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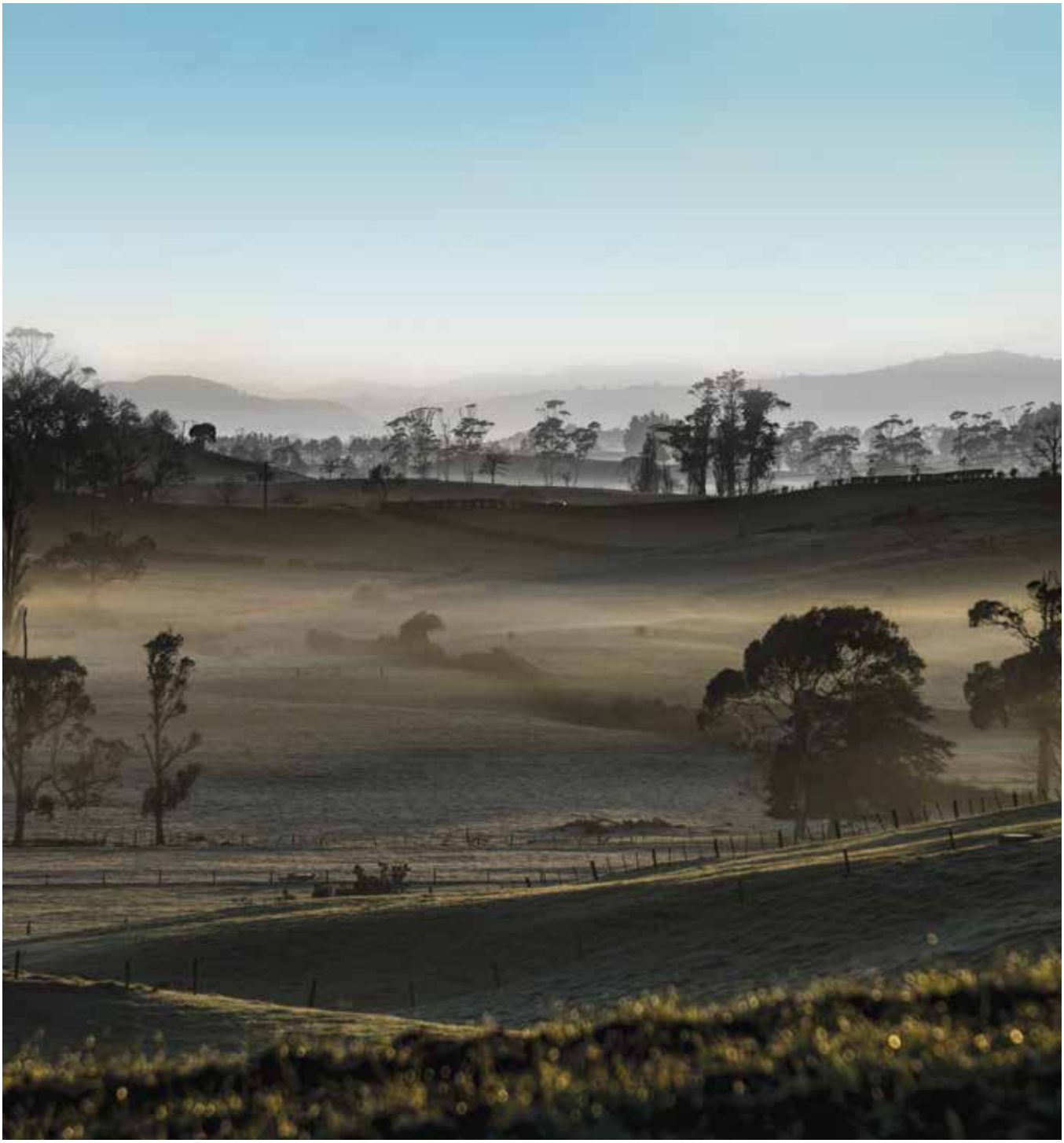
THE JOURNAL

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



VEGANISM – IS IT A THREAT TO DAIRY? ONGOING BIOSECURITY CHALLENGES **DIVERSIFYING SOURCES OF CAPITAL FOR THE PRIMARY SECTORS** SHEEP DAIRY MILK INDUSTRY **CYBERSECURITY FOR THE PRIMARY INDUSTRIES**

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The primary industry's time to shine

Since the emergence of COVID-19 from Wuhan, China in December 2019, New Zealand and many other countries across the world have taken unprecedented and drastic measures to quarantine their populations to control the spread of the virus.

Within New Zealand the tourism industry and other businesses that rely on the free flow of people and goods have been severely hit by travel restrictions imposed on the public in a global effort to reduce the transmission of COVID-19, which has had a devastating impact on many individual's livelihoods.

In many ways farming enterprises have been fortunate to be able to continue operating within the confines of controlled on-farm environments, while still being able to send their products for further processing, albeit at reduced capacity levels as processing facilities adapt their workplaces to maintain safe distancing requirements and deal with logistical disruptions in moving product.

Challenges still do exist on-farm, with many farmers having to manage tight feed supplies on the back of dry weather conditions in many regions across the country. Despite these extreme conditions, farmers and rural professionals have been able to get on with most of the tasks at hand, which unfortunately has not been the case for people and businesses involved with the tourism and travel industries.

To understand the gravity of international travel restrictions to the tourism industry, the number of international visitors that entered New Zealand averaged around 321,000 per month for the year ending February 2020.[1] However, since the start of the lockdown on 26 March the number of international visitors passing through our borders has almost been non-existent.

The associated impact to the New Zealand economy will be significant. In the year ending March 2019, the export value from the tourism industry was worth $17.2 billion.[2] To provide context this closely rivals New Zealand's largest export sector – the dairy industry – at $18.1 billion (YE June 2019).[3]

Unfortunately, the prospect of a speedy recovery within the tourism sector looks grim as countries around the world look to maintain tight controls on the movement of people to minimise the transmission risks of COVID-19. All of which is occurring in the backdrop of a deteriorating global economy.

With the tourism industry in the doldrums and a relatively small manufacturing base, New Zealand's tradable export sector is now dominated by the primary industry, with export revenues from the primary sectors forecast to be worth just over $46 billion by the year ending June 2020.

As New Zealand looks at what can be done to rebuild the economy from the turmoil created by COVID-19, the primary industry also needs to consider what role it plays in helping revitalise and grow the economy.

In many ways we have a golden opportunity to engage and reset the discussion with urban New Zealand on how we can innovate and grow the economy sustainably. But this will require different types of discussions whereby we are more open in understanding and respectfully discussing each other's views in working through areas of concern, including: improving water quality, demonstrating high quality animal care and reducing greenhouse gas emissions, among others. This could be an uncomfortable experience for the individuals and organisations involved and potentially requires the parties to concede ground on their respective positions around certain issues.

This will require us to deeply reflect on how we wish to work and engage with each other in this new world, as it would be far too easy for inflated egos and vested interests to take advantage of the primary industry's current position to push certain agendas. But, as experienced by the tourism industry, we should also be very mindful of how quickly the tables can turn within our industry when dealing with biological systems and biosecurity threats, with PSA in kiwifruit and *Mycoplasma bovis* being cases in point.

Instead the opportunity exists for this country's primary industry to use its new-found status to respectfully show and demonstrate leadership in reaching out and engaging with urban New Zealand as the time is right for the primary industry to shine. J

1. www.stats.govt.nz/information-releases/international-travel-february-2020
2. StatsNZ Tourism satellite account: 2019
3. MPI's Situation and Outlook for Primary Industries, March 2020

JOHN ALLEN

VEGANISM AND COVID-19 – IS IT A THREAT TO UK DAIRY AND WHERE TO NEXT FOR THE INDUSTRY?

The rise of veganism, climate conscience and wider social changes were impacting the dairy sector as the COVID-19 crisis emerged. This article outlines the findings of a 2019 Kite Consulting UK report on the growth of veganism, and notes that the debate on all these issues has been brought to a head by the crisis.

Growth in veganism

In Spring 2019, Kite Consulting commissioned a research document that explored the growth in veganism in the UK in recent years and some of the drivers for that change. It also reviewed how social media use impacted on consumer choice and sense of identity, how the UK dairy industry had responded so far, and how the industry should respond going forward.

The key findings of the report were first that it was clear that the pressure on the dairy industry from the vegan movement was increasing. It was flourishing from the perfect storm of motivations – ethical, health and environmental concerns – aided by the reach and resources of the internet and social media.

The report also found that the activists in the vegan movement had hijacked the climate change issue and were linking consumption of livestock products to damaging the environment. It was gaining traction and they were moving towards promoting their movement as being the equivalent of the civil rights movements of the 1960s and 1970s.

It noted that for many consumers the offer of 'peace of mind' – that they were doing something about the climate change issue by switching dietary habits away from dairy (rather than taking tough choices on foreign travel and so on) – appeared attractive. Yet 'extreme' vegans remain a very small part of the population, with many people identifying as such actually adopting a part-time vegan or flexitarian lifestyle.

A further finding was that while veganism poses an often 'noisy' threat to UK dairy, the threat of interventionist government policy based on ethical grounds seems to be minimal. This was because the UK already has stringent and world-leading welfare standards, which are regularly reviewed and improved through existing supply chain mechanisms. However, there has been evidence of policy-makers starting to make changes to the consumption of dairy and livestock products (e.g. the UK Committee on Climate Change recommending that we consume 20% less meat and dairy).

Along comes COVID-19

Just as across the world those involved in animal agriculture were starting to feel the pressure, along comes the pandemic of COVID-19. It is still being brought under control globally, and although a clear end is not in sight we can already hear voices talking about what the new post-COVID-19 world should be like.

Plant-based products are often quite expensive, especially when viewed on a cost of nutrients consumed basis.

Everyone has their views about how we will all live a different life – perhaps not wishing to travel again and suddenly having discovered a new post-COVID-19 way of living. Each of us comes to the debate with prejudices and preconceived ideas. What seems certain is that the vegan movement will not have changed its views, and we already have Extinction Rebellion claiming the campaign of 'Never again'.

Meanwhile, many will claim that when consumers had to choose they went back to the basics of bread, milk and meat. This is playing to the narrative that we will revert back to the good old days when we will be wanted as producers of food, and premiums for good local produce will re-emerge as people recognise what matters in this world – good local food with provenance. There is no doubt that for many this will be true and there could be the emergence of more opportunities to meet consumer needs with this approach.

However, we will also emerge from this crisis with the world in a recession and many consumers being financially challenged, so value for money will remain a key priority. In a world where 25% of all calories produced cross a border to reach a consumer, then global food supply chains that have actually held together through the crisis will remain important.

Yet another driver for change will be meeting increased sustainability targets. Extinction Rebellion are correct, and it is hard to argue against the need for change to avoid more world crises. Human nature is such that people will be more averse to risk as we retreat back into wishing to meet our more basic needs for security along the lines of Maslow's hierarchy of needs. This is evident from behavioural studies emerging from China where people are more willing to obey government instructions for their own safety.

We can anticipate government having to play a greater role in our lives as they aim to clear up and pay the debt. Government will also have the partnership of major retailers who, to a large extent, kept the country fed and avoided food shortages, thus maintaining public discipline.

In such a world it is to be anticipated that the key driver will be for safe, more sustainable, food chains with no additional cost. This will demand more innovation from the supply chain, with greater simplification and integration to take out cost and add value, so investment in making our sector more sustainable can take place. That is, the wheel of change will go faster. The need for greater resilience along the supply chain will also increase.

Has the vegan threat gone away?

So, has the vegan threat gone away? The simple answer has to be no. Is the UK now in a different place to grasp opportunities? The answer is definitely yes.

In addition to the vegan threat there is the emergence of plant-based food businesses, backed by considerable funding. This is playing a part in getting consumers to move towards more plant-based products, which are often quite expensive, especially when viewed on a cost of nutrients consumed basis. These businesses, often backed by large organisations (such as Unilever, Danone and Kraft) will now have to re-evaluate their marketplace, which will be far more price sensitive. The risk of launching new artificial, factory-made food lines into a financially challenged marketplace may deter further investment.

If we come out of this crisis with society demanding more sustainability and 'never again', then the opportunity for dairy is to ensure consumers see that we agree and are innovating to do our bit to reduce our environmental footprint, while at the same time providing affordable, nutritious and tasty food.

We will have seen the greatest experiment in the Anthropocene era with flying and road transport having been massively reduced. We will have the evidence to show what we, as a society, need to do to make our world safer for our next generations. We also have the capability to work as an industry to make our contribution to reducing our environmental footprint.

Much more change needed

The 2019 Kite Consulting report also noted the following two areas of importance:

A new culture was required in the industry

The dairy industry's existing culture no longer works. There isn't a consistent consumer-facing mentality running as a thread throughout the sector, and the industry can be prone to defensive behaviour rather than being outward-looking and engaging.

Much of this can be blamed on the fact that the dairy industry, and indeed the wider agricultural industry, had perpetuated an approach based on an expectation of continuing post-war gratitude that our farmers feed a hungry nation. This 'thank a farmer' mentality was not unique to the UK. However, this cultural position means that much industry communication is about imploring consumers to appreciate how hard farmers work producing food in difficult weather, in difficult markets, and with huge challenges – almost a 'don't take us for granted' position. This is more important than ever and there are already signs in the farming media of this attitude.

As consumers have become more distant from agriculture, yet at the same time more able to access information (due to the porosity of our digital age), this approach no longer resonates. When a vocal minority (such as the vegan movement) then start questioning the ethics, environmental performance and health benefits of an established agricultural sector (such as dairy), and the industry responds defensively and on occasion antagonistically, the danger is that average consumers (those who actively consume the products in question) end up viewing the industry in a negative light.

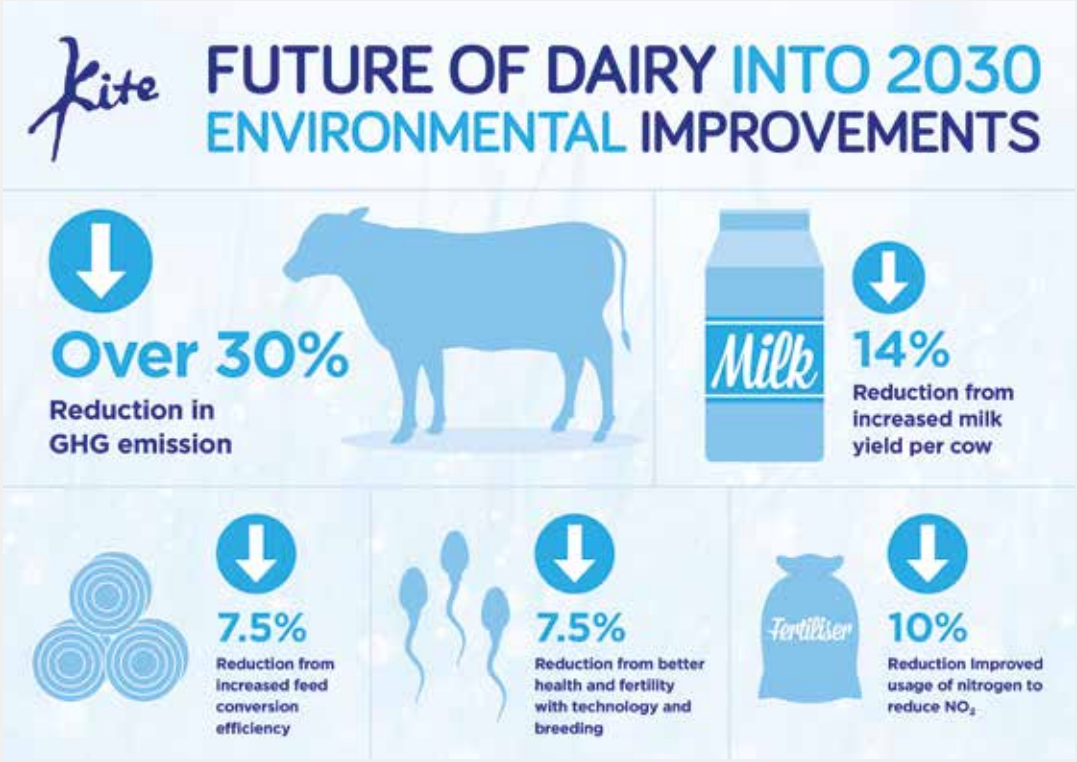

Figure 1: A 30% reduction in GHG emissions using targeted areas

To build goodwill, the industry cannot rely on consumer gratitude any longer. It must see the current situation (the rise of veganism and milk alternatives, the pressure from climate conscience and the growing awareness of animal welfare issues) as an opportunity, a chance for self-reflection and a driver of innovation. Rather than continuing to justify current practice in a defensive way, it must show that it cares about the things that consumers care about, and then explain why its practices deliver that.

The industry must also root out any people in the industry who do not demonstrate those values and make it clear that such practices will not be tolerated in the future. As supply chains rapidly adapt post-COVID-19, then we should not be surprised to see retailers and processors become less tolerant of poor practices and more concerned with provenance and brand reputation.

If the dairy industry embraces this new wave of urgency for change with greater sustainability, then we have a massive opportunity to be on the 'front foot' coming out of this crisis. Rather than reacting to consumer concerns, the industry must lead. This means driving the environmental and welfare agenda further and faster than ever before, and shouting about the positive health benefits of a balanced diet that includes dairy and meat consumption at every opportunity.

Dairy 2030 … a 30% reduction in our environmental footprint

Just before the COVID-19 crisis emerged Kite Consulting had suggested a Dairy 2030 commitment. This is because the UK has the potential to reduce its environmental footprint for dairy by over 30% in the next 10 years. There is no doubt that the UK dairy industry can rise to this challenge and reduce its environmental footprint while maintaining milk supply, or even increasing it if the industry and policy-makers require us to. This can be done by focusing on developing environmentally efficient animals and production systems and implementing changes to current practices.

The dairy industry is one that can deliver a significant reduction in greenhouse gas (GHG) emissions through science, technology and good management, and by using the latest innovations and developments.

Change of this scale requires a different way of thinking. Some of the options may not be popular with every farmer (e.g. the adoption of more mixed farming practices or even taking some land out of agricultural production). However, unless we drive the change required, the industry will be forced to change. It is better to drive progress and maintain public trust than be seen as environmental laggards potentially damaging the reputation of the industry further.

How to deliver a 30% reduction

Figure 1 gives more detail about how a 30% reduction in GHG emissions could be achieved in the UK.

There are three key areas to make improvements in:

Increasing yield

Increasing the milk solids yield per animal and reducing the number of livestock will be a cornerstone to achieving this reduction. The Kite Consulting model looks at increasing the average yield per cow from 8,090 ECM litres in 2020

Table 1: UK dairy industry outlook to 2030 – maintaining 15 billion litres of milk

YEAR	2020	2030 (FORECAST)
Herds	11,670	7,890
Cows (million)	1.84	1.34
Milk yield (litres/cow)	8,090	11, 080
Herd size	156	170
UK output (billion litres)	14.8	15.00

to 11,080 ECM litres by 2030 *(see Table 1)*. However, it is expected that improved genetics, management and feed efficiency will increase yield per cow across all systems.

This increase will potentially remove over 520,000 animals from dairy production in the UK and remove a similar number of calves from the industry. In some instances, this will allow land to be available to offer the public for environmental options, with a payment being made to the farmer for such. In addition, the herd reduction will contribute to global cooling as cow numbers fall and methane emissions are reduced.

