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Technology Use On Farms

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Contents

1.0 Summary

This report provides an overview of some of the developments in technology and how they have impacted on dairy farming at an industry level as well as an individual level. The process of innovation and adoption that can be applied to farmers is discussed, followed by a review of how proven precision technology is being used in some current dairy farming businesses. Finally, two case studies provide an insight into the adoption process some farmers have employed to incorporate new technology/systems on their own farms.

The types of technology being used on farms and the reasons for their use are as varied as the farmers who use them. However, there are some commonalities in motivation amongst the farmers interviewed for this project and they include:

- Improved profitability either indirectly (better decision making, redistribution of labour) or directly (reduced labour, decreased cost for health/vet/herd testing, less infrastructure)
- The desire for less dependence on staff (either skill level or number)
- The ability to make decisions faster through better use of information
- The achieving of better fed and therefore higher producing cows
- Less stress on themselves, their staff and the whole farm system

The process of Awareness, Interest, Evaluation, Trial and Adoption was followed by most of the farmers interviewed for this study, although the amount of time farmers spent on each area and the amount of support they required varied considerably between individuals.

As an industry, we can aid the adoption of new technologies by providing accurate and timely evidence to show the effectiveness of different technologies within the restraints of resource and financial capability.

2.0 Introduction – The Beginnings of Farming

When tillage begins, other arts follow. The farmers, therefore, are the founders of human civilization." - Daniel Webster (1782-1852)

Farming began eight to ten thousand years ago in the Middle East and the Holy Land. It apparently began after certain wild wheat mutated (Leinhard, 1997). The seeds of those wild grains weren't as fat and rich as modern wheat, but they blew in the wind. They sowed themselves. They could be harvested without planting.

Modern wheat was a fertile mutation of wild wheat. It made much better food but its seeds don't go anywhere. They're bound more firmly to the stalk, and they cannot ride the wind. Without farmers to collect and sow wheat, it dies. Thus began the evolution of farming. From now on, with this wonderful new food, we would live better, but we would also be forever bound by the new technology of agriculture.

Since that time there have been innumerable innovations and technological leaps in both agriculture and farming. New Zealanders have built a reputation on being innovators in the agricultural industry and the "No 8 wire" concept is a cornerstone of our enterprises. Whilst the Maori were great cultivators and growers of crops they were limited in their access to large animals such as the cow and for this reason, dairy farming was not established here until the arrival of the white settlers.

From modest beginnings, the dairy industry has grown to its current size of approximately 4.25 million cows in 11,600 herds. This growth has come about through constant innovation and experimentation. Improvements in cow and pasture breeding has resulted in changes in land use, increased stocking rates, increased nitrogen use, improvements in monitoring and measurement and improved dairy facilities. While not all of these innovations have been seen as advancements in dairy i.e. the effect of increased nitrogen use on the environment, they have certainly aided the increase in dairy production we see today.

The purpose of this report is to provide an over view of some of the developments in technology and how they have impacted on dairy farming in general and also at an individual level. The process of innovation and adoption that can be applied to farmers is discussed, followed by a review of how proven precision technology is being used in some current dairy farming business. Finally two case studies provide an insight into the adoption process some farmers have employed to incorporate new technology/systems on their own farms. In some cases the technology employed on farm has not been proven in the New Zealand system or is difficult to quantify in terms of financial return so the thought process involved in adopting these new technologies is investigated.

3.0 Developments in Dairy Farming

"Should we force science down the throats of those that have no taste for it? Is it our duty to drag them kicking and screaming into the 21st century? I am afraid it is." – Sir George Porter, 1920

Cows have been milked in New Zealand for approaching two hundred years - the first dairy cows to arrive in New Zealand were Shorthorns, known at that time as Durhams. They were introduced in 1814 by missionary Samuel Marsden for mission stations in the Bay of Islands. The cows came from the New South Wales Crown herd, and were a gift from Governor Lachlan Macquarie. Shorthorns were useful draught animals, which gave good milk and provided excellent meat.

Before the establishment of the mission farm at Te Waimate in 1831, the agricultural activities of early missionaries were fairly small scale, providing only minimal subsistence. This was essentially "gardening" rather than farming – small cultivated patches of wheat and potatoes, gardens of English vegetable and fruit trees, with cattle and pigs running free and foraging in the nearby bush and scrub.

