doi:10.2489/jswc.66.5.140A

FEATURE

Dairy farm impacts of fencing riparian land: An analysis of farmers' perceptions of the costs and benefits

Sharon R. Aarons

Uncontrolled stock access to streams contributes excessive nutrient and pathogen inputs from urine and dung, causes trampling and pugging or poaching of banks, and leads to overgrazing of riparian vegetation (Trimble and Mendel 1995; Hooda et al. 2000; Agouridis et al. 2005). In addition, in Victoria, Australia, all of the processes that potentially threaten riparian biodiversity are influenced by grazing management of riparian areas (NRE 1997; Lowe et al. 2000).

The grazing-based dairy industry in the Gippsland region accounted for 35.3% of Victoria's dairy production in 2009 and 2010 (DA 2011) and half of the agricultural production in Gippsland (WGCMA 2004). GippsDairy, the regional dairy board, highlighted water and biodiversity management for community and on-farm benefits as major challenges currently facing the industry (GippsDairy 2006), with the desired outcomes including (1) a reduction in nutrient contamination of waterways and groundwater while maintaining dairy farm productivity and (2) the protection and enhancement of native vegetation, wildlife habitat, stream banks, and wetlands on dairy farms to increase biodiversity assets.

Riparian Interventions. Improvement in riparian management and water quality on dairy farms includes the installation of buffers (Dabney et al. 2006), exclusion of stock (Line et al. 2000), and rotational grazing (RMS 2009). Means-oriented approaches such as these are best used in conjunction with goal-oriented policies to ensure that natural resource interventions are achieved (Stobbelaar et al. 2009), although the role of agencies in delivery of interventions is by no means exclusive. For example, the Integrated River Health Policy and Investment team in theVictorian state Department of Sustainability and Environment (DSE) develops policy frameworks and best practice management guidelines (means oriented) that are used to support catchment management authorities across Victoria, such as the West Gippsland Catchment Management Authority (WGCMA), while also providing financial support for rehabilitation activities (DSE 2009).

Sharon R. Aarons is the senior research scientist at the Future Farming Systems Research Division, Department of Primary Industries, Ellinbank Centre, Ellinbank, Victoria, Australia.

The WGCMA, responsible for protection of Gippsland's natural resource assets, set resource condition targets for surface water quality and for the protection and enhancement of biodiversity (WGCMA 2004), based in this example on the GippsDairy Natural Resource Action Plan (GippsDairy 2006)—an implicit acknowledgement of the perceived importance of the dairy industry to the economy and to natural resource management in the region.

The means-oriented approach adopted to meet water quality and riparian biodiversity resource condition targets, involves the restoration, or more commonly rehabilitation of riparian zones on dairy farms (Rutherfurd et al. 2000). The approach recommended is the removal of exotic invasive plants such as willows (Salix sp.), revegetation of the riparian zone with native species of local provenance based on the ecological vegetation classes (EVC) (NRE 1997) being replanted, and fencing of the riparian zone to exclude dairy stock. Recommended fencing widths range from 10 to 50 m (32.8 to 164 ft), if aiming to improve native biodiversity (Straker and Lowe 2004).

Policy Instruments. A voluntary approach is one of four instruments that can be used to ensure improved natural resource management behavior, with motivational or informational incentives used to reinforce practice change (Gunningham and Young 1997). Voluntary instruments have included encouraging and supporting the formation of environmental cooperatives as a means of improving natural resource management through increasing internalization of environmental policies, improving the landscape-scale perspectives required for natural resource management, and enhancing social capital of landholders (Curtis and De Lacy 1996; Pretty 2003; Stobbelaar et al. 2009). Thus, institutional arrangements such as Landcare provide farmers with the social structures required to increase adoption of environmental management recommendations, potentially assisting in moving farmers toward postproductivism (Curtis and De Lacy 1996; Pretty 2003; Burton and Wilson 2006).

The implementation of strategic interventions for water and biodiversity by the WGCMA occurs through many Landcare groups in GippsLandcare, which, amongst other things, assist farmers with applications for incentive funding. Price-based incentives are used in conjunction with voluntary instruments to encourage dairy farmer adoption of riparian rehabilitation. Incentives available from state and federal agencies contribute to the costs and labor associated with fencing and/or revegetating riparian areas. While farmers are encouraged to fence as wide as possible, incentive funding from some organisations is often dependent on minimum fenced widths.

Other voluntary approaches available to dairy farmers include the use of environmental management systems tools such as DairySAT, which offer a participatory approach to integrating natural resource management within farm management practices (Ridley 2004; DA 2009). EcoTender, a market-based instrument developed by DSE, uses an auction approach to provide landholders with financial incentives to improve management of environmental assets. Farmers, for example, estimate their costs for improved environmental management with the most cost-effective suppliers of multiple outcome environmental benefits selected by public buyers (the government) in an auction system (Eigenraam et al. 2007).