Improving feed conversion efficiency (FCE)

Getting higher yields of solids can come from the development of new genetic tools to measure FCE. Using new genetic technologies (such as genomics, sexed semen and remote sensing) is a major way to improve FCE.

Improved N utilisation

Currently, nitrogen (N) fertilisers are being wasted and creating potential problems with the environment through diffuse pollution and NO_2 losses. It is possible to move to lower protein diets with cows, better slurry and manure storage systems, and improved applications that can reduce N usage by over 30% in average operations.

Upskilling people

The dairy industry already has many of the tools and skills it needs to deliver this reduction. Adopting new technologies and attracting and upskilling new and existing high-quality workers to help deliver this reduction will be crucial. Sequestration (absorbing and holding CO_2 in the soil) cannot be included in figures at this time, because although this area has huge potential for UK agriculture it is still not proven.

Protect and promote – become immunised

Farmer-owned dairy business Arla UK has started a campaign based on 'protect and promote', and this approach has huge potential for the whole dairy industry given the circumstances we face. Fundamentally, it is based on the idea of ensuring you do the right things to protect your brand, and promote the good things you are doing to provide healthy nutritious food, while also addressing any areas of reputational risk.

Coming out of COVID-19, the UK dairy industry is in a great place to promote all the good we do and demonstrate that the industry is responsive to consumer and societal needs. In a strange way we can come out of this stronger than when we went into the crisis – we are immunised.

Summary

In short, the dairy industry must accept that in order to have a licence to operate for the future, it must demonstrate that it cares about the same issues that its consumers care about. The industry can therefore be trusted to be custodians of the countryside and the way that food is produced, so consumers should continue to buy its products.

Everyone involved, right through the supply chain from farm to processor and retailer, must work together positively to promote all aspects of dairy. The industry must adopt a customer-centric sales approach to its consumers – listening to their concerns, demonstrating empathy, and countering these concerns politely.

The UK dairy industry needs to stop behaving as if it is taken for granted because to continue down that path is to see its markets disappear. Instead, it needs to welcome and be grateful that it has a huge customer base of people regularly buying what it produces. It also needs to engage that consumer base in a positive way to ensure it secures their future custom.

COVID-19 could create a catalyst for real change in this respect. Suddenly, consumers have been reminded about how important dairy food is to them as part of their daily diet. However, consumers are also expected to emerge from this with much greater environmental concerns, which will shape future purchasing. COVID-19 has demonstrated very visibly the environmental impact of humankind due to the significant global impact of lockdown on CO_2 and air pollution.

It will take a change in approach. However, if the UK dairy industry can act fast, accelerate existing plans to reduce environmental impacts and further improve cow welfare (while improving the promotion of what we do and the products we provide), then we can come out of this global crisis on the front foot and with real opportunities ahead.

John Allen is Managing Partner of Kite Consulting LLP, a consultancy business with 35 consultants. They are recognised specialists working along the UK dairy supply chain. Email: john.allen@kiteconsulting.com.

MAKE YOUR SMART IDEA A REALITY

APPLY FOR THE RURAL PROFESSIONALS FUND

Do you have an innovative idea that could create change for Kiwi farmers? Rural professionals, farmers and scientists are being encouraged to team up to apply for $50,000 of funding to rapidly test smart ideas and share the results.

When NZIPIM surveyed its members in July 2018, it noticed a sense of frustration that agricultural research hasn't kept pace with the rapid changes happening on-farm, and that science wasn't helping farmers meet environmental challenges, increasing levels of compliance, or fast-changing consumer purchasing behaviours.

NZIPIM members wanted to see more research into farm system change, designing farm systems to reduce nutrient losses, practical and affordable on-farm solutions to mitigate GHG emissions, and the associated impact on the profitability and sustainability of farming businesses.

'In a small country like New Zealand, researchers, rural professionals and industry need to work more closely together in developing strong and relevant research programmes,' says NZIPIM Chief Executive, Stephen Macaulay.

'We need to encourage and resource individuals and innovative businesses to embrace risk without fear of failure in testing out new ideas.'

To this end, NZIPIM has collaborated with the Our Land and Water National Science Challenge to create a new research fund. The Rural Professionals Fund enables farmers and rural professionals to partner with scientists to test radically new ideas and innovations that could lead to significant improvements in farming systems.

The fund is now open and accepting applications for projects that can test ideas and innovations within six months. The fund will invest up to $50,000 in each project. Project teams must include a rural professional who is a member of the NZIPIM.

'Rural professionals are trusted among their peers and can be better champions of research than scientists,' says Our Land and Water chief scientist, Professor Rich McDowell.

'The Rural Professionals Fund allows us to quickly explore a lot of options, and encourage and resource more innovators and entrepreneurs to test their good ideas.'

Applications should align with the Our Land and Water National Science Challenge objective: 'To maintain and improve our land and water quality for future generations, while enhancing the value of the primary sector to New Zealand.'

The underlying purpose of the fund is to create benefit for New Zealand farming communities, so when funded projects are complete, they'll be required to share what is learned with the wider rural profession and farming community. This is the case even for projects that don't have the desired outcomes, so that others can learn from those experiences too.

For more information, conditions and the application form see: ourlandandwater.nz/ruralprofund

APPLICATIONS ARE DUE BY 17 JULY 2020

WHAT TYPE OF PROJECTS WILL BE CONSIDERED?

Our Land and Water has three core research 'themes' and is interested in applications that contribute evidence and innovative ideas to these areas:

- **Future Landscapes:** We need greater diversity of land uses and practices, matched to what the land is most suitable for, to support the vitality of te Taiao (our land, water, air and all living communities). Future landscapes will involve a mix of existing and new land uses and practices. We need evidence to demonstrate the (economic, environmental, social and cultural) viability of mixed systems.
- **Incentives for Change:** We need high-value products and collaborative value chains that improve the health of land, water and people. We need to identify the signals (from market, social, cultural, natural or regulatory sources) and the monetary and non-monetary rewards that motivate behaviour and changes that benefit te Taiao.
- **Capacity for Transition:** We need to bring together people and organisations from across the agri-food and fibre system to create new pathways towards future landscapes. We need to identify the barriers to change, and how to overcome these (e.g. new sources of investment, new models of processing infrastructure). We need to implement and practically demonstrate new land use options and value chains.

TIM MACKLE

BIOSECURITY CHALLENGES ONGOING

COVID-19 has shown us the significant impacts biosecurity threats can create. Protecting our agricultural production is more important now than ever – but it requires an ongoing community-wide effort to mount an effective biosecurity response.

COVID-19 challenges

As a remote island nation reliant on agriculture and tourism, our way of life depends on a united approach to protect our plants, animals and people from biosecurity threats. Last year, primary sector exports totalled $46 billion (with dairy export revenue alone at $18 billion), while 3.8 million international visitors arrived and Kiwis made a further three million trips abroad. With such widespread movement of people, animals and goods, biosecurity is not something one party alone can deliver.

We are currently seeing the scale a biosecurity challenge can pose with COVID-19. It is not easy to detect and requires significant coordination across and within countries to respond to – by government, businesses and individuals.

Monitoring a range of diseases

Mycoplasma bovis poses similar challenges with detection and it has tested New Zealand's biosecurity system all along the chain. It has had a significant impact on our rural communities, and has required that both farmers and organisations working with farmers step up their biosecurity awareness and practices.

The economic impact of disease outbreaks can be devastating, with African Swine Fever (ASF) recently wiping out 65% of China's pork herd. An outbreak of a disease like

Protecting biosecurity requires teamwork on and off-farm

foot and mouth could potentially do the same here, crippling our livestock sector which contributes $28 billion to our GDP.

Biosecurity will continue to be a critical issue for New Zealand. As we adapt to a changing world as a result of COVID-19, we have a unique opportunity to regroup and renew our focus on biosecurity.

This is critical to protect the agricultural backbone of our economy and safeguard our food security. Our geographic isolation from the rest of the world, usually a challenge for exports, provides us with a unique opportunity to tackle biosecurity risks that many landlocked countries simply do not have.

Our rural communities have valuable biosecurity knowledge hardwired into our collective memory. We have faced diseases such as Enzootic Bovine Leukosis (EBL) and tuberculosis (TB), and despite challenges communities have persevered and gained ground as a result of coordinated biosecurity action. EBL, a virus that can lead to cancer in cattle, was successfully eradicated here in 2008. This occurred 11 years after it was first detected, and the eradication followed a successful milk screening programme.

TB has been here for over 100 years. Actively managed since the 1950s, TB had a resurgence in the 1980s and 1990s, and by 1994 almost 1,700 herds were affected. Turning that around took hard work from farmers, with support from the government, until by 2019 only 26 herds were affected. The TB fight is far from over as we have recently seen, but farmers continue to share their biosecurity knowledge with the next farming generation through regional committees.

Farmers and the community are part of our biosecurity response

Finding, containing and controlling biosecurity threats is not easy. They are usually difficult to detect, take a significant amount of time to tackle, and setbacks are common along the way. Over the past 18 months, DairyNZ has been working with farmers, Beef + Lamb NZ and the wider community through our OnFarm Biosecurity programme to address how we can collectively take responsibility and respond to these threats.

We have seen farmers becoming increasingly biosecurity conscious, with many treating their farms as an island with strong borders. Improved biosecurity measures have been put in place – secure fencing, vaccination against infectious diseases, and visitor procedures to clean boots and equipment. Stock movements are planned and tracked and regional farmer action groups champion biosecurity in the community.

Given the right tools and support most farmers will take the right steps to protect their livelihood. However, as with any community, there are always some who let the rest of the team down. Responsibility for on-farm biosecurity also goes well beyond the farmer, and it will

Farmers, government and vets are working together to improve NAIT

We have seen farmers becoming increasingly biosecurity conscious, with many treating their farms as an island with strong borders.

be important that the upcoming Biosecurity Act review recognises this.

To be successful, the whole community needs to be aware of what others are doing and the risks they themselves could pose to on-farm biosecurity. This helps identify those who need additional support and to call out those who are actively flouting the rules. Changing longstanding behaviour is a process rather than an overnight event.

The role of rural professionals

Rural professionals also play an important role in advising and supporting farmers through change when they are adversely affected by biosecurity threats. Farmers, government, transporters, vets and rural professionals have worked together over the past year to support ongoing improvements to NAIT. The government recently recognised that having industry and farmers at the table with them has fundamentally improved the *M. bovis* programme and shown the way forward for future biosecurity management.

Thanks to the commitment of many farmers across the country, the farming community has a better understanding of biosecurity threats and how to manage them. But, ultimately, we can only protect ourselves if we work together to strengthen the weak links in our defence. It takes perseverance and teamwork to overcome biosecurity threats and we all have a part to play to protect our precious vegetation, animals and people.

More information

For detailed advice on protecting farms, practical tools and guidance visit www.dairynz.co.nz/biosecurity. Local OSPRI committees can also provide valuable support and tips – see www.ospri.co.nz.

Dr Tim Mackle is Chief Execuitve at DairyNZ.
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STEPHEN CANTWELL

CYBERSECURITY FOR THE PRIMARY INDUSTRIES – A GROWING CONCERN

This article looks at the rise of cyber attacks and breaches, specifically those involved in the primary industry, the increasing importance of protecting private and confidential information, and practical tips to manage you and your client's cyber exposure.

Technology important to primary industries

The primary industries are about to embark on one of the most exciting periods since the invention of the first petrol-powered tractor. Although the primary industries have not had quite the same technology movement and investment as other industries (like transportation, health and manufacturing), they are not too far behind.

There are increasing challenges for farming businesses such as reducing the carbon footprint, improving water quality, reducing nitrate leaching, maintaining good staff, and health and safety regulations — the list goes on. Technology is going to be a big part of the solution to these challenges. Also, driven by efficiency and increasing sophistication, there is a lot of technology that already exists such as precision agriculture, driverless tractors, robotic milking sheds and drones.

Stepping back, it goes without saying that in the future farmers will be more connected than ever and have more opportunity to engage with technology as more rural areas have access to dependable highspeed internet. For example, by May 2021, Fonterra will have installed milk vat monitoring technology in vats all across the country, meaning that over 80% of New Zealand dairy farmers will have Internet of Things (IoT) technology.

The increased technology and connectivity of the primary industries is extremely positive. However, we also need to be aware about the risk that it poses for cyber security issues. Cyber attacks and breaches are already impacting on rural businesses in New Zealand and this is expected to increase. While this risk should not put users off embracing technology, as it will be very important in overcoming the challenges facing the primary industries in the future, cyber security needs to be addressed. Luckily, there are many practical things that can be done to reduce the risk of a cyber attack or breach.

Another common area of cyber breaches is the release of private or commercially sensitive information.

Cyber attacks on the increase

It is becoming more common to see coverage of cyber attacks and breaches in the media. There have been some very high-profile cases involving organisations such as Yahoo!, Sony and Air New Zealand where thousands (and in some cases millions) of emails, passwords and other information has been stolen, or confidential or private information breached. These issues are becoming more common in New Zealand, costing individuals and businesses $16.7 million in 2019.

There are many types of attacks such as:

- ***Phishing***
  For example, unsolicited emails purporting to be from an organisation that people are familiar with such as a bank, courier or supermarket. They are designed to get someone to click a link, open an attachment, or divulge private user account and password details – leading to a hacker or virus potentially taking control or stealing funds or identities
- ***Ransomware***
  This type of attack involves a hacker taking control and preventing access to files or them operating the computer until a ransom is paid
- ***Invoice fraud***
  This is when the criminal sends a fake invoice, or changes the bank account details on a real invoice to a different account, resulting in them being paid rather than the correct recipient. Most attacks are motivated by financial gain, but some have other motives. For example, 'hacktivism' is when cyber attacks are used to promote a political or social agenda.

Primary sector not immune to attack

When reading about cyber attacks and breaches it is easy to assume that they would be a minor threat to New Zealand primary industries – after all these businesses often operate in the rural areas of one of the most geographically isolated countries in the world. However, the internet has made the world a lot smaller and, as noted, these cyber attacks and breaches are very real. Although cyber security may be a relatively new phenomenon for those of us in the primary industries, this is not so for most industries and pleading ignorance will fall on deaf ears.

Several FMG clients have already experienced cyber attacks and breaches. An example of this is when cowsheds have been essentially locked down and a ransom been demanded to restore access. Because access was restricted, cows were unable to be milked, which unless resolved quickly can result in animal health and welfare issues. Fortunately, in most of these cases the cowsheds had a factory reset and all the data for the cows (including health, nutrition and milking details) was able to be restored from viable back-ups. Another example was where a hacker changed the bank account on an invoice, resulting in the customer paying into the hacker's account. These payments have been in excess of $100,000.

Important to protect private and confidential information

Another common area of cyber breaches is the release of private or commercially sensitive information. Many rural professionals who are NZIPIM members hold this type of information about their clients and/or their own operations. Those members including farm advisors, bankers, accountants and lawyers could be particularly vulnerable when it comes to these breaches, due to the sensitive nature of the information they hold and the serious professional implications if breached.

Proposed amendments to privacy legislation currently before Parliament will (once passed) only increase the major consequences should serious privacy breaches occur. Under the proposed changes, the Privacy Act 1993 will be updated to reflect the rise of the internet and the digital economy. Specific changes proposed include:

- A mandatory requirement to report privacy breaches to the Privacy Commission and affected individuals who cause 'serious harm'. The Privacy Commissioner is creating an online breach reporting tool to coincide with these amendments coming into law. The reputational impact of 'named and shamed' privacy infringers may be significant
- There will be new substantial fines for privacy breaches of $10,000 (up from $2,000). These changes align with equivalent reforms in the European Union and Australia under the European Union's General Data Protection Regulation (GDPR) and Australia's Notifiable Data Breaches (NDB) scheme, respectively.

For these reasons it is increasingly important that businesses have good systems and processes in place for handling personal and confidential information.

Embracing the future

New technology will have many positive impacts for the primary industries. However, it is important that all those in the sector improve their cyber security in order to receive the benefits that technology and connectivity bring while minimising the risks involved. Rural professionals not only need to enhance their own cyber security practices, but should also stress the importance of this to clients.

PRACTICAL TIPS TO MANAGE CYBER EXPOSURES

There are a number of practical cyber security steps that can be taken to protect a business from cyber exposure such as:

Check invoices

- Invoice fraud has risen dramatically in the past 12 months. As noted, this is where a criminal sends a fake invoice or changes the bank account details on a real invoice to a different account
- Whenever paying an invoice for the first time, double check the account number with the payee. For regular payees, if the bank account changes get in contact and double check this with them.

Use a strong password

- Avoid using the same password on multiple sites, as criminals regularly steal entire password lists from websites and try to use them elsewhere
- Consider using pass-phrases instead. Take a phrase and add numbers or special characters (like F4rmstr0ng!) and never disclose your password to anyone else. Using password manager software is a great way to generate strong passwords, and store all your passwords in one place. Some password managers are free to use
- Consider using two-factor authentication (2FA) to strengthen login security. Again, there are some 2FA tools that are free to use.

Keep systems protected

- Use the updating tool in the software settings to ensure that it is current. This should keep up protection against most of the known vulnerabilities in your software, including that on smartphones and tablets
- Keep antivirus and firewall software up to date
- Secure equipment by adding a password and locking it or shutting it down when not in use.

Look out for phishing emails

- Watch out for unsolicited emails encouraging you to take action, such as clicking on a link, especially if it is from an unknown sender. They may be trying to get you to click a link or open an attachment — leading to a virus or a hacker potentially taking control, stealing your data and/or holding you to ransom
- Hover the mouse over the link and read the address that pops up. Take care to check that the link is legitimate and goes where you expect it to
- If an offer sounds too good to be true — it probably is. It is common for criminals to use items such as laptops, phones and iPads as bait to get you to click by offering them as prizes.

Have a plan in place for loss of system or data

- Establish a plan for the loss of a key system or data. It is necessary to know that the business can function without this, as it may take some time to recover from an attack or breach
- Make sure data is backed-up regularly — ideally daily. Use an external hard drive and/or Cloud service
- Test that the restoration from back-ups actually works, and that there is a person to contact to help restore systems and data.

To get further tips on how to improve cyber security check out the National Computer Emergency Response Team New Zealand's (CERTNZ's) website www.cert.govt.nz for their top 11 tips for cyber security. Following these tips will go a long way to boosting cyber security, and most of them can start to be done straight away. Pass these tips on to your clients to help protect their businesses.

