

Involvement and decision making on-farm: the use of wintering feedpads and nitrogen inhibitors on dairy farms in New Zealand

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Abstract. Dairy farming has the potential to pollute waterways through the loss of nitrogen (N), Phosphorus (P) and Faecal Indicator Organisms (FIO). Two on-farm management actions that can reduce losses of N, P and FIOs are the use of wintering feedpads, and the application of nitrification inhibitors. In this paper we outline the results of research undertaken to explore the adoption of these amongst dairy farmers in New Zealand. Thirty-five semi-structured qualitative interviews were undertaken in 2008/09. The results indicate that the decision to adopt a wintering feedpad is a high involvement decision driven by farm context. However the decision to adopt nitrification inhibitors is less involving and so is dependent on personal triggers. Three key learnings from this work are; involvement influences the type of decision making used by farmers; context influences high involvement decision making; different strategies are needed to promote adoption under low involvement compared to high involvement.

Keywords: decision making, involvement, dairy farming, wintering feedpads, nitrification inhibitor

Introduction

The loss of nitrogen (N), Phosphorus (P) and Faecal Indicator Organisms (FIO) to waterways is a key environmental issue facing dairy farmers in New Zealand. Two technologies that can be used on farm to help avoid or lessen either N, P or FIO losses are the use of wintering feedpads and the application of nitrification inhibitors. In this paper, the results of research undertaken to explore types of decision making used in the adoption of wintering feedpads and nitrification inhibitors amongst dairy farmers in New Zealand are outlined.

Wintering feedpads and nitrification inhibitors

Wintering feedpads are built to provide an alternative space for cows, in order to take them off pasture and have supplementary feed bought to them. Typically wintering feedpads have room for cows to lie down and have additional space for feeding. Wintering feedpads provide a means of reducing wet season grazing. Wet season grazing can be damaging to soils. Effluent from the dairy shed can be collected and stored for land application once suitable soil conditions are reached. Wintering feedpads help reduce the damage to soils from pugging and/or compaction (Longhurst et al. 2006) as well as reducing the risk of nitrate leaching from urine when the soil is saturated (de Klein and Ledgard 2001).

Nitrification inhibitors are chemicals that can be used to delay the formation of ammonium from nitrate in order to reduce nitrous oxide emissions from fertiliser or urine (de Klein and Eckard 2008). There are three inhibitors that have been developed commercially; Nitrapyrin, dicyandiamide (DCD) and 3,4-dimethylpyrazole-phosphate (DMPP) (Edmeades 2004). In New Zealand there are two formulations of DCD available; Eco-N from Ravensdown which is a liquid suspension sprayed onto soils, and N-Care from Ballance AgriNutrients which is a granulated urea product with DCD and is applied as a fertiliser (Edmeades 2004). There is also a urease inhibitor available; Sustain from Summit Quinphos which is granulated urea coated in a urease inhibitor, and bonded to elemental sulphur (Edmeades 2004). Edmeades (2004) provides a complete description of the processes involved in nitrate leaching and the differences between nitrification and urease inhibitors.

Consumer purchasing as a model of adoption behaviour

The approach taken to understand the adoption of new agricultural technologies and practices draws on the conceptual foundations of consumer behaviour theory and farming systems theory (Kaine 2008). The framework outlined by Kaine (2008) provides a means of determining the population of potential adopters rather than assuming that a technology or innovation is applicable to all farmers. Consumer behaviour theory suggests 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.

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 (see Table 1).

Table 1. Consumer purchase behaviour

	High involvement purchase decision	Low involvement purchase decision
Decision making (More effort)	Complex decision making (e.g. cars)	Variety seeking (e.g. snack foods)
	High motivation to search for information High effort into learning and discovery Evaluation both prior to and after purchase	Low motivation to search for information Some effort into learning and discovery Evaluation after purchase
Habit (Less effort)	Brand loyalty (e.g. athletic shoes)	Inertia (e.g. laundry detergent)
	Less effort into learning and discovery as consumer already has a product they are satisfied with Evaluation based on experience with the product	No motivation to search for information No effort put into learning and discovery Evaluation after purchase

Source: Adapted from Assael et al. (2007).

