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Adoption of Environmental Best Practice Amongst Dairy Farmers

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Summary

The adoption of environmental management practices is addressed in this paper. The use of consumer behaviour theory and a market research approach is discussed by describing how it was used in the study. Qualitative methods were used to gather data from dairy farmers in four New Zealand catchments. The environmental practices explored were; excluding stock from waterways, reducing phosphorus use, improving soil macroporosity, managing effluent and improving the efficiency of border-dyke irrigation. The findings are discussed, highlighting that farm contextual factors influenced farmers' decision making in terms of adopting environmental management practices. The results suggest that environmental practices need to be linked to farm context. This should provide practical solutions that farmers' will be more likely to adopt.

Key Words

Environment, adoption, dairy farms, context

Introduction

Our aim in this project was to identify the factors that influence dairy farmers' propensity to adopt sustainable management practices, in particular, fencing off streams. We were also interested in best practices associated with reducing phosphorus use, improving soil macroporosity, managing border-dyke irrigation systems and effluent management. The work in this project was carried out in four catchments where best practices to address environmental issues in dairying are being evaluated. These catchments were Toenepi, Waiokura, Waikakahi and Bog Burn.

The approach we took to understanding the adoption of new agricultural technologies and practices draws on consumer behaviour theory and, in particular, complex decision making. In the next section each best practice is described. The theoretical framework used for this study is then outlined. After outlining the methodology, the results are presented and finally conclusions are drawn.

Specific sustainable practices

Excluding stock from streams

Researchers suggest that minimising the access of stock to waterways should help improve water quality (Quinn and Wilcock 2002). Fencing is the simplest and, in

principal, the easiest means of excluding stock from streams. There are comprehensive guidelines available to farmers such as Environment Waikato's "A Guide to Managing Waterways on Waikato Farms" (Legg 2002). Unfortunately there is some disagreement in the literature regarding the impact of fencing off streams on water quality. Line, Harman et al. (2000) found that water quality improved after fencing, with the exception of nitrogen levels. However, others have not found a significant difference in water quality after stream fencing for between two and four years (Homyack and Giuliano 2002).

Reducing phosphorus use

Reducing use of phosphorus fertiliser on-farm is regarded as a high priority in all four catchments as Olsen P levels are generally very high. Researchers have estimated that half the current maintenance rates of phosphorus could be applied without harming soil fertility (M O'Conner, *pers comm.*, quoted in Monaghan, Drewry et al. 2003). The recommended best farm practice is to undertake a nutrient budget to assess what nutrients are needed and then design a fertiliser program based on this information.

Improving macroporosity

Improving soil macroporosity was also identified as a priority management objective in all four catchments. This involves minimising wet soil damage through pugging. Current best practice is to ensure that cows are moved to feedpads when soils are waterlogged (Monaghan et al. 2003).

Managing effluent

Current best practices for managing effluent are applying effluent at low rates, and storing effluent when the soil is too wet in order to reduce nutrient leaching (Monaghan et al. 2003). This may involve reducing the speed of a travelling irrigator applying effluent, or converting to K-line irrigation. K-line irrigation has a low water application rate and initial research indicates that nutrient losses are reduced under this system (R Monaghan *pers. comm.*, 2005).

Improving the efficiency of border-dyke irrigation systems

Improving the efficiency of the border-dyke irrigation systems involves reducing runoff to below 10% of inflow, using soil mounds at the end of the border (bunding) to prevent runoff, and making sure that the time between irrigating and fertilising or grazing is as long as possible (Monaghan et al. 2003). Note that water in the Waikakahi catchment is quite cheap and this suite of best practices can be very expensive if re-engineering of the irrigation system is required. This means there is little financial incentive to change the system (Monaghan et al. 2003).

Consumer behaviour as a model of adoption behaviour

The approach we have taken to understanding the adoption of new agricultural technologies and practices draws on the conceptual foundations of consumer behaviour theory (Assael 1998). This theory proposes that consumers use a variety of decision processes when purchasing products. The type of decision process they actually follow depends partly on the importance of the purchase to the consumer, and partly on how much time and effort consumers can devote to the decision. In this section we describe the different types of decision processes used by consumers, the circumstances in which they are used, and the implications of these for understanding adoption decisions.

Involvement and purchase decisions

Consumers make purchase decisions in a variety of ways depending on circumstances. One of the key factors which influences the way in which a purchase decision is made is the level of consumer involvement in the product. When involvement is high consumers tend to engage in complex decision making or brand loyalty depending on the degree of effort they invest in the purchase decision. When involvement is low consumers tend to engage in variety seeking behaviour or habit depending on the degree of effort they invest in the purchase decision.

Consumer involvement depends on how important the purchase is to the consumer. High involvement purchases are purchases that are important to the consumer (Assael 1998). High involvement products are generally expensive, rarely or infrequently purchased and closely tied to self-image and ego. High involvement purchases usually involve some form of risk, such as financial, social or psychological risk. Where the risks are high the consumer is more likely to devote time and effort to careful consideration of alternatives before making a purchase. Typical high involvement purchases are homes, motor vehicles, white goods, clothing and perfumes.

Low involvement purchases are purchases that are relatively unimportant to the consumer (Assael 1998). These purchases are commonly inexpensive products that are routinely purchased and involve little risk. The consumer is unlikely to devote much, if any, time and effort to consideration of alternatives for low involvement purchases before making a decision. Typical low involvement purchases are groceries, toiletries, and laundry products.