Farmer Attitudes and Motivations. To maximise adoption and practice change, the attitudes of farmers towards improved natural resource management need to be acknowledged so that the barriers to

on-ground management action can be identified and engagement programs developed (Vanclay 2004; Pannell et al. 2006). A number of studies and reports have described farmer beliefs, identities, and attitudes regarding natural resource management in general and riparian and/or biodiversity management in particular and the influence of these on adoption (Wilson and Hart 2001; Rhodes et al. 2002; Parminter and Nelson 2003; Vanclay 2004; Boxelaar and Paine 2005; Burton and Wilson 2006; Pannell et al. 2006; Stobbelaar et al. 2009). Rather than a shift towards postproductivism, farmers' self-concepts predominantly remained productivity oriented (Burton and Wilson 2006). Likewise, when Victorian farmers were grouped according to their attitudes to riparian or biodiversity management on their farms, Parminter and Nelson (2003) categorised farmers into four groups based on their motivations to implement improved on-farm biodiversity management. Of these, the "production" motivated farmers were the largest group—with the highest dairy production and for whom biodiversity practices should not interfere with farm management. Economic reasons and the impact of the required environmental change on farm management were factors that influenced adoption (Wilson and Hart 2001; Vanclay 2004; Pannell et al. 2006).

Financial cost was one of the reasons most cited by farmers for not improving riparian management (Rhodes et al. 2002), both in terms of the capital outlay required and the potential increase in financial risk associated with changed management (Vanclay 2004; Pannell et al. 2006). Likewise, the perceived loss of productive land when riparian areas are fenced for the reestablishment of native vegetation is considered an important disincentive by Gippsland and other Victorian dairy farmers to undertaking improved riparian management (Curtis and Robertson 2003). Vanclay (2004), Pannell et al. (2006) and Stobbelaar et al. (2009) recommend that the costs of implementation of environmental management need to balance the benefits to ensure internalization by landholders.

In conjunction with a research experiment to quantify the costs to the enterprise of pasture excluded from production if the riparian area was fenced (Aarons and Melland forthcoming), the three dairy farmers were interviewed regarding their attitudes and motivations to riparian fencing and revegetation to explore the value of segmentation approaches as a means of encouraging practice change.

CASE STUDY DAIRY FARMS

The three farms selected for the pasture production experiment are located in the WGCMA region, where two are adjacent to each other in the Strzelecki bioregion (Farms A and C). The third farm (B) is located approximately 30 km (18.6 mi) to the northeast in the Highlands–Southern Fall bioregion (NRE 1997). All dairy farms represent small- to medium-sized dairy enterprises based on herd sizes. Of the two farms in the Strzelecki bioregion, one was a typical commercial dairy farm, while some of the herds on the other were managed primarily for dairy research experiments, with the main herd managed to maximise profits. Extensive revegetation of parts of the latter farm had occurred, with the waterway fenced and revegetated from 2005 onwards. In contrast, less extensive revegetation of the former farm and its waterway has occurred, but initial fencing of the waterway occurred over 20 years ago. The farmer in the Highlands–Southern Fall bioregion, also a typical commercial farm, had likewise implemented revegetation of much of the farm.

Survey Method. A questionnaire was developed to record riparian management activities undertaken on each of the three case study dairy farms. Farmer attitudes and motivations to on-farm production and natural resource management activities were also collected. The farmers were interviewed after the pasture production experimental data were collected; although, previous comments made by the farmers were used where relevant. The questionnaire included both closed and open questions, where the open questions allowed the farmers to expand on answers by giving their reasons and any additional comments.

FARMERS' RIPARIAN MANAGEMENT

Farm B has the longest waterway frontage with one waterway traversing the property and another forming one boundary to the farm. Based on the farmers' estimates, this farm has the greatest fenced widths, despite the highest perceived land value of AU$20,000 ha^{-1} (US$8,529 ac^{-1}) (table 1). Taking a minimum fenced width of 5 m (16 ft) along the waterway gives 1.5 ha (3.75 ac) fenced area, amounting to a value of AU$30,000 (US$31,983). Farm C, with the lowest estimated land value had the smallest fenced area of 0.64 ha (1.6 ac), based on a maximum width of 4 m (13.1 ft) and a fenced length of 1.6 m (5.2 ft). The land values near Farm C may be closer to AU$11,200 ha^{-1} (US$4,776 ac^{-1}), as a 142 ha (351 ac) property in the vicinity recently sold for AU$1,600,000 (US$1,686,032) (Laidlaw, pers. comm.). Like on Farm B, the waterway on Farm A was completely fenced, and stock never had access to the waterway, an estimated loss of land valued at AU$12,000 (US$12,645).

