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MYCOPLASMA BOVIS – GETTING IT RIGHT CLIMATE CHANGE IMPACTS AND MITIGATIONS
GENOMICS IN THE PRIMARY INDUSTRY COST OF COMPLYING WITH HORIZONS ONE PLAN

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

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

NZIPIM MEMBERSHIP ENQUIRIES
Stephen Macaulay
027 226 3331 stephen@nzipim.co.nz

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Contents

Stephen Macaulay
CEO's comment 2

Feature articles

Ashleigh Dobson
Mycoplasma bovis and on-farm biosecurity – getting it right 3

Harry Clark
Climate change impacts and mitigation – a New Zealand perspective 8

Keith Woodford
Short and long-lived greenhouse gases need different accounting systems 13

Dorian Garrick
Genomics and its applications in primary industry improvement 16

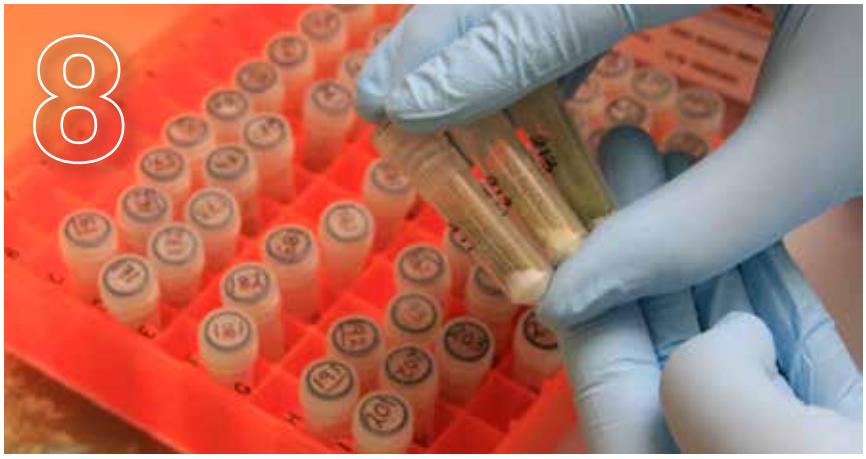
Ben Allomes
Redefining the labour market in the dairy industry – who are our customers really? 23

Alesha Cooper
Cost of complying with the One Plan – a case study of the regulatory requirements for a dairy farm in the Horizons region 29

Grant Jackson
Miraka – a Māori agribusiness global success story 37

Profile

Charlotte Glass 43



STEPHEN MACAULAY CEO

Undervaluing biosecurity represents a serious threat to our primary industries

The occurrence of *Mycoplasma bovis* (*M. bovis*) has been a devastating blow to our dairy and beef farmers, and represents a serious biosecurity wake-up call for our primary industries. In response to the *M. bovis* outbreak, the Government and farming sector group leaders recently announced their agreement to attempt to eradicate this cattle disease from New Zealand in order to protect the national herd and the long-term productivity of the farming sector. This decision has been taken while there remains a chance to get rid of the disease.

The full cost of phased eradication over 10 years is projected at $886 million. Of this, $16 million is loss of production and is borne by farmers and $870 million is the cost of the response, including compensation to farmers. Most of the eradication work is expected to occur in one to two years. Government will meet 68% of this cost and DairyNZ and Beef+Lamb New Zealand the remainder.

We should not underestimate how challenging it will be to eradicate *M. bovis* as it is a difficult disease to diagnose and control. This has been made worst by inaccurate record keeping of animal movements within NAIT, particularly where farm-to-farm animal transactions are involved.

Speculation still abounds about how *M. bovis* entered the country. The Ministry for Primary Industries (MPI) are vigorously trying to determine how this biosecurity breach occurred and I, like everyone else, hope they are successful in identifying the pathway for the incursion of the disease into New Zealand farms.

Any biosecurity threat such as *M. bovis* represents a significant challenge to the primary industries. It is with disconcerting regularity that we seem to be seeing more and more biosecurity breaches in New Zealand. As recently as last month the invasive weed great willowherb was found growing in several areas in Canterbury. Twelve months before that myrtle rust, first discovered in Kerikeri, has spread to well over 540 infected sites across the North Island and now the top of the South Island.

It doesn't seem that long ago that the kiwifruit industry faced turmoil with its own biosecurity breach through the discovery of the *Pseudomonas syringae* pv. *actinidiae* (Psa) bacteria, which causes the death of kiwifruit vines. While the kiwifruit industry is a shining light on how to effectively respond to a biosecurity threat and come out the other side in an even stronger position as an industry, this may be difficult to replicate when farming under different biological systems and industry structures.

The ability to stop biosecurity incursions is extremely problematic, and in some respects made more difficult by our position as a highly trade-dependent economy. New Zealand has one of the most open market economies in the world with its involvement in the free flow of goods among a wide range of trading nations.

We are also seeing greater movements of people through our borders. Close to 3.8 million international visitor arrivals were reported in the year ended April 2018, and this is expected to increase to 5.1 million by 2024. Trips abroad by New Zealanders were 2.9 million to the year ended April 2018 (MBIE: Key Tourism Statistics). Given the size of our population it is staggering to think that 6.7 million passengers were counted travelling in and out of New Zealand over this period.

The freedom of movement of goods and the increasing number of people crossing our borders does increase New Zealand's primary industries exposure to ongoing biosecurity threats in the future. This reinforces the fact that there is no such thing as zero risk, and that we must always be vigilant about such threats and ensure good processes are followed.

Farmer expectations around on-farm biosecurity have certainly heightened since *M. bovis* was first identified. As mentioned in the article by veterinarian Ashleigh Dobson in this issue, rural professionals should consider their role in minimising the risks of spreading diseases when planning farm visits, such as arranging visits in advance, staying on the main tracks, maintaining clean boots and equipment, and using on-farm cleaning and disinfection treatments. Other useful tips are available on DairyNZ's website.

Rural professionals also have an important role in monitoring and reporting possible biosecurity incursions, particularly when they come across unidentified invasive plants/weeds, unfamiliar insects and unknown diseases etc. So while there is certainly an elevated awareness about biosecurity matters at the moment, we should not lose sight of or grow complacent about biosecurity threats lurking around the corner. J

ASHLEIGH DOBSON

Protect our sector – please arrive at on-farm events with clean boots

Veterinarian and developer Ashleigh Dobson discusses on-farm biosecurity in the face of the Mycoplasma bovis outbreak in New Zealand, highlighting what rural professionals and farmers can do to make a positive difference.

MYCOPLASMA BOVIS AND ON-FARM BIOSECURITY – GETTING IT RIGHT

The current challenge

Since July 2017, when the bacteria *Mycoplasma bovis* (*M. bovis*) was first diagnosed in New Zealand, dairy and beef farm biosecurity practices have been under increased scrutiny. New Zealanders rightfully take great pride in punching above their weight on the world stage in many areas. Unfortunately, many think of biosecurity as something required only at the border and in our interactions with the rest of the world. It is time to change that mindset to include protecting the borders of our farms, our communities, and our food supply, as well as our other assets.

The entry of the disease into our country and the subsequent challenges encountered during the response have highlighted areas where we can improve biosecurity, both behind and beyond the farm gate. While the incursion of *M. bovis* has been absolutely devastating to many farms, creating considerable stress and upheaval in some areas, many have been fortunate to emerge relatively unscathed. Of great concern is the possibility that if we don't learn what we can from this experience, and change our practices on-farm and in the wider community, the next time something breaches our defences it may cause far greater damage to our farming industry and global trading relationships than *M. bovis*.

***Mycoplasma bovis* – an overview**

M. bovis causes disease in cattle only. The bacteria does not infect people and presents no food safety risk. The main signs seen in New Zealand cattle have been multi-quarter, non-responsive mastitis and arthritis. In one farm, several young calves showed neurological disease. Reports of ill-thrift (failure to gain weight) in calves are thought to be multifactorial and the role of *M. bovis* is still being examined, but at this point in time it is not considered the primary cause.

M. bovis is a fragile bacteria in the environment, because it does not have a cell wall like most other bacteria. It is easily killed by UV light and cannot withstand being dried out by heat and wind. However, the same characteristics that make it fragile in the environment are responsible for

Provide visitors with spare personal protective equipment (PPE) or have a dedicated cleaning and disinfection point

For New Zealand pastoral farms, animal health gold standard biosecurity is practised on farm systems that prevent contact between stock from different sources.

making it difficult to kill once it is inside an animal. It is resistant to many antibiotics used on-farm and there is no effective *M. bovis* vaccine. For this disease, *prevention* of disease transmission is much more effective than trying to cure an infected animal.

It is very difficult to detect *M. bovis* in infected animals. Typically, in an infected herd, 80-90% of infected cattle show no clinical signs of disease. Infected animals shed the bacteria intermittently, which makes finding and eliminating them next to impossible. The testing strategies currently employed in New Zealand are based on multiple tests done over time to try and increase the chances of finding infected animals that are intermittently shedding bacteria.

Stress in cows at drying off and again at calving time may trigger shedding and/or clinical disease. At those times it will be important to remember that the bacterial infection with *M. bovis* may have been there for some time before the stressful event, and that this event has brought on the clinical signs.

The transmission of *M. bovis* occurs primarily through direct physical contact between groups of cattle and through feeding contaminated milk to calves. With that in mind, the strategies that will be most effective in protecting cattle from *M. bovis* will be those that eliminate direct physical contact and mixing between cattle from multiple sources, and that protect calves from contact with infected animals and the consumption of milk that contains *M. bovis* bacteria.

Gold standard biosecurity – not just a buzzword

Boiled down to basic principles, biosecurity is having a plan to minimise the risk of pests (e.g. weeds, plant and animal diseases, and some insects) establishing on a farm. Gold standard biosecurity refers to farm systems where people have taken all reasonable steps to protect their farm and stock from the incursion of pests and diseases. Examples of this can be seen in many pork and poultry operations where everything is contained in a barn, including:

- Positive pressure ventilation
- Vermin control
- All-in/all-out animal group movements
- Strict protocols for visitors to the facility – people have a shower on entry and get dressed in farm-specific personal protective equipment (PPE), and shower and change back into their own gear before they leave.

It is important to note that even under these conditions pest incursions and disease outbreaks can still occur.

For New Zealand pastoral farms, animal health gold standard biosecurity is practised on farm systems that prevent contact between stock from different sources. This includes farms that are operated as a 'closed herd', populated by animals that leave when sold or going to slaughter, but do not leave the property and then return (e.g. for grazing or lease). A truly closed herd does not buy in or lease any animals, but is re-populated by young stock raised on the farm. Breeding is done using

The fences and gates that surround a farm are the main defence against unwanted visitors, both human and animal.

artificial insemination, which can carry some risks, but those risks are lower than those posed by bulls or rams from other herds or flocks. Feed is grown on the main farm where possible, and bought in only from reputable sources if necessary. Owner-operated run-off or grazing arrangements that ensure 100% separation of stock from different sources are also practising animal health gold standard biosecurity.

For some New Zealand farms, the gold standard biosecurity described above is impractical. That does not mean that those farms cannot make changes to improve biosecurity practices. Some of those changes can happen immediately, and some can be planned for when funds and time are available. Longer-term changes may mean some adjustments to the farm system itself, such as the use of service bulls and off-farm grazing. Remember, any changes made are an improvement to the farm's biosecurity compared to the status quo.

Advice from rural professionals for farmers on biosecurity

The following recommendations are in the Biosecurity Warrant of Fitness (WOF) documents and in the grazier information that can be found on the DairyNZ and Beef+Lamb New Zealand websites. These are helpful tools that rural professionals can use to assist farmers improve biosecurity on-farm. Ideally, the WOF documents can be used by farmers, rural professionals and veterinarians working together to provide their individual expertise to an overall farm biosecurity plan. Keep in mind that these recommendations are *not* all specific to *M. bovis*, but are general, good biosecurity recommendations.

Boundaries and visitors

The fences and gates that surround a farm are the main defence against unwanted visitors, both human and animal. Fences and gates should be regularly maintained and, where possible, there should be a single entry point to the farm with any other entry points securely closed. In addition, where contact with neighbouring stock is possible, farmers are advised to create a two metre wide buffer zone to ensure that animal noses are kept at least one metre apart. Farmers are encouraged to have good relationships with their neighbours, and plan grazing to minimise the times when there are animals on both sides of boundary fences.

A sign at the farm entrance will remind visitors of farm biosecurity requirements. If visitors are unexpected, the sign should direct them to remain on the main farm track and give them the phone number of someone to contact about their arrival. Where possible, visitors should be transported through the farm on farm vehicles and leave their vehicles on the main farm track. If visitors are leaving the main farm track to enter a farm they should be provided with farm PPE, or asked to clean their boots and gear at a farm disinfection station (e.g. foot bath) on arrival and again on departure from the farm.

Prevent contact between animals across boundary fences using double fencing, outriggers, or other barriers such as hedgerows

Make sure machinery and equipment is cleaned and disinfected between farms

Rural professionals and contractors should realise they and their equipment are potential vectors of disease and other biosecurity risks.

Stock movements

There are many diseases that are carried by stock. Before farmers purchase, lease or allow stock on their property, they should aim to know as much as possible about where the animals have come from and what their health status has been. Farmers should ask questions about animal health, TB status, vaccinations, and disease and treatment history. They should consider using a pre-purchase checklist, such as the one found on the DairyNZ and MPI websites.

All cattle movements must be recorded in the National Animal Identification and Tracing (NAIT) system and all animals must have NAIT tags. Animal Status Declarations must also be completed and retained for the required amount of time. Any incoming stock should be kept separate from other stock for at least seven days. This is to allow newcomers to empty out any weed seeds they ate at the home farm, to give farmers time to watch for any signs of disease before they mix the new animals with their other stock, and to check that all the records are complete and accurate.

When sending animals off-farm, other than those going direct to slaughter, farmers should discuss biosecurity risks with their transport operator. Farmers should make sure that their animals are transported in a clean truck, and there is no mixing with animals from another herd. When having these discussions around truck cleaning, farmers must consider the transport operator's access to water, wash facilities, effluent disposal and time constraints. Farmers have the right to expect good biosecurity for their transported stock, but we all must respect the reality of constraints on transport operators. Truck effluent should not be dumped on-farm, so transport operators need access to effluent disposal that will not compromise farm biosecurity or contaminate the environment.

If farmers are sending animals to grazing, they should have a discussion around arrival, departure, and general expectations with the grazier well in advance of stock leaving their farm. Ideally, stock should not be exposed to stock from other farms at any point, and direct physical contact must absolutely be prevented from occurring. The use of grazier yards for arrival, vaccinating, drenching, tagging, drafting and departure must be planned in advance to reduce the chance of disease transmission. Where possible, farmers should consider doing tasks that require yarding at the home farm.

When stock return home from grazing, they should be kept separated from any other stock on the home farm for at least seven days. This gives the farmer time to observe them for any signs of illness before they are mixed with the rest of the stock on the farm.

Rural professionals and contractors – spread of disease

Rural professionals and contractors should realise they and their equipment are potential vectors of disease and other biosecurity risks. Farmers will have a growing expectation that any rural professionals visiting farms bring gear that has been cleaned and disinfected – that includes their boots, equipment, PPE, and anything they use that is going to touch an animal. It is simply good practice not to carry

Resources are available to help you protect your farm

mud and muck from farm to farm. While faecal spread is of low importance for disease caused by *M. bovis*, it is important for the spread of other diseases and some weed seeds.

Machinery can spread weed seeds and soil-based organisms and pathogens between farms. Farmers should discuss their expectations with all contractors so they know what is expected before arriving on-farm.