We believe that the adoption of most agricultural innovations represent a form of high involvement purchase for primary producers. Usually the adoption of a new agricultural practice or technique is high risk. The new technology or practice must be integrated into the existing mix of technologies, practices and resources that exist on the farm (Crouch 1981; Kaine and Lees 1994). This means, generally speaking, the likely outcomes of adopting a particular technology or practice are difficult to predict. The compatibility of the technology or practice with the existing farm system, and the resulting benefits, depends on a range of contextual factors that are specific to the circumstances of each farm enterprise. Consequently, the decision to adopt an agricultural innovation is often financially risky. As such they entail social risks and psychological risks in that the outcomes affect the wellbeing of family members and can influence producers' feelings of achievement and self-fulfilment.

Complex decision making

The second key factor which influences the way in which a purchase decision is made is the degree of effort the consumer is willing to invest in making a purchase decision. Consumer behaviour theory suggests that consumers can invest either a high or low effort in making high involvement purchases (Assael 1998). Complex decision-making is associated with investing a high level of effort. It is a systematic, often iterative process in which the consumer learns about the attributes of products and develops a set of purchase criteria for choosing the most suitable product. Complex decision making is a decision making process consistent with explanation based decision theory (Cooksey 1996). Complex decision making is facilitated when there is adequate time for extensive information search and processing (Beatty and

Smith 1987), adequate information is available on product characteristics and the consumer has the ability to process the available information (Greenleaf and Lehmann 1995).

Purchase (or benefit) criteria

Purchase (or benefit) criteria represent the key benefits sought by the consumer and generally reflect their product usage situation. In the case of consumer goods the usage situation is often a function of the consumer's past experiences, their lifestyle and their personality (Assael 1998). For example, economy, dependability and safety are key purchase criteria for many consumers with families that are buying motor vehicles that will be used daily to transport family members, especially children. Having settled on a set of purchase criteria for deciding between products, the consumer then evaluates the products against the criteria and makes a choice.

Consumers from different usage situations will seek different benefits from products and therefore will employ different purchase criteria to evaluate products. Conversely, consumers from similar situations will seek similar benefits and so will employ similar purchase criteria. Information on the similarities and differences in the key purchase criteria used by consumers can be used to classify consumers into market segments (Assael 1998). This information can also be used to develop and promote a suite of products with characteristics that are tailored to provide the benefits sought by consumers in each particular segment.

In the case of agriculture the purchase criteria that producers use to evaluate new technologies should reflect the key benefits the technology offers given the producers' usage situations. In this instance the usage situation is likely to be a function of the farm context into which a new technology must be integrated. Broadly speaking, the farm context is the mix of practices and techniques used on the farm, and the biophysical and financial resources available to the farm business that influence the benefits and costs of adopting an innovation (Crouch 1981; Kaine and Lees 1994). Similarities and differences among farm contexts for an agricultural innovation will translate into similarities and differences in the key purchase criteria that producers will use to evaluate that innovation.

Given that the usage situation for agricultural innovations is defined by farm contexts, differences in farm contexts will result in different market segments for an innovation. Logically, the market for an innovation will be defined by the set of farm contexts for which the innovation generates a net benefit (see Kaine, Bewsell et al. (2005) for examples).

As is the case with consumer products, knowledge of similarities and differences in the key purchase criteria that will be used by producers to evaluate an innovation can be employed to tailor the innovation to meet the specific needs of producers in a segment and promote the innovation accordingly.

To the degree that the mix of farm practices, technologies and resources that influence the benefits and costs of adopting an innovation are different for different innovations, the purchase criteria used to evaluate innovations will change accordingly. This means purchase criteria are frequently innovation-specific and often cannot be generalised across innovations.

Complex decision making can be influenced in two ways (Assael 1998). One is to persuade consumers to change the purchase criteria they use to evaluate products. The other is to change their beliefs about the extent to which products meet their criteria. Both of these changes lead to changes in consumers' evaluations of products which may subsequently cause changes in product choices.

Research into adoption of environmentally sustainable practices

The adoption of sustainable practices has been the subject of many studies. Curry's (1997) research involved British farmers and he believed that new skills were needed in order for farmers to successfully operate in an environment that promotes "green" values and practices. However, he also notes that this could be difficult given that farmers have been given economic signals to maximise food production for many years (Curry 1997). Fullen (2003) argues that different approaches to promoting adoption of conservation practices, particularly soil conservation, are essential to ensure change. Other studies have found that "environmentally aware" farmers are more likely to be influenced by conservation considerations, than by farm management concerns (Beedell and Rehman 2000).

Studies focussing on adoption of stream fencing found that costs dominated reasons why farmers were not prepared to fence off streams (Rhodes et al. 2002; Curtis and Robertson 2003). Other studies have found farm management factors such as stock management affect farmers decisions with regard to riparian management (Parminter et al. 1998; Habron 2004). However Robinson and Napier (2002) did not find any predictive factors, such as farm size or farm income, that determined whether a farmer would adopt a conservation practice. Their conclusion was that more resources should be allocated to reducing the risk and cost of adoption of conservation practices by farmers (Robinson and Napier 2002). Interestingly, concern about the environment or sustainability was not identified as a factor influencing the adoption of sustainable practices in any of these studies.

We believe our approach based on consumer behaviour theory may explain the variable and contradictory nature of these findings. We expect that focusing on understanding the role of the farm context may help explain why predictive factors such as farm size may not always work. Our approach is based on the idea that adoption of a practice only occurs in circumstances where adoption provides some benefit to a dairy farm. Hence, there is no reason to expect a consistent relationship between adoption of a practice and factors such as farm size, farm income, farmer education and experience unless, of course, a particular practice exhibits scale economies or requires a formal education qualification to implement.