The farmers indicated that farm management would change dependent on the width of the fenced zone (table 1) and the subsequent areas lost from milk production (Aarons and Melland forthcoming). Farmer C was the only farmer to consider leasing additional land (paddocks) to compensate for the fenced areas at an estimated cost of AU$220 (US$232) per year, along with the additional fertiliser required for the leased land. Farmer A was prepared to incorporate the loss of land (1 ha [2.47 ac]) associated with fencing to 5 m (16 ft) by increasing stocking rates on the remaining farm area. However, this farmer would destock if required to fence to 20 m (65.6 ft) and, in so doing, accept the reduction in milk produced. Farmer B, with the greatest areas that would be fenced, felt that increasing pasture production on the rest of the farm would be required, particularly for the loss of almost 10% (when fenced to 20 m [65.6 ft]) of their milking area.

Attitudes. The survey questions were used to explore these farmers' attitudes regarding production and natural resource management in general and riparian management more specifically (table 2). While all farmers had undertaken production/business-related courses and/or utilised agricultural consultants, only one farmer (Farm B) belonged to an environmental

Table 1

Riparian management and land value data for the three case study farms.

	Farm A Strzelecki Ranges	Farm B Highlands–Southern Fall	Farm C Strzelecki Ranges
Riparian management			
Waterway frontage	~2 km	3.087 km	2.3 km
Proportion fenced	All	All	70%
Width of fencing	5 m	5 to 10 m for most	< 4 m
Stock access–points	No	No	Yes
Stock access–frequency	Never	Never	1 to 2 times a year
Land financial value			
Cost of land*	AU$12,000 ha^{-1} + (US$5,117 ac^{-1})	AU$20,000 ha^{-1} (US$8,529 ac^{-1})	~AU$10,000 ha^{-1} (US$4,264 ac^{-1})
Leasing costs†	$0	$0	$0
Potential management change required‡			
5 m fenced width	Change management and increase stocking rate	Change management to add more fertiliser and resow or destock	Lease more land
20 m fenced width	Destock	Change management to grow more grass—from 7 t up to 10 t and more fertiliser (10 years ago). Destock (currently).	Lease more land at AU$220 per year + fertilizer cost§

*Land cost estimated by the farmer. Exchange rate as of 24 June 2011

†These farmers did not lease any land for their enterprises—a means of compensating for the land lost from production.

‡Changes to farm management the farmer determines he would need to make to compensate for fencing to either 5 or 20 m from the riverbank.

§This farmer estimated the cost of implementing the potential changes.

group. This is in line with "material wealth and financial security" as one of the five general goals of landholders and their families (Pannell et al. 2006). Nelson et al. (2003) noted that farmers gave as a priority to "build a valuable farming business" and "produce to maximise farming profits". Their business focus notwithstanding, all case study farmers had implemented natural resource management activities on their farms suggesting that good farm management for these farmers included environmental management (Vanclay 2004). Their actions contradict the positive relationships reported between association with environmental groups and adoption of conservation activities as all but one of these farmers were not involved in conservation groups (Curtis and De Lacy 1996; Pannell et al. 2006; Stobbelaar et al. 2009).

Only Farmers A and C had done an environmental assessment (DairySAT) (DA 2009) of their farms, in association with the Department of Primary Industries and local agricultural college students, respectively. However, those assessments appeared to be less motivated by the farmer's attitudes towards enterprise management than by the needs of the state department and the agricultural college. All farmers rated highly the benefits of riparian fencing, but while Farmers A and B gave equivalent ratings of the costs, those estimated by Farmer C were lower (table 2).

Motivations. A number of factors influence adoption of natural resource management changes by farmers on their farms (Vanclay 2004; Pannell et al. 2006), including farmers' identities, constructs of social systems, and beliefs (Burton and Wilson 2006). Occupational identities, such as that associated with commercial agricultural production, could strongly influence adoption through perceptions of the relative advantages associated with implementation of change management (Burton and Wilson 2006; Pannell et al. 2006). Thus, the costs to implement the practice, including any potential reductions in profits, ongoing impacts to farm management, and any associated increased risks, are part of the economic and social factors that farmers will assess. Despite the importance of economic influences on adoption, environmental management and sustainability issues are considered integral to farm management by farmers (Vanclay 2004).

Farmers A and B gave on- and off-farm environmental benefits as the primary goal (i.e., motivation) for natural resource management activities (table 3), with their reasons for implementing changes consistent with this goal. Farm productivity was a clear driver for Farmer C's environmental activities, giving production as his primary goal, although he rated the costs of fencing lower than the other farmers.

When asked to describe the costs associated with fencing, only one farmer (A) indicated loss of grazing area as a cost associated with fencing. Farmer C, early in the project, identified land value as a barrier to farmers fencing riparian areas, as had other farmers in regional riparian workshops and forums. At the end of this project, however, Farmer C pointed out that for many farmers with crown frontage (waterway land leased by the farmer from the government for a small cost) land value was not a valid reason.

