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

USE OF GMOs IN NEW ZEALAND UK AGRICULTURE POST-BREXIT **OFFSETTING PASTORAL GHG EMISSIONS USING FORESTRY** REGENERATIVE AND SUSTAINABLE AGRICULTURE **SOIL TESTING FROM THE SKY** HELICROPPING

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NZ Institute of Primary Industry Management

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Situation deteriorates on-farm as multiple demands escalate

In my working career within the primary industry I have never quite seen the wave of new and proposed regulatory and legislative changes that are now occurring at farm level. The sheer scale and velocity of these changes shows no signs of slowing. Many farmers and rural professionals are struggling to keep up and navigate a pathway forward as regulators and policy-makers forge ahead in setting new environmental standards along with highly ambitious targets for our industry.

On 5 September 2019, the Government announced National Policy Statements for Freshwater which propose tighter restrictions for further intensification of land use, and significant nitrogen loss reductions in certain catchments. Further to this, the Zero Carbon Bill continues to weave its way through the parliamentary process, which includes some very aspirational targets for biogenic methane emissions levels out to 2050 that largely rest on some yet to be discovered scientific breakthrough.

While our farmers have always shown great aptitude in adapting and shifting their farming systems where circumstances and actions have demanded it, somehow this feels different given the overwhelming scale of new environmental regulations and standards coming down the pipeline.

There is an expectation by farmers and the public of the need to continue to improve water quality entering our waterways and to reduce greenhouse gas emissions. Unfortunately, many farmers and rural professionals are battling to understand what this look likes on-farm and how it can be effectively achieved while ensuring the future viability of farming businesses.

The opportunities for science to find applicable solutions to enable farmers to respond to new environmental regulations seem few and far between as our science institutions also try to come to grips with proposed changes. Once known they then have to embark on the long-winded process of seeking research funding to explore new areas of research that can help farmers apply practical and affordable strategies to mitigate their environmental impact.

Against this backdrop, the Reserve Bank of New Zealand is still considering whether it will require banks to increase the amount of capital they hold. It is widely acknowledged that increased capital requirements will be an additional cost to borrowers as banks build their capital positions. Banks are already tightening up their lending arrangements through greater focus on the repayment of loans and tighter access to credit facilities.

The potential for increased debt repayment comes at a time when farmers will be asked to implement strategies to mitigate their environmental risks. Many of these strategies require additional capital without necessarily increasing on-farm profitability, including the ongoing development of riparian margins, building feed or stand-off cattle pads, and establishing wetlands, to name some.

Competing interests for on-farm capital in meeting new environmental regulations, along with increased pressure from banks for debt reduction, will continue to feature highly in farmers' thinking as well as that of their advisors. More so now on the back of static or declining equity positions, where capital gains in land values can no longer be relied upon to beef up the balance sheet.

The conundrum of being drawn in multiple directions by regulators, banks and the public must seem overwhelming and frustrating to many farmers, particularly where the interests of various groups' priorities are misaligned or directly challenge one another.

Such sentiment and agitation is being seen in a number of farmer and business confidence surveys. Most recently, a Federated Farmers survey showed farmers had the lowest level of confidence in the economy since July 2009 in the wake of the Global Financial Crisis. In this survey farmers were most worried about tougher emissions reduction targets under the Zero Carbon Bill, followed by increased regulation and compliance costs, and then bank debt.

So in spite of reasonably good commodity prices, we have a farming sector down on confidence. In a climate of low confidence there is less inclination to want to change and try new things, which potentially limits the type of step change hoped for by so many.

Building confidence within the farming community has to become critically important if we are to be successful in implementing meaningful on-farm change. This does not solely rest on industry sectors, but needs to extend to central and local government as well as through other influencers, such as the media. A core component of this is to better articulate what the future of the primary industry can look like, and to enhance the knowledge base of farmers and rural professionals in the application of on-farm environmental risk management strategies based on robust science. J

WILLIAM ROLLESTON

OVERVIEW – THE USE OF GMOs IN NEW ZEALAND

Harvesting the ryegrass for analysis
Source: Agresearch (HME Ryegrass)

The use of genetic technologies is being recognised as an important tool to support our environmental stewardship and market claims. Farmers are now facing the challenge of reducing our environmental footprint while remaining competitive and at the forefront of consumer choice. Former President of Federated Farmers, William Rolleston, brings us up to date with this fast-moving development in technology.

Long history since 2003

Genetically modified organisms (GMOs) have been the subject of considerable public angst in recent decades. In 2003, following a Royal Commission of Enquiry into Genetic Modification, 15,000 people marched down Auckland's Queen Street demanding a ban on GMO technology in this country.

The Royal Commission reported that New Zealand should proceed with caution while preserving our opportunities. New Zealand has not moved very far since their report, while the advent of gene editing, along with the pressure on farmers to reduce their environmental footprint, has raised the debate again.

What is genetic modification?

The terms 'genetic modification' (GM) and 'genetic engineering' are synonymous and refer to the *in vitro* (in a test tube) manipulation of the genes of an organism. Genes, made up of DNA, are held within the chromosomes and provide the code for the production of proteins within a cell. These proteins work together to create a particular trait, known as a phenotype.

The DNA which makes up the genes consists of four building blocks or 'letters' – A, C, T and G – which form a readable string just like the letters on this page. The full genetic code (the genome) of a human is around six billion letters long. While every cell in an organism (e.g. a sheep) contains the whole code, the cells within that organism are different (kidney cells are different to liver cells). This is because within each cell type particular genes are switched on or off, and therefore different proteins are produced which work together to make the cell what it is.

Scientists in the 1970s and 1980s learnt how to construct genes in the laboratory, combine them with these switches, and insert them into the genome of an organism to produce a new protein in a specific tissue (e.g. to produce a pharmaceutical protein in the mammary gland of a cow).

The information to create the gene can be obtained from a different species (transgenics) or the same species (cisgenics). It is also possible using these techniques to up-regulate a gene to increase the production of a particular protein, down-regulate it, or knock it out completely.

More recently, gene editing is a technique whereby a gene can be changed by as little as one letter in a targeted way without introducing any foreign DNA – a targeted mutation.

In nature, mutations are random changes in the genetic code. If the mutation is in the reproductive cells (e.g. sperm, ova, zygote, pollen, ovule or seed) it is passed on through the generations. This is the basic mechanism of evolution. Conventional (non-GM) plant breeders use chemicals such as mustard gas or radiation to speed up the mutation rate. Mutagenesis, as it is known, creates thousands of random and unspecified mutations at one time and, in 'a suck and see' approach, they plant the resulting plants to see if any mutations were beneficial. Wanted mutations, conferring disease resistance, for instance, would then be back crossed into the commercial cultivars.

If a book were to represent the genome of an organism, traditional GM would be akin to randomly shoving a pamphlet, possibly on an unrelated topic, in between the pages. Gene editing would be like using the 'find and replace' function on the computer to change the exact word, in the exact paragraph on the exact page, in the way you want to. Mutagenesis would be akin to giving the book and a crayon to a monkey and seeing if it could make any improvement.

Under current New Zealand law, the Hazardous Substances and New Organisms (HSNO) Act, GM and gene editing are strictly regulated but mutagenesis is not.

The use of GM internationally

Like many advances in biological science, GM was first used in medicine. In 1982, Genentech inserted the human insulin gene into bacteria to create the first biotech (recombinant) drug. Until then insulin was extracted from pig and cattle pancreases, but the supply was constrained, demand was increasing, and many diabetics could not tolerate animal-derived insulin. There was also the risk of disease transfer. Recombinant (GM) proteins eliminated these risks while providing supply.

By the 1990s, techniques had been developed to genetically modify plants and these were commercialised beginning in 1994. In particular, plants were modified to resist the herbicide glyphosate or to be resistant to insect pests using genes from the organic spray bacteria *Bacillus thuringiensis* (bt). Bt is used in organic sprays and in the Auckland biosecurity response to painted apple moth where it was sprayed over suburbs.

Broad acre crops such as cotton, corn, soybean and canola were the first to be genetically modified. GM crops have been popular with farmers, and within 20 years of their introduction into the US as much as 90-96% of these crops were genetically modified. Analysis has suggested that the impact of GM has been:

- An increase in crop production valued at US$167 billion
- A reduction in pesticides of 620,000 tonnes
- A reduction of CO_2 emissions of 26 million tonnes in 2016 alone
- An average global increase in farmer profit of 68%
- 2.4 to 9 million fewer farmer poisonings in India.

In the late 1990s, GM was used to protect the papaya from ringspot virus, saving the industry in Hawaii from

Trial after harvest has been completed
Source: Agresearch (HME Ryegrass)

GM products have been developed with direct benefit to the consumer such as low-spray eggplant, non-browning apples, healthier potatoes and 'animal-free' meat.

destruction. By 2016, 190 million ha of GM crops were grown by 18 million farmers in 27 countries. The first releases of GM crops provided direct benefit to the farmer through easier or lower cost production. More recently, GM products have been developed with direct benefit to the consumer such as low-spray eggplant, non-browning apples, healthier potatoes and 'animal-free' meat.

The sale of fast-growing GM salmon in 2015 was the first GM animal product to reach the market. GM wheat was put on the back-burner a decade ago in response to activist and public pressure. However, it is now being trialled in the field by the public sector in Australia and the UK. Also under development by the public sector are GM banana (Australia), ryegrass (New Zealand), camelina (Europe), mustard, chickpea, pigeonpea (India) and rice (South East Asia).

The rate of progress is accelerating. By 2015, there were over 80 GM agri-food products at field trial stage across the globe.

Safety of GM crops and food

Activists continue to assert the environmental harm and health impacts caused by the genetic modification of crops and animals, but these assertions have not withstood scientific scrutiny. Now more than 270 national science bodies and regulators conclude that approved GM is as safe as conventional breeding. Like climate change, fluoridation and immunisation, the scientific debate on safety is essentially over.

The use of GM in New Zealand

GM is used in research laboratories throughout New Zealand – it is a basic and essential tool of biological science. Medical and commercial use of GM began in the 1980s. As well as insulin, recombinant chymosin (a GM form of rennet for cheese-making) was introduced at that time.

Today, many of the modern drugs, known as biologics, are manufactured using GM. Cancer treatments like Keytruda are expensive and there is growing pressure on the Government to fund them through Pharmac.
Live GMOs are also being used in medicine to treat cancer and for vaccination against infectious diseases. A cancer treatment trial in Auckland uses a GM virus to attack liver cancer cells and boost the immune response.

It is now possible to extract immune cells from the blood of a patient and genetically modify them to attack the cancer. New Zealander, David Downes, interviewed on *Radio New Zealand* in early August 2019, told how after months of unsuccessful and aggressive chemotherapy he was given just 2.5 ml of his own cells – genetically modified to become cancer killing cells – and was in remission 28 days later. Gene editing is accelerating these types of developments.

Some claim that New Zealand is GM-free in its food production, but the poultry, pork and dairy industries import GM soy and cotton meal. GM is used in cheese production and a live GM virus is approved as a vaccine for equine influenza. In all, five GM organisms have been approved by the Environmental Protection Authority (EPA) for release into the environment, and 79 GM food products have been approved for importation and consumption by Food Standards Australia and New Zealand (FSANZ).

Our Crown Research Institutes are undertaking a number of GM projects, including those set out in ***Table 1***.

Table 1: GM projects in New Zealand

PROJECT	AIMS AND STEPS
Accelerated breeding of apple trees	• Modify apple trees to reduce the age of flowering • Breed desirable traits conventionally • Breed out the GM genes to leave a non-GM plant
Sterile pine trees	• Produce sterile pine tree to: – Eliminate the risk of wilding pines – Provide more energy for wood production
Enhanced breeding of trees	• Use GM to target, enhance and accelerate desirable qualities in trees
High metabolisable energy ryegrass	• Ryegrass with increased lipid leading to: – Increased production – Reduced methane and nitrous oxide emissions – Reduced nitrogen leaching – Increased water efficiency
Biologic production in milk	• Animals modified to produce bioactive proteins in milk for use as pharmaceuticals, reducing their cost and increasing their availability
Low allergenic milk	• Milk produced specifically for those with allergies to particular proteins

Gene drive is a gene-editing technique that is opening up possibilities for the control of mammalian predators.

The market

It has been argued that New Zealand will lose its markets if we were to release any GMOs into the environment. It is certainly well known that purchasers of our product express a non-GM preference. What is not so clear is what would trigger rejection or discounting were GMOs to be released into the New Zealand environment.

The evidence suggests that there is no premium for GMO country freedom. New Zealand meat sells below Australian meat where GM crops are grown. GM-free canola, while selling at a premium to GM canola, sells at the same price whether it is grown in GM-free Tasmania or on the Australia mainland where it co-exists with GM canola.

The Corngate political storm, where in his 2003 pre-election book *Seeds of Distrust* Nicky Hager accused the Helen Clark Government of covering up an inadvertent release of GM crops, caused not even a ripple in the price of New Zealand products.

It is a marketing maxim that consumers pay a premium where they perceive value. For some consumers, that is where GM has been avoided in the production process. The US non-GM project claims US$19 billion worth of products have its certification. In the context of the US$5.32 trillion food market, this represents around 0.36%, leaving the other 99.64% available for GM or GM-derived or unlabelled products.

On the other hand, some GM products are perceived as more valuable than their conventional counterparts. In Bangladesh, GM eggplant, which requires less pesticide, is perceived as safer and sells at a premium. The unashamedly GM Impossible Burger is selling well at a 50% premium because it is perceived as healthier and better for the planet.

Food products which are more than 1% GM (per ingredient) must be labelled in New Zealand. Processed foods where no GM DNA or protein is detectable, such as vegetable oil, are exempted. Animals that consume GM feed do not need to be labelled. At the same time, they cannot be labelled as GM-free. Our trading partners have similar rules.

Co-existence of GM and organic

The Royal Commission heard from those opposed to genetic modification that GM would destroy the organics industry and co-existence was impossible. This set up the argument that New Zealand's future was either organics or GM.

Court cases claiming contamination have hit the news from time to time, but faded again as the claims have been rejected. However, the negative publicity has tended to stick and provided a public narrative that co-existence is not possible.

The reality is that 20 years on the US is the largest producer of biotech (GM) crops and is also one of the biggest producers of organic food. New Zealand even sources 'GM-free' corn seed from the US where 93% of the crop are GMOs. There is no regulation to maintain co-existence in the US, but good neighbours, realistic purity standards and industry practices (akin to seed purity standards and protocols here in Canterbury) ensure that GM, conventional and organic farmers can farm together.