Research methods

The use of complex decision making in high involvement purchasing implies that the purchaser develops explicit chains of reasoning to guide their decision making. This is consistent with explanation-based decision theory, where the focus is on "reasoning about the evidence and how it links together" (Cooksey 1996). This suggests that there should be shared and complementary patterns of reasoning among dairy farmers and consistency in the decisions they reach. To identify the factors influencing dairy farmers' decisions we followed a convergent interview process

(Dick 1998).

Convergent interviewing is unstructured in terms of the content of the interview. The interviewer employs laddering techniques to systematically explore the reasoning underlying the decisions and actions of the interviewee (Grunert and Grunert 1995).

We interviewed dairy farmers from each of the four best practice dairy catchments selected. AgResearch researchers provided an initial list of dairy farmers to interview in each catchment. Care was taken to interview farmers operating large and small scale enterprises, and from a range of educational and occupational backgrounds. A total of 30 interviews were carried out (see Table 1).

Table 1: Number of Interviews in Each Catchment

Catchment	No. of farmers
Toenepi	12
Waiokura	5
Waikakahi	5
Bog Burn	8
Total	30

Results

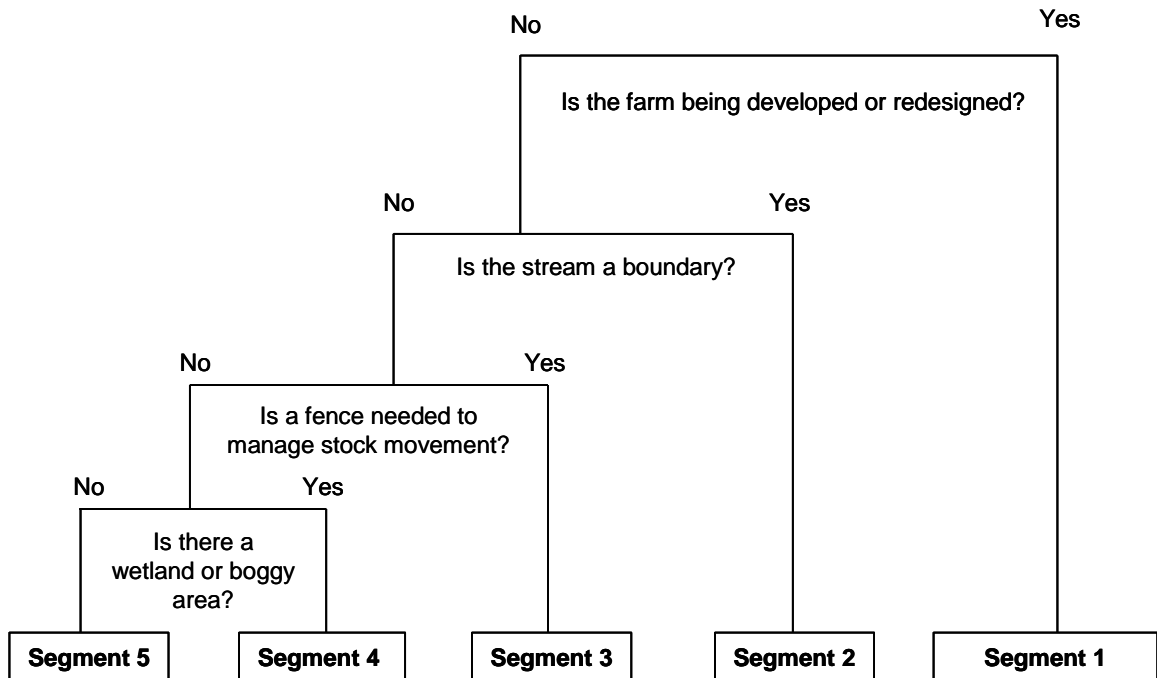
Excluding stock from streams – fencing streams

Interviews with farmers revealed that for most, deciding to fence a stream is based on whether there are issues with controlling stock, as the literature suggests. Based on the information gathered in interviews we classified farmers into segments based on why they had fenced part or all of the streams on their property (see Table 2 and Figure 1).

Table 2: Segments for Fencing Streams, Rivers, Lakes and Their Banks to Exclude Stock.

	<i>Segment one</i>	<i>Segment two</i>	<i>Segment three</i>	<i>Segment four</i>	<i>Segment five</i>
Farm is/has been redeveloped or redesigned	Yes	No	No	No	No
Stream is a boundary	No	Yes	No	No	No
Stock could get stuck in stream	No	No	Yes	No	No
Wet or boggy area	No	No	No	Yes	No
Animal health issues	No	No	No	No	Yes

Figure 1: Typology of Segments for Fencing Streams, Rivers, Lakes and Their Banks to Exclude Stock



Segment 1

The first segment consisted of farmers who have or are in the process of redeveloping or redesigning their farms. These farmers have taken the opportunity to shift paddock boundaries and as part of that process, have fenced off streams. For some farmers this process has led them to develop a plan for managing stream fencing. For other farmers it has simply been the best way of managing the redevelopment process. This has helped them improve the management of their farm through improving livestock handling.

“Shawn is a dairy farmer in the Waikoura catchment. Recently he bought some land next door which prompted him to undertake some redevelopment. He did a riparian plan with the Regional Council. Although he had done a fair bit of fencing, he found the process quite helpful, particularly to help choose appropriate plants. Most of the waterways on his farm are wide and deep gullies. Some have been planted in pines. During the redevelopment process he was able to realign paddocks and fence streams off. The streams run the right way with the paddocks which made it easier!”