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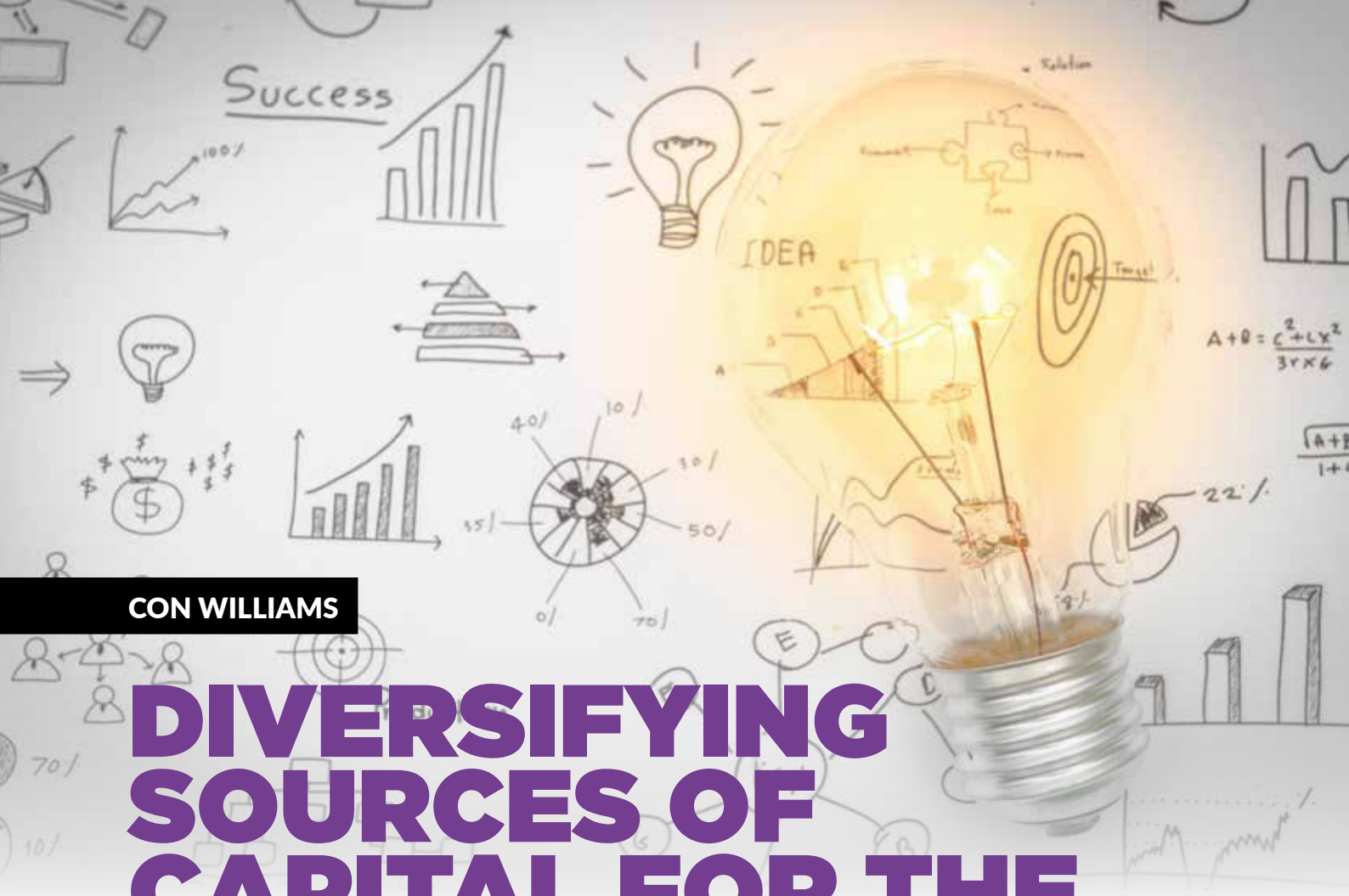

CON WILLIAMS

DIVERSIFYING SOURCES OF CAPITAL FOR THE PRIMARY SECTORS

The primary sectors are in need of finding more innovative ways to attract capital with both bank credit and foreign investment having tightened. There are a range of possible domestic sources for both debt and equity. To attract some of this capital the sectors need to adopt a different approach and be investment ready.

Access to capital funding

Having access to capital funding is very important in determining the long-run health of a business. Cash flow is often described as the lifeblood of any business – in the case of capital it provides the structure or foundation. Having access to capital funding provides the critical ability to make a step shift when required (or desired) and allows reinvestment to occur to remain relevant in a fast-paced world.

While the New Zealand primary sectors have historically been well served with access to foreign capital, domestic bank capital and internal equity, things have notably tightened in recent years. The two key catalysts were first the dairy downturn tightening bank credit availability and lowering internal equity or retained earnings that were available to reinvest. The other was the Labour-led coalition placing new restrictions on foreign investors when purchasing land-based assets and requiring investment proposals to demonstrate greater economic benefit to New Zealand.

An additional pressure pre-COVID-19 was the Reserve Bank of New Zealand changing the capital requirements for domestic banks (i.e. types of and how much capital is needed to be held against loans) when lending to the primary sectors. This potentially makes it less profitable for banks to lend to the primary sectors versus other areas of the economy.

Post-COVID-19 some of these new measures and the timing of implementation are in a state of flux. However, a post-COVID-19 economic environment is naturally going to make accessing capital more difficult, with bank profitability under pressure, lower internal equity available to reinvest, and general economic uncertainty leading to business cautiousness.

Table 1: Potential pools of domestic capital that could provide more capital to the primary sectors – mid-2019 assessment

	TOTAL ASSETS ($)	NZ ASSET ALLOCATION %	NZ ASSETS ($M)
Crown Investment Entities			
NZ Super Fund	$44,000	40%	$17,600
ACC	$45,000	40%	$18,000
Savings Industry			
Government Super/NPF schemes	$10,000	40%	$4,000
Kiwisaver Funds	$55,000	60%	$33,000
Other Super funds	$25,000	50%	$12,500
Broker Wealth FuA	$25,000	50%	$12,500
Bank Wealth FuA	$30,000	60%	$18,000
Independent Adviser Wealth FuA	$6,000	40%	$2,400
Private Investments			
Non advised wealth	$15,000	90%	$13,500
Family offices	$15,000	25%	$3,750
Iwi funds	$9,200	80%	$7,360
TOTAL	**$279,200**	**51.1%**	**$142,610**

The main point is that with two of the largest sources of capital funding 'restricted' compared with yesteryear, where could additional capital be sourced to fund the future needs of the primary sectors?

The size of the capital gap

The future size of the capital gap for the primary sectors is not well known. There has been limited research conducted on it and it is a dynamic measure that changes with economic conditions. The historic easy availability of bank funding has perhaps limited the need for it and also reduced potential innovation for how the primary sectors attract capital.

An ANZ report from 2012 (*ANZ Insight: Greener Pastures – The Global Soft Commodity Opportunity for Australia and NZ*) provided a base case for the New Zealand primary sectors. It showed that to achieve real value growth of 2.1% p.a. until 2050, $210 billion of capital would be required to grow production/value and $130 billion for intergenerational succession/farm turnover – a total of $304 billion. Some of this was expected to be funded via bank debt and retained earnings, but a capital gap of $110 billion (or $2.8 billion p.a) was identified.

While the analysis is dated, real export value growth has been running at around the mid-2% p.a. mark since. Capital has been found to fund growth through this period, but we suspect general productivity and market conditions (through the record terms of trade) have done more of the heavy lifting to achieve the higher growth rate.

The reality is that a substantial capital gap is still apparent and a lot of capital is still required to fund the following:

- Intergenerational transfer
- High-growth areas such as horticulture and forestry land use change
- Recapitalisation of dairy balance sheets
- Investment to meet environmental/social standards
- Productivity improvements, infrastructure needs (i.e. irrigation)
- Investment needs beyond the farm-gate (i.e. coolstores and fruit packhouses).

In a post-COVID-19 world you might add that the urgency and need to address the capital gap question is even greater if the primary sectors can provide new employment opportunities and help maintain every New Zealander's long-term standard of living.

Some ideas

In New Zealand there are a number of different pools of capital that could potentially be tapped more vigorously to provide funding options either in the form of equity and/or debt. Altogether the government investment arms, the New Zealand savings industry and private equity outside the residential property market are estimated to have total assets of around $280 billion, of which about 50% is estimated to be allocated to New Zealand ***(see Table 1)***.

For context, the total on-farm asset base of the primary sector is estimated to be around $225 billion and total bank debt stands at $63 billion, the lion's share of which is associated with dairying at $40 billion. Outside the private equity space both the government investment arms and the savings industry have very low overall exposure (thought to be in the low single digits) to the primary sectors or land-based investments. So only

On the debt funding front there would appear more room for mezzanine debt. This could be used to fund riskier development activities through to recapitalisation of dairy businesses that are currently too financially stretched.

a small proportion of the total capital available would need to be allocated to such enterprises to help fill the capital gap in the primary sectors.

There are range of reasons often given about why the primary sectors have failed to attract funding from some of these pools of capital including:

- Investment structures not being suited to the investors' need and/or regulatory requirements
- Private owners being reluctant to accept 'external' capital and easy access to bank capital as an alternative
- The long-term nature of ownership and often uncertain exit strategies
- Primary sector businesses often not presenting a professional 'investment ready' case (i.e. the financial reporting and record-keeping has not been to the required standard)
- Liquidity concerns if investor funds are required back quickly, or the business under-performs
- Perceived historical under-performance of the asset classes with low rates of cash returns versus risks, which has also led to difficulty in agreeing on valuations
- General lack of sector understanding and experience, with more education required.

Addressing these concerns is not insurmountable, but requires good professional input and more formal business arrangements and procedures. Examples include the primary sector-focused companies that are listed on the NZX. However, these are the minority and their operations/asset base tends to be focused on mid-supply/value chain activities, with generally limited ownership of production end assets. So there appears to be room for new financing innovations to occur at greater scale, especially at the production or farm/orchard end of the supply chain.

Indeed, looking at the Australian market a number of listed and private agri-funds have been created in recent years to buy different portfolios of assets. We are seeing the emergence of some in New Zealand, but the field is fairly limited at present. On the debt funding front there would appear more room for mezzanine debt. This could be used to fund riskier development activities through to recapitalisation of dairy businesses that are currently too financially stretched. Redeemable preference shares could do similar things to mezzanine debt, but in its more traditional form could also be suited to help facilitate succession. Then there is the more traditional form of equity partnerships which exist but have largely been between private investors.

The primary sectors and professionals who provide investment and strategic business advice all need to be looking at more innovative ways of attracting capital.

Being investment ready

While all these funding options can be adapted to different situations in the primary sectors the first thing a business needs to do is to become investment ready. When introducing outside equity or debt there is a need for more formal business arrangements, financial controls and procedures.

The first aspect of being investment ready is to define partner goals, motivations and timeframes. Central to the success is alignment of the partners' goals. During the formation period, and regularly throughout the lifetime of a relationship, it is healthy for all partners to test their alignment with the business strategy. The key considerations should include:

- What are the objectives of the venture?
- What is the investment scope and timeframe for the venture?
- Are each of the partners' investment objectives aligned?
- Will partners be locked in for an initial term for the protection of the business goals?
- How will the venture be funded?

After common goals and timeframes are established a more thorough understanding of a business and what makes it tick is required. This means undertaking all the normal due diligence on a proposition, including:

- What are the inputs, processes and outputs of the business?
- For each of these, what are the key elements for value creation?
- What must the business get right (critical success factors) and what might go wrong (the key risks)?
- How will the business get the critical success factors right, and how will it mitigate the risks?

The formal part of this involves the construction of a business plan showing the returns and assumptions used, a capital expenditure budget and other future development plans, financial projections and so on. Also, directors/managers should be researched, independent legal and financial advice needs to be sought on all structural, ownership and financial decisions, and there should be common objectives among all the partners.

Following this if everything aligns binding business agreements should be entered into. Collectively, these agreements set out the joint venture's goals and how it will operate. They should anticipate the possible points of future disagreement and contain 'ground rules' for the procedures to be followed if partners cannot agree. Common features that a Shareholders' Agreement might contain include:

- Objectives and purpose of the venture
- Authority to make commitments on behalf of the venture
- An indicative investment period (i.e. 'sunset' clause) and a clear process to allow partners to exit, or transfer shares from the partnership
- A share valuation process for changes of ownership
- Financing arrangements
- Meetings and reporting standards. Reporting systems should be regular and timely, and provide all the information to which partners are entitled, which keeps all parties well informed and ensures there are no surprises. Full transparency is an important aspect of successful partnerships
- Voting procedure on major decisions (e.g. capital expenditure, leases, debt funding, investment in other enterprises)
- Disputes processes and how they are to be addressed
- Appointment of directors and an outline of the decision-making process and responsibilities between governance and management
- Other clauses aimed at protecting individuals' property rights
- Employment contract terms for key people, which includes a detailed contract and job description.

In the case of a debt instrument the requirements are usually not the same, but as part of being investment ready it should still be required.

Innovative ways of attracting capital

To conclude, these are just a few ideas of the different options and what could help diversify the sources of capital in the primary sectors. Loosening restrictions on both bank credit and foreign investment could also be thrown in the mix, depending on how much growth needs to be ignited in a post-COVID-19 world. But like most things it is good to have choice. In order to foster this, the primary sectors and professionals who provide investment and strategic business advice all need to be looking at more innovative ways of attracting capital.

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KEVIN WILSON

VULNERABLE DEBT IN THE DAIRY INDUSTRY

If – and it is a big if – the analysis presented by Kevin Wilson is in the ballpark for vulnerable debt in the dairy industry, then the industry and the banks are in a delicate position. Combined, they have $16 billion plus debt subject to medium-term cash flow issues, including a potential $6.7 billion estimated to be over 'acceptable' security margins on land. This article looks at the possible extent of the debt and the implications for banks' profitability and balance sheets.

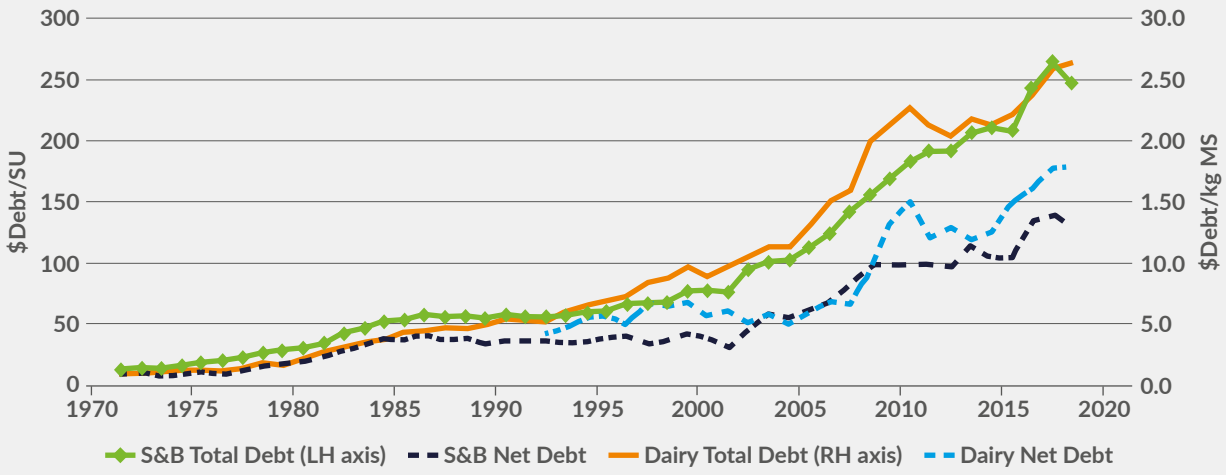

Figure 1: Debt per unit of production. Source: DairyNZ and Beef + Lamb Economic Surveys

$16 billion of vulnerable debt

Much is written with hand-wringing by many commentators about the rate of increase and extent of the debt owed to banks by dairy farmers. The amount is over $40 billion, or $23/kg MS. Less is said about the sheep and beef industry, which illustrates similar trends, albeit with a total debt of around $15 billion.

In 2017/18 the New Zealand dairy industry consisted of 11,600 herds, producing 1,838 million kg MS and carrying $42 billion of bank debt or an average of $23/kg MS (Reserve Bank of NZ, Table hs34). However, not all of the $42 billion is at risk (only a portion of it), and little is said about what size that portion might be and at what financial parameters.

Segmenting aggregate dairy industry debt into risk bands is a multi-dimensional challenge requiring many assumptions, all of which can be challenged. Many scenarios can be developed to assess sensitivity to the assumptions. This article is an interpretation of 2017/18 industry data using a scenario based on medium-term averages of financial parameters.

The top line results from industry data suggest:

- $16 billion of debt held by 2,800 herds with 440 million kg MS would be in varying degrees of financial difficulty at a medium-term gross farm income (GFI) of $6.60/kg MS and a 6% interest rate on debt. That is, 24% of herds, 24% of production and nearly 40% of industry debt
- About $6.7 billion of debt greater than $24/kg MS ($24.7 billion) is assessed as being over the banking convention of an 'acceptable' security margin for a loan being less than two-thirds the capital value of land.

The figures make no allowance for off-farm assets and investments, which are significant at over $600,000 for the average farmer in the DairyNZ Economic Survey 2017-18. The industry as a whole needs an estimated medium-term average GFI of $7.80/kg MS to breakeven at a 6% interest rate, and the most heavily indebted herds (410) would still have debt serving around 36% of GFI.

While the New Zealand banks are reported as some of the more robust in the world, $16 billion of non-performing debt is perceived as being difficult to swallow, and a potential $6.7 billion of debt over acceptable security margins is seen as a financial challenge.

Vulnerable dairy farms

Sensitivity analysis on the vulnerability of the 'average' dairy farm to changes in interest rates, income and debt servicing ratios do not provide any context on an industry-wide basis. That is, how many businesses and how much debt is financially 'exposed' and under what scenarios? Any analysis includes questions about the level of farm working expenses needed to run and maintain the business. Other questions that should be asked include what interest rate should be used to calculate the cost of servicing debt, how big is the interest rate risk, and what other costs should be provided for?

The problem is multi-dimensional, including needing information on:

- Numbers of herds
- Distribution of production
- Distribution of debt
- Interest rates used
- Income assumptions
- Assumptions about costs other than interest
- The ability of the farmer to withstand the stress of financial pressure and still manage the whole business in an efficient way.

Distribution of debt in the dairy industry

DairyNZ Dairy Statistics 2017-18 Table 2.4 give a distribution of the number of herds, the number of cows and average production for DairyNZ data in bands of 50 cows. The data is for all herds in New Zealand. DairyNZ Economic Survey 2017-18 Table 5.10 provides a distribution of debt-to-assets for the survey.

The two data sets were combined by *assuming* that the distribution of debt to assets was the same across all bands of herd size. This is a big assumption, because while the DairyNZ Economic Survey data is the best available, it is arguably a small sample (265) and does not represent the average for the whole industry as owners with multiple herds are not included.

The second big assumption was to decide a figure for the average value of total assets/kg MS in order to reverse calculate the debt from Table 5.10. A figure of $47/kg MS gave an industry debt of just over $42 billion, very close to the Reserve Bank of NZ figure of $41.6 billion at May 2019. The comparable total assets figure in the DairyNZ Economic Survey 2017-18 is $51/kg MS, made up of land and buildings, stock and plant, farm investments (dairy company shares), and other assets of $36/kg MS, $6/kg MS, $5kg MS and $4/kg MS, respectively.

The above assumptions have allowed the derivation of *Table 1* showing the number of herds, kg MS and total debt associated with each debt band.

The averages for *Table 1* are relatively close to the DairyNZ Economic Survey 2017-18, which gives some validity to the methodology in this article.