In 2002, Farmer B expressed an unwillingness to fence to greater than 5 m (16.4ft) along a creek of 891 m (2,923.2 ft) in length, although he then belonged to and is currently the chair of the local Landcare group. Farmer B stated that, "Most of our farm is hill country. The land around the creek is too valuable to fence off more than 5 m (16.4 ft), especially in summer when the hill country dries off." Despite this evidence of risk aversion (Pannell et al. 2006), the farmer subsequently fenced part of the creek to prevent stock accessing the waterway and crossing to other paddocks. The loss of time incurred locating cattle, as well as the difficulties associated with retrieving stock from the creek, were reasons given for fencing small areas of the creek before major rehabilitation

Table 2

Attitudes to production and natural resource management activities and involvement of the three case study farmers based on the interviewees' answers to questions in the questionnaire.

Query	Farm A	Farm B	Farm C
Involvement in industry production groups	No, but uses an agricultural consultant	No, used to use an agricultural consultant, but doesn't now	Yes, participated in Target 10*, was a previous chair of the GippsDairy† Regional dairy board
Involvement in environmental groups	No	Yes, chair of Tanjil Valley Landcare	No
Undertaken business management assessments/plans	Yes, e.g., whole farm planning, pasture/diet/oil and fertiliser management, herd health and reproduction	Used to years ago, especially when employed a farm consultant	Australian Institute of Management Farm business course—Human Resources Management. Also used prior tertiary knowledge and through networks developed management plans for the business early in farming
Undertaken environmental management assessments/plans	Yes, DairySAT‡, local milk factory total farm sustainable management	No	Yes, worked through DairySAT with 34 Advanced Diploma students as part of their course requirements
Implementation of environmental changes on farm§	Yes, all mentioned examples undertaken, 40,000 trees planted	Yes, all of the above—fenced all gullies, creeks, and rivers; put up shelterbelts; beautification	Yes, fenced off riparian zone
Rating of costs of fencing the waterway‖	2–3	2.5	1–2
Rating of benefits of fencing the waterway‖	4	5	5

*Target 10 program ran "Soils and fertiliser" and dairy cow feed management training programs for farmers.

†GippsDairy (Regional development program for dairy farmers in Gippsland, http://www.dairyaustralia.com.au/Industry-overview/Dairy-regions/Gippsland.aspx.

‡DairySAT, http://www.dpi.vic.gov.au/DPI/nrensr.nsf/LinkView/DE9182C10850CE31CA25740B000EED3C26200B8A5DC746B0CA2573A3000E1592/$file/Dairy%20Self%20Assessment%20Tool.pdf; contact Dairy Australia to access the self assessment tool, http://www.dairyaustralia.com.au/Home/Standard-Items/Search-Results.aspx?q=dairysat&page=1.

§Examples of on-farm environmental changes provided to farmers in the questionnaire were revegetation, erosion control, biodiversity improvement, riparian management, and effluent management.

‖Interviewees were asked to rate on a scale of 1 (low) to 5 (high) the costs or the benefits to them of fencing the waterway.

works scheduled by the WGCMA commenced in 2004. The fence was seen to improve herd management on that farm by facilitating herding of cows at each milking. Trialling such as this is seen as an evaluative part of the learning process of adoption, especially for technology that is easily divisible and observable (Pannell et al. 2006). Thus, farmers are willing to adopt environmental technology in spite of perceived financial loss when it is seen as being practical to their management (Vanclay 2004).

Farmer A itemised the financial costs of fencing, both materials and labor, while Farmer B listed the time spent, where time can be a surrogate for the cost of hiring labor. In contrast, Farmer C suggested that the establishment costs were low based on the type of fencing and their use of student labor.

Fencing cost was a consistently important factor for these farmers, and incentives are a means of minimising barriers (Wilson and Hart 2001; Pannell et al. 2006). Curtis and Robertson (2003) and Rhodes et al. (2002) describe cost as an important barrier and suggested that the availability of funding and information about these incentives would increase the participation rate and extent of participation of farmers who had intended to implement on-farm changes. Incentives generally can also indicate community commitment to riparian management through support for farmers (Vanclay 2004).

Included in the costs associated with fencing, on-going management (i.e., weed management) of fenced riparian areas was uniformly acknowledged—both the emotional ("scary (because of snakes) to spray in head height grass and long undergrowth") and physical costs. These raise issues of the changes to farm management required (i.e., weed control), the complexities of these changes and their ongoing nature, and impacts on lifestyle—important considerations in determining the relative advantage of fencing riparian areas (Pannell et al. 2006).

Table 3

Farmer motivations towards undertaking natural resource management activities on the three case study farms based on the interviewees' answers to questions in the questionnaire.