Segment 2

The second segment consisted of farmers who have streams or water bodies on property boundaries. These streams are routinely fenced simply because farmers do not want stock getting into their neighbour’s property. For example:

“Terry runs a 115 ha dairy farm milking 360 cows in the Toenepi catchment. Most of the drains and wetlands on his property are on boundaries and are fenced on his side of the boundary.”

Segment 3

In contrast, farmers in segment three have had problems with stock getting into streams and getting stuck. This also seems to apply to managing drains. These farmers fence off those streams that cause problems for stock. For example, Gavin, Jeff and Mick:

“Gavin share-farms a 55 ha dairy farm milking 187 cows in the Toenepi catchment. Gavin is planning to fence off the stream because he is sick of the cows getting in. The Toenepi stream is a problem because if cows get in you can't get them out. The banks are steep and muddy. However Gavin also believes he will have problems with weeds and maintenance if he fences out the stream – the blackberries, gorse or ragwort will take over.”

Segment 4

Farmers in the fourth segment have fenced off areas of their farm because they are wetter patches that pug easily.

“Dale runs a dairy farm in the Toenepi catchment. He has fenced off most of the drains and waterways on his place to stop the stock getting into them. He started with areas on the farm that got boggy in winter. He would clean them out, get the drains working and fence them out.”

Segment 5

Farmers in the fifth segment have fenced off streams on their properties because of concerns such as animal health.

“Martin share-farms a 42 ha dairy farm milking 140 cows in the Toenepi catchment. All the streams and drains on the farm have been fenced. Martin says that it's important to keep the cows out of drains in particular as they can catch liver fluke. They have also put in crossings so that cows wouldn't have to even walk through a drain. Martin also sprays out the drains which decrease the stock's interest and there is no reason for them to go there.”

We also interviewed farmers who had decided not to fence off streams on their property. These farmers did not believe that fencing would have any significant benefit to either their stock or water management. Others did not have any problems with stock getting into streams and saw no reason to fence. For example:

“Aaron and Sherry manage a 118 ha dairy farm milking 386 cows in the Toenepi catchment. The Toenepi stream flows through one part of their property but Aaron and Sherry have no plans to fence it off. They don't have a problem with cows getting into the stream so they see no reason to fence it off. They only time they see animals in waterways is in winter when they are break feeding.”

We found that farmers were fencing off waterways in order to manage stock. Interviews with farmers did not reveal that farmers were fencing streams to improve water quality or for any other environmental reasons. This suggests that understanding animal management in each catchment is important, in terms of type of stream bed, amount of sediment and other location specific factors, in order to promote adoption of waterway fencing.

Managing effluent

With the exception of the Toenepi catchment, most of the dairy farmers we spoke to were irrigating effluent onto land. Many had converted from a pond system, usually when they started to increase cow numbers and, as a consequence, had to either increase the capacity of their ponds, or install a different effluent treatment system.

We found there were several systems for dealing with effluent. The first was a pond system. Most of the farmers with this system were located in the Toenepi catchment. For some farmers, ponds were the only system that would work on their property because of the proximity of buildings or the presence of drainage.

The second system for managing effluent was irrigating effluent onto land. Farmers we interviewed had previously managed with a two pond system, but had found that, due to increasing herd size, or more stringent requirements from their Regional Council, a two-pond system was no longer effective. These farmers had switched to irrigating effluent on land. Most were happy with the change. For other farmers a pond system did not suit the environment.

Farmers in the Waikakahi catchment were often using their existing irrigation system to irrigate effluent. It was evident from interviews with farmers that their context influenced the type of system they used for managing effluent. The topography of the land, the climate, soil types and farm development issues were key factors influencing decisions made on effluent systems.

Reducing phosphorus use

Most of the dairy farmers we interviewed used soil tests to determine the mix and amount of fertiliser required. They also sought advice from their fertiliser rep or farm consultant and used their own experience to evaluate any recommendations. Some farmers had been advised that their phosphorus levels were high and they could gradually cut back on the amount applied. Generally, farmers were inclined to take this advice when it was given. For example:

Duncan is a sharemilker in the Waikakahi catchment. A rep from Ballance comes in once a year and does a soil test and a fertiliser recommendation. After this the farm owner is consulted to see whether or not there can be cut-backs.

Fertiliser management

Although reducing fertiliser use does save money, there can be complicating factors. Some farmers commented on some of the difficulties involved in trying to fertilise parts of the property differently to others, for example when some of the property was high in potassium. Farmers talked about the dangers of cutting back on fertiliser such as losing pasture growth. Other farmers commented that due to a need to build up their pastures their fertiliser use was high at present, but would be cut down over time.

From our interviews it seems that opportunities to reduce fertiliser use will be considered by farmers. However the advice given needs to be trusted. In addition whole farm recommendations will be considered favourably rather than complicated fertiliser recommendations.