Consumer involvement depends on how important the purchase is to the consumer. High involvement purchases are purchases that are important to the consumer (Poiesz and deBont 1995; Assael et al. 2007). 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 (Celsi and Olsen 1988). 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 et al. 2007). 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 (Verbeke 2008). Typical low involvement purchases are groceries, toiletries, and laundry products.

Kaine (2008) likens the decision to adopt an agricultural technology to a consumer purchasing decision for several reasons. The first is that generally farmers buy new technology for use on the farm, just as consumer by products for their own use. Even those technologies or management strategies that are free involve resources that have an opportunity cost (Kaine 2008). Another reason is the consumer purchasing literature, being based on social psychology, recognises that different processes are called upon under different circumstances (Salmon 1986; Verbeke 2008). This means that there is acknowledgement of the difference between routine purchasing decisions (e.g. inputs) and adopting a new technology or practice. The decision to adopt an agricultural innovation is often risky, reflecting the difficulties of integrating a new technology into the existing mix of technologies, practices and resources that exist on the farm (Pannell et al. 2006; Kaine 2008).

Complex decision making

Complex decision-making is associated with 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 criteria represent the key benefits sought by the consumer and generally reflect their 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 et al. 2007). 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 similar situations will tend to seek similar benefits from an innovation or technology and so will employ similar purchase criteria (Pilling et al. 1991; Salmon et al. 2006). Information on the similarities and differences in the key purchase criteria used by consumers can be used to classify consumers into market segments (Assael et al. 2007).

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.

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. Logically, the market for an innovation will be defined by the set of farm contexts for which the innovation generates a net benefit. This allows the population of potential adopters to be identified (Kaine 2008).

Farm context

Farm systems theory helps define farm context by providing a framework that identifies the relevant elements of farm context which influence the benefits of adoption of a technology (Kaine 2008). Farming systems research was developed in response to the failure of traditional approaches to research when developing technologies for small scale farmers in developing countries (Norman 2002). The farming systems approach was based on the idea that researchers had to begin with understanding the problems of farmers from the perspectives of farmers; and that solutions had to be based on a proper understanding of farmers' objectives and their environments (Collinson 2000; Norman 2002).

The farming systems approach recognises the dynamic causal relationships between the parts of the farm system (Kaine 2008). These relationships can restrict the way in which parts of a farm system can be changed to accommodate a new technology. As such the benefits of a new technology depend on the way in which it interacts with the different parts of the farm system and the modifications required. Frank (1995) illustrates this in his study of adoption of a range of practices in the beef cattle industry in Queensland Australia. Frank (1995) observed that practice change occurred over time in an orderly process and practices were in sets, i.e. grouped together so that adoption of one practice may depend on the adoption of two other practices.

Given this Kaine (2008) defines the farm context as "[the] elements in the farm system that are functionally related to the innovation (such as resources, constraints, agricultural technology and management practices, and strategies for managing risks) and so influence the achievement of the ... objectives of the producer." (p. 65). This means that identification of the potential population of adopters of a technology can be identified once the farm contexts which result in the technology offering a benefit to the farmer are identified (Kaine et al. 2005; Strong and Jacobson 2006).

Focusing on the farm context to help understand adoption of new technologies may help understand why predictive factors (such as farm size), may not always be useful. This approach

suggests there is no reason to expect a consistent relationship between adoption of a practice and farm size, farm income, farmer education and experience unless a particular practice exhibits scale economies or requires a formal education qualification to implement.

Methods

High involvement decision making implies that the decision maker develops explicit chains of reasoning to guide their decision making (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 elements of farm context influencing dairy farmers' decisions on wintering feedpads and nitrification inhibitors we developed a semi structured interview process. The semi structured interviewing process allowed the employment of laddering techniques to systematically explore the reasoning underlying the decisions and actions of the interviewee (Grunert and Grunert 1995). Laddering is an interview procedure based on repetitive use of the 'why' question which enables the interviewer to gain an understanding of the connections between decisions and actions (Laaksonen 1994). The list of initial questions used for each technology as a checklist and for prompts is available on request from the corresponding author.