Further opportunities

Opportunities for New Zealand fall into two categories: gene editing where there is no addition of foreign DNA to accelerate genetic gain in our production species; and traditional GM to achieve these outcomes which cannot be achieved with conventional (non-GM) breeding. Traditional GM, which would require labelling, is unlikely in those products which are directly consumed – our sheep, cattle, fruit etc – until there is stronger market acceptance. More likely is modification of our animal feed crops, rumen bacteria, trees or for pest control, bioremediation and biosecurity. There also exists the opportunity to develop new products such as alternative proteins, human and veterinary medicines, and bioplastics.

Gene drive is a gene-editing technique that is opening up possibilities for the control of mammalian predators. Modified male possums, rats or stoats that produce only male offspring will spread that trait quickly through the population, leading to its collapse. Gene editing is also being looked at to control wasps.

Gene editing where no foreign DNA is added can be considered a form of precision breeding to help us address environmental issues such as methane emissions and water quality, and to improve animal welfare such as polled cattle to avoid de-horning. The advantage of gene editing is that even if the same outcome could be achieved through traditional breeding, the rate of genetic gain is accelerated because there is no need to back cross to eliminate undesirable traits – an inevitable consequence of conventional breeding.

Where to for GM regulation?

The use of GM is regulated by the EPA and GM food by FSANZ. New Zealand regulations are some of the strictest in the world. Even within the laboratory, using low-risk GMOs requires multiple levels of authorisation and form filling, whereas in other countries these organisms are considered no-risk and using them is a permitted activity.

Royal Gala – a GM apple tree variety with constant flowering breeding parents and that flowers and fruits at the same time
Source: Plant and Food

Using GM in agriculture is possible in New Zealand, but getting through the regulatory system is expensive and impractical, creating in practice a *de facto* moratorium. To be clear though, there is no national moratorium either in legislation or policy.

In the spirit of openness and inclusion our system provides for public participation in applications for field trials, controlled release and, in some cases, for development in containment. Activists have used this to their advantage, resulting in acrimonious hearings and court battles where the decisions of the regulator are challenged. This not only results in significant expense and delay for the applicant but, if approved, the conditions can be onerous and unjustifiable.

By comparison, in Australia or the US, applications simply require an exchange of scientific and risk information between the applicant and the regulator, resulting in approval conditions which are more appropriate to the actual risk. This is why AgResearch have chosen to conduct their ryegrass field trials in the US.

In a rather circular argument strict regulations are sometimes cited as evidence that GMOs are dangerous. However, while regulation is (we hope) informed by science, it is, in the end, a political response.

'Genetic modification' is a legal classification, not a scientific one. In 2014, the High Court confirmed that gene editing is considered GM under New Zealand law. The corollary was that mutagenesis must also be GM so New Zealand had, according to law, been growing thousands of hectares of GM crops since the enactment of the HSNO Act. Red-faced officials quietly rewrote the regulations to exclude mutagenesis. Now any breeding technique developed after 1996 must be specifically excluded by Cabinet from the definition of GM.

Australia, the US, Japan and Sweden have moved to classify gene editing as 'not GM', but in Europe it remains as GM for now. Gene editing is not only cheap, accessible, precise and predictable, it is also undetectable. It will therefore be almost impossible to be sure we have kept gene-edited organisms out of New Zealand.

I discussed gene editing with a cattle breeder recently. He was enthusiastic about what it could do for his breeding programme, but also made the point that it would allow his competitors to catch up. This illustrates the dilemma for New Zealand, as it will be increasingly difficult to stay competitive if we do not use gene editing technology.

In addition to the strict regulation and a conservative regulator at central government level, some local councils have chosen to place moratoria on the use of GM outside the laboratory. This means that some farmers will be able to use GM which has been approved by the EPA and some will not. Council bans have also affected medical treatments. A strict and poorly thought through ban on GM by the Auckland Council almost saw a liver cancer treatment trial prohibited. Fortunately, the rules were modified at the last minute to enable it to proceed.

The HSNO Act is 20 years old and there is criticism that it has fallen well behind the science. Environment Minister, David Parker, has expressed no intention to change the rules saying they do allow GM to occur. He is right, but he ignores that the system is not efficient, not cost-effective, and not practical because it targets a technology and not the risk. Therefore, it is not enabling.

Scientists are now speaking publically in support of genetic technologies and legislative review. Politicians across the House are beginning to join that call as they recognise the environmental challenges we face and the need to have all the tools in the toolbox at our disposal.

Dr William Rolleston CNZM operates a farm and biotech business in South Canterbury. He is Chair of the Life Sciences Network and has led the biotechnology industry, Federated Farmers and the World Farmers Organisation.
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JOHN GILES

A UK PERSPECTIVE – WHAT HAPPENS TO UK AGRICULTURE POST-BREXIT?

This article from a UK-based author examines the issues leading up to and surrounding the current Brexit negotiations, particularly the impact on their agricultural sector and the possible effects for other countries such as New Zealand.

How did we get here?

The UK voted in a national referendum, and by a close margin of 52-48%, to leave the European Union just over three years ago. Although Article 50 (the legal mechanism by which a country can leave the EU) was then triggered, two dates by when we should have left have already passed. The latest date is now set for the end of October 2019.

Views on the impact of this on the UK agricultural and food sector are almost as polarised as the result of the vote itself. Some will point to a highly positive view of the UK being able to farm and produce food in a manner free from the supposed shackles of the Common Agricultural Policy (CAP), and able to take advantage of new trade deals with the likes of India, China, other Asian markets, the US and Oceania. Others hold a more cautious view and, in some instances, predict a potential disaster.

Political log jam – and a new Prime Minister

In the UK Parliament, there has been an unbreakable political log jam for many months. Some EU countries, such as Ireland and The Netherlands, have made it clear that they would rather the UK didn't leave at all and would be prepared for further discussions on how any adverse impacts of the UK departure can be minimised when it exits the EU.

Leaving the EU without a deal would mean reverting to trade with other EU countries on WTO terms, with much higher import and export tariffs in place for the UK.

The agri-food sectors of both these countries are intertwined with the UK, not just over trade, but with a series of significant investments in joint ventures, mergers and acquisitions over a prolonged period of time. In Ireland, there is additional concern over the nature of border and security arrangements between Northern Ireland and Ireland. Others in the European Commission and European Parliament are more tough nosed in their approach and have stated that there can be no further negotiation on what has been agreed to date.

The ongoing political wrangling in the UK eventually cost Theresa May, the Prime Minister throughout most of this process, her position. She was personally a 'remainer', and looked to reach a consensus across the political spectrum but failed. She therefore ended up pleasing no-one.

Enter a new Prime Minister in July – Boris Johnson. He is a committed 'leaver', and his first Cabinet appointments were also packed full of other committed 'leavers'. He has said repeatedly he is willing to walk away from the EU in October without any deal in place. Even if Johnson wants to do this, it still needs to be ratified by the UK Parliament, but to date this has proved to be impossible. In the Spring of 2019, seven different options on how to leave the EU were all rejected by Parliament. However, a US$6 billion package to prepare for a No Deal, and a US$125 million public advertising campaign on this that was funded by the Government, suggests he is deadly serious about this.

Deal or No Deal?

Leaving the EU without a deal would mean reverting to trade with other EU countries on World Trade Organisation (WTO) terms, with much higher import and export tariffs in place for the UK, and much stricter regulations on the movement of labour around the UK and EU as well as a potential hard border between Northern Ireland and Ireland. A 'deal' would see a much softer approach to all of these issues and maybe the UK staying in the EU Customs Union for a further period.

Johnson has stated initially that he sees the chances of a No Deal Brexit as minimal and we could still stay in the EU Customs Union for a further two years while the UK re-negotiates what was agreed under May's leadership. In more recent days he has also stated that this could now also be a "touch and go" process and that a No Deal is still on the table as far as the UK is concerned. Even in the time between now and the end of October it seems likely that a good deal of brinkmanship on both sides is inevitable.

Johnson has also stated that the blame for a No Deal scenario would be laid squarely at the door of the European Commission in Brussels for failing to re-engage in further talks on what conditions underpin the UK's departure. It is clear to see why he might not be the most popular person in Brussels at the moment.

We need to import

Where has this left the agricultural and food sector and what might be the consequences, especially of a No Deal Brexit? Historically, the UK has over a very long period of time been a large net importer of agricultural and food products, and its one reason we had an Empire. We are now only about 60% self-sufficient in food production, and this is even lower in some cases such as horticulture. Put bluntly, we have to import. There is a big danger that these imports could be severely impacted if the UK left with a No Deal. Increases in UK production could be seen, but there is an awful lot of ground to regain and investment required to do this.

WTO tariffs for fresh produce, as an example, range between 15% and 20%; for dairy the rate is 35% and for red meat up to, in some cases, 80%. This would inevitably see supply chain prices rise, but no-one wants that, not least the consumer. And certainly not fresh fruit and vegetable exporters to the UK from the rest of the EU, the US, Chile, Peru, South Africa, New Zealand etc, or dairy exporters from the EU and Oceania countries.

The imposition of import tariffs would see domestic grower/producer prices rise, but on top of import tariffs, additional costs incurred such as border and phytosanitary checks and potential transport delays might add anywhere from 5-8% to import costs. Increased prices in the supply chain would logically lead to food inflation and potentially reduced consumption. This is not good news for UK farmers, the rest of the supply chain or consumers.

New trade deals?

There has also been lots of talk of new trade deals with the rest of the world, post-Brexit, and this includes the US. On his recent visit to the UK, President Trump talked of doing a 'quick and outstanding' trade deal with the UK. But how quick is quick – two years, three years, five years? And 'outstanding' for who? Agriculture and food would be at the heart of this. And rightly or wrongly, the UK has very strong views on areas such as chlorinated chicken, hormone-treated beef and GM soybeans, all of which the US would love to export to the UK. This will not be an easy negotiation.

UK milk parlour

Many farms in the UK are now very dependent on migrant labour from Eastern Europe, and in the build-up to Brexit we have already seen a steady stream begin to leave the country.

Talks on this were to begin in August though, according to latest reports, and might end up with US exporters having much better access to the UK. This would only add to the competitive pressure faced by UK farmers. They might have also lost great access to lucrative EU markets – something of a double whammy.

There is similar concern that a trade deal with Australia and New Zealand would benefit farmers in these countries, more than it would do the UK, not least as their producers are already well versed in operating in international markets. Much depends on whether Oceania-based farmers and exporters see the future opportunity in the UK or other exciting markets (such as China), or other South East Asian countries (such as Indonesia, the Philippines and Malaysia), where they have already established an increasingly strong foothold.

Areas of concern

There are a number of areas of huge concern for the UK agricultural industry about the impacts on domestic farming and food such as:

- **The UK Government will need to develop its own agricultural policy**

  This will be in time to replace the EU Common Agricultural Policy. The HM Treasury has in the past stated that the only reason they pay out subsidies is because they have to as part of our EU membership. Given an opportunity to remove these subsidies, they would, as it does not fit UK Government thinking, almost regardless of which political party is in power.

A new UK Agricultural Bill is working its way through Parliament, but has been bogged down in the Brexit process. There will be increased payments for good environmental practices and the supply of public goods and services, but reductions for more conventional production support. Existing levels of support for farmers will be guaranteed in the relatively short term, but will then almost certainly go through a fundamental review over the next five years.

The reality is that too many farmers in the UK are overly-dependent on CAP-type support. Without an urgent restructure of how farms are managed and financed, any reduction of CAP-type support will put UK farmers under severe financial pressure. This is particularly the case in the beef and sheep sectors, and potentially smaller dairy farms, whereas the horticultural sector has not traditionally received high levels of production support and thus would see less of a detrimental impact from any reduced support.

- **Market access to the EU**

  A very high percentage of UK exports go to the EU, and in return many products are imported from there. In the case of fresh produce, for The Netherlands, the UK is their second most important market with trade in fruits and vegetables worth some £1.1 billion per annum. For Spain, the UK is their third most important market, with fresh produce exports to the UK worth about £1.6 billion. For many horticultural products, especially tomatoes, cucumbers and peppers, there are few alternative external suppliers of high-quality produce beyond the EU, especially The Netherlands and Spain.

- **Access to labour**

  Many farms in the UK are now very dependent on migrant labour from Eastern Europe, and in the build-up to Brexit we have already seen a steady stream begin to leave the country. This is because, in some cases, they no longer feel welcome in the UK per se, but also with a weakened Sterling, the wages of East European nationals living in the UK have already fallen compared to what they might be able to earn in other parts of Europe.

  We are already struggling to find the right labour for our farms and this issue will become more acute. Post-Brexit, it is likely that the supply of this labour could be restricted and the administrative burden associated with sourcing it will increase.
- **Effects on costs and prices**

  As most crop inputs are traded globally in USD, any weakening of the Sterling would see the costs of fertilisers and chemicals to growers increase. At the same time, a weaker Sterling might also see UK agri-food production become more price competitive against imports per se. It is expected that, overall, there will be more price volatility in the UK market.

Initial impacts on the dairy sector

For individual sectors, at Promar International we have carried out an analysis of a number of specific sub-sectors, including dairy, which is of special interest to New Zealand. We believe that the true impact of Brexit might not be felt for some time, but will accelerate (at least in the short term) many of the trends and changes we have seen already playing out over the last 10 years.

Based on our insight and industry feedback, we also suspect there will be no drastic wholesale exit from the sector, but this will continue at the same levels as seen in the past at around 3% per annum. Herd and farm sizes will gradually get bigger over time. Exit levels will still be driven by the relative age of dairy farmers in the UK and the lack of effective succession planning. In some cases, this might provide opportunities for younger farmers.

Those farmers who are on the so-called aligned contracts with major retailers will be best positioned to continue to invest in their farming operations, while those who are not will remain more vulnerable to volatility in overall market conditions. The key task for dairy farmers will still be to have a greater understanding of the true costs of production and then have the ability to control these.

Most of the farming systems found in the UK dairy sector will largely remain. However, there might be a move, in some cases, towards more specialisation with the increased use of Spring calving and robotics etc, which is already happening.

Welfare standards upheld

At one stage, many farmers who voted for Brexit seemed to believe that exiting the EU and the CAP might end in a 'bonfire of the (EU) legislation'. UK retail support for liquid milk, however, will remain high and standard/accreditation schemes such as 'Red Tractor' will continue to set the minimum requirement for suppliers beyond any statutory legislation.

Supermarkets will raise the standards required by looking for the additional attributes of animal welfare, animal health and the all-round sustainability credentials of their farmers. Animal welfare will still be seen as a key issue for farmers to address and there will be no slackening of this. UK consumers will still want to see dairy products being produced to a high standard.

No-one is totally safe

Lower-performing UK farms, regardless of size, will be put under pressure first and could easily end up quite quickly with serious financial difficulties and face bankruptcy and insolvency. The pressure to exit the sector will increase on the lower-performing herds. Even the more able farmers might consider exiting the sector when faced with the cold facts, but their decision to do so will be based less on emotion and more on the reality of the situation. Indeed, they might be the first to exit, as some others will continue to bury their heads in the sand and pretend this is not happening. Banks are unlikely to lend to any dairy farmers who do not have in place well-developed business and succession plans.