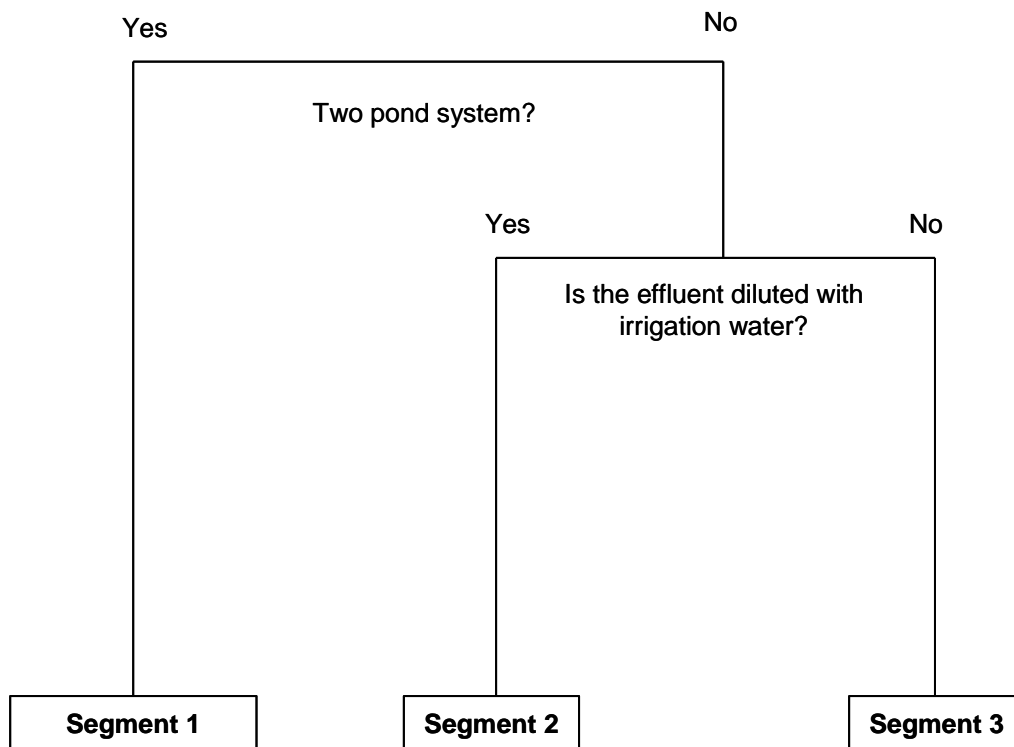
Management of the effluent disposal area

One major part of managing nutrients is managing the effluent disposal area. Interviews with farmers revealed that most were irrigating effluent onto land. Based on this information we classified farmers into three segments describing farmers' perceptions of the influence of effluent on these areas (see Table 3 and Figure 2).

Table 3: Segments for Managing the Effluent Disposal Area

	<i>Segment one</i>	<i>Segment two</i>	<i>Segment three</i>
Farmer sees difference in pasture growth in effluent paddock	No	Yes	Yes
Difference is significant	No	No	Yes
Two pond system	Yes	No	No
Irrigating effluent	No	Yes	Yes
Effluent diluted	No	Yes	No

Figure 2: Typology of Segments for Managing the Effluent Disposal Area



Segment 1

Farmers in the first segment were more likely to have two pond treatment systems. They had the ponds cleaned out once every year or two. The liquid effluent was pumped onto a paddock, and sludge spread out as well. These farmers indicated that they did not see any significant difference in grass growth on the paddocks where the effluent was spread. This belief influenced their decisions when planning fertiliser application. They did not believe it was worthwhile making changes to fertiliser application on that area. For example:

Mick has a two pond effluent system, which then goes into a drain. The ponds are emptied every year by spraying it on the paddocks. He usually has it spread on three paddocks one time and a different three the next. He uses the same fertiliser on the effluent paddocks as for the rest of the farm. This is because he hasn't noticed a difference in the paddocks that have effluent sprayed on them. Mick thinks he would notice some difference if he was pumping effluent directly from the shed onto the

paddock as the water would have an effect on the pasture.

Segment 2

Farmers in segment 2 were diluting the effluent before application. These farmers did not have a two pond system but were diluting the effluent with fresh irrigation water coming onto the farm and then irrigating it as normal through the border-dyke system. We found these farmers did not believe that the effluent made a difference to grass growth. For example:

Ken and Barb are dairy farmers in the Waikakahi catchment. On their farm, effluent is collected in a pond. Effluent is pumped from the pond into the head-race while irrigating and so it is diluted by the fresh water coming onto the farm. Ken does not believe there is any difference in grass growth because the effluent has been diluted considerably.

Segment 3

In contrast many of the farmers in the third segment believed there was a considerable difference in grass growth in the area where effluent was spread. These farmers were irrigating undiluted effluent directly onto pastures. Some talked about the difference in grass growth because of the water, rather than the nutrients, especially when it was a dry summer. For example:

Mario and Susie are dairy farmers in the Toenepi catchment. Mario and Susie converted from a two pond effluent system to an effluent irrigation system four years ago. They are really pleased with how this has gone. They have a large holding pond so they don't have to irrigate every day. Mario is able to irrigate pasture when it is dry, and promote growth. He sees lots of benefits to the effluent irrigation system.

Differences in perceptions

Other farmers believed that there were significant amounts of nutrient being applied in the form of effluent and so took care to change their management of that area. For example:

Jed is a dairy farmer in the Waiokura catchment. He irrigates effluent onto pasture. He is able to store a great deal of effluent as he has ponds with large carrying capacity. This means he doesn't have to pump out everyday. Jed pumps effluent over 26ha, rotating the paddocks. He notices the difference in paddocks with effluent and doesn't use any fertiliser on paddocks that have effluent sprayed on them. He is planning to increase the area he irrigates effluent onto as the nutrients are getting too powerful.

However although several of the farmers we interviewed believed they could see some difference in grass growth on the effluent paddocks, some did not believe it was significant enough to change their fertiliser application. For example:

Lex and Kristy are sharemilkers on a dairy farm in the Waikakahi catchment. They don't see much of a difference in the grass where the effluent is applied, so they don't change the fertiliser application on those areas.

