THE JOURNAL

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The Official Publication of The New Zealand Institute of Primary Industry Management Incorporated

NZ Institute of Primary Industry Management

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NATIONAL OFFICE
Gleneagles Building
Level 3, 69 The Terrace Wellington 6011
PO Box 5304, Wellington 6145
Phone (04) 939 9134
www.nzipim.co.nz
admin@nzipim.co.nz

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PRESIDENT
Guy Blundell

CHIEF EXECUTIVE
Stephen Macaulay
stephen@nzipim.co.nz

EDITOR
Helen Greatrex
helen.gr@paradise.net.nz

EDITORIAL COMMITTEE
Nico Mouton, Jeremy Neild, Keith Woodford, Dave Gray, Phil Journeaux, Kevin Wilson, Jeremy Savage and Nicola Kloeten.

PRINT PRODUCTION AND ADVERTISING ENQUIRIES
The Printroom
(04) 473 1211
glenn@theprintroom.co.nz

NZIPIM MEMBERSHIP ENQUIRIES
Gary Walton (South Island)
027 496 4700 gary@nzipim.co.nz

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STEPHEN MACAULAY CEO

CEO's comment

What does the future look like for New Zealand lamb?

I have been pondering this question for some time. Having been brought up on a sheep and beef farm in the rolling hills of South Canterbury, and worked in the meat industry during the early part of my career, I have a great affinity and passion for the product. Yet I wonder what the future holds for lamb and our highly productive sheep farmers who continue to produce high quality lamb products for consumers across the globe.

Despite the national sheep flock having halved during the past 25 years to around 29 million, the amount of lamb exported to world markets has remained relatively stable, dropping just 2% to 385,000 tonnes. This is a positive indication of the inventiveness of both producers and processors alike.

New Zealand has one of the most productive flocks in the world. Our sheep farmers have made great strides in increasing productivity through better on-farm management systems and genetic improvements. But have the on-farm productivity gains been rewarded to reflect these improvements, or are they simply needed to keep pace with increasing cost structures within the farming business? Can these gains be reduced to a cost savings argument in response to declining revenues on-farm?

Over the last 10 years, the average lamb farm-gate price has increased by 60% in nominal terms and 29% in inflation-adjusted (real) terms (see **Figure 1**). Part of the increase has been the price signal to produce heavier lambs and the average carcass weight has increased 5% (+0.85 kg) over the decade. Over the same period, inflation in the price of farm inputs has been 23%.

There has been a steady decline in the national sheep flock over the last 25 years for a number of reasons including: dairy conversions of high-performing lamb finishing areas; changing land use such as subdivision of land into lifestyle blocks near metropolitan areas; the loss of extensive high country land to the DOC estate; and the reversion of uneconomic land to scrub and in the 1990s when whole farms were converted to blanket forestry.

Land farmed under sheep, beef, goat and deer pastoral systems decreased by 3.9 million ha (-31%) from 1990-91 to an estimated 8.6 million ha in 2015-16. Over the same period the amount of land used by dairy farms has increased by 1 million ha to 2.37 million ha (Beef + Lamb New Zealand Economic Service estimate based on figures from Statistics NZ).

It is truly remarkable that although some of the best sheep and beef farmland has been lost to other uses, lamb production on a carcass weight basis has only dropped around 2% since 1990-91.

It is truly remarkable that although some of the best sheep and beef farmland has been lost to other uses, lamb production on a carcass weight basis has only dropped around 2% since 1990-91.

In terms of future supply, the prevailing view is that the New Zealand sheep flock is expected to continue to fall, but at a much slower pace in the future with a continued offset of ongoing underlying productivity growth.

The market

New Zealand accounts for 5% of world sheepmeat production and supplies over half of the world's lamb exports. By volume, our biggest market for lamb is still the European Union (EU), ahead of North Asia, taking 42% and 32% respectively.

European Union

Approximately 40% of New Zealand's lamb export volumes are to the EU, and about half of that is to the UK. This includes steady growth in sales of chilled higher value cuts for the Christmas and Easter periods.

In the UK and most other markets, retailers do not like to alter prices as price increases lead to consumer resistance. Consumers generally face a steady price regime, but the wholesale market that New Zealand exporters sell into is more volatile than at retail. This is further compounded by currency fluctuations between GBP and the NZD.

Overall, there is lower sheepmeat consumption in the UK than 15 years ago largely due to the competitiveness of alternative protein sources. Per capita sheepmeat consumption in 2000 was 6.6 kg, but by 2014 it had declined to 4.6 kg. Lamb is the highest priced meat protein followed by beef, pigment and then poultry. This price relativity pattern is the same across most markets.

New Zealand sheep farmers have made significant productivity gains over the last 25 years through better on-farm management systems and a focus on genetic improvement.

China

New Zealand's sheepmeat exports to China are heavily dominated by lamb value cuts and mutton. China is our largest volume market for mutton, but it also takes around 30% of our export lamb. The value of lamb exports to China has increased 350% over the last five years from $102 million to $459 million.

China has been underpinned by rising sheepmeat consumption and a lift in disposable incomes. However, future in-market values will be moderated by growing domestic production of their own flock, and for the short term a looming Chinese economic slowdown. Overall, China has a significant growing middle class that has sufficient income to make choices about what they consume.

Looking to the future

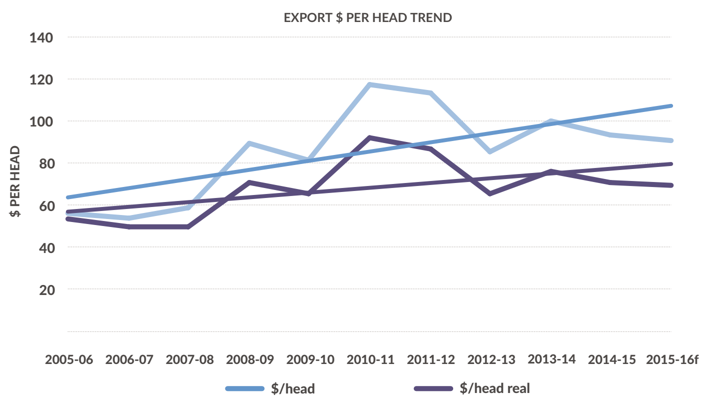
New Zealand sheep farmers have made significant productivity gains over the last 25 years through better on-farm management systems and a focus on genetic improvement. There is an expectation that similar productivity gains can be made in the future with a large proportion of the flock on a genetic improvement path that will continue to lift overall productivity at a national level. But can we expect or be reliant on achieving similar gains over the next 25 years?

In New Zealand we have an aging group of sheep farmers, typically with high equity positions in their farm businesses. According to UMR research funded by the Red Meat Profit Partnership there is greater resistance to change within the older farmer demographic group. The key question for the industry is how to encourage and motivate the uptake of new information and knowledge in striving for increased productivity at a pace similar to that of the last 25 years.

Looking to our markets, New Zealand lamb racks, loins and leg cuts are high-end market products competing for shelf space with alternative protein sources. As it stands we have a niche product in a niche product category. The focus now clearly needs to be on growing demand for premium New Zealand lamb cuts with affluent consumer groups in select international markets as well as increasing the value of other lamb cuts, offal and lamb skins. But such conclusions are not new and mimic past commentaries on the industry, accompanied with bookshelves weighed down with various reports saying the same sorts of things.

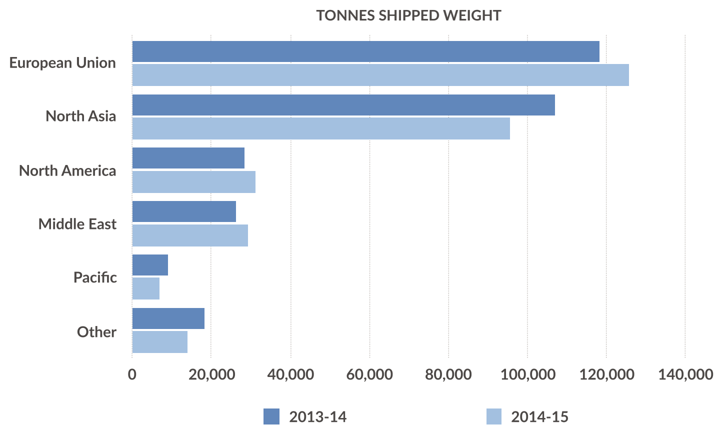
In writing for *The Journal* in December 2014 Sir Graeme Harrison (Chairman of ANZCO Foods Ltd) succinctly summed up the situation as follows: 'Important elements for success require developing a credible provenance story based on deep integrity systems, which are linked to specific consumers, often via a partnership value chain. For this to grow, true partnerships will be vital between farmers, processors and other links in the value-added chain. The trader and transactional relationship which has characterised the New Zealand meat industry to date will need to change.'

Figure 1: Diminishing supply offset by increased productivity gains



Source: Beef + Lamb New Zealand Economic Service

Figure 2: Export lamb markets



Source: Beef + Lamb New Zealand Economic Service

The question is whether there is the appetite within the sheepmeat industry to move toward a true partnership of trust between farmers, processor-exporters in the value chain and the consumer. Or do we accept the industry as it is and simply ride the commodity cycle grumbling when prices fall and saying nothing when prices rise?

Do we protest the need for closer alignment between the farmer and the first stage processor in the knowledge that it will take time, effort and energy to ensure that products better meet specifications? The industry does not appear to be without considerable opportunity, but that opportunity appears to sit mostly beyond the realm of the simple transactions that may have served the industry adequately for the last 150 years. J

KIM RICHARDSON AND GREG BRYAN

Options for enhancing the growth and energy components of NZ pastures using a genetically modified approach

Off-shore field trials and animal nutrition studies are required to test a new genetically modified ryegrass developed by AgResearch, which may offer solutions to reducing environmental impacts and increase pasture productivity.

A New Zealand brand

High quality agricultural products from grass-fed animals is a New Zealand brand. A favourable climate and extensive pastures, combined with world-leading farming practices, has given us an international reputation in agricultural production and provides a point of difference in the world marketplace.

A significant factor is that our pastures are used to grow forages of the highest possible quality in order to maintain this competitive advantage in agricultural production. However forages generally lack the level of nutrition that allows the feedlot industry to achieve approximately double the productivity of pasture-based systems.

> With government targets for increased productivity from the primary sector and reduced environmental impact, genetically modified technologies may offer solutions to these two challenges.

Metabolisable energy

Accumulation of dry matter and energy content are the key drivers of pasture production and is referred to as metabolisable energy (or ME, measured in megajoules per kilogram of feed, MJ/kg DM). Where there is a shortfall in metabolisable energy the use of supplementary feed is increasingly used to compensate. However this can be an expensive option comprising a high proportion of the total farm budget. Given the productivity of the feedlot industry and the costs associated with supplementary feed, it needs to be considered whether similar results can be achieved by growing a higher quality pasture.

With government targets for increased productivity from the primary sector and reduced environmental impact, genetically modified, or GM, technologies may offer solutions to these two challenges. The Plant Biotechnology team at AgResearch has developed plants which utilise genetically modified technology to increase both the metabolisable energy and the biomass of perennial ryegrass, the most common pasture grass in New Zealand.

High metabolisable energy and lipids

This internationally significant breakthrough has been achieved using a technology known as high metabolisable energy, or HME. It is the result of a long-term research programme that aimed to increase foliar lipids to 8%, which approaches the levels used in the feedlot industry in an attempt to substantially boost the metabolisable energy available in a forage diet. However the real innovation of high metabolisable energy is the significantly enhanced growth rates of these plants.

Lipids were chosen as they are the densest source of dietary energy – greater than either carbohydrates or protein. In this case lipids in the form of triacylglycerol (TAG) are the target. Initially, a non-genetically modified feeding trial was used to test the feasibility of the high metabolisable energy technology. Here pasture-fed ram lambs were supplemented with lipids to simulate levels expected in high metabolisable energy ryegrass. This resulted in a 15% reduction in dietary intake to achieve the same carcass weight, combined with a potentially healthier fat profile of the meat, i.e. increased unsaturated and reduced saturated fatty acids.

Typically the lipid level in the foliar portion of forage plants is about 3.5%, which mostly forms the membrane component of cellular organelles. The greatest variation in the level of leaf lipids are seasonal and developmental (higher in winter, lower in summer and lower in reproductive plants) with a very limited genetic variation across the available germplasm. As such, this limits the ability of plant breeders to exploit lipids as a trait using traditional plant breeding methodologies.

Beyond their role as a component of cell membranes in plants, lipids are also known to accumulate as oil bodies in seeds and pollen, e.g. in canola and other oil seed crops. The high metabolisable energy technology breakthrough used a unique approach that enables seed-like oil bodies to accumulate in the green tissue of plants. This is achieved through the expression of two genes in the leaf; the first elevates lipid biosynthesis, and the second encapsulates the lipid to form oil bodies.

Figure 1: High metabolisable energy technology allows ryegrass to grow about 40% faster than the controls

While expression of the first gene alone does temporarily elevate lipid levels, these lipids are soon broken down and do not accumulate. This is where the second gene is important because it is responsible for forming a protective protein coat around the micro-lipid droplets as they form, producing oil bodies that resist breakdown. Stable oil body accumulation has been measured in ryegrass up to four weeks after cut-back (simulated grazing).

Enhanced growth rate

While the high metabolisable energy plants are visually indistinguishable from other plants, their growth rate is up to 40% faster than plants of the same cultivar. In a pot trial designed to simulate grazing, where plants were clipped every three to four weeks and allowed to regrow, the Plant Biotechnology team showed that this enhanced growth rate was consistent over a long period (over 30 months so far). This enhanced growth rate is a direct consequence of increasing the lipid levels in these plants.

The fatty acid synthesis occurs initially in the chloroplast and produces CO_2 as a by-product of that process. This CO_2 is then directly accessible to the photosynthetic machinery within the chloroplast. As the high metabolisable energy plants have a continuous demand for fatty acid biosynthesis to provide the precursors for TAG, the plants have an increase in the level of CO_2 recycling. Therefore the enhanced growth rates are due to an increase in CO_2 assimilation or, in other words, more efficient photosynthesis. The increase in carbon assimilation has been measured at 24% in Arabidopsis (the plant scientist's lab rat) and 20% in high metabolisable energy ryegrass.

The proposed mechanism behind the increased growth rate in effect means that the high metabolisable energy plants have a photosynthetic rate more like C4 species, such as corn and sugarcane, rather than a C3 plant. It is quite possible that high metabolisable energy ryegrass

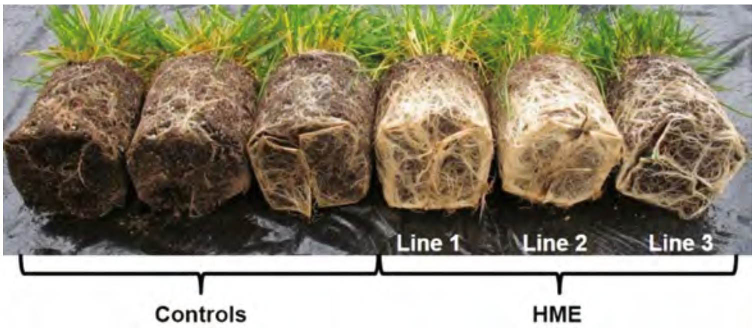


Figure 2: Plants modified with the high metabolislable energy technology have significantly enhanced root systems

may also behave more like C4 plants in terms of water use efficiency in drought conditions or high temperatures. The importance of the high metabolisable energy breakthrough can be put into a context where attempts to convert C3 rice into a more productive C4 species have attracted funding by the Bill & Melinda Gates Foundation (C4 Rice Project at the International Rice Research Institute).

Intellectual property

The high metabolisable energy technology has generated a significant amount of intellectual property throughout its development and, at this stage, is tightly protected by a broad family of patents. This protection ring-fences high metabolisable energy for commercialisation in New Zealand-based plant species where benefit accrues to our agricultural sector, but also allows for licensing of crops outside of the New Zealand sphere of interest. For instance, the use of high metabolisable energy in soybean has been licensed in the United States to the biotechnology company Zeakal Inc.