We interviewed thirty-five dairy farmers over October/November 2008 and March 2009. Initial contact lists were compiled by dairy industry contacts from the industry body (DairyNZ), and additional contacts added as needed from a range of sources, including researchers, Regional Council personnel and other personal contacts. A total of 32 farmers were interviewed about the use of nitrification inhibitors. Care was taken to interview a range of farmers about nitrification inhibitors. Farmers that were using inhibitors were interviewed as well as farmers who had tried inhibitors but were no longer using them. Some farmers who had not used inhibitors were also interviewed. In addition farmers from different regions were interviewed, including farmers that were currently in a region with regulations outlining limits to the amount of nitrogen that can be applied (i.e. Taupo/Bay of Plenty in the North Island), and thus could be experiencing additional pressure to use inhibitors. The number of farmers in each category is outlined in Table 2.

A total of 22 farmers were interviewed about the use of wintering feedpads. Although care was taken to select a range of farmers, including those who currently had wintering pads as well as some who did not, in some cases it proved difficult to determine the type of feedpad on the farm prior to the interview. This resulted in several interviews covering the use of feedpads during spring, rather than over winter and one interview with a farmer who had a herd home.

Table 2. Number of interviews and range of farmers interviewed about nitrification inhibitors and feedpads.

No. of interviews	Inhibitors – regions with regulations	Inhibitors – regions without regulations	Feedpads
Not using	4	7	11
Using	4	7	11
Tried not currently using	6	4	NA
	14	18	
Total		32	22

Results

Wintering feedpads

Interviews with farmers revealed that the decision to install a wintering feedpad on farm was a high involvement decision dependent on three critical issues; the use of supplements, winter milking and the condition of the soil over winter. These issues interact in various ways.

Depending on pasture availability and growth, some farmers chose to meet the feed requirements of their cows through winter with supplements. Supplements ranged from palm kernel to grass silage. Some supplements are best delivered via troughs, e.g. palm kernel, whereas other supplements, e.g. silage, can be easily distributed in a paddock. However, feed wastage tends to be higher in a paddock than on a feedpad, and even more so if the soils gets very wet. Depending on feed requirement, and/or the state of the soils, a feedpad could be the most effective way of delivering supplements.

In addition, some farmers chose to supply winter milk. This was previously known as town milk supply. Generally this means they will autumn calve a proportion of their herd, or their entire

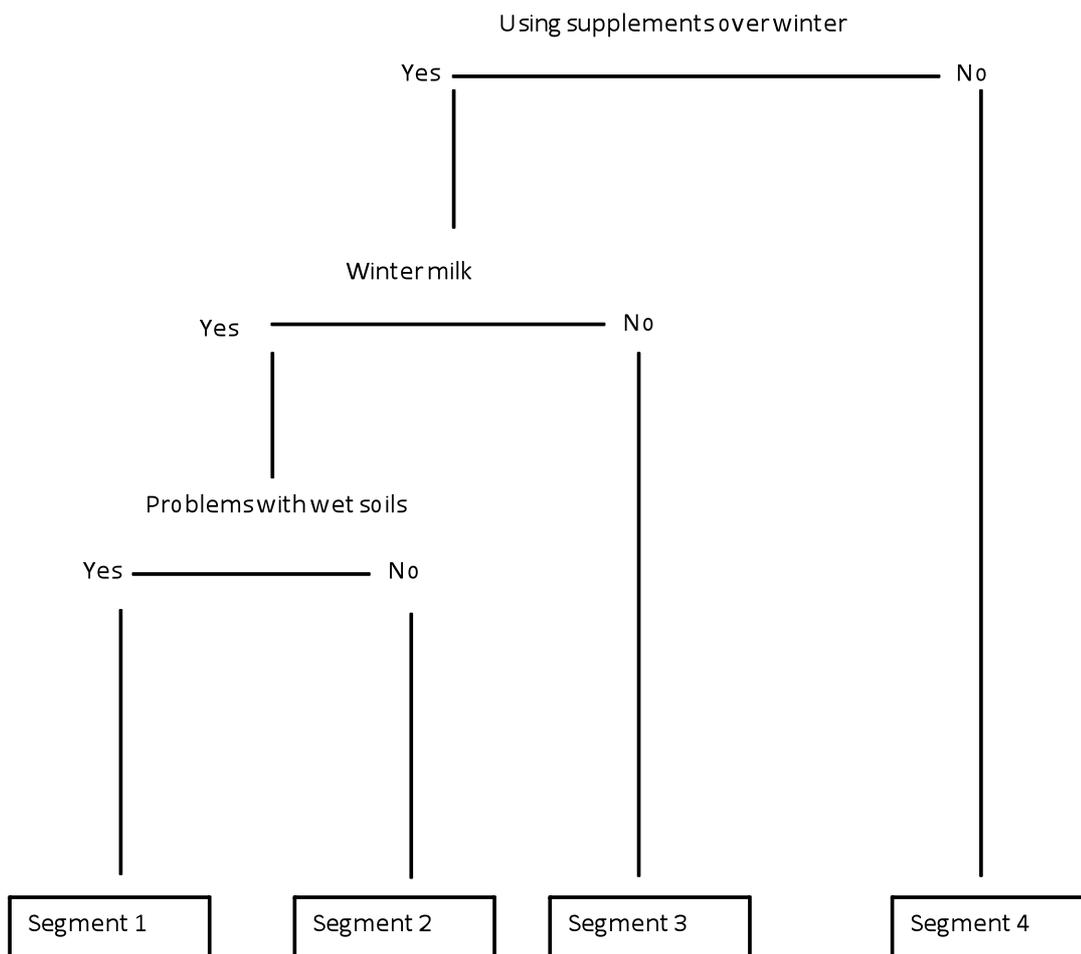
herd in order to supply milk over the winter period. Winter milking has implications for the feed requirements of the herd. For example, a farmer from the Manawatu explained;