A feature of all early settlements around the coast of New Zealand was the presence of dairy cattle, not large herds but in small groups of one or two, sufficient to meet the dairy needs of individual colonial families. The following three paragraphs were taken from Stringleman and Scrimgeour (2011) and describe the early days of the New Zealand dairy industry.

Domestic milking and processing

All settlements had dairy cows, each family usually keeping one or two to provide its dairy needs. Women and children generally had the task of milking, which they did in a paddock. They restrained the animal with a leg rope or halter, and sat on a stool or upturned bucket. The milk was strained through fine mesh, and then allowed to settle so the cream rose to the top. This was skimmed off with a ladle and made into butter in a small churn. Cheese was made by curdling whole milk with lactic acid or rennet from the lining of a calf's stomach. Whey – the watery waste product – was usually fed to the pigs.

Better butter

Before refrigeration, butter sent from New Zealand to Britain or Australia invariably arrived in poor condition. However, butter sent to New Zealand from Ireland, and cheese from England, arrived in good condition, and was sold at a premium. Overseas butter was heavily salted, and was packed in salt, and was thought to be of the highest quality. In 1882 New Zealand exported the first refrigerated shipment - a worldwide first - of meat and butter from Port Chalmers, Dunedin to London on the ship "Dunedin".

The advent of refrigerated shipping enabled New Zealand to develop a substantial dairy export trade to the United Kingdom, which remained the largest export market until the 1970s, when Britain joined the European Union.

Dairy products

In the early days of New Zealand settlement, butter was the only dairy product with a marketable value – although it was often bartered rather than sold for cash. As late as the 1880's butter that was surplus to a family's requirements was taken to the local store and swapped for food or farm tools. The storekeeper would then sell the butter for a profit. Dairy products added protein and fat to the limited pioneer diet of bread, meat, some fish, and a few fruits and vegetables. Butter, cheese and yogurt stayed fresh and edible a lot longer than raw milk or cream

In 2011, dairy cattle in New Zealand number around 4,250,000 and produce more than enough milk to meet the nation's dairy requirements. The remaining ninety-five percent of production is exported. This increase in cows and production has come about through a lot of lot hard work and innovation on the part of early pioneers and their descendents. Some of these innovations include:

Murray and Board's Vacreator

Until the 1930s New Zealand butter was often tainted with unpleasant smells. Lamont Murray and Frank Board ran a butter factory in Te Aroha, and aimed to deodorise the cream they used without affecting its flavour. In 1933 they patented a steam pasteurising process they named the Vacreator. It sold widely in the US as well as in New Zealand.

Aerial topdressing

New Zealand was the first country to successfully use light aircraft for sowing seeds and distributing fertiliser. The first attempts took place in the 1930s but were halted by the Second World War. The availability of ex-military aircraft and pilots allowed aerial topdressing to expand rapidly from the late 1940s. High prices for farm produce in the 1950s and support from the public service helped New Zealand topdressing firms to maintain a technological edge over those in much larger countries.

Gallagher's electric fence

Hamilton farmer, Bill Gallagher, was forced to be resourceful during the economic depression of the 1930s, and built his own tractors out of other vehicles. After a horse repeatedly scratched itself on his car, Gallagher's brother Henry experimented with cheap and effective forms of stock control and in 1953 was awarded a patent for a 'wire-winding reel for electric fences'. Gallagher electric fencing technology was exported worldwide, and in 2009 the company had offices in more than 30 countries.

Callender's farm bike

The world's first farm bike was invented in 1963 by New Plymouth farmer and keen motorcycle mechanic, Johnny Callender. He was soon swamped with orders but faced difficulties expanding production. His bike used a Suzuki engine, and the Suzuki company soon built and sold their own version, making it impossible to develop Callender's invention into a local industry.

Hartstone's Milk Meter

In 1963, during a bout of hayfever that kept John Hartstone awake all night, a life-changing inspiration came to him. He was sitting at the kitchen table with a cup of tea and reading old farm magazines when he came across an article that said the British Milk Marketing Board was looking for a way of accurately measuring individual cow's milk production. Grabbing a pen and paper and material from the local chemist, plumber and gunsmith (once they were open!), Hartstone directed the creation of what was to become one of New Zealand's most successful inventions. The now named Tru-Test milk meter is credited with helping boost dairy production around the world by giving farmers the ability to identify the cows that are the best milk producers and therefore best for breeding.