Through Zeakal, AgResearch's Plant Biotechnology team has unencumbered access to information and resources that can be used to develop high metabolisable energy white clover and lucerne. Within New Zealand, in addition

The high metabolisable energy technology has generated a significant amount of intellectual property throughout its development and, at this stage, is tightly protected by a broad family of patents.

to ryegrass the high metabolisable energy technology has been introduced into white clover, lucerne and camelina (an oil seed crop). In all cases the high metabolisable energy trait has expressed as expected, suggesting a wide applicability of this technology for many crop species.

Biophysical modelling

Biophysical modelling has been used to explore the potential of high metabolisable energy forages in dairy, and beef and lamb production systems. The modelling and laboratory work conducted so far for dairy suggests that a farm using this technology could expect a 12% increase in milk solids production, improvements in birth rates and possible increases in live weight gains, while at the same time achieving a decrease in greenhouse gas emissions (17% decrease in N_2O, 15-30% decrease in methane).

Farmers would have more options for pasture management due to greater pasture growth rates, improved drought tolerance due to enhanced root systems, and improved water use efficiency. It is possible that changes in milk and meat lipid composition may provide human health benefits due to an improved ratio of unsaturated to saturated fat. Similar benefits in productivity are expected for a sheep and beef farm. The effect of ensiling high metabolisable energy ryegrass is also underway as part of a postgraduate thesis in collaboration with Massey University.

Translating glasshouse results into the field

Since the high metabolisable energy ryegrass was developed using genetically modified technology, the plants have only been grown in a secure greenhouse environment. Exactly how much of the enhanced growth rate and energy benefit measured in the glasshouse experiments will transfer to the field is yet to be determined. Based on international Free-Air [CO_2] Enrichment (FACE) studies where plants grown in increased CO_2 environments have increased photosynthesis and significantly higher yields (15%), we would expect a significant proportion of the increased glasshouse growth to be translated into the field.

Understanding how high metabolisable energy varieties may perform in a typical paddock is essential. This would include determining the optimum expression of the trait, how it performs within a mixed sward, and the ideal fertiliser and water management for maximal performance and maintenance of fungal endophyte associations. It will be important to identify if the plants are more or less susceptible to stress, insect predation, disease, have normal reproduction, and also assess their response to water stress. To do this carefully designed field experiments need to be performed and replicated in multiple environments over several seasons.

It will also be essential to conduct animal nutrition trials to measure animal performance, safety, metabolism, determine the fate of the additional lipids in animal products, measure greenhouse gas emissions and identify if there are any negative effects. It is not possible to conduct these types of studies as enough feed cannot be produced from plants grown in a glasshouse.

However there are major hurdles to growing high metabolisable energy ryegrass in the field in New Zealand. At present the Hazardous Substances and New Organisms Act 1996 imposes significant burdens on developing innovations such as high metabolisable energy forages or any genetically modified plant. The field trial provisions of the Act are not suitable for conducting large-scale field experiments and the conditional release provision presents a catch-22 scenario, which requires knowledge from field trials to help identify the regulatory controls for the release.

AgResearch has a three-step plan toward field testing high metabolisable energy plants:

- Field trials of high metabolisable energy soybean (Zeakal Inc) has USDA-APHIS approval and are planned to start in May 2016
- Following consultation with industry stakeholders (Dairy Industry Leaders Forum, Dairy NZ, Beef & Lamb and selected seed companies) it was agreed that high metabolisable energy ryegrass field trials and related animal nutrition studies will be conducted overseas. These trials are planned to start in the northern hemisphere summer of 2018
- Knowledge gained from these trials will be used to inform industry and regulators in this country about the costs and benefits of New Zealand field trials. If the decision is made to proceed and approval is gained these new trials will occur from 2021-2024 and be released to the market from 2025.

Summary

High metabolisable energy technology has been used to generate a ryegrass with significantly greater dry matter production and potentially increased energy content. Modelling work also indicates significant benefits for greenhouse gas mitigation. Field testing of these plants is needed to ensure that the enhanced qualities actually occur under New Zealand farming conditions. AgResearch is looking to perform the initial field tests and animal nutrition trials offshore to obtain animal nutrition data to support any application to perform New Zealand-based field and animal nutrition trials.

KIM RICHARDSON is a Senior Scientist in the Plant Biotechnology team at AgResearch in Palmerston North
Email: kim.richardson@agresearch.co.nz
GREG BRYAN is a Principal Scientist in the same team.
Email: greg.bryan@agresearch.co.nz

JOHN HARTNELL

Unprecedented growth & challenges

The road to prosperity can be full of potholes

Apiculture: the skill of the beekeeper to work with nature, support and nurture the hive and its workforce, and provide optimum conditions for harvest success.

Economic growth

Apiculture sounds simple, but in reality this is not the case. As an industry we have enjoyed a 10-year period of substantial growth and economic prosperity, with international receipts rising from $30 million to $300 million. The sector has witnessed a massive leap in new entrant beekeepers and hive numbers and this trend is expected to continue. However with it comes some unrealistic expectations and potential potholes which the industry must address.

Apiculture's contribution to New Zealand's GDP is substantial – the projected figure of direct revenue earnings combined with the results of our pollination activity in horticulture and agriculture exceeds $5 billion per annum. Seventy percent of all pollination activity in the world is done by the honeybee – clearly as an industry we fly well under the radar.

Looking back to the 1980s and 1990s, the industry was supported by the revenue generated from pollination services and pastoral honey production. During this time hives were domiciled on permanent apiary sites

Apiculture's contribution to New Zealand's GDP is substantial – the projected figure of direct revenue earnings combined with the results of our pollination activity in horticulture and agriculture exceeds $5 billion per annum.

where the farmer traded pollination requirements, in particular white clover, for honey production rights. It was a sound relationship; the requirement for direct nitrogen application was offset by the benefits of the pollinated clover seed falling back to the soil. The outcome was sustainable and balanced with the pollinated seed providing many years of ongoing benefit.

From the beekeeper's perspective traditional sheep, beef and arable farming were conducted on properties with good shelter belts, used as flight paths, and those very 'bee' beneficial gorse hedges, one of the primary sources of pollen for the hive. Prices for honey were stable, but returns could only be described as 'lifestyle' rather than commercial. Our export efforts focused on the European market where honey was a tradeable commodity, and while New Zealand quality was respected it did not carry a serious premium. The exception was organic honey varieties.

The bee workforce

In comparable human terms pollen is the vitamin and minerals, while nectar (honey) is the food and energy that maintains a healthy bee. Over the course of a season the hive will consume in excess of 25 kg of pollen and up to 70 kg of nectar just to make the necessary brood and collect all they need to survive the year. This means for a beekeeper to produce a viable crop, the surplus above the sustainability of the hive, total honey production must exceed 100 kg of honey per hive.

So how is this achieved? With a nectar yield of 17 mg per 100 flowers, this will mean the worker bee, which can carry a nectar yield of 90% of its own body weight, must make 580 million flower visits to deliver this production outcome per hive. No unions, no sick leave, no holiday pay – just hard graft by a workforce totalling close to 65,000 per hive. Simply outstanding!

Varroa mite

Fast forward to the year 2000, the industry faced a serious game changing event when a devastating biosecurity breach occurred with the discovery of the deadly varroa mite in the Auckland region. We were an industry unprepared with no tools in the toolbox to fight back. How did this happen, who was to blame, could we eradicate and was this actually possible? So many questions and simply no answers. Opinions were varied, particularly between government and industry, and tensions where frayed.

We were to find out that the varroa mite came at a substantial cost, not only to our industry but also to those who required the honeybee to deliver commercial pollination outcomes. This burden remains today because without human intervention all the honeybees in the country would now be dead. It took 13 years for the varroa mite to reach Southland; the annual cost of management is estimated at $20 million per annum.

Positive mānuka industry

Whilst varroa has had a major impact on how we manage our hives, on a positive note we have seen the rise of the mānuka industry. The pioneering work of Dr Peter Molan led to the discovery of the anti-bacterial properties

Mānuka honey commands the highest price of any honey in the world, demand is at an unprecedented level, and through the ongoing marketing activities of our export community our industry is riding a super wave of success.

The honey harvest

of native mānuka honey. It was a lightbulb moment and signalled the start of an amazing journey for many in the industry.

Historically mānuka honey was unsaleable, extremely difficult to extract from the honey comb, and the taste was something the New Zealand public would not accept. We preferred white creamed pastoral honey. Beekeepers fed the mānuka comb honey back to the hive in the spring, rather than attempting to process it. The hives thrived and honeybee health was very good, making sense really when we look back.

Today what a very different story. Mānuka honey commands the highest price of any honey in the world, demand is at an unprecedented level, and through the ongoing marketing activities of our export community our industry is riding a super wave of success. It can roll on or break!

Mindful of the potential challenges, and the need for continual improvement, we must always be attentive and understand that what goes up may come down. Are we working as smart as we can, and do we understand that the rise and fall of industries can be dramatic and inflict serious pain? Others within the agriculture sector understand this very well.

Integrity and compliance

The impact of rapid growth has brought with it new challenges, new attitudes and a breed of revenue-driven stakeholders who have put aside respect, integrity and long-term relationships in favour of the mighty dollar. Not only are we seeing this at the beekeeper level, with apiary sites swamping production areas and serious overstocking, but now the landowners and some government agencies are seeking a slice of the gold rush. Is it time to take stock and put some reality into the discussion?

Couple this with an escalating increase in compliance requirements and the tightening of our export market access criteria, add the need for full and transparent traceability from the hive to the jar, there is an industry having to grow up in a big hurry. For those who do not like change the option to exit the industry at this point is very attractive. Hive values have risen 10-fold and there are a steady stream of very keen buyers.

Changes and challenges

The following explores some of these changes and challenges in more depth, starting at the beehive, the wooden variety.

Bee health

To deliver the best outcomes, the health of the bee stock is paramount. Varroa mite has already been mentioned. During the act of feeding off the live bee the mite pierces its body which creates exposure to bacteria, viruses and pathogens. This erodes the bee's natural defences and dramatically reduces its lifespan.

We know our bee stock is currently in a precarious position and it would only take the arrival of another major bee disease to potentially tip the balance and place beekeeping and the honey bee on the endangered list. It is important to note that it is illegal to feed drugs and antibiotics to bees in New Zealand, so the integrity and quality of our honey and live bee stock is very high. Our country is unique in this matter as it is common practice to feed drugs and antibiotics in most countries today.

Biosecurity

The industry opposes the import of any bee products into New Zealand. The current status is that there is no import health standard for honey or bee products in place, except for some historical trade in bulk honey with the Pacific Islands, from countries where there is no known risk. We will vigorously defend this position. The industry is clear; this is not trade protection, but it is paramount that we ensure that no further risk is placed on the health of our bee stock.

Why do we take this stand? Simply, honey, pollen, other bee products and used hive components carry bacteria and viruses and a graphic example of this is the kiwifruit industry and PSA. It was through the import of pollen from overseas that PSA most likely entered the country. By using this pollen and spraying it in orchards to boost pollination that industry mistakenly spread this plant disease – the rest is history.

Our nearest neighbour is Australia, a country keen to see their honey products on our shelves, but we do not share the same honeybee pest and disease profile. Australia fortunately does not have the varroa mite and

Migratory beekeeping has become the norm. The practice of permanent apiary sites has been replaced with seasonal sites and the chasing of the honey crop.

this is something they will vigorously protect and rightly so. In New Zealand we do not have European foulbrood, or EFB, a deadly disease that infects the brood in the hive, nor do we have Israeli paralysis cirus or the devastating hive beetle. All these are present in Australia, with European foulbrood treatment being antibiotics as the preferred management tool.

The New Zealand apiculture industry does not support the management practice of drug feeding, as it masks other disease activity in the hive and bee health is seriously compromised. Should European foulbrood be added to the current New Zealand varroa cocktail the apiculture industry would be in serious trouble, as would other industries that are reliant on pollination services. Where would the kiwifruit industry be without the honeybee?

Biosecurity and the protection of our industry from new pests and diseases are not negotiable. If required, our industry will go to the people of New Zealand for their support to ensure our bee stock and bee health is protected. We are all beneficiaries of this amazing insect and its activities.

Critical resource

The face of farming has changed dramatically over the last 10 to 15 years, as we have seen the removal of shelter belts and hedge lines in favour of open spaces and post and wire. Traditional pollen-foraging resources have been stripped away, such as gorse, broom and now willow, and the pasture of old based on white clover has been replaced with grass-only varieties. This new face of farming can only be described as 'hostile' to the honeybee. It is devoid of pollen and the honeybee is severely exposed to the weather as these safe corners of the farm have been lost. We are experiencing pollen dearth in many regions, with overstocking of hives compounding the issue.

Seeing this outcome approaching, the apiculture industry launched the Trees for Bees programme seven years ago. It is a proactive industry initiative designed to educate and assist landowners to understand the needs of our industry, provide plant guides, and help to develop farm management and planting programmes that benefit all parties, especially the critical honeybee pollen resource.

The beekeeper

Today, for many, migratory beekeeping has become the norm. The practice of permanent apiary sites has been replaced with seasonal sites and the chasing of the honey crop, in particular mānuka, from Northland to Wellington and Nelson to Bluff. Whether by helicopter or truck, this practice comes at a cost. The honeybee is put under greater stress, is exposed to more disease risk, the pollen resources available are generally of poorer quality, and there is no guarantee the apiary sites will yield sufficient nectar to generate a surplus for the beekeeper. With the massive increase in hive numbers, the big question is where are they placed after the honey flow has ended?

We all appreciate that change is a common factor in a modern business world, but the transition from traditional practice to new generation beekeeping will take some adjustment. Let us hope that common sense and not greed wins out on the day. It is a work in progress.

The landowner

As beekeeper returns have increased, so has the desire of landowners to clip the ticket along the way. There is nothing wrong with this, and recognition of ownership of the nectar resource is fair, provided it is structured correctly and the risk is shared by all parties. If there is no crop because of climatic events, there is no money available for anyone. What must also be recognised is the benefit the landowner receives from clover pollination and the subsequent nitrogen gain. So careful thought is required as different regions produce different outcomes, as 'one fit for all' will not work.

The market

The irresponsible actions of a few can destroy markets and industry member's livelihoods. This has heightened the need for greater compliance, improved traceability, and competent management of what is a high-value food and health product. These issues must be addressed with urgency to protect and strengthen New Zealand's market presence. The industry must take responsibility and lead by example – there is no room for complacency.

Industry representation

After many fractured years the unification of our industry under one peak body – Apiculture New Zealand – has been achieved. This is without question a milestone moment of significant importance to all stakeholders in the industry. From this base it will be critical that our industry builds on the platform, speaks with one voice, and delivers positive outcomes for the benefit of members and other key industries that are reliant on the activity of the honeybee.

The future

Clearly there will be rationalisation; the export packing network will become smaller as the large players with serious bank accounts seek to protect their markets and dominate the purchase of the bulk honey supply. Coupled with this will be a drive by these same organisations for more vertical integration and beehive ownership, something which is becoming more evident on a daily basis.

What will our industry look like in 10 years' time? Where will everyone fit? I am confident that there will be a place for all stakeholders at the apiculture table.

JOHN HARTNELL is a Member of the Executive Council of Apiculture New Zealand based in Wellington.
Email: john@hartnellnz.com

STUART ORME

MĀNUKA

A rapidly growing industry

There was a time when the government paid farmers to clear mānuka from their land. What has changed? This article unravels the issues surrounding the source of New Zealand's 'liquid gold'.

Global demand for high-value mānuka products is increasing. New Zealand's marginal landowners are uniquely placed to take advantage of this, but developing a sustainable venture based on mānuka is not necessarily straightforward. There are many practical and economic aspects to consider.