“We first built a feed pad probably about 1970 and we’ve always been one of the old town milk farms so we’ve always milked cows through the winter and when we first built it of course it was to feed through the winter time, we only fed through the winter.” [#33]

For some farmers their location and soil type meant that their property gets very wet over winter. This could be because they are in a high rainfall area, and/or because they have heavy soil types that are prone to waterlogging. Managing wet soils can become particularly complex when winter milking as meeting the feed requirements for the herd is critical for consistent milk supply. Farmers indicated that they had a range of methods for managing wet soils. Most involved shortening the length of time cows spend in a paddock. Farmers indicated they put cows onto a sacrifice paddock, on the races or on a feedpad and/or standoff pad.

We were able to classify farmers into four segments based on the data from interviews (see Figure 1). Note that one farmer was not classified into these segments because they had a herd home rather than a feedpad. Individuals in three of the four segments were potential adopters of wintering feedpads. Segmenting provided details on the reasons why farmers in segments one to three would have considered adopting this technology. Segmenting also allowed documentation of reasons why farmers in segment four would not have considered using wintering feedpads.

Figure 1. Outline of segments on the use of wintering feedpads



Segment 1 – need wintering feedpads There were five farmers in segment 1. They were feeding supplements on farm over winter, were winter milking and had problems with wet soils over winter. They had installed a wintering feedpad to help them manage these issues. Cows were fed on the pad, and were occasionally left on the pad for long periods of time if there was extended wet weather i.e. for some farmers it doubled as a loafing pad or standoff pad as well

as a wintering feedpad at times. A loafing or standoff pad is a purpose built free draining area for holding stock during wet conditions (Ryan 2009). Cows do not have access to feed when on them. For example, two farmers from Canterbury indicated that their winter milking cows had access to the feedpad and feed at all times. This was the best way to manage the very wet soils they had.

The winter milked cows (approximately 160) were fed silage and grain on the feedpad, although they also had access to a paddock and fresh break each day. Each morning the cows were pushed off the feedpad, it was scraped clean and fresh silage added to the trough. Most cows wandered down to the paddock and had some grass as well or slept there, although [names omitted] had noticed some cows prefer the feedpad and fed and slept on it without going into the paddock. They have always had to go down to the paddock to collect some cows for milking. At night they would just put a bit of fresh silage in. The feedpad was originally put in to try and save the paddocks over winter. The soil is very heavy on their farm and pugs easily in wet weather. This damages the pastures very quickly. They did not think the cows were getting enough feed, because the available grass is minimal and silage is easily trampled on in the paddock. [#8, from notes]

Another farmer from Canterbury explained that their winter milking herd was fed on a feedpad and generally spent about 45 minutes there.

“Probably 45 mins [length of time the cows spend on the feedpad]. In extreme weather conditions yes, they spend a lot more time there. ... I think we had two days of that.” [#9]

A farmer from the Manawatu indicated they had installed a feedpad 30 years ago, because they were winter milking and needed to keep stock off the pastures in winter.