Query	Farm A	Farm B	Farm C
Primary goal for on-farm environmental changes*	For environmental benefit to farm and/or community	For environmental benefit to farm and/or community	To improve farm productivity/ profitability
Farmer reason for undertaking environmental changes	• Production is not the driving force • To keep water cleaner, to keep cows out, and to not lose cows • To make paddocks easier to strip graze	To leave the farm in a better shape than it was	To diminish stock loss and time
Describe the costs of fencing your riparian zone	• Loss of grazing area • Costs of fencing \$500 km^{-1} (labor and materials) • Ongoing management (blackberries and time to spray)	• Time to fence • Energy (depending on time of year) • Weed management—time and scary to spray in head-height grass and long undergrowth • Willow regrowth	• Physical—establish fence • Management/labor—weed control, but no difference to unfenced
Describe the benefits of fencing your riparian zone	• Aesthetic (looks terrific) • Environment (feels good having cleaned up water) • Keep cows out of creek • Makes putting up temporary fences easier	• Birds just singing because we have got the rain • Stock not getting in • Vegetation—flowers at this time of year and scented dogwoods	• Limit stock access to dangerous waterway • Mitigate soil and nutrient loss through buffer zone • Capacity to regenerate natural vegetation
Impact of fenced and replanted riparian zone on farm management.	• Adds workload (maintenance by spraying weeds). • Reduces workload (collecting cows and strip grazing cows)	• Stock always in paddock • Beauty • Lessens workload	Makes management easier because of greater stock control and completing fenced boundaries
Does a fenced and replanted riparian zone improve farm property value?	• Not sure, but think so • Depends on who wants to buy it, but some farmers might consider the loss of land an issue	Yes, absolutely—aesthetically. Fenced gullies and spring-fed dam increased value for him (a potential buyer for some of their farm that is currently for sale); although, he (the potential buyer) was still interested in boundary fences and wires.	• Improve, given potential buyers (into this area) are likely to like lifestyle rather than be commercial farmers. • Commercial farmers focussed on pasture and productive basis of farms

*Interviewees were asked to select from (a) To improve farm productivity/profitability or (b) For environmental benefit to farm and/or community

For all farmers, keeping stock out of the waterway was considered a benefit of fencing their riparian zone, and for two of the three farmers also a management reason for implementing environmental change on their properties. Farmers B and C indicated that fencing their riparian zone had a positive impact (i.e., reduced workload and facilitated herd management) on their farm enterprises. The "productivist" (Burton and Wilson 2006) or "productionist" (Parminter and Nelson 2003) orientation of farmers indicates that information targeted to these farming styles should incorporate the production benefits associated with changed natural resource management. The disadvantages associated with stock losses and lost time when herding cows is an example of information that could influence more production-oriented farmers to improve riparian management.

Farmer A, while acknowledging a decreased workload, again focused on the issue of weed management as a negative impact, which increased with fenced widths. Farmer A described weed management for an area that was fenced considerably wider than the rest of the riparian zone. "The bigger the area the bigger the weed problem. [We] left tracks that can be accessed with 4 wheel bikes to assist with weed management, but [it's] an occupational health and safety issue; steep banks and snakes." For this farmer, the relative advantage associated with fencing was reduced after trialling wider widths (>10 m [32.8 ft] from the riverbank), suggesting that considerable incentives or legislation would be required to convince Farmer A to implement this extent of fencing throughout the farm.

Environmental benefits of fencing, both personal (e.g., "aesthetic," "birds," "vegetation") and for the broader community ("cleaned up water," "soil and nutrient loss"), were also described by the case study farmers. Only Farmer B was conclusive in

the assessment of the impact of a fenced replanted riparian zone on farm property values, most likely due to the feedback the farmer received from a potential buyer of part of the farm which the farmer had revegetated extensively. The priorities of noncommercial/alternative farmers were acknowledged as being responsible for the increase in property values of rehabilitated zones. The proximity of these farms to a major urban centre has increased the number of landholders for whom conservation practices such as riparian revegetation would be a high priority (Pannell et al. 2006). All farmers agreed, however, that this aesthetic appeal was not a dominant driver for commercial farmers. In fact Burton and Wilson (2006) describe the perception by farmers internationally that conservation land management aesthetics is not good production practice and potentially part of the social barriers to adoption. However, as farmers move to a conservationist self-identity, possibly driven by their involvement in environmental cooperatives such as Landcare, their motivation and adoption of environmental best practice appeared to increase (Curtis and De Lacy 1996; Wilson and Hart 2001).

SEGMENTATION STRATEGIES

Farmer drivers and barriers to implementation of natural resource management changes are thought to be significant factors influencing practice change. Policy agencies seek to understand farmer behavior as part of their intervention programs. For example, the Victorian River Health Policy and Investment team in DSE are developing a Riparian Management Framework (DSE 2009) to identify barriers to management and policy implementation.