Waste water from cleaning gear, equipment and machinery must not go into waterways or into the farm effluent irrigation system, because this is another way to spread weed seeds. A 'clean on, clean off' policy is a good start to reduce the biosecurity risks of visiting contractors and others who come to the farm.

Conclusion

New Zealanders need to make improving biosecurity practices a priority. We have an opportunity to learn from this experience and improve our farming systems so that we are better prepared for an incursion of another pest or disease. A spin-off from this will be better management of pests and diseases that are endemic to New Zealand, such as bovine viral diarrhea (BVD). Working together with a biosecurity expert such as a veterinarian will enable both short-term and long-term goals for improving biosecurity on-farm to be developed and implemented.

Further reading

Biosecurity WOF:
www.dairynz.co.nz/media/5788853/biosecurity-wof-a4-brochure.pdf
https://beeflambnz.com/knowledge-hub/PDF/biosecurity-wof-checklist

Beef +Lamb New Zealand and DairyNZ Drystock Biosecurity Guidelines:
https://beeflambnz.com/knowledge-hub/PDF/drystock-biosecurity-guidelines

Grazier biosecurity:
www.dairynz.co.nz/environment/biosecurity/biosecurity-on-grazing-properties/
https://beeflambnz.com/knowledge-hub/PDF/mp-bovis-%E2%80%93-information-graziers

Pre-purchase checklist:
www.dairynz.co.nz/media/5787884/myco-bovis-pre-purchase-checklist-aug-2017.pdf

Grazing checklist:
www.dairynz.co.nz/media/4112103/heifer-grazing-questionnaire-stock-owner.pdf

Biosecurity Communication Plan for Graziers:
www.dairynz.co.nz/media/5789396/biosecurity-communication-plan-for-graziers-a4.pdf

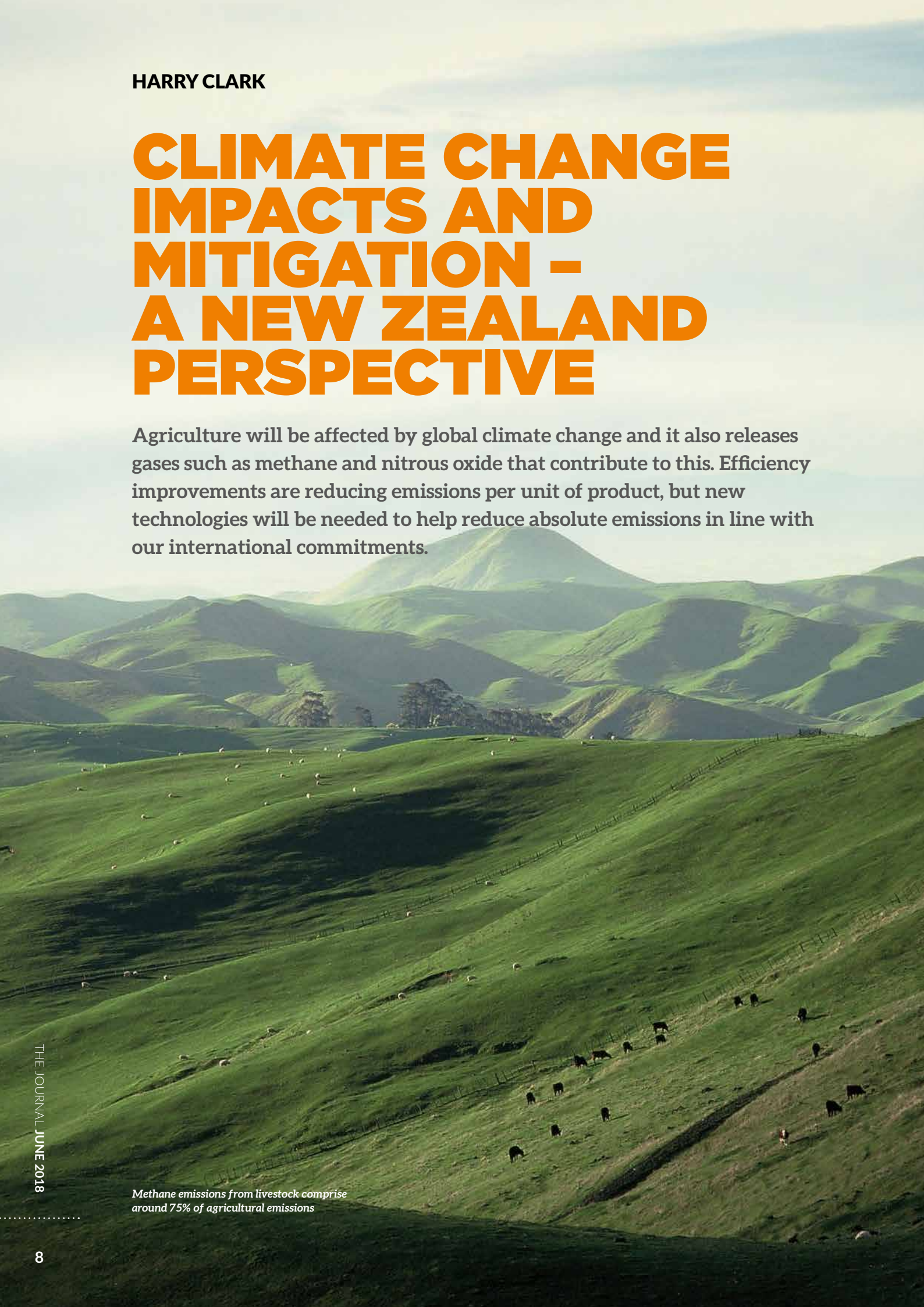
Ashleigh Dobson is an Invercargill-based veterinarian, DairyNZ and Beef+Lamb New Zealand developer, and 50/50 sharemilker with her husband Mark. Email: ashleigh.dobson@dairynz.co.nz.

Have one main access to the farm and close off any alternative entry points

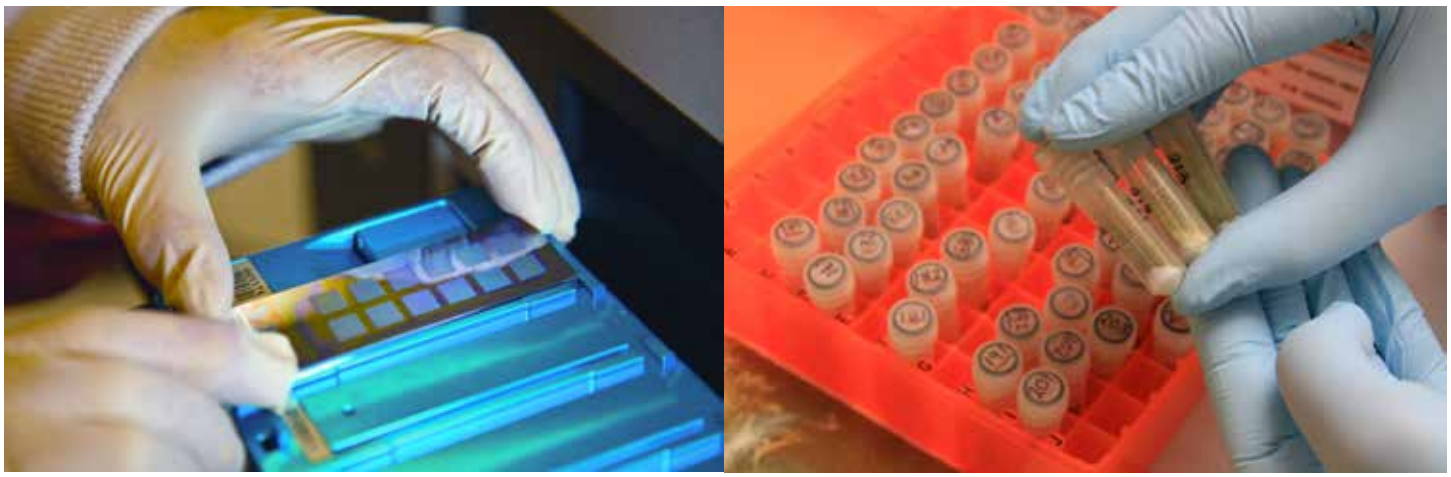
HARRY CLARK

CLIMATE CHANGE IMPACTS AND MITIGATION – A NEW ZEALAND PERSPECTIVE

Agriculture will be affected by global climate change and it also releases gases such as methane and nitrous oxide that contribute to this. Efficiency improvements are reducing emissions per unit of product, but new technologies will be needed to help reduce absolute emissions in line with our international commitments.



Methane emissions from livestock comprise around 75% of agricultural emissions



Government, industry and researchers work together to develop tools to help reduce emissions intensity and total emissions without curtailing production

Positive and negative impacts

Just as the New Zealand economy is sensitive to international events, our agricultural sector is susceptible to impacts from global climate change. Some will be direct, such as climatic impacts on domestic agricultural production. However, further indirect impacts could come from overseas via trade, such as climate-induced production shifts, greenhouse gas (GHG) mitigation measures, consumer perceptions, purchasing preferences and reputational issues.

Not all of these impacts will be negative. Many climate impacts and responses overseas, such as increased demand, higher returns, competitive advantage and smart marketing, could all help to offset (even outweigh) domestic weather impacts and emissions mitigation costs.

A hungrier world

If, as projected, the world's population reaches 9.1 billion by 2050, the UN Food and Agriculture Organisation (FAO) says global food production will need to increase by some 70% by 2050. The demand for livestock products could increase even more. Under a business as usual scenario, meat demand in low and middle income countries will increase 80% by 2030 and over 200% by 2050.

Food security is already a major problem. Approximately one in nine people suffer from hunger or are undernourished and the number is growing. The FAO also estimate that a further two billion suffer what it calls 'hidden hunger'. While not malnourished, they cannot access an optimum diet and suffer adverse health effects from poor nutrition.

Food exporters such as New Zealand stand to benefit from increasing food demand. Our agricultural exports already feed an estimated 20 million people, but the industry's stated aim is to double export production over the next decade.

Market forces

If climate change drives overseas productivity down, or costs up (either directly through climatic effects or indirectly through constraints on, for example, GHG emissions), this could benefit New Zealand farmers and agricultural exports.

Such benefits are difficult to quantify, but studies of yields of major commodity crops under climate change found that global maize and wheat production fell between 1980 and 2008. The European heat wave of 2003 resulted in maize yields falling by 30% or more in France and parts of Italy. Under unmitigated climate change, such heat wave conditions are expected to become the norm in Europe by mid-century.

New Zealand producers will be affected by changes in our weather patterns, such as increased drought risk, but generally they are forecast to be less severe than those experienced by some major food-producing regions overseas. So, as demand rises and climate change puts increasing pressure on food production in other parts of the world, New Zealand farmers could be well placed to fill any supply vacuum.

Amid the interactions with many other economic drivers, the benefits from such opportunities remain uncertain, especially with uncertainty around the rapid developments in synthetic milk and meat products. However, current studies indicate that New Zealand farmers would benefit from production losses caused by climate change in other world regions.

Effect of climate change on domestic production

Climate change will bring mixed prospects for New Zealand farmers. Climate science is constrained by many variables, but modelling has indicated that under the most likely scenario western and southern regions will largely receive more rain and warmer temperatures. However, drought frequency could double (or even triple) by 2040 in eastern and northern regions.

Under a less likely (yet still plausible) projection, most of New Zealand would become drier by the middle of this century. Drought has a profound effect on primary producers – the 2007-2008 drought cost around $2.8 billion in lost production.

Water security in regions such as Marlborough, Hawke's Bay, Waikato and Northland will be affected by warmer temperatures and increased evaporation, and existing pests and diseases might be expected to spread as conditions become more favourable. New pests and diseases could also establish.

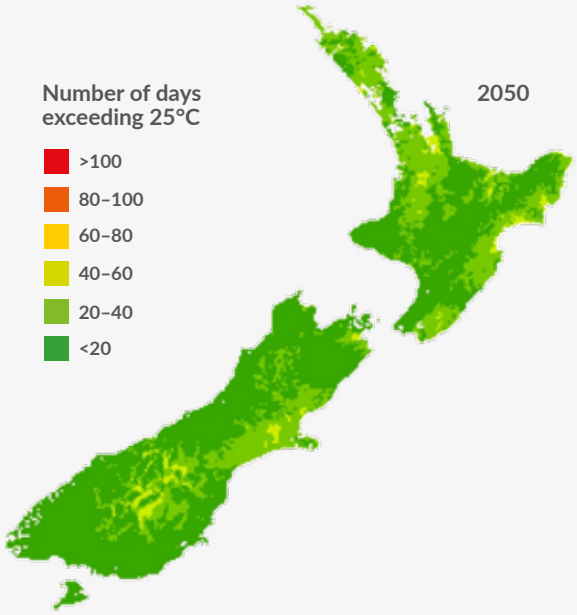


Figure 1: Estimated number of days with maximum temperatures exceeding 25°C for mid-21st century (~2050)
Source: Royal Society of New Zealand (2016)

All cattle have an optimal environmental temperature range. Beyond that range (estimated at around 25°C) they suffer a number of negative responses, such as reduced intake and milk solids production, and difficulties in conceiving. By the 2040s, under a mid-range emissions scenario, the number of such days in the Northern Bay of Plenty, for instance, are likely to nearly double to 42 a year (see *Figure 1*).

As climate patterns shift, most sectors of the primary industry – meat and wool, dairy, arable, horticulture, viticulture and forestry – will experience changes in productivity, profitability and management. They will also experience more frequent severe weather. These changes will test the adaptability of farmers and could shift production zones within New Zealand.

International policy – losses and gains

New Zealand farmers will also be affected by international climate policy, which will have important implications through the global trade in food and livestock products. Many of those global responses, some of which are already being implemented, bring potential gains (but also risks) to our farmers.

Some policies, such as past US legislation to boost biofuel production, had a positive effect on our economy through increased international food prices arising from the introduction of subsidies and mandates that diverted corn used as an animal feed into ethanol production. Likewise, overseas policies to limit deforestation (and reward afforestation) will constrain land clearing for food production, and could therefore increase commodity prices. The Inter-American Development Bank has stated that deforestation bans in Latin America and the Caribbean could strip US$12.7 billion worth of agricultural production from those regions by 2030.

If other countries were to move towards actively constraining their agricultural GHG emissions this could also benefit New Zealand via increased global commodity prices. Since agricultural production in this country is less GHG intensive than in most other countries, model studies suggest that it is better for New Zealand if everyone mitigates agricultural emissions than if no-one does because this would enhance our competitive advantage.

However, it is not just hard costs that will influence New Zealand's fortunes. Consumer preferences may well play an important role. Low carbon branding offers opportunities and risks. New Zealand is recognised internationally as being a highly efficient producer of livestock products, but these products themselves tend to produce more GHGs per unit of protein and energy than plant-based products.

What are we doing to reduce agricultural GHGs?

The implications of climate change go beyond dealing with changes in the weather. Agriculture is the largest contributing sector to New Zealand's GHG emissions (49%), compared with an OECD average of about 12%. Agricultural emissions comprise mainly methane and nitrous oxide emissions arising from livestock farming. On a global scale, however, this country's total emissions are small – New Zealand produces less than 0.2% of total global GHG emissions.

Under international agreements New Zealand has committed to reducing its emissions to 5% below 1990 levels by 2020, and 30% below 2005 levels by 2030 (this equates to 11% below 1990 levels). The 2030 target will be a challenging target if agriculture does not contribute. Currently, the agricultural sector does not have any obligations under the domestic emissions trading scheme (ETS), but this could change as the newly-formed New Zealand Interim Climate Change Committee has been asked specifically to consider agriculture and the ETS.