Some of these farmers may have had soil tests to confirm this. For example:

Rowan is a dairy farmer in the Bog Burn catchment. He has had soil tests done on the effluent blocks and they do not really indicate there is much of a difference. Rowan doesn't think it is worth changing the fertiliser program for those paddocks. He thinks that there is a dilution effect as the effluent is being spread widely.

Managing effluent application over tile drainage

Managing effluent over tile drainage was an issue particular to the Bog Burn catchment. This catchment, like most of Southland, has been extensively drained. Generally, there were no plans available showing the location of tile drains. Some of the farmers we interviewed indicated they were not exactly sure where the drains were. Others were confident they were able to spot them. Generally, share-milkers were less confident of their ability to spot tile drains, due to the length of time spent on the property, whereas owners were more likely to have spent some time working out where drains were.

Interestingly none of the farmers we interviewed were using K-line irrigation to apply effluent to land. This is one of the best practices being investigated by researchers. However, the results suggest that the type of system a farmer has for disposing of effluent affects their perception of the impact of that effluent. The type of system chosen depends on farm context, such as soil and climate.

Improving macroporosity – management of wet soils

Previous work on wet soils management

Kaine and Niall (1999) investigated the adoption of options for managing waterlogged soils by dairy farmers in Victoria and Tasmania, Australia. Options for dairy farmers included installing sub-surface drainage or using on-off grazing in conjunction with feedpads or stand off areas. Kaine and Niall (1999) conducted interviews with a range of dairy farmers, and followed this with a mail survey. They found that a third of farmers in the study area did not have a problem with waterlogging on their farm. The remaining two thirds of farmers were classified into six segments based on how severe the waterlogging was on their farm, and when the waterlogging occurred (Kaine and Niall 1999). There was a strong relationship between the severity and timing of waterlogging and investment in subsurface drainage or feedpads. The segments are illustrated in Figure 3 and Table 4.

Figure 3: Market Segments for the Management of Waterlogged Soils, from Kaine and Niall (1999).

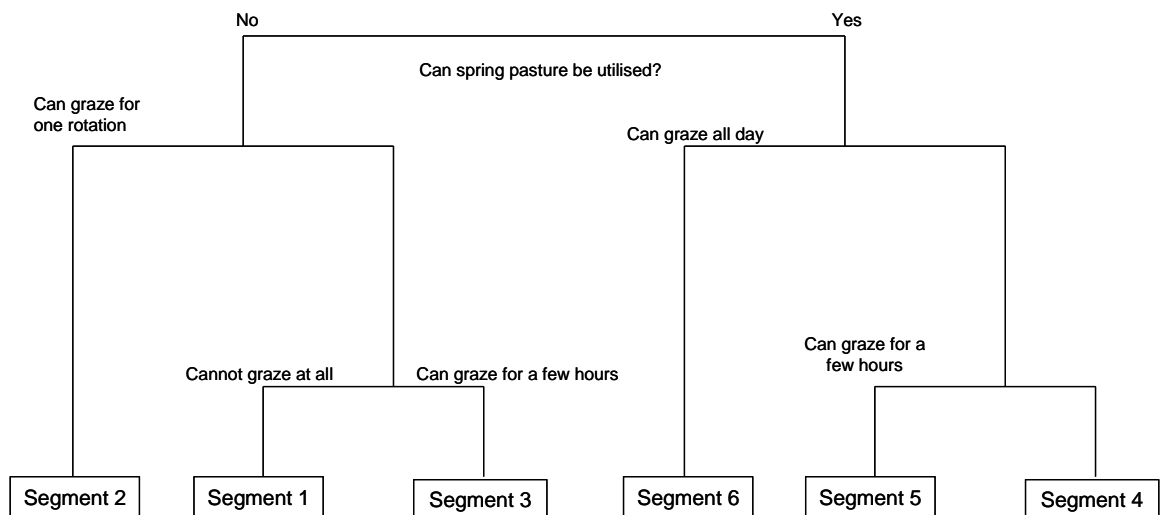


Table 4: Market Segments for the Management of Waterlogged Soils, after Kaine and Niall (1999).

Characteristics	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
Can utilise spring pasture	No	No	No	Yes	Yes	Yes
Can graze all day	No	No	No	No	No	Yes
Can graze for a few hours each day	No	No	Yes	No	Yes	No
Can graze for a few hours for one rotation only	No	Yes	No	Yes	No	No

Farmers in the first three segments had problems with waterlogging in winter and in spring. Often a large proportion of their farms were affected. Farmers in segment one could not graze their pasture in spring for very long without causing damage from pugging. Farmers in segment two could graze their cows for a few hours but only for one rotation, while farmers in segment three could graze their cows for a few hours each day.

In contrast Kaine and Niall (1999) found that farmers in segments four, five and six experience waterlogging in winter, but not in spring. Usually less of the farm was affected. Farmers in segment four could not graze their pastures very long in winter and only for one rotation. Farmers in segment five can graze pastures in winter for a few hours each day, while farmers in segment six could graze all day unless it was very wet.

Kaine and Niall (1999) found that farmers in segments one and two experience considerable economic and lifestyle losses from waterlogging and as such they could justify the installation of sub-surface drainage. Some farmers in segment three could also justify sub-surface drainage, but it would depend on the soils and topography of

the farm as well as the farm infrastructure, and the availability of labour and capital. Farmers in segments four, five and six, could not justify installing sub-surface drainage and instead other options such as a stand off area, feedpads and on-off grazing were of more use.

Management of wet soils

We used this work by Kaine and Niall (1999) as a starting point for classifying farmers into segments based on information gathered from interviews in the best practice dairy catchments.