Processors and retailers alike will want to protect their milk pools and avoid any sense of panic. This will see them look to strengthen the integrated nature of their supply chains.

The really talented dairy farmers will be more involved in the multiple ownership of units on different sites and the development of new units. They will be the farmers to lead any growth in UK production. There might be some farmers switching from beef/sheep (and the arable sectors), as they are likely to be hit harder by Brexit and might end up considerably less profitable than in the past. Farmers who have excellent all-round management skills will do best of all.

More volatility is the new norm

With reduced protection in the mid to long term, UK dairy farmers will truly be more exposed than ever to global milk price volatility, and when/if prices go low the traditional response of 'tightening the belt further' is unlikely to be enough on its own. Farms of between 200 and 300 cows will feel the pressure of labour issues most of all. Some will choose to go down the robotic route and more skilled labour will inevitably be required, but as noted this is already in short supply.

There will be a move towards bigger farms, with more use of larger rotary-type parlours and not just the use

Lower-performing UK farms, regardless of size, will be put under pressure first and could easily end up quite quickly with serious financial difficulties and face bankruptcy and insolvency.

of robotics. Farmers might find it more difficult to obtain credit with adverse knock-on impacts to the rest of the supply chain such as vets, feed companies and other input suppliers.

The need to control and reduce costs will see more farmers move to more grazing-based systems and focus on keeping farming systems as simple as possible, especially for the use of labour and machinery. There is likely to be a move to more shared farming agreements/arrangements and collaboration between farmers on a 'needs must' basis.

Farmers who can control/manage their costs well will still be able to make money from dairy farming, but those who are not able to do this will find life tough. Those with high levels of existing debt will struggle in particular. All UK dairy farms might be at some risk, but clearly some more so than others. Farms still need to be run more efficiently and in a much more business-like manner. UK dairy farmers will be producing in a very different market environment and the overall mindset of the industry will be forced to change.

Supply chain impacts

UK milk production is running at around 14 billion litres over the last few years. The five-year average UK farm gate milk price was 27.23 pence per litre (ppl) in the summer of 2019, down 2.4% from the same the month in 2018 when it was 27.91 ppl, showing the relative stability of the five-year average. The average can hide a wide degree of variation though with the highest prices being paid to UK dairy farmers reaching 33 ppl and the lowest, typically for processing contracts, much nearer to 25/26 ppl.

The UK dairy sector is strongly intertwined with the rest of the EU – 90% of our dairy imports are from the EU and 70% of our dairy exports also go to the EU. And a number of the leading processors – the likes of Muller and Arla etc – are all EU-based businesses too. The impact of leaving the EU in October 2019 is likely to have far-reaching consequences across the supply chain as a result.

High-end retailers will encourage farmers towards outdoor systems of production, but the majority will want them to control the costs of production, and so there will not be an automatic move to these. Indeed, there might be moves to increase indoor production and the development of higher-yielding herds.

The issues surrounding the availability of labour will act as a brake on the development of so-called super units.

There will be no major change in the key geographic areas of dairy production in the UK. Any potential expansion in the sector to potentially replace UK imports of dairy products will be driven by the demands made by retailers and the ability of processors to expand capacity and invest in this.

Processors might find it difficult to procure sufficient volumes of milk. The smaller, less efficient of these, in particular those producing non-branded products or own label retail products, will find life much more difficult. The potential lack of milk would drive the further consolidation of processing capacity, especially for cheese.

To do this, there will need to be investment in processing capacity by the leading players, many of whom are somewhat ironically owned by the Irish, Danes, Germans and French. Like it or not, the fate of the UK dairy sector is massively interlinked with Europe, regardless of Brexit. A great British dairy sector? We are part of a global supply chain, but sometimes act like we are not.

The likely reaction of the UK retailers to a No Deal would be that, faced with less options for imported products, they would look to encourage additional production in order to provide a full range of dairy products for their consumers and also help keep a lid on the price of these products. They would still want to be able to meet the full range of choice of products required by UK consumers and have efficient producers to supply them. The more able and talented dairy farmers, in particular, should be able to thrive in this scenario.

Others will be impacted too

It is unlikely that there will be any expansion in the demand for liquid milk, which has been the subject of long-term decline in the UK. Any growth in the UK dairy sector will therefore be driven by increased demand for products such as cheese, butter and ingredients. This would help displace some of the UK's current imports, especially from countries such as Ireland, who under the prospect of a No Deal Brexit will see their exports to the UK become more expensive.

Indeed, the impact of a No Deal will be felt as much in countries that export to the UK, such as Ireland, as it is here. The Irish have as much, if not more, to fear from a No Deal Brexit than the UK. As a result, the well-organised and resourced Irish Food Board, Bord Bia, is stepping up efforts to identify and develop new export markets, especially in Asia and the Middle East.

UK cow shed

So – what next?

No-one still really knows. The European Commission has said repeatedly that there is no further room for negotiation on what has been agreed to date. The pro-Brexit members of the UK Government believe there is still time to achieve this, but if not they are willing to walk away with a No Deal. This would still have to be ratified by the UK Parliament and, to date, they have been just as divided on this issue as the wider population.

The Government has a wafer thin overall majority. Getting a No Deal through Parliament will still be a huge challenge – and time is running out. The UK is due to leave the EU by the end of October 2019, but Johnson has indicated that this could be done with a further two-year transition period agreed.

In the meantime, the UK economy overall still continues to do relatively well against some of our European neighbours such as Germany, Italy and France. Consumer confidence is somewhat fragile though – and understandably so. The threat of a No Deal Brexit still acts as a brake on many areas of commercial activity. At a retail level, online shopping and the role of the discount stores, Aldi and Lidl, still put pressure on the more established Big 4 supermarkets.

And – for food producers?

For farmers, nothing is agreed, and nothing is certain. What is known though is that the UK farming and food sector is about to go through a huge amount of change in the next five to 10 years. This was happening already, but whatever sort of Brexit we end up with, what we have seen happening over the last 10 years will be accelerated.

Farmers need to be preparing for change and doing this now – not waiting to see what happens over the next five years and then pretending the direction of travel has not been seen coming.

There are many highly able and extremely competent farmers in the UK, but we are going to need more of them in the future. We also need:

- More farming for public goods and services
- Less overall subsidy support
- More use of agri-tech in all its forms
- More genuine supply chain partnerships
- More formal benchmarking
- Better marketing and promotional support
- More efficient production per se.

These will all be part of the future. For those who get organised, plan ahead and engage with suppliers, customers and consumers, it will be an exciting time.

Disclaimer

The views expressed in this article are based on a combination of research carried out for organisations such as the UK Agricultural and Horticulture Development Board, the Welsh Government and a range of private sector clients from across the UK and international supply chain, and (in some cases) are of a more personal opinion.

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RUPERT TIPPLES

Dairy migrants in the news

A NEW APPROACH TO EMPLOYER ASSISTED WORK VISAS AND REGIONAL WORKFORCE PLANNING

This article presents strategic proposals for changes to the existing work visa requirements affecting the dairy production industry. It does not address the new 'Gateway' measures, which will place a major role on employers wanting to employ labour with work visas. These strategic proposals are set in a context of the likely future demographics of the industry and the identified weaknesses of the present system.

Changes in the dairy farming industry

New technology has reduced demand for labour (e.g. rotary milking parlours, centre-pivot irrigators, automated robotic milking), but at a substantial capital cost when many dairy farmers are already heavily indebted. From the 1990s, the dairy industry tended to shift southwards from the traditional dairying areas of Waikato, Northland, Bay of Plenty and Taranaki to the wide open spaces created by converting sheep/beef farms in Canterbury, Otago and Southland to dairying. This was often done by large-scale dairy owners with the necessary capital and was facilitated by the availability of irrigation.

One constraint on these larger farms with more cows was the availability of labour. Whereas farms in the North Island tended to be farmed by owner-operators and sharemilkers with limited (often family/employed) labour, in the South Island most dairy farm labour was employed. However, rural populations were small and diminishing and there was a marked reluctance to engage in dairy farming.

Rural isolation is part of the problem in relation to labour recruitment and the requirement to live on-farm has always been a two-edged sword in farming. Yes, the worker gets a house and the farmer gets a worker on-farm, but losing the job or resigning means finding a new home. In the era of Generation Y (Gen Y or Millenials born between 1980 and 1994), living in the country away from the bright city lights is a problem for maintaining social contact.

In a New Zealand context this has been illustrated for the greater Canterbury area by research entitled *The Influence of the Black and White Tide – Dairy Farming, Landscape and Community Change* carried out by Philippa Rawlinson in 2011. She studied dairy workers who not only found it difficult to form new friendships in rural Canterbury, but also to maintain established friendships when friends in Christchurch failed to maintain contact with them. The dairy workers had moved closer to town for this reason.

Working in dairy farming is considered a 3D job – Dirty, Dangerous and Demeaning – not very desirable to the youth of today.

With the shift of dairying southwards, many managers and other staff moved south too, but that was insufficient to staff the rapidly growing South Island dairy industry. The shortage was filled by migrant workers:

- In 1990, 93% of dairy farming was in the North Island and 7% in the South. By 2015, that had fallen in the North Island to 60% and 40% was now located south of Cook Strait. Moreover, 10% of the workforce were now migrant employees on temporary visas, which had an average duration of 1.5 years, and half of them were from the Philippines
- In Canterbury in 2001, some 13% of employee hires were from beneficiaries and migrants were less than 2%, but by 2013, 11% were migrant hires and only 8% were beneficiaries. Also, in this period there was little unemployment in South Island rural areas.

Another feature is that working in dairy farming is considered a 3D job – Dirty, Dangerous and Demeaning – not very desirable to the youth of today.

Future demographics

The future sustainability of the dairy farm labour force is in question and demographic risks appear to be becoming greater. With diminishing traditional sources of willing recruits, such as young Kiwi workers, the industry is also facing a considerable ageing of the dairy population. The dairy industry had attracted young entry-level workers, but this was not sustained in subsequent age groups (>20 years old). The numbers available in the youth segment of the labour force were declining and would continue to do so. The demographic change is accompanied by the problems with engaging Gen Y in the labour force and continuing problems staffing the dairy production industry.

Besides highlighting the need for more migrants to offset a structural ageing of the dairy farming population, there is the likely increased competition for the labour of young and old alike. From an analysis of the 2013 Census of Population data there is a further long-term problem as suggested by Natalie Jackson in her 2014 article in this journal, 'Demographic Change and Some Observations for the Dairy Industry'. She suggests there will not only be increases in demands for local labour, but also that the dairy industry will be challenged by the '… demographically tight labour market unfolding both onshore and in other countries' (p.12).

Jackson further says that dairy farmers need to ponder this, especially the implications for succession in the industry – who will buy and work dairy farms in the future? The answer so far has been in the use of migrant labour, which many in the industry now believe has become essential to the New Zealand dairy industry.

Why employ migrant workers?

First, in the opinion of dairy farmers, they exhibit dedication to their work, they are reliable and the farmer can depend upon them. They have come to New Zealand for a particular reason – to work. The converse was also important – there have been poor experiences with New Zealand staff. Often they did not want dairy farm work and they go dairying because they want a house or a well-paid job. As they hated the work, there were frequent problems.

In 2012, Elizabeth Christie noted in her research, *Migrant Dairy Farm Staff in Canterbury – Filipino and Chilean Experiences*, that New Zealand workers had:

> *'… no performance … It's very, very easy to motivate motivateable people but very difficult to motivate a person that's unmotivateable … I went dairy farming because I enjoyed farming and not to be a social worker or financing people's accounts or a marriage guidance counsellor … With migrant workers, that stuff has all gone away.' (p.2)*

But what if migration ceases to be a politically acceptable policy? At the present time with rising unemployment rates, particularly amongst youth, such a likelihood is possible.

The unemployed?

The unemployed in New Zealand are not a big group by OECD standards, with the level being 3.9% in November 2018 compared to 5.2% as the OECD average. The subject of youth unemployment is, however, a concern. New Zealand had a rate of 14.1% as at December 2018, compared to an OECD rate of 16% for the 20-25 age group. In New Zealand, the danger is potentially worst for the not in employment, education or training (NEET) group.

Maori and Pacifica youth unemployment has been over 27%. However, the problem is largely an urban one, with most living north of Hamilton or in the east of the North Island. The new dairy jobs are largely in Canterbury, Southland and Otago at the other end of the country in the regions. Their parents and the youth themselves probably know nothing of the job opportunities in these other regions, so there is a serious disconnection between the jobs available and the unemployed youth who might fill them.

Shifting from one location to another to obtain employment is not easy for many unemployed people. Not only might they be leaving their family, friends and whanau, it is not cheap relocating. Further, it may also be a high expense if the 'new' job does not work out. The housing made available by the employer may also be unsuitable, depending on family circumstances.

Dairy migrant from the Philippines

Also, where Maori Incorporations carry out major dairy developments on their lands in both the North and South Islands, they do not appear to have realised how that could provide job opportunities for the tangata whenua in the future (e.g. *The Press*, 13 February 2011). Surely they should be able to provide the socially concerned and appropriate dairy management that the Maori NEET youth seem to need?

History of recent migration schemes

Horticulture and viticulture

Between 2007 and 2014, the Recognised Seasonal Employer (RSE) scheme provided horticulture and viticulture's need for seasonal labour in a way so as to ensure quality and certificated production. The large and relatively under-employed labour force around the Pacific solved New Zealand's seasonal needs for workers. It also delivered win-win-win outcomes for stakeholders in New Zealand and the Pacific:

- *Win for governments* – New Zealand was able to access global labour. Pacific Islands were given work, not aid, and a further source of remittances and foreign exchange
- *Win for growers* – apples were picked on time in the best conditions, with growers enjoying labour supply certainty, so they extended their plantings, thus contributing to the boom in horticultural production and exports
- *Win for workers* – they had well-paid seasonal work and were able to save and send remittances to families and communities.

The RSE scheme was so effective that it became a joint winner of the Excellence in Working Together for Better Services Award in the IPANZ Gen-I Public Sector Excellence Awards in 2011. Its success suggests the merits of a planned and systematic approach to migrant workers in the dairy farming industry. The Consultation papers (2018) are suggesting a number of strategies to go down that road which the author heartily supports.

Dairy

Staffing problems in the dairy industry have been particularly apparent since the rapid growth in South Island dairying during the 1990s. Still, many problems did not go away as revealed by a dairy farming self-analysis in 2007 (*Dairy InSight*, 2007). For example, the self-analysis revealed:

- Dairy farming was not attractive compared to other industries
- The hours were long
- The staff turnover was high and recruitment and retention continued to be problematic
- The accident rate was third worst in terms of injuries per person employed
- Dairy staff were required to live on-farm so were socially isolated
- There was a lack of rural support networks.