Approaches to understanding farmer behavior have included learning about farming styles and subcultures (Vanclay et al. 1998), market segmentation (Nelson et al. 2003), value orientations (Ridley 2004), self-identity theories (Burton and Wilson 2006) and personality traits (Pannell et al. 2006). Nelson et al. (2003) recommend that policy agencies use social marketing approaches to effect behavioral change. Within target design, the second of four stages in developing a social marketing plan, the target audience is identified, objectives and goals are established, and the target audience's motivators and barriers are identified. The social marketing approach was used to segment farmers in southwest Victoria based on their motivations to undertake biodiversity management. Subsequently, the authors recommended that communication and education programs be developed based on the four farmer segment or target audience groups (i.e., productionists, cosmopolitans, future builders, and conservationists) identified in their study. The productionists, the largest group, respond to information that has both production and environmental outcomes and include those that contribute to farm management generally and are a low cost.

Ridley (2004) reported that out of four value classes, approximately 40% of farmers in 1978 assessed their value orientations to be based on economic motivations (i.e., instrumental values—farm as a means of obtaining income and security). This percentage remained the same twenty years later, and, for these farmers, the importance of ensuring future income had increased in that time.

The responses given by the farmers in this study corroborate the importance of acknowledging the priority given by dairy farmers to production-related drivers, even where the farmers are also strongly motivated by environmental benefits. Improved stock handling, (equating to reduced stock losses and minimised herding time) as well as the financial and time/labor expense (of fencing and ongoing weed management) are production-related benefits and costs that need to be considered in policy strategies (Rhodes et al. 2002). For instance, the impact of fencing riparian zones on profitability will vary depending on whether the riparian zone is fenced solely to restrict stock access or for enhancing native biodiversity (Aarons and Melland forthcoming). The use of incentives to defray fencing expenses will depend on an accurate assessment of the costs and an understanding of the contribution of farmers to community good.

Alternative approaches to market segmentation of target groups are based on the understanding that behavior is a product of social interactions, beliefs, attitudes, and identities that involves many different stakeholders and that people's behavior is variable, unpredictable, and context specific (Vanclay 2004; Boxelaar and Paine 2005; Burton and Wilson 2006; Pannell et al. 2006). Productivist, postproductivist, and multifunctional farmer self-concepts as developed by Burton and Wilson (2006) acknowledge that farmers can have multiple identities (agricultural producer, agribusiness person, conservationist, and diversifier) which are expressed (i.e., salient) to varying degrees in different situations. Consequently, farmers can express attitudes that may seemingly be in conflict with their actions regarding natural resource management. The predominance of productivism worldwide indicates that, despite the increase in conservation policies and activities, there is little evidence of increased postproductivist farmer identities, that economic factors strongly influence the natural resource management behavior of farmers, and therefore that farmers in general do not appear to have internalized environmental policies (Burton and Wilson 2006; Stobbelaar et al. 2009). Consequently, the economic impacts of implementation are likely to continue to be important factors for farmers despite any conservationist identities (Curtis and Robertson 2003; Pannell et al. 2006).

Boxelaar and Paine (2005) identified five factors that influence farmers' management of their natural resource base. These include their frame of reference which determines their beliefs; their economic, social, and other aspirations; the farmers' identity, influenced by their aspirations; the farmers' capacities for change; and their access to social capital. Not only will behavior differ from farmer to farmer, the social dimensions that influence each farmer will change over time. Thus, when asked if and how they would change their farm management to compensate for giving up a fenced zone of 20 m (65.6 ft) in width, Farmer B said that it "depends on the journey of the farmer." If they were 10 years younger, they would change their management to grow more grass, i.e., use more fertiliser and resow their pastures. At

their current stage, they would destock, decreasing their herd size (table 1).

On a similar note, Farmer C indicated that conflicts with an older generation regarding the appropriate way to manage riparian zones and keep them neat and free of scrub (i.e., free of weeds) is another barrier to riparian rehabilitation. This barrier also agrees with anecdotal reports by other farmers of the importance (particularly placed by older farmers) of keeping riparian areas "tidy." Bearing in mind the average age of Victorian dairy farmers of 48 years (Axam, pers. comm.), the requirement for neat riparian areas may be a significant barrier that needs to be considered in intervention development. In agreement with the contention that human behavior is unpredictable, Farmer B was the oldest dairy farmer (early 60s) with extensive revegetation of the farm. Pannell et al. (2006) describe both positive and negative relationships between farmer age and adoption, while Burton and Wilson (2006) reported that older farmers were more conservation-minded in their study.

Farmers' aspirations are not exclusive and spillover effects can influence other farmers' intentions (Pannell et al. 2006). Farmer C indicated a desire to implement further riparian changes on his farms: "Would like to remove willows and replant but need neighbor agreement." He is not eligible for WGCMA assistance with willow removal until his neighbor agrees to the exclusion of stock from his side of the waterway and to the removal of willows.

The factors influencing farmers' behavior as described by Vanclay (2004) and Boxelaar and Paine (2005) challenge conventional approaches for intervention management by policy groups. These authors recommend that policy agencies need to invest in identifying the internal and external motivators and inhibitors that may shape farmers' response to improving riparian management as a first step to change management. An approach that identifies the scope of the motivators and inhibitors rather than associating these with adoption by particular target groups may better reflect the complexity of human behavior and societal influences. The drivers and barriers for on-farm change identified in this paper, many of which have been described elsewhere, are a selection of those that may influence farmers. However further research is recommended to more completely identify dairy farmer drivers and barriers across the state and within regions and sectors (i.e., dryland vs. irrigation) of the dairy industry. Effort needs to be placed in identifying whether a change in practice will ever be adoptable before developing intervention strategies (Pannell et al. 2006).

