintering pads could increase their animal health costs. Some farm managers were reported to have introduced shelterbelt plantings on significant parts of their farm blocks.

In terms of the workshops, we have begun to assess the adoptability of several land management practices. Cary et al (2001) used key informants to assess the adoptability of NRM practices, and likewise we used primary producers and agricultural consultants. The findings in the workshops and interviews were alike; costs play a key role. We conclude that economic drivers were more important than environmental protection drivers in the adoption process. Primary producers adopted or rejected environment friendly land management technologies and practices based on their perception of three aspects: cost, fit with their current farming system and

whether they were convinced that the technology or practice would achieve its purpose. Technologies and practices that were affordable, fit the current farming system and achieved its purpose were adopted. Three of the 7 technologies were adopted and four were rejected based on these reasons.
Given this background, in the next section we discuss the expected responses to policy interventions intended to improve lake water quality by encouraging the use of new technologies.

Application to policies for water quality

Primary producers' current situation provide us with some clues of important aspects that need to be taken into account in policy for improving water quality in these catchments. There were a number of factors that could assist Regional Council staff working with primary producers for the implementation of more environmentally friendly practices. These included primary producers' values, long-term planning, level of awareness about environmental issues and normative behaviours. In summary: Participants said they valued the land and natural environment and they wanted to protect it. This is a strongly held value which may engender positive responses to compatible policy implementation. Most participants had long term business plans in place, which took cognisance of the need to balance between economic, social and environmental outcomes. There was a general understanding of how nutrient leaching worked and the pathways for farming emissions into the environment. Most primary producers already apply some of the most commonly known practices.

Participants identified a number of issues that could make the introduction of new environmental practices more difficult for Regional Councils. These included the level of responsibility that they felt they had for environmental effects, the risks associated with making rapid changes, their lack of confidence in some of the research into new practices, the financial costs of investing in new technologies, and a lack of sufficient social support for change. In summary: Primary producer participants partly deny their responsibility for improving water quality in the lakes, choosing to blame the problem on residential properties instead. They have already made a number of practice changes to reduce their environmental impact and this may actually strengthen primary producers' resistance to change because they may argue they have already done enough. Participants believed that research results didn't really apply to their particular area and situation. All the participants were strongly driven by the economic effects of introducing new technologies. Any technologies that appeared impractical, expensive to implement or that required a lot of capital to establish were avoided. Some of the Maori groups reported that they especially lacked the capital resources required to develop their land. Many of the participants make use of farm consultants, whom they trust. Botha, Coutts and Roth (2006) have shown that these farm consultants don't advise on best practice regarding the environment because: they are not seen as knowledgeable in that area and it is not a service that many primary producers are willing to pay for. Hence farm consultants, who are paid for their advice, do not provide environmental consultancy.

In terms of adoptability Pannell (2005) says that: "If they (innovations) are not (adoptable), then communication and education activities will simply confirm a farmer's decision not to adopt as well as degrade the social standing of the field agents of the organisation. (Agricultural) extension providers should invest time and

resources in attempting to ascertain whether an innovation is adoptable *before* proceeding with extension to promote its uptake". Extension, a form of adult education, is a popular policy instrument in countries where it has been institutionalised and government support is common, e.g. USA and Australia.

However, in New Zealand there is no formal government or agricultural industry extension service available. Instead extension activities are carried out by some individual officials in Regional Councils and by designated staff in industry organisations (e.g. Dexcel). Much of the extension efforts in New Zealand to encourage the use of good environmental practices is said to be of limited effect and focussed on raising awareness, rather than encouraging behaviour change (Ford, personal communication 2005). Our finding in terms of the adoptability indicate that a voluntary approach like extension or adult education to behaviour change is unlikely to positively impact on water quality in the Taupo and Rotorua catchments.

Acknowledgements

We acknowledge all the research participants who freely gave their time and views and contributed in others ways to this research. We also acknowledge the Foundation for Research science and Technology as the project funder.

References

Barrett-Ohia O (2005). Governance and multiple owned lands: a literature review. Research report to the Foundation for Research Science and Technology.

Burggraaf V, Lambert G, Power I and Botha N (2005). Land use, land use practice and technological options for preventing nitrate leaching in the Taupo catchment.

Botha N and Blackett P (2005). Farmer decisions and issues in managing the impact of dairy farming on the environment. Report to the Dairy Environment Review Group.

Botha N, Coutts J and Roth H (2006). The role of agricultural consultants in the New Zealand Research, Development and Extension system. Paper prepared for the 12th Annual conference of the new Zealand Agricultural and Resource Economics Society (Inc).

Cary J, Webb T and Barr, N (2001). The adoption of sustainable practices: Some new insights. Land and Water report available on: www.lwa.gov.au/download/final_reports/BRR19.pdf Accessed 12/12/2005.

Clarke R (1996). A Primer in Diffusion of Innovations Theory. Web source: http://www.anu.edu.au/people/Roger.Clarke/SOS/InnDiff.html Accessed 12/12/2005.

Dye TR (2005). Understanding public policy. 11th ed. Pearson: Prentice-Hall.

Guerin LJ and Guerin TF (1994). Constraints to the adoption of innovations in agricultural research and environmental management: a review. Australian Journal of Experimental Agriculture, 34, 549-71.

Journeaux P (2004). Water quality in Lake Taupo. Document available on website: http://www.maf.govt.nz/mafnet/publications/rmupdate/rm14/rm14-02.htm Accessed 25/01/2006

Milne J (2004). Maori land being cashed up. Document available on website: http://www.arena.org.nz/landsale.htm Accessed 20/11/2005.

Nutley S, Davies H and Walter, I. (2002). Conceptual Synthesis 1: Learning from the Diffusion of Innovations. Available on: http://www.st-andrews.ac.uk/~cppm/Learning%20from%20the%20Diffusion%20of%20Innovations.pdf. Accessed 25/11/2005.

Rogers EM (1995). Diffusion of Innovations. New York: Free Press.

Rogers EM and Scott KL (1997). The diffusion of Innovations Model and Outreach from the National Network of Libraries of Medicine to Native American Communities. Draft paper prepared for the National Network of Libraries of Medicine, Pacific Northwest Region, Seattle, USA.

Roth H, Botha N and White, T (2005). The adoption decision-making contexts of Maori groups in the Lake Taupo and Rotorua catchment areas. Paper presented at the Industry Development and Practice Change conference, Hamilton 4 October 2005.

Rutherford JC, Pridmore RD and White E (1989). Management of phosphorus and nitrogen inputs to Lake Rotorua, New Zealand. Journal of Water Resources Planning and Management, Vol. 115, No. 4, July/August 1989, pp. 431-439

Pannell, D (2005). Pannell Discussions: Salinity Investment Framework III. Available on http://www.general.uwa.edu.au/u/dpannell/pd/pd0062.htm Accessed 15/12/2005.

Pannell DJ, Marshall GR, Barr N, Curtis A, Vanclay F and Wilkinson R (2005). Understanding and promoting adoption of conservation technologies by rural landholders. Web document available on: http://www.general.uwa.edu.au/u/dpannell/dp0502.htm Accessed 14/12/2005.

Vanclay, F (1992). Barriers to adoption: a general overview of the issues. Rural Society 2(2) Centre for Rural Social Research. Charles Stuart University, Wagga Wagga, Australia.