Has anything changed since 2007?

While the number of employees in the dairy sector continue to grow, there are still problems with ongoing

While the number of employees in the dairy sector continue to grow, there are still problems with ongoing staff turnover. Retaining staff has continued to prove difficult.

staff turnover. Retaining staff has continued to prove difficult. Informal comments suggest migrants do not change employers as frequently as locals because of the difficulty of changing their visas, but this has not been thoroughly researched.

From 2010, Lincoln University and WEB Research were involved with DairyNZ in a long-term project (2010-2017) to improve the wellness and wellbeing of dairy farming. This was terminated early in 2014 after identifying what made for 'Decent dairy farming' in Canterbury through a 2013 report by Tipples, Hill, Wilson and Greenhalgh:

- *What a 'decent' dairy farm has.* It provides good accommodation, which is comfortable, well maintained, safe, warm and well fenced; good working hours that are fair, with regular time off, which is negotiable and with enough employees; operating in a safe working environment with an active health and safety plan, hazards map and relevant training and appropriate safety gear
- *What a 'decent' dairy farm does.* It provides good leadership, with employees knowing the targets of the business, and fairness, with each getting home on time. Clear expectations also featured. In terms of rewards, a decent dairy farm was one which told its employees when they had done well, and which provided job variety and flexible rosters, with the chance of increased responsibilities
- *What characterises a 'decent' employee?* They could explain why they wanted to work on their farm and knew what that required. They were healthy: physically, emotionally, psychologically robust and drug-free. Some previous work experience was seen as good, but it was not essential. Where they were in a relationship, valuing family life was seen as important, together with being 'house proud'.

These results were incorporated in a joint employment package developed between DairyNZ and Federated Farmers of New Zealand called *A Sustainable Dairying Workplace Action Plan*, which was launched on 8 October 2015. This puts forward a range of policies for dairy employers to adopt to improve the employment relations of their businesses, much as the horticulture and viticulture industries were required to improve their employment practices before the RSE policy was introduced.

It marks a radical change in the attitude of the dairy farming industry, moving beyond the need to be compliant to seeking what would make good employers, which should at last impact on the long-standing recruitment and retention problems in a more-than-trivial way. Now that has been done, the dairy industry is in a much stronger position to ask the Government to facilitate the entry of migrant dairy workers to keep the industry in a sustainable state. That case seems to be well supported for the South Island where they are believed to make up 10% of the dairy farming workforce.

Problems with current immigration regulations

One of the major limitations for migrant dairy workers is that they are allowed entry to work in New Zealand on temporary visas with an average duration of 1.5 years. While considerably longer than seasonal horticulture visas, such short-term visas reduce the value for New Zealand of any investment made in their ongoing training, which is vital to keep up industry productivity.

Also, off-farm training helps to counter rural isolation as well as maintaining the human capability invested in the industry. In effect, off-farm training provides an important point of contact with other dairy staff in a situation which is quite unlike that they would have encountered in their own country. Approximately one-half of migrant workers in New Zealand are from the Philippines, a country of 100 million people, who are used to a lot of close social contact. Training sessions provide that to a degree. Further skills training is also needed to continue to develop industry productivity and use the investment of employers and government, via the Primary Industry Training Organisation, to best advantage.

While many of those visas are of short duration, the fact that they are often renewed for the same farm shows that dairy farmers appreciate the migrants' contribution as they have to support such renewals. The retention of the more 'New Zealand experienced' migrants is important as their skills are readily recruited by other international dairy producers such as Australia and Canada. Recently, the former President of the Filipino Dairy Workers in New Zealand Inc. moved to Australia as there was a better chance to obtain permanent residence there.

In field work in Canterbury and Southland for our report in 2013 we found that farmers go out of their way to support cases for migrants to gain permanent residence, only to be frustrated by the job classification and related job descriptions used at the time to assess them. The main point at issue seemed to relate to the degrees of financial responsibility that the migrant might have.

Financial responsibilities tend to remain with small business owners (which most dairy farmers are), who

Gypsy Day – moving stock

rarely delegate them to anyone, including their own family. Migrants often have full responsibility for livestock and machinery worth millions of dollars, but because they do not have it for cash handling, their cases for permanent residence are rejected. That issue may be a consequence of the New Zealand adoption of ANZSCO, which to a rural labour market specialist seems to be often poorly related to actual New Zealand situations. For instance, ANZSCO does not recognise the roles of Herd Manager or Assistant Herd Manager. In my view, it is extremely unhelpful to let policy be driven by an Australasian statistical classification and it is the reason why we no longer have as much useful farm labour data. Farming can hardly be held responsible for other industries trying to leverage off this distinction that is found useful in dairy farming.

Migrant dairy workers come to New Zealand, often followed by their families, and make a real commitment to our rural communities. They have good family values and pay their taxes. One rarely hears of their involvement in criminal activity. They often go to church, and want to fit in, but that is made difficult by their circumstances as migrants. Many are keen to develop a successful career in the New Zealand dairy industry and ascend the dairy farming career ladder.

In our field work we used schools as locations for focus groups. The migrants brought their children with them when they came to talk to the research team, and they really appreciated New Zealand's free system of education for children. We learned that many of the migrants were graduates and had veterinary and animal science degrees. Their children did well at school and one was dux in theirs. But there is a problem for migrant families. If their children finish school they cannot go to a New Zealand university without paying the exorbitant foreign student fees unless their parents have achieved permanent residence. Yet their parents have been paying taxes since their arrival to work in New Zealand. As there are a lot of graduate migrants dairy farming, surely their children will be the bright young students New Zealand wants to support its future human capability?

One other problem we encountered in our research was the apparent difference in interpretation of immigration regulations between central Wellington-based staff and those out in the regions such as Invercargill. While this is understandable, it is not desirable, especially if it requires expensive trips to Wellington to sort out the inconsistencies. The most recent proposals in the 2018 Consultation papers at last seem to address the issue of regional needs rather than just lumping all national issues together.

Effect of proposed changes on 21st century dairy farming

The Review of Immigration New Zealand skill shortage lists – Farming (2015) was problematic. Several features did not seem to clearly portray what actually happened in the dairy industry and the dairy farm labour market. The new 2018 proposals appear better attuned to regional needs for temporary migrant dairy workers with their regional and sectoral focus. Potential pathways to permanent residence are still essential for revitalisation, the future supply of dairy farmers (potentially inadequate) and enhancing the human capability of the New Zealand labour force at large. Migrants generally want their children to get ahead via a good education.

The true value of migrant workers is not in their coming just for one visa period to New Zealand, but staying so that their skills remain in the industry. Further, their children will add to the future human capability of New Zealand. In the case of the RSE scheme, it was the same temporary migrants returning year after year which added the extra value. They did not need to be trained again and could train other new migrants. Then they help to maintain continued productivity growth and provide future experienced staffing for the industry. The current job hierarchy offers career progression, and the motivation to continue developing and do well for their employers and their families. Thus, they can repay the investment in them by their employers and indirectly the Government through the funding of the Primary Industry Training Organisation.

Key points

- *Fewer Kiwis want to work in dairy farming.* If they come off the unemployment register or are jobseekers they may be more prone to turnover and this will add to the industry's retention problem. They can bring a range of social problems that the dairy industry can well do without
- *Migrants come and work.* If they do not, they have to go home again. Generally they want to do well, develop themselves and ascend the dairy work pyramid. Many seek to achieve permanent residence, but are often frustrated by unfair administrative requirements. As many are very well qualified they would add to New Zealand's stock of human capability. Their families add to it too and their rapid integration into New Zealand society and all its benefits should be encouraged. Many South Island rural communities and schools have been reinvigorated by the influx of dairy workers and their families from wherever they have come
- *More migrant dairy employees reaching permanent residence would allow more to become the next generation of dairy farmers.* This would overcome the weakness of the present succession scenarios. Who will be the dairy farmers of tomorrow? Greater chances of obtaining permanent residence, maybe with a bond to continue in the dairy industry, would further enhance the desired sense of career progression in the industry
- *More migration is good for the economy.* Migrant dairy workers are good employees, taxpayers and potential citizens. Increasing the overall rate of migration for all migrant categories to New Zealand by 40,000 per year would, as noted by the NZIER in 2014, add $410 each year per capita to GDP. The proposals to simplify and rationalise the administrative hurdles for visas is highly desirable. To encourage more migrant dairy workers to become a permanent part of New Zealand and the future of dairy farming needs serious consideration because the industry is facing a future staffing crisis that will not be resolved by future mechanisation.

There needs to be a triple win for changed migration regulations for migrant dairy farming workers: a win for government, a win for dairy employers and a win for dairy migrants.

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PHIL JOURNEAUX

OFFSETTING PASTORAL GHG EMISSIONS USING FORESTRY

Over recent months The Journal has run various articles on climate change/greenhouse gas (GHG) emissions. One of the factors raised about using forestry as a pastoral offset is the concept that this is not a permanent solution – that a landowner will need to continue to plant additional forest areas once the initial areas are harvested. This appears to be a difficult concept to grasp, so this article is an attempt to clarify this issue.

A practical example

The easiest way to illustrate this issue is to give a practical example, so assume a 640 ha sheep and beef farm emitting 1,984 tonnes of GHGs per annum. To offset this by 100%, using the new averaging system which is about to be introduced, the farm would need to plant 148 ha of pine trees. This area would vary by region, but let's stick with this illustration for the time being.

In this example the farmer plants the 148 ha of pine trees. In year 28, when the trees are harvested, two things are required: first, the initial 148 ha needs to be replanted, and secondly a further 148 ha needs to be planted.

Why? The first 148 ha needs to be replanted because the GHGs emitted by the farm over the 28 years is still in the atmosphere, and will be for a long time, and still needs to be offset. The reason behind this is that, under the Emissions Trading Scheme (ETS), the carbon stored in the wood harvested (approximately 50% of the tree under averaging) is deemed to be lost, while the remainder of the tree (the stump, roots and slash) rots away over time and the carbon is released.

Essentially, the farm has emitted GHGs for 28 years which have been offset by the carbon stored in the forest. However, under the averaging scheme, half the carbon in the forest is assumed to be emitted or burnt into the atmosphere and the other half is stored in the forest which remains. Under the ETS no further carbon can be stored by that first 148 ha forest as it is now in a harvest rotation, so the farm needs another carbon storage or offset solution and is effectively back to year 0. The farm therefore has to replant the forest to continue to offset the GHGs emitted up to that point.

The forestry industry is working with the Government on this issue because whether the carbon 'vanishes' at the time of harvest depends on the end use of the wood. If it goes into houses and furniture, then it is likely to be around for another 100+ years, and the intent is to make an allowance for this.

The second 148 ha needs to be planted because the farm is still emitting GHGs, and will do so into the future, which need to be offset. Whether the full 148 ha needs to be planted will depend on the level of GHG emissions. It may well be that as a result of the initial planting the farm operation has reduced somewhat, resulting in fewer animals and less GHGs being emitted.

At the end of the second rotation (i.e. 56 years from the start) both 148 ha blocks are harvested and need to be replanted because: (a) the half carbon in the trees is assumed burnt and has vanished; and (b) the GHG emissions they were offsetting are assumed to still be out there. Now a further area needs to be planted to offset future emissions for the next rotation. Whether this area needs to be 148 ha is moot. By now we've planted 296 ha of our original 640 ha, so it is very likely the farming operation and attendant GHG emissions have reduced, which means the next area to be planted is likely to be much less than 148 ha.

And this cycle continues to repeat.

It is the same for a non-pastoral company seeking to offset their GHG emissions. For example, if (say) Air New Zealand plants an area in trees for timber to offset their carbon emissions, then the same principle applies. At harvest they will need to replant the area to continue to offset the emissions already made, plus plant a further area to cover future emissions. An alternative would be to plant trees just for carbon offset, e.g. natives, which are never harvested.

So the main advantage of using forestry to offset GHG emissions is that it gives us 25 to 30 years to come up with a more permanent solution. If we don't come up with a more permanent solution, then there's going to be a lot of trees out there.

Under the ETS the carbon stored in the wood harvested (approximately 50% of the tree under averaging) is deemed to be lost, while the remainder of the tree (the stump, roots and slash) rots away over time and the carbon is released.

Differential treatment of methane and nitrous oxide

Having outlined the above, there is now a wrinkle to this approach. Under the Zero Carbon Bill, landowners cannot offset methane (CH_4) emissions via forestry directly. The logic of this is not clear, mainly because there isn't any, but it is of crucial importance because 78% of the average pastoral farm's GHG emissions are CH_4. Part of the reasoning is that CH_4 has a much shorter lifespan in the atmosphere, which is why the Government has agreed to treat it separately.

If the Zero Carbon Bill stands as is, then it is still possible to offset CH_4 via forestry, but it is just a bit more complicated. For example, assuming our 640 ha farm is emitting 1,548 tonnes of CH_4 per annum (as CO_2e) (1,984 x 78%), then the landowner could plant an area of trees that sequesters 1,548 tonnes CO_2e per annum (= to 115 ha in this example), sell these via the ETS, and use the money to offset the cost of the carbon tax on the CH_4.

But given that both CH_4 and carbon sequestration are measured in CO_2e, there's no reason not to offset one against the other directly.

What this would mean is that the forestry regime would need to be tailored to the shorter lifespan of the CH_4. This is not that difficult to achieve, but it means the principle of replanting/planting new areas as outlined earlier doesn't hold in total.

For nitrous oxide (N_2O), which is a long-lived gas, the principle outlined of replanting/planting a new area would still hold. But inasmuch as N_2O makes up 22% of a farm's emissions, then the area of forestry required to just offset the N_2O would only be 22%, i.e. our 148 ha would reduce to 33 ha.

Happy planting!

Phil Journeaux is an Agricultural Economist working with AgFirst based in Hamilton. Email: phil.journeaux@agfirst.co.nz.

Trees provide shelter and shade for livestock
Source: GroundTruth Ltd

Pasture livestock and forestry upper Manawatu
Source: GroundTruth Ltd

JACQUELINE ROWARTH, ANTS ROBERTS AND MIKE MANNING

REGENERATIVE OR SUSTAINABLE AGRICULTURE – SIMILAR OR DIFFERENT GOALS FOR NEW ZEALAND?

Regenerative agriculture is the new 'organic' being upheld as an environmentally-friendly alternative to conventional agriculture. The concept is that regenerative agriculture releases farmers from dependence on agribusiness products and results in sustainable food and fibre production. This article examines the approach in the context of New Zealand's current systems and considers what such a change would mean globally.