The market for mānuka

The main product of the mānuka tree (*Leptospermum scoparium*) is, of course, honey. New Zealand honey exports have experienced an exponential growth rate over the last 10 years. This makes it one of, if not the, fastest growing land-based industry, with the main driving factor being the increasing prices and demand for mānuka honey.

With international acceptance and understanding of the medical opportunities mānuka has and can provide there is a justifiable expectation that the growth limits are sustainable, if managed well, for some time yet. Prices range from $18 to $130+/kg, depending on 'activity'. There are also now a wide range of products that use mānuka honey including:

- Food and beverages
- Skincare, soaps and lotions
- Natural health products – throat lozenges and cough medicines
- Medicinal products – used to treat wounds and infections. The anti-bacterial quality of mānuka honey has been scientifically proven, largely due to the research efforts of the late Dr Peter Molan and associates.

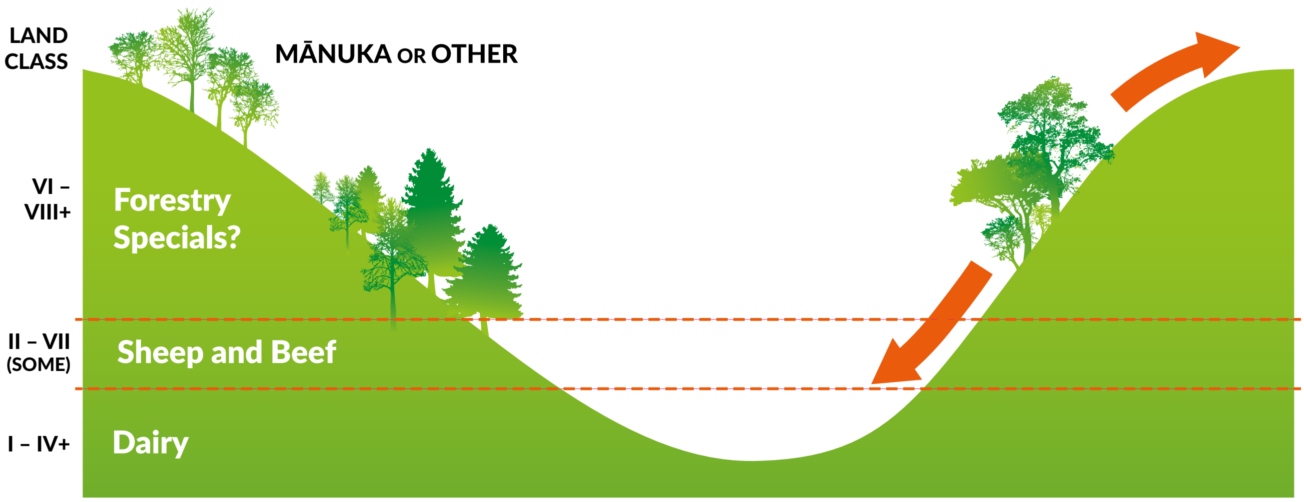
Tea tree oil, also well known for its medicinal and therapeutic properties, can be derived from mānuka foliage. An average mānuka stand could potentially produce 2-4 tonne/ha/annum on a biannual managed basis. Income can be in excess of $100/tonne (after costs) for foliage. If the foliage is harvested after flowering, a stand may take advantage of both honey and oil crops.

Understanding the mānuka honey value chain

Most apiarists place hives on other parties' land and compensate the landowners accordingly. Gone are the days where the beekeeper drops off a pot of honey (almost). Examples of current agreements between the

> **WHAT DO WE MEAN BY 'ACTVITY'?**
>
> *The term 'activity' as it relates to mānuka is used to describe its antibacterial activity. In the case of mānuka this varies in scale, with higher-rated activity levels being used for medicinal products and enjoying an increased price premium (higher activity = higher price) in the marketplace.*

Figure 1: Land class use opportunities



apiarist and landowner vary and may be based on a percentage of profit, a dollar value per kilogram of honey harvested, payment per season per hive, or a mixture of all these arrangements.

It is recommended that landowners always seek independent advice prior to entering into any agreement. Once happy with the operator they are going to work with, it is best to give the beekeeper at least two years' access before judging the results as climate, flowering and eventual volume can be outside of the apiarist's control. When happy with the partnership, a long-term contract should then be considered which allows both parties to manage it and the joint returns to the best possible outcome.

What is the best land use?

The underlying question for any production opportunity has to be "what is the best land use?" There will be a matrix of solutions depending on land type (suitability and productivity), economic factors (harvest costs, distance to market etc) and landowner aspirations.

Figure 1 (previous page) illustrates the perception that 'good' land can and should be used to produce food. This then leads to the question of 'what is the best marginal land use?', which is invariably some form of vegetation. This article is not meant as an incentive to rush out and change current land use just because the return on investment looks better than the current options. It simply provides information for consideration of mānuka as a crop, whether managed (by stopping the regular clearing) or by planting.

For best bee performance

Honey returns from mānuka depend on the bees' ability to harvest the nectar and process it in the hive. The easier it is for the bee to operate the more likely the crop will be maximised. An ideal hive site may:

- Have a basin with an all-around aspect, with a sheltered hive location in the bottom by a water source that can be easily accessed and kept secure
- Have a native mānuka population with high activity nearby (if a planted crop) which can add initial cash flow as young plants gets established. The native trees could be managed out and replaced with better material over time
- Not have any neighbouring operators/vegetation that might attract the bees elsewhere
- Be located in a position where bees need to fly over mānuka to get to other more appealing sources of nectar further away, which will prompt the bees to choose the mānuka for ease of proximity.

The above factors are common to both reverted mānuka and the planted mānuka crop.

The quality and quantity of honey available annually is not guaranteed, more so from a natural resource where the plant parentage will be variable and often exposed to honey dilution from other plants that attract bees.

Mānuka as a vegetation of choice

The benefits and challenges for mānuka as the vegetation of choice are summarised in **Table 1 (**below):

Existing resource

By far the most profitable option for a landowner is to receive income from an existing mānuka resource on their property. With an existing resource there is an opportunity to effectively 'mine' it for mānuka honey at no initial additional cost, other than perhaps access establishment. This income can exist until the seedlings growing beneath the mānuka break through the canopy and replace the mānuka nurse crop.

Table 1: Benefits and challenges of mānuka

Benefits	Challenges
Effective erosion control Biodiversity enhancement Commercial opportunities	Mānuka is a primary species in that it naturally dies out when larger trees supersede the canopy. Unless a significant area of mānuka is established or managed there may not be a mānuka industry in 50 years' time
In some cases, mānuka is a resident species as part of the natural reversion process, which can be an advantage	The landowner has no influence on climate and associated flowering success leading to annual variability
Riparian planting – consider supplementary bee fodder plants	Lack of clarity of information within the industry
Improved water quality Proven demand for products Increased returns on current land use	Market challenges: ▪ integrity in the rating and labelling of mānuka honey ▪ potential growing pains in the current exponential growth in this sector

Table 2: Return to landowner from an 'existing' mānuka resource

		10% share		20% share		30% share	
Activity	$/kg	$/hive	IRR	$/hive	IRR	$/hive	IRR
5	$18	$5	0.45%	$45	36%	$90	68%
10	$35	$43	34%	$130	96%	$218	159%
15	$55	$93	70%	$230	168%	$368	266%

Improved honey returns for an existing and emerging mānuka are potentially available through:

- Active management by removing competing pollen sources
- Additional plantings of improved material of a higher activity rating
- Removing transition species in order to suspend the reversion process and retain the mānuka crop on-site
- Planting support species such as pussy willow, flax and five species (see www.treesforbees.org.nz) which can feed bees outside of the mānuka season, which provides an opportunity for hives to stay on-site all year round. This ensures a robust healthy bee population capable of maximum honey collection in what is normally the short window available to it.

A working example

As noted, the quality and quantity of honey available annually is not guaranteed, more so from a natural resource where the plant parentage will be variable and often exposed to honey dilution from other plants that attract bees. Having a good relationship and trust in a competent beekeeper is invaluable as, over time, a commercial arrangement that benefits everyone can be developed.

Table 2 shows what is possible from a 100 ha example using the following assumptions:

- The landowner spends $100/ha in the first year on access establishment or upgrade and $40/ha/annum on land costs, i.e. rates and administration
- The site carries 100 hives – one hive per hectare
- It models three different activity levels and associated $/kg of honey, currently (or close to those) being paid in the market
- Hive production averages 25 kg/annum over a 31-year period – a number above the 'old' accepted North Island average, below the average production noted by the Ministry for Primary Industries (MPI) in 2014/15 of 31.7 kg/hive, and possibly well below or above any New Zealand site at any given time
- It notes the $/hive cashflow back to the landowner and the internal rate of return, or IRR, from that land use investment based on three different percentage shares of gross hive revenue.

The figures underlined denote where the beekeeper has most likely lost money on the arrangement, which in the long term is not good for the landowner either. It becomes evident that with trust and good records there is room to come to an arrangement that rewards a landowner for managing a native crop of mānuka to maximum production. There is also strong evidence to support the planting of mānuka as a forest crop for honey, carbon and biodiversity values. This is especially the case when compared to internal rates of return of 2-4% for the average sheep and beef and dairy farm, excluding current market returns.

Planted mānuka

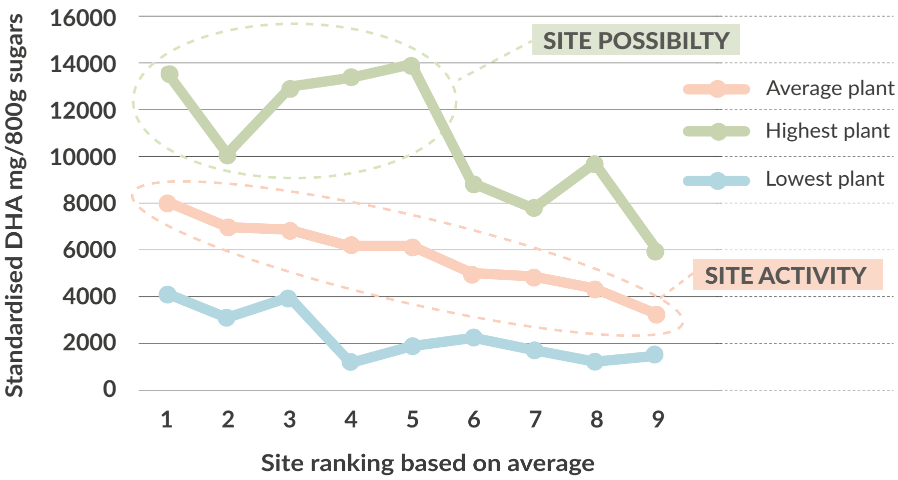
Costs associated with planting mānuka are higher than 'mining' and/or managing an existing resource. Hence the expected internal rate of return available will be lower, but will still appear to be better than mainstream returns if looking for an alternative or supplementary land use. It costs the same amount of effort and resources to establish a 'poor activity' mānuka crop as it does a 'high activity' crop. Proven genetics are therefore important when selecting which mānuka crop to plant.

Costs can range between $1,650/ha to $2,500/ha depending on the required:

- Land preparation
- Pest control – critical if goats are present
- Tree stock purchased
- Planting costs – normally not too different to the cost of planting normal forestry species
- Weed control
- Ongoing pest and weed control to get the crop successfully established.

Costs associated with planting mānuka are higher than 'mining' and/ or managing an existing resource but will still appear to be better than mainstream returns if looking for an alternative or supplementary land use.

Figure 2: Site activity compared to site possibility



Source: Midlands Apiaries Limited (2016)

Figure 2 summarises some work that Midlands Apiaries completed recently showing the range of activity in several mānuka populations.

The key point to understand from Figure 2 is that the current mānuka honey activity is made up of the average activity in the mānuka crop, less whatever contamination comes into the crop by way of foreign nectar from plants competing for the bees' attention. By establishing plants that have a history of high activity (or the offspring of them) in the right site, a honey crop with a high activity is more likely to be produced. This is a good value proposition.

Table 3: Return to landowner from 'establishing' a mānuka resource

		10% share		20% share		30% share	
Activity	$/kg	$/hive	IRR	$/hive	IRR	$/hive	IRR
5	$18	$5	-13.8%	$50	-4.3%	$95	-1.15%
10	$35	$48	-4.5%	$135	0.66%	$223	3.39%
15	$55	$98	-1.02%	$235	3.71%	$373	6.45%
20	$95	$198	2.72%	$435	7.41%	$673	10.27%

Table 3 takes the same examples as **Table 2** and assumes an additional $2,000/ha to plant a mānuka crop which does not start producing in full until 10 years of age. Given what a good plant breeding programme is capable of, it also models the return from a higher activity level that currently commands a top price in New Zealand off the hive.

In this table the underlined figures denote that the landowner is out of pocket. If we add potential carbon returns (assuming $15/NZU – NZ Units from the Emissions Trading Scheme) based on the MPI carbon sequestration tables the above internal rate of return increases from -13.8% in the first example to 3.2%. In the last example it lifts from 10.27% to 12.5%. This is an average carbon income (assuming $15/NZU) of $142/ha/annum once growth variances are accounted for. Incidentally, some mānuka blocks we have measured exceed the MPI indigenous carbon sequestration tables for their region.

Summary

Some landowners are spending upwards of $2,000/ha to clear mānuka, apply capital fertiliser and seek to bring back naturally reverting land into grass production. Others may already have sectioned off similar land that is receiving a diminishing grazing return, but a climbing carbon and honey return. Neither approach is necessarily wrong, but the values derived in the environmental, biodiversity and long-term economic sustainability areas will be quite different.

'What is the best land use' will be different for everyone and more than likely the 'best' option will be a matrix of possibilities. The common thread however is that whatever the best use is – whether driven by history, core skill set, aspiration or cashflow – the decisions around it need to be made and reviewed from time-to-time in an informed manner and with a medium to long-term view.

With a growing community expectation to improve environmental standards, planting the right species on the right land has gained acceptance within the agricultural community and is further supported by agencies that provide funding, allowing landowners to make considered land use changes. Once $0.66 (and more) in the dollar was available to clear scrub and indigenous forest for pasture – now up to $1,500/ha is available to re-establish it.

STUART ORME is a Registered Forest Consultant based in Masterton. Email: stuart@woodnet.co.nz

NZ Institute of Primary Industry Management

NZIPIM 2016 National Conference

Rydges, Rotorua, Monday 8th and Tuesday 9th of August

Principal Sponsor:

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NZIPIM's National Conference will be held at Rydges in Rotorua on Monday the 8th and Tuesday the 9th of August 2016.

This year we have brought together a great range of speakers covering a diverse range of topics within the primary industry and business management strategies in changing times.

Our key international speaker is Robert Easton from Accenture, based in the US, who will be speaking on flourishing and driving change in enterprises needing to evolve in new market and business environments.