“Just we were winter milk[ing] ... and ... just to keep the stock off the pastures in the winter time that was probably the main reason. ... [in response to how long the cows spent on the feedpad] it just depends on how much you’re feeding but often about an hour.” [#34]

Segment 2 – wintering feedpads optional for milking cows There were three farmers in segment 2. They were feeding supplements on farm over winter and were winter milking but did not have problems with wet soils over winter on a regular basis. For some of these farmers a wintering feedpad was the best way of managing the feed requirements cows had over winter. A farmer from the Manawatu explained;

“So that’s why I milk all year round to utilise that capital that I have in the cowshed. And I took that same argument to the feedpad if I’m going to spend this money I want to use it every day. So now I’ve had this paradigm shift in thinking maybe there’s times of the year that I might not use the feedpad. But in the nine years of it’s been running it has been used every day twice a day.” [#25]

Not all farmers in this segment believed that a wintering feedpad was the best way to manage supplements. For some farmers, a wintering feedpad was considered an unnecessary expense as they had other strategies for managing the feed they bought in. For example, another farmer from the Manawatu was feeding his winter milking herd in the shed.

“What we have got in the large herd shed is a Rotary and we’ve got feeding facilities that we can feed during milking. ... [The property] ... its all sand and both well the bigger unit probably a third of its too wet, a third of it’s about right, and a third of its too dry. So we’ve always got somewhere to escape to.” [#20]

Segment 3 – wintering feedpads optional for dry cows We interviewed one farmer who was in segment 3. He was feeding supplements on farm over winter but was not winter milking. They were wintering dry cows on the property and ensuring they had enough feed through supplements. For some, a wintering feedpad was an appropriate way of managing the feed requirements of the herd. This farmer, from the Waikato, explained;

“Having tractors and feed out wagons out on the pasture when its wet on rolling country is dangerous. And not only that your utilisation of your maize and that is just pathetic. So it was a no brainer really the feedpad and we thought I don’t see why anybody who is feeding maize silage doesn’t have a feedpad I just cannot for the life of me understand why they wouldn’t.” [#26]

Segment 4 – no wintering feedpad Fourteen farmers were in Segment 4. These farmers were not using supplements on the farm over winter, either because their cows were taken off farm

for the winter, or because they had enough feed on farm over winter (for some, or all, of their herd). These farmers indicated that they saw no reason to have a wintering feedpad. For example, some farmers in Canterbury indicated that their cows were wintered off, saying “All our cows go off farm for the winter.” [#12]

Another farmer from the Waikato indicated that they used forage crops in winter.

“No we use the swede crops in winter like a sacrifice paddock. ... All our races [lanes] are pumice and at that time of year the races aren't getting used so even if they are wet they are still really solid. We can spread them out on that if we need to. We've still got paddocks on the farm that have so little top soil that it doesn't matter how much rain we get they can't pug them so we use those for calving on. So we don't have to it doesn't matter what rain we get we don't have to shift those cows.” [#21]

Population of potential adopters These results indicate that, at present, adoption of a wintering feedpad is limited to those farmers who winter milk, bring in supplementary feed and/or have problems with wet soils. Supplementary feeding, i.e. choosing a high input system, is a major driver for the use of a wintering feedpad, but only if cows are on the farm over winter (whether milking or dry). Davies et al. (2009) explore these issues in more detail in their report on grazing management practices in the Waikato region.

Nitrification inhibitors

Twenty-one of the 32 farmers we interviewed about nitrification inhibitors had tried or were using inhibitors. Most of the farmers we interviewed who had tried or were using inhibitors were using Eco-N (n=16). Two indicated they were currently using Sustain and another indicated they were using SustainGreen. Two farmers reported using N-care, one of whom had also tried Eco-N.

Farmers identified two key reasons for trying inhibitors on their property. The first was for production, to obtain more grass. The second was to help the environment by reducing the amount of nitrate leaching. Half of those who had tried or were using an inhibitor indicated that both of these reasons were important. Another 10 farmers indicated that use was purely for production gains.