Introduction

Regenerative agriculture is being promoted as the way forward for New Zealand agriculture. Instead of purchasing synthetic fertilisers for soil fertility, farmers are being urged to adopt diverse crop rotations, no-till planting and management of livestock grazing impacts thereby restoring soil carbon and biodiversity. The proponents of the system have used research from overseas to make their case for a move towards what they believe is a more sustainable system for food and fibre production.

The ability to change does, of course, depend on the starting point and environmental conditions in which the change is being requested. New Zealand soils, topography and climate are very different from conditions in other parts of the world from where the 'urging' has originated. This puts into doubt whether the concept of regenerative agriculture will achieve the goal of sustainable primary production.

This article should help rural professionals provide their clients with facts that will help maintain agricultural productivity while protecting the environment, i.e. achieve sustainable production systems.

Regenerative agriculture ... [is] ... a system of farming principles and practices that increase biodiversity, enrich soils, improve watersheds and enhance ecosystem services.

Sustainability

The United Nation's Food and Agriculture Organization (FAO) agreed to a framework for evaluating sustainable land management in 1993. The concept followed acceptance that after a focus on production the new need was 'a value system which enshrines the principle of sustainability over generations.' Framework authors Smyth and Dumanski acknowledged that sustainable development means different things to different people, but emphasised that the idea itself is simple. They suggested that models for a relatively steady state society should be developed, with population in broad balance with resources and the environment.

The FAO framework includes notions of limits to resource availability, environmental impact, economic viability, biodiversity and social justice. Of particular importance in the current discussion about the path to achieve a sustainable future for primary production in New Zealand is its emphasis on the concept of sustainability being dynamic: 'what is sustainable in one area, may not be in another, and what was sustainable at one time may no longer be sustainable.' The framework also acknowledges that sustainability cannot be measured directly, but that assessments of sustainability can be made on the performance and direction of the processes that control the functions of a given system at a specific location.

The accepted FAO definition of sustainable land management in 1993 is set out below and contains five points:

Sustainable land management combines technologies, policies and activities aimed at integrating socio-economic principles with environmental concerns so as to simultaneously:

- *maintain or enhance production/services (Productivity)*
- *reduce the level of production risk (Security)*
- *protect the potential of natural resources and prevent degradation of soil and water quality (Protection)*
- *be economically viable (Viability)*
- *and socially acceptable (Acceptability).*

Again, the framework notes that evaluation is made taking into account the physical, economic and social context of the areas concerned. This acknowledges that systems which are successful in one area might not be in another, particularly when factors such as available manpower, marketing infrastructure, or transport are considered. Within the framework it was suggested that evaluations should include the local constraints on land use choice which have been taken into account.

Regenerative agriculture

In some contrast to the contextual approach of the FAO towards sustainable land management, proponents of regenerative agriculture present it as the solution for improved primary production for everywhere. Terra Genesis International defines regenerative agriculture as a system of farming principles and practices that increase biodiversity, enrich soils, improve watersheds and enhance ecosystem services. The aim of regenerative agriculture is explained to be reversing global climate change by capturing carbon in soil and above-ground biomass, while offering increased yields, resilience to climate instability, and higher health and vitality for farming communities.

Of note is that the system draws on long-term scientific and applied research into organic farming, agroecology, holistic grazing and agroforestry. The studies are not easily found, however, and meta-analyses of organic (a form of regenerative agriculture that includes other factors such as avoidance of antibiotic use) and conventional production systems do not support the suggestion that one system is any better for the environment or food quality than the other.

The animal component of regenerative agriculture involves 'rotating them frequently through small pastures so they stay bunched together and impact the land evenly via their trampling and waste distribution' and then giving time to 'rest and regrow between rotations.' This rotation has been used in New Zealand for many decades, enabled by the electric fencing developed in this country for intensive grazing situations, which allows breaks to be changed according to grass growth and feed demand or by paddock-to-paddock rotations on more extensive grazing systems. Here, where it has been possible to grow 15,000 kg DM/ha without fertiliser nitrogen (N) from a clover-ryegrass pasture, rotation length is generally around three to four weeks. In dry countries, where soil organic matter accumulation is poor, the rotation may well be months or years.

Soil organic matter has been recorded at 6% after a transition to regenerative farming. New Zealand pastoral soils are generally around 8%, reflecting the following factors:

- Rotational grazing management
- The use of legumes in mixed sward perennial pastures
- The use of mineral N at times of the year when pastures are N limited
- The soils and climates within which the farmer is operating.

The comparisons

Lobby groups and overseas commentators, particularly those talking about the flow of liquid carbon into the soil, are misrepresenting the state of the research on regenerative agriculture and are using comparisons that are simply inappropriate for New Zealand.

Regenerative agriculture proponents make the case that conventional agriculture has destroyed the soil, causing desertification. While there are examples of over-cropping in various countries, pastoral agriculture in New Zealand is very different from the extreme examples. Furthermore, desertification is not the norm.

Research in Canada comparing archived soil samples with matched current soils has reported that soil mineral composition had not declined in intensively-cultivated areas with fertiliser applied appropriately. Author Robin Marles, Senior Scientific Advisor for the Bureau of Nutritional Sciences, Health Canada, has pointed out that most historical reports have not accounted for the changes that had occurred between the decades of testing such as data sources, crop varieties, geographic origin, ripeness, sample size, sampling methods, laboratory analysis and statistical treatment.

At the root of concerns for regenerative agriculture proponents is the use of synthetic fertiliser, particularly N. Greenpeace New Zealand has called for a ban on synthetic N (26 March 2019). Other advocates have suggested that synthetic N erodes organic matter and should be replaced by allowing clover to fix N because plant-fixed N is not susceptible to leaching.

Examination of the research reveals that reduction in organic matter when farm yard manure is replaced by synthetic N reflects a change from a compound fertiliser (farm yard manure, containing carbon, N, phosphorus and everything else) to a single nutrient input. For N loss, research at Ruakura published in 1996 showed that N leaching was the same, whether from ryegrass fertilised with 146 kg/ha N or from ryegrass-clover pastures estimated to be fixing 146 kg/ha N, or from pure ryegrass swards fertilised with the same amount of N as urea.

An alternative explanation of the use of fertiliser nitrogen can be found in research at Rothamsted Research Station in the UK, which showed that the application of extra N could boost crop yields. In particular, the research showed that the form of nutrient (organic vs inorganic) made no difference to yield and that organic N was insufficient to create the highest yields. While it is accepted that 'highest' might not be what is required, the debate needs to be in context with the concept of sustainable land management.

A world without nitrogen

The contention made by proponents of regenerative agriculture that the world can survive without synthetic fertiliser is true, as long as the world accepts a considerably reduced population. Professor Vaclav Smil of the Massachusetts Institute of Technology (MIT) in the US estimates that half the current world's population is fed because of the Haber Bosch process used in the manufacture of fertiliser N.

Although a global meta-analysis did report in 2007 that using N-fixing plants like clover and lucerne can provide enough biologically-fixed N to replace the entire amount of synthetic N fertiliser currently in use, without reducing

The contention made by proponents of regenerative agriculture that the world can survive without synthetic fertiliser is true, as long as the world accepts a considerably reduced population.

the amount of food produced, the report has been widely discredited. What were described as fatal flaws included:

- Claiming non-organic yields as organic
- Misreporting of organic yields
- False comparisons with uncharacteristically low conventional yields
- Multiple counting of high organic yields
- Lack of weighting according to rigour of research.

Frequently forgotten in comparisons of production systems on a per crop basis is the nature of rotations and cover crops. The suggestion that legumes could provide enough N overlooks the facts that growing legumes for soil N (biological regeneration of fertility) interrupts growing food and that legumes are moisture and temperature-dependent. When the legume is grown for food (e.g. pea or soybean harvest), little extra N is found in the soil as it has been removed in the protein crop.

Biodiversity

Biodiversity is a goal for many farmers in New Zealand, hence the planting of native species, QEII covenants and the installation of wetlands on many farms. More is being urged and the regenerative agriculture proponents have stated that removing N fertiliser by 100 kg/ha will increase varieties found in pasture (from one to 16) without reducing food production.

However, the research involved natural grassland where all above-ground biomass dies during winter. Tropical grasses were the bulk of the original mixed sward, and dry matter production was estimated by clipping a small strip; no base yield was given. Nor was there any suggestion in the MIT research report that 'a farm can do away with 100 kg of nitrogen fertiliser (per hectare) and still produce the same amount of food.' It did say, however, that over the 25-year period there was a trend to suggest that once equilibrium had been reached in response to the change in N inputs, there would be no relationship between biodiversity and productivity, which is consistent with other research.

To maintain biodiversity in its current state, it is vital to prevent agricultural expansion. It is expansion *per se* that is the biggest threat to biodiversity, not the type of agriculture being undertaken. Oxford University's Food Climate Research Network has urged the adoption of sustainable intensification, allowing increased production to be met through higher yields on current land to avoid the major environmental costs which would be experienced if the area of agricultural land increased.

Sustainable intensification

The fundamental driver for sustainable intensification is meeting the nutritional needs of a growing global population without despoiling the global environment, which is home to that population as well as biodiversity as a whole. Emeritus Professor Anthony Trewavas at the School of Biological Sciences at the University of Edinburgh has suggested that the current global problems, including climate change and population growth, need agricultural pragmatism and flexibility, not ideology. To avoid catastrophe, he urged all scientists to assert the primacy of properly established and critically assessed scientific knowledge in the formulation of agricultural policy, as well as in all areas of human activity.

Professor Trewavas' proposal is a focus on integrated farm management (IFM), which combines the best of traditional farming with the responsible use of modern technology. Technological developments, backed by science, have allowed the protection of the environment to align with safe, efficient methods of production. IFM emphasises the importance of the context of the system, as does the FAO framework for sustainable land management.

Conclusions

There are few people who would deny that conventional agriculture has, in some areas, had unintended consequences. In the same way that scientific and technological advances created the possibility of increased food production per hectare (e.g. the Green Revolution), and then enabled the identification of unintended consequences (e.g. soil erosion and increased nitrate in waterways), science and technology is already developing solutions.

Precision agriculture, slow release fertilisers and inhibitors all have a part to play in enhancing efficiencies and research is being done in the New Zealand context. Picking a solution based on overseas research without considering the context is unlikely to achieve the five points of sustainable land management, which would have detrimental consequences for farmers and for all New Zealanders.

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MIKE WHITE

SOIL TESTING FROM THE SKY – A REALITY FOR NEW ZEALAND HILL COUNTRY

Improving precision application of fertiliser informed by remote-sensing soil fertility is close to becoming a reality for New Zealand hill country farms. This article provides an update on Ravensdown's Primary Growth Partnership programme 'Pioneering to Precision', which offers important developments for hill country farmers.

Pioneering to Precision

Transforming fertiliser applications from pioneering to precision by capturing soil tests remotely is an ambitious goal. Hill country farms cover a wide range of varying land slopes, aspects, soil properties and altitudes, all of which affect the potential productivity of grass/legume pastures. Even within a single paddock, significant differences in soil fertility occur and all these differences translate to variability in fertiliser responsiveness.

However, in this variability lies opportunity. If we can gather soil fertility on a detailed scale not previously achievable then we can also become much more precise at applying the right nutrient, at the right rate in the right place at the right time, to maximise the return on every fertiliser dollar spent on these farms.

We have now just entered the final year of our seven-year research programme 'Pioneering to Precision', a Primary Growth Partnership (PGP) with the Ministry of Primary Industries. It is three years since I wrote an article in the June 2016 issue of *The Journal* on the potential of this technology and much has changed since then.

A recap

Soil fertility management in hill country has been achieved by traditional soil testing methods involving the physical collection of soil samples representing different land management areas of the farm to accommodate the variability highlighted above. Given the large areas involved, there is a limit to how many samples can be collected to represent a farm's soil fertility.

Nutrient and lime application decisions are then planned to consider this picture of the farm's fertility, pasture and animal productivity, fertiliser costs, product returns and physical attributes of the farm. While this approach has served farmers well in the past, shrinking margins require that we evaluate new ways to maximise the return on fertiliser investment, while also ensuring that we minimise environmental impacts where nutrients are in excess of plant requirements and that fertiliser does not directly enter surface water.

The solution – technology and big data

There have been important advancements in hyperspectral imaging coupled with the rapid sophistication of data analytics. Spectroscopy instruments measure the light that has been emitted, reflected or shone through different objects. Hyperspectral sensors through imaging make a visual representation of the scan, generally measure many more light bands than multispectral sensors, and offer advantages in identifying underlying relationships.

In the 'Pioneering to Precision' programme the relationships being established are the detection of nutrient content and other properties of pasture across farms. In a two-step process the remotely-sensed pasture nutrient content is then used to assess the underlying soil fertility status. The key to making this successful is calibration, and to achieve this the programme has collected over 20,000 soil and pasture samples from a range of hill country farms spread across the country over multiple years.

When the hyperspectral sensor is flown in a fixed-winged aircraft at 600 m altitude it can measure light signatures at a resolution of 1m^2. This is the equivalent of conducting 10,000 soils tests per hectare *(see Figure 1)*, a resolution that cannot be achieved with traditional soil testing. A further advantage of the technology is its ability to cover large areas in a short space of time with a survey rate of 1,000 ha an hour, which is the equivalent of (at a resolution of 1m^2) conducting 10 million soil tests in an hour.