Table 1: Distribution of herds, production and debt

DEBT BANDS %	NO. OF HERDS	PRODUCTION (MILLION KG MS)	$ MILLION	DEBT PER HERD	$/KG
<10	490	77	36	74,100	0
10-20	270	42	199	736,500	5
20-30	1,070	169	1,591	1,486,700	9
30-40	1,160	184	2,594	2,235,900	14
40-50	1,650	261	4,910	2,976,200	19
50-60	2,230	354	8,300	3,721,900	24
	6,870	1,087	17, 630		
60-70	1,960	311	8,767	4,472,800	28
70-80	1,250	199	6,536	5,228,900	33
80-90	1,110	177	6,640	5,981,900	38
90-100	360	57	2,411	6,700,400	42
>100	50	7	346	6,916,500	47
	4,730	751	24,700		
Totals	**11,600**	**1,838**	**42,330**		
Average for table		**158,400**	**3,649,200**		**23**
Industry average[1]		**161,600**	**4,269,000**		**26**

Note 1: DairyNZ

While the New Zealand banks are reported as some of the more robust in the world, $16 billion of non-performing debt is perceived as being difficult to swallow.

Table 2: Averages and medians for selected financial parameters up to year end 2018 ($/kg MS)

MEASURE	GROSS FARM INCOME	FARM WORKING EXPENSES (FWE)	DEPRE-CIATION	DRAWINGS, TAX AND LIFE INSURANCE	FIXED OVER-HEADS	AVAILABLE FOR DEBT SERVICING	INTEREST PAID (%)
Avg 3 years[1]	6.00	3.86	0.41	0.55	4.82	1.18	5
Avg 5 years	6.49	3.99	0.40	0.62	5.01	1.48	6
Avg 7 years	6.61	4.01	0.40	0.62	5.03	1.58	6
Median 7 years	6.77	4.07	0.41	0.65	5.13	1.64	6

Source: DairyNZ Economic Surveys
Note 1: Weighted average. GFI includes income from milk plus other farm income

The data suggests that 60% of herds with an average debt of $24/kg MS or less account for 60% of production, but only 40% of the industry debt ($17.6 billion). So how exposed to the vagaries of the markets are the other 40% of herds and the remaining $24.7 billion of debt?

A viability assessment

There are differing opinions on the calculation to assess the viability of a farm business. What follows calculates the GFI necessary to breakeven at given costs plus debt servicing.

The costs include farm working expenses, depreciation and an allowance for drawings, tax and life insurance, all derived from the DairyNZ Economic Survey 2017-18 *(see Table 2)*. The sum of the above three items is called 'fixed overheads' for the purpose of this article. The sum of the fixed overheads plus the cost of debt at an interest rate gives the GFI at which the farm will breakeven at the specified interest rate and debt. If the calculated breakeven is more than the medium-term expected GFI, then the debt will be in varying degrees of difficulty.

Depreciation is included as an allowance should be made for replacement of plant. An allowance for drawings, tax and life insurance reflects actual expenditure rather than a calculated figure for wages of management.

The figure of $6.60/kg MS was used as the medium-term GFI and $5/kg MS for the fixed overheads, leaving a margin of $1.60 to service debt (or 24% of GFI). That approximates to another longstanding bank credit convention that debt servicing should be no more than 25% of GFI – not that the rule was always applied! Increasing the medium-term GFI to $7/kg MS increases the amount available for debt servicing to 30% of GFI and $5/kg MS fixed overheads.

A judgement is also required on what interest rate to use in calculating the amount of debt that can be serviced by the $1.60 available. Interest rates are currently at their lowest in nearly 50 years. The average interest rate paid on dairy farm debt peaked in 1991 at just over 13% and is now around 5%. The long run average paid is 8% and has averaged 6% for the past 10 years *(see Figure 2)*.

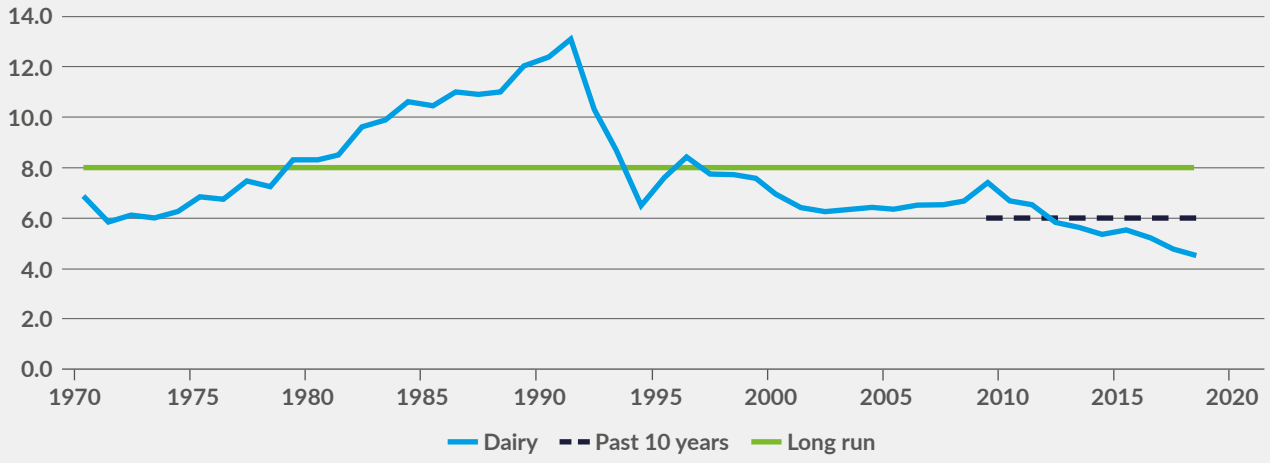

Figure 2: Interest rate paid by dairy industry (%). Source: DairyNZ Economic Surveys
Note: 6% was used for breakeven analysis

Table 3: Base data and breakeven analysis

BASE DATA												
Debt band %	<10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	>100	Gr Tot
Debt/$kg MS	0	5	9	14	19	24	28	33	38	42	47	
Debt ($m)	36	199	1,591	2,594	4,910	8,300	8,767	6,536	6,640	2,411	346	42,330
Cumulative total debt						17,630					24,700	42,330
No. herds	490	270	1,070	1,160	1,650	2,230	1,960	1,250	1,110	360	50	11,600
Cumulative total herds						6,870					4,730	11,600
Production (million kg MS	77	42	169	184	261	354	311	199	177	57	7	1,838
Cumulative total production						1,087					751	1,838
$/KG MS GFI TO BREAKEVEN (DEBT SERVICING % OF GFI)												
Interest rate %												
4	5.00					5.90 (16)			**6.50 (23)**		6.90 (27)	
5	5.00					6.20 (19)		**6.60 (25)**				
6	5.00	5.30	5.60	5.80	6.10	6.40 (22)	**6.70 (25)**	7.00 (28)	7.30 (31)	7.50 (34)	7.80 (36)	
7	5.00					**6.60 (25)**	7.00 (28)	7.30 (32)	7.60 (34)	8.00 (37)	8.30 (40)	
8	5.00 (1)				**6.50 (23)**	6.90 (27)					8.80 (43)	

Note: Most numbers are rounded. The dark shaded column approximates the industry average debt/kg MS. The lighter shaded rows approximate the debt percentage bands where the breakeven GFI required is greater than medium-term $6.60/kg MS at that interest rate

Results

As expected, the GFI to breakeven escalated rapidly as both the debt per herd and interest rate are ramped up. If in the medium term (five to seven years):

- GFI is to average around $6.60/kg MS, and
- the fixed overheads are $5.00/kg MS, and
- the interest rate averages 6%

then the amount of debt becoming exposed to varying degrees of cash flow difficulties is significant at up to $16 billion. Changing the long-term interest rate to 8% increases the amount of debt exposed to cash flow issues up to $33 billion as it drags in the debt on the average farm.

Aggregating the data in *Table 3* above provides an estimate of vulnerable debt at different interest rate scenarios.

The figures in *Table 4* are based on interest only being paid on debt. If banks require principal as well, that can add the equivalent of 2% (and up to 4%) to amortised debt repayments, depending on the time period for repayment.

Cash flow is one issue and a second is security for the loan. Loan-to-value ratios for debt around $24/kg MS is likely to be close to another banking convention of two-thirds the value of the farm (at $36/kg MS land and buildings). Debt over $24/kg MS soaks up available security. Debt greater than $36/kg MS will likely exceed the value of the farm and be relying on other security (if any) to cover the loan(s). Around $25 billion (4,700 herds) is associated with debt over $24/kg MS, of which just above one-quarter ($6.7 billion) is estimated to be over a two-thirds security margin.

Table 4: Estimated vulnerable numbers of herds, dollars debt and production at varying interest rates

INTEREST RATE (%)	NUMBERS OF HERD*	$ BILLION DEBT*	$ BILLON EXCEEDING SECURITY MARGIN	MILLION KG MS*
4	400 (4)	3 (7)	1 (33)	64 (4)
6	2,800 (24)	16 (38)	5 (33)	440 (24)
7	4,800 (40)	25 (58)	7 (30)	750 (41)
8	6,900 (60)	33 (78)	7 (20)	1,100 (60)

Note: Measured against the medium-term GFI of $6.60/kg MS
**Percentage of total*

Is $16 billion debt a problem to New Zealand banks?

As noted, $16 billion of debt with cash flow difficulties in the medium term is perceived as being difficult to swallow. Similarly, provisioning for $6.7 billion debt over a two-thirds security margin (16% of agricultural debt) would be a financial challenge. The annual charge in financial statements for suspect debt is a before net profit item. Large annual provision charges dent profits. The credit quality of a loan portfolio influences the amount of capital required to be held against that portfolio. A downgrade in credit quality would require a larger amount of risk weighted capital to be held against the rural portfolio.

The following numbers are aggregated from the 2018 annual disclosure statements from ANZ, ASB, BNZ, Westpac and Rabobank:

- Profit after tax – $5,200 million
- Profit was after making $220 million provision for bad debt over all loans as an expense item
- Net loan assets were $383,430 million after accrued provisions for bad and doubtful debt of $1,776 million or 0.4% of net loan assets
- Lending to agriculture totalled $53,430 million or 14% of net loan assets – total lending to agriculture from all sources is $63,000 million (Reserve Bank of NZ, Table hc5)
- Housing loans totalled $201,490 million or 52% of net loan assets
- Shareholders' funds were $37,220 million or about 10% of net loan assets
- Dairy farm bank debt is $42,330 million (disclosure statements do not provide a separate item for dairy farm debt for each bank).

Any impact on the banks and the industry will be determined by how fast the banks react. Different banks will have different exposures to the dairy industry and their dairy loan portfolio will have different credit qualities.

Other influences include how banks are allowed to react by the Reserve Bank of NZ, politicians, the farming community and the bank's lenders. The real crux of the matter will be the circumstances that lead to cash flow difficulties in the dairy industry and if (and how) those circumstances also impact on the wider New Zealand economy.

Discussion

The methodology and assumptions in this article can be questioned and endless sensitivity analysis done to produce ranges in the amount of exposed debt. The median answers could likely be around those presented here.

No scenario analysis has been done to justify why GFI will average around $6.60/kg MS, why fixed overheads

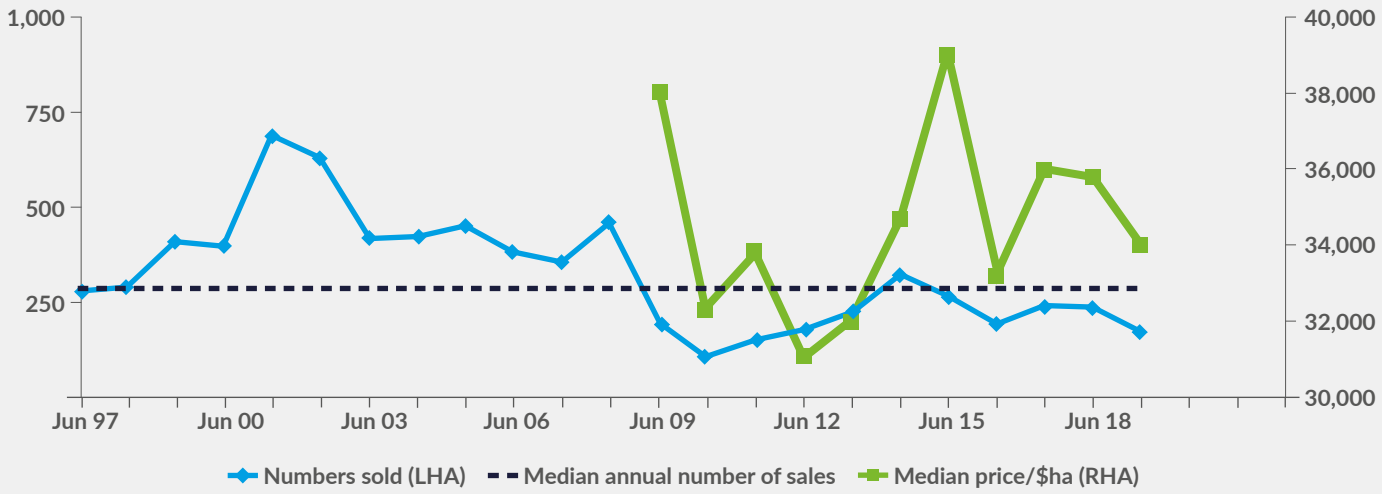

Figure 3: Dairy farm sales (June 1997 to June 2018). Source: Derived from Real Estate Institute of NZ sales data

The saving grace for the dairy industry is the income stream has continued and will continue. Demand for product appears steady.

will average $5.00/kg MS, or when interest rates might return to 6% or higher. Some will argue that using $6.60/kg MS GFI and/or a 25% debt servicing ratio is too conservative and the figures should be higher. Past economic history is often said not to be a guide for the future, but it is noted that the price of almost all commodities commonly fluctuates 20% or more either side of recent averages or medians and at unpredictable intervals. Dairy product prices are no exception.

The calculations ignore any impact of tightening environmental regulations, animal welfare issues, carbon taxes and the prospect of higher capital requirements for banks. They also ignore the significant amount of 'other assets' held by the average dairy farmer. Sundry creditors and other assets totalled more than $600,000 in the DairyNZ Economic Survey 2017-18 and that figure excludes $748,000 in dairy company shares. The combined assets do provide some wriggle room to restructure/pay down debt if required.

Whether interest rates will ever return to near long-term average is also debatable. The current interest rate environment and its influence on the sharemarket and property values are surreal to the writer, although to be expected if there is capitalisation of future benefits at low capitalisation rates.

One can speculate at what might happen to land values if the above scenario is realised – historic precedents suggest at least a double whammy. There would be a large number of properties under financial pressure for sale. The number of sales per year may fall by 30%. The economic value would also take a tumble with the present value of future income discounted at 5% or 6% instead of 2% or 3%. Bank lending policy would be interesting, to say the least, and the speed at which banks acted to recover exposed debt would be critical.

Does data from the Real Estate Institute of New NZ indicate that the banks and the market are already reacting to all the influences on the value of dairy farm land mentioned above? Anecdotal evidence is that the dairy land market is weak *(see Figure 3)*.

The article was written before Coronavirus-19 became worldwide. That does not change the underlying analysis, but it does change its context within the New Zealand financial sector. The virus is hugely disruptive to global and domestic economies. It is likely fatal for a lot of businesses in the tourist, hospitality, accommodation and retail sectors.

The saving grace for the dairy industry is the income stream has continued and will continue. Demand for product appears steady. The current NZD price of whole milk powder is suggesting a milk price over $7/kg MS for 2019/20, albeit boosted by an NZD/USD exchange rate 10 plus cents below recent averages.

While the extent of vulnerable debt in the dairy industry remains significant, it is now only part of a much larger economic and policy challenge for the Government, the Reserve Bank, banks and all New Zealand businesses over at least the next five years.

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PABLO GREGORINI AND THOMAS MAXWELL

GRAZING IN FUTURE MULTISCAPES – FROM THOUGHTSCAPES TO ETHICAL AND SUSTAINABLE FOODSCAPES

Agricultural products reflect the history of our landscape, foodscapes and agricultural systems manifested though soil and plant chemistry, and thereby our health and that of the planet. This article looks at creating sustainable and ethical foodscapes.

Grazing and landscapes

Throughout different landscapes of the world, livestock fulfil essential roles in ecology, agriculture, economies and cultures, including families, farms and communities. Not only do they provide food and wealth, they also deliver ecosystem services through the roles they play in environmental composition, structure and dynamics. Grazing, as a descriptive adjective, locates livestock within a spatial and temporal pastoral context where they naturally graze or are grazed.

In some cases, however, grazing driven by a single and myopic objective of maximising animal production and/or profit has transformed landscapes, diminished biodiversity, reduced water and air quality, accelerated loss of soil and plant biomass, and displaced indigenous flora, fauna and people. Such degenerative landscape transformations have jeopardised present and future ecosystem and societal services, breaking the natural integration of land, water, air, health, and social sphere, and even our own thoughtscapes.

Thoughtscapes, socialscapes and foodscapes – towards healthscapes

Land users, policy-makers and the wider society are calling for alternative approaches to pastoral systems; a call for diversified-adaptive and integrative agro-ecological and food-pastoral systems that simultaneously operate across multiple scales and 'scapes'. There needs to be a paradigm shift in pastoral production systems and how grazing livestock are managed (grazed) within them. This would be derived initially from a change in paradigm (i.e. our perception of how pastoral production systems provide wealth through the pursuit of health), which requires a change of 'thoughtscapes'.

Building off Aldrich's 1966 definition of landscape – a specific view of a space or scenery from a specific perspective – by thoughtscapes we are referring to the geography of the mind. This is the interaction of the thinker and their spatial and temporal perception(s) of the dimensions of space and time (i.e. the spatial and temporal mindset of the observer, applied to their land, people, food, society, communities and their role in life). In pastoral spaces, alternative thoughtscapes will include paradigm shifts where graziers move away from the one-dimensional and myopic view of contemporary pastoralism. This is where the animals grazing our grasslands are perceived as a source of meat, fibre and milk products only, existing in isolation to the wider landscape and societal functions.

Alternative future landscapes are thoughts – re-imagined – as ethical, creative and sustainable. There is adaptive, generative, re-generative and/or sustainable

Land users, policy-makers and the wider society are calling for alternative approaches to pastoral systems.

intensification of processes with synergetic adaptive management, to put in place and achieve multidimensional visions and purposes. Adaptive management is the process of learning about (while simultaneously managing) natural resources to reduce associated inherent uncertainty. From this will come a change in collective thinking and practices concerning the agriculture of grazed livestock, crops (or both mixed together) and how communities and cultures (socialscapes) perceive their relationships with the land where they 'graze' (pastures, grasslands and rangelands).

Landscapes are the tables where humans and livestock gain their nourishment (i.e. foodscapes). Foodscapes concepts are used to study public health and food environments, including institutional arrangements, cultural spaces and discourses that mediate our relationship with food. Foodscapes and dietary perceptions (a component of our thoughtscapes) dictate dietary-choice actions and reactions. These are changing as developed countries grapple with diseases related to obesity and developing countries battle regional famines and starvation crises.

Societies are demanding healthscapes and nutraceutical foodscapes and, paradoxically, some are moving away from animal products in pursuit of healthier lives. Animal sources are the most complete protein sources because they contain all of the amino acids we need for optimal health. The heme iron in a red meat steak is the best and most bio-available source of iron, and a small 115 gram serving of beef contains 95% of the daily required intake (DRI) for B12, something you cannot get from plants. Iron and B12 are two of the most common nutrient deficiencies worldwide according to the US Centre for Disease Control (CDC).