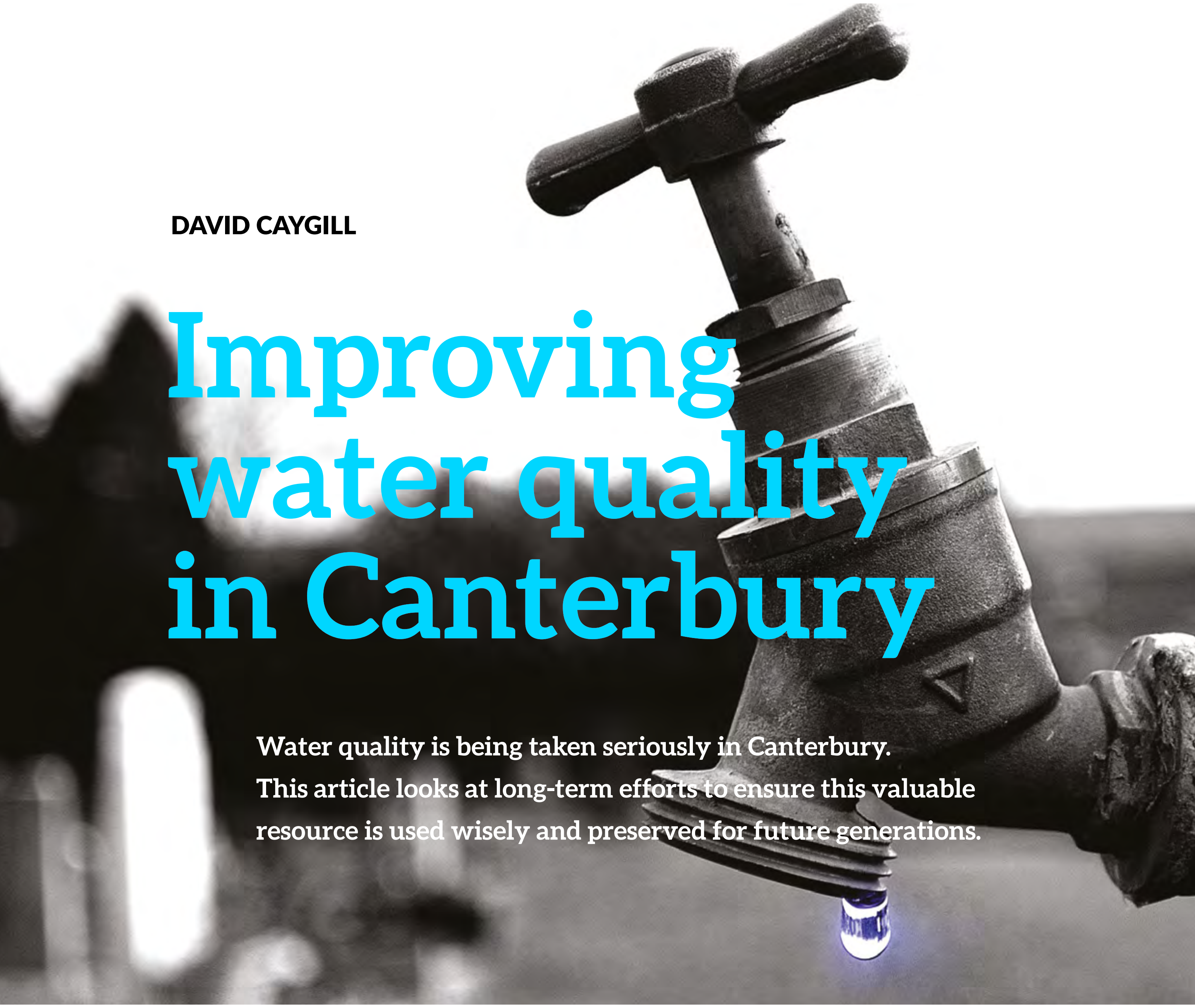
We will also be looking at Maori agribusiness and farming operations, with a focus on how rural professionals engage and provide professional services to Iwi farming enterprises. Once again the conference will include industry sector updates, as well as a presentation on the economics of planting mānuka for honey production.

On the second day, John Allen from Kite Consulting will be reporting from the UK on what is occurring on farms and provide an overview on the dairy market in Europe from a consultant's perspective. After that we will focus on environmental matters including: a review on the Rotorua lakes catchment as an example of environmental action and change, exploring the latest research on mitigation strategies for N loss, and an economic analysis on meeting nutrient limits.

In the afternoon we have two concurrent streams on Business & Governance and Technical & Extension.

The conference closing session includes presentations on hot science in the primary industry. Bill Kirkley from Massey University will then speak on adapting to change in a fast-moving times, followed by our closing presentation by James Allen who will provide his views and insights on the future of the rural profession.

NZ Institute of Primary Industry Management, PO Box 5304, Wellington 6145
Email: admin@nzipim.co.nz Phone: 04 939 9134 Website: www.nzipim.co.nz



DAVID CAYGILL

Improving water quality in Canterbury

Water quality is being taken seriously in Canterbury. This article looks at long-term efforts to ensure this valuable resource is used wisely and preserved for future generations.

In February the government released its proposals about water quality in the discussion document *Next Steps for Fresh Water*. Reaction has focused on whether our lakes, rivers and streams should be wadeable, swimable or drinkable. Important though this debate is, it is addressing end goals that in some cases are still very far away. Sadly, the choice of objective will make little difference to the actions we need to take in Canterbury in the next few years.

In much of Canterbury the quality of our water meets none of these targets. Whatever targets we set, the immediate action required is exactly the same. We must address the consequences for water quality of more intensive land use. In an urban context we must also address the consequences for run-off 'stormwater' of the way we choose to live. The good news is that a strategy has been agreed, and initial measures have been deployed, but much remains to be done.

A valuable resource

Before describing the work that is underway and that lies ahead, let's step back a moment. There is a reason, besides perhaps a natural inclination to argue, that explains the years it took to reach agreement on the Canterbury Water Management Strategy (CWMS). Water is a difficult subject about which to reach agreement because we use it and value it in many different ways. We drink it. It helps grow plants and sustain animals. As irrigation it alleviates droughts and allows a wider range of agriculture, which leads in turn to greater employment and the maintenance of rural populations.

Water is also valued as a source of recreation. Indeed many types of recreational user often compete to use our water: fishers, kayakers, jet boaters, off-road drivers, swimmers and bird lovers to name a few. It is also valued in its own right, as part of the environment we appreciate and seek to protect. Cultural values such as 'mahinga kai' and 'kaitiakitanga' are increasingly recognised. In Canterbury, our rivers also play a significant role in the generation of our nation's electricity.

Deteriorating water quality

Few dispute that the quality of water in Canterbury has been deteriorating for some years. Levels of nitrate, in particular, have been rising in both streams and shallow groundwater. A disappointing proportion of places where people used to swim are no longer safe. Apart from community supplies, many wells now come with health warnings that mothers and infants should avoid their use. There is no question that much needs to be done.

Nor is there serious disagreement as to the causes of this decline. The intensification of land use, chiefly in the form of conversion from sheep and beef to dairying, has increased the amount of nitrate finding its way into Canterbury's water. Across the region as a whole dairying and dairy support is now the predominant land use on about half the land. Arable crops still occupy a quarter of Canterbury's land. All other uses (horticulture, pigs, poultry, forestry as well as sheep and beef) take another quarter. While dairying is by no means the only source of nitrate, it typically contributes more than other forms of farming to the pollution of our water.

Nitrate limits set

In August 2012 the Canterbury Regional Council, a partner in the CWMS, formally proposed for the first time region-wide limits on the amount of nitrate that can be allowed to leach from Canterbury's farmland. It is possible, but awkward and costly, to measure nitrate loss directly via an instrument called a lysimeter. In practice, nutrient loss from each farm can be estimated using OVERSEER, a proprietary computer programme originally designed to calculate the optimal amount of fertiliser that should be applied for a given soil, climate, farm type and so on. Looking backward (and taking into account the actual fertiliser used, stock numbers and other factors) it is possible to calculate the residual nutrients that have been lost from the farm system.

We must address the consequences for water quality of more intensive land use. In an urban context we must also address the consequences for run-off 'stormwater' of the way we choose to live.

In many catchments water quality will unfortunately get worse for some time yet before it starts to get better. But we need to do more than just put a cap on nutrient loss. We need to actually reduce the amount that is being leached to the soil and then to the rivers and aquifers.

The rules limiting such nutrient loss were made operative in September 2015 following public hearings chaired by David Sheppard, former chief judge of the Environment Court. These limits reflect the average nutrient lost between 2009 and 2013. In other words, they set a cap on nutrient loss. They are designed to ensure that the situation doesn't get any worse.

This is not the same thing as saying that water quality won't get any worse from now on, because about half of Canterbury's water is underground, in aquifers. It takes many years – 20 or more is a typical estimate – for water to flow through an aquifer and reach the sea. So at this point we are still adding to the legacy of past nutrient losses. In many catchments water quality will unfortunately get worse for some time yet before it starts to get better. But we need to do more than just put a cap on nutrient loss. We need to actually reduce the amount that is being leached to the soil and then to the rivers and aquifers. This is happening in two main ways.

Good management practices

First, at a region-wide level, the nutrient limits are being toughened, to reflect the adoption of GMPs. This follows the advice of the Land and Water Forum, in particular Recommendation 15 in the Forum's third report *Managing Water Quality and Allocating Water* in 2012 that 'Good Management Practices (GMPs) should be defined and adopted in all catchments' and that 'regional plans need to incorporate and incentivise GMPs.'

Environment Canterbury took this seriously. Working with a number of industry partners and Landcare Research, we reached agreement on narrative definitions of GMPs relating to water quality, including cultivation and soil structure, nutrient management, irrigation and effluent and wastewater disposal. These 'Industry-agreed Good Management Practices' were launched by Federated Farmers and our other partners in April 2015. These partners included the Federation of Arable Research, New Zealand Pork, DairyNZ, Beef & Lamb New Zealand, Horticulture New Zealand and Deer Industry New Zealand. Several other regional councils also contributed to the project.

These same partners then set about agreeing on ways in which OVERSEER could be modified to reflect these GMPs. Protocols to achieve this were substantially agreed by the end of 2015. In February this year Environment Canterbury therefore notified changes to its Land and Water Plan to require compliance with nutrient limits that reflect the use of these GMPs by 2020. These changes will be the subject of public hearings later this year.

Thus far the discussion has referred to rules that apply across Canterbury. Different rules relate to different 'nutrient allocation zones'. Red zones, for example, are regarded as already 'over-allocated', i.e. already receiving more nutrient than they can cope with. They are therefore subject to the most stringent rules, both in the current Land and Water Regional Plan and in the changes to reflect GMPs. But these rules and these nutrient zones cover the whole of Canterbury.

New catchment regime

Beneath the region-wide rules another sub-regional or catchment regime is being constructed. This reflects the considerable variation that exists in what is New Zealand's largest region in terms of area. There are few dairy farms on Banks Peninsula, for example, whereas much of the Ashburton District is already irrigated from the Rangitata Diversion Race constructed in the 1930s and 1940s.

The CWMS called for a catchment-by-catchment approach. Canterbury has therefore been divided into 10 geographic zones, corresponding broadly to one or more water catchments. In each a zone committee has been established jointly by Environment Canterbury and the relevant city and/or district council(s). In addition to these councils, Ngai Tahu runanga are represented. The councils have jointly appointed six community members to each zone committee covering the range of skills and interests relevant to the principal task: to recommend how the CWMS can best be implemented in their zone.

Thus while the region-wide rules hold the line or establish a default position, zone committees have all recommended programmes to implement the CWMS in their area. Progressively these recommendations are being turned into detailed sub-regional rules that supplant and frequently toughen the generic rules. For example, in the Selwyn/Waihora catchment that drains into Te Waihora/Lake Ellesmere, rules are now in place that will progressively require even greater reductions in nutrient losses than those that would reflect the adoption of GMPs. Similar reductions have been recommended and agreed following public hearings in relation to the Hinds catchment south of Ashburton. Detailed plans have also been drawn up by the relevant zone committees in relation to the Waitaki basin, the Lower Waitaki coastal area, Lake Wairewa, and the Hurunui and Waiau catchments. More will follow.

It is one thing to set limits on the amount of nutrient that farmers can allow to leach from their land. It is another thing to achieve these limits, particularly if they go beyond presently agreed good practices. How realistic are these limits? Remember that they have been recommended by local committees after extensive public engagement and tested in formal public hearings against both the requirements of the Resource Management Act and the National Policy Statement for Freshwater Management.

How farmers can help

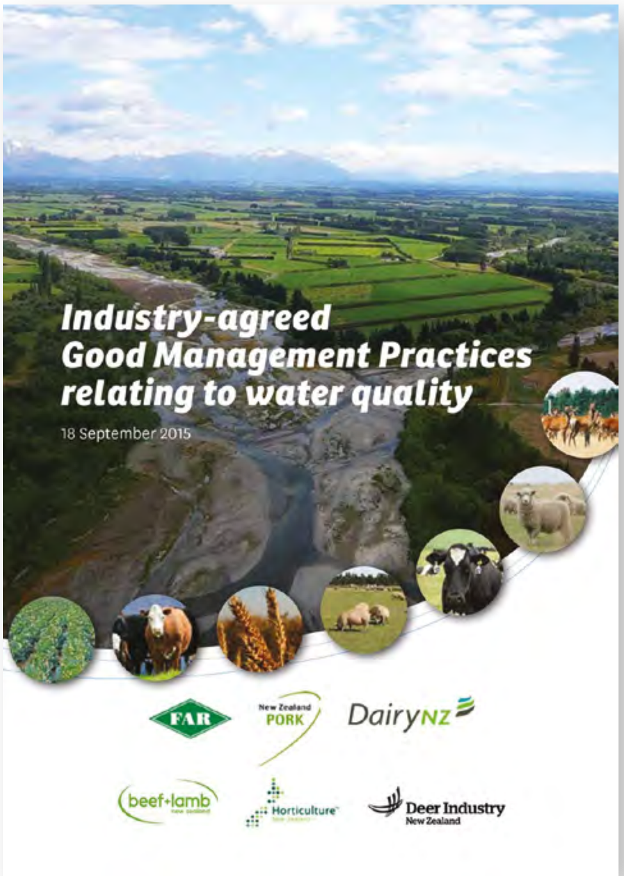
So one could have some confidence that these limits meet public standards of reasonableness and practicality. But here is a short list of the main ways in which farmers may respond to the growing need to reduce nutrient losses:

- Farmers could implement the GMPs themselves, e.g. in respect of fertiliser application and effluent disposal. They could move from border dyke to more efficient forms of irrigation and make land management changes such as streambank planting
- They could reduce their stock numbers, often without reducing their net income, although this may reduce total production and have an impact off-farm

They could change what they feed their animals, e.g. less clover and more herbs

- Plants with longer roots absorb more nutrients
- They could select stock genetically for their nitrate efficiency and not merely for their total production
- They could apply nitrate inhibitors. Lincoln University has demonstrated up to 40% reductions in nitrate loss through this means. Currently this product is not available, and is waiting until a residue standard is set by the World Health Organization
- Dairy farmers could winter off their cattle, i.e. they could spread their nutrient losses over a wider area, in the same way as many arable farmers will seek to average their losses over a range of land parcels and crops
- Some may choose to build barns, capturing all their effluent and nutrients, to be re-spread according to plants' needs in accordance with good management
- Or they could adopt 'precision agriculture'. A well-known farmer near Methven claims to have achieved no nutrient loss at all over the last three years through detailed farm mapping and the precise application of fertiliser and water.

Significantly, only the erection of barns would require large financial investment. The other steps would require changes in management, adaptation and new skills, all of which will take time.



Industry-agreed Good Management Practices booklet

Storage and distribution projects

Meanwhile, another aspect of the CWMS is gradually taking shape. A precursor study identified a number of storage opportunities in Canterbury – locations where significant quantities of water might be stored – to allow the region's already extensive irrigation to be both extended and rendered more reliable. Gradually, both of these aims are being achieved.

Of six major storage and distribution projects identified by 2010, one of them (using Lake Coleridge) is already in action. Water from that lake is now being released into the Rakaia river and retrieved lower down by the Barrhill-Chertsey and the Central Plains irrigation schemes (on the south and the north sides of the river respectively). There is nothing new about water from Lake Coleridge ending up in the Rakaia. What is new is that instead of happening at times that best meet the need for electricity, this water is now being used as well at times that suit irrigation.

One interesting and desirable impact of this change is that gradually farmers in stage one of the Central Plains scheme are abandoning their groundwater wells in favour of cheaper, reliable alpine water. This is relieving pressure on the groundwater, to the benefit of the environment and ultimately on water quality lower down the Selwyn/Waihora catchment.

Irrigation infrastructure has been slow to get off the ground, in part because it is essentially farmer financed. We are building only the storage and distribution systems that today's farmers can afford.

Another important aspect of the CWMS is the drive for greater efficiency in water use. This is being achieved in part through the retirement of redundant stockwater races in central Canterbury and in part through the piping of irrigation distribution systems. The latter is significantly reducing the amount of water that may need to be stored to achieve greater reliability of irrigation. As water becomes more reliable less is used, because farmers are able to irrigate based on need rather than opportunity, which in turn accords with the GMP of only irrigating based on plant need.