Change through the Decades

Changes on New Zealand farms through the decades are outlined below but are by no means a complete summary (Source: www.techhistory.co.nz)

1950s: Herds predominantly Jersey cows; Shorthorn cow numbers declining; Set stocking management; Serpentine superphosphate in use; Diverse pasture species; Natural mating; Walk-through cow sheds; "Stripping" of udders; Hand making of silage and hay

1960s: Silage pits; Shift to Friesians becoming evident; Rotational grazing systems; Alkathene pipeline for water: Pluoronics for bloat; Improved pasture species; Artificial breeding; Herringbone cowsheds; Penicillin for mastitis; Contagious abortion vaccine; Facial eczema prevention; Mobile hay baler; Calcium borogluconate for milk fever

1970s: Maize silage/greenfeed; Use of nitrogen; Magnesium for staggers; Dairy beef industry grew; Rotary cow sheds; Lodophors and detergents for milking machines; Uptake of electric fencing

1980s: Grazing-off of replacements; Mechanisation of silage and hay; Large bales for hay; Reproductive techniques (CIDRs etc); Payment for protein in milk with a charge for volume (1987)

1990s: Mechanisation; 4-wheel motor bikes; Indoor calf rearing; Embryo technology; Plastic cover for large bales; Personal computers in home

2000s: Robotic milking; Wireless receivers; Pasture growth measurements from space; Automated data collection

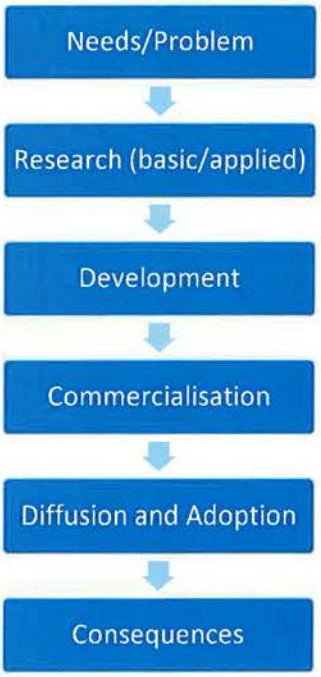
The most recent advances in farming have been technological (the way data on farm is collected, managed and utilised), as well as physical (pasture based robotic milking, automatic heat detection, herd homes). In most cases the objective of the development is to reduce labour time and costs while making farm management easier and more accurate. While the scientific evidence around the efficacy of using these innovations may or may not be limited, this does not stop early adopters from introducing technology to their farm.

4.0 The Process of Innovation and Adoption

Whether it is big or small, nearly all innovation starts with the identification of a need or problem. This is then followed by a series of steps that will hopefully result in a solution. This chapter looks at the process of innovation, the information needs of farmers at different stages of adoption and factors that affect the rate of adoption.

3.1 Generation of Innovation

The Innovation-Development process is described by Everett Rogers (1962) as having six main phases:



Development is the process of putting a new idea in a form that is expected to meet the needs of the audience of potential adopters.

Commercialisation is the conversion of an idea from research into a product or service for sale in the market place.

Diffusion and adoption includes the decision to 'release the product' and may include a consensus development conference

Consequence is the change that occurs as a result of the adoption of the innovation i.e. has the problem been solved?

3.2 Innovation-Decision (Adoption) process

The adoption process consists of a series of actions and choices over time through which an individual (or organisation) evaluates a new idea and decides whether or not to incorporate the innovation into ongoing practice

Individual's Adoption Stages

Awareness — In this stage the individual is first exposed to an innovation but lacks information about the innovation. During this stage of the process the individual has not been inspired to find more information about the innovation.

Interest — In this stage the individual is interested in the innovation and actively seeks information/detail about the innovation.

Evaluation — In this stage the individual takes the concept of the innovation and weighs the advantages/disadvantages of using the innovation and decides whether to adopt or reject the innovation. Due to the individualistic nature of this stage Rogers notes that it is the most difficult stage to acquire empirical evidence

Trial — In this stage the individual employs the innovation to a varying degree depending on the situation. During this stage the individual determines the usefulness of the innovation and may search for further information about it.

Adoption — Although the name of this stage may be misleading, in this stage the individual finalises his/her decision to continue using the innovation and may use the innovation to its fullest potential.

An individual might reject an innovation at any time during or after the adoption process.

3.3 Information Needs

Table 1 describes the information needs of farmers at different stages of adoption, the kind of information required and the preferred sources of this information.