Current situation

New Zealand farmers are already demonstrating part of the solution to limit climate change. On average, GHG emissions per unit of meat or milk on-farm produced have dropped by about 1% per year for at least the past 20 years. In technical terms, the 'emissions intensity' (emissions per unit of product) has decreased, because farming has become more efficient. Improved animal genetics and management, combined with better grassland management and feeding practices, means that farms are using resources more efficiently to increase their outputs.

However, the rate of decrease in emissions intensity has not been matched by a similar decrease in New Zealand's *total* agricultural GHG emissions. Total agricultural emissions in 2016 were 3% below those estimated for 2005, and this is simply because overall agricultural production has grown in response to international demand.

Without the efficiency improvements achieved by New Zealand farmers, total GHG emissions from agriculture would have increased by approximately 40% since 1990 to deliver the same amount of product (see *Figure 2*). Latest projections indicate that emissions would not increase

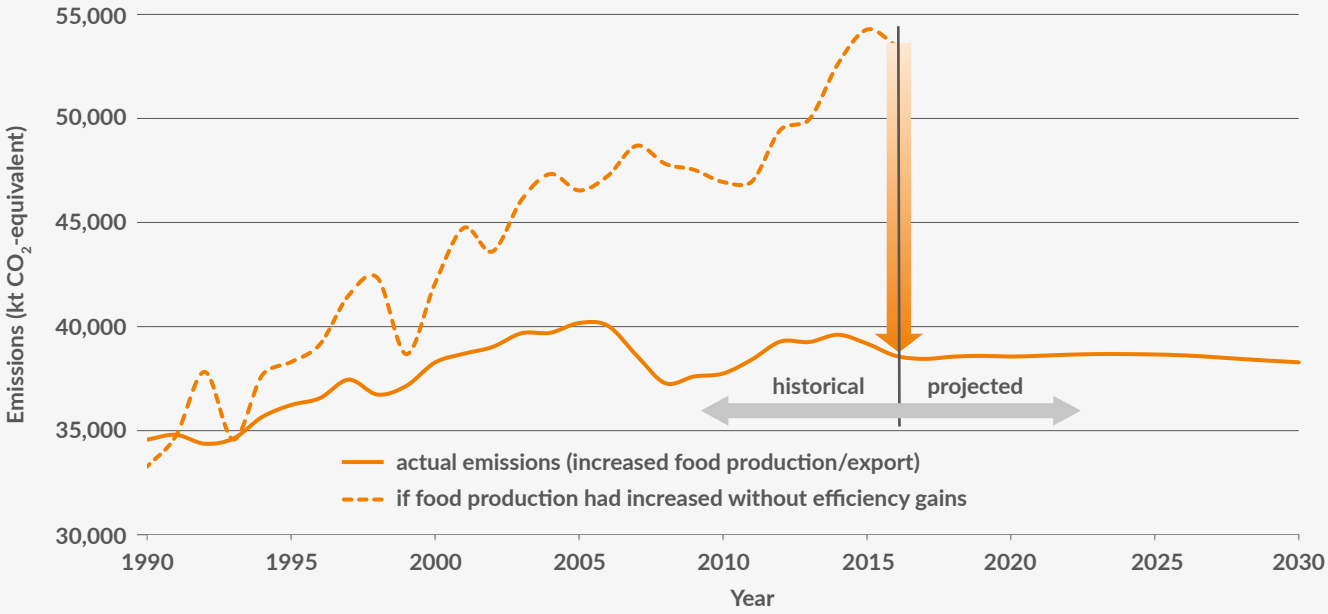


Figure 2: Overview of New Zealand's actual and projected agricultural greenhouse gas emissions from 1990 to 2030
The solid orange line shows greenhouse gas emissions from agriculture in the past (1990–2016) and projected for the future, including changes in production and on-farm efficiency gains. The dotted orange line shows where emissions would have been in 1990–2016 if farmers had increased their production but had not made any efficiency gains

Under international agreements New Zealand has committed to reducing its emissions to 5% below 1990 levels by 2020, and 30% below 2005 levels by 2030 (this equates to 11% below 1990 levels). The 2030 target will be a challenging target if agriculture does not contribute.

further, reflecting a balance between declining animal numbers and increasing performance per animal. However, decreases in emissions intensity are unlikely to be enough on their own to bring about substantial reductions in absolute emissions, given the generally positive international trading situation for livestock products.

As a responsible global citizen, and because our biological systems and economic interests benefit from a stable climate, New Zealand can be expected to contribute its fair share to the global effort to reduce GHG emissions and the risks from climate change.

At the moment, farmers can reduce their emissions intensity further by continuing to adopt good management practices and making additional efficiency gains as fast as possible. Since most of this country's agricultural GHG emissions are related to production for export, there is an active debate about where New Zealand should focus its efforts:

- Reducing absolute emissions (which is difficult without limiting total production), or
- Reducing emissions intensity without constraining production and absolute emissions (if we don't produce it someone with a higher GHG footprint will).

In an ideal world farmers would have the tools to do both.

Developing new mitigation solutions

Government, industry and researchers are making a concerted effort to develop practical new tools to help reduce emissions intensity and total emissions without curtailing production. This effort is driven jointly by the government-funded New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) and the industry-led, industry/government funded Pastoral Greenhouse Gas Research Consortium (PGgRc). Methane emissions from livestock, which comprise around 75% of agricultural emissions, are a major focus and the four main avenues of research are described below.

Breeding low methane-emitting sheep and cattle

Research has found that some animals emit less methane than others and that this trait can be passed on to their offspring. Based on data obtained to date, sheep selected for their low emission traits are ~5% lower than the average industry animal. These naturally low-emitting animals appear to be as productive as average animals, so there would be no direct financial penalty from selecting these sheep.

There is still an opportunity cost, however, since adding this additional breeding trait lowers the rate of gain in achieving other breeding objectives. The sheep industry is now trialling low-emitting sheep with a small group of elite breeders. Work on breeding low-emitting cattle is still at an early stage and is held back by the difficulties in accurately identifying low-emitting animals at a reasonable cost.

Low methane feeds and feed additives

The type of feed influences methane emissions, but making major changes to the diet of New Zealand's ruminants is

Increased farming efficiencies contribute to reducing agricultural GHGs

difficult. Our highly efficient farming systems are based around exploiting our natural ability to grow large quantities of highly nutritious pasture. Even our most intensive dairy systems still rely heavily on home-grown pasture.

Brassicas have been tested extensively in sheep in New Zealand and forage rape has consistently reduced methane emissions by 20-30% when fed as a full diet. However, the area grown is small and it is a minor component of the diet for most animals, so the impact on emissions is minimal. Preliminary studies with fodder beet have shown a reduction in methane when fed at >75% of the diet. However, the consequences of feeding fodder beet at such high levels need to be studied further.

Methane inhibitors

Researchers are looking for animal-safe compounds that suppress the methane-producing microbes in the rumen, and thus reduce overall methane emissions from animals without side effects. An inhibitor suitable mainly for feedlot animals has been successfully tested in long-term trials overseas, where it has been shown to reduce methane emissions by 30%. This inhibitor is being developed by the Dutch company DSM, with commercial release planned by 2019.

However, the effectiveness of this inhibitor is likely to be much reduced in New Zealand as the current formulations are designed for systems where it can be fed daily with every meal. DSM are, however, actively exploring formulations suitable for grazing animals. A New Zealand-led programme of work has also made substantial progress in identifying compounds that work at very low concentrations and hence are suitable for slow release delivery systems. These compounds have successfully reduced emissions in short-term animal trials and are currently being refined.

Methane vaccines

New Zealand scientists are working to produce a vaccine that stimulates the animal to produce antibodies that suppress key methane-generating microbes in the rumen of livestock. Prototype vaccines have demonstrated that they can generate antibodies that alter the microbial populations and methane production in laboratory studies. A comprehensive programme of testing is underway to identify vaccine formulations that can be shown to achieve substantial methane reductions (>20%) in sheep and cattle.

Summary

New Zealand livestock agriculture will be impacted by climate change. As a major agricultural exporting country, the global impacts of climate change and climate change policies will also have implications for the future prosperity of New Zealand farmers. Farmers, through their existing efforts to increase the efficiency of production and the resulting reduction in emissions per unit of product, are already making a contribution to reducing the production of agricultural GHGs. However, reductions in emissions per unit product may not be enough on their own to reduce absolute emissions. Domestic and international research is underway that, if successful, will give New Zealand farmers the tools to allow them to reduce absolute emissions below their historical levels.

Harry Clark is Director of the Grasslands Research Centre in Palmerston North. Email: harry.clark@nzagrc.org.nz.

KEITH WOODFORD

SHORT AND LONG-LIVED GREENHOUSE GASES NEED DIFFERENT ACCOUNTING SYSTEMS

Keith Woodford explains why methane and carbon dioxide need separate accounting systems rather than being aggregated into a 'catch-all' single emissions trading scheme.

Methane accounting

A key issue for New Zealand is how to meet the 2015 Paris Agreement commitments for greenhouse gas (GHG) emissions. Fundamental to any analysis is the different attributes of long-lived and short-lived gases. In particular, how should methane be accounted for, and how should it be brought into any emissions trading scheme (ETS).

Back in 2016, the current Commissioner for the Environment Simon Upton raised the importance of placing short-lived gases in a different regulatory 'basket' from long-lived gases (see www.rmla.org.nz/2018/02/21/managing-biological-sources-and-sinks-in-the-context-of-new-zealands-response-to-climate-change-2/#_ftn13). Remarkably, our rural leaders appear to have failed to pick up on the importance of this issue.

More than any other country in the world, New Zealand's gross emissions are influenced by methane-producing ruminant animals. No other developed country has a comparable emissions profile, with the arguable exception of Uruguay. Accordingly, the issue of methane accounting, which is crucial to us, really does not matter to almost everyone else so no-one else will lead on this one. It is up to New Zealand to lead the debate.

Stocks and flows of various gases

At the heart of the issue is the concept of stocks and flows of the various gases. In the case of methane from all New Zealand sources, but predominantly ruminant agriculture, the flow of emissions into the atmosphere is now lower than 20 years ago, having peaked in 2006 at 35,915 kt of CO_2e, declining to 33,784 kt of CO_2e in 2016 (see www.mfe.govt.nz/climate-change/state-of-our-atmosphere-and-climate/new-zealands-greenhouse-gas-inventory).

For those who like bathtub analogies, in the New Zealand methane bathtub the tap and the plughole are roughly in balance. For the CO2 bathtub, the tap keeps flowing at a fast rate while there is still only a dribble coming out the bottom.

The other key metric for determining the net flows and pools of methane is that the atmospheric residence time of methane is 12.4 years (calculated as a logarithmic decay function). This is the average amount of time that a methane molecule remains in the atmosphere before being converted back to CO_2.

Bringing these metrics together, the current situation for methane from all New Zealand sources (but largely pastoral agriculture) is that the amount of methane entering the atmosphere is approximately equivalent to the amount that is leaving via conversion to CO_2 and then back into grass and related feeds via the carbon cycle. Given that inflows roughly match outflows, then atmospheric heat sources are being lost approximately as fast as they are being gained. The quantity of methane in the atmosphere is therefore staying much the same.

In contrast, CO_2 is largely a stock resource. Every time we produce more CO_2, mainly from burning fossil fuels, it stacks up in the atmosphere in amongst all the CO_2 that is already there. It takes some hundreds and even thousands of years for the extra CO_2 to be dissolved in the oceans or converted into inert forms, such as new coal or oil.

This means that if we keep burning fossil fuels at the current rate, then atmospheric levels of CO_2 will increase. Even if we reduce the burning of fossil fuels, the stock of CO_2 in the atmosphere will still increase. Also, even if we stopped all use of fossil fuels, then it would probably be many decades before we would see a meaningful decline of atmospheric CO_2.

And there lies the nub of the issue. Methane from ruminant nutrition is essentially a flow resource, which flows in and out of the atmosphere, while CO_2 is a stock resource that keeps on building up.

For those who like bathtub analogies, in the New Zealand methane bathtub the tap and the plughole are roughly in balance. For the CO_2 bathtub, the tap keeps flowing at a fast rate while there is still only a dribble coming out the bottom.

These concepts of stocks and flows are embedded within modelling techniques called system dynamics. Developed originally in the 1960s by an American Jay Forrester, I used these techniques within my own PhD a long time ago. I used them in a biological context, although the principles are the same as is needed to model the stocks and flows of GHGs.

A mostly unrecognised issue

The recognition that short and long-lived GHGs need to be considered differently has escaped both policy-makers and the general public. Our current Commissioner for the Environment stands out for his recognition of the issue, but he has largely been a voice in isolation.

In contrast to the public and the policy-makers, the importance of choice of accounting metric is understood within at least parts of the scientific community. This is clearly laid out in Chapter 8 of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). However, these important issues do not get carried forward to the report summary for policy-makers, and almost no-one but a few career scientists would read the full document, which is some thousands of pages.

Counter arguments

There are two key counter arguments. The first argument is that the carbon equivalent system already takes into account the short-lived gas effect. The answer is that it does indeed do so in terms of comparing the gross emissions over a 100-year period, and this includes an allowance for the fact that these same methane molecules are also departing from the atmosphere over that time. But it does not take account of the net emissions (inflows versus outflows) and hence the stock of methane that is occurring at any point in time. In other words, it does not measure the amount of water in the bathtub, yet it is the amount in the bathtub that determines the heating effect at any point in time.

To reinforce that point, what the current measurement system does not do is allow for the fact that methane does its damage quickly and then goes away. In contrast, whatever damage CO_2 does is long, drawn out and irreversible.

There is also a remarkable assumption buried within the current measuring system that we are only interested in global warming potential (GWP) for the next 100 years, which is called the GWP100. This means that we effectively capture all of the methane effects, but miss most of the CO_2 effects, because these relate to beyond 100 years.

If we were to measure the relative effects of methane and CO_2 over a 500-year time period, then we would be saying that whereas each methane molecule equates to about 28 molecules of CO_2 within the GWP100 (the current best estimate), then that number is reduced to around eight CO_2 molecules using a GWP500. I first wrote about those issues back in 2006 (*Primary Industry Management* 9(1): 7-8). There are, of course, considerable uncertainties relating to all of these numbers and all GWP estimates are likely to change again in the future.

Rural leaders must come to grips with the underlying GHG science and associated GHG issues. There is also a role in all of this for rural professionals. A key starting point is to accept that methane does indeed have warming potential for the period it is in the atmosphere.

The second argument is likely to be around the issue that there has been a 2.5-fold increase in global concentrations of methane in the atmosphere since the pre-industrial era. Clearly, it would seem, something needs to be done.

However, what also needs to be recognised is that on this global scale, unlike in New Zealand, most of the methane has nothing to do with ruminants. Reducing methane leakage from oil and gas fields would be a good place to start. Another reduction focus could be from landfills and associated wastes, plus wastewater, which jointly contribute about 20% of the world total. Rice paddies are also a major source, but there is no current or likely solution to that issue.

A fundamental issue with most of these other sources is that, unlike New Zealand ruminant agriculture, the gross emissions tap has continued to run faster. If this tap were turned down, then global warming from methane would also soon decline.

Rural leaders and rural professionals GHG aware

Within the current context of the Paris Agreement, agriculture emissions are indeed important and that includes methane. Also, agriculture produces another gas called nitrous oxide and this is a long-lived gas. So, in a world that is worried by climate change, regardless as to one's perspective about the science of global warming, agricultural industries, along with others, do have to step up to the table. Or as one rural leader recently put it, if you don't come to the table then you will undoubtedly be on the menu.