Irrigation infrastructure has been slow to get off the ground, in part because it is essentially farmer financed. We are building only the storage and distribution systems that today's farmers can afford. That means that the risk of over-building that used to flow from central government ownership is not an issue. But the converse risk that today's farmers may not be able to afford to build what tomorrow's farmers would benefit from – a risk that we build too little – may still be an issue. Environment Canterbury is working to ensure that each project proponent is aware of its neighbour – that as far as possible the infrastructure network as a whole is optimised, even if it's not physically linked.

Importantly, irrigation schemes and their water customers are not exempt from the nutrient limits, either current or proposed. Nutrient limits apply whether a farm is irrigated or not and whether dairying or not. In many ways the fact that irrigation is simultaneously being encouraged and made subject to strict quantity and quality limits reflects the multi-faceted nature of the CWMS. The CWMS target areas include ecosystem health and biodiversity, the natural character of braided rivers, kaitiakitanga, drinking water, recreation and amenity opportunities, water-use efficiency, irrigated land area, energy security and efficiency, indicators of regional and national economies, and environmental limits.

Irrigation schemes can apply for a 'global' discharge consent, which in effect allows them to aggregate the individual nutrient limits faced by their members. Some have done this, just as some schemes are helping their members prepare the Farm Environment Plans that the rules require as the principal means of demonstrating compliance with the obligation to move to GMPs. So far, however, no scheme has chosen to set up an internal trading mechanism to facilitate the exchange of 'nutrient allowances' between their members, as economists might be expected to recommend.

The Taupo example

In this respect there is an important contrast between the approach to improving water quality in Canterbury and that around Lake Taupo, which faces similar pollution problems. In Taupo an overall nutrient limit has been fixed for the catchment as a whole. Individual allowances have been issued to each farmer, with which they must comply. But while they may also trade these allowances amongst each other, a public fund is gradually buying them up and retiring them, to reduce the total amount available and therefore the total nutrient that may be leached into the lake.

In Canterbury no authority has offered to buy up nutrient entitlements. The scale of the area and of the reductions involved suggests this would be impractical. Rather farmers are being required to make the adjustments necessary to conform to limits that are recommended by the local committee, as well as complying with national requirements.

In other words, in Canterbury the costs of adjustment are largely being borne by farmers. However some would say that the costs of having allowed nitrate levels to rise as they did have been borne by the environment and the wider community. But the fact that the adjustment is largely happening farm-by-farm arguably affects the speed of adjustment that is achievable.

A moratorium on dairy conversions?

Some have called for a moratorium on dairy conversions. Others respond that this is neither sensible nor legally possible. Arguably the limits on nutrient losses and their link to past activities are achieving the same as a moratorium – if that is not otherwise being brought about by the downturn in dairy returns. What is certain is that farm investment in Canterbury is being shaped by the limits that are now in place, the tougher limits that have already been notified, and the even tougher limits that are likely to evolve over time.

Need for change

Whatever 'next steps for fresh water' are agreed nationally, the steps being taken in Canterbury are real and significant. While they reflect national dialogue and encouragement, they are essentially being driven by the local certainty that our ways need to change and our practices improve. Water quality is being taken seriously in Canterbury.

DAVID CAYGILL is Deputy Chair of the Environment Canterbury Commissioners. Email: davidcaygill@gmail.com

MATTHEW NEWMAN AND CARLA MULLER

The impacts of reducing N leaching and P loss on Southland dairy farms

This article looks at how Environment Southland is considering the economic impacts of setting nutrient discharge limits under the National Policy Statement for Freshwater Management. It describes the economic modelling work undertaken for dairy.

Background

Under the National Policy Statement for Freshwater Management, regional councils throughout the country are required to set water quality and water quantity limits that will maintain or improve freshwater values.

Environment Southland is tackling this requirement through Water and Land 2020 & Beyond. This programme aims to set community objectives for water quality, ensure no further decline in water quality, and determine how the objectives for water quality will be met. It has two main components: developing a new Southland Water and Land Plan, and setting water take and nutrient discharge limits. Note that information from the economics project was not used for the Southland Water and Land Plan which is due for notification in early June 2016.

Over the last couple of years a large amount of important scientific and economic research has been undertaken to provide information for the nutrient discharge limit-setting process. This work, which will continue over the next couple of years, will enable Environment Southland to better understand communities' objectives and values, Southland's natural water systems and the potential impacts of limit-setting. One component of this work is the Southland Economic Project, which sits under the umbrella of the Water and Land 2020 & Beyond.

The methodology, including the limitations and constraints plus the high-level results for reducing nitrogen (N) leaching and phosphorus (P) losses for dairy farms, is outlined in this article.

Southland Economic Project

In July 2014, the project was launched with the aim of developing tools to help in understanding how future catchment policy options could impact on the region's economy and communities. This project is not about deciding outcomes, but will assist Environment Southland to work out the impacts of various pathways to achieve the proposed nutrient limits.

The Southland Economic Project is a joint initiative between DairyNZ, Beef + Lamb New Zealand, the Ministry for Primary Industries, the Southland Chamber of Commerce, the Department of Conservation, Te Ao Marama and Environment Southland. There are three studies included in the project:

- **Economic Sectors** – gathering information on contaminant discharges to water from agricultural, rural residential, industrial and municipal sectors, and the financial costs of dealing with these discharges. This project is nearing completion
- **Regional Economy** – using the information gained from the Economic Sectors study to develop a Southland economic model that can show how the possible financial costs to these sectors could flow through the rest of the economy. This project is now underway
- **Community Outcomes** – using the knowledge gained from the Economic Sectors and Regional Economy studies to look at how some of the costs to the economy might have social and cultural impacts on local communities.

The Economic Sectors study also involved other organisations and agricultural industries in project work. A big part of this study focused on the nutrient discharges from agriculture (dairy, sheep, beef, deer), arable, horticulture, flower and bulb growers, and forestry. Each industry collected farm/grower data and carried out mitigation modelling, using Farmax and OVERSEER, to determine the likely impacts of reduced N leaching and P loss at a farm level. The remainder of this paper concentrates on the mitigation of N and P losses on dairy farms and the likely economic consequences for the farms modelled.

It is likely that future policies will require different levels of effort (nutrient loss improvements), depending on the characteristics of the catchment a farm is located in, the vulnerability of the soil type to nutrient loss and/or various farming activities such as intensity and wintering practices.

Dairy farm selection

In 2014-15, there were 971 dairy herds in Southland. To investigate nutrient losses 41 case study farms were selected that represented the size and diversity of dairy farming in the region. To our knowledge this is the largest dairy farm nutrient mitigation modelling study of this nature ever undertaken in New Zealand.

The farms were selected from four zones, also known as freshwater management units (FMUs): Waiau (3 farms), Aparima (11 farms), Oreti (13 farms) and Mataura (14 farms) in proportion to the number of dairy farms in each FMU. The key components used to select farms were the location (FMU), soil drainage, rainfall and the intensity of the farm system (low, medium or high). Variations in the types of farms are shown in **Table 1**.

Wintering practices were also analysed, as winter grazing and cropping are an integral part of dairy farming in Southland. In this study, 17 farms wintered cows on owned or leased support blocks, 19 farms sent cows to a grazier during winter and the remaining five farms used a combination of milking platform, support blocks and paid grazing during winter. Support blocks were included in the analysis when there was sufficient data. In general, the inclusion of support blocks made little difference to the overall N leaching figures, although it did have an impact on individual farm businesses, depending on the soil type and how the blocks were used.

Table 1: Dairy farm variations by FMU

	Poor or imperfectly drained soils	Well or moderately well-drained soils	Low system	Medium system	High system	Irrigation	Farms with off-pasture structures	Support block (owned or leased)
Waiau	0	3	0	3	0	0	0	1
Aparima	6	5	1	8	2	1	3	7
Oreti	10	3	3	6	4	0	7	5
Mataura	7	7	2	9	3	2	8	9
Total	23	18	6	26	9	3	18	22

Methodology

The farms were visited to obtain 2013-14 physical and financial data to enable base OVERSEER (Version 6.2.0) and Farmax (Version 6.6.5.00) files to be created. A mitigation strategy was developed so that the modelling for all farms followed the same overall process, but there were differences in the mitigations between farms due to their individual characteristics.

The mitigation strategies used in this modelling did not aim to optimise a system, but rather attempt to be the most cost-effective method of reducing nutrient loss without major capital implications. This is a stepwise process in which reductions in farm inputs are sequentially applied to the base farm, although major systems are initially avoided as we believe farmers have chosen a system for various reasons and will prefer not to change.

> **The analysis using different milk prices indicated that while mitigation may be possible in some years, it may mean some farms are unviable in other years and this could have large implications, including increased overdrafts to survive some seasons.**

Other, more capital-intensive, mitigation modelling (barns, changes in wintering practices and significant changes to the effluent storage and disposal system) were undertaken on a couple of chosen farms to test the impacts.

It is likely that future policies will require different levels of effort (nutrient loss improvements), depending on the characteristics of the catchment a farm is located in, the vulnerability of the soil type to nutrient loss and/or various farming activities such as intensity and wintering practices. However in the absence of policy 10%, 20%, 30% and 40% reductions in N leaching and then phosphorous losses from the base position were targeted. Many farms did not make the higher targeted reductions before land had to be retired, e.g. feed supply exceeds feed demand in perpetuity.

The first stage of N mitigation followed a standardised sequence where agreed measures were applied:

1. If the farm has an existing off-pasture structure the use of this is optimised.
2. Autumn N fertiliser applications are reduced and then removed.
3. Spring N fertiliser applications are reduced and then removed.
4. Imported supplements are reduced (up to a 20% reduction from the base).
5. Stocking rate is reduced (up to 20% reduction of cow numbers from the base) and the feed supply and demand is balanced.

P mitigation employed a similar process as N, with de-intensification first followed by some system changes on a couple of farms:

- If the farm was suitable for the use of reactive phosphate rock (RPR), phosphate fertilisers were swapped. For this to be applied to a farm, the Olsen P must be above 30, soil pH below 6, rainfall above 800 mm per year and P retention less than 95%
- If the farm has an Olsen P above the agronomic optimum, P is initially mined
- Key areas of risk not impacting production, e.g. effluent and cropping practices as well as areas impacting production such as the use of once-a-day milking for part of the season and decreasing cropping areas, are identified and addressed where appropriate
- Stocking rate is reduced (up to 20% reduction of cow numbers from the base) and the feed supply and demand is balanced.

There are a number of assumptions made in this analysis including:

- An assumed average milk price of $6.50/kg milksolids. Fertiliser and feed prices were standardised across farms
- A $5,000 annual cost per farm for the creation and monitoring of nutrient budgets and plans
- Cow numbers could be reduced up to a maximum of 20% from the opening numbers
- ProGibb was only applied on farms currently using it.

Nitrogen mitigation results

The average N leaching of the 41 farms was 39 kg/ha and reasonably normally distributed, with 59% of farms with N leaching between 25 and 45 kg/ha, 17% over 50 kg/ha and 5% below 20 kg/ha. Base N losses were considerably higher on well-drained soils compared with poorly-drained soils.

Abatement curves compare reductions in nutrient losses with the changes in farm operating profit per hectare (EBIT) from the original base point for each farm. Separate curves were created for N and P mitigations for each farm. Specific policies and how farmers decide to achieve the targets will ultimately decide what the individual impacts will be. This modelling is an indication only to show likely magnitudes and variations in impacts between farms.

The results can be shown as percentage changes or as absolute changes. **Figure 1** shows the N abatement curves for the 13 farms in the Oreti FMU. They demonstrate significant differences in the cost of abatement between farms.
A distribution of the impacts on operating profit from reducing N leaching for the 41 farms is shown in **Figure 2**. The number of farms changes at each level of mitigation as some drop out when they cannot achieve the reduced N level. Thirty-one farms could achieve a 30% reduction in N leaching, but this dropped quickly to only 12 farms at a 40% N leaching reduction.

In general, the higher the reduction in N leaching the larger the impact on operating profit. For example, the reduction in operating profit ranges from -3% to -17% at a 10% reduction in N leaching, while it ranges between -10 and -30% at a 30% reduction.

Phosphorus mitigation results

The average P loss of the 41 farms was 0.8 kg/ha. Fifty-nine percent had a base P loss between 0.5 and 1.1 kg/ha, 15% a loss of over 1.3 kg/ha, and 14% losses of below 0.5 kg/ha. The response of farms to P mitigations was more variable in comparison to N mitigations and the abatement curves were also much steeper. This indicates that P losses are more costly to reduce than N leaching. Approximately 80% of farms could not achieve a 20% reduction in P loss before having to retire land (see **Figure 3**).

These results show that, in percentage terms, an approximate 10% reduction in P loss reduced operating profit by -10 to -13%. There were some co-benefits at this level of reduced P loss, with N leaching also reducing by between -5 and -19%, but production also reduced by between -4 and -6%.

Figure 1: Nitrogen abatement curves for farms in Oreti

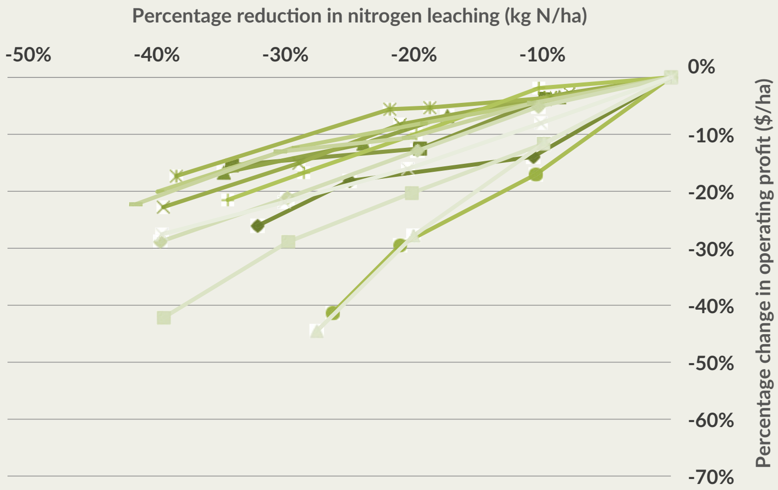


Figure 2: Nitrogen leaching impacts for 41 Southland dairy farms

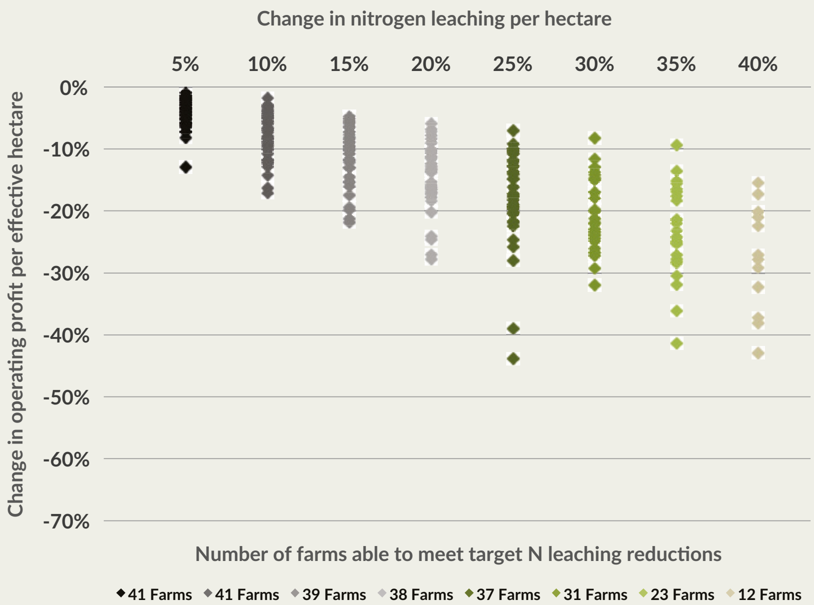
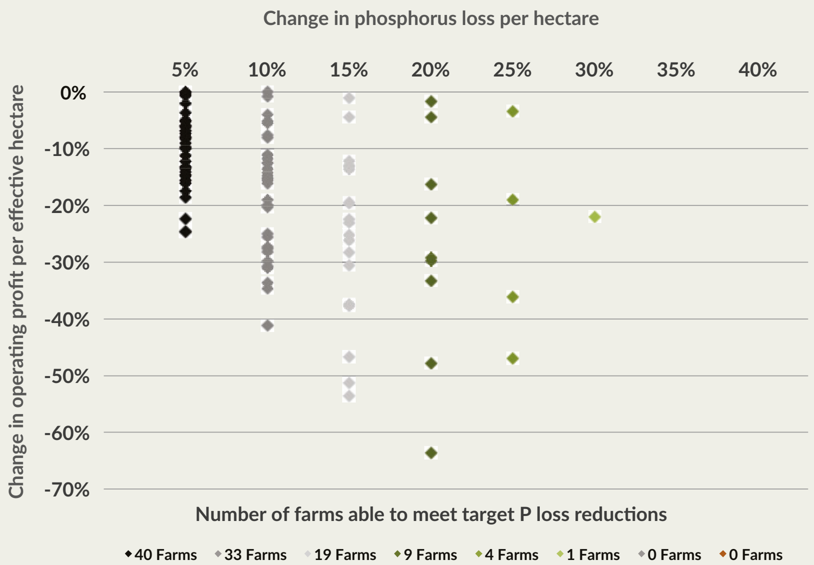


Figure 3: Phosphorus loss impacts for 41 Southland farms



Catchment nutrient load limits will become commonplace around New Zealand as councils work through changes to regional plans to address water quality issues.