To get the same amount of protein in a 115 gram steak (181 calories) you would need to eat 340 grams of kidney beans, plus a cup of rice which equals 638 calories, and 122 grams of additional carbohydrates. Plant-based diets are at risk of nutritional deficiencies such as proteins, iron, vitamin D, calcium, lycine, selenium, methionine, taurine, creatine, choline and iodine, as well as Omega-3 and vitamin B12. Such deficiencies are related to premature delivery, lower birth weights and post-partum depression, as well as general depression in men. These conclusions have been reported by studies conducted at George Manson University (USA), Section on Nutritional Neurosciences, National Institute on Alcohol Abuse and Alcoholism (USA) and Faculté de Médecine, Sorbonne Paris Cité, Université Paris Descartes (France), amongst others.

Despite our obvious defence of animal protein sources, there is another point to be made around the integrity and contemporary necessity for nutritionally-rich food products sourced from grazing livestock. It is that they originate in *sustainable and ethical foodscapes* that satisfy the moral, spiritual, economic, socio-cultural and bio-geophysical requirements (demands) of the human ego.

Creating sustainable and ethical foodscapes with our pastoralscapes

Across the world, rural places are in a state of transition. The recent government focus on curbing the negative externalities of food production within national

An ethical and sustainable foodscape is a conceptual framework that helps us focus on the opportunities to challenge the existing ways of pastoral food production, consumption and commercialisation.

land management and planning bodies has led to an undermining of the autonomy of pastoral farmers. Also, dispersed and isolated attempts at addressing different environmental integrity issues of livestock production and agricultural in general have led to the rise of competing agendas when addressing the complicated social-ecological relationships that produce rural landscapes. The pastoral livestock-landscape-climate-consumption culture nexus is one such system.

The multiple stakeholders producing this system represent many different agendas – environmental compliance, biodiversity conservation, livelihood security, climate change mitigation/adaptation, animal welfare and sustainable consumption, among others. However, their engagement with each other is often assembled through political, intellectual and institutional hierarchies. For example, this pits the interests of pastoral livestock producers looking to expand on their existing business against those fighting to minimise the environmental impacts of primary production or introduce management regimes that address the current and future impacts of climate change. It often seems that the divide between these different interest groups is only growing wider.

The production and consumption of food influences our health and that of the environment. In itself, the notion of foodscape captures different agendas in 'healthier' and 'sustainable' food production, and thus can (if embraced) reduce the gap in such a divide. According to Professor Morgan of Cardiff University, the notion of ethical and sustainable foodscapes involves a wide spectrum of food-supporting values that claim to make a positive contribution to human and environmental health, the local economy and primary producers, animal welfare and biodiversity.

Professor Goodman from the University of Reading adds a utilitarian dimension, in which ethical and sustainable foodscapes are seen as a way of conceptualising and engaging with the processes, politics, spaces and places of the praxis of ethical relationalities embedded and produced in and through the provisioning of food. An ethical relationalities praxis is the practice of engagement between beings and the physical environment, relating specifically to people and the food *they choose* to consume, produce or sell.

For us, an ethical and sustainable foodscape is a conceptual framework that helps us focus on the opportunities to challenge the existing ways of (in this case) pastoral food production, consumption and commercialisation. This creates a new variety of future trajectories by selecting design over default. For the trajectories to be ethical, and sustainable, they must:

1. Promote community (common unity), i.e. be embedded in a healthy comm-unity (integrated-connected) in which animal (including humans) and ecological values are recognised.
2. By food production, consumption and commercialisation, promote integrative health at a small scale and through regional ecosystems.
3. Enhance food security by being socio-ecologically sustainable and inclusive, while creating opportunities not only to eat, but also to farm and sell food.
4. Exert resiliency within the agroecosystem by encouraging taxonomical and biochemical diversity, redundancy (equivalence) and modular spatio-temporal integrations.
5. Ultimately, encourage tight multi-dimensional feedback and feed-forward loops at several scapes.

Conclusion

The process of deciding the future of pastoral production systems is often exclusionary, failing to capitalise on the synergies within the spectrum of stakeholders, views, needs and feelings. A solution is using the notion of ethical and sustainable foodscapes as a unifying theme and primary subject in which various systems and people interact. This is the idea at the heart of our multiscapes viewpoint (i.e. our iteration, thoughtscapes).

Ko au te whenua,
ko te whenua ko au.
I am the land,
and the land is me.

Further reading

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THOMAS MACDONALD

THE NEW ZEALAND SHEEP DAIRY INDUSTRY – A GROWTH AREA

This article looks at the growing sheep dairy industry in this country – its history, and recent developments through farm system innovation and genetic development.

Global demand

While New Zealand has a history of milking sheep dating back several decades, it has been the vision and investment to develop a consumer-led and market-focused industry that has laid the recent foundation for sheep milking to scale commercially. The New Zealand sheep dairy sector is entering a period of growth, built upon recent developments including a strong demand from the market, premium branding, access to globally relevant genetics, a low environmental impact farming model and demonstrated farming systems.

The sheep dairy industry in New Zealand is positioned well to capture growing global demand for alternative dairy products. Primarily, this demand has been led by consumers seeking a more digestible source of dairy products. Channelling this consumer need for alternative dairy products, the New Zealand sheep dairy sector has worked collaboratively with government, research organisations and manufacturers to unlock and advance the foundational aspects for a demand-led sheep milk industry in New Zealand.

Industry snapshot

New Zealand's current sheep dairy farms can be classified into two main categories:

- Those farms operating at a smaller scale mainly supplying domestic markets from flocks of 200 to 500 ewes. These producers, a mix of recent industry entrants and long-established businesses, operate their entire supply chains to produce fresh cheese and bottled milk
- More recently, those of a commercial scale farming between 500 and 3,000 ewes per farm and supplying one of the now established Waikato-based dairy companies. In 2019, a national study completed by Massey University identified that there were 18 individual farms milking approximately 12,500 ewes, six of which had joined the industry in the previous year. Most farms are in the North Island by way of proximity to manufacturing sites, with only five the South Island (Canterbury). While appetite has been strong in other regions of New Zealand, a lack of suitably sized manufacturing assets currently prevents the development of a viable business case to enable production.

There are two major players in the Waikato region – Spring Sheep and Maui Milk. Both companies utilise the Food Innovation Waikato Drier located at Ruakura in Hamilton.

Spring Sheep maintain a domestic and export market presence, with products in more than five key markets under the Spring Sheep New Zealand brand. Products include sheep milk calcium tablets, infant formula and full

cream milk powder drinks. Maui Milk recently announced a partnership with multinational brand owner Danone as the customer for their sheep milk. Products include infant formula produced for the Karicare brand in export markets. The domestic market is well supplied with fresh products, including multiple award-winning sheep cheeses, as well as new-to-market sheep milk drinks which have reached many supermarkets. Both Spring Sheep and Maui Milk are now scaling milk supply in the Waikato through supplier farmers, and expect to welcome a further seven farms to the industry in the 2020 Spring.

The sheep

One of the primary hurdles to scaling a commercial sheep dairy industry in New Zealand has been the lack of dairy sheep and available dairy sheep genetics. While renowned globally for our sheep and genetic capabilities, the existing dairy sheep population in New Zealand (with some limited exceptions) produced only 100 to 150 litres/ewe/yr and lacks the diversity required to propel the industry forward.

Although selection pressure will improve the yield from New Zealand breeds over a long period of time, the key dairy sheep traits required for a successful industry have been perfected in Europe and the UK through established breeding programmes that have operated for more than 50 years. In 2016, the Ministry of Primary Industries (MPI) opened a rigorous importation protocol for sheep germplasm from the EU/UK to New Zealand. This move enabled several operators to access germplasm for the French Lacaune breed and supplementary lines of the East Friesian from the UK.

Access through both semen and embryo importation gave New Zealand the required traits to establish a breeding population capable of contributing to an improved milking sheep for New Zealand. From the low aforementioned yield in the years leading up to 2015, production has increased in line with expectations, and is now between 200 and 300 litres/ewe/yr on average for experienced operators.

A range of farm systems and breeding strategies have a large impact on yield per ewe, and the interaction of these two variables must be well understood by those entering the industry. Today, globally relevant yields can be achieved in a New Zealand farm context. New Zealand now has experienced farm operators with multiple generations of sheep with elite dairy genetics that are averaging in excess of 375 litres/ewe/yr, with top ewes producing over 500 litres/ewe/yr.

Type of farming system

New Zealand has a strong pastoral advantage in operating grazing systems. However, in seeking to harness the power of recently acquired European dairy genetics that are mainly farmed indoors, farming operators have settled on a range of farm systems that suit the available land, capital, expertise and genetics. Sheep Horizon Three (an MPI Primary Growth Partnership programme led by Spring Sheep) has been investigating and operating multiple farm systems suited to modern dairy sheep. In setting up sheep dairy farming systems, the industry has adopted many successful aspects of New Zealand's pastoral rotational grazing system and innovated with many of the conventional measures, including forages, labour and inputs.

The typical commercial sheep dairy platform contains between 20% and up to 60% of non-ryegrass and clover stands. Forages such as lucerne, red clover or chicory are used to provide a range of grazing options for summer safe feed, as well as assisting in the management of the animal health of the ewes. A range of people have been attracted and retained in the industry from non-primary sector backgrounds through cleaner milking parlours and plenty of time spent nurturing lambs in the Spring.

Notably, the industry has a joint vision for upholding a high standard of animal welfare and has embedded a strong commitment to recognising value through raising and farming all progeny. A strong focus on data-informed decision-making, in-field trials and novel solutions has become synonymous across the industry's farming systems. There is also strong collaboration between farmers as operating procedures are established and refined.

Sheep being milked in a converted cow dairy parlour

Hybrid system – sheep dairy farm located in Reporoa in the Waikato

Pasture grazing sheep dairy farm systems currently range in size from between 500 and 1,000 ewes. Stocking rates vary based on pasture grown, but typically range from 14 to 18 ewes/ha.

'Bovine to Ovine' conversion model

Many traditional Waikato dairy farm units are between 50 and 80 ha. As economies of scale, family succession and land use have become frequently considered topics for dairy farmers, conversion to alternative land uses must be considered. This is particularly the case because aging infrastructure in some cases may no longer lend itself to ongoing bovine dairy production due to a lack of environmental compliance. Yet, fundamentally, a decision about changing land use must consider recognising the existing value in both the human capital and infrastructure capital on-farm.

The Bovine to Ovine conversion model is fast becoming the most popular sheep dairy farm system as the industry increases scale, and it is seen as a great entry method for many traditional sized properties. Often referred to as the 'stranded asset' model, the Bovine to Ovine conversion seeks to take a farmer's invested capital in farm system knowledge, livestock, dairy company shares and surplus plant, and recycle this into a milking shed conversion, extra wires on fences and the purchasing of a flock of dairy sheep.

Akin to a low input farm or a System 2 model, the Bovine to Ovine system uses limited imported feed and relies on sound pasture management techniques and summer safe forage. The lower environmental footprint, opportunity for new generations, repurposed infrastructure and non-commodity land use that sheep dairy provides is an attractive opportunity as farmers look to invest into their operations. Pasture grazing sheep dairy farm systems currently range in size from between 500 and 1,000 ewes. Sheep are milked seasonally, with lambing in July/August through until April. Stocking rates vary based on pasture grown, but typically range from 14 to 18 ewes/ha.

Hybrid system

In a cross-over between typical international sheep dairy farms and New Zealand's grazing systems, the hybrid farm system combines the 'best of both worlds' for farmers, with greater access to capital and an ability to operate higher input feeding systems. Likened to a medium input System 4 farm, return from off-paddock feeding and shelter is recognised through ease at lambing, early lactation supplement feeding, and cooler summer days spent out of the sun.

Farm gate milk prices for commercial operators range from $2.50 to $3.00 per litre, paid per kg MS, which is approximately $14.50 to $17.00/kg MS.

A typical hybrid system utilises pasture grazing between the am and pm milking during early Spring. As daytime temperatures rise, grazing between the pm and am milking (i.e. overnight grazing) is used to avoid the hot days in the paddock. Toward the end of lactation and throughout the dry period, ewes are grazed full-time on pasture. With off-paddock feeding comes advantages for the environment through a direct reduction in nitrogen leaching risk. This results in duration-limited grazing and a per animal lift in production by removing seasonal and nutritional diet variances.

Hybrid farms currently range in size from 800 to 2,500 ewes and follow a seasonal lambing model. Pasture management and an appropriate forage mix remain essential to the success of the hybrid systems, as they are the basis of both the off-paddock and in-paddock ration. Sheep are milked seasonally as in the pasture-based models, with lambing in July/August through until April.

On-farm financials

As the interaction of new genetics and new farming systems have been refined over multiple seasons, a clear understanding of farm financial performance is emerging. While each farm operator will have unique factors best modelled on a farm-by-farm basis, a range of input and output assumptions are now clear. In the first instance, consideration of the macro-drivers of revenue and farm working expenses will guide analysis. Revenue on-farm is generated from milk, meat (wool) and the sale of surplus dairy stock, all contributing to a diversified top line.

Milk revenue, the majority income stream, is a function of yield per ewe and milk price. Maximising milk revenue per ewe through access to a proven high-yielding flock linked to a sustainable farm gate milk price is essential for success. Farm gate milk prices for commercial operators range from $2.50 to $3.00 per litre, paid per kg MS, which is approximately $14.50 to $17.00/kg MS.

Livestock sales through surplus animals is seen as a strong supplement to farmers entering the industry in the early years. These surplus animals are often on-sold to new sheep dairy farmers as the industry grows. Cull ewes, male lambs and wool, while paling in comparison to milk and sheep sales, can be accounted for at traditional values.

Farm working expenses have strong links to a standard bovine dairy budget for key operating and land-based expenditure. Labour requirements vary by farm, but are typically one full-time equivalent (FTE) per 400 to 500 ewes on a commercial farm, plus seasonal support staff at lambing. Lamb rearing (achieved through milk powder or naturally on the ewes) and lamb finishing costs must be budgeted in detail and vary based on the number of lambs born per ewe. Noting the above revenue from livestock sales, livestock rearing and finishing become critical annual investments and must be viewed as such. A full range of financial budgeting and production assumptions are available through existing dairy companies, as well as in the proceedings of the SheepMilkNZ Conference (2020).

Summary

Significant progress has been made in developing both suitable genetics and farming systems for a globally relevant New Zealand sheep dairy industry. This progress has created opportunities for more farmers to adopt sheep dairy as a new land use, with uptake strongly linked to environmental, social and financial benefits before and after the farm gate.

New Zealand has in the past experienced challenges when establishing new primary industries through a predominantly supply-based focus, leading to a lack of awareness about customer requirements, product demand and investment in R&D. In recent years, the New Zealand sheep dairy industry has channelled growing demand for alternative dairy into sustainable products, markets and brands which now underpin growth in supply. Strong links between consumers and farmers will continue to shape on-farm practice and farm system design, as the industry remains focused on supporting the premium position of sheep milk in the domestic and global marketplace.

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WARWICK CATTO

AN OVERVIEW OF PHOSPHORUS LOSS FROM RECENTLY APPLIED FERTILISER

Addressing water quality improvements is now focusing more broadly than on nitrogen (N) to include phosphorus (P) loss, sediment and bacterial contamination. It is claimed that the majority of New Zealand waterways are P limited rather than N limited, meaning P addition is the dominant factor controlling water quality. P loss comes from many sources, but the contribution from fertiliser is perhaps the simplest to address. This article discusses some of the science and merits of using a lower water soluble P fertiliser to reduce P loss to waterways.

Developing tools to address P loss

In the early 2000s I became interested in the non-agronomic aspects of P fertilisers and in particular whether they were less vulnerable to leaching or run-off losses. This led to a sequence of work that manifested itself particularly through Ballance's Clearview PGP programme into the fertiliser product now branded Surephos. The key motivation for this research was the recognition then that many waterways are impacted more by P loss than by N leaching.

This insight led to the desire to identify or create more environmentally and agronomically efficacious fertilisers. Importantly, it also led to decision support tools that would quantify and identify where those losses came from in the landscape (hence the MitAgator tool that identifies critical source areas for P – also N, sediment and *E. coli*). See the MitAgator risk map *(Figure 1)*.

This programme of work was about providing new tools for farmers/growers to enable them to address P loss. This

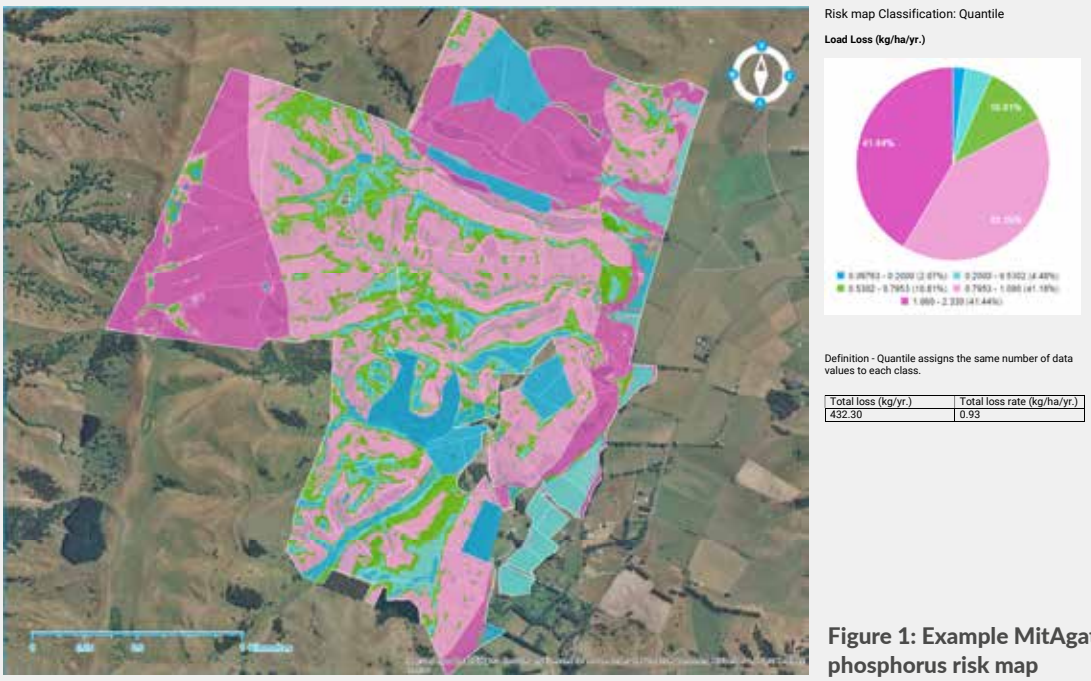

Figure 1: Example MitAgator phosphorus risk map

article does not directly address cost benefit, although for reducing P loss within farm systems independent analysis identifies the use of low water soluble fertilisers to be one of the least cost mitigations to achieve this. See the mitigation cost table *(Table 1)*. What follows provides some of the science that supports the rationale for developing and using low water soluble P products.