The Toenepi catchment

The information we gathered during interviews with farmers in each catchment offered an insight into how much of a problem wet soils were. In the Toenepi catchment most of the wet soil problems occurred in winter and farmers were used to dealing with this. Most had well established strategies to ensure that there was minimal damage to the pasture. Feed pads were used by a few farmers. Most of the Toenepi farmers were considered to be similar to the descriptions for either segment four or five (see Table 1 and Figure 1, depending on the severity of the waterlogging in winter.

Most farmers in the Toenepi catchment had tile drains on part of their properties, put in as the land had been developed. Some had increased the amount of drainage on the property as an attempt to manage pugging with mixed results.

The Waiokura catchment

In the Waiokura catchment most of the wet soils problem also occurred in winter. Once again, all of the farmers interviewed had strategies for dealing with this, including feedpads or standoff areas. Most of the Waiokura farmers were considered to be similar to the descriptions for either segment four or five, depending on the severity of the waterlogging in winter.

The Waikakahi and Bog Burn catchments

Similarly, farmers in the Waikakahi and Bog Burn catchments had problems with wet soils in winter. However farmers in these catchments wintered their cows off farm. Most of the Waikakahi farmers were considered to be similar to the descriptions for segment four.

However, for farmers in the Bog Burn catchment, wet soils were also a problem in spring. All farms in this catchment are tile drained. It would not be possible to farm in the area without tile drains. The farmers in the Bog Burn catchment were considered to be similar to the descriptions for segments one and two, depending on the severity of waterlogging in spring.

This is consistent with Kaine and Niall's (1999) work, as farmers who experienced waterlogging in winter were less likely to install subsurface drainage or experience many benefits from installing subsurface drainage. However those who experienced severe waterlogging in spring were more likely to install subsurface drainage.

Managing macroporosity

In terms of managing macroporosity of soils, it was clear from interviews with farmers that they all had rules of thumb for managing pugging. For example, Jeff, as

mentioned before:

“...it’s the flats that have the most problem with pugging. And so he tries to stay off that area when there is any danger of pugging. Generally he finds that the ground there will pug within two hours. So he will put them in the paddock for two hours then stand them off in the yard.”

And Mario, also from the Toenepi catchment:

“...it depends on the conditions as to how long it takes before the cows start damaging the pasture. If it is very wet it can take a couple of hours.”

Improving border-dyke irrigation

The Waikakahi catchment is the only one of the four catchments covered in this project where irrigation is required. Farmers in this catchment were using border-dyke irrigation systems, with limited areas of K-line irrigation. Generally the K-line has been installed on land that has been unable to be irrigated via the border-dyke system. Farmers in the catchment are using bore water or water from the Waikakahi stream to run their k-line irrigation. For example:

Bevan and Kaylene are dairy farmers in the Waikakahi catchment. They have border-dyke irrigation across the majority of the property. However, 50 ha of the run-off is under K-line. This area had never been irrigated and at the time K-line irrigation was cheaper to install, and used less water which was important as there had been some concerns over security of supply. Bevan pumps from the Waikakahi stream for the K-line.

It quickly became apparent from discussions with farmers in the Waikakahi catchment that their management of irrigation is dictated by the water delivery system. Farmers are given a roster so that they know when the water will arrive, and how long they have access to the water. Border-dyke irrigation is better suited to the roster system, in contrast to K-line systems. K-line systems require flexibility in water delivery.

One of the key practices researchers are studying is bunding at the end of the borders to control the amount of runoff. Few farmers had installed bunding. Depending on the location of the farm runoff water went straight into the Waikakahi stream, or into collection areas, before going into the stream. The farmers we interviewed did not see any major problems with the system as it was. For example:

Bevan and Kaylene own a dairy farm in the Waikakahi catchment. The border-dyke irrigation, on most of their farm, drains into a soak area at the top of the farm. This water then can drain into the Waikakahi stream, although this only happens if the property is over-watered but this doesn’t happen very often as his system is very reliable. Bevan has clocks on the gates and he knows that if one clock doesn’t work there will be another one going off in an hour so not too much water will be wasted.

The main issue discussed was how quickly you could get around the farm once the water arrived. For one sharemilker, this was the worst part of managing the property. *Lex and Kristy are sharemilkers on a dairy farm in the Waikakahi catchment. They know that a lot of water is wasted, as they see it heading off the property into the stream. The farm doesn’t water very well because the original conversion wasn’t done correctly. The farm was converted in 1984 and borders were designed*

according to the contour of the land. The emphasis was on getting the water to the border, not how well the border watered. They get water for 10 days but often struggle to get around the property. They often have to get extra water which is an extra cost for them.

For others, irrigation becomes a constant part of managing the property.

Daryl is a sharemilker on a property in the Waikakahi catchment. Most of the property is watered with a border-dyke system. One third has been rebordered since it was first converted and those paddocks water quickly. It takes Daryl 12 to 13 days to water the property, and he gets water every 16 days, so he is irrigating constantly.

The interviews revealed that the amount of labour required for irrigation, and the timing of irrigations were key factors influencing farmers decisions on management. In addition, water is relatively inexpensive and so runoff is not of great concern. There is little incentive for farmers to change the way they manage their irrigation, unless there are changes the structure of the delivery system in particular.

Discussion and conclusion

Adoption of stream fencing

The farmers we interviewed identified a number of factors that influenced their decision on whether to fence off streams and other waterways. These factors were centred on management of stock. Farmers were also likely to fence off streams when redeveloping their property. This is similar to the results from the study by Parminter, Tarbotton et al. (1998), In some follow up work, Parminter and Wilson (2002) found that dairy farmers associated riparian management with increasing the risk of flooding and reducing nutrient contamination of waterways. We also found that flooding management was a potential problem raised by farmers. Weed control was also seen as a problem when fencing off streams.