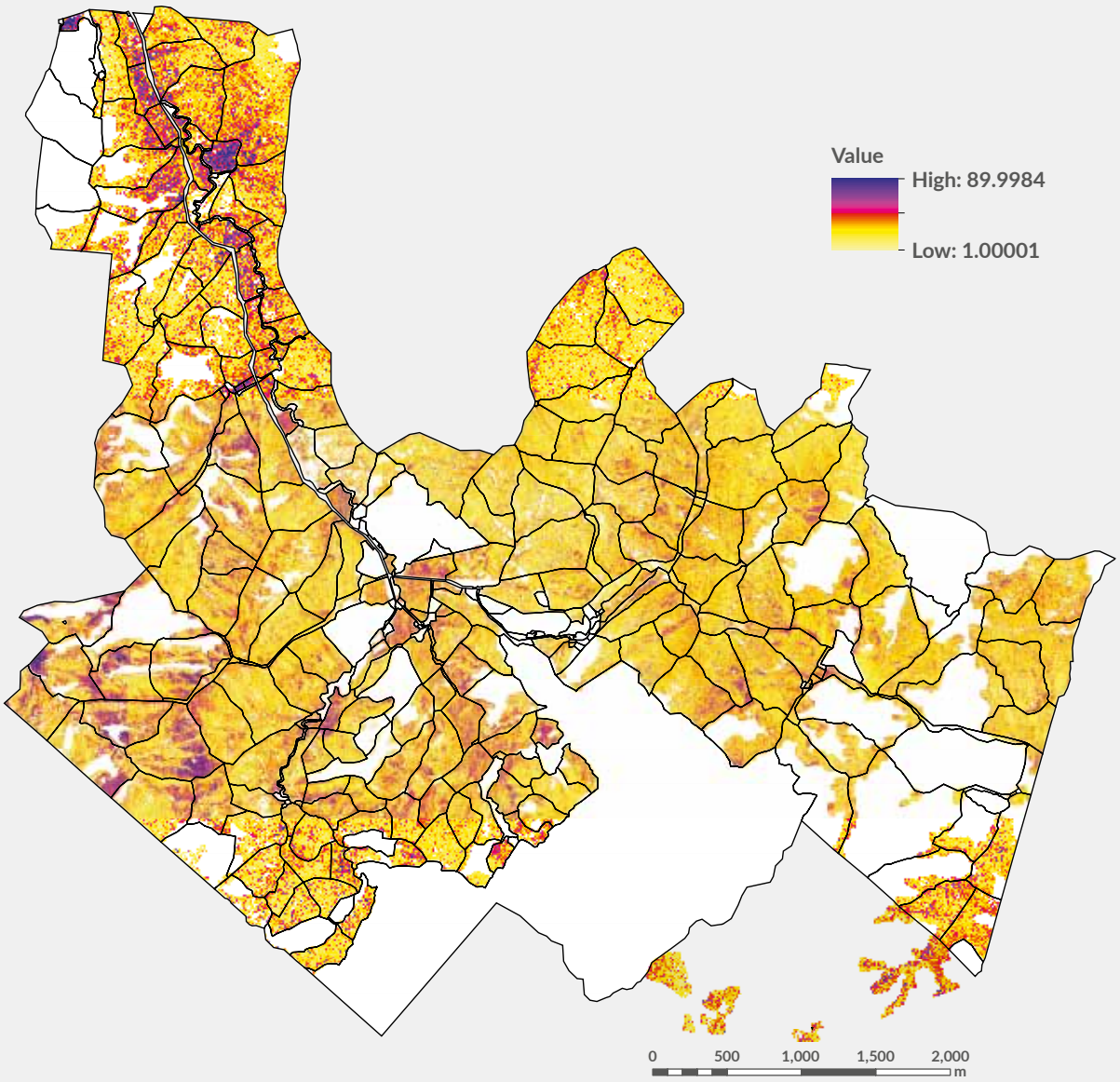

Figure 1: Olsen P prediction of a farm's fertility at a 1 m² resolution

We can become much more precise at applying the right nutrient, at the right rate in the right place at the right time, to maximise the return on every fertiliser dollar spent.

We are confident with our calibration results to date that there is a relationship between the hyperspectral imagery and the plant nutrients nitrogen (N) and phosphorus (P) and soil Olsen P. Additional nutrients are currently being investigated, as well as validation surveys carried out, focusing on testing remote-sensing soil fertility predictions against physical soil testing.

The programme has now conducted validation surveys across 12 independently chosen farms over two years and four seasons, representing a robust test of the technology. Some challenges remain, with it being critical that pastures are in rapid growth and a vegetative state to obtain a good correlation between plant chemistry and soil fertility.

New applications (due to the versatility of the sensor) are still being uncovered in the last year of the programme through Massey University's Centre for Precision Agriculture and the Farms Systems Group at AgResearch. However, Ravensdown is now concentrating on ensuring that the technology is suitable to be offered as a commercial service.

Fence lines become irrelevant

With the ability to soil test to 1m², fertiliser plans are no longer restricted to recommendations for discrete paddocks, i.e. fences lines become irrelevant

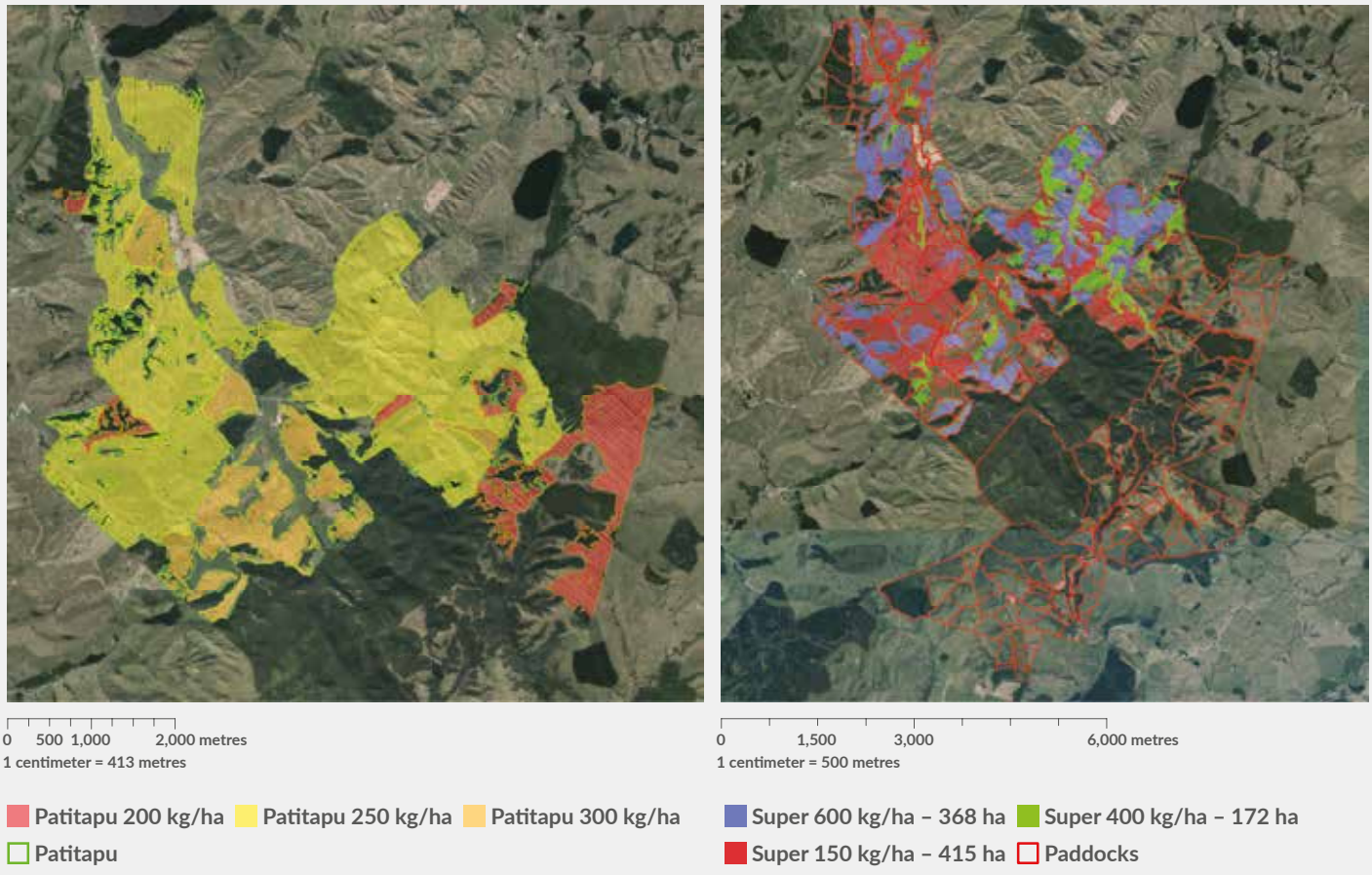

Figure 2: Examples of a variable applied fertiliser programme's applications applied on the same farm by Ravensdown's variable rate capable control system using existing technology on the left (10–20 soil transects and blocks defined by paddock boundaries) and by remote sensing at a resolution of 1 m^2, making fence lines irrelevant

(as demonstrated in ***Figure 2***). Associated with this programme we have developed decision support tools which can integrate high-resolution soil fertility information with the farm's rainfall, slope, aspect, altitude and soil moisture properties to predict current and potential (unlimited by soil fertility) pasture production.

Using these predictions, a cost-benefit analysis unique to each farm can then be completed to determine the benefits (from a productive and financial perspective) of maintaining/increasing soil fertility or withholding fertiliser specific to that farm.

A technology with side benefits

Remote-sensed hyperspectral imagery has also been shown to be capable of differentiating pasture species from other landscape components such as pine trees, manuka, gum trees, rushes, farm tracks, open soil and water bodies ***(see Figure 3)***. This allows for accurate assessment of productive pasture area and the portion of this pasture area that is of adequate size to be fertilised (fertilisable pasture area).

This offers the potential for such imagery to inform fertiliser prescription maps for variable rate application by automating the process of defining non-pasture and environmentally-sensitive areas where fertiliser application is not required. In practice, we have observed large discrepancies in the estimated (as determined by a visual classification) and actual effective pasture areas (calculated from hyperspectral imagery) on farms involved within the programme. These discrepancies may be for the whole-farm effective pasture area assessments and/or down to within-paddock effective area assessments.

These area assessments can have large implications for fertiliser expenditure, even for small differences (<2%). On average, this has been worth more than $2,000 in excess fertiliser spend or lost productivity for a farm size of 1,000 ha.

Enhanced topdressing aircraft for a better result

Ravensdown has also worked on another aspect of realising the potential of hyperspectral imaging to enable the precision application of the right nutrient, at the right rate in the right place. In the last six years, automated flow control has been introduced into four of our commercially operating topdressing aircraft. These application systems can receive an electronic instruction in the form of a prescription map which facilitates the spreading of the nominated fertiliser rate to the intended area of application.

These prescription maps can also be modified in order to meet environmental constraints. It is relatively straightforward to incorporate fertiliser exclusion zones into the application map to avoid applying fertiliser to ineffective or environmentally-sensitive areas of the farm. These systems have also been shown to reduce the field

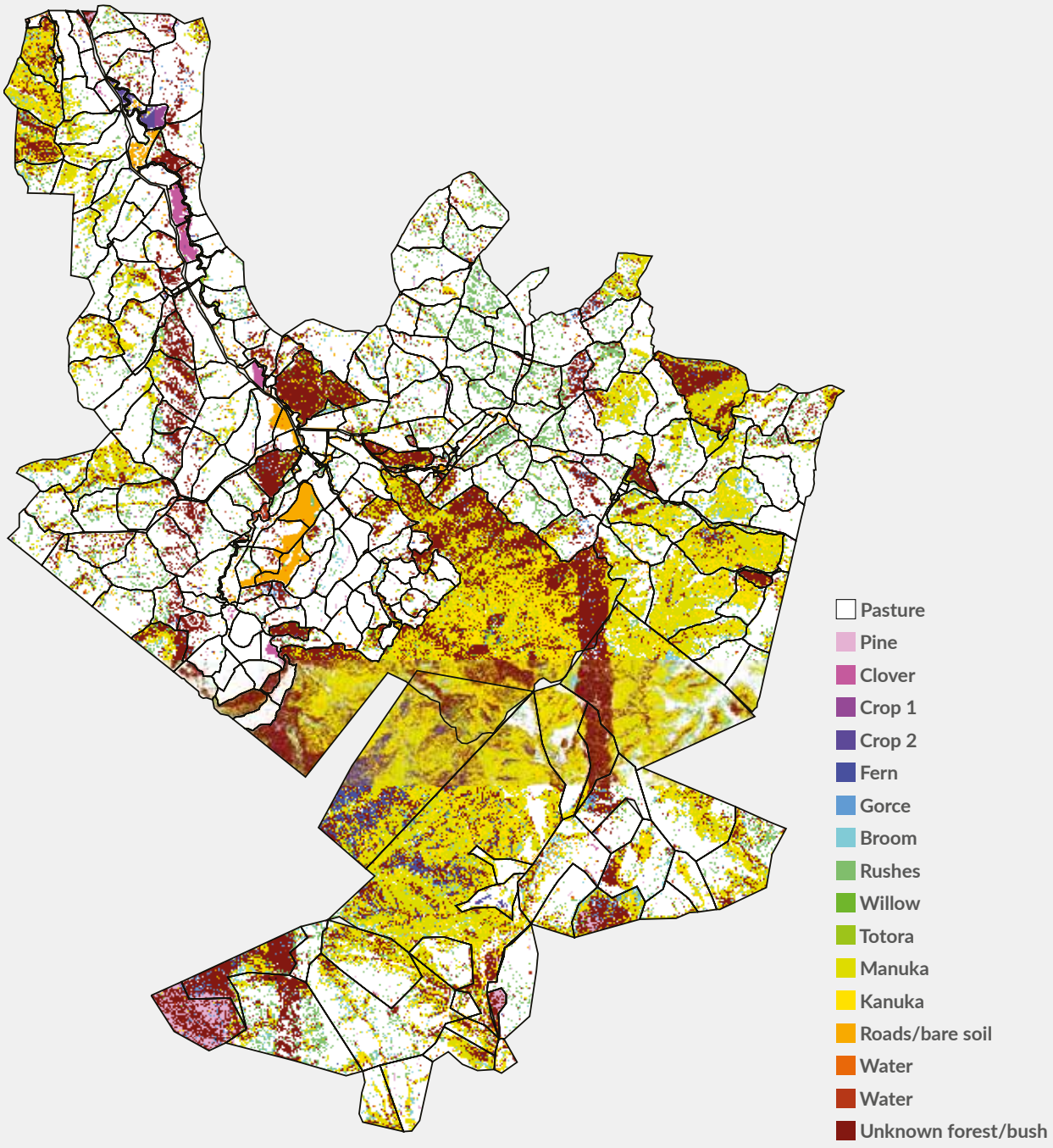

Figure 3: Remotely-sensed hyperspectral imagery showing the potential of differentiating pasture species from other landscape components such as pine trees, manuka, gum trees, rushes, farm tracks, open soil and water bodies

coefficient of variation (CV) of aerial fertiliser application from 78% to 42%, which is aligned with CV values found in ground spreading. Automation will also improve pilot safety as they are able to focus on aircraft operation rather than fertiliser spreading.

Summary

New thinking and technologies are therefore helping country farmers optimise soil fertility. Remote sensing using hyperspectral imagery is showing great promise in being able to estimate soil Olsen P on a scale and resolution not previously thought possible. In practice, this detailed information (coupled with automated flow control in topdressing aircraft) is a potential game-changer for increasing the precision of variable rate fertiliser strategies.

This delivers three significant advantages: improving the targeting of areas which require capital fertiliser applications because fertility levels are low; reduced fertiliser application rates are needed where fertility is high; and ineffective or environmentally-sensitive areas can be avoided. These advantages have positive economic benefits, either immediately for reduced or nil application or over a longer timeframe, for capital fertiliser applications.