INTERVENTION APPROACHES

Intervention strategies are required to ensure internalization of environmental policies, thereby moving farmers towards postproductivist or conservation-oriented identities. Participatory strategies, such as those described by Ridley (2004) and Pannell et al. (2006), contribute to greater adoption, although these approaches can range from mere consultation to involvement and empowerment. These strategies can be developed using one or a combination of theories (rational choice, deterrent, reasoned action, or social learning), in conjunction with farmer sociological drivers. Parminter (2006) recommends reasoned action theory informed by social learning theory if human behavior change is the goal rather than environmental change per se. This approach recognises that change management is complex, involves a number of stakeholders, and requires interactive communication rather than a linear process of information/knowledge dissemination (Boxelaar and Paine 2005). Discussion and negotiation between stakeholders is not recommended for change management (i.e., knowledge preceding action), but rather action and practice iteratively as the mechanism of change. Stakeholders work together in this process with new knowledge generated and change management goals developed collaboratively.

Within the collaborative approach to achieving improved riparian management, provided information needs to be considered in the context of the drivers (and barriers) for change. Information about riparian best management practices was related to implementation of change management of these zones (Rhodes et al. 2002; Curtis and Robertson 2003). However, the information needs to be relevant and responsive to farmers' sociological influences, suggesting that providing the required information in one format will not be adequate. For example, group extension activities are not always the most appropriate (Vanclay 2004; Pannell et al. 2006). Further, by using a collaborative approach when discussing practice change, consensus can be reached that may lead to greater involvement of farmers in developing and implementing on-farm riparian change (Ridley 2004). Groups that can form the platforms for generating riparian management goals and on-farm actions can include natural resource agencies such as Landcare. However, bearing in mind the importance of managing the farm business to many farmers' identity, policy agencies should develop strategies to engage production-focussed groups such as the milk factories and dairy agronomists and provide their service providers with the skills to engage with farmers in discussions about improving riparian management. The use of environmental management systems tools with dairy (DairySAT) and New South Wales (Ridley 2004) farmers encouraged adoption of improved environmental management through interactions with milk factory field officers and scientists, respectively. Policy agencies need to be aware that the practice and action intervention approach, while likely to encourage greater change management, is expected to be more costly, especially when compounded with the need to provide resources according both to the size of the environmental problem and to the lag phase before improvements will be evident (Parminter 2006).

ACKNOWLEDGEMENTS

The author would like to thank the farmers who kindly assisted with this research study by agreeing to participate in the survey and providing farm data when requested. Lianne Dorling prepared the surveys with the assistance of Ivor Awty, attended the interviews, and collated the data. This project (MIS 06829) was supported by the Victorian Department of Primary Industries.

REFERENCES

Aarons, S.R., and A.R. Melland. Forthcoming. Pasture production and dairy farm productivity

impacts of fencing riparian land. Journal of Soil and Water Conservation

Agouridis, C.T., S.R. Workman, R.C. Warner, and G.D. Jenning. 2005. Livestock grazing management impacts on stream water quality: A review. Journal of the American Water Resources Association 41:591-606.

Boxelaar, L., and M. Paine. 2005. The Social Dimensions of On-farm Change to Improve Water Quality and Biodiversity. Victoria, Australia: The University of Melbourne.

Burton, R.J.F., and G.A. Wilson. 2006. Injecting social psychology theory into conceptualisations of agricultural agency: Towards a post-productivist farmer self-identity? Journal of Rural Studies 22(1):95-115.

Curtis, A., and T. De Lacy. 1996. Landcare in Australia: Does it make a difference? Journal of Environmental Management 46(2):119-137.

Curtis, A., and A. Robertson. 2003. Understanding landholder management of river frontages: The goulburn broken. Ecological Management & Restoration 4(1):45-54.

DA (Dairy Australia). 2009. DairySAT - new online tool for dairy farmers. Dairy Australia. http://www.dairyaustralia.com.au/Standard-Items/News/Dairy-News/DairySAT---new-online-tool-for-dairy-farmers.aspx.

DA. 2011. Latest statistics: Milk production -Victorian regional. *In* VicMilkProduction_Apr11.xls, Dairy Australia. http://www.dairyaustralia.com.au/Statistics-and-markets/Production-and-sales/Latest-Statistics.aspx.

Dabney, S.M., M.T. Moore, and M.A. Locke. 2006. Integrated management of in-field, edge-of-field, and after-field buffers. Journal of the American Water Resources Association 42(1):15-24.