Table 1. Information needs of farmers at different stages of adoption

	1. Functions	2. Kind of information needed	3. Preferred sources
Awareness	Become informed	Notification	Mass media channels, Fellow farmers, Agencies
Interest	Become informed	More details	Mass media channels Fellow farmers, Agencies
Evaluation	Self-persuasion (or legitimation)	Will it work for me? Local trial consequences • Economic • Social Opinion of trusted others • Mainly farmers Results elsewhere	Trusted fellow farmers, Trusted others
Trial	Decision to use	Application • How? • How Much? • When?	How-to publications, Local dealers, Self, Neighbours
Adoption	Confirmation	Own results, Experience of others	Own experience, Other farmers

3.4 Factors Affecting Rates of Adoption

It may seem logical that if farmers see a technology that is working in one farm system they would be quick to install that same technology in their own system. However, there are some key factors that affect the rate of adoption including:

1. Relative advantage to existing system
2. Cost
3. Compatibility (values, experience, needs)
4. Complexity
5. Experimentation (ability to experiment, instalments, divisibility)
6. Observation

In addition, motivational factors come into force in the decision to adopt and these can be influenced by size of the business, age of the farmer, performance of the system and farm goals, farming styles and attitudes. For example a late-career farmer may be reluctant to utilise the benefits of automation if it means up skilling computer expertise.

A survey conducted by Colmar Brunton for Dexcel (now DairyNZ) in 2005 categorised farmers into one of five types of adopters based on their survey responses. The categories were: Strategic Investor, Progressive Optimist, Striving Young Farmers, Passive Small Players and Concerned Sitters. Survey respondents were quite evenly spread across each category and the results are shown in Table 2.

These results give some indication as to why some farmers incorporate new (sometimes unproven) technology onto their farms while others resist. Most of it is to do with attitudes, individual situations, career stage and goals.

Table 2. Farmer groups and their general goals, barriers and the networks the Farm Systems Programme will target to reach them. (Based on Colmar Brunton survey, 2005.)

	Strategic Investors	**Progressive Optimists**	**Striving Young Farmers**	**Passive Small Players**	**Concerned Sitters**
Goals	Return on investment Balanced risks	Growth Performance	Growth and Progression Cash sufficiency	Lifestyle Cash sufficiency	Cash sufficiency
Barriers	Availability of skilled staff	Cost of land Low RoA	Cost of land Lack of capital Availability of skilled staff	Lack of motivation	Cost of production Suspicion of external forces
Priority topics	Feed harvested Labour productivity	Feed grown Labour productivity	Feed harvested Feed grown Animal performance	Animal performance Labour productivity	Animal performance Labour productivity
Primary Network leading change	People Training	Information Products and Services People	Information People Training	Products and services	Products and services
Supporting Networks	Information Products and Services	Training	Products and Services	Information People	Information People
Proportion of farmers In segment	16%	24%	22%	20%	19%
Farm size	Medium/Large	Medium/large	Small/Medium	Small	Medium
Possible productivity gain (%)	3.9	5.0	4.4	1.8	1.8

5.0 Farmer perceptions of technology

A major factor in the success of the New Zealand dairy industry has been the readiness with which technological advances have been incorporated into farming practice, often enough under the stress of falling prices and the necessity to vindicate land values resulting from excessive optimism in periods of rising prices." W M Hamilton (1942).

In the nearly seventy years since Hamilton was writing, similar influences have acted on the industry, and it has reacted similarly: new technology has been incorporated into both farming and processing to counteract cost increases.

Superior milking systems, the electric fence, improved animal health and breed, and other advances have all contributed to improvements in dairy farm productivity over the past forty years but this has not made dairying a more popular occupation; the number of dairy farmers has more than halved and the remaining farmers have maintained their living standards in the face of reducing real returns by increasing herd size. The number in the average herd had doubled to 120 by 1980 and is now 370. Doing this without changing the number of labour units on the farm has only been possible because of the technological changes that have occurred.

In a recent series of workshops (DairyNZ, 2011), farmers were asked to quantify their use of technology: what is being used on farm, what is lacking, barriers to use and adoption, processes for data management, key decisions and changes in decision making that have occurred since investment in this technology. The questions were limited to the use of dairy shed technologies (rather than all technologies on farm).

The workshops were held in four locations (Taranaki, Canterbury, Southland, Waikato).The farmers who took part in the workshops were not well known to DairyNZ extension staff. They ran large farms which tended to have higher technological input. All had rotary sheds ranging in size from 28 to 80 bails and participation in the study, required dairies to have a minimum technology of milk meters (to measure milk flow) and automatic cup removers (ACRs), with herd management software for data storage and retrieval. The farmers were early adopters of new technology (technology available on farm <5 years) and were users of other benchmarking tools (such as DairyNZ's DairyBase which allows an individual business to compare itself to other similar businesses in terms of management and location).