Problem-solving approach

There is a practical problem of fertiliser P losses occurring soon after direct application into defined catchment channels, referred to as Recently Applied P (RAP). Soluble fertiliser P is rapidly removed downstream from the application sites as Dissolved Reactive Phosphorus (DRP).

Estimates from sheep and sheep and cattle farming systems show that RAP losses occurring in catchment channels could respectively comprise 61% (0.369 kgRAP/ha/yr out of a TP loss of 0.6 kgP/ha/yr) and 25% (0.330 kgRAP/ha/yr out of a TP loss of 1.3 kgP/ha/yr), of total P (TP) losses per year from that channel.

The RAP losses from fertiliser application directly into catchment channels could potentially be reduced by 75% following the use of Surephos rather than superphosphate, because of its proportionally lower water solubility properties. Any management that can minimise RAP losses by avoiding fertiliser application onto drainage channel areas could allow marginally greater application rates on non-susceptible pasture areas. Most research on this topic has been done using run-off plots to compare fertilisers, soils or management effects on P movement.

Fertiliser form is one aspect of the 4Rs – right product, right place, right time and right rate – which are equally important considerations.

Environmental concerns with P loss

The movement of P from farmland soils to water bodies has long been regarded to be of environmental concern. The two identified pathways are by overland flow, and by leaching through the soil profile and subsurface drainage. Most New Zealand farmland is regularly fertilised with mainly P fertilisers. However, the contribution of rainfall-induced surface run-off in carrying P directly from recently applied fertiliser material has received little attention.

Incidental P loss

The term incidental P loss has been introduced to describe the P in run-off that has been derived from fertiliser, rather than from the soil P store. This term does not adequately describe and define the specific origin of the P source, so a new term – Recently Applied P (RAP) – is used here. This infers that the run-off P source is from material that has been recently applied.

P movement vs P loss

It is important to differentiate between P movement and P loss. In the long term, almost all P moves from fertiliser material in a soluble form to soil. For some fertilisers, such as Reactive Rock Phosphate (RPR), this may take a long time.

P movement will result in P loss from farmland into water bodies when a transfer of P from pasture to catchment channels occurs, or subsurface drainage leads to flow from a catchment. The connection of P movement to catchment P loss is mainly through the definition of Critical Source Areas (CSAs) within catchments. CSAs may represent from 5% to 100% of the catchment area, depending on storm size and soil conditions.

Table 1: Cost efficacy of P loss mitigations at Lake Rotorua (McDowell, 2010)

	STRATEGY	EFFECTIVENESS (%)	COST (NZD $/KG P CONSERVED)
management	Optimum soil test P	5-20[1]	highly cost-effective[1]
	Low solubility P fertilizer	0-20	0-30
	Stream fencing	10-30	5-65
	Greater effluent pond storage	10-30	30
	Low rate effluent application to land	10-30	45
amendment	Tile drain amendments	50	25-100
	Restricted grazing of cropland	30-50	150-250
	Alum to pasture	5-30	150->500
	Alum to grazed cropland	30	160-260
edge of field	Grass buffer strips	0-20	>250
	Sorbents in and near streams	20	350
	Retention dams / water recycling[2]	10-80	>500
	Constructed wetlands[3]	-426-77	>500
	Natural seepage wetlands[3]	<10%	>500

[1] Depends on existing soil test P concentration, but no cost if already in excess of optimum. [2] Upper bound only applicable to retention dams combined with water recycling [3] Potential for wetlands to act as a source of P renders upper estimates for cost infinite

Factors related to RAP loss

Forms of RAP loss

It is important to identify the three forms of P loss that can occur immediately following fertiliser P application:

- *Dissolved P* – the first is as Dissolved Reactive P (DRP) directly from the fertiliser material
- *Recently enriched surface particulates* – Dissolved Inorganic P (DIP) from fertiliser that has rapidly become

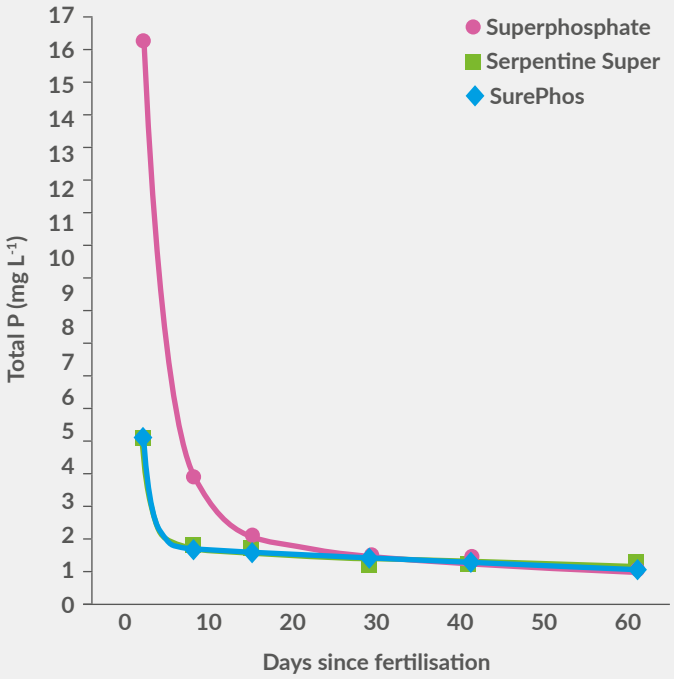

Figure 2: Stylised P loss over time since fertilisation (Orchiston & McDowell, 2019)
Note that Surephos and Serpentine Super loss are the same

sorbed onto fine soil particulate matter, which is subsequently moved in surface run-off

- *Unmodified P fertiliser material* – rainfall immediately following P fertiliser application moves solid fertiliser granules or particles across the soil surface in run-off water.

The contribution of each of the above forms to total RAP loss will depend mainly on the rate of loss of soluble P from the applied fertiliser to DRP, and subsequently sorption onto surface sediments during initial rainstorms. The movement of unmodified P fertiliser material itself in surface run-off will be affected by the specific gravity of the fertiliser material.

Time window of sensitivity to RAP loss

The potential for P loss from fertiliser application declines exponentially with time as P sorption processes occur. Significant P losses from fertiliser are therefore highly dependent on the early coincidence of P application with run-off producing storms.

Results from run-off plots in 2003, 2004 and 2011 indicated that the critical period of RAP loss from superphosphate was from seven to 60 days with a mean of 21 days. The conclusion was that run-off P losses from fertiliser occurring later than 21 days after fertiliser application can be expected to be less than 10%.

P loss from fertiliser can be significant where a major run-off event occurs within the 21-day window after fertiliser application. Such events can produce a large proportion of the surface run-off for the year and will also dominate P loss for the year (e.g. the 94% of the total P lost in one run-off event 17 days after fertiliser application to a hydrophobic soil that was found in a 2011 study). This relates closely to the 90% of P expected to be usually released by day 21.

Major factors driving RAP loss

There are five major factors that drive RAP loss and these are given in order of significance:

- *Avoidance of fertiliser application to stream channels*
  The most immediate contribution to RAP losses from farmland comes from fertiliser applied to stream channels within the hill pastures. The newly available aerial SpreadSmart type technology is ideally placed to minimise the risk of this occurring.
- *Amount of P fertiliser applied*
  It was concluded from a range of plot studies in 1997 that DRP and PAP in surface run-off was influenced more by the amount of P fertiliser applied than by the initial soil P status. Obviously, higher rates of P fertiliser application directly to catchment channels will result in higher P losses.
- *Surface run-off flow timing*
  One 2011 study highlighted that flow rate accounted for the greatest degree of variation in P loads. P loss from fertiliser can be significant where a single major run-off event occurs within the 21-day window after application. These storms are, of course, unpredictable and vary in number and intensity from year to year.
- *Time of year effects on surface run-off and P losses*
  Studies in 2005 and 2007 showed that in Southland the risk of TP losses varied with time of year, being 23-24% in June, 12-13% in September and 4-9% in December. The seasonal differences were associated with surface run-off potential during these months, being higher in June because of higher soil moisture conditions than in December.

  Another study in 2007 showed that on dry East Coast hill country, most surface run-off was generated during periods of low soil moisture and associated hydrophobic soil conditions during dry summer and autumn months, with little surface run-off occurring in winter. At Waipawa about 25% of total run-off occurred in January-February from 25-29% of annual rainfall. This contrasted with July-August when 22% of annual rainfall produced 52% of total run-off.

  Earlier 1997 studies from run-off plot studies at Waipawa and Whatawhata research areas showed that DRP concentrations in surface run-off water were higher when storms occurred on dry rather than wet soils, and similarly were higher from soil on north compared to south aspects.
- *Type of P fertiliser used*
  The main P fertiliser used in New Zealand is single superphosphate, and most studies of run-off P loss have been made with this fertiliser. However, some comparisons have been made with RPR. One 2003 study reported that although P loss in overland flow was similar from areas with a long-term history of

topdressing with either superphosphate or RPR, after a fresh application of fertiliser P losses were 16 times greater from the plots that had received superphosphate. Two years later in 2005 a further study demonstrated that the risk of P loss from fertiliser can be estimated from the water solubility of the fertiliser.

On the West Coast in 2010 it was found that as a result of about 50 run-off events per year, 30 kgP/ha applied as superphosphate resulted in losses of 8.2 kgP/ha (27%), whereas RPR applied at the same P rate resulted in losses of only 4 kgP/ha (13%). In contrasting conditions in 2010 in Hawke's Bay it was measured to have significantly lower Filterable Reactive P (FRP) in stream run-off water when RPR was applied instead of superphosphate. Subsequently, following comparison of a range of P fertilisers with differing water soluble characteristics, the Hawke's Bay study concluded that to decrease P losses from fertiliser a low P solubility product may be of benefit.

Also, over three years at Waipawa an average of 85% higher DRP and 75% higher TP losses occurred from the superphosphate-treated catchment than from the RPR-treated catchment. The DRP loss from the superphosphate catchment represented 67% of the TP loss, compared with 18.5% of TP loss from the RPR fertilised catchment.

What determines the range in annual RAP loss?

RAP losses will be governed by four major factors:

- P fertiliser application rate
- The success or not of trying to avoid fertiliser application to the stream channels
- The percentage of a catchment that is occupied by the drainage channel
- Rainfall intensity and total.

It can also be asked, what annual reduction in RAP loss would be expected from using a low water soluble P product such as Surephos? The two fertilisers most commonly used in comparison of P losses in run-off have been superphosphate and RPR. Solubility criteria for these are shown in *Table 2*.

Table 2: Contrasting P fertilisers and % by weight characteristics (note Whenua has been branded Surephos)

FERTILISER TYPE	TOTAL P %	CITRIC SOLUBLE P %	WATER SOLUBLE P %
Superphosphate	9	85	78
RPR	10	30	N/A
Whenua	8	75	20

A 2004 study suggested that Serpentine Super (75% superphosphate plus 25% serpentine) was a possible alternative to superphosphate. The following year another study demonstrated from run-off plots that the risk of incidental P loss in surface run-off can be estimated from the water solubility of the fertiliser.

The use of a P fertiliser with a lower water soluble P value than superphosphate would be expected to reduce short-term P loss. Surephos was about 58% by weight lower water solubility than superphosphate. If the results from using RPR fertiliser with near zero water solubility are any indication, then a significant reduction in short-term RAP losses would be expected from the use of Surephos.

Surephos placed within a catchment channel should result in an estimated 75% lower RAP being released into stream water in the short term compared to RAP losses from superphosphate.

Based on the estimated RAP losses from superphosphate use on sheep farms of 0.369 kgRAP/ha/yr, the estimated short-term RAP losses following use of Surephos fertiliser could be reduced to 0.092 kgP/ha/yr. For sheep and cattle farms, short-term RAP loss could similarly be expected to be reduced from 0.33 kgP/ha/yr to 0.082 kgP/ha/yr.

It has already been noted that the use of SpreadSmart technology could potentially avoid application of fertiliser directly into catchment channels, but this will not be practical in all on-farm situations. The complete avoidance of fertiliser placement within small catchment channels would involve the avoidance of topdressing a significant buffer margin on either side of each channel. In complex topography this will not be practical. Consequently, the use of a lower water solubility product such as Surephos becomes a real advantage in reducing RAP losses from on-farm catchment channels.

How significant would this residual P retained be agronomically? Because the major saving of RAP relates to P retention in catchment channels, this will not result in significant benefits agronomically. Retention of greater quantities of applied P on target sites such as steeper slopes will have some benefits, although they will be small.

Conclusion

Of the on-farm tools available to mitigate P loss to waterways (considering the water soluble content of the P fertilisers used), Surephos is one example of a product type that is a cost-effective mitigation and would have the quickest impact relative to reducing Olsen P or other farm system changes. Regarding fertiliser, however, the key point to emphasise is that fertiliser form is only one aspect of good fertiliser management and ensuring it is applied at the right time, place and rate is equally important.

Further reading

McDowell, R.W. 2010. *The Efficacy of Strategies to Mitigate the Loss of Phosphorus From Pastoral Land Use in the Catchment of Lake Rotorua*. Report for Environment Bay of Plenty.

Orchiston, T. and McDowell, R.W. 2019. *Phosphorus Losses in Run-off From Four P Fertilisers of Contrasting Water-Soluble P Contents.* Report for Ballance Agri-Nutrients.

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VIRGINIA SERRA

LINCOLN UNIVERSITY DAIRY FARM (LUDF) – 20 YEARS OF SUCCESSFUL ON-FARM DEMONSTRATION

LUDF has been one of the most successful demonstration farms in New Zealand, leading the way in on-farm demonstration of highly profitable/low-footprint dairy production systems. This article provides an overview of this success, including a summary of the key changes over time and how these have impacted on the farm's profit and environmental footprint.

About the farm

LUDF is a 160 ha milking platform owned by Lincoln University and managed by the South Island Dairying Development Centre (SIDDC) *(see Figure 1)*. It is a former university sheep farm converted to dairy in 2001. The farm is fully irrigated from ground water with a spray irrigation system, including two centre pivots (118.3 ha), small hand-shifted lateral sprinklers (32.2 ha) and k-lines (9.9 ha). It has a range of soils that represent most of the common soil types in Canterbury. The average PAW (profile available water) of the soils is 112 mm, ranging from 96 mm to 144 mm.

It is a well set-up farm with a good layout, but unlike many other farms in the region LUDF has no in-shed feeding system or any other feeding facilities. Effluent is distributed through pot spray applicators via a separate line underneath the pivot in the North Block. A 300,000 litre enviro saucer was built in 2011 and the Cleartech Effluent Treatment System was established recently to recycle water and reduce environmental impact.

Leading the way

LUDF has developed an impressive following among farmers and rural professionals. It has hosted well-attended field days and received thousands of visitors over the years. In 2001 when LUDF was established, irrigated dairy farming in Canterbury was still relatively new. LUDF has led the way in applying relevant and well-researched principles of successful pastoral dairying to irrigated systems in Canterbury. The farm also led the way in managing reproductive performance without induced calving before it was compulsory to do so.

After 10 years of a well-run production system, the environmental footprint from dairy farms became a key challenge, especially in Canterbury. It was then that LUDF led the way again in demonstrating high profit/low-footprint dairy systems. Since then several adjustments and fine-tuning of the 'new production system' have occurred, and no doubt LUDF will continue to evolve to adapt to future challenges and opportunities.

The original system – 2003/04 to 2009/10

Two seasons after its conversion, LUDF was well settled into the production system that would successfully run for the next seven years. It was based on a few well-implemented key decision rules that saw the farm achieving consistent high performance. It was a simple system with one herd, 24-hour grazing, low and consistent

Table 1: 2003/04 to 2009/10 seasons

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	AVERAGE
kg liveweight/ha	1,960	1,960	1,960	1,974	2,058	2,107	1,941	**1,994**
Cows/ha	4.0	4.0	4.0	4.2	4.3	4.3	4.1	**4.1**
kg MS/ha	1,684	1,719	1,772	1,703	1,741	1,634	1,710	**1,709**
kg MS/cow	422	426	440	404	410	383	415	**414**
Imported suppl. fed (kg DM/cow)	304	277	320	235	407	338	262	**306**
Imported suppl. fed (kg DM/ha)	1,213	1,117	1,291	945	1,715	1,437	1,119	**1,263**
Pasture eaten (t DM/ha)*	15.3	16.1	15.3	16.4	17.9	17.2	16.2	**16.3**
kg N applied over 160 ha	200	200	187	187	164	200	185	**189**

**As estimated on DairyNZ's DairyBase*

Table 2: 2009/10 to 2013/14 seasons

	2009/10	2010/11	2011/12	2012/13	2013/14	AVERAGE
kg liveweight/ha	1,941	1,914	1,860	1,878	1,872	**1,893**
Cows/ha	4.1	4.2	3.95	3.94	3.9	**4.0**
kg MS/ha	1,710	1,638	1,861	1,878	1,725	**1,762**
kg MS/cow	415	392	471	477	440	**439**
Imported suppl. fed (kg DM/cow)	262	463	359	434	507	**405**
Imported suppl. fed (kg DM/ha)	1,119	1,911	1,500	1,714	1,996	**1,648**
Pasture eaten (kg DM/ha)	16.2	16.9	17.3	16.8	14.9	**16.4**
kg N applied/ha (over 160 ha)	185	260	340	350	250	**277**
Drainage mm/yr (Overseer)	333	333	333	333	na	**na**
Purchased N surplus (kg N/ha)	116	193	242	259	na	**na**

grazing residuals (seven clicks on the rising plate meter or 1480 kg DM/ha using the winter formula), and a focus on simple and replicable systems. Young stock were grazed off the milking platform as were cows over winter. The physical productivity of the farm during this period is summarised in ***Table 1***.

There was no pre-grazing mowing during this period and grass silage was cut to control pasture surpluses. Nitrogen (N) was applied after each grazing with clear decision rules about when to start and stop applications. The cornerstone of this production system was to grow as much pasture as possible, and then optimise its management to harvest as much high-quality pasture (ME) as possible.

Wind of change

With time, other top-performing Canterbury farmers started to catch up and pass LUDF on performance. The profitability comparison of LUDF with other high-performing dairy farms that started in 2010 identified areas for improvement. At this time, the Canterbury Land and Water Regional Plan (LWRP) process started with clear indications that N in waterways was an issue and that N leaching from dairy farms was a contributing factor.

The spread of the clover root weevil in Selwyn in the early 2010s decimated clover on many local farms, including LUDF, prompting an increase in N fertiliser use from around 189 kg N/ha (average from 2003/04 to 2009/10 seasons as presented in ***Table 1***) to 250-350 kg N/ha (from 2010/11 to 2013/14 seasons as presented on ***Table 2***). Eco-N was used during this period to reduce the risk of N leaching until it was removed from the market in 2013. Reproductive performance (without inductions) and maintaining cow condition throughout the season, especially for younger animals, were other challenges that the farm was facing. LUDF had demonstrated how to run a successful and profitable production system for nearly 10 years, so it was a good time to demonstrate a different system that could address the challenges mentioned above.