In stepping forward to the table, rural leaders must come to grips with the underlying GHG science and associated GHG issues. There is also a role in all of this for rural professionals. A key starting point is to accept that methane does indeed have warming potential for the period it is in the atmosphere. From there, the key issue is that the most insightful metric is the stock of any gas and how that changes over time. It is all about stocks and flows.

Keith Woodford was Professor of Farm Management and Agribusiness at Lincoln University for 15 years through to 2015. He is now Principal Consultant at AgriFood Systems Ltd. Email: kbwoodford@gmail.com.

DORIAN GARRICK

GENOMICS AND ITS APPLICATIONS IN PRIMARY INDUSTRY IMPROVEMENT

The application of genomics has changed the manner in which populations of dairy cattle and laying hens are improved. Professor Dorian Garrick describes some recent developments in genomics that he routinely applies in his research to improve food production systems.

AgResearch in New Zealand has lead the world in genomics research in sheep

The genome

A typical livestock or mammalian genome is diploid, which means it consists of two complete paired sets of chromosomes, plus two sex chromosomes, with one set inherited from the sire and the other from the dam. Each chromosome is made up of a DNA strand formed by a sequence of about 100 million nucleotides or base pairs.

A complete set of chromosomes inherited from one parent includes about 2,500 to 3,000 million base pairs, so there are about six billion base pairs in a single diploid copy of the genome. Only about 1% to 1.5% of those base pairs comprise the genes which are identified by a specific sequence at their start and end. In the typical livestock or mammalian genome there are around 25,000 genes. The remaining sections of the genome between the genes are called intergenic regions. Genes contain the information required for the production of proteins.

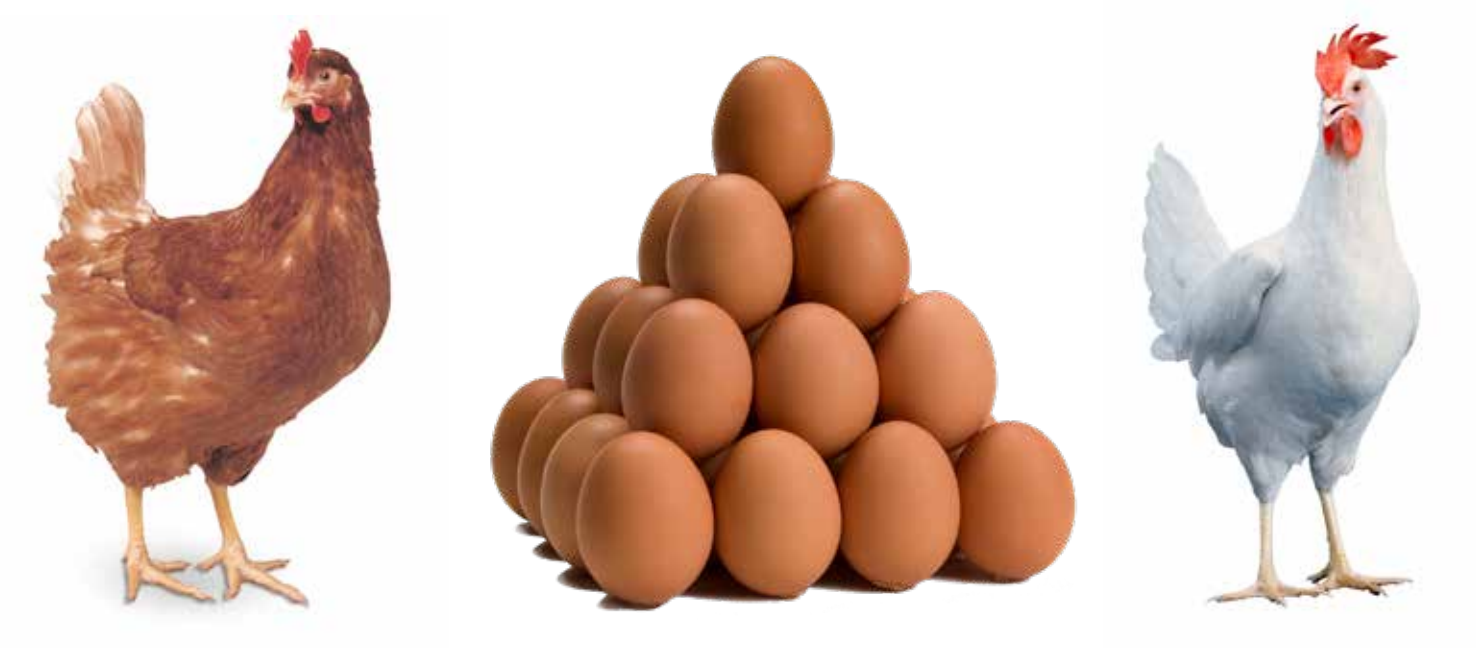
Proteins are sequences of 20 standard amino acids, and the DNA contains information on that sequence based on the triplet code that maps the 64 combinations of three nucleotides to the 20 amino acids. Cell divisions that occur during reproduction (meiosis) or growth (mitosis) require copying of DNA sequences. The copying process is not perfect and numerous errors, commonly referred to as mutations, are made on every chromosome.

All of these mutations may then be subsequently passed on to later generations if they are present in the germ line cells, e.g. in testicular or ovarian tissue. Given that mutations have been occurring and have been passed on over numerous ancestral generations, it is not surprising that every individual inherits a great many of these from their sire and a great many from their dam.

The details can vary widely between species. The typical livestock genomes (including for cattle, sheep, and pigs) are quite similar to the human genome, but have different numbers of chromosomes. Plant genomes can be much more diverse, and can have four or more sets of polyploid chromosomes, rather than the paired diplod sets in animals and birds. Plant genomes often contain significantly more genes than the typical mammalian genome.

Genomics

Genomics is the science involved in studying the genome. The genome is an organism's complete set of DNA, including all of its genes. Genomics differs from genetics in the sense that it is all encompassing – genetics might refer to the study of just a single gene, whereas genomics extends to all the genes and to their interactions. Molecular geneticists study the structure and function of genes from a cellular, molecular or biochemistry perspective, whereas quantitative geneticists study genes from a phenotypic (i.e. based on observed physical measurements) or a population viewpoint.



Brown and white laying hens are improved using genomic prediction

The technological developments that have spawned the rapid growth of genomics across a range of species and applications in our primary industries include many discoveries in a wide range of disciplines.

Animal and plant breeders have tended to be trained in quantitative genetics with a strong emphasis on statistics and are tasked with using knowledge of genetics and biology to improve populations. These various disciplines now interact much more closely given the technological advances, particularly in whole genome sequencing and genotyping, that have allowed scientists to simultaneously examine information about the entire genome and also due to its common form for which many methods can be applied across species.

There are other fields of 'omics' that are closely related to genomics and have become popular over the last decade or so:

- Transcriptomics, which studies the transcripts of the genome (such as ribonucleic acid or RNA) and often the entire transcriptome of a cell, tissue or organism
- Proteomics, which studies the structure, function and interactions of all the proteins produced by genes in a particular cell, tissue or organism
- Metabolomics, which includes all metabolites or chemical fingerprints that are left behind by cellular processes.

Whereas genomics is often interpreted in the context of the host genome, i.e. the livestock animal itself, there are also other branches of genomics that focus on the microbiome, the vast army of microbes that are part of the community of every individual animal. Going further, scientists might focus on the rumen microbiome, the respiratory microbiome, the faecal microbiome, or the microbiome of the reproductive tract. Whereas these 'biomes' were once thought to compromise host performance, we now know that microbiomes are a critical part of the community of organisms that are required in every healthy human or livestock subject.

There is also the field of phenomics, which involves the study of the quantitative and qualitative physical and biochemical traits in a particular organism so as to refine the definition of phenotypes.

Advances in genomics technologies

The technological developments that have spawned the rapid growth of genomics across a range of species and applications in our primary industries include many discoveries in a wide range of disciplines. Most of these have been underpinned by massive public and private investment in studies of human disease and personalised medicine. These discoveries have transformed our abilities in at least five areas:

- *DNA handling* – development of methods for analysing small quantities of DNA, including cutting or copying it. One of the major enabling inventions was the polymerase chain reaction (PCR) that mimics cellular processes to amplify specific regions of the genome
- *Sequencing* – current methods for sequencing begin by breaking DNA into libraries of small sequences, and then reading the library contents over small distances at one or both ends. New methods of sequencing allow for much longer read lengths or for the library fragments to be locally bar coded so that a new reference sequence can be constructed from each individual. Sequencing is still very challenging in large genomes, i.e. many plant species. The newest

Livestock Improvement Corporation (LIC) researchers used genomics to identify mutations associated with hairy and slick coats

approaches to sequencing allow us to separately align the mutations on the maternal and the paternal chromosomes in a process known as phasing

- *Multiplexing* – this refers to the simultaneous or parallel conduct of an assay (or test). Multiplexing is now routine in sequencing and in genotyping. In sequencing, the contents of many of the fragments in a DNA library are sequenced in parallel. In genotyping, the presence of particular single nucleotide polymorphism (SNP) can be interrogated at a million loci in parallel. A common genotyping assay used in livestock would interrogate 50,000 SNP (50K) on as many as 96 individuals in a single analysis. Developments in multiplexing have meant that many more individuals can be processed for the same cost, and the time taken to run the analyses is a fraction of what would otherwise be the case
- *Informatics* – this refers to the process of turning data into knowledge. There have been a number of huge improvements in informatics as a result of developments in genomics. Web accessible databases have been created to store and share data and results. Reference genomes, libraries of known mutations, annotations of genomes and databases of disease-gene associations have all been created and are regularly updated. Tools have been developed for comparative genomics across species, which are very helpful for those working on poorly represented species
- *Gene editing* – this refers to the process of making precise edits to a genome, in a similar manner to what might be done with a search and replace tool on a computer. Gene editing allows DNA to be broken at specific locations in terms of nucleotide sequence. Cell repair mechanisms will identify and repair the break, but can be encouraged to make the repair in a particular manner so that one or more nucleotides might be substituted, or some nucleotides deleted or inserted.

Applications of genomics technologies to improve primary production

The use of genomics for industry improvement varies widely by species for two reasons. First, the tools are better developed in some species, such as cattle, that have been more widely studied than other species, such as goats. Many of the less studied species do not have reference genomes which indicate the compete genome sequence of a reference individual.

The extent of genomic annotation of the sequence, which can include the location of genes, the tissues in which they are active, and their roles, varies widely by species. Sequencing new individuals can identify previously unknown mutations, and some species like cattle have had thousands of individuals from many different breeds sequenced. This means that databases that report the known mutations are much more complete in some species than in others.

Second, the value proposition for applying genomics varies widely by species. Commonly-farmed species enjoy economies of scale where higher demand for genomic tools has made pricing much more competitive. This is true for cattle, chickens and pigs, but not for sheep or goats. Applying genomics to new species, such as ryegrass, manuka or *Pinus radiata*, may require substantial investment and development work just to produce tools that are already in the public domain for other species like cattle. Further, the business models for capturing value from existing genetic improvement in order to invest in promising applications of genomics varies widely by species. It is best in species such as dairy cattle, laying hens and maize, and poorest in species like beef cattle and ryegrass.

Commercial use of genomics

The most widespread routine use of genomics would be in the form of routine genotyping, mostly undertaken

Beef and lamb genetics is researching the use of genomics to improve maternal cow productivity

using multiplex SNP panels. Common applications are to test whether a selection candidate is a carrier or is free of some known undesirable recessive allele, such as those that cause inherited diseases or embryonic failure. Virtually every individual is a carrier of at least one undesirable recessive allele, but most of these alleles are at very low frequency in the population, so few if any offspring would demonstrate the undesirable phenotype. However, every individual that is widely used will result in its rare alleles becoming much more common in the next generation. Subsequent wide use of any descendants may then result in a recessive defect being discovered if it is not already known, and that defect may then benefit from routine testing.

Parentage testing is easily done with large SNP panels

An offspring cannot normally inherit two copies of any particular allele if either of its parent carries two copies of a different allele at that locus. Counting the number of loci for which a putative parent-offspring pair have opposite homozygous alleles allows rejection of impossible pairings. Given enough SNP markers, e.g. 50K, there will often only be one possible parent-offspring match in beef cattle applications.

Genomic prediction using marker variants

Many of the complex traits that are of interest in primary production are polygenic, being controlled by many genes. The net effect on offspring performance of all the superior and inferior alleles carried by an individual is known as its breeding value (BV). Selection to improve all our livestock species and some of our plant species has been conducted based on estimates of breeding values (EBVs) that have been predicted using pedigree and performance information on the selection candidate and its relatives.

Pedigree relationships are useful for determining the proportion of their genomes that relatives are expected to share. For example, a non-inbred individual is expected to share 25% of its genome with its grandparent, and two full siblings are expected to share 50% of their genome in common. In practice, some will share a little more than was expected, whereas others will share a little less. Genomic information such as that determined from an SNP chip can be used to compute genomic relationships that capture this departure and will provide more accurate EBVs, particularly in young individuals that have yet to be observed for a phenotype of interest. The most appealing traits for genomic prediction are those that are difficult or expensive to measure.

In New Zealand, genomic prediction is widely used in dairy cattle improvement, to a lesser extent in sheep and beef cattle, and is a subject of intense interest in other industries such as tree breeding and ryegrass improvement.

Genome wide association study (GWAS)

An association study involves an analysis that estimates effects, or tests for significance, of markers spanning the genome. These may be done one marker at a time, or by simultaneously fitting some or all markers. It can be an effective method to determine any genomic regions with major effects on variation of a trait, even at relatively low densities like 50K which are only a fraction of the number of sequence variants. The results of GWAS identify genomic regions with large effects that are known as quantitative trait loci (QTL), and this information is of interest for determining positional candidate genes that might underlie traits of interest. Published QTL are available online, characterised by species, trait and genomic location. A GWAS is often the first step in trying to identify causal mutations and it represents a phenotype-first approach to determine causality.

Gene editing is a technology that is sadly under-represented in New Zealand research, due to its enormous potential to positively impact the environmental, sustainability, welfare and production aspects of our ecological and primary production systems.

Sequence

The use of next-generation sequencing of widely-used individuals or lines is a common practice for two reasons. First, it provides base information as to the variants that exist in a population by characterising pre-existing variants. These variants can then be used for GWAS to try and find causal variants that influence the risk for disease. Second, pedigree data can then be used, for example, to verify if predicted harmful variants are under-represented or absent in certain ways, as this may indicate in an embryonic failure or some other reduction in fitness of the animal. Many harmful variants for reproduction have been discovered using this sequence-first approach.

Genomic prediction using causal variants

It is generally anticipated that genomic prediction will be more accurate, particularly across families, breeds or admixed lines, if causal variants rather than just associated markers were used in the genomic prediction. A number of projects in New Zealand, including some that comprise Genomics Aotearoa, are aimed at improving genomic predictions by identifying causality using sequence variants in GWAS.

Research use of genomics

Genomics is being rapidly adopted for research studies, leveraging genotyping and sequencing activities that were undertaken for commercial purposes of selection, or sometimes simply to improve our understanding of traits of interest. Sequencing of DNA allows us to characterise variants, and global endeavours are focusing on sequencing one or more individuals from every genus, then every species, to better understand evolution.

Gene annotation of livestock genomes is a research activity that is currently being implemented by an international consortium. Commercial interest tends to focus only on genes that are of immediate interest, whereas researchers are interested in annotating every gene, and all the tissues and stages of life in which it is active. One reason is that in future it might be possible to detect early stages of cancer from an omic analysis of a blood sample, or to predict a young cow that is more likely to resist disease and enjoy a longer life by measuring attributes in its blood.