The workshops found that, in general,

- Labour is a key driver for investment
- There is a creative use of information to drive farm efficiencies (e.g. grouping herds on milking speed to reduce milking time)
- Over 75% say profit has increased as a result of investment but a higher level of skill is required on farm
- The farmers see value in facilitated learning groups

Summary of Workshops

Effect of technology on efficiency: For some farmers, technology meant boosting productivity without increasing labour requirements, while for others it was an opportunity to re-distribute or decrease labour requirements.

Animal Health: Farmers are subjective about issues such as mastitis and to a lesser extent, lameness and recent technological advances have meant that these problems can often be detected (with an associated number of false positives) long before they are seen visually. Conductivity meters are readily available for mastitis detection and internal rumen boluses which measure deviations from the norm in temperature (usually associated with oestrous or illness) are currently in the testing phase in New Zealand. The DairyNZ workshops showed that farmers are very keen to see progress in this area, and many are waiting for these technologies to be proven before adoption.

Main reasons for Investment: The main reasons given for investing in automation were to reduce labour requirements and to make milking easier. Attracting and retaining staff and providing efficient feeding for animals were important for approximately 50% of owners, while purchasing the technology for cow health, reproduction and culling decisions rated much lower.

Benefits of Automation: More than 90% of survey respondents agreed that the investment was worthwhile, more than 80% agreed it saved time, that it was simple to use the information in decision making, and that they would install again, while more than 70% agreed it had made herd management easier.

Limitations to the use of current technology: Survey respondents indicated that they were using, on average, 61% (range 20-95%) of the system capabilities but could potentially use 83% (range 25-100%). The most common response was they would like further automated technologies to complement those already installed. Other respondents wanted improved software or reporting capabilities and compatibility with existing software systems. Reliability was also a factor for a small percentage.

Farmers require support to get the most out of their systems. Information required by farmers varied widely. Some farmers only wanted the basic information out of their systems, (e.g. how many cows are in each herd, missing cow lists), but either the systems were not capable of generating this or farmers had not been given the support to generate these reports for themselves. Other farmers wanted more complex reporting such as being able to rank their herd on any parameter they desire, for instance milk quality, but there was the need for up-skilling time to get the best out of the technology. Many of the technologies were developed overseas and for different farming systems compared to New Zealand farming practices, so terminology and functions can be unrelated to New Zealand conditions potentially making the herd management programs harder to navigate and decipher.

Technology failure and reliability issues: Equipment specifically developed for housing conditions, yet sold in New Zealand to pastoral farmers, can mean the technologies are less effective when applied under New Zealand conditions (such as automated heat detection technologies). General reliability of the technologies was also debated. While some farmers were happy with the system they were using others reported regular failures in the technology leading to the conclusion that it was a "waste of time". Interestingly, when

farmers were asked if they had visited other farms prior to installing their system, the majority had not, although a small sub set had spoken with other farmers.

The famer discussions highlighted the disparity in expectations and use of the technology. Some farmers expected the system to meet their needs immediately while others had played with the system settings and/or their management procedure to "accentuate" the technology. A general comment was that products were not meeting expectations because systems were not doing what they should be capable of doing, as opposed to farmers expecting the systems to have more advanced capabilities.

Impact of investment on skill level required of people on farm: In general most felt that the skill level of staff needed to be higher than prior to installing dairy technologies, although some argued that it allowed greater disparity and therefore they could use lower skilled staff with key highly skilled staff members overseeing the more important aspects of daily farm management. Vulnerability through staff turn-over or illness/injury could then be an issue.

Influence on farm profitability and method of measurement:

1. Decision Making: The system assisted in decision making, such as preferentially feeding high producing cows, drying off decisions, identifying and treating animal health cases earlier than visual detection, averting a problem when cows were losing condition and the ability to make informed culling decisions.
2. Reduction in labour and capital outlay: Technologies such as automatic cup removers can replace a labour unit in the dairy or alternatively milking more cows per labour unit is possible. Although hard to measure, reduction in labour requirements or more efficient use of labour can lift profitability. Improved staff retention allows greater up-skilling of staff. If the technology cuts a whole labour unit, for some farms this will save the cost of a house and wages.
3. Other cost reductions: Flow on effects such as discontinuation of herd testing, better targeting of supplements to high producing cows. Profit from individual feeding might be linked to better reproductive performance and/or other herd health improvements.