Sensitivity analysis

Two sensitivity analyses were undertaken as a part of this study. One looked at the impact of the inclusion of interest and rent payments on operating profit to assess the feasibility of undertaking mitigations and the other at the effects of changes in the milk price. This is particularly relevant in an industry experiencing increased volatility in milk price, especially if chosen mitigation options require capital investment.

The analysis using different milk prices indicated that while mitigation may be possible in some years, it may mean some farms are unviable in other years and this could have large implications, including increased overdrafts to survive some seasons.

Limitations wand constraints

There are a wide range of systems, farmer management abilities and dairy farm performances in Southland. While the approach in this study uses case study farms which provide real farm data for a point in time, the degree to which these farms represent dairying in the region is uncertain.

OVERSEER is the model used to assess the level of nutrient loss on the farms. OVERSEER undergoes constant development, with the available version (6.2.0) generating different outcomes to earlier and later versions. This is not the only possible way to reduce nutrient losses, and this work does not attempt to capture each farmer's decision-making process but assumes that least cost options are preferred.

A relatively large amount of P is lost in storm events. It has also been noted that typically 80% of P losses from catchments originate from 20% of the land area. These critical source areas (CSAs), are created by the interaction of environmental factors, hydrological conditions and management factors, and include laneways, races, troughs, gateways and stock camps. Targeting these CSAs with mitigation strategies is potentially an efficient and cost-effective method of reducing P loss. Many CSAs on farms cannot currently be modelled within OVERSEER so not all P losses in this modelling are captured.

This study does not consider the flow-on effects of mitigation beyond the dairy farm gate. For example, it does not attempt to capture the impacts on other industries such as sheep and beef farmers providing wintering services. These will need to be considered in the Southland Economics model.

Given all the limitations of the study it is important to recognise that the relative economic impact of the various scenarios, and the order of magnitude of the impact, should be the overriding considerations rather than a focus on the detail of the numbers in the changes modelled.

Conclusion and next steps

Catchment nutrient load limits will become commonplace around New Zealand as councils work through changes to regional plans to address water quality issues. It will require smart solutions on-farm, as the options are limited if substantial changes to production systems or large amounts of capital investment are to be avoided. Some small reductions in N and P losses can be gained by focusing on improving on-farm efficiency, but in order to make larger gains (e.g. higher percentage reductions from base) it is likely a farm will be required to adjust the system they are operating. However in many cases either the cost of doing this is too high or the loss in milk production will have significant consequences for the farm, the industry and the regional economy.

Each farm is unique and what may be viable for one farm may not be for another. The ability of farmers to achieve large nutrient reductions varies considerably. Farm systems models, such as Farmax in combination with OVERSEER, can be used to determine what these on-farm impacts might be. However this process is time-consuming and, like all modelling, is based on a number of assumptions. An abatement curve may aid in the estimation of the expected impact on-farm and the results can feed into catchment level modelling.

The next stage of the Southland Economic Project is to build a dynamic regional economic model and incorporate all the agricultural sector farm level modelling, as well as the industrial and municipal mitigation work. The development of this model is already underway. The dairy farms in this study will be required to be weighted within an FMU and this process was undertaken with a number of farm consultants and bankers who have good knowledge of dairy farming in Southland.

In addition, expected land use changes occurring from potential policy, mitigation adoption rate timeframes, and community social and cultural impacts need to be considered and included in the Southland Economic Project model. The regional model is due for completion in late 2017, in time to provide information for limit-setting processes within each FMU.

MATTHEW NEWMAN and CARLA MULLER
are DairyNZ Economists based in Hamilton.
Email: matthew.newman@dairynz.co.nz

MIKE WHITE

Transforming hill country fertility and fertiliser applications

New thinking and technologies are pointing to an exciting future for hill country farms in terms of optimising soil fertility. Making the most of the fertiliser dollar will improve the economic and environmental outcomes for these farms.

Are we on the crest of a technology tidal wave? In reality there are always new technologies and possibilities emerging, but the challenge is taking a new technology and converting it into something that farmers can and want to use. What does new technology look like for soil fertility management?

Don't throw the baby out with the bathwater

There are many lessons and best practices that can be gathered from existing knowledge. There is a wealth of scientific evidence showing that fertiliser nutrients and lime, when applied where required, increase pasture production and quality in New Zealand hill country. Applications of superphosphate have been demonstrated to increase both quantity and quality of herbage. For example, at the Ballantrae Research Station in the Southern Hawke's Bay application of 125 kg superphosphate/ha/year achieved a 30% increase in dry matter (compared to no application) and 375 kg superphosphate/ha/year in a 70% increase since the early 1970s to today.

Ryegrass and clover content also improved with rate of application. Equally, on the same farm where superphosphate was withheld over a seven-year period pasture production declined by nearly 5% every year. Nitrogen (N) is also a critical nutrient as New Zealand hill country pastures are chronically N deficient. Increased dry matter production can generally be achieved from fertiliser N whenever moisture and/or low temperature are not strongly limiting growth. A national programme of N use on hill country found average increases of 22 kg dry matter per/kg/N applied.

Topdressing for hill country farms used to mainly be about blanket application when it came to addressing the soil fertility needs across the entire farm. Given hill country farms have a mixture of slope, aspect, soil types and depth, it is relatively easy to think that there must be a better method of fertiliser application which will improve farm returns.

Soil testing from the sky may sound far-fetched, but the technology is in the here and now.

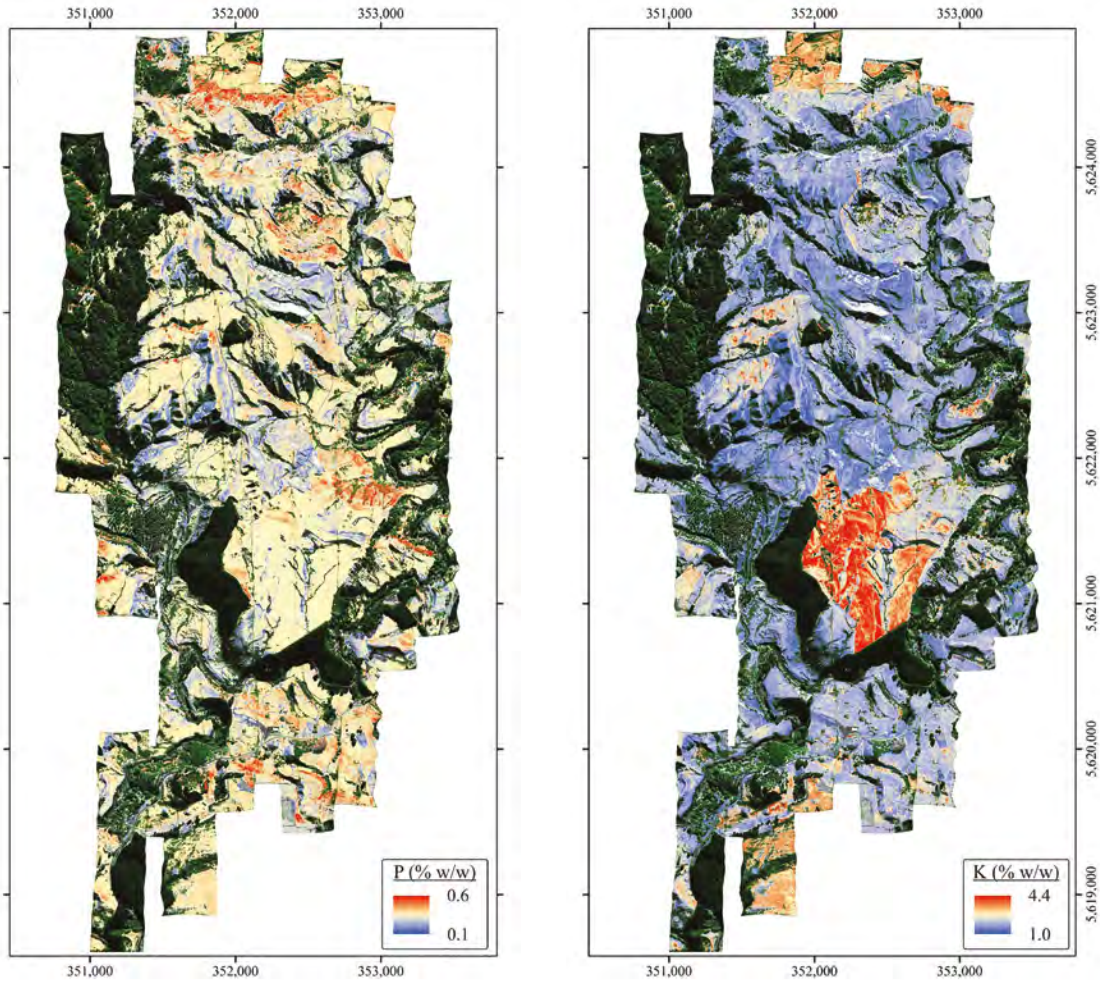
Controlling the controllables

The main levers on quantity, quality and seasonality of pasture are moisture, temperature and soil nutrient status. Of these, soil nutrient status is the only controllable factor, through the use of fertiliser applications which can be targeted with the appropriate rates and types of nutrients.

Using the knowledge and experience of the farmer/farm staff and fertiliser company technical staff, some hill country farms have been divided into different land management units (LMUs) based on their potential productivity influenced by topography, aspect, existing forage species and limitations. Following this, a more intensive soil sampling programme as a one-off exercise can be carried out to better understand the overall soil fertility and the variability between and within the different units. Based on the above information, an economic assessment for the farm in question can be made to set soil fertility targets for each LMU. This is an established approach, but takes considerable time and effort and the challenge is to resource such an exercise.

Soil testing from the sky – from Mars to Masterton

Soil testing from the sky may sound far-fetched, but the technology is in the here and now. Spectroscopy imaging instruments (cameras, sensors) have recently helped pinpoint chemical species on the surface of Mars to unprecedented accuracy so something a little more terrestrial may indeed be within our grasp. Establishing the capability of hyperspectral imaging is one focus of Ravensdown's 'Pioneering to Precision' Primary Growth Partnership (PGP) programme in conjunction with the Ministry for Primary Industries. The capability of the



Example of changes in phosphorus and potassium concentrations in pasture across one of the Pioneering to Precision research farms from hyperspectral imaging

imagery in New Zealand hill country is currently being explored through this programme with Massey University's Centre for Precision Agriculture and the Farm Systems group at AgResearch.

In simple terms, spectroscopy instruments measure the light that has been emitted, reflected or shone through different objects. Often these sensors work in different light bands with multispectral cameras composed of about two to 10 light bands of relatively large bandwidths, whereas more recently developed hyperspectral sensors are generally composed of many more light bands (can be greater than 400) but in narrower bandwidths. As a result, hyperspectral sensors often generate larger datasets and may also offer advantages in identifying underlying relationships.

The key to the use of these sensors is the derivation of accurate and robust correlations of the measured light patterns to the properties of interest such as plant and soil nutrients, which is very much like finger printing. Developing these robust relationships involves the development of extensive spectral libraries where each spectral sample is finger printed to a particular plant or soil nutrient status. In the case of this programme, it is expected to exceed 20,000 individual samples.

Contributing to the exciting possibilities of these sensors has been the enhanced ability to spatially image the light measurements. Advances in sensor capability mean that the hyperspectral sensor used in this programme is able to measure light signatures at a resolution of one square metre. If robust relationships can be developed this would be the equivalent of conducting 10,000 soils tests per hectare – a resolution that could never be achieved with traditional soil testing. Moreover, the integration of global positioning system (GPS) receivers with the sensors are improving the localisation of measurements to accuracies of a few centimetres or even less.

It is likely that hyperspectral sensors similar in capability to the one in this programme will have many other applications including disease, biomass measurement and plant species identification. However all these applications will require the same ground work in terms of developing extensive spectral libraries against the target application to ensure accurate and robust correlations. In addition, these types of sensors are still the size of a suitcase so will not be mounted on the type of drones which have attracted recent media attention.

Promising signs and early days

The programme is only in its third year of seven, so it is still early days, but already it has proven the potential to produce high resolution maps of pasture nutrient status across farms. Major nutrients N, phosphorus (P), potassium (K) and sulphur (S) in pasture and sensor spectra appear to be highly related (levels of explanation with R^2 values ranging from 0.76 to 0.90) and offer significant opportunities to gain valuable insights into nutrient variability across a farm's LMUs.

The final hurdle for the programme is establishing robust direct or indirect relationships to the underlying soil fertility, which is its current focus.

Assembling the hill country fertility puzzle

Assembling this puzzle requires all the pieces. Once farms have been separated into LMUs and intensively soil sampled (from the sky and/or the ground) as described previously, appropriate nutrients and rates can be recommended. As opposed to the traditional blanket application, this often results in recommendations where the nutrients are differentially targeted to different parts of the farm to maximise pasture production and/or reduce over-application of nutrients. In practical terms, this means that the fertiliser programme is targeted according to production potential with flat areas and easy hill areas receiving more P and S fertilisers to encourage legume growth than steep areas and with non-productive areas omitted completely. Under such a scenario, it is feasible that the overall fertiliser spend or tonnage could remain the same and even decrease but would end up better targeted.

The last part to the hill country fertility puzzle is ensuring that this differentially targeted fertiliser application is applied as accurately as possible. Differentially capable control systems were first trialled in New Zealand by Massey University (Centre for Precision Agriculture), Ravensdown Fertiliser and Ravensdown Aeroworks (formerly Wanganui Aeroworks) in the late 2000s. These systems have now evolved in terms of computer processing power and speeds and are commercially available in some regions.

Essentially, these systems vary the rate of fertiliser applied through an automated hydraulic hopper door and GPS as opposed to relying on the pilot controlling it manually. This allows fertiliser to be placed where it is most needed to improve pasture productivity and minimise application to sensitive areas, such as waterways and bush areas. One way to measure accuracy of spread is the standard deviation around the mean of the targeted application rate or coefficient of variation (CV).

A previous study indicates that conventional aerial applications achieve a CV of between 63-70%. Recent work by Ravensdown, Massey and Ravensdown Aeroworks has shown a reduction in CV to 44% when using differentially capable control systems. There may be additional flying costs associated with such a precision programme, but because of the improved fertiliser efficiency variable rate application will be compelling economically and environmentally. Environmental benefits rest in the ability to more precisely avoid sensitive areas across a farm, thereby reducing risk of fertiliser run-off.