Gene editing is a technology that is sadly under-represented in New Zealand research, due to its enormous potential to positively impact the environmental, sustainability, welfare and production aspects of our ecological and primary production systems. In agriculture and horticulture it can demonstrate causality of suspected variants, and then be used for quickly producing individuals with combinations of variants that would otherwise be significantly time-consuming and expensive to produce using conventional methods.

It can also be used to produce new mutations and these are of interest to produce, for example, individuals with greater disease resistance, better welfare or reduced environmental impacts that result from greenhouse gases released into the atmosphere or urinary urea deposits that leach into our waterways. Specific examples include short-tailed lambs that do not require docking, and resistance to facial eczema, or more generally other diseases that threaten our biodiversity, such as myrtle rust or kauri dieback. Other than wide-scale use of poison such as 1080, gene editing also probably provides the only practical option to massively reduce our populations of pests and predators. However, such activities are not possible without significant research being undertaken to identify and verify gene editing targets.

Conclusions

Our primary production industries are all complex systems, and we have considerable opportunity to improve them for environmental, welfare, cultural, productive or economic reasons. An age-old approach was to simply change one or more components and hope for the best. In recent decades, we have focused more on understanding the inputs and outputs and developing tools that enable predictions of outcomes based on given inputs. This enables identification of a few strategies and specifically which components need to be changed so that favourable net benefits will result.

Such an understanding has been limited by our inability to measure and characterise the fundamental processes that underlie system performance. Developments in genomics are now allowing us to gain insight into those fundamental processes, and that will provide us with a much better means of changing our systems so that they are improved without the same level of unintended consequences we have suffered in the past.

However, most funding requires a well-defined business case and for these activities this can be difficult to achieve. In addition, a largely uninformed sector of the public would rather not provide social licence to do this work. Collectively, this means that New Zealand will rely mostly on offshore developments to provide leadership for our genomic activities, and understandably such developments will not have New Zealand's primary interests at the forefront.

Professor Dorian Garrick is Chief Scientist at the AL Rae Centre of Genetics and Breeding in the School of Agriculture at Massey University. Email: d.garrick@massey.ac.nz.

NZ Institute of Primary Industry Management

2018 NATIONAL CONFERENCE

SKY CITY HAMILTON, MONDAY 6TH AND TUESDAY 7TH OF AUGUST

Among the highlights of the conference programme we consider the national roll-out of FEPs and rural professionals' role in the development of these on-farm. We will also be taking a high-level overview of policy developments on greenhouse gas emissions and what this means to the farming community with a presentation by Nick Tait of DairyNZ. This will be followed by a presentation by Stuart Orme of Woodnet on how to extract greater value from trees under the ETS and how can farmers best optimize carbon credits. Along with sector updates on the sheep milking and avocado industries, John Quinn of NIWA will demystify what is meant by swimmable rivers and discuss what is achievable.

The following day includes a presentation by Chris Morley who will reflect on what has occurred with *M.bovis* and discuss the importance of risk management policy/ protocols for on-farm bio-security. We will also be exploring future opportunities in plant breeding and improvements in animal genomics with presentations by Derek Woodfield (PGG Wrightson) and Dorian Garrick (Massey University) respectively.

Once again we will be running concurrent sessions: Business & Governance session will look at upcoming trust law changes (Glenda Graham); facilitated on-farm succession and governance workshop; and develop an expanded understanding on factors for success for farmers accessing off-farm capital (Ross Verry). Our Technical session will look at how to create greater appetite for the uptake of technology by the farming community (Bridget Hawkins); RMPP will outline its aspiration and goals for its action network; and finally there will be a paper on ClearTech turning 'green to gold'.

Well-known agricultural journalist, Tony Leggett, will look at the changing nature of rural publications and will discuss new methods and mediums of communicating with farmers. This will be followed by a session with Simon Sankey (DairyNZ) on how rural professionals can be more effective in encouraging and sustaining the uptake of new ideas with their farming clients. Justine Kidd will discuss how farmers can effectively manage a team of consultants and rural professionals within a farming enterprise and have them 'play nice'.

FOR MORE INFORMATION ON THE CONFERENCE, PLEASE CHECK OUT NZIPIM'S WEBSITE (WWW.NZIPIM.CO.NZ) OR CONTACT ADMIN@NZIPIM.CO.NZ | 04 939 9134

BEN ALLOMES

REDEFINING THE LABOUR MARKET IN THE DAIRY INDUSTRY – WHO ARE OUR CUSTOMERS REALLY?

A change in mindset led dairy farmer Ben Allomes and his team on a journey to understand their own respective needs. What they discovered was an opportunity to not only get the job done better, but to revolutionise their labour structure. For his business, they found that their staff were their customers and their greatest asset.

Charlotte Oram inspects silage quality with Nick Bailey as part of the practical skills programme run on-farm

Creating the right culture is important in building the team

Creating a customer-centric model with our employees at its heart, understanding their needs, and developing a system that works for them (whether they want to strive for farm ownership or settle into a career on-farm) is essential.

Uncertain times ahead

As a sector, agriculture (and particularly dairy) is potentially facing its most uncertain time since Rogernomics and the removal of supplementary minimum prices (SMPs) in the 1980s. The uncertainty this time, however, is not related to the removal of a direct market in the UK, rather it is about the recognition and reduction of a less direct subsidy – the environment and our people. The pioneering days of our seemingly ever-expanding dairy industry are over and we are reaching a period of maturity and consolidation. This has been brought about by the recognition of our farmers and the wider community of the impact our industry has had on both the environment and its people.

The recently refreshed Dairy Industry Strategy goes a long way towards defining a new future, as it focuses on what we can do on-farm and near-farm to ensure our operating models are fit-for-purpose. What it cannot do, however, is predict what the world environment will be like because of issues such as climate change, social change, government policies, alternative protein sources, competing land use and changing rules.

Our 'right to farm' is also being challenged by a newly-engaged public and we cannot predict where this will end. It is our responsibility to be good corporate and community citizens and we need to step up to the plate. Some farmers are therefore leading a transition to new operating models, focusing on continuous improvement while waiting for science, technology or both to catch up with what they need to succeed.

Redefining our labour system

On-farm labour has historically not been done well in our dairy system, although we have come a long way from the one weekend off a month days. Times, attitudes, rules and expectations are changing and we need to not only keep up with societal expectations but get ahead of them. Failure to do this is not only inefficient, it also damages our reputation. Our dairy industry has been grown as a result of the drive and passion of its people and their willingness to sacrifice lifestyle in the pursuit of building equity. It now needs to change to meet the needs of all employees.

Our future stands in redefining our labour system. Creating a customer-centric model with our employees at its heart, understanding their needs, and developing a system that works for them (whether they want to strive for farm ownership or settle into a career on-farm) is essential.

Partial employment model

Moving forward, with a tightening labour market and signals of increasing wages looming, competition is getting stronger for the right people. With near-record employment levels a new term is emerging from the current government called 'partial employment'. Partially employed people are those in our communities who are looking for work but cannot commit to be full-time because of personal circumstances.

The traditional dairy model of 50-60 hours per week cuts our potential labour market down considerably and in the past we have reached to immigration to fill this gap. With this disruption, it is now time for us to look at changing our model, broaden our potential labour market, and make better use of the people who already live in our communities.

Future-proofing on-farm systems

We operate a 1,000 ha, 1,350 cow multi-property dairy and beef business including sharemilking, equity and lease

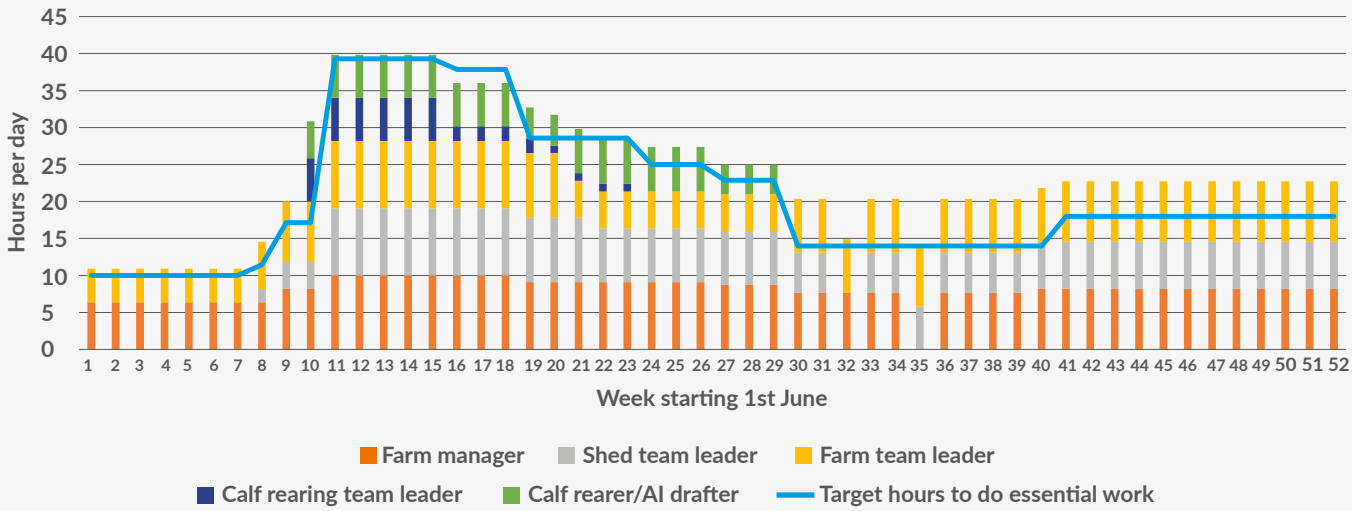


Figure 1: Labour demand versus supply – we budget on 8,000 hours per year and analysis has shown efficiencies of up to 1,000 hours can be achieved

One routine change following our analysis saved one hour per milking, and when that is timed by four staff we save four hours a day.

arrangements, and employ up to 17 people depending on the time of the year. Over the last three years our business has undergone a series of strategic changes to de-risk and simplify operations.

One such change is around how we interact with our people. Tired of the risk of losing people and filling key positions by trying to put 'square pegs in round holes', coupled with the recognition that if we choose to farm for the 'lifestyle' then why couldn't our people do the same, we set about embedding a fundamental change in mindset.

We asked ourselves, 'What if our team was our customer – what would we do differently to ensure they have the best experience they can while working for us?' We then developed a now fundamental question for our business: 'How can we meet the needs of our team so they can thrive and strive for excellence within our business while achieving their personal goals?'

With this question in mind, in the 2016/17 season we started an HR trial on our larger 800 cow equity partnership farm, Hopelands Dairies. We set about researching and understanding the needs of our current team and those in our wider community to develop a fit-for-purpose HR model that de-risked our business and better met the needs of our business and community. This led to us redesigning our HR policy and management system to leverage off the strengths and opportunities of the people within our community, rather than trying to change their goals and desires to suit ours.

Flexible modular staffing structure – what did we do?

The following points show how we went about altering our business using a flexible modular staffing structure.

Know your workspace and labour requirements

We created a demand graph of the hours we needed to operate the farm each day, seasonally based and capturing the essential and non-essential work required on a daily basis (*Figure 1*). This enabled us to not only plan when our busy periods were, but it also showed us which jobs on-farm we could apply labour saving investments to and where we were being inefficient. We now budget and report on hours per day and per season and see these as powerful key performance indictors (KPIs) rather than trying the traditional full-time equivalent (FTE) model. One routine change following our analysis saved one hour per milking, and when that is timed by four staff we save four hours a day.

Understand your team

We met with our team to discuss their needs and their availability to work. This allowed us to create a supply profile of available hours and work out where any holes or over-supply occurred. We found many of the team would rather work different hours to what we had available under our current structured system.

Through a simple conversation we were able to meet their needs much easier, which made them more settled and productive in their work. As part of our consultation feedback it showed our team preferred hourly rates,

Health and safety is a large part of team culture at Hopelands Dairies

Our people are our customers and our greatest asset. If we continue to treat them as commodities or FTEs only we are doomed to failure. If we develop a system that meets the needs of our people that are important to them, we are certain to succeed.

so we put all of our staff (except managers) onto hourly pay rates. For those who wanted it, we offered guaranteed hours per week.

Current trends in the dairy industry around reducing working hours and increasing time off are great, but it still doesn't necessarily meet the needs of the individual. By allowing the individual to determine their own roster and working hours, it allows them to work the hours they need to achieve their goals, be it pocket money for the weekend or striving for farm ownership.

Break down work requirements into packages

We then created different work packages for essential and non-essential work and connected them to seasonal requirements:

- *Essential work* – this became our base requirements for labour, i.e. what do we need to do each day to ensure the farm functions. This was captured by a fixed roster using our more permanent team. These jobs include activities such as effluent management, feeding, milking, machinery maintenance and records
- *Non-essential or specific seasonal work* – jobs such as fence repairs, weed control, mating and calf-rearing were put into packages of hours and pay rates and were made available to the base team if they wanted extra hours. If not, they were then made available to our wider team or put to the local market. Weed control, for example, used to be a job strongly disliked by the team, rushed between milkings and poorly done. By creating a 50 hour package at a set pay rate, which included training, a motorbike and a timeframe, it became a fixed-term position and can be filled by anyone in the team or wider community who wants to do it.

Redesign your reporting and responsibility structure

Our team is very diverse as our employees range from 15 to 66 years of age and from none to 45 years of experience. After talking with them, understanding their personality types and their needs, we found wanting responsibility was connected to personal goals and personality type, not a position. By having all the on-farm jobs in packages, we are able to mix and match these around the team and allocate responsibility and reward to those who want it.

To that end, we have developed a vertical *personal* responsibility structure rather than a horizontal *position* responsibility structure. If we get someone new to the team, rather than them being 'assists' in a wide range of jobs, they can instead be responsible for a narrow band (and in a very short time). This appeals to the younger members in the team who want to be the boss from Day 1. As their experience builds, their width of responsibility expands along with their pay. Clear targets are recorded and captured for all staff with pay incentives connected to responsibility.

Culture and attitude are critical

A culture of continuous improvement and positive attitude has been instilled in our team. We therefore employ on attitude and personality before skills. We do not compromise our culture for a specific skill as the disruption to the rest of the team is very damaging.

We also invest heavily in training in a combination of the full and shared cost with our team and provide three levels of training:

- *Job-specific skills required on-farm* – trained internally and on short courses such as milk quality and other specific targeted skills

- *Broader vocational training* – such as Primary ITO Level 3 to diploma level
- *Personal skills* – such as leadership development and self-awareness skills to help achieve future goals.

Our goal is to have two, preferably three, people in the team trained in a particular job, primarily to provide cover for absences but also to broaden the skills of the individuals on-farm. It is the responsibility of the person in charge of the job to provide the training for that position. This ensures ownership is effectively transferred and really helps to cement the knowledge into both parties.

Since the development and implementation of this system we have seen many benefits. The team are happier, more productive and less stressed. We have become far more labour efficient and have been able to pass some of these efficiencies on to our team in the form of higher pay rates, more training opportunities and a bit of surplus capacity. We are still on a journey developing this system, but we believe we are travelling in the right direction. Our most important learning is that there is no 'one size fits all' HR model that can be placed into a business. Rather, it is more about understanding your business needs, knowing your own strengths and weaknesses, and understanding the resources available in your wider community.

This then enables a fit-for-purpose model to be created in any community that best utilises the people around you. As mentioned, changing our mindset was the first step in achieving this. Our people are our customers and our greatest asset. If we continue to treat them as commodities or FTEs only we are doomed to failure. If we develop a system that meets the needs of our people that are important to them, we are certain to succeed. It is all down to us.

The side-box panel contains the view of our farm manager, Nick Bailey, who has helped us on our properties to bring a young person's perspective to improving on-farm labour management.