Conclusion

The initial reason for purchase of the dairy technologies was to reduce labour and to make milking easier (more efficient and more labour-friendly). Common indicators of milking efficiency by farmers were cow throughputs and harvesting rates, though there was considerable emphasis on the effect on staff. Many farmers indicated skill of staff and cow behaviour were common factors affecting their milking performance, as well as the dairy design.

Most participants felt the technology had improved profitability, either through indirect (better decision making, redistribution of labour) or direct savings (reduced labour, decreased cost for health/vet/herd testing, less infrastructure), and the majority of farmers were positive regarding the performance of their dairy technologies. Dissatisfaction arose from non-user–friendly herd management software, the level of support or training offered by suppliers in the use of the software and double entry of data when using non compatible programs. Most farmers wanted the ability to generate their own customised reports and more up-skilling in software use. There was clear demand for user groups, provided by suppliers (particularly at a novice level) and potentially for advanced farmer user groups

Farmers also mentioned the lack of suitability of some equipment to NZ conditions and some with poor product reliability. Farmers want improved accuracy of technologies, in particular for heat detection and SCC/conductivity. Many want to see progress in herd management software and Minda compatibility.

6.0 Case Studies

The previous chapter focused on farmer perceptions of proven technology – ideas and inventions that through science and time have been proven to work and provide benefits. But what about the technology that is currently available but which has not been trialled extensively in the New Zealand farming system? This represents a cost to the farmer both in terms of capital outlay and risk management. Two case studies were undertaken – both of which involved some capital outlay: minor (<$5,000), and major (>$120,000). For both case studies, the technology has not yet been proven to be of benefit in the New Zealand pastoral dairy system so farmers have not had access to relevant scientific information to aid their decision making process.

The aim of the case studies was to evaluate the following:

- What were the changes made to the existing farm system?
- What prompted the decision to change?
- Who else was involved in the decision making process?
- How will the technology be assessed in terms of return on asset or profitability?
- If they were doing it again what would farmers change or wish they knew before they started?
- What could the industry do to help farmers make investment decisions?

6.1 Case study 1: River stones for calf bedding

The first case study looks at a relatively small investment (<$5000) on farm of changing the surface material that calves are housed and reared on. The majority of farmers rear their calves on farm so infrastructure is generally already in place. This investment represents a small change that most farmers could accommodate quite easily if they wanted.

Background:

The use of river stones as bedding material for calves is a management practice that is not common amongst dairy farmers but may be gaining popularity, particularly in regions where more traditional bedding material can be difficult and/or expensive to obtain. A small number of farmers (exact numbers not known) have been using river stones for a number of years and see them as a better option than sawdust or other conventional bedding materials.

To date there has been no scientific evaluation regarding the welfare of calves reared on river stones. In spring 2011, an observational trial is being conducted in the southern South Island comparing behaviour, thermal conditions and health of calves kept on river stones with calves kept on sawdust. The results of this trial are expected to provide a preliminary, objective assessment of the impact of river stones on calf health and welfare.

A total of nine farmers were interviewed and this is by no means a representative sample, but the feedback from this group provides some information about river stones as calf bedding from the perspective of those who have used or are using this substrate on farm.

Method:

The interviews consisted of 2 face-to-face and 7 phone conversations, depending on location of the farmer. A total of 33 predominantly open-ended questions formed the interview, covering the following areas: decision to change to river stones, advantages or disadvantages of river stones as experienced on own farm, shed set-up, stock observations, drainage and river stone maintenance, and plans for the future.

Of the nine respondents, 4 were from Waikato/South Auckland, four from Southland and one from Bay of Plenty. A range of durations of use of river stones was reported across the respondents – from only one season up to 7 seasons (average 3.4 seasons). All but one farm operated 2 calf rearing sheds, and farms reared between 300-2000 calves (average 680, median 475). A range of stone sizes were being used, from 20mm to 60mm (average 37mm) diameter. All farmers reported that it was easy to source river stones.

Summary

What were the changes made to the existing farm system?

The traditional sawdust/wood chip surface material was replaced with river stones. In some cases this required some minor changes in pen set up (larger/smaller pens, additional concrete and/or drainage) and in some cases no changes were required at all.

What prompted the decision to change?