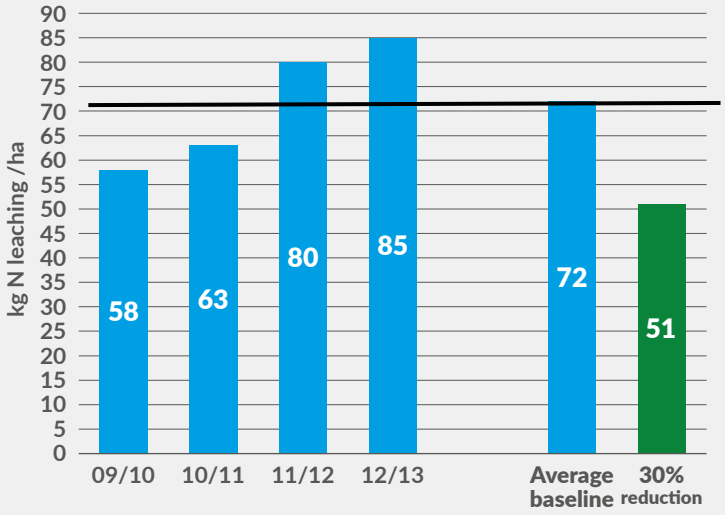

Figure 1: Estimated N leaching

High input/high output system – 2009/10 to 2013/14

LUDF is in the nutrient allocation zone of Selwyn Te-Waihora under Plan Change 1 (PC1) of the LWRP. Under this plan, from the 2017/18 season the farm is required to operate at or below its baseline N leaching figure based on the farming system between the 2009/10 to 2012/13 seasons, assuming industry agreed good management practices (gmps), and especially modified for PC1 and referred to as 'little gmp'. From 2022, dairy farms will have to operate 30% below the gmp baseline. All the Overseer modeling presented in this article was conducted by Ravensdown Environmental using OverseerFM v.6.3.2.

Table 2 presents key parameters for the period between 2009/10 and 2013/14. This period is important because the first four years represent the baseline period (2009/10 to 2012/13) and from 2010/11 to 2013/14 represent the transition period towards 'precision dairying'. During this period, the farm achieved higher production per cow with higher supplement and N fertiliser use.

As shown in *Figure 1*, the average N leaching for the baseline period for LUDF was estimated at 72 kg N/ha/year, but significant changes occurred over these four years. Looking at N leaching in a simple way there are two key aspects to consider: drainage and N surplus.

The higher the drainage, the higher the risk that N will be leached into groundwater. Similarly, the higher the N surplus (N in inputs minus N in outputs), the higher the risk of N leaching.

Drainage (estimated by Overseer) remained unchanged during the baseline period at 333 mm/ha *(Table 2)* as the irrigation system and management was modelled the same over these four years. Therefore, the main reason behind the increase in N leaching during the baseline period was explained by the increase in N use (from 185 in 2009/10 to 350 kg N/ha in 2012/13) and supplement fed (from 262 to 434 kg DM/cow). As mentioned earlier, clover root weevil was a key driver behind the increase in N fertiliser.

The temporary suspension of Eco-N (DCD) in 2013 required a change in farm practice. As described in Pellow (2017) in early 2014, it became apparent that the farm would exceed the 2009/13 N leaching baseline for the 2013/14 season. Measures were taken in late lactation to stay below the baseline, including drying-off all cows in early autumn. It is estimated that these short-term reactionary responses cost the farm about $84,000. This experience prompted LUDF to seek alternative management strategies that would ensure N leaching would not be above the baseline and on target to achieve the required reduction.

Nil-infrastructure/low-input system – 2014/15 to 2018/19

From the 2014/15 season, LUDF adopted and scaled up the 'Nil-Infrastructure/low-input' farm system emerging from the Pastoral 21 (P21) research programme. This research was jointly funded by the Ministry of Business, Innovation and Employment, DairyNZ, Fonterra, Beef + Lamb New Zealand and the Dairy Companies Association of New Zealand.

This move was a further step to exploring systems with lower environmental footprint and higher efficiency. The changes have been well described by Pellow in 2017 and Chapman in 2017. The physical productivity of the farm during this period is summarised in *Table 3*.

Table 3: 2014/15 to 2018/19 seasons

	2014/15	2015/16	2016/17	2017/18	2018/19	AVERAGE
kg liveweight/ha	1,680	1,724	1,700	1,680	1,656	**1,688**
Cows/ha	3.5	3.5	3.5	3.5	3.4	**3.5**
kg MS/ha	1,742	1,812	1,789	1,571	1,733	**1,729**
kg MS/cow	498	522	517	451	504	**498**
Imported suppl. fed (kg DM/cow)	302	134	397	444	22	**260**
Imported supp. fed (kg DM/ha)	1,186	468	1,377	1,538	76	**929**
Pasture eaten (kg DM/ha)	15.7	16.6	16.0	16.2	16.5	**16.2**
kg N applied/ha (over 160 ha)	143	179	173	178	148	**164**

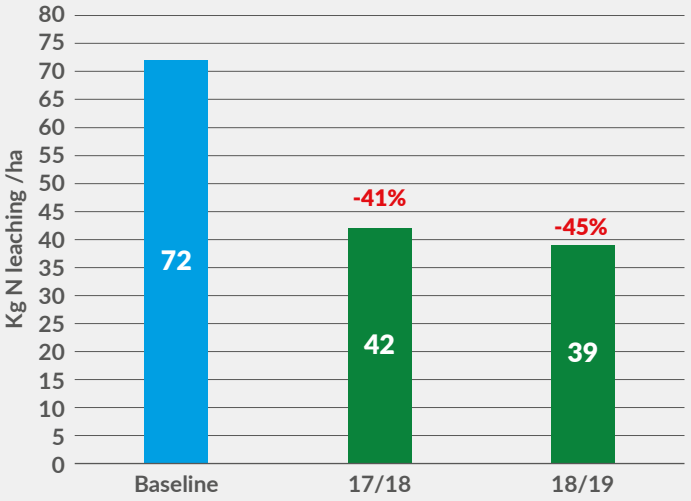

Figure 2: N loss reduction from baseline

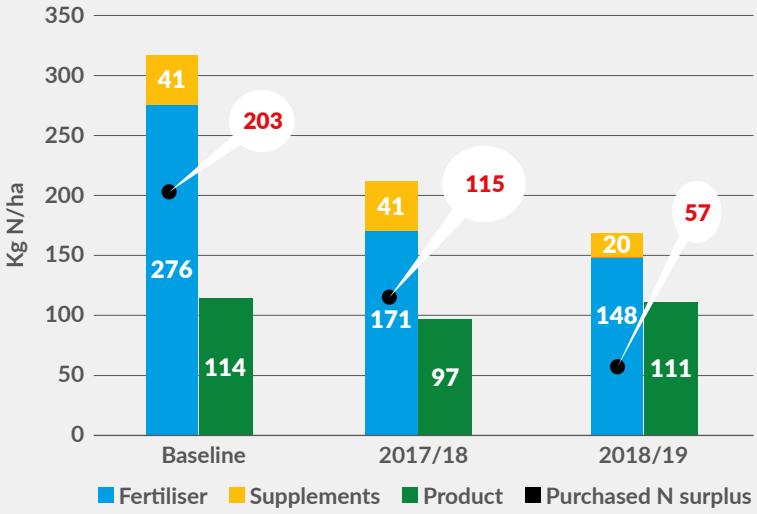

Figure 3: Purchased N surplus (kg N/ha)

During this period cows/ha (and kg LW/ha) was reduced by 12.5%. The focus on growing and harvesting pasture was still a key component of the system, but during this period more emphasis was placed on achieving high-performance per cow to compensate for the lower cow numbers. The key elements of this management included a split herd to preferentially feed young/light animals, pre-graze mowing and a more strategic use of N. The quality of the herd also improved because of the extra culling when moving to the lower stocking rate of the new system.

Environmental footprint

In the 2018/19 season, N leaching was 45% lower than during the baseline period *(Figure 2)*. This magnitude of N loss reduction exceeds the 30% reduction required by 2022, therefore LUDF has achieved compliance with Plan Change 1 and ahead of time. *Table 4* shows the estimated contribution of the key changes to the 45% reduction.

Table 4: Proportional contribution of changes to the reduction in N leaching

	CONTRIBUTION TO N LOSS REDUCTION
Soil moisture meters	14%
Irrigation system changes	14%
Effluent system change	2%
Farm systems change	15%
Total change	45%

Changes in the irrigation system and management

Changes in irrigation and management can explain 28% of the reduction from the baseline period. The key changes were: (a) improved decision rules around irrigation management with soil water meters (as the baseline was modelled without them); and (b) an increase in the area under pivot irrigation by 10.5 ha in the 2018/19 season. These changes improved the efficiency of irrigation with a lower volume of irrigation applied in the area irrigated by pivots and an overall reduction in drainage from 333 to 222 mm/ha/yr *(Table 5)*.

Changes in N surplus

The rest of the reduction is explained mainly by reductions in the farm N surplus resulting from the change in the production system. Farm systems changes explain approximately 15% of the reduction in N leaching compared to baseline. The main factors were: (a) a substantial reduction in N fertiliser use; (b) a reduction in supplements and therefore in N imported from that source; and (c) a reduction in herd size and feed demand, which resulted in less feed (and N) eaten per hectare. There was a small change in the effluent area from 34 ha to 39 ha in 2018/19, but this had only a minor effect on the modelled N leaching reduction (<2%).

As a consequence of these changes, the whole farm purchased N surplus (N in fertiliser + N in imported feeds minus N in products) fell from 203 kg N/ha in the baseline period to 57 kg N/ha in 2018/19 *(Figure 3)*.

Table 5: Drainage (mm/ha/yr)

	2009/10–2012/13	2017/18	2018/19
Whole farm drainage mm/ha/yr	333	281	222
Average drainage/average PAW	2.95	2.5	2.0
Irrigation applied pivots (mm/ha/yr)	508	355	355
Area pivots (ha)	107.5	107.8	118.3

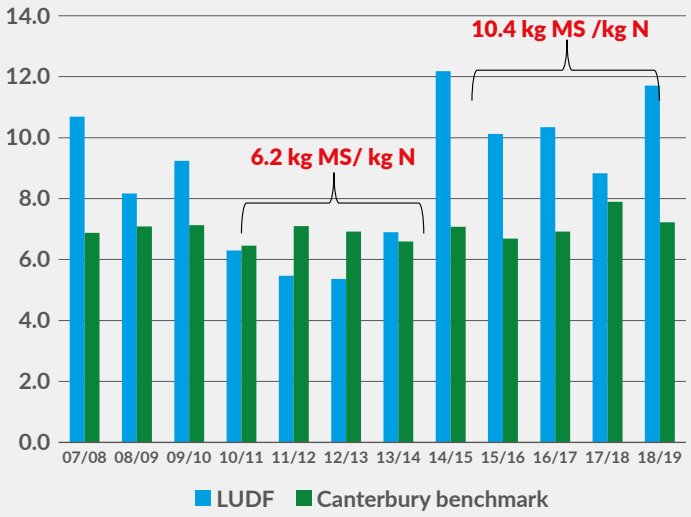

Figure 4: Kg MS produced/kg N fertiliser applied

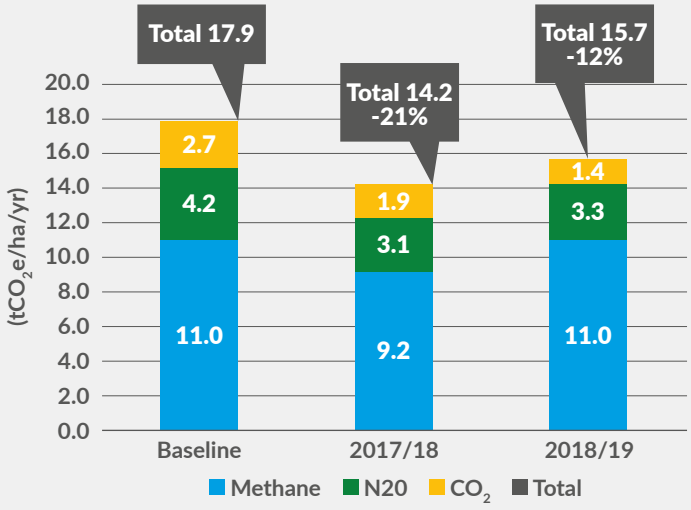

Figure 5: GHG emissions (t CO_2e/ha/yr)

This is substantially lower than what is commonly seen on Canterbury farms. Meanwhile, the overall N use efficiency of the farm (kg MS/kg N fertiliser applied) increased significantly compared with the baseline years (10.4 versus 6.2 kg MS/kg N fertiliser), a remarkable improvement in the overall system efficiency and a key step toward reducing the N footprint of the farm. This was achieved by halving N fertiliser input while 'losing' only ~40 kg MS/ha *(Tables 2 and 3)*. In doing so, LUDF went from similar or slightly below the Canterbury benchmark to markedly above it in N use efficiency *(Figure 4)*.

The reduction in N fertiliser was implemented using two main methods:

- Changing the frequency and amount of N applied at each event – contributing to 85% of the overall reduction in N applied
- Markedly reducing N fertiliser applied to the effluent areas – contributing to 15% of the reduction in total N applied.

A key feature of the change in fertiliser management was 2.4 fewer applications per year, and an average of 8 kg N/ha less N applied at each fertiliser spreading event (David Chapman, pers. comm.). The fewer applications per year was, in turn, facilitated by 1.7 fewer grazings per year reflecting a mean four-day increase in rotation length. The increase in rotation length resulted in an increase in leaf stage at grazing of ~0.3 leaves/grazing, which was estimated to have recouped about 1.1 t DM/ha of the expected reduction in pasture growth resulting from removing N fertiliser. This explains most, if not all, the 'buffering' of pasture yield reduction resulting from removing N fertiliser.

Having a high percentage of tetraploids in the pastures (95% of paddocks now have at least some component of tetraploids) has helped with the higher pre-grazing covers generated by the longer grazing rounds. Pre-grazing mowing has also been used to achieve the targeted residuals. It is important to mention that clover has returned to the pastures as it was before the clover root weevil outbreak.

There were also differences in the timing of N fertiliser applications with no N applied after the end of March. This can contribute to lower leaching not necessarily via direct leaching of N from fertiliser, but by having fewer grazing events into the late summer-autumn period where the N leaching risk of urinary N increases.

Stocking rate, dry matter intake and footprint

The total dry matter intake, estimated by Overseer, as an average for the last two seasons was 13% lower than during the baseline period. This difference reflects the lower demand per hectare driven by lower requirements from maintenance and milk production (reflected by lower liveweight/ha and lower MS production/ha). Less feed eaten translated into lower N excreted, from 787 kg N/ha to 652 kg N/ha.

As reported by Chapman et al. (2017), if we were accounting for the footprint of the whole business including wintering and young stock, the comparison would show an extra N loss reduction due to less dry matter intake consumed by fewer young stock and fewer cows over winter (about 122 t DM less feed eaten for the total farm operation). Carrying fewer cows over winter can have a significant impact because winter is a high-risk time of the year for N leaching. The caveat of this statement is to consider what would be the alternative use of land 'spared' by less animals and the alternative footprint compared with wintering or young stock grazing.

Greenhouse gas emissions (GHGs)

In light of the Zero Carbon Bill and possible commitments under He Waka Eke Noa it is important to note that GHG emissions, as an average for the 2017/2018 and 2018/19 seasons, were reduced by 16.5% from the baseline period *(see Figure 5)*. This was driven by the lower dry matter intake (as methane emissions are highly correlated to dry matter intake) and lower N surplus (as nitrous oxide is highly correlated to N surplus).

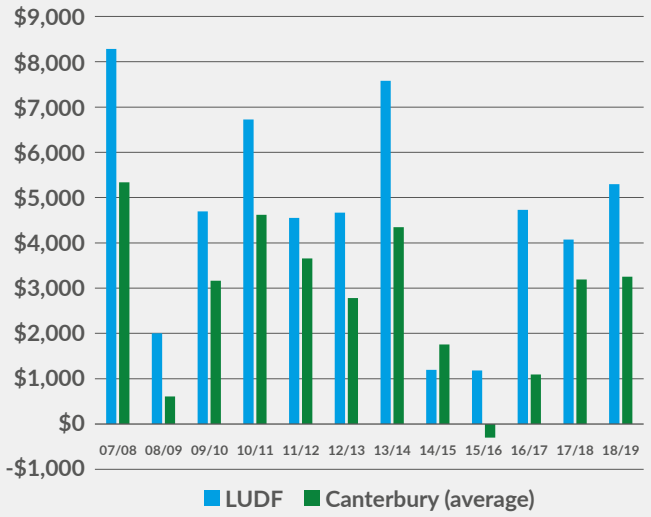

Figure 6: Operating profit ($/ha) LUDF and Canterbury benchmark

Changes in profit

Figure 6 compares operating profit per hectare for LUDF with the average Canterbury benchmark available on DairyBase. Except for the 2014/15 season LUDF achieved higher profit than the benchmarking group.

The comparison of the operating profit per hectare of LUDF and the Canterbury benchmark signal that the profitability at LUDF has not been severely affected by the changes over the last five years. Another way of comparing the impact on profitability of the changes is to compare the changes in milk production and the potential changes in cost.

Over the last five seasons, milk production per hectare is only 2% below the previous five but it was produced by 80 less cows, with less N fertiliser (-113 kg N/ha/yr) and less imported supplements (-0.77 T DM/ha) *(Tables 2 and 3)*. Therefore, it is likely that similar output was produced with lower expenses including lower cow costs (e.g. animal health and breeding), lower N fertiliser and supplement costs, and less young stock and wintering grazing costs. Therefore, it can be expected that the system run over the last five years has the potential of higher profitability compared to the systems run previously.

Final thoughts

LUDF has arrived at a production system that has reduced N losses and GHG emissions, with a high level of productivity and potentially higher profit. The principles of the P21 research have been successfully implemented at LUDF over the last five years. This is a clear and valuable example of how P21 research can be scaled-up from farmlets to commercial businesses to help give farmers confidence. In this case, confidence that the industry can meet current and future environmental regulations while retaining high productivity and profitability.

LUDF has successfully transitioned to a lower-input system while maintaining a strong focus on monitoring and decision-making, and the tactical use of supplements and N. A range of adaptation tactics were used to mitigate the impacts of lower N inputs on feed supply from pasture, so that the overall system remained strongly pasture-based and costs of production were controlled. These included longer rotations and appropriate decision rules for supplement use and N fertiliser applications.

Further changes to the system have been modelled, including further improvements to the irrigation system in the areas not currently irrigated by pivots, as well as some alternative strategies for autumn management (culling strategy and supplement use). These options can reduce N loss further, but the magnitude of reduction will be smaller now that the 'big ticket items' have been addressed. In the future, further reductions in N loss could be achieved with a different pasture base (e.g. plantain and the adoption of 'low-N' cow genetics). Both of these options are being investigated now in R&D programmes with promising results.

In 2020, after nearly 20 seasons under its belt, LUDF continues to be a reference for dairy farmers in Canterbury and across the country, leading the way on profitable and low-footprint grazing production systems.

Acknowledgements

I would like to acknowledge Arron Hutton and Clare Buchanan (Ravensdown) for providing the Overseer modelling, David Chapman (DairyNZ) for the data and analysis of the impact of farm system changes on N leaching, and Ron Pellow and Peter Hancox and the farm team for implementing the changes over the last five years.

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CORRIGAN SOWMAN

HOW DOES THE PRESSURE OF CHANGE INFLUENCE FARMER THINKING AND THEIR ABILITY TO ADAPT?