Ben Allomes and his wife Nicky operate a 1,000 ha multi-property dairy and beef business in the Woodville and Dannevirke areas of the Tararua Ranges. Ben was the 2015 recipient of a Nuffield Scholarship and, along with Nicky, the winner of the New Zealand Sharemilker of the Year award in 2008. Email: ballomes@inspire.net.nz.

Team member Charlotte Oram and farm manager Nick Bailey inspect the plantain and clover sward at Hopelands Dairies

KNOW YOUR PEOPLE – EMPLOYEE PERSPECTIVE

Nick Bailey, 23-year-old farm manager, Allomes beef and dairy business

Farm manager Nick Bailey has been instrumental in the development and implementation of the new system

Understanding the change in people's needs in our workforce will allow us to develop systems that attract and retain the next generation in our workforce. Today we have multiple generations of people – baby boomers through to Generation X and Y, and Generation Z – who are just starting to enter it.

It is important to understand what motivates the people in our workforce so that we can better cater for them to attract them and retain them in our industry:

- Baby boomers are motivated by recognition of achievements, opportunities for professional development, positions of authority, and workplace benefits such as pensions, holidays and health benefits
- Generation X are motivated by a good work-life balance, family-based benefits such as childcare benefits (younger Generation X), lifestyle benefits such as holiday/luxury goods benefits (older Generation X), corporate wellbeing, professional development opportunities and recognition of achievements
- Generation Y, aka Millennials, are motivated by money, flexibility in working hours, an enjoyable workplace environment, short changeable and fast tasks, opportunities to express creativity and opinions, and the chance to learn new technologies
- Generation Z are motivated by respect, money-saving schemes, mentoring platforms, experience days, and out-of-work socialisation with colleagues.

The motivating factors for the different generations of people in the workforce are therefore very diverse. We have to be flexible in the way we manage our people as it is not a 'one size fits all' model. We cannot expect Millennials to work in the same conditions and systems as baby boomers do as they are motivated by different things.

To be able to develop systems to look after our people it is important to find out what motivates each individual. It helps to ask a few key questions of employees such as:

- What do you/don't you want to do in the workplace?
- What are your interests in and out of work?
- What do you know?
- What do you want to know?
- How do you want to get there/how can we help you achieve it?

This allows us to create an environment that appeals to their motivators: flexibility in working hours, the opportunity to be engaged and have an opinion, to have ownership/responsibility of a job/task, to upskill and grow, and to gain recognition and respect.

ALESHA COOPER

COST OF COMPLYING WITH THE ONE PLAN

A CASE STUDY OF THE REGULATORY REQUIREMENTS FOR A DAIRY FARM IN THE HORIZONS REGION

Environmental compliance requirements are on the increase around the country. A case study has been completed outlining the requirements for a dairy farm in a target catchment of the Horizons region.

There is currently a lot of discussion and uncertainty about the environmental regulations that will be enforced around the country. The National Policy for Freshwater Management (NPSFM) requires regional councils to implement the contents of this policy in their plans by 2025. A number of regions are on their way to meeting the requirements of the NPSFM and have already adopted varying approaches to regulate nutrients and other contaminant loss to water, with others soon to follow suit. Horizons was one of the first regions to take action. The case study in this article looks at the requirements of current rules in the region and explores the impact these may have.

Horizons Regional Council

Regional councils' role is to find a way to balance the use of natural resources for economic, cultural and social well-being, while keeping the environment in good health. This is an exceptionally hard task and regulations will continue to evolve over time with the intent of achieving this balance. In the Horizons region, the One Plan outlines objectives, policies and rules to control the use of resources. Under the One Plan, farms may require consents to allow for day-to-day farming activities. Consents that are commonly required on an ongoing basis are water permits, effluent discharge consents and land use consents for intensive farming.

Land use for intensive farming

The One Plan introduced new rules regulating intensive farming that had not been present in previous regional plans. Intensive farming includes the following land uses:

- *Dairy farming* – this means using any area of land greater than 4 ha for the farming of dairy cattle for milk production. It includes land used as a dairy cattle grazing run-off, but excludes any dairy grazing arrangement. Such an arrangement is a third party commercial arrangement between the owner of the dairy cattle and another landowner for the purpose of temporary grazing
- *Commercial vegetable growing* – this means using an area of land greater than 4 ha for producing vegetable crops for human consumption. Fruit crops, vegetables that are perennial, dry field peas or beans are not included
- *Cropping* – this means using an area of land in excess of 20 ha to grow crops. A 'crop' is defined as cereal, coarse grains, oilseed, peanuts, lupins, dry field peas or dry field beans. This definition does not include crops fed to animals or grazed on by animals on the same property
- *Intensive sheep and beef farming* – this refers to properties greater than 4 ha engaged in the farming of sheep and cattle, where any of the land grazed is irrigated.

Conversions to intensive farming anywhere in the region require land use consent. Existing intensive farms in one of the nine target catchments require land use consent (see *map on page 31*). Depending on the catchment, the intensive farming rules came into effect between 1 July 2014 and 1 July 2016. Existing intensive farming activities outside target catchments and non-intensive farms do not require land use consent under current rules.

In general, the major requirements to obtain an intensive land use consent are that a nutrient management plan is completed, all cattle are excluded from waterways, and nitrogen leaching maximums are met. Once consent is in place, all actions committed to in the nutrient management plan must be completed by the specified date and annual nutrient budgets must be submitted to Horizons to show ongoing compliance with nitrogen leaching limits. The nitrogen leaching maximums have been determined based on Land Use Capability (LUC) class and are set out in *Table 14.2* of the One Plan (shown below).

Table 14.2 is possibly the most controversial part of the One Plan. There has been much debate about whether using LUC is an appropriate method for setting nitrogen leaching maximums, why the numbers are not updated with Overseer version changes, and why there is one set of numbers for the whole region rather than catchment-specific limits.

In early 2017, the Environment Court determined that Horizons had not been implementing some aspects of the One Plan intensive land use rules in a lawful manner. Since this time only a small number of land use consents have been granted, which leaves a large number of farms unconsented.

Table 14.2: Cumulative nitrogen leaching maximum by LUC class (kg/N/ha/year)

PERIOD (FROM THE YEAR THAT THE RULE HAS LEGAL EFFECT)	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	30	27	24	18	16	15	8	2
Year 5	27	25	21	16	13	10	6	2
Year 10	26	22	19	14	13	10	6	2
Year 20	25	21	18	13	12	10	6	2

Source: Horizons One Plan (2014)

Case study farm

The dairy farm is located three kilometres from the coast in the Rangitikei near Bulls. Soils are sandy and pasture growth is minimal over the summer period without irrigation. The farm has effluent discharge and water consents in place, but is yet to obtain an intensive land use consent (consent to farm) from Horizons, which is currently the biggest risk to the business.

Summary of farm system

Area: total 437 ha – 399 ha effective (331 ha irrigated with centre pivots), 6.5 ha wetlands, 12 ha riparian areas and trees, 20.5 ha non-productive

Stock numbers: 1,150 cows (2.9 cows/ha) – spring calving with carry-overs milked through on winter contract, replacement stock grazed off-farm

Production: 470,000 kg/MS (409 kg/MS/cow, 1178 kg/MS/ha)

Cropping: 40 ha brassicas

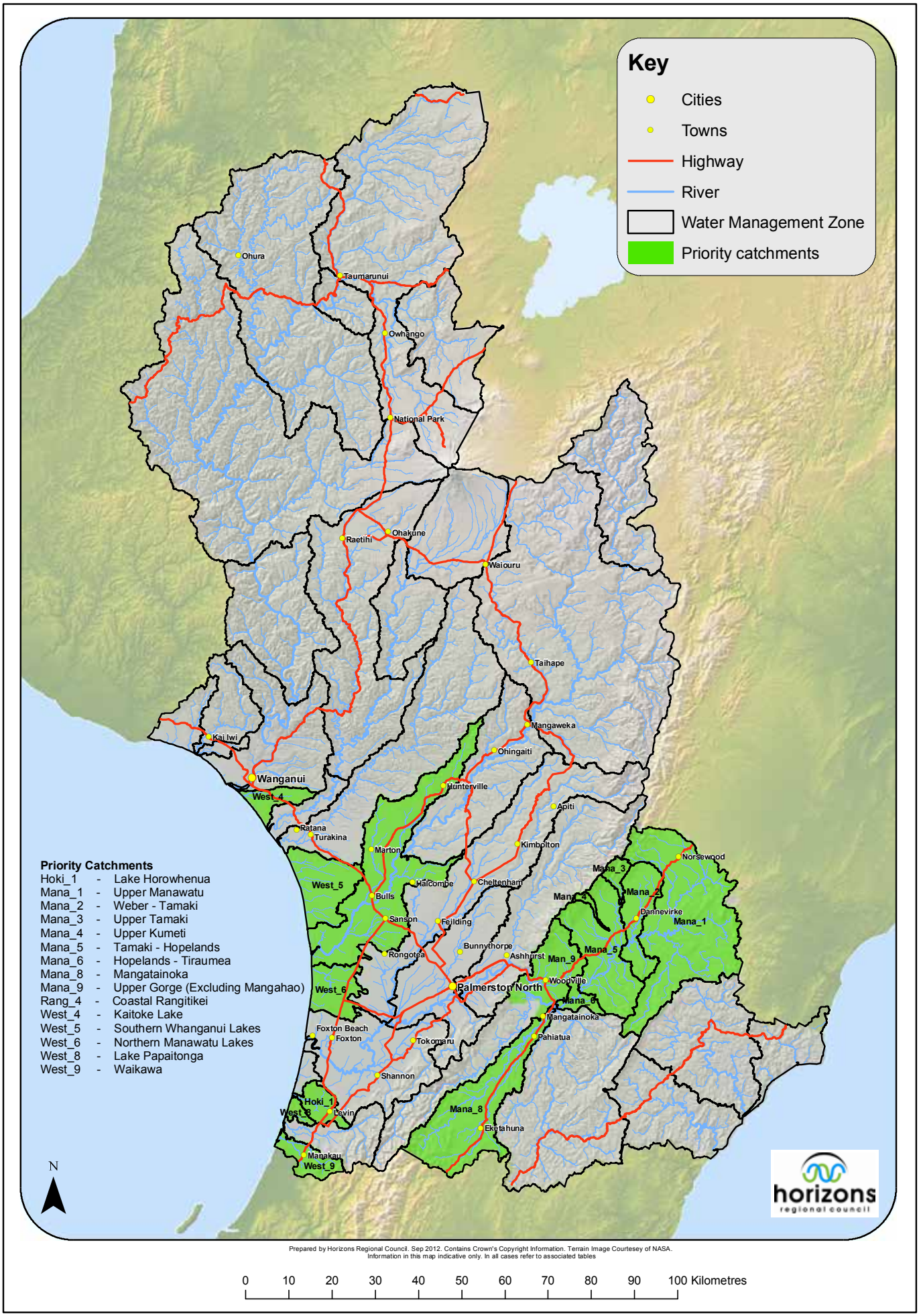
Imported feed: 1,000 t DM

Irrigation: as required from November to March, soil moisture monitoring used for scheduling

Pasture production: 15-17.5 tDM/ha/yr irrigated, 7-10 tDM/ha/yr dryland

Infrastructure: lined effluent storage pond, feedpad, two centre pivots

People: eight staff employed


Key
Cities
Towns
Highway
River
Water Management Zone
Priority catchments
Ohura
Taumarunui
Owhango
National Park
Raetihi
Ohakune
Waiouru
Taihape
Mangaweka
Kai Iwi
Ohingaiti
Wanganui
Hunterville
West_4
Apiti
Ratana
Turakina
Marton
Kimbolton
Norsewood
Mana_3
Mana_2
Mana_4
Dannevirke
Mana_1
West_5
Halcombe
Cheltenham
Bulls
Sanson
Feilding
Bunnythorpe
Rongotea
Ashhurst
Mana_5
Man_9
Woodville
West_6
Palmerston North
Mana_6
Mangatainoka
Foxton Beach
Foxton
Tokomaru
Pahiatua
Shannon
Hoki_1
West_8
Levin
Mana_8
Ekatahuna
Manakau
West_9
Priority Catchments
Hoki_1 - Lake Horowhenua
Mana_1 - Upper Manawatu
Mana_2 - Weber - Tamaki
Mana_3 - Upper Tamaki
Mana_4 - Upper Kumeti
Mana_5 - Tamaki - Hopelands
Mana_6 - Hopelands - Tiraumea
Mana_8 - Mangatainoka
Mana_9 - Upper Gorge (Excluding Mangahao)
Rang_4 - Coastal Rangitikei
West_4 - Kaitoke Lake
West_5 - Southern Whanganui Lakes
West_6 - Northern Manawatu Lakes
West_8 - Lake Papaitonga
West_9 - Waikawa
N
horizons
regional council
Prepared by Horizons Regional Council. Sep 2012. Contains Crown's Copyright Information. Terrain Image Courtesy of NASA.
Information in this map indicative only. In all cases refer to associated tables
0 10 20 30 40 50 60 70 80 90 100 Kilometres

The main waterway flowing through the property – all waterways have been fenced to exclude stock. A riparian planting plan is underway with a new section of riparian margins planted each year

Current concerns

The main questions the farm is currently grappling with are:

- Is there a farm system that will allow us to be compliant with the rules of the One Plan while continuing to support eight staff and their families?
- We have halved our nitrogen leaching in the last four years, so will we need to further reduce our leaching in the next few years, or will there be a plan change that allows for a more achievable timeframe to reduce leaching over?
- Our business has been successful because we adjust to best manage the conditions (payout, climate). Regulation limits our ability to adapt, so how will our business cope with this decreased flexibility?
- As we are in a smaller coastal catchment, ongoing water quality monitoring data is not available, which means there is a lack of clarity on what the main water quality issues are. How do we know where to focus our efforts if the issues that need to be solved are not clear?
- To allow us to implement the best environmental management practices we need to be paid more for our products. We see the potential to sell the story of carbon neutrality or grass-fed animals and demand a premium for this, but we are struggling to see how reduced nutrient loss to water can be effectively marketed. While our local customers care about water quality, does our main overseas customer base care and can we gain a sufficient premium to fund environmental protection works?
- Continual innovation is an important part of our culture, but the regulatory process does not encourage, or in many cases allow for, innovation. Will this change in the future? If not, should we direct the time and money spent on trialling innovative ideas elsewhere?

Intensive farming land use consent

The farm is located in the Southern Wanganui Lakes (West 5) catchment, a target catchment under the One Plan. The *Table 14.2* nitrogen leaching maximums for the farm (shown below) are significantly lower than the past and current leaching, which is a major challenge.

Although the farm is yet to obtain a land use consent, a number of measures to reduce losses to the environment have been implemented. For the 2014/15 season, nitrogen leaching from the property (as determined in Overseer version 6.3.0) was 69 kg/N/ha. Following this, mitigations to reduce leaching were implemented, resulting in a

Table 14.2: Nitrogen leaching maximums (kg/N/ha/year) for the farm

YEAR 1 (2015)	YEAR 5 (2020)	YEAR 10 (2025)	YEAR 20 (2035)
23	20	18	17

Source: Horizons One Plan (2014)

There is 6.5 ha of wetlands on the property and they are an important part of the landscape and play a crucial role in filtering drainage water. All wetland areas are fenced to exclude stock and weed management is carried out annually

reduced nitrogen leaching of 59 kg/N/ha/year in the 2016/17 season. This season, further mitigation measures have been implemented which have reduced the leaching to 36 kg/N/ha/year. This is a 47.8% reduction in nitrogen leaching in a three-year period, which is a significant achievement. The mitigations undertaken on the property that resulted in the largest reduction in leaching were wintering all dry cows off-farm, reducing winter crop area, reducing urea use by 140 kg/N/ha/year, and altering the type of imported feed.