This suggests that it is important to address these concerns whenever fencing is being promoted. In addition, demonstration sites could be important for providing practical examples of dealing with weeds and flooding issues.

Effluent management, phosphorus use, managing wet soils

We found that farmers were choosing an effluent management system based on their herd requirements and their location. As farmers built up herd numbers an older two-pond system might no longer be suitable.

Regional Councils have a consent system in place with rules about the size of ponds per number of cows and the area required for irrigating effluent. Farmers must abide by these rules. However, when managing the fertiliser requirement for the property farmers' perceptions of the difference in pasture yield on those areas where effluent was irrigated became important. There appeared to be a consistent association between farmers' perceptions of whether effluent made a difference to grass growth in a paddock and their management of fertiliser in every catchment.

In the Bog Burn catchment there was an obvious gap in knowledge in terms of knowing where the tile drains were particularly in relation to managing effluent irrigation. The Regional Council do not have any plans which show the tile drainage

layout (S Crawford, *pers comm*, 2004). This makes it difficult for sharemilkers in particular to manage effluent irrigators effectively in terms of ensuring that nutrients do not drain into waterways.

The farmers we interviewed did not see phosphorus as a separate issue deserving special treatment separate from other fertilisers. Phosphorus was part of the fertiliser mix going onto the farm. Some farmers had responded to advice recommending a reduction in phosphorus application, especially as it saved money. However not all were getting this advice. Some farmers noted that this was starting to change, “*fertiliser companies are no longer competing on how much fertiliser to sell you, but on how much they can reduce your fertiliser use,*” said one farmer from the Waikakahi catchment.

This suggests that working with the fertiliser companies and farm advisors may have more effect than working directly with farmers. There is an obvious conflict of interest – selling fertiliser is a fertiliser company’s business and so why would they recommend less? However the research work – on reducing the application of phosphorus – and recommendations coming from that work appear to be having some effect.

Managing wet soils is an issue for all farmers in all catchments. Many however are only faced with pugging problems in winter and have rules of thumb which work for their property, depending on the timing and severity of waterlogging. There was some surprise from farmers in the Toenepi catchment when told the macroporosity was low, due to pugging. This suggests there is a need to investigate this further, perhaps developing some trials on-farm to determine how much of an issue it is in the catchment.

Improving irrigation management

Interviewing farmers in relation to irrigation revealed that they have few problems. The major issue for some farmers is how quickly they can get around their property in relation to the roster. For farms that have not been rebordered since converting to irrigation, this can cause problems. On these farms borders tend to be smaller and take longer to water. Where farmers have been able to reborder they have found that irrigating is quicker and easier. Adopting a pressurised irrigation system, such as K-line, lateral move or pivot, is impractical given the circumstances.

Farmers were less concerned with runoff. Water did not pond on their property, and generally they felt that excess runoff only occurred occasionally.

Adoption of the environmental best practices

While we found that all the farmers we interviewed agreed that looking after the environment was important, they were not convinced that some of the best practices being promoted as environmentally friendly were actually practical. On this evidence we believe farmers’ decisions about the environmental practices they use on their farm are primarily based on a systematic and pragmatic evaluation of their production contexts and the management options that are available. These evaluations appear to be based on a deliberate and systematic process of learning about management options by experimenting with these options in the particular context of their farm. This is consistent with our view that farmers follow a complex decision making process when considering the adoption of environmental best

practices. This suggests that the choices farmers make in regards to adoption of these practices are not strongly influenced by their attitudes to sustainability and the environment. We found that those farmers that had undertaken some of the best practices outlined in this report had done so to address specific needs. Their context motivated them to adopt particular practices.

The importance of linking best practices that address environmental issues to farm context should be seen as critical to the successful adoption of these practices. A one-size-fits-all approach is inappropriate. Practical solutions are needed that link strongly with farming context.

Dairy farmers do acknowledge that in the future there may be a need to signal to others, such as dairy factories and export markets, their diligence in pursuing environmental sustainability. This suggests that interest in environmental best practices may increase if external pressures to demonstrate the use of environmental practices continue to rise, particularly if the use of such practices becomes a precondition for milk pick-up. However at present this is not the case. Milk is still being picked up whether or not the dairy company or Regional Council believes that a farmer is abiding by environmental best practice.

Conclusion

Our aim in this project was to identify the factors which influence dairy farmers' propensity to adopt sustainable management practices. We were particularly interested in identifying the factors which influence farmers' propensity to fence off streams.

Our results suggest that a farmer's decision to adopt management practices depends on their perception of the benefits of those practices. Our results indicate that these perceptions are based on the systematic evaluation of practices in terms of salient characteristics of the production context of the individual farmer. Hence, farmers' choices in regard to fencing off streams, reducing phosphorus use, managing effluent and wet soils are the result of pragmatic considerations in regard to the commercial and practical realities of dairying. The attitudes of farmers to sustainability and the environment have, at best, a limited role to play in these choices. As a consequence, inferences about farmers' attitudes towards the environment and sustainability cannot be drawn simply from observations of the production techniques they use.

This means that we simply cannot assume that failure of a farmer to adopt a particular technique or practice is an indication of unfavourable attitudes toward the environment. Nor can we assume that adoption of these techniques is the outcome of favourable attitudes towards the environment. Those responsible for promoting environmental best practice, both inside and outside the dairy industry, should be cognisant of this. Clearly demonstrating some of the practical benefits of the best practices being promoted is critical.

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