All 9 respondents started using river stones as a result of positive word-of-mouth information either from other farmers or from calf rearing supply companies. Specific references were made to reports of better calf health, lower costs associated with materials and labour, and better hygiene.

Six of the nine farmers surveyed reported that they had heard about the use of river stones from one of two sources and this prompted them to try it. It appears that from the farmers contacted, two major influences in this area are at work – a local farmer in Taranaki who also uses river stones and a merchant based in Whangarei (who actually is not in the business of selling or sourcing river stone but actually manufactures and sells rubber ware and calf rearing implements). This indicates the power that word of mouth can have to influence change.

Who else was involved in the decision making process?

As previously stated, most had heard "good things" from the two sources mentioned but others involved in the change included the farm staff and more specifically the calf rearers (two of those interviewed were from Landcorp farms and this SOE has decided to trial this method on a number of its farms).

How will the technology be assessed in terms of return on asset or profitability?

At the moment the success of the change is being monitored in terms of visual observation of calf health and well being and the ease of use of the material. Comments from seven respondents reported a change in calf behaviour, including: running around more (4), lying

down more (3), lying down less (1), happier calves with less vocalisations (2). Five farmers reported that they had noticed changes in calf health, including: a lot less scours, less pneumonia, no hoof problems, no more naval infections, less arthritis, general improvement, less hair on knees (grows back once on pasture). When asked what they felt were benefits of continuing to use river stones, respondents said: easy to manage/clean, calf health better, recycling stones around the farm useful, keeping clean and dry, cost savings, less smell.

If they were doing it again what would they change or wish they knew before they started?

The main comment in this area would be that it is easier to manage a new build and install river stones than adapt an existing shed. For example, older calf rearing sheds tend to be fairly dark and with poor drainage. Using river stones to their maximum advantage requires plenty of light to dry them and absorb heat) and good drainage to facilitate the regular cleaning and disinfection.

Figure1. Calves being reared on a river stone surface

What could the industry do to help farmers make investment decisions?

More information required to advise farmers on; stone size and depth, cleaning requirements for optimising hygiene and minimising disease risk, importance (or not) of providing an alternative surface for sick or newborn calves and implications of re-using stones from season to season.

6.2 Case study 2: Construction of a facility to stand cows off pasture

The second case study looks at a relatively large investment involving some major infrastructure changes in the dairy shed and a complete change to the current farming system. The cost of construction of the shed was approximately $150,000 and it is able to hold the herd of 300 cows for as long as required. While having a facility to stand cows off pasture is not new technology as such, it is not common practice to cover the stand-off facility and the covering aspect represents a substantial additional cost to the build.

Background:

The farmers interviewed are a mid-stage Northland farming family who share milked on the family farm for 7 years before purchasing it outright 5 years ago. They milk 300 cows (split-calving) on 120 effective hectares of land. Improvements to the property and plant are a priority but only as cashflow allows – they are not willing to take on more debt. Technology use is limited on the farm at present (due to cashflow and the more pressing priorities such as securing water availability)) so their only other large purchase in recent years has been the addition of the ProTrack system (automatic weighing and drafting) to the dairy shed. However, the philosophy on farm is that if the technology is there and it can be incorporated into the farm system then it should be used. The main goal for the business is to get the owners out of the shed within the next ten years and have a succession plan to allow the children to take over the farm in the future if they have the desire.

Summary

What were the changes made to the existing farm system?

A Redpath shelter was erected in March 2009 which gives the ability to stand cows off pasture all months of the year if required. The shelter is constructed of a metal base, woodchip floor and a clear, heavy duty plastic roofing. Previously the only structure on the farm for standing cows off pasture was a woodchip pad of smaller dimensions.

Figure 2. A covered stand-off facility (left) and the more traditional uncovered stand-off facility after use during winter

What prompted the decision to change? What was the need identified?

There were two main reasons for the incorporation of the shelter into the farm system. These were control and animal welfare. Historically the farmers had grazed their dry stock off the property on lease blocks or at graziers. After a couple of consecutive years of stock returning to calve on the farm and being in poor condition, the desire to retain control of all stock

management developed. In addition, adverse climatic conditions meant that, in the farmers' view, the cows were not always being adequately fed even on the home farm and the Redpath shelter meant that cows could be fed to meet their requirements far more accurately.

What was the decision making process?

The initial stages involved information gathering from vendors and viewing similar shelters at field days (as none existed prior to theirs in Northland). The farmers found the perspective of the local merchant reps very useful in that they were (hopefully) unbiased and had the capacity to view a number of these buildings in operation as they visited farms in other areas.