Options to further reduce nitrogen leaching are currently being evaluated. A viable system that meets the ***Table 14.2*** limits has not been able to be identified. The questions must be asked: Is it fair or realistic to require a farm to reduce leaching from 69 kg/N/ha/year to 23 kg/N/ha/year in the space of a few years? Is a few years suitable time to allow people to fully evaluate the situation and determine the best course of action, especially when this action may be increasing debt to invest in infrastructure or selling the business? If there are no suitable solutions available, is a few years long enough to allow for innovation?

Horizons have recognised that their timeframes may be unrealistic and are currently considering whether a plan change is the best option. A plan change could take any form from updating a specific aspect, such as the numbers in ***Table 14.2***, through to a full plan change. Even a minor plan change will likely take years to be implemented, which leaves a lot of uncertainty for farmers in the interim.

Annual compliance cost

The total current compliance cost is $12,268/year which includes annual fees to Horizons and ongoing monitoring that is required for ground water takes on the property. At first glance this seems like a substantial ongoing cost that some may find excessive, yet when looking at this in comparison to other costs the amount equates to only 0.57% of farm working expenses. Compliance costs of less than 1% of farm working expenses are nothing to complain about. However, this does not include the cost of the intensive land use consent, which has the potential to change this equation significantly.

The cost of obtaining land use consent and ongoing compliance costs associated with this are expected to be larger than the costs for other consents, but the magnitude is not yet known. To give an example, the costs could be $50,000 for the preparation and processing of a consent application, $50,000 annually for mitigation actions and $10,000 for annual monitoring. For a consent term of 10 years, this would equate to annual costs of $65,000, bringing the total annual compliance cost to $77,268, or 3.5% of farm working expenses.

This farm has scale that others do not have, but perhaps the average farm having to budget on annual compliance costs of $10,000 to $20,000 is the 'new normal', and maybe this needs to be accepted as part of the cost of operating a business. It is worth noting that this example does not factor in major changes to the farm system.

A tall fescue, brome and clover pasture mix is used for irrigated pastures, and this mix has greater persistence than ryegrass on this farm. To successfully manage the fescue and brome pastures, achieving target pasture residuals is essential

Change in land use

Some may question whether dairy farming is an appropriate land use on light soils. Overseer modelling has been completed to determine nitrogen leaching that could be expected if the property was converted to other land uses. For each alternative land use, it has been assumed that good environmental practices, such as nutrient inputs aligning with plant demand, will be implemented. Irrigation area and management has remained the same as the current system.

Expected production levels and crop yields have been determined based on averages for the area. The intent of this modelling is to provide an indication of nitrogen leaching from differing land uses on this property, but the results are not transferable to other farms as each situation is unique. This modelling has not extended to assessing the economic viability of each option. The results indicate that dairying is comparable to or has lower nitrogen leaching than alternative land uses on this property, as summarised in *Table 1*.

The non-irrigated scenario has the lowest nitrogen leaching, but given the infrastructure present on the property and the lowered production this is not a viable option. The presence of irrigation is also allowing for accelerated soil development, resulting in greater amounts of carbon stored in the soil and the improved productive capability of the soil for future generations.

Being proactive and innovative

Being proactive rather than reactive and innovating is essential to keep the industry moving forward, especially with regard to environmental management. On this farm, while continuing to evaluate options to reduce nitrogen leaching, significant effort is also going into investigating options to mitigate or reduce nitrogen leaching that may not be reflected in Overseer. Although minimal credit is given to these alternative options under the current regulatory approach, they believe that focusing on identifying alternative solutions to reduce their environmental impact is the best way forward.

Table 1: Alternative land uses

LAND USE	REVISED STOCK UNITS/TOTAL HA	NITROGEN LEACHING
Current dairy system – pasture production – irrigated 14.5 tDM/ha eaten, dry 8.5 tDM/ha eaten	26	36 kg/N/ha/yr
Mixed cropping – maize grain (14 t/ha), barley (8 t/ha), annual ryegrass	6.7	63 kg/N/ha/yr
Vegetables – lettuce, cabbage, broccoli	–	>80 kg/N/ha/yr
Beef finishing – pasture production – irrigated 10.7 tDM/ha eaten, dry 6 tDM/ha eaten	16.5	35 kg N/ha/yr
Sheep and beef – 60% sheep 40% beef	16.5	35 kg/N/ha/yr
Sheep – pasture production – irrigated 10.5 tDM/ha eaten, dry 6 tDM/ha eaten	16.1	34 kg/N/ha/yr
Non-irrigated sheep (lamb finishing) 6.2 tDM/ha eaten	11.1	19 kg/N/ha/yr

They are leading the way for farmers in the Horizons region when it comes to identifying and trialling alternative solutions. The following innovative solutions are being investigated on the property:

- *Alternative pasture species* – ryegrass persistence was a problem on the property due to the sandy nature of the soils. A number of alternatives have been trialled. Best results were found with a tall fescue, brome and clover mix. This pasture mix has been introduced across the property, and has increased persistence and greater rooting depth than the ryegrass pastures that were previously used on it. It is expected that increased plant density and greater rooting depth will result in reduced nutrient loss from the soil profile, but this is yet to be quantified
- *Drainage control solutions* – a Sustainable Farming Fund project is underway on the property to investigate options for managing and treating drainage water before it enters main waterways
- *Water swap trial* – surface water on the property has higher nutrient concentrations than the ground water. If surface water was utilised for irrigation this would allow for plant uptake of these nutrients. To maintain stream flows, while surface water is abstracted an equal volume of ground water could be pumped into the stream. The ground water would mix with the surface water to improve the overall water quality of the stream. A small-scale trial of this technique is to be undertaken and, depending on the results, the water swap could be scaled up
- *Shading of waterways* – periphyton growth has been identified as an issue on the farm. It is considered that in this environment, focusing on nitrogen leaching alone will not sufficiently control periphyton growth and shading the stream may be a more effective approach. Natives have been planted along some waterways, but the height of these must be limited due to the use of centre pivots, which makes creating sufficient shade along waterways a challenge. Trial work is underway to investigate the effectiveness of natural (vegetation) versus artificial (shade cloth) shading of waterways.

Are other farms in the same position?

While some farms have been able to meet the *Table 14.2* limits, others are also struggling to identify a system that will meet the nitrogen leaching limits along with providing sufficient returns. A report titled 'An Impact Assessment of One Plan Policies and Rules on Farming Systems in the Tararua District and the Manawatu Wanganui Region' was completed by Terry Parminter in 2017. This work assessed six existing intensive farms in target catchments.

It was found that reducing nitrogen leaching to meet the *Table 14.2* limits resulted in reduced profit and return on assets for all six farms. For two of the farms, profitability remained sufficient to support expected debt levels and return on assets remained sufficient to provide the owners with financial security. For the remaining four farms this was not the case, as it was found that profitability was insufficient to support expected debt levels and return on assets was insufficient to provide financial security for the owners. The findings from this work are summarised in *Table 2*.

Impact of the One Plan to date

The One Plan has limited the opportunity to convert to intensive land uses or expand existing intensive operations in the region. The intent was to encourage intensive land use to occur on the most appropriate land, which has probably been achieved. For dairying, farm sales have been slower and prices have been down compared to a few years ago. It is generally accepted that the One

Table 2: Summary of findings from 'An Impact Assessment of One Plan Policies and Rules on Farming Systems in the Tararua District and the Manawatu Wanganui Region'

FARM	N LEACHING PRIOR TO REGULATION	TABLE 14.2 N LEACHING LIMIT	PROFIT WITHOUT REGULATION	PROFIT WITH REGULATION	RETURN ON ASSETS WITHOUT REGULATION	RETURN ON ASSETS WITH REGULATION
Dairy 1	32 kg/N/ha	18 kg/N/ha	$1,627/ha	$629/ha	5.3%	2.0%
Dairy 2	42 kg/N/ha	17 kg/N/ha	$1,848/ha	$1,064/ha	6.4%	3.7%
Dairy 3	54 kg/N/ha	17 kg/N/ha	$2,283/ha	$1,745/ha	7.0%	5.0%
Dairy 4	64 kg/N/ha	17 kg/N/ha	$2,456/ha	$1,850/ha	6.8%	4.8%
Arable 1	39 kg/N/ha	24 kg/N/ha	$915/ha	$477/ha	2.6%	1.3%
Arable 2	60 kg/N/ha	25 kg/N/ha	$3,192/ha	$1,152/ha	8.2%	3.0%
Average		-28.8 kg/N		-$900.7/ha		-2.8%

The farm is irrigated with two centre pivots. The introduction of irrigation on the property has resulted in soil development and a significant increase in organic matter content

It is important for all parties involved in environmental regulation to remember that we are trying to find a balance between economic, social, cultural and environmental outcomes. All four of these factors are interdependent and each is important.

Plan has had an impact on farm sales, but this is hard to quantify as there have also been a number of other factors affecting the market.

Following the Environment Court decision last year and the reduced ability to obtain consent, there are still a few hundred farms in target catchments that are yet to obtain an intensive land use consent. There is significant uncertainty for these farms, and the region in general, as it is not clear what regulations will require people to do within the next five years.

With water quality trends, monitoring results show that nitrogen levels across the region are either remaining the same or improving. This demonstrates that farmers have been moving in the right direction.

What does the future hold?

Despite the good work that has occurred, it cannot be disputed that there is a long way to go, which means increased environmental regulations will continue. We must advocate for implementation methods that are practical and achievable for farmers. Wherever possible, we must also fight to maintain flexibility to allow for some degree of adjustment between seasons to account for market (crop type, sheep:cattle, feed costs) and climatic variations.

It is important for all parties involved in environmental regulation to remember that we are trying to find a balance between economic, social, cultural and environmental outcomes. All four of these factors are interdependent and each is important. Long-term economic outcomes cannot be achieved without sustainably managing our resources and, equally, a strong economic position allows for further investment in environmental protection works. Social and cultural outcomes need to be provided for because the most important consideration is people.

This case study farm will continue to implement mitigations that they believe provide the biggest environmental gain from investment. Innovative ideas will be progressed to find solutions that allow them to continue to support their people and the wider community.

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Alesha Cooper is an Agribusiness and Environmental Consultant with AgFirst Manawatu-Whanganui.
Email: alesha.cooper@agfirst.co.nz. J

Corey Cassin and Rah Bennett, dairy workers at Wairarapa Moana, the largest Miraka milk supplier

GRANT JACKSON

MIRAKA
A MĀORI AGRIBUSINESS GLOBAL SUCCESS STORY

In March 2012, this journal featured an article on Miraka as a new independent dairy processor. This update looks at the continuing success of the venture six years on, in particular its efforts at becoming an environmentally sustainable and vertically-integrated company using best practice labour policies.

Miraka can use renewable geothermal steam from the Mokai geothermal field to run its processing operations – a world first for the whole milk powder processing industry.

Traditional values

Traditional values lay the foundations for modern innovation and future success at Māori-owned dairy-processing company Miraka. The company, which is relatively small but well-established in New Zealand's multi-billion dollar export dairy processing industry, has strong values founded on the cultural beliefs of its owners.

The Miraka vision is 'nurturing our world', aspiring to be recognised globally for best practice in sustainability and innovation, drawing both on its own experience and knowledge from external partners to achieve this. Its founding values – Excellence, Kaitiakitanga (guardianship/stewardship), Integrity, Tikanga (correct customs, values and practices) and Innovation – guide its business decisions, underpinning its relationships with people and with the natural environment.

A growing enterprise

Miraka takes its name from the Māori word for milk. First incorporated in 2010, and with its first day of production on 1 August 2011, it is now in its seventh season. The company is owned by a group of Māori trusts and incorporations, including Wairarapa Moana Incorporation, Tuaropaki Kaitiaki Limited, Waipapa 9 Trust, Hauhungaroa Partnership, Tauhara Moana Trust and Pouakani Trust. Its strategic partners and investors include Te Awahohonu Forest Trust Limited, Vinamilk, a leading milk manufacturer and dairy products enterprise in Vietnam, and Global Dairy Network, which brings experience and knowledge in dairy sales and marketing internationally.

Miraka has around 100 local farms within an 85 kilometre radius supplying its factory. The company believes this small supplier footprint creates farm-fresh advantage, resulting in higher quality products, while also allowing it to build strong and direct personal relationships with each supplier. Such is the importance with which personal relationships are viewed, new suppliers, new staff, or any subsidiary business becoming involved with the company are officially welcomed at the local marae.

Geothermal steam, worm castings and low emissions

The company's commitment to environmental sustainability has been evident from its beginning. Being located in Mokai, 30 kilometres northwest of Taupo, means Miraka can use renewable geothermal steam from the Mokai geothermal field to run its processing operations – a world first for the whole milk powder processing industry. A number of monitoring bores around the property ensure there is no impact on the water table.

Meanwhile, biological waste created during the drying process is composted at Tuaropaki Kaitiaki Limited's worm farm nearby. The worm castings, in turn, go to a local native plant nursery and these plants are used for riparian waterway planting.

The farm excellence programme gives farmers the potential to earn an extra 20 cents/kg/MS premium on top of the milk price by meeting 30 standards, 13 of which are mandatory.

These innovations reduce its emissions of greenhouse gases, which the company sees as critical to its role as Kaitiaki (guardians) of the natural environment. Meanwhile, its state-of-the-art manufacturing plant has the capability and capacity to turn more than 300 million litres of milk into powders and ultra heat treatment (UHT) products every year.

Protecting the environment, the natural world, is of paramount importance to the company's shareholders as it reflects their traditional values. They understand that they only hold the land in trust for their children's children's children. The company wants to ensure that future generations benefit from its work and that the footprint created today continues to nurture in harmony with the world.

For Miraka, this is an important point of difference for consumers globally who are increasingly looking to buy products with a low carbon footprint and are willing to pay a premium price for products from a sustainable source. The company exports its products to more than 23 countries across the US, Africa, the Middle East, Asia and Oceania.

Vertically-integrated business

The company's growth strategy was to build a strong base with commodity products, then work towards producing value-added items and high-end brands. From the start, its shareholders were consulted and endorsed its plans to add value beyond the farm gate by creating a vertically-integrated business.

Five years ago, the company expanded its processing plant to include a UHT milk production plant now running at capacity to produce 60 million litres of this milk a year with two lines of 250 ml Tetra Pak cartons. Building on the success of whole milk powder and UHT, it has launched two new consumer brands (Whaiora and Taupo Pure) in the last 12 months.

Farm excellence programme – Te Ara Miraka

To ensure these values are in action from the 'cow to the consumer', the company has introduced a holistic and sophisticated farm excellence programme, Te Ara Miraka (The Miraka Way). This is a financially incentivised system for its farmers to increase their earnings by meeting a set of defined quality standards. The farm excellence programme gives farmers the potential to earn an extra 20 cents/kg/MS premium on top of the milk price by meeting 30 standards, 13 of which are mandatory.

The programme aims to improve efficiency in order to couple greater profitability for the company and its farmers, with improved sustainability and a lower environmental impact. Te Ara Miraka has also become the internal culture for the company, which is aiming for excellence across its supply chain.

The company advocates for a proactive approach to cow health through an annualised animal health plan created with a veterinarian. This avoids reactive and often hasty decisions and usually provides better control over a farm's animal health spend.

Five pillars (Pou) and ISO accreditation

The key drivers to Miraka farmers becoming world-class milk producers are resilience and production efficiency. The standards for Te Ara Miraka are founded on five Pou or pillars: People, Environment, Cows (Animal Care), Milk Quality and Prosperity. Each standard has a rating and farmers receive a score out of 100 at the end of the season, which is the percentage value they will get paid of the available premium.