During 2019, Corrigan Sowman spent 18 weeks travelling overseas on a Nuffield Farming Scholarship. The focus of his research was to better understand how farmers were responding to the pressure of change occurring around them, including its effect on their decision-making and ability to adapt. This article is based on the results of this research.

We are in a very strong position in New Zealand as we produce food and fibre in a way unique to much of the world. We also have a powerful landscape and cultural identity that is extremely beneficial for positioning ourselves in a premium part of the market. But more than this, how we behave as people is one of our greatest assets – we put the wellbeing of people first and for this we are trusted.

In this COVID-19 era we are all experiencing a new reality containing greater uncertainty and faster change than ever before. While there are tremendous differences only just starting to become apparent, many things also remain unchanged. One of those is how we as humans react to the pressure of change, how it influences our thought patterns and subsequent behaviour, and how we can take control and perform better in this new environment.

Change in agriculture

Farmers today are facing a future of increased complexity arising from new regulatory requirements, such as the Zero Carbon Bill, changing consumer awareness, and concerns about meat and dairy consumption and their link to methane emissions. The challenge is how to balance the needs of the planet with the needs of people, while at the same time achieving economic prosperity.

Agriculture receives criticism for its degradation of soils, contribution to climate warming, the use of animals, the exploitive consumption of water, the lack of biodiversity, the overuse of chemicals, and (in some parts of the world) genetic modification. At the same time, agriculture is essential for supporting the planet's growing population, solving the challenges of malnutrition and food insecurity, and supporting continued urbanisation.

A spectrum of solutions has been proposed to fix the problems in agriculture. Some suggest the mass production of synthetic food protein, rendering many current agricultural production systems obsolete. Others advocate regenerative principles – a return to small family farms, low-intensity, organics, carbon farming and a simpler and more 'connected' way of life.

In the middle of this lies today's farmer, often isolated, confused and feeling judged. Once considered a noble profession, farmers now feel like they are under the microscope and that those doing the scrutinising only have half the facts. While COVID-19 had provided an opportunity for society to reconnect with the value of food and the role of farmers, it has not lessened the pressure of change ahead of us. There is more to respond to than time, money or current technology allows. For some farmers, they are overwhelmed, and this is reflected in their mental wellbeing.

Mental health

Statistics about farmer mental health show concerning trends and highlight that the rural sector often lacks access to the critical support networks required. A 2015-2016 survey of Canadian farmers found that 45% could be classified as suffering from high levels of perceived stress, 58% met the criteria for anxiety classification, and 35% met the criteria for depression.

Another survey at the same time commissioned by the U.S.A. Farmers' Bureau found that 30% of farmers identified mental health as a major problem for them, 48% of rural residents said they were experiencing more mental health challenges than a year ago (with younger people the most vulnerable), and 91% of farmers/farm staff said financial issues and fear of losing their farm impacted on their mental health.

Once considered a noble profession, farmers now feel like they are under the microscope.

More recently in New Zealand, a 2018 survey of topics critical to rural New Zealand titled 'The State of the Rural Nation Survey' found similar trends (see www.bayer.co.nz/readnews.php?id=NZ+Rural+Mental+Health+Survey). Of the 260 respondents, 70% felt increased stress over the last five years. Financial pressures were the leading issue for 54% of respondents, with 49% citing environmental factors that affected their work and livelihoods as the second most important issue.

Data compiled by DairyNZ in 2020 as part of its own wellness programme in the New Zealand dairy sector highlights some of the challenges (see www.dairynz.co.nz/people/wellbeing/dashboard/). It reports that of the participants in its health pitstops (run alongside extension events around the country), 25% report levels of exhaustion, 9% are disengaged with their work, 76% have waist circumferences indicating they are overweight, and 55% admit to taking on-farm safety shortcuts.

Farmer pressure

Many farmers, growers, producer groups and marketers who I interviewed while overseas spoke of the emotions associated with fast change and negative social judgement. They talked about the expectations they felt society now has of them, how they were now feeling scrutinised for what they were previously encouraged to do, and how the consequences of past management decisions form perceptions about agriculture today. Their circle of concern has grown larger while their circle of control and influence has shrunk. Farmers have become more uncomfortable and, in many cases, lack the tools to manage this.

I use the word 'pressure' to describe how the following five factors ultimately combine to challenge how farmers think, behave and act. These factors (taken from sports psychologist Dr Ceri Evans' 2019 book *Perform Under Pressure*) are:

- Uncertainty
- High stakes
- Small margins
- Fast changes
- Judgement.

Ceri Evans states that:

> *The brain interprets pressure in two ways: either as a threat or as a challenge. It is important to recognise that we need the threat response and it is critical to keeping us alive, but in order to perform under pressure we need the skills to identify false threats and switch our state of thinking to developing internal challenge.*

California tomatoes in the Central Valley near Fresno

Chile potato harvest by hand

Buenos Aires Cattle yard – traditional Gaucho horseman

The simple message is that to shift thinking in response to pressure cannot happen with a busy and overwhelmed mind.

This concept of pressure is important because the discomfort it creates directly challenges farmers' ability to cope with and overcome the problems confronting agriculture. In other words, it influences their ability to adapt to change. The world has evolved and the rate of current change is unsettling for farmers, especially as technology allows traditional business models to be disrupted and replaced. Social judgement through new social expectations, scrutiny and fear of political consequences is changing the pressure gradient for farmers.

Ceri Evans explains that '… if we are intent on realising our potential, we have to accept pressure.' He points out that most pressure arises from negative judgements about us. It was this concept that helped me to better understand what I had heard from interviews with farmers and growers around the world, and what I was witnessing and feeling here in New Zealand about the change required within agriculture. My observation is that this social pressure – which is negative judgement – is difficult to process for farmers because it is a relatively new experience.

Thinking about our thinking

The subject of 'thinking about how we think' is called 'metacognition', and it is at the heart of how we adapt to change. It is higher order thinking that enables understanding, analysis and control of one's cognitive processes, especially when engaged in learning.

One of the best examples we have in New Zealand comes from sports psychology and is about the All Blacks. After their loss in the 2007 Rugby World Cup, their subsequent internal review identified that how they were thinking under pressure was the crux of their ability to adapt to a changing environment. As noted by James Kerr in 2013 in his work on what the All Blacks can teach us about business and life, the All Blacks recognised that their thinking under pressure was 'heated', 'overwhelmed' and 'tense' (H.O.T. thinking). They were acting as though under threat, and this was triggering natural survival instincts in their brains, referred to by Ceri Evans as 'fight', 'flight' or 'freeze' behaviours.

Currently in New Zealand agriculture the reaction to the threat of change and increased pressure is often similar to H.O.T. thinking. Collectively, these instinctive behaviours that are with us from birth can limit our performance. They are a natural human response to keeping us comfortable, safe and alive. The problem is that aggression and confrontation through our natural fight responses can shut down dialogue, negotiation and ultimately the opportunity for achieving positive outcomes. It is very hard to adapt to change if we are fighting it. Similarly, the flight response only puts off facing the reality of the situation – we can run but we cannot hide.

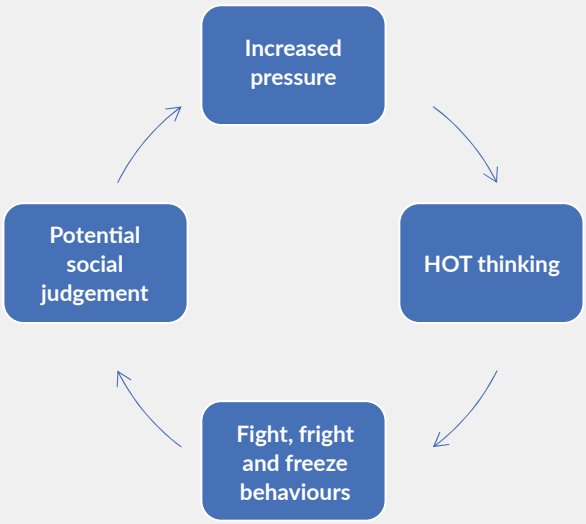

Figure 1: The cycle of pressure

So how does society perceive us when we are fleeing from our problems in agriculture? Do they think we do not care? Perhaps most challenging of all, especially for a country driven to make change and further its position as a world class agricultural producer, is that we freeze and end up in a state of inertia unable to see the bigger picture. In my view, this situation of pressure and H.O.T. thinking can work as a negative feedback loop *(see Figure 1)*.

To understand the farming brain, we need to recognise historical and genetic factors which set farming society apart from the general population. The prehistoric emergence of farming was a result of our move into agrarian agriculture thousands of years ago. This innate drive to work the land and produce food is 'in the blood' of farmers. It pushes them to take risks in the pursuit of their farming objectives, but farmers can have a deep sense of failure and depression if they do not succeed because of external pressures.

A model for thinking – red and blue

Ceri Evan's notion of a red and blue model helps put 'pressure' in context. Pressure triggers our reactions and there are two ways to consider it: threat, where we cross our tolerance threshold; or challenge, where we build resilience. These two responses have very different outcomes. The main differences between the red and blue brain are:

- The red brain (primarily concerned with feeling) is our brain stem, limbic system and the right hemisphere of our brain. It is designed to run our organs and body, sense immediate threats and emotional stimulus around us, and above all keep us alive by controlling our behaviour. The red brain is fastest, working in the tens of milliseconds
- The blue brain is our left hemisphere where logical and reasoned thinking occurs, and it helps us to plan and make goals and decisions. The blue brain is slower, working in the hundreds of milliseconds.

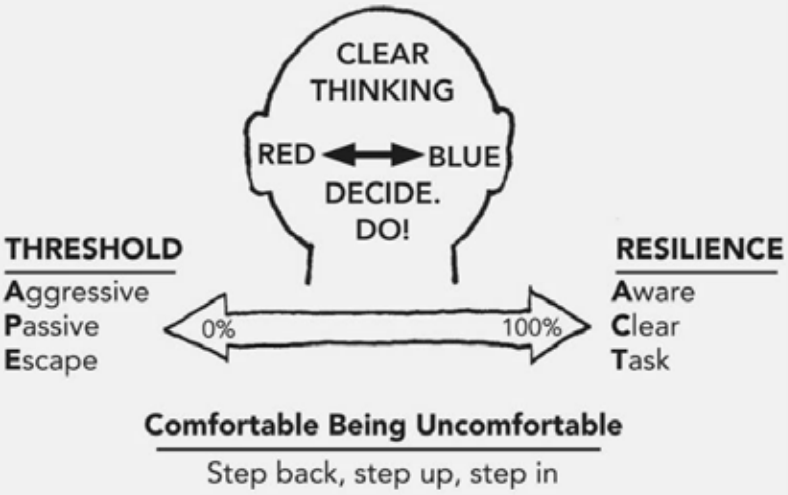

Figure 2: The red-blue model. Source: Evans (2019)

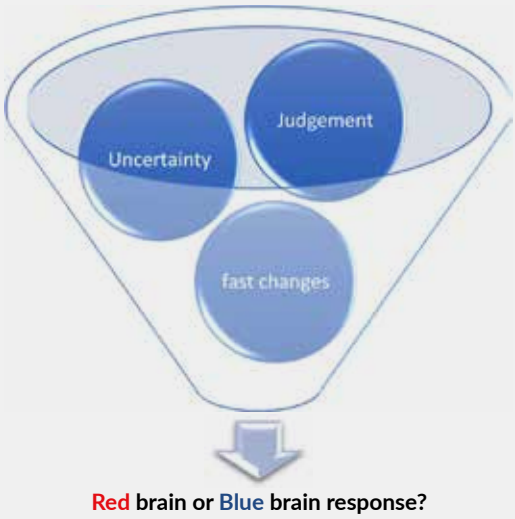

Figure 3: The funnel of pressure

These are key points that we need to be aware of when considering our actions under pressure *(Figure 2)*, or when encouraging and supporting someone else through change.

In my view, this model can be applied to agriculture because it gives us a means to explain how we feel using the science of the brain and thought processes. This model also gives us a place to find common ground around something we all share – how all people think and ultimately behave.

The confrontation of challenges we face through change in agricultural practice is too often fuelled by emotion as a means to drive action. Social media platforms have provided a strong emotional lever, but as the red-blue model explains they can drive the wrong sort of action.

I liken this situation to a funnel *(Figure 3)*. Pressure across many interweaving factors and actors is swirling around, but there is only one way for it to go – it must pass through our brain. What outcome and actions result from this is only something we can determine. It will be based on how we choose to think about the information we are receiving – but are we using our red or our blue brain?

RPs supporting our farmers through change

At the very top of red-blue brain model is clear thinking. The simple message is that to shift thinking in response to pressure cannot happen with a busy and overwhelmed mind. We each need to have tools that allow us to gain awareness. This is a critical aspect if you are supporting someone else through change. How can you provide them with a clear head? What tools are you using? Farmstrong (2020) mentions cognitive switches in its resource material to farmers. Their example of identifying an unhealthy thought is to 'catch it, check it and change it'.

In supporting others through change, I encourage you as rural professionals to start by considering how they are thinking, and what you can do to foster a shift to a blue brain approach. Historically, farmers have adopted a mindset – like many other businesses – that growth is the answer. However, as growth is now being constrained by new regulations, finance, consumer pressure and an unpredictable climate, they require a different mindset. To develop this mindset, they need to better understand how their thinking and wellness connects with their actions, and how their actions will shape the food and fibre they produce.

My report makes four key recommendations. First, we need to better recognise pressure in the New Zealand primary sector and its influence on farmer thinking when considering behaviour change. Secondly, we must invest in training our farmers to think about their thinking, which is critical to performing in a rapidly changing environment. Thirdly, let us recognise New Zealand success stories of performing under pressure such as the All Blacks, as we can relate to these and use this success as motivation for our own change. Lastly, we must connect the big picture that pressure drives our thinking in a way ultimately reflected by the food we produce. In essence, thinking is at the heart of New Zealand's future food story.

Acknowledgements

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LAURA KEENAN

This profile looks at the life and career of Laura Keenan, including her roles outside her work at Agricom.

Ag a passion

Laura has always been interested in agriculture, which she finds face-paced and multi-faceted. She grew up in Southland and spent a lot of time at her grandparent's sheep and beef farm. This provided the underlying passion for her head to Lincoln University after leaving school where she completed an Honours degree in Agricultural Science, graduating in 2014. Further education has included the Advanced Sustainable Nutrient Management course in 2015 and An Introduction to New Zealand Greenhouse Gases in 2019, both through Massey University. Laura is now based in the Manawatu where farming is still a huge part of ger life, living on her partner's parent's arable and finishing property near Feilding and working in the primary industries.

A career helping farmers

Her first role after leaving university was for three years (2014 to 2016) as an Environmental Consultant in Canterbury – Soil Matters, helping farmers with their consents and farm environment plans. This role allowed Laura to get a taste for the primary industries, develop connections with farmers, and provide the foundation for what tasks are required day-to-day in a 'real career'.

She then moved into her current role as the Territory Manager for Agricom based in Palmerston North and managing the Western North Island. She has been in this role since 2016 and says that it gives her the perfect balance. Eighty percent of her time is spent in the field with farmers talking about their various farm systems. She notes that even though she studied science, her job

‘Like me, most farmers are visual learners. I get to help them grow a variety of forage crops and they can see their progress within 100 days.’

is all about people – understanding them and their farm and then helping choose the right seed, plant, grass or crop for their environment and business. The other 20% is spent in the office on planning, organisational tasks and professional development, which provides stability and structure to the role.

Laura says, ‘Like me, most farmers are visual learners. Every day they’re dealing with very tangible things. I get to help them grow a variety of forage crops and they can see their progress within 100 days. It’s hugely satisfying and has exceeded my expectations of how rewarding a career can be.’

She believes you can change a farm business by listening, then helping farmers make decisions by offering agronomy information and ongoing support. This can lead to growing more feed, eliminating weed species, and filling or shuffling feed deficits and surpluses for stock to generate more money for the business. Taking all of these elements and coming up with a plan is the space where Laura gets to work and she feels it is a real privilege. There is now another element to consider on-farm with the Essential Freshwater package and Zero Carbon Bill, which adds another layer of complexity for farmers. She sees it as an opportunity to add more value to our products and our businesses while assessing short, medium and long-term risks.

For Laura, the agricultural sector is a great place to work as there is a high level of support and encouragement. Its size means everyone is almost instantly connected and you get to hear people’s stories. For her, there is nothing better than listening to a farmer’s story, helping them make a plan, seeing them execute it, and watching them succeed and make a profit.

NZIPIM work and other roles

Laura is currently a member of the Central Districts NZIPIM branch and joined in 2018. She was named the NZIPIM Emerging Rural Professional of the year in 2017 and used her prize package to successfully complete a Kellogg Rural Leadership Program in 2019, a highlight of her career thus far. She completed an industry project through the Kellogg Program, ‘What is the Future for Farm Compliance in New Zealand?’ (see https://ruralleaders.co.nz/what-is-the-future-for-farm-compliance-in-new-zealand-laura-keenan/).

In 2018, Laura joined the New Zealand Grassland Association (NZGA) Executive Committee. The aim of the NZGA is ‘to enhance pastoral agriculture’ through providing a forum for communication of science, technology and knowledge. Formed in 1931, the NZGA facilitates discussion on grassland farming, and promotes the value of research and its application. Our membership includes a wide range of scientists, consultants, agribusiness and farmers – making it truly ‘fuelled by science and tempered by experience’. The executive committee oversees the organisation annual conference, journal and publications while interacting with members of the organisation based around New Zealand.

Laura was also one of the founders of the Women in Agribusiness initiative in 2017, which is a group of national rural women who come together to learn, grow and network. With three meetings a year, held around national conferences, this initiative was formed to provide a high-level platform for engagement with leaders of the sector and to provide pathways and connections for its members.

State of the primary industry sector

Laura’s advice to rural professionals is simple: ‘Keep your eyes open. If you are prepared to listen, learn, collaborate and adapt, there are endless opportunities to help the food and fibre sectors of New Zealand grow. My life long goal is for our primary industries to collaborate and integrate for more productivity and profitability across the sector.’

She believes there are many challenges ahead. There are complex policy trade-offs between environmental protection and economic growth that current and future generations will have to address. The challenge of compliance to farmers is one of the most significant they may experience in their lifetime. The opportunity to secure ‘premium’ high prices for our exports based on a brand is also compelling.

Compliance is becoming a large part of that brand and it is evident that more customers are willing to pay for sustainability. Protecting and enhancing this brand will enable sustained and value-added economic growth, and this will need to be linked to conservation and the environment in mutually reinforcing ways. It is already challenging to build and maintain this strategic advantage. Laura believes it will become more so as customers become more discerning, and as product traceability is more widespread.

The complexities of the interactions that now exist between human and natural ecosystems require critical decisions to be made with pre-evaluated impact. For Laura, these factors and skills combined are rare and not too dissimilar to ‘superpowers’. She says, ‘We need more people with these superpowers in our sector. People with deep farm systems knowledge, environmental knowledge, provenance and market knowledge, animal and biosecurity knowledge, and people who show empathy and a pathway forward with innovative thinking when challenged with adversity.’

For her, there is no more a noble profession than being in the business of food production. Laura believes that there is an opportunity in everything – you just have to have the tenacity, determination and motivation to find it.

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