Who else was involved in the decision making process?

The farmers have a "team" approach to decision making and will regularly meet with their accountant, bank manager and consultant together to ensure that they are making decisions with a view from every angle. They attribute some of their success in keeping costs to a minimum and an ability to repay debt to this team approach. So, the team was integral in determining whether to go ahead with the capital expenditure.

What are the benefits of the change?

Improvements in mastitis incidence, lameness, calf survival, cow condition and milk production have all been noted by the farmers and while this information is available there has been no analysis done to quantify the changes. Other less quantifiable benefits that were mentioned include fewer sleepless nights worrying about cows damaging pasture during wet weather, happier cows, fewer staff issues.

How will the changes made on farm be assessed in terms of return on asset or profitability?

At this stage, the returns are based on gut feel and no financial analysis has been done. However, the financial return is less important than reducing the stress factor and in that regard the farmers are happy that they are making good returns on their investment.

If they were doing it again what would they change or wish they knew before they started?

The farmers were happy with everything that had been done to date and the only aspect they would change would be the location of the shelter. It is on the side of a hill and doesn't allow for too much machinery movement in the vicinity. However, they were restricted in where it could be located due to existing infrastructure and for anything to have been done differently would have required a clean site and more cost.

What could the industry do to help farmers make investment decisions?

Information that would have helped in the decision making process included:

1. A cost: benefit analysis of the system that they could apply to their own situation;
2. The pros and cons of different systems;
3. Management of the shelters and the flow on effects it has to other area of the farm;

4. Some documented case studies and personal experiences from others who have used the system.

The origin of the information was not important to this farmer (i.e. he wasn't worried if it came from the vendors of the product or was published from an independent source such as DairyNZ). However he did acknowledge that this may be a concern for other farmers.

7.0 Conclusion

Innovation and the use of technology are not new to farming – they have formed the basis of farming since agriculture first began.

The manner in which farmers take up new technology and their reasons for doing so, are as varied as the technological improvements themselves. However, there do seem to be some commonalities in motivation amongst the farmers interviewed for this project.

They include:

- Improved profitability either indirectly (better decision making, redistribution of labour) or directly (reduced labour, decreased cost for health/vet/herd testing, less infrastructure)
- The desire for less dependence on staff (either skill levels or number)
- Better use of information and the ability to make decisions faster the ability to make decisions faster through better use of information
- The achieving of better fed and higher producing cows
- Less stress on themselves, their staff and the whole farm system

Some of the disadvantages of the technology were the level of reliability, the need to up skill staff, the incompatibility of the technologies. However, of those farmers interviewed both in the Rotary Benchmarking Workshops and for the case studies, very few were actually investigating how the use of technology on farm had actually impacted on their bottom line.

While following the Innovation/Adoption process some farmers would have liked more scientific evidence but were unwilling to wait for the science community to catch up. As an industry, dairying would benefit from having a process that identifies the innovators on farm and feeds that back to the research organisations for appraisal. In this way, the gap between identifying innovation and adoption by the wider industry could potentially be closed.

It is hard to imagine what technologies may be available in the future but a method to quantify how change on farm affects profitability may be what is needed before a larger proportion of the industry is willing to take up that change. .

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10.0 Glossary

Automatic cup removers	Automated device that removes the milking clusters off each cow following milking. The use of these frees up a labour unit at milking.
Bails	The stalls cows enter as they step onto the rotary platform
DairyBase	A web based software tool managed by DairyNZ that enables accountants and consultants to analyse farm physical information and financial statements. DairyBase also provides benchmark data allowing dairy farmers to compare their performance.
Milk meters	A device for measuring total milk yield on an individual cow basis at milking.
Minda	A software programme distributed by LIC which allows farmers to record all herd details and generate reports for making management decisions
Rotary	Rotary milking sheds consist of a turntable with 12 to 100 individual stalls for cows around the outer edge. The turntable is turned by an electric-motor drive the speed of which is determined by the time it takes to completely milk out the cows. The rotary system is capable of milking very large herds (over a thousand cows).
SCC (Somatic Cell Count)	An indicator of milk quality. Somatic cells are leukocytes (white blood cells). The number of somatic cells increases in response to pathogenic bacteria like *Staphylococcus aureus*, a cause of mastitis. The SCC is quantified as cells per ml. General agreement rests on the values of less than 100,000 cells/ml for uninfected cows and greater than 300,000 for cows infected with significant pathogens