The first step was to introduce the programme to their farmers and provide additional tools, resources and access to experts to help drive greater profitability, stronger communities, and improve stewardship of the land so they were not 'going it alone'.

Since the 2016 season, farms in Te Ara Miraka have been independently audited by a third party accredited under the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) to International Standards ISO/IEC Guide 65, the international standard for ensuring competence in those organisations performing product certifications. There is a governance structure in place for farmers to appeal or review their scoring.

The programme is nearing the end of its second season of implementation and the company is pleased with farmer engagement into the initiative and the significant gains made on-farm. Te Ara Miraka will be an evolving journey. They believe that to remain relevant and challenge their farmers to achieve excellence every day, it will require a focus on innovation within the industry, strong communication and farmer support.

It is hoped that programmes such as Te Ara Miraka become the norm in time, to the benefit of the whole population. For them, it is more than just validating a social licence to operate, it is providing their supply community with recognition for living their values and striving for operational excellence every day. More detail about the five pillars (Pou) follows.

People: Nga tangata

Miraka encourages a proactive focus on staff growth and development through formalised training and mentoring, as well as a personalised approach to each staff member's needs and existing skills. The company also believes that unless this process is formally documented and owned

The company also recognises the importance of the local community in which it operates, and its desire to see that community thrive and grow by providing employment opportunities and support for dairy farming.

by the employer, commitments are not always adhered to, even if the intention is there. This can result in trust being lost, initiating the breakdown in an employment relationship.

Te Ara Miraka provides support for farmers with the help of templates, and guidance on fair employment practices and developing strong relationships, as ways to attract staff and increase retention.

The company advocates the use of formal timesheets that are reviewed regularly by employers, to ensure labour laws are adhered to and that individual staff achieve a good work-life balance to both maintain productivity and reduce the incidence of on-farm accidents. Farmers are also required to create active health and safety policies for each farm, identifying farm-specific risks to personnel along with farm policies to mitigate them, thereby reducing the risk and stress in their role as employers.

As with the other Pou, the 'People' pillar looks beyond the farm gate, recognising that farmers and their staff are a vital part of their local rural communities and that investment in these communities benefits everyone. The rationale is that regions with strong, supportive communities will help to attract and retain high quality staff and ensure their families settle, which in turn enhances productivity.

Environment: Te Taiao

As noted, Miraka has been serious about its role as Kaitiaki of the land and the environment since its beginning, believing it is fundamental to the sustainability of continued milk supply and the prosperity of its farmers, their future generations and therefore of the company itself.

Water is recognised as a key element within the physical farming environment, with water quality an essential for life, particularly the biodiversity of waterways and soils. It is also important to local communities for recreation needs, tourism and other supportive businesses.

The company has identified that the important issues facing water quality currently are the negative impacts on waterway turbidity, pH, *E. coli*, chlorophyll (nutrient levels), heavy metals, dissolved oxygen and temperature. The criteria within this Pou focus on the most critical elements influenced by farmers, namely, nutrient run-off and leaching, sediment run-off, *E. coli* and toxin pollution. Soil structure is also critical to the ongoing performance of pasture production and is therefore a key driver of cost-efficient feed production. Mitigation of the negative effects of stock pressure on soil quality is also considered.

The company also encourages all its supplier farmers to be proactive in the management of their farm environment in order to minimise any negative footprint. To this end, it provides a guiding document for this via an environment management plan, detailing all identified risks, on-farm policies to avoid these risks, and actions to mitigate milk production impacts. Again, Miraka supports farmers in need of guidance towards best practice through access to industry experts and templates.

Cows: Nga kau

Not surprisingly, animal welfare is a significant concern for not only the company but also for its customers across the globe, and is strongly aligned to its values of Integrity and Kaitiakitanga. As well as obvious cow welfare expectations, the company encourages its farmers to appreciate the link between cow stress and productivity.

The programme aims to see cows flourish within optimum farm conditions. First, farmers are expected to consistently care for their cows within the five freedoms. Other best practice standards are based on the expectations of its environment and health conscious target consumer groups, such as no growth hormones, antibiotic use by prescription only, and grade-free milk quality that directly relate to the health and welfare of the cows.

The company advocates for a proactive approach to cow health through an annualised animal health plan created with a veterinarian. This avoids reactive and often hasty decisions and usually provides better control over a farm's animal health spend.

The company also views as important the need to monitor the performance of individual cows to drive feed conversion efficiency, and ultimately profitability, because it believes in a competitive environment in which to drive efficiencies. This extends to each herd, as each mouth competes for the same blade of grass.

Creating an ideal environment for cows to produce milk solids involves proactive management of nutrition, grazing, reproduction and the minimisation of climate extremes. To achieve an optimum industry-recognised six-week in-calf rate, a farmer must optimise all of the above throughout the year.

An optimal mean calving date means an extended mean lactation length across the herd and greater days in milk. Once again, the company supports its supplier farmers' needs to drive performance in this area in conjunction with industry partners. Overall, we are encouraging a

proactive focus on creating the optimum environment – physically, nutritionally and socially – for cows to perform at their best within each farm environment.

Milk: Miraka

Meeting the quality assurance demanded by its customers is fundamental to the success of the company and its growth strategy, which is based on high quality and the safest possible source of nutrition to its consumers. Te Ara Miraka helps the company market its products globally by ensuring that the messages it puts in the market are based on reality.

The future of the company as a leading processor of dairy is dependent on its ability to ensure the safety and quality of its products. The farm excellence programme aims to both financially incentivise and support supplier behaviour that will result in optimum raw milk quality by banding its purchase price for raw milk based on the quality.

Prosperity: Taurikura

Increased prosperity for its farmers from implementing Te Ara Miraka has been an overriding motivation behind the initiative. Profitable supply farms that prosper and grow themselves are fundamental to the success and profitability of Miraka as a company.

The company also recognises the importance of the local community in which it operates, and its desire to see that community thrive and grow by providing employment opportunities and support for dairy farming. It also encourages its farmers to monitor and proactively manage their costs, cash flow and equity in relation to past and forecast production to retain better control of the net outcome of their business.

The introduction of this programme provides the company with an opportunity to link with the unique vision and values of the organisation, and to position the Miraka brand as delivering on what it promises.

Te Ara Miraka therefore embodies the vision of nurturing our world and values that ensures sound environmental stewardship and best practice are achieved in animal welfare, people management, milk quality and the entire on-farm performance.

Supplier response to Te Ara Miraka

Most of the company's suppliers (as many as 99%) are now actively engaged in the farm excellence programme and are all striving to achieve standards of excellence. Feedback from suppliers indicates they welcome the opportunity to supply a company that shares their values, has an invested interest in all aspects of their business success, and is prepared to offer financial incentives to support the regulatory requirements being placed on dairy farmers.

They also recognise that Te Ara Miraka is about production efficiency on-farm and putting structures in place to mitigate their risks by maximising the quality and integrity of their products and insulating their revenue from the volatility of dairy commodity prices.

Grant Jackson is General Manager of Milk Supply at Miraka based in Taupo. Email: grant.jackson@miraka.co.nz. J

CHARLOTTE GLASS

Rural start

Charlotte's love of farming, rural communities and the seasonality of nature was nurtured from the beginning by a family life that encouraged hands-on learning and a love of the outdoors. The youngest of four siblings, much of her time growing up was spent outside on the farm – the first step in a life-long journey of practical and academic learning. In the Glass family learning and education were highly valued. 'We were expected to know our own minds from a young age and, if we didn't know, to ask questions. We learned to debate and to articulate our views from a logical perspective,' notes Charlotte. These skills remain fundamental to her work today.

Her father Derek emigrated from Northern Ireland to New Zealand with his family when he was 18. By the time Charlotte was born, Derek and Rae (her mother) were farming successfully in partnership with an aunt and uncle near Methven. A large and close-knit extended family together with frequent guests from around the world made for a rich family life. With the constant stream of visitors, the dinner table conversation was flavoured with views on international politics, history and innovations from abroad.

Lincoln and Aberdeen study

Boarding at Rangi Ruru Girls School in Christchurch, Charlotte already knew what she wanted to study and do as a career – animal nutrition. This led her to complete a Bachelor of Agricultural Science with honours at Lincoln University. 'The degree reinforced my interest in animal nutrition and the management and marketing papers fed my need to have a broader understanding of business,' she says. During her time at Lincoln she also completed an Outward Bound course funded through Young Farmers.

It was not until after graduation at Lincoln that she experienced her first 'real world culture shock.' New Zealand was in the process of adopting principles of equality with the passing of the Human Rights Act in 1993. Despite that, Charlotte soon learned that being female and seeking employment in agriculture might not be as easy as she had expected. After being turned down for a job in 1997, she phoned the manager to ask what she could do to improve her chances. His response, 'Oh we just didn't think that part of the country would cope with a female in that role,' reflected the underlying prejudice that still existed. In his typical pragmatic fashion, her father's advice was that in agriculture, 'she had to be able to do the same

Charlotte was at Dexcel/DairyNZ for eight years, learning and working across many programmes and projects.

work as any man outside and still more than that inside and, if she didn't have enough muscle, she had better use her brain to find another way to get the job done.'

Soon after this Charlotte got her first grown-up job as a Field Officer in Marlborough and Kaikoura for Ravensdown. She found these regions to be a great place to start a career. The small and friendly farming communities made her feel very welcome. Still the shy farm girl, she drew on her technical and practical knowledge to earn the farmers' respect and trust. Joining the Renwick Young Farmers Club further cemented her into the community and helped her to grow both her professional and personal confidence.

Still keen to specialise in animal nutrition, a Beef and Lamb scholarship in 1998 provided the opportunity to blend study and travel. References from Lincoln combined with help from networks in Northern Ireland led to her being accepted for a Masters in Animal Nutrition at the University of Aberdeen in Scotland. She says it was an amazing time spent between the university, the Macaulay Land Use Research Institute and the Rowett Research Institute. With much hard work (and a few late nights), Charlotte graduated with her Masters with Distinction in 2000.

Northern Ireland

From Scotland, Northern Ireland was the obvious destination and the chance to reconnect with extended family. After a few months milking cows she became a Formulator at John Thompsons and Sons, a large multi-species feed mill in Belfast. For her, it was a fascinating time to be working in Northern Ireland with the signing of the Good Friday (Peace) Agreement ending hostilities with the IRA.

Belfast proved to be an excellent base from which to travel and, despite a very modest salary, Charlotte scraped together enough savings to see a lot of Europe while she was there. It was further education in understanding the world and New Zealand's special place in it. She saw first-hand the wisdom of Mark Twain who said, 'Travel is fatal to prejudice, bigotry, and narrow-mindedness, and many of our people need it sorely on these accounts. Broad, wholesome, charitable views of men and things cannot be acquired by vegetating in one little corner of the earth all one's lifetime.'

Returning home

The 2001 foot-and-mouth outbreak in the UK depressed the agriculture sector across the British Isles and a job offer as a ruminant nutritionist for a premix company in Christchurch New Zealand was too good to resist. It was the dream job that wasn't: 'I loved specialising in animal nutrition, but feed milling in New Zealand was still pretty basic and relied on selling farmers something that they often didn't need. It was a tough lesson but gave me a fresh appreciation that farms, and businesses, need to get the grass-roots right to succeed.'

Charlotte returned home to Methven, working on her uncle's dairy unit while she contemplated her next career move. She took a junior consultant role at FarmRight and later accepted a Business Developer role in the Environmental team at Dexcel (later DairyNZ). She was in the middle of her Kellogg Rural Leadership Programme course at the time.

It was another step in her love of learning and looking back, she is grateful for the time at Dexcel. 'The role required translating science into action and, as a person who likes to understand from first principles and enjoys working on-farm, it was extremely fulfilling.' Charlotte was at Dexcel/DairyNZ for eight years, learning and working across many programmes and projects. Through additional grants, she furthered her international exposure with travel to the USA and UK, and then later attended the FAME (Food and Agribusiness Market Experience) programme in 2009.

Lifestyle block

While working at DairyNZ, Charlotte began farming a small 10 ha irrigated lifestyle block at Dunsandel, hoping to grow from there to a full-time farming business. However, balancing the needs of a demanding job and travel schedule while trying to run a farm proved challenging. Frequently farming in the dark, before or after rushing to the airport to fly to Hamilton or some other part of New Zealand, was gruelling. Weekends were spent catching up on farming tasks and dealing with the surprises she hadn't seen during the week.

'I wore myself out and there wasn't enough margin to cover the mistakes I was making,' says Charlotte. 'I wasn't getting the grass-roots right, so was spending more on supplements to compensate. Still, as Dad wryly noted, it was better to learn on 10 ha than 100.'

She decided to take a different tack and sold the block to a neighbouring dairy farmer. 'It was an extremely valuable experience and it further cemented the huge respect I have for farmers and other rural people. It was incredibly frustrating to be making silly mistakes when I had the knowledge and training to be doing better. I also learnt the importance of good rural support. I had the

Agri Magic Limited was born in 2015, with its strap line 'Supporting your farming future'. The company has grown quickly, now employing seven full-time and three part-time staff.

most brilliant neighbours anyone could ask for. They looked after me in a good way. They didn't bark advice or make me ask for help, but it was there when I needed it and they made it easy for me to accept. It was a kindness and generosity that I will never forget.'

Agri Magic – business ownership

After eight years with DairyNZ, Charlotte felt it was time to move back to private enterprise. After a short stint with the Ravensdown Environmental Team she decided to take on a large new challenge and start her own business.

Agri Magic Limited was born in 2015, with its strap line 'Supporting your farming future'. The company has grown quickly, now employing seven full-time and three part-time staff. The rapid growth has been due to a massive demand from farmers for help to manage their diffuse nutrient losses and comply with new land and water regional planning requirements. Her professional network, particularly the Canterbury branch of NZIPIM, has been invaluable in supporting this new challenge.

Charlotte gets a real sense of pride in helping 'grow' her staff at Agri Magic. When recruiting she looks for the same attributes that have guided her own development; attitude first and an eagerness to learn. 'In particular I look for proof that they haven't been afraid to get their hands dirty,' she says. 'I am incredibly fortunate to have a great bunch of staff and clients at Agri Magic. We try so hard for our clients because the Agri Magic team all share the same values that I gained back at my family dinner table; we love farming, we love learning and we enjoy a laugh.'

Women in agriculture

Charlotte also encourages her team to get involved in organisations such as Young Farmers and NZIPIM, two that have been hugely valuable to her and her career so far. 'I don't have a lot of time for "women's only" networking groups, as all hell would break loose if they had "men's only" ones, but I do think it is important to break down gender barriers.'

'I was taught at home to focus on ability and equality and that has guided me through my career.' Interestingly, the only times she has experienced any 'issues' regarding gender have been with allied farming businesses, not from farmers themselves. 'Many farms are run as family businesses and, while the partners may perform different roles, both contribute to the success of the enterprise and the farms are partly owned and run by capable women. Fortunately, the agriculture sector is much better now at dealing with equality than it was when I was starting out.'

A return to farming

Charlotte still hopes to be farming one day – when the time is right. For now, Agri Magic is her main focus. She has loved the challenge of starting and growing the company with the help of their networks, a great team and, of course, their farming customers.

'The demands on our farming customers will continue to change over time but I'm excited because we're building a team at Agri Magic that has the attitude and aptitude to learn and adapt to help our customers meet whatever new challenges are thrown their way.'

Charlotte Glass is Director of AgriMagic Limited, Agricultural Consultants based in Christchurch.
Email: charlotte@agrimagic.co.nz.

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