DSE (Department of Sustainability and Environment). 2009. Victorian River Health Program. http://www.water.vic.gov.au/environment/rivers/river-health-program.

Eigenraam, M., L. Strappazzon, N. Lansdell, C. Beverly, and G. Stoneham. 2007. Designing frameworks to deliver unknown information to support market-based instruments. Agricultural Economics 37:261-269.

GippsDairy. 2006. GippsDairy Natural Resource Action Plan. Warragul, Australia: GippsDairy.

Gunningham, N., and M.D. Young. 1997. Toward optimal environmental policy: The case of biodiversity conservation. Ecology Law Quarterly 24:243.

Hooda, P.S., A.C. Edwards, H.A. Anderson, and A. Miller. 2000. A review of water quality concerns in livestock farming areas. The Science of The Total Environment 250(1-3):143-167.

Line, D.E., W.A. Harman, G.D. Jennings, E.J. Thompson, and D.L. Osmond. 2000. Nonpoint-source pollutant load reductions associated with livestock exclusion. Journal of Environmental Quality 29(6):1882-1890.

Lowe, K.W., K. Preece, N. Amos, and D. Parkes. 2000. Victoria's biodiversity reporting system: A bioregional approach to refining priorities and partnerships for biodiversity conservation. *In* Proceedings of the The Second Southern Hemisphere Ornithological Conference, Griffith University, Brisbane.

Nelson, T., T. Parminter, T. Makin, H. Poussard, K. Atkins, J. Wilson, and L. Hanes. 2003. Investigations into the Role of Trees in Protecting Water Quality and Biodiversity on Dairy Farms in South West Victoria. New Zealand: AgResearch.

NRE (Department of Natural Resources and Environment). 1997. Victoria's biodiversity: Directions in management. Department of Natural Resources and Environment. http://www.dse.vic.gov.au/conservation-and-environment/biodiversity/victorias-biodiversity-strategy/victorias-biodiversity-strategy-1997.

Pannell, D.J., G.R. Marshall, N. Barr, A. Curtis, F. Vanclay, and R. Wilkinson. 2006. Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture 46(11):1407-1424.

Parminter, T. 2006. Developing policy strategies for natural resource management using human behavior theories. *In* Proceedings of the Practice Change for Sustainable Communities: Exploring Footprints, Pathways and Possibilities. Australasian pacific extension network. 2006 International Conference, La Trobe University, Beechworth, Victoria, Australia, The Regional Institute Ltd.

Parminter, T., and T. Nelson. 2003. Dairy farmers' evaluation of biodiversity practices in south west victoria. *In* Proceedings of the Extending Extension: Beyond Traditional Boundaries, Methods and Ways of Thinking. APEN National Forum, 2003, Hobart, Tasmania,

Pretty, J. 2003. Social capital and the collective management of resources. Science 302(5652):1912.

Rhodes, H.M., L.S. Leland, Jr., and B.E. Niven. 2002. Farmers, streams, information, and money: Does informing farmers about riparian management have any effect? Environmental Management 30(5):665-677.

Ridley, A.M. 2004. The role of applied science in helping farmers to make decisions about environmental sustainability. Australian Journal of Experimental Agriculture 44(10):959-968.

RMS (Riparian Management Systems). 2009. Riparian management system model. http://www.buffer.forestry.iastate.edu/HTML/buffer.html.

Rutherfurd, I.D., K. Jerie, and N. Marsh. 2000. A Rehabilitation Manual for Australian Streams: Volume 1. Canberra, Australia: Land and Water Resources Research and Development Corporation and the Cooperative Research Centre for Catchment Hydrology.

Stobbelaar, D.J., J.C.J. Groot, C. Bishop, J. Hall, and J. Pretty. 2009. Internalization of agri-environmental policies and the role of institutions. Journal of Environmental Management 90(Supplement 2):S175-S184.

Straker, A., and K. Lowe. 2004. Native Biodiversity Resource Kit - Environmental Management in Agriculture. Melbourne, Australia: Department of Sustainability and Environment.

Trimble, S.W., and A.C. Mendel. 1995. The cow as a geomorphic agent - a critical review. Geomorphology 13:233-253.

Vanclay, F. 2004. Social principles for agricultural extension to assist in the promotion of natural resource management. Australian Journal of Experimental Agriculture 44(3):213-222.

Vanclay, F., L. Mesiti, and P. Howden. 1998. Styles of farming and farming subcultures: Appropriate concepts for australian rural sociology? Rural Society 8(2):85-107.

WGCMA (West Gippsland Catchment Management Authority). 2004. West Gippsland Regional Catchment Strategy: 2004 – 2009. http://www.wgcma.vic.gov.au/images/stories/PDF/Programs/REGIONAL_PROGRAMS/rcstrategy.pdf.

Wilson, G.A., and K. Hart. 2001. Farmer participation in agri-environmental schemes: Towards conservation-oriented thinking? Sociologia Ruralis 41(2):254-274.