Farmers interviewed tended to agree that it was hard to determine whether the application of nitrification inhibitors resulted in any production gain. One respondent said; “It's an incremental increase of 10% in a paddock, you're much better than me if you can see it!” [#5] Some felt they could see a difference via other indicators, for example in the amount of nitrogen needed, with one respondent saying, “I just found I wasn't using as much nitrogen probably over the critical time like in the springtime.” [#23] However, others could not determine whether the inhibitors had made a difference, for example; “... we had a trial paddock done in a strip and we couldn't really see anything but it's just hard to call it...” [#7] Those farmers who reported that they were no longer using inhibitors indicated that they had ceased use because the results were disappointing with regard to production benefits. Therefore, they felt they could not justify the cost when they could not see results.

Involvement in use of nitrification inhibitors Most decisions to adopt new technology on-farm, as opposed to the familiar, routine purchase of agricultural inputs, tend to be high involvement, (Kaine 2008). That is, farmers put a great deal of time and effort into thinking about the technology or strategy they adopt. They are generally able to discuss how the technology does or does not fit into their farm and context, and therefore can provide reasons on why they adopted the technology or why they decided not to adopt the technology. Our results, from interviewing farmers about their use of nitrification inhibitors, reveal that decisions on inhibitors appeared to be less involving than decisions about wintering feedpads.

Assael et al. (2007) describes one type of low involvement decision making as variety seeking or limited decision making behaviour, characterised by passive learning (see Table 1). From our results there were no indications that farmers were following a complex decision making process. There appeared to be little active search for information, but evidence of some post purchase evaluation, made difficult because of the problems determining whether there was any difference as a result of applying the inhibitor as outlined above.

Farmers indicated that for nitrification inhibitors:

1. Passive learning tended to dominate the process of gaining information on this technology. For example, one farmer from the North Island who had been to a field day at the Lincoln University dairy farm (South Island Dairying Development Centre) said; “I was down at Lincoln

and we heard Keith Cameron speaking about the research that they're doing [on inhibitors] and it was pretty convincing listening to the researchers on the responses they were getting." [#33] That had prompted him to trial nitrification inhibitors but this farmer also indicated that "...this next year I haven't got it in my budget at all..." [#33] There was a great deal of information available on inhibitors if you were prepared to look for it. As one farmer put it; "... for a few years now there's been a lot of talk about it and a lot of people pushing the product and trying to sell it." [#21] Another said: "Have considered [inhibitors] and never got round to doing anything about it and I was talking to some people and they say they're good, so I suppose we just haven't got round to doing it." [#6]

2. There was little risk to trialling inhibitors. It appeared that nitrification inhibitors were compatible with current farming systems. Those farmers who had tried inhibitors but then decided not to continue using them simply went back to their usual fertiliser program. One farmer said; "...you don't have to do anything different..." [#21]

3. Most evaluation of inhibitors was post purchase. One farmer said; "And I guess we're approaching a period soon when we're going to have to make the same decision. And I would say that right at this moment that it will not be used. Now that's as much on the basis of input costs as whether it worked last year or not..." [#20] Another said; "This coming season I'm actually thinking not doing it mainly because the cost and the payout has dropped mainly budget cash flow sort of thing." [#23]

4. Farmers were prompted to try inhibitors for individual reasons, for example, because the fertiliser representatives they had were promoting it heavily. One farmer said, because of "... Ravensdown and Lincoln promotion..." [#1] Other farmers had heard about inhibitors and thought that they might improve their production, for example; "The economic return, I heard that it grew more grass..." [#5]

Discussion

The results of this research indicate that the decision to adopt a wintering feedpad is a high involvement decision driven by contextual factors such as feed deficits, wet soils and winter milking. This means that the use of wintering feedpads is based on a systematic and pragmatic evaluation of the farm context and the other management options that are available. It was evident that farmers undertook a deliberate and systematic process of learning about wintering feedpads and how they might apply the technology to the particular context of their farm. This is consistent with the view that farmers follow a complex decision making process when considering the adoption of most technology on farm. This implies that, at present, the pool of potential adopters of this technology is limited to those farmers who systems incorporate one or more of these factors.

In contrast and somewhat surprisingly, the decision to adopt nitrification inhibitors appeared to be less involving. This is surprising because, as Kaine (2008) indicated, most technology that is adopted on farm is not a routine decision, but requires a decision making process that allows for the integration of a new technology into the existing set of technology, practices and resources on-farm. However, it appeared that for most farmers', nitrification inhibitors do not have a huge impact on existing farm practices, beyond some adjustment to the farm fertiliser program. This implies that, at present, the potential adopters of this technology are those farmers who perceive there is a relative advantage offered by this product, such as increased production.