What farmers can do now

There are exciting new technologies and possibilities emerging for soil fertility management in hill country. The one constant with these possibilities is that they often integrate with geospatial information systems (GIS) and hence benefit from having accurate farm maps. There are a number of commercial mapping systems available which will support these emerging technologies. These systems already have significant benefits on their own including establishing accurate assessments of a farm's effective area, providing the platform for proof of application maps, and making available other developing decision support tools such as spatial nutrient models.

Summary

There have been significant advances in sensors in recent years that provide a real possibility that remote imaging of a farm's soil fertility status is achievable. However the derivation of accurate and robust relationships will require the development of extensive 'ground truthing' before they can reliably be adopted for use by New Zealand farmers and consultants.

To maximise the possibilities that sensor technologies can provide, the knowledge and experience of the farmer/farm staff and fertiliser company technical staff and decision support tools will still be required to optimise the potential productivity of different LMUs across the farm. Furthermore, differentially targeted fertiliser application should be applied as accurately as possible and this will require taking advantage of differentially capable control systems as they become available locally. Gains in dry matter production or fertiliser savings will be there for farm owners and managers to use wisely, although these will differ between farms depending on the proportion and range of slopes, the base fertility levels and farm management.

Nonetheless, regardless of how successful the technology is the fundamentals do not change in that fertiliser nutrients and lime, when applied where required, will increase pasture production and quality in New Zealand hill country and the best strategy is to optimise this response.

MIKE WHITE is Technical Development Manager at Ravensdown based in Napier.
Email: michael.white@ravensdown.co.nz

WARWICK CATTO

Precision nutrient placement technology

This article looks at how Ballance Agri-Nutrients have used Primary Growth Partnership funding to develop two new technological advances that will help farmers in the current environment of tighter environmental regulations.

Reducing the environmental footprint

The emphasis on managing nutrient losses is growing, particularly with tighter environmental regulations. The ability to put the right fertiliser in the right place in exactly the right amounts is therefore increasingly valued, especially by farmers trying to make farm budgets stretch even further.

With funding support from the Primary Growth Partnership (PGP), Ballance's $19.5 million Clearview Innovations research programme has resulted in two new technological advances, the first at the grass roots level and the second from the air. Used in conjunction with soil testing the first development, N-Guru™, enables farm consultants to interpret the results to identify which areas of a farm will produce a greater response to nitrogen (N) than others.

The second development, SpreadSmart™, is precision technology developed for fixed-wing aerial topdressing. It combines GPS guidance and tracking systems with computerised farm mapping to automate the opening and closing of an aircraft's fertiliser hopper at the right time, in the right place.

The strategy underlying Ballance's PGP and core research investments has been focused on reducing the environmental footprint per unit of production through either a better response to fertilisers or reducing losses from the farm system. N-Guru™ is a new decision support tool that has been a key output of the N work stream.

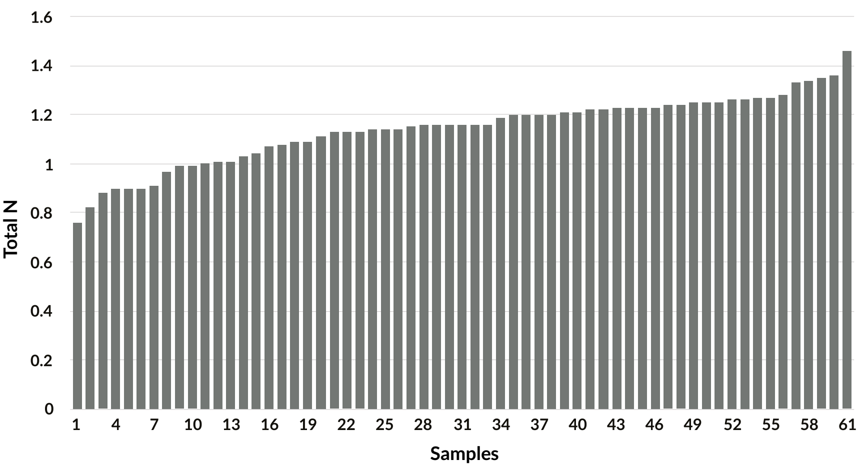
Historically, there has been no tool to objectively estimate the magnitude of response expected from N fertiliser from pasture, a major weakness given the increasing consumption of N fertiliser and the importance of reducing farm system N losses.

This new decision support tool has been based on a simple Total N soil test, which utilises the same normal 7.5 cm soil sample used for soil fertility assessment on-farm, and therefore requires no additional sampling. The key challenge, as with any soil test, is what does the number mean? Untangling what the Total N soil number means in practice has been the core of the investment, which led to developing a calibration across seasons, rates and regions as to the predictability of the response to N. The calibration curves developed calculate absolute response, but are strongest when considered as a relative response. The information has been incorporated into this decision software tool, which can be used to evaluate the pasture yield advantage of varying the rate of N across a farm rather than applying a uniform single rate.

How variable is the soil N across a farm?

Figure 1 shows the range in total N for a flat contoured dairy farm near Te Awamutu. The soil levels range from 0.7, a moderate soil N level, to 1.4 a high level. The soil N level is influenced by soil type with the variation driven by factors such as slope and fertiliser history. The variation below is typical of most soil test variables such as Olsen P and pH and represents a similar opportunity to manage.

Figure 1: Within farm variability – Waikato example



Is there any value if there is no or little variation?

In practice, for fertiliser advisors there is one main advantage remaining in that they advise across a region or district and therefore they still gain a better understanding of how N response can vary across that region or district and the need for their advice to vary. Within the farm the main advantage is they will still have more confidence in the magnitude of response and hence the cost benefit that the N will generate.

CASE EXAMPLE:
OWL FARM

St Peter's School/Lincoln University Demonstration Dairy Farm

Owl Farm is a 165 effective ha dairy farm near Cambridge running 465 cows producing 1,220 kg MS/ha. The farm normally applies on average 120 kg N/ha annually. For this relatively uniform farm, the variation in Total N was small ranging from 0.56% to 0.77% (medium levels for soil N). Using the N-Guru™ decision support tool the best response is gained changing from an average 30 kg N/ha rate to a variable rate of 0, 30 and 46 kg N/ha across the property, generating an increase in pasture production response of 3.4% from a single N application (see **Table 1**). Across seasons or multiple applications the magnitude of the response will change but the difference in relative response will remain.

Table 1: Owl Farm N-Guru modelled output for variable and uniform N strategies

Rate of N	Calculated average N response kg DM/kg N	Estimated total pasture response total kg DM
Uniform 30 kg N/ha	17.3	35, 874
Variable 0, 30, 46 kg N/ha	18.0	37,109

This decision support tool enables advisors to predict the pasture response to the nutrients accurately and impartially and tailor their advice accordingly and it is this interpretation ability which is the novel part of the research. Using the technology, we can tell farmers in advance what pasture and production gains they can expect from their fertiliser programme.

It is a good tool to use strategically guiding the allocation of the N budget for a season. Allocating more of the season's N to the low testing areas and less to the high testing areas improves N response efficiency and the returns on a farm's fertiliser investment.

Approximately 400,000 tonnes per annum of fertiliser and lime is applied by fixed-wing aircraft in New Zealand.

Variable rate fertiliser from aircraft

Approximately 400,000 tonnes per annum of fertiliser and lime is applied by fixed-wing aircraft in New Zealand. The ebbs and flows of fertiliser demand from the dry stock industry has made aerial topdressing a challenging business to operate. In recent times, and especially with improved beef returns, fertiliser use on hill country has increased. This increase in fertiliser demand has also occurred concurrently with increasing environmental pressure on reducing direct and indirect nutrient losses to waterways.

CASE STUDY:
WAIPAWA RESEARCH FARM

Agresearch

In hill country the significant variation of land, soil and fertility creates an opportunity to capture benefits from non-uniform treatment of land with fertiliser in particular. The advantages of treating land in a non-uniform way was best illustrated by a trial conducted by Dr Allan Gillingham of AgResearch at Waipawa (a dry east coast research farm) in the Hawke's Bay during the 1990s (**see Figure 2**). On this research farm differential fertiliser applications to north and south aspects of differing slope classes (easy and steep) were evaluated.

The research showed that for steep northerly faces receiving <800 mm of rainfall, N is the most economical fertiliser treatment compared with phosphorus (P) applications. The underlying driver of the relative responses was the presence of legumes, especially white clover. This goes back to the fundamental tenet of fertiliser responses being that P, potassium (K) and sulphur (S) are primarily applied to drive the clover content of our pastures.

Under dry north-facing aspects (or cold southerly aspects in other regions) clover growth is poor and therefore responses to PKS fertiliser will be poor. Given that clover growth is poor the N status of these zones will be low and therefore very N responsive. Dr Gillingham exploited this variation to show how N and P can be differentially applied for the greatest economic gain.

Converting the science into a service or product

Taking the next step, however, has been converting the science into a service or product for farmers and this next phase has been funded via Ballance's PGP Clearview research programme. As with lots of technology, the first challenge was for us to get some definitions in place and we have defined two terms to aid the understanding of variable rate fertiliser application:

- Variable rate fertiliser application – where fertiliser is being applied at more than two rates within a zone. Example: phosphate rate varying across a landscape based on stocking rate
- Differential fertiliser application – where two different nutrients or fertiliser are applied within a zone, typically where one is N responsive and the other P and S responsive. Example: N being applied to north aspects only and P and S being applied to south aspects.

So for variable and differential rate technology Dr Gillingham's research and that of others has shown the potential benefits of varying the application of fertiliser. The next challenge for us was to develop the hardware and mapping rules to commercialise the technology.

The primary challenge with aircraft has been developing an automated hopper system that works in real-time, but

We as a primary sector must continue to invest to provide tools to assist with the dual challenge of increasing productivity and reducing the environmental footprint

can be overridden by the pilot to provide for safety if a load has to be dumped rapidly (the requirement is within five seconds). The hopper system developed also has utilised hydraulic arms to achieve rapid closing of the hopper door within 0.5 seconds. The speed and responsiveness of the hopper door is important as this determines the resolution of each 'pixel' or the smallest parcel of treatable land. Most fixed-wing aircraft travel at 200 km/h or faster and so a practical resolution for management units has been set at 45 m.

The other major external factor that needs to be factored into the rate of discharge of fertiliser is plane speed, which varies as the planes navigate the hill country increasing and decreasing their altitude. This factor has been built into a real-time GPS system linked to the hopper door control, so the discharge rate is varied according to changes in the aircraft speed, thus maintaining a constant fertiliser application rate on the ground. In the past, for pilots to deliver a variable rate they had to manually make all the above adjustments on the go. SpreadSmart™ now allows pilots to focus on flying with a resulting increase in safety and confidence in the job being done accurately.

The hardware and associated software has now been loaded in two Ballance Super Air aircraft. The approach to prescription mapping and fertiliser needs is based off-pasture production, which is driven strongly by slope and aspect. These elements, along with recognising the 45 m resolution capability of aircraft, are incorporated into creating a fertiliser prescription map. The map is loaded into the aircraft GPS system and the pilot simply flies the property with the fertiliser rate and placement being automated.

So having generated a prescription map, and the ability to apply fertiliser variably or differentially, the first question should have been does the farmer really want the technology? **Figure 3** is from a survey of drystock and dairy farmers illustrating that accurate placement was the most important attribute for using the technology with cost ranked as the fourth most important. The technology can therefore meet the key demands of customers and the rate of adoption will determine how quickly the rest of the Super Air fleet is converted.

Conclusion

Technology is an enabler and Spreadsmart and N Guru are just two of many new tools that are providing farmers and consultants with more objective tactical decision-making. However these tools must and do also concurrently provide direct or indirect environmental benefits. We as a primary sector must continue to invest to provide tools to assist with the dual challenge of increasing productivity and reducing the environmental footprint – a challenge well suited to PGP investments where the government is a co-investor.

Figure 2: Pasture responses (kg DM/$) over four years (1995-1999)

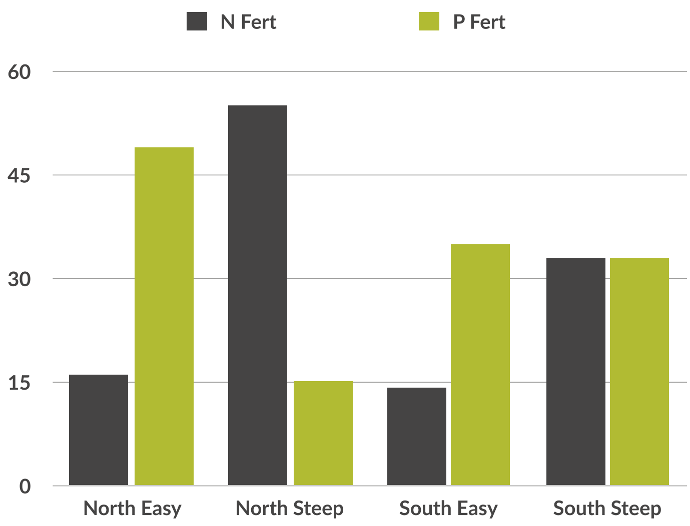
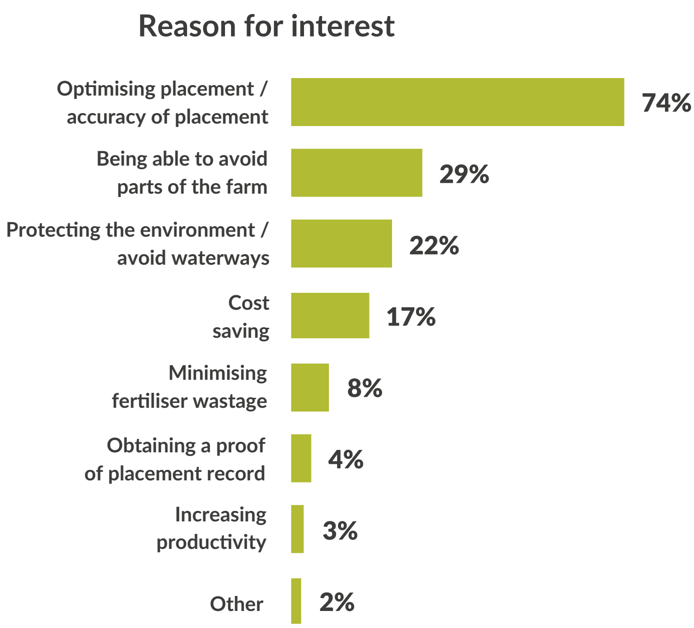


Figure 3: Frequency graph of the reason farmers would use variable rate application



WARWICK CATTO is Science Strategy Manager at Ballance Agri-Nutrients based in Tauranga. Email: warwick.catto@ballance.co.nz

BEVIN HARRIS

Promising developments in dairy genetics

To remain internationally competitive, the New Zealand dairy industry relies on future generations of cows to be better converters of feed into profit. This article reports progress on how the science of dairy cattle breeding is being changed by the use of DNA markers.

Genomic selection of bull calves

Picking genetics during the artificial breeding season works on the assumption that, when it comes to breeding and production efficiency, farmers want new generations of replacement cows to outperform the previous generation. This largely comes down to good sire selection.

Arguably still in its infancy, the genomic selection of bull calves is finally getting traction in New Zealand, where benefits for LIC's sire selection processes are emerging and better alignment between forecasted genomic worth and realised breeding worth (BW) is the expectation. Genomically-selected bulls have been marketed by LIC for eight years, with mixed results in the first several years. Progress has been made since 2013.

Using milk and traits other than production (TOP) information from a bull's daughters, the process takes LIC seven years to get an accurate estimate of a bull's genetic merit, commonly referred to as BW. Only after that 'progeny test' period will the bull's genetics become commercially available to the nation's dairy farmers. This is the traditional method of 'proving' a bull's value as a breeder of dairy cow replacements.