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MURRAY LANE

HELICROPPING – AERIAL NO-TILLAGE CROPPING TO PROTECT SOILS

Helicropping can no longer be called 'spray & pray' now that there are farmers doing forage cropping programmes of more than 200 ha using only a helicopter. This article looks at how helicropping works in conjunction with protecting the soil.

Establishing small seeded forage crops

Traditional wisdom has it that the way to establish a crop is with cultivation to create a fine firm seedbed to enable good seed to soil contact. The cultivation process helps control weeds and mineralises the soil, releasing nutrients to support seedling growth. However, it is expensive, time-consuming and destructive to the soil structure, often burying topsoil and bringing subsoil to the surface. This leads to soil moisture loss in the shorter term and soil organic matter loss in the longer term, and it increases the risk of soil erosion. Viewed from the worm's point of view it is rather cataclysmic.

Perhaps there is another way? For almost 20 years now we have been developing techniques to establish small seeded forage crops using only a helicopter. By following the programme it is proving to be very effective, and very efficient, at around 6 ha of crop established every hour. Confidence is such that one farmer established 280 ha of forage crops last year using only a helicopter. The establishment process is also kind to the soil because it is essentially aerial no-tillage.

We know what 'best practice' helicropping looks like to achieve great small seeded forage crops. We can establish a crop almost anywhere – from flat land to steeper land. The challenge to the farmer/consultant/pilot is to recognise that as with any cropping comes the responsibility to ensure the crop type and season of grazing is matched to stock type and land class so the soil is protected from erosion. For example, on steeper land, rather than large animals grazing winter crops, summer crops would be more suitable (perhaps with smaller stock like sheep), and it can be back in new pasture for winter grazing.

Helicropping – what is it?

In 2000, John Reeves, a farmer from Te Akau in the western Waikato, approached us with the challenge of how to grow crops on non-tractor land. 'Us' being the Waikato representatives of Monsanto NZ Ltd, Ballance Agri-Nutrients and Wrightson Seeds. We approached the task with the attitude that cost does not matter, the important thing is to identify the variables that led to success or failure, and then work out how to address

Left: Effect of placement of 100 kg DAP/ha near to turnip seed in slot to overcome lack of mineralisation with no-tillage cropping

A key value point of helicropping is the speed with which it can be done, plus the retention of soil structure and soil pest/predator balance.

them. It was surprisingly easy to be successful. With a large amount of knowledge in the team covering fertiliser requirements, crop types, and weed and pest management tools, the first 5 ha Pasja crop was very successful … we were on our way.

It is now 18 growing seasons later and we have many farmers doing most, if not all, of their cropping programme using helicropping techniques. From small beginnings of 5-10 ha, and lots of learnings from watching farmers and pilots, we are at the point where many farmers are successfully establishing 50-100 ha cropping programmes using only a helicopter.

With helicropping, 40 ha of cropping can be completed in a morning's work, about six hours, with everything being done with one helicopter visit. The crops can be established on any class of land, for grazing in any season and by any stock class, but here lies the source of one of the challenges. Now that we know how to grow small seeded forage crops almost anywhere the question becomes, 'Where is it appropriate to grow the crop?'

There is clearly a need for farmers to match the crop type and season of grazing with land class, animal type and age. For example, two-year-old bulls on a 20°C slope, grazing swedes in the winter, would be inappropriate. However, on that same slope lambs grazing Pasja or rape over the summer, with the paddock back in grass for winter, would be quite appropriate.

For those concerned about CO_2 emissions, calculations using the Lincoln University Budget Manual and pilot data using a Squirrel helicopter show that helicropping uses 24-25 litres aviation gas/ha for crop established compared to 50-55 litres of diesel when full ground cultivation is used. Also, aerial 'no-tillage' helicropping leaves the soil carbon/organic matter intact.

A key value point of helicropping is the speed with which it can be done, plus the retention of soil structure and soil pest/predator balance, which prevents the explosion of grass grubs three to four years after cultivation.

How to grow a great crop

The key to growing any crop successfully is planning and to identify in advance the key stressors that may affect that crop's success and then address them. The main stressors for small seeded forage crops are:

- Weed competition
- Insect pressure, particularly springtails, slugs and snails
- Insufficient fertility – capital fertiliser is applied on the day and lime should be applied much earlier
- Soil moisture.

Weed pressure is easily sorted with an appropriate treatment of Roundup (glyphosate) herbicide. Ideally, everything is done on the same day. The Roundup is sprayed onto the existing pasture, managed to be 1800-2000 kg DM/ha cover, in late October/early November, with the addition of an insecticide (diazinon) for controlling springtails. Within hours transpiration from the pasture ceases, meaning that any soil moisture present is now available for the sown crop. The slowly dying pasture creates a micro-climate, acting as protection for the germinating crop seed from wind desiccation and intense heat from the sun.

After the one-pass spraying operation the dry inputs need to be applied. With a very good mixing system, the seed, slug bait and capital fertiliser can be applied mixed together. However, each input has very different ballistics and therefore a different spread pattern. The calibration therefore needs to be adjusted so the helicopter can fly multiple passes instead of one, while accurately applying all three key inputs at the correct per/ha rate, exactly as if it was being applied by ground equipment.

Alternatively, each of the components could be applied separately. Ideally the seed, with poor ballistics, would be flown on at half rates in two directions. Then the slug bait, then the fertiliser. If you are not going to apply slug bait, you can save yourself some more money by not applying the seed. Lime should be applied much earlier (six to nine months) if needed.

How much of each of these inputs is required?

The Roundup rate will depend on target weed species. Select the rate according to target species. Because cropping usually begins with a spring spray-out, which generally gives poor control of perennial weeds (such as couch, Californian thistle etc), use the higher recommended rate on the label to maximise the kill. Ideally the crop is started with an autumn spray-out for good perennial weed control, with an annual ryegrass grown through the winter prior to sowing the targeted summer crop. If you fail to control springtails, then the crop will be a failure. Diazinon or chlorpyrifos are suitable insecticides, but check the label for use rates.

Seeding rate is anywhere from 1.0 to 2.0 times the standard application rate. Depending on stressors there will be attrition. With slug bait use the highest rate on the label, generally 10 kg/ha. It is surprising the population of slugs and snails that are present in pasture. As with springtails, fail to control them and the crop will be a failure.

Use of Accuflow nozzles enables accurate targeting of spray without drift

One of the goals of successful helicropping is to ensure that the aerial spray operation causes no off-target drift.

Often the helicropping crops are established on low-fertility parts of the farm, the goal being to grow a great crop and at the same time apply capital fertiliser to grow a great future pasture crop. With brassica crops we suggest 400-500 kg Cropzeal Boron Boost/ha. Brassica crop growth is driven by N and phosphate (P), plus they need the boron to prevent brown heart bulb rot. We know from experience that 200 kg/ha will lead to less-than-reliable establishment and growth. An N side dressing of 100-150 kg Sustain/ha should also be applied three to four weeks after sowing. With clover, chicory and plantain crops, 400 kg DAP/ha would be appropriate.

One of the goals of successful helicropping is to ensure that the aerial spray operation causes no off-target drift, as this can be costly and ruinous of neighbourly relations. To ensure spray drift does not occur, it is recommended that Accuflow low-drift nozzles are used on the helicopter spray boom *(see photo above)*. The use of these nozzles provides accuracy in spraying along fence lines and leaves areas, such as riparian strips or steeper areas, unsprayed if required. It can even enable grass strips to be left across large hillsides to act not only as overland flow interceptors, but also to facilitate electric fence set-up.

A key stressor is birds. There will be seed losses from birds with spring sowing, but generally there are adequate sources of other feed for birds at this time of year. When it comes to re-establishing new pasture in winter after the swede/kale crop or a grass 'cover crop' between kale and swede crops, the seed is applied to the surface at a time when birds are hungry. Large seeded species such as oats are particularly easy pickings. It appears that adequate numbers of ryegrass and clover seeds do get through, but it would be prudent to use higher-than-normal seed rates to ensure there is enough seed to germinate for successful crop establishment. We are currently evaluating ways to overcome the bird problem and seed colour may be one of the options, or it might be that seed is applied in sections over the crop just prior to grazing. If re-grassing results are less than satisfactory, allow the paddock to run to seed, thus shedding a large volume of seed for the following autumn.

Why helicropping works

Spraying Roundup 'stops the pump', i.e. it stops transpiration and the soil is covered with green, but dying, vegetation to shade it. The value of this should not be underestimated. Many crops sown into cultivated soils

Brassica seedlings germinating through dying pasture

fail because of soil moisture loss. As long as the 'seedling eating' predators (e.g. springtails, slugs, snails, greasy cutworm and crickets in autumn) are controlled, the seed will germinate and establish in the dying pasture, well shaded and protected from wind desiccation and with adequate soil moisture *(see photo above)*.

Having created a great environment for seed germination, the challenge becomes how to give the seedling the vigour to outgrow pest resurgence (slugs, springtails and cutworm) and to reach canopy closure sooner rather than later. With crop canopy closure comes weed suppression. Those experienced with no-tillage will know that by not disturbing the soil, as in cultivation, broadleaf weed species become a minor problem and grass weeds are generally the main concern.

One of the benefits of cultivation is soil mineralisation. This means the soil is aerated and worms and other soil fauna are killed, and the rotting carcases release nutrients for the germinating crop. This does not happen with no-tillage cropping or helicropping. We know that in no-till cropping, placing N plus P near to the seed in the drill row overcomes the effects of lack of soil mineralisation and seedlings grow with vigour *(see photo page 34)*. With helicropping, the N and P placed near the seed on the soil surface has the same effect.

As stated earlier, we know that 100-200 kg/ha DAP or Cropzeal Boron Boost is not enough to ensure that adequate numbers of fertiliser granules land near to the seed. However, at 400-500 kg/ha there are generally numerous fertiliser granules within reach of each seed. The N and P supplied from these granules results in the seed having the early vigour to compete. As very little of this fertiliser will leave the paddock, it is largely a capital dressing enabling a great crop to be grown and an improved rye/clover pasture to follow.

Protect the soil when grazing

We are all aware of the tremendous damage done to soil on low-lying wet ground with cattle grazing winter brassicas or fodder beet. This is rightly frowned upon on flat land and more so on sloping ground. With overland flow from heavy rain, unprotected soil can be lost from the paddock or the farm, taking with it P and leading to the eutrophication of waterways.

Once the soil has left your farm it is no longer working for you. Once it gets into the river it is no longer working for the community and poses the environmental risk of reduced water clarity. Also, once lost it takes a long time to recreate that lost soil. On cultivated land the problem is worse, with greater risk of soil loss, and with low-fertility, low-organic matter subsoil being brought up to replace the lost high-fertility topsoil.

To reduce the risk of soil loss there are a number of considerations to be aware of:

- Compared to cultivation, helicropping already leaves the soil structurally intact during the establishment phase. Because there is no soil disturbance and plant residues from the previous pasture cover the soil for months, almost no soil will be lost at crop establishment
- Matching stock type and age with crop type, season of grazing and slope of land is paramount
- To reduce the risk of soil loss, steeper land should be put through summer crops such as rape, and grazed with smaller stock, ensuring the paddock is sown back to perennial pasture prior to winter grazing
- The greatest risk occurs during winter grazing, regardless of the stock class, slope or establishment method. With winter cropping, sowing cover crops with a helicopter (between swede and kale) or perennial pastures soon after grazing the brassica

Once the soil has left your farm it is no longer working for you. Once it gets into the river it is no longer working for the community and poses the environmental risk of reduced water clarity.

will aid in protecting the soil. This is the key focus of the current MPI Sustainable Farming Fund three-year project co-funded by Beef + Lamb, Ballance Agri-Nutrients, Agricom, PGGWrightson Seeds and Nufarm *(see photo below).*

- We are also working to identify appropriate companion crops to sow with winter forage crops that will survive crop grazing, so that once grazed in winter they rapidly revegetate to protect the soil from erosion and prevent nitrogen (N) from leaching.

Cost

Helicropping swedes will cost approximately $1500/ha, depending on helicopter location relative to the crop. This is about the same cost as if established using full cultivation. If no-tillage establishment is used the cost is $200-300/ha cheaper. Slug bait is the only other major input which would change the price, costing in the order of $95/ha. No-tillage is widely practised in North and South America and it is preferable to cultivation for the reasons mentioned earlier. But tractors are limited on broken, rocky or undulating ground, opening an opportunity for aerial no-till, i.e. helicropping.

Summary

Helicropping is a new cropping technique that opens up significant areas of land for development into more productive pasture through small seeded forage crops. Costing about the same as a full cultivation programme, the process is very efficient with time and very effective assuming a few rules are followed. Responsible decisions are required to match stock class to slope, and to crop type and season of grazing. As with all land development, appropriate subdivision and stock water supply is needed to be able to capture the value created.

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Left: No cover crop sown
Right: Annual rye cover crop aerially sown mid-July

DEREK DANIELL

A FARMER PERSPECTIVE – THE UNINTENDED CONSEQUENCES OF THE ONE BILLION TREES PROGRAMME

This article looks at the potential future negative effects of the One Billion Trees programme. Wairarapa-based farmer and former Nuffield Scholar Derek Daniell also discusses related issues such as whether ruminant emissions should be taxed, food-producing land used for trees, putting New Zealand agriculture at risk, and a wilding pines solution to reducing greenhouse gases (GHGs).

Why One Billion Trees?

The Government has set a goal to plant one billion trees in the 10 years between 2018 and 2017. This carbon sink strategy is its response to New Zealand's commitment (through the Paris Accord) to reduce this country's GHG gas emissions.

Having been involved with logging from my farm and other forestry blocks for 17 out of the past 25 years, I have strong doubts about the sustainability of the number of woodlots that the One Billion Trees programme would require. For instance, the logging of hill country say 17 times in the next 500 years will be extremely problematic for a number of reasons, both environmental and economic.

Soil, road and environmental damage

The washing away of soil after logging is a common occurrence and there will be less and less soil left behind. No other civilisation in history has mass planted this amount of trees. If we do not log them, there is the unsustainability of planting land trees and just leaving them. Planting trees on hill country tends to be irreversible, so we need to look at the viability of committing future generations to locking up land in forestry for the future, probably under corporate-based farming structures.

Increased forest planting also comes with damage to roads – with one billion trees planted there will be around 50 times the tonnage of logs being carted than sheep and cattle.

Increased forest planting also comes with damage to roads – with one billion trees planted there will be around 50 times the tonnage of logs being carted than sheep and cattle. Other negative side effects include the impacts on invertebrates in water affected by tannins, slash and pollen. The scallop resource in Tasman Bay has already been diminished by these contaminants, and the 10 main scallop beds in the Kaipara Harbour have been reduced down to one.