The relative advantage of inhibitors was determined by a range of factors including their complexity, compatibility, trialability and observability (Pannell et al. 2006). Inhibitors were not overly complex, compatible with current farming systems, and easy to trial, thus providing farmers with a means for deciding whether or not inhibitors did offer any advantages over their usual fertiliser programme. Observability was an issue, with many farmers interviewed indicating there were difficulties in determining whether there were any differences in production after applying inhibitors. For some farmers the information on inhibitors provided by researchers, particularly the information on Eco-N from Lincoln University, was proof of the benefits to adopting this product. Other farmers, while initially enthusiastic, did not see enough benefit from using inhibitors to justify the extra expense involved.

The consumer product literature suggests a number of strategies for promoting purchase of low involvement products, some of which are applicable to nitrification inhibitors. The first strategy is to promote low involvement products in terms of minimising problems, rather than maximising benefits as consumers are looking for "acceptable, not optimal, products" (Assael et al. 2007, p. 136). This may be possible for nitrification inhibitors as long as the experience farmers have with using inhibitors reinforces this view.

Assael et al. (2007) also suggest that low involvement decisions are more likely to be price sensitive. This was apparent from the comments made by farmers about future use of inhibitors. For many, a reduced income (because of a lower payout) meant that use of inhibitors ceased. Even when farmers indicated they had been satisfied with the results of using inhibitors, the need to cut input costs meant that they would stop using nitrification inhibitors.

Another suggested strategy for attempting to increase the rate of adoption of low involvement products is to promote trialling of the product (Assael et al. 2007). The results presented here suggest that this strategy may not be applicable to nitrification inhibitors. Although they appear to be easy to trial, farmers indicated that it was not always easy to determine the effects of using inhibitors.

The idea of attempting to shift farmers' level of involvement from low to high is another way of addressing adoption of nitrification inhibitors. Assael et al. (2007) suggest several methods for doing this including linking the product to a highly involving issue, and promoting the product as a means of solving a problem. The fertiliser companies that are promoting nitrification inhibitors seem to be taking this strategy, by linking use of inhibitors to an increase in production through increased grass growth or by highlighting inhibitors as a means of solving an environmental problem.

Implications for extension programmes

These findings have implications for extension programmes designed to increase the use of wintering feedpads and nitrification inhibitors in order to reduce the losses N, P and FIOs. In the case of promoting adoption of wintering feedpads, farmers will only respond to the recommendation to install one if their context provides particular benefits to doing so, i.e. if they have issues with feed deficits, wet soils and/or winter milk. Farm context drives the adoption of this technology. Providing information, e.g. via an extension programme, will not necessarily change the farming context. Therefore, there is no reason to suspect that simply promoting the use of wintering feedpads to all farmers will prompt them to change their practice. However, a carefully targeted extension programme, designed to identify farmers who experience feed deficits, wet soils and/or winter milk, and promote the use of wintering feedpads, could prove successful.

In the case of nitrification inhibitors, the results of this work suggest that there is more scope for an extension programme to raise awareness of this technology and promote trialling on-farm. However, one of the issues highlighted by farmers was the problem of observability. It appears that determining the effect of nitrification inhibitors is difficult. An extension programme that draws attention to indicators that help farmers evaluate the results of using this technology could help promote the use of inhibitors. More research is needed as this technology becomes more widely used to determine whether or not involvement in this product changes. This information could then be used to redirect extension efforts if required.

Key learnings

Three key learnings from this work are;

1. Involvement, applied amongst consumer behaviour researchers to determine the type of decision making used by consumers, can be applied to the issue of adoption of technology on farm. The level of involvement in the technology or management strategy influences the type of decision making used by farmers.
2. Context influences on-farm decision making when involvement is high. The results of the research outlined in this paper adds to other research (e.g. Kaine et al. 2005; Strong and Jackobson 2006) which indicates that understanding farm context helps understand what is influencing adoption of technology on farm; and
3. Different strategies when developing extension programmes are required when promoting adoption under low involvement as compared to high involvement conditions. Identifying potential adopters of specific technology and targeting extension programmes to these farmers ensures that extension efforts are effective.

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