However genomic selection, using the latest science methodology, offers the industry an attractive alternative proposition. What we want to do is get a reliable estimate of genetic quality at a bull's birth, rather than having to wait five years (for daughter information).

Reliable estimate does not mean it has to be as reliable as progeny testing. This is because if you save four years, you can actually forgo some reliability and make greater levels of genetic improvement, just by using the slightly less reliable bulls at a younger age. This is the essence of genomic selection.

Genomic selection hones in on a series of DNA markers that control the key traits that dairy farmers are interested in (e.g. fertility, fat, protein and udder support). The idea is that DNA is used from young animals when they are born. This derives a better estimate of their BW than it is possible to get from the parent average BW, bypassing progeny testing in the process. This is achieved by using

> **Arguably still in its infancy, the genomic selection of bull calves is finally getting traction in New Zealand**

their DNA, specifically the DNA markers. Some markers are associated with genes that control the traits we are interested in. If there is a marker that is associated with a positive trait, it is possible to work out whether that animal will be of good quality.

Slower progress

The method is working well in almost all dairy industries around the world, but progress has been slower in New Zealand and a few Scandinavian countries. New Zealand, Norway and Finland have large cow populations, but our industries also feature multiple breeds and cross-breeds. When there is one population (e.g. exclusively Holstein as in the United States) it seems to work much better.

With cross-breeding, the associations between the DNA and the traits are split up so there is much more admixture in the genome. It is now a matter of driving the science forward and gaining a good understanding of how to take account of the cross-breeding within these genomic predictions. This is the really important component in getting genomic selection really firing.

Recent developments

There are aspects of this technology that are doing extremely well. Five years ago, bull calves for LIC's Sire Proving Scheme were selected exclusively on ancestry records. Now, LIC pre-selects a list of 2,000 male calves from cow families that have sound conformation traits and are deemed as the most efficient producers in New Zealand. Before leaving the farms they are born on it is possible to run all young sires through DNA testing. The sires are run across the DNA chip – looking for key 'marker' traits. At LIC the top 200 to 250 from the initial list of 2,000 are taken for LIC's Sire Proving Scheme.

Sire acquisition managers will visit farms throughout the country to look closely at the 200 to 250 bull calves and

Before arriving at the LIC Newstead farm to join the Sire Proving Scheme, bulls such as these have had their DNA screened for traits that farmers are most interested in.

their dams before confirming their place in the Sire Proving Scheme. This is a significant change from what happened previously, which was to select the top 200 to 250 based purely on the parent average (i.e. the BW index).

Although parent average is still a significant factor, the genomic selection tool complements the process. Bull composition is slightly different under the improved pre-selection method, as there is much more choice and a wider range of bulls. Looking at a list of 2,000 sires allows genomic selection specialists to open the way for a small number of animals that might not have otherwise come on the radar. We can use the knowledge that a bull has good genomic values compared to his parent average, which gives him a greater probability of having a successful outcome from progeny testing.

LIC is also carrying out more embryo transfer work which helps, for instance, if you take two identical full brothers who have identical parent averages. It is possible to use the DNA information to show differences – one bull might have better associations in the desirable traits so he will be chosen.

Using heifers to generate elite bulls

LIC is also using more heifers to generate elite bulls. Previously, it was necessary to wait until cows were milking to get an idea of how good they were before using them as mothers of bull calves. Samples can now be obtained of the heifers' DNA, generating breeding values before they have calved. This speeds things up even more (intensifying the selection), so it is possible to turn generations over.

Promising signs

In 2013, LIC made a significant change in the method behind genomic selection, including the mathematics behind it. The focus is on trying to improve the stability of the difference between what we say the animal is going to be (based on DNA information) and what it finally comes out at (when daughter information comes through). Ideally, the numbers would be the same. It is important, however, not to over-promise on the genetic level of these animals or on the accuracy predicted from the genomic BWs.

LIC is also using a different system to calculate the association between genomic markers and the traits farmers are most interested in – milk solid production, fertility and survival.

Looking at bulls that had their progeny test results coming through in 2014 and 2015, their original genomic predictions (using the improved calculations) appear to be holding up as more daughter information becomes available.

Pre-selection is therefore working and results are now seen in the Ranking of Active Sires (RAS) List. Instead of having a group of sires below zero (i.e. falling short of initial genomic predictions when daughter proofs emerged), they are not there anymore. In other words, those that inherit poor genes from their parents are less likely to be progeny tested. If improved rates of genetic gain are achieved, this will result in more profitable cows for farmers.

BEVIN HARRIS is Science Leader at Livestock Improvement Corporation (LIC), leading the development of LIC's genomic selection tool. LIC is owned by 10,500 New Zealand dairy farmers. Email: bharris@lic.co.nz

FORBES ELWORTHY

The digitisation of corporate farming

This article looks at the benefits of corporate farming in New Zealand and the increasing trend towards the adoption of digital tools by those who work in this area.

Corporate farming in New Zealand

After the 1980s farm crisis, a number of corporate farming groups were created in New Zealand, for example, the NZ Rural Properties Trust. Their aim has been to bring the benefits of scale in order to offer farms resources that are not always available to the average family farmer. These include:

- Access to long-term, committed, professionally managed equity capital
- Sector research and strategy formation
- Staff safety and human capital development
- Accounting systems for payment, control and other key performance indicator (KPI) reporting
- Bulk purchasing of farm supplies and financing
- Farm produce marketing and exposure risk management
- Cross-farm benchmarking and communication systems
- Environmental standards.

At the same time many corporate farming enterprises still realise the importance of behaving like the 'owner-operator' family farms. New Zealand has innovated structures for shared ownership of the farm and/or livestock. The aim is to retain family farming values 'on-farm', but supported by an umbrella of shared 'corporate' resources.

This article discusses the way that digital decision support and communication tools can spread in corporate farming, as an example of such a shared resource.

Adoption of digital tools by the farming industry

The white collar industries saw the benefits of digitisation early, and we are only now seeing digital-enabling technologies spreading to the blue collar industries, including farming. For example, the white collar legal profession started using LexisNexis from the 1970s. Office workers had access to Microsoft Word, Excel and Outlook tools from the 1980s. In the 1990s, Bloomberg spread throughout the wholesale financial markets. Yet it was only after 2010 that improved GIS software and connectivity began transforming the blue collar and service professions, as we have now seen with Uber and taxis, AirBnB and accommodation.

> **Digital information companies are 'integrators' of agricultural data, helping farmers monitor farm performance across a large range of different data sources.**

In farming, digital information companies are helping that aim to bring farmers both paddock-level and enterprise decision support tools. These tools are naturally emerging in the larger corporate farming businesses, but they are now being extended to family farming businesses. Family farmers are essentially banding together to get the benefits of scale. It is not cheap to hire the developers and data scientists needed to build, for example, a precision fertiliser application tool.

These digital information companies are 'integrators' of agricultural data, helping farmers monitor farm performance across a large range of different data sources. Data is integrated in applications on smartphones and computers. Performance and financial KPIs (e.g. grass growth, margin/cow/day and margin/ha/day) are tracked with farm metrics tools. Other tools help the benchmarking of farm KPIs against regional average data configured to a benchmark group (e.g. a peer group of farms on light soils, or clay soils, or using irrigation), or are for modelling farmland financial returns or farm budgeting and control. These companies therefore need to be trusted, farmer-oriented information service providers.

The farming digitisation debate

Will digital tools sweep through our industry as fast as they have for other blue collar and service sectors? Some of the issues in this debate follow.

Everything is digital now

Many industries, including farming, are no longer primarily 'about' traditional physical relationships. For example, although car companies and taxi drivers thought they were in the car business they recently discovered they were really in the transport business. They have realised that to be a manager of transport demand and supply you do not need to build or own (or finance) cars – you need to organise transport. Hence Uber and other similar companies, some of them providing power services in the agricultural space by helping scale tractor hours, are transforming the transport industry.

Tri-angularity

The large digital companies – Amazon, Google, Facebook, LinkedIn, AirBnb, Uber and many more – almost always have a tri-angular mode of commercialisation. They 'give away' something of compelling value (free in the case of Google, convenient in the case of AirBnB and Uber) to create a community of users. Then they 'monetise' the value of this community through harvesting the information their users generate, which in turn enables them to provide even more compelling value to them.

Traditional modes of 'selling' products do not apply in the digital economy. It makes more sense for digital companies to give away compelling value to their users in order to create large user groups that then create the really valuable thing – scaleable sets of user information.

Platforms out-perform capabilities

Although the tools that measure the fertility of soils are powerful creators of value for users, these sorts of capabilities are, in the long run, not as sustainably value-creating for a digital entrepreneur as clusters of such capabilities bundled together into a 'platform'. The most integrated financial information platform brings together analysis, data, news and messaging in one place so that 'the sum of the parts is greater than the whole'.

Independent, transforming innovations out-performing sector incumbents

Are bold, transformational and independent platforms such as Uber and AirBnB now out-performing incumbent offerings? Climate Corp is an agricultural example of both saint and sinner. Its founders took a clear leadership position in agricultural data and crop modelling in the United States with a fresh and independent approach. However after selling themselves to Monsanto (for just under $1 billion) their industry momentum has slowed. Farmers no longer see them as an independent information platform and they are therefore now not getting sign-ups for the service as fast. The quality of the precision farming prescriptions that Climate Corp provide may not have changed, but the perceived independence of the provider has.

Concluding remarks

A 'not-on-platform' attitude is typical of many blue collar and service industries, including farmers. However the efficiency advantages of shared sector productivity platforms is likely to see them spread well beyond the functions that say Uber does well – organising transport. This is especially so in the more fragmented industries that have many small to medium-sized companies, where it can be valuable to access outsourced decision support technology. It is also the case in the data-intensive industries like farming where recent advances in GIS, satellite and big data promise to deliver large productivity gains.

The time for the digitalisation of primary industries is now upon us now. Digital information companies are certainly leading the charge in our farming businesses. The prevailing farmer attitude of 'too difficult to do' has to change with the active support of professional advisors and managers as they work increasingly with digital platforms and technology.

FORBES ELWORTHY is a farmer and digital entrepreneur as the Chairperson of Craigmore Sustainables, which is currently operating 26 farms and six forestry properties, and the Founder of Map of Agriculture. Email: forbes.elworthy@mapof.ag J

John Tavendale

John Tavendale (ONZM, FNZIPM) is a registered farm management consultant based in Ashburton. This profile looks at his career, including as a director of Landcorp for seven years, and his work in the community.

Lincoln start

John grew up in a rural village, Ngapara, in North Otago where his family was involved in flour milling. From a young age he had an active interest in farm animals, crops and farm machinery. He attended Waitaki Boys' High School, and although he was discouraged from studying agriculture all his holidays were spent on farms in Southland and North Otago.

As the first recipient of the North Otago Progress League Agricultural Scholarship, John attended Lincoln College from 1963 to 1966 and completed a Bachelor of Agricultural Science majoring in soil fertility, production economics and farm management. He enjoyed farm management and the structure of the teaching process, which involved regular visits to farmers and analysis of on-farm activity.

Farm advisory and consultancy

Farm management graduates had many employment opportunities in the 1960s. John was appointed the Fourth Advisor to the Lauriston Farm Improvement Club based in Ashburton, and was responsible for a group of 40 farmers ranging from intensive arable and livestock farmers to extensive pastoral properties.

Most fee-charging farm advisory officers at the time worked for Farm Improvement Clubs. However, in 1969, John and three other advisors established the first fee-charging private farm consultancy practice in the South Island (Engelbrecht Royds Smith and Tavendale). In 1987, he established a new practice committed to the advancement of modern agricultural techniques and providing consultancy services to both farmers and the agribusiness sector.

John notes that farm consultancy in the 1960s and 1970s was an exciting occupation for a graduate. The Agricultural Production Council was actively promoting increased agricultural output. Low interest loans were available and government incentives, such as the interest-free Land Development Encouragement Loans and the Livestock Incentive Scheme Grants, were all outcomes of the low income era in the mid-1960s. Conferences such as the annual Farm Improvement Conference and the then fledging NZ Society of Farm Management were inspirational to those new to the profession.

In these almost boom times he felt that the wise counsel of more senior advisors was important to him as a young advisor. Fees, however, were being paid at a time when the government offered a 'free advisory' service through the Department of Agriculture. This competition ensured that all advice – technical, systems-based or financial – was profit-driven for the client. It was this one-on-one advice to farmers that differentiated the fee-charging sector from the government service.

Professionally, John enjoyed working in the hill and high country and his clientele included some of the most progressive and largest tussock grassland properties in the South Island.

Mid-Canterbury at that time was predominantly arable farming, where land use could change on an annual basis between crops. Gross margins were completed annually for crop and livestock options were available to ensure that the farm management programme adopted maximum financial results. It was this flexibility of management systems that developed the skill base of farm consultants working in the area to the extent that many were regarded as leaders in the profession.

Hill and high country work

Professionally, John enjoyed working in the hill and high country and his clientele included some of the most progressive and largest tussock grassland properties in the South Island. The Land Development Encouragement Loans of the 1970s were the catalyst for significant changes to pastoral management in the hill country. He was at the forefront of planning development and capitalising on increased productivity, including the introduction of deer.

Many of John's clients were the pioneers of deer farming in New Zealand and he was also at the forefront of establishing farm management systems for deer. He has been involved in large-scale hill development on many pastoral stations in the South Island.

Overseas consultancies

John's initial agribusiness interest was an involvement with Animal Enterprises Ltd, a Hamilton-based group involved in the export of breeding sheep and cattle. He was involved in both market development projects and associated consultancy work in Eastern Europe, Central and South America the Middle East and Australia. He studied intensive livestock production systems in the United States and Canada, including the feedlotting of sheep and cattle. He used this experience when acting as a consultant for the establishment and operation of feedlots in New Zealand for preparing livestock for export shipments.

Governance

John's association with entrepreneurial farmers and the agribusiness sector resulted in him gaining a very good reputation in the farming community of thinking laterally. He was also regarded as having a unique ability to combine both production and business principles to help achieve highly profitable farm businesses.

The recognition of these skills has seen John involved in many governance roles as a director. He is chairman of a large privately-owned farming company, W Pinckney Ltd, an advisory board director of a number of large-scale pastoral companies, and a director/shareholder of Fernside Holdings Ltd, a 2,600 cow dairy property in Canterbury.

John was a director of Landcorp Farming Ltd for seven years and had a significant input into the dairy and deer development programmes undertaken. Landcorp was a challenging directorship, in that the properties in the state-owned enterprise were initially at the lower end of productivity. However commercial principles and an outstanding commitment by staff ensured that production gains and productivity rivalled those of the private sector. John had an unswerving philosophy that Landcorp should be a leader and catalyst for change within the agricultural sector.

Dairy development on the West Coast of the South Island and genetic gains with livestock breeding programmes were two very good examples of what could be achieved with the application of science and management. In his view, state ownership of land and the opportunities it provides for competent agricultural workers and management is still preferable to foreign ownership.

Community work

John's 300 ha family farm of irrigated land at Ashburton specialises in intensive land use horticulture (blackcurrants), dairy support (kale and maize), arable crops and trading sheep. This a significant diversion from the extensive pastoral properties served by his consultancy.

John has served his community as a director of Electricity Ashburton Ltd for 13 years (chairman for seven years), and as chairman of the Barrhill Chertsey irrigation scheme. In seven years the scheme has developed a pressurised water supply to 22,000 ha of the Ashburton County.

John is chairman of Ashburton Contracting Ltd, an Ashburton District Council company that is a shareholder in the development of Lake Hood, a large man-made aquatic recreational lake and housing development close to the town.

Compliance cost concerns

John's passion for agriculture and businesses has not diminished in his senior years, but he has many concerns about the acceptance and cost of many of the compliance issues now facing agriculture. While confident that science can and will provide many of the answers to these issues, the present degradation of agricultural science in New Zealand is another major concern to him.

ONZM honour

In 2013, John was recognised in the Queen's Birthday Honours list for his contribution to agriculture and business by being made an Officer of the New Zealand Order of Merit (ONZM). J

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