There will also be negative effects on biodioversity from monoculture planting. Pine trees suck moisture from the ground and dry up streams that used to run all summer, killing koura, native fish and invertebrates. New Zealand's native biodiversity is already very low – there are just 58 species of freshwater fish compared to 1,279 in Africa, but the water in Africa is always muddied by hippos, elephants and other animals. There are claims that farmers are polluting our streams and rivers with farm animal waste, but our natural ecosystems have already been altered by introducing trout, salmon, Canadian geese and Mallard ducks.

Although the agricultural sector has been blamed for waterway pollution, 80% of cities and towns are non-compliant with sewage and stormwater regulations. Auckland, Taupo and Queenstown pay little or no fines for polluting beaches and waterways, but farmers do. Also, along with increased logging comes the extensive use of methyl bromide on wharves to control fungi on log stacks. This is a hazard to human health, yet regulators are still allowing this practice until a viable alternative is found.

Landscape, land use and community effects

Another unintended consequence of planting one billion trees will be a dramatic change in the appearance of New Zealand's landscape, which will happen if millions of hectares are planted in *Pinus radiata*. Do we want to have a similar landscape to New Finland and, importantly, what do tourists want to see?

A further issue is world deforestation – it is estimated that around 500,000 ha of natural forest is being cut down every year around the world and the land converted to some form of farming. My question is why decimate our pastoral industry, which has been the backbone of the New Zealand economy for 170 years, at the risk of achieving nothing on a global scale? Not only will the rural landscape be altered, but this will happen in conjunction with the current urban creep. The urban area in New Zealand now covers one-third of the area of dairying and lifestyle blocks cover 850,000 ha, and we have unwisely used some of our best food-producing land for housing.

As a farmer I also have serious concerns about the effect of blanket tree planting on small rural communities and provincial towns. For instance, as more and more farms are planted, communities could gradually die. Non-forestry-related employment could wither, local school rolls go down and the few left in the area might be constrained by reduced services, vehicle safety issues from logging trucks, and enhanced fire risk.

Economic viability

From an economic perspective, there is uncertainty over future timber markets. While there is an assumption that there will be a profitable market for logs in 30 to 40 years' time, New Zealand is currently very exposed to one market – China – for exports. However, as China becomes more self-sufficient in their wood supplies this market could progressively diminish – just as New Zealand is expecting another 'wall of wood' from the One Billion Trees programme. Also, unlike the cropping and meat industries, over the past 25 years there have been longer periods of lower than higher log prices.

Hidden costs of the carbon sink strategy

There will also be hidden costs in the carbon sink strategy to be carried out through the One Billion Trees programme. For example:

- The lost export income from shrinking the sheep and beef sector
- The payment of carbon credits to those landowners who plant trees, including overseas investors
- The loss of rural communities, as well as the capital tied up in houses, schools and other infrastructure, e.g. the Affco meat processing plant in Wairoa
- The much increased wear and tear on roading caused by logging
- The increase in unemployment benefits as rural communities become hollowed out – one estimate has the current plan costing the average household $7,000 per year by 2050.

Taxing ruminant emissions

Related to the discussion about reducing GHG emissions, the current Government could be the first in the world to tax ruminants for their natural emissions, despite ruminants evolving 90 million years ago. However, the other 1.2 billion cattle, one billion sheep and 450 million goats in the world will not be taxed. Furthermore, 80% of these animals are in developing countries where billions of people are dependent on them for survival and it is difficult to ask them to change their eating habits quickly.

Another unintended consequence of planting one billion trees will be a dramatic change in the appearance of New Zealand's landscape.

In my view, New Zealand should only tax animal emissions if all other countries are going to do the same. Will countries growing rice tax their farmers for the methane emissions from paddy fields, which are greater than all the livestock emissions in the world?

Pastoral farming is one of the most natural forms of farming plants and animals together. New Zealand exports enough nutrient-dense, protein-rich food to provide for 40 million people, eight times our population. Does any other country export such a surplus to help feed the world? New Zealand has 0.2% of the land in the world, but produces 0.6% of the world's food. GHG emissions should therefore be calculated over 40 million people, not five million. Also, if we produce less, some less efficient food-producing countries will have to produce more. Cows, sheep and deer are the perfect filter to transfer pasture, indigestible to humans, to a suite of nutritious foods.

The pastoral industry has shrunk from grazing 60% of New Zealand to 40% now. Ruminant numbers have also shrunk from their peaks, sheep from 70 to 27 million, beef cattle from 6.4 to 3.6 million, and deer from 1.8 million to 850,000. Even dairy cows have declined from their peak number of 6.5 million.

Global ruminant numbers have been static for the past seven years so their short-term GHG cycle has stabilised. But global oil output, at 94 million barrels of oil per day, is pumping fresh CO_2 into the atmosphere every day. For many years New Zealand pastoral farming has been demonstrating a 1% annual improvement in GHG emissions per kilogram of product, but this continual improvement in productivity is not matched by the overall economy.

Putting New Zealand agriculture at risk

The global population keeps rising as long as there is enough food, but the projection for the current 7.7 billion to reach 11.2 billion by 2100 is of great concern. The increasing stress on natural resources will be extreme, in particular as cities encroach over food-producing land and wilderness continues to be taken over by people in Africa, Asia and South America. Every extra person will add to GHG emissions.

New Zealand is naive to think that other countries are going to undermine their key industries to meet promises made in the Paris Accord. A recent article in *The Economist* outlined the lack of progress made by all the European nations in meeting their interim targets. The US has not signed the Paris Accord, and China and India (the biggest GHG emitters in the world) plan to have large increases in GHG emissions by 2030.

In my view, there is no point in New Zealand putting at risk its most productive and long-term sector – agriculture. Similarly, the symbolic gesture of closing down exploration for oil and gas is equally naive when world demand is still increasing. The oil industry provides the raw resources for three other large industries – synthetic fibres, plastics and nitrogen fertiliser. Without nitrogen fertiliser, the world's farmers would grow enough food for only three billion people and 60% of the global population would starve.

In my view, the main driver subsidising tree planting is the government guarantee on the value of carbon credits and cash payouts from year six after planting pines. There has been poor take up of the One Billion Trees programme, which offers government assistance for planting, but the landowner then relinquishes a chunk of the income from carbon credits. It was designed to encourage the planting of native bush, but 88% of the area claimed for is destined for pines.

Possible solutions – wilding pines and taxing air travel

As a solution, if the Government considers that more trees in New Zealand will help the global situation then let wilding pines spread across our barren landscapes. At a spread of 90,000 ha per year, this would provide a temporary offset for the 45% increase in New Zealand's population since 1990 and the 93% increase in the use of fossil fuels. Importantly, it would cost nothing and would actually save the money currently being spent on trying to prevent the trees spreading.

Alongside wilding pines as a solution, I will suggest that there is a departure tax for every flight in New Zealand, which will be graduated on hours in the air – I would suggest $50-$100 per hour – so a 16-hour flight to Houston would cost an extra $800-$1600. This excellent extra source of tax revenue would help spread the load away from our efficient farming industry, one of very few sectors in the New Zealand economy that has continually improving productivity.

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CARLA MULLER

Journey into the primary sector

Carla grew up in Tauranga on a lifestyle block in the country, and while she loved the outdoors she had no career plan. Her journey into the primary sector began in 2010 at Massey University. Initially enrolled in a business degree, she loved economics and changed to a Bachelor of Applied Economics. Her passion for the environment led her to undertake an Honours year in Environmental Management. While not studying agriculture, she was fully immersed in the culture, including the Young Farmers Club which was a big part of agricultural life at Massey. She also found a partner who is a sheep and beef farmer, and has had the opportunity to explore various corners of New Zealand through jobs he has had.

Carla sees NZIPIM as crucial to the development of the primary sector in New Zealand.

DairyNZ years

During her third year at Massey, Carla completed an internship with the Palmerston North City Council where she had the opportunity to lead research into the economic profile of the primary sector in the region. As part of this, she made connections with DairyNZ, and when a job came up in their Economics Group after finishing her Honours year she was encouraged to apply and moved to Hamilton for the role.

Working at DairyNZ cemented her love for the primary sector. Carla enjoys the sector as it is an integral industry for our environment, our communities and our economy, as well as being full of highly talented people. She finds the passion and care of those involved in the sector inspiring, especially as most of them genuinely want to do their best for this country.

At DairyNZ she was involved in the Economic Farm Survey, as well as environmental policy development, particularly water quality policies being rolled out throughout the regions. She was able to work with an excellent team, and travelled across New Zealand meeting diverse people, including rural professionals and farmers. While at DairyNZ she also completed her Masters in Environmental Management, with a thesis focused on the impact of nutrient management regulations on dairy farm land values.

Despite having little experience on dairy farms before getting the job, her full immersion in the industry, along with analysing the data of hundreds of farms in various projects, gave her a thorough understanding of it. Spending time on various sheep and beef farms around the country has also given her an appreciation of that sector.

NIWA appointment

After three-and-a-half years at DairyNZ, Carla has now spent over two years at NIWA as an environmental economist. This change has given her the opportunity to work on a broader range of research projects, improve her skills, and add value to NIWA's science in the process. In her role she largely focuses on freshwater-related science, but has been involved in many transdisciplinary projects across a range of topics. Big projects include research into irrigation, freshwater biosecurity, analysis of the costs and benefits of edge-of-field mitigations, and economic policy options.

Governance roles

Carla is a professional director and has spent time on various community and organisation boards. She started out with the College of Business Board during her time at Massey University and, as mentioned, the local Young Farmers Club. She looked for ways to get involved in her community once she had moved to Hamilton, also spending time with the local Young Farmers Club there and joining the Hamilton Life Education Trust.

She recently took up a directorship with Primary ITO, a role she feels she can add value to from her varied experience across the education and primary sectors. The current government reforms of the vocational education system provide an interesting backdrop for this role, but Carla is thrilled to be involved in what could be a significant positive change for industry and students, provided it is done well. She is also a Board Advisor with Cycling NZ.

Governance for Carla is a way of adding value to her communities, including the primary sector, at a strategic level. While she has a passion for governance, she believes it requires ongoing skill development, as for any other role. In recognition of this, she received the Waikato Institute of Director's Emerging Director Award in 2018, which has provided access to mentoring and formal training, including the flagship Institute of Director's Company Directors Course and a year's placement with the Wintec (Waikato Institute of Technology) Board.

Carla is a strong believer that governance isn't just an option for those who have had senior management experience, and is a champion for ensuring diversity of thought exists around a board table. She feels more needs to be done to help remove barriers that are hindering people from minority groups to feel confident and competent to stand for governance roles, with appointment being based on merit and value added by diversity of thought. She notes that governance does have serious responsibilities though and, like any job, isn't for everyone.

Leadership development

Carla has benefited from some of the excellent leadership opportunities the primary sector has to offer. These have included an AGMARDT Leadership Scholarship, which she used primarily on the Agri-Women's Development Trust's Escalator Programme. She feels this year's long leadership and governance course has made her dig deep and challenge where she wants to be and why, and it has also created for her a strong network throughout the primary sector.

Carla has been lucky enough to have some very good mentors throughout her journey, from both within the primary sector and outside it, who have challenged and pushed her to continue to improve. She says to never underestimate the benefit of surrounding yourself with

There are some huge changes ahead, including the reform of vocational education, which will dramatically affect how and where many workers in the sector train.

people who always challenge you to be the best version of yourself, but make sure you pay it forward by supporting others in turn.

The New Zealand primary sector is facing some complex challenges, but Carla believes to overcome these we need to encourage others to find and follow their passions so they can reach their greatest potential and contribute in a way that maximises their skills.

NZIPIM involvement

Carla was elected to the NZIPIM Board in 2016 and is currently Vice-President, as well as being a committee member for the Waikato Branch. She became involved with NZIPIM while at DairyNZ through attending events and speaking at the Waikato NZIPIM Winter Forum. While on the Agri-Women's Development Trust's Escalator Programme she looked for an opportunity to live her values and try and make a positive difference.

She stood for a board member role because she felt her fresh perspective could contribute to the board and outcomes for the Institute. To her, the ethos of NZIPIM is about ensuring members are equipped to help the broader primary sector continue to improve, something which directly aligns with her values.

During her time on the board she has been involved in initiatives such as a strategy refresh, developing certification opportunities, and ensuring that NZIPIM is responding to the constantly evolving challenges facing the professional services industry.

She has also been instrumental in contributing to the Waikato Branch's submission on the Proposed Plan Change One – Healthy Rivers. She is proud of what the branch has been able to do through its volunteers and believes that the work it has done will help inform the hearing commissioners around issues directly relating to the membership. This process has highlighted the challenge and opportunity of having such a diverse membership. She feels it is challenging as NZIPIM and the branches need to be clear about what our mandate is and what our role is in important debates. However, the opportunity also lies in this diversity of thought and debate giving our members a chance to learn from each other.

Carla sees NZIPIM as crucial to the development of the primary sector in New Zealand. She sees our role as being two-fold: to enable those on the ground growing and farming to be world class by providing them with world-leading support, research and knowledge; and to ensure rural professionals are supported, developed and successful in their own careers.

Thoughts on primary sector

Carla believes there is a lot going on in the primary sector, including issues around climate change and regulation, and the need to access talented people on-farm and in the broader industry. She feels that regardless of the challenges facing us, the biggest thing we need to get right is how we are working. We need to ensure that we are truly collaborating, we are being brave and challenging the status quo, and that we are willing to put aside fighting in our own corners and all compromise to move the industry forward.

For her, by working together effectively we minimise duplicating our resources and we are harnessing as much knowledge and diversity of thought as we can from both our peers and those with different perspectives and experiences. For her, by encouraging those who want to challenge the status quo and being open to listening and learning from each other, we all stand to learn.

Carla says that while we may not all agree, robust and respectful debate is crucial to finding the best solutions. We need to ensure that we as an industry and a broader community are having respectful, but rigorous, conversations on big issues such as climate change and genetic modification. She believes that NZIPIM is an excellent platform to help facilitate these conversations and encourage this way of working, and we need to make the most of this.

Carla is looking forward to the next few years within the primary sector. There are some huge changes ahead, including the reform of vocational education, which will dramatically affect how and where many workers in the sector train. Other changes are the Government's proposed Integrated Farm Plan, the continued roll out of regional plans, the Zero Carbon Act and the One Billion Trees policy. Interwoven with all of this is a need for rural professionals to stay up to date with vast amounts of information, and help farmers navigate through these changes, making networking, discussion and referrals (when needed) even more important.

The previously mentioned opportunities, and many more, provide positive platforms for change. Carla feels we need to ensure the implementation and detail of these are right, and that we need talented people passionate about the sector contributing to this, who focus on the long-term bigger picture and not just individual short-term interests. Above all, she says we need to be excited about change and moving forward, remembering it isn't just about us. It is about those who come after us.

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