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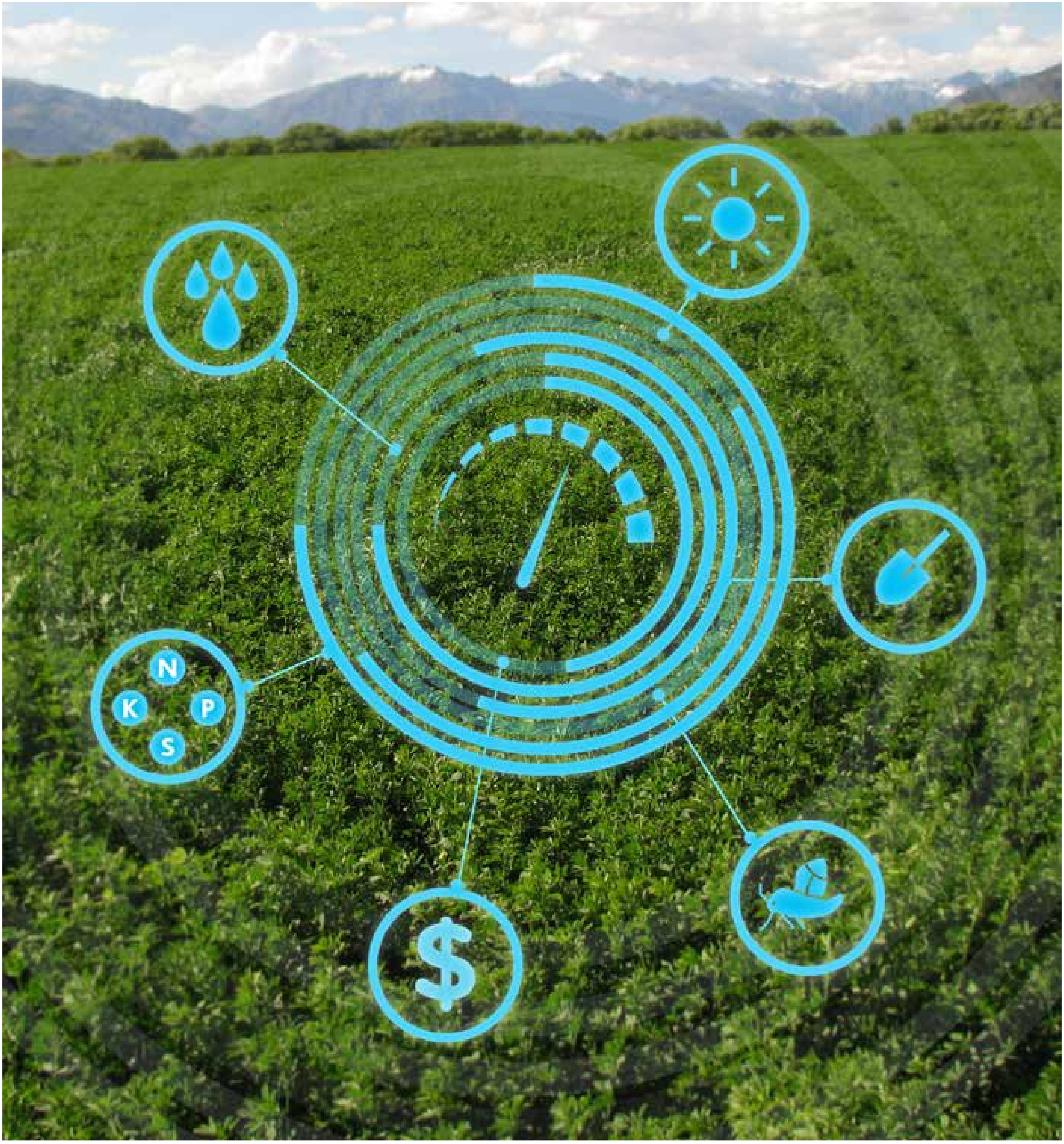

FOREIGN OWNERSHIP THE GLYPHOSATE DEBATE **IRRIGATION AN EVOLVING INDUSTRY**
OVERCOMING LACK OF NITROGEN **SHEEP INDUSTRY UPDATE**

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50 YEARS ANNIVERSARY

NZ Institute of Primary Industry Management

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NZ Institute of Primary Industry Management

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The Journal is the quarterly publication of the New Zealand Institute of Primary Industry Management. *The Journal* is provided free of charge to NZIPIM's members from across the rural profession including farm management advisors, rural bankers, farm accountants, fertiliser consultants, rural valuers, specialised service providers, farm managers, representatives from industry good organisations, CRIs and universities.

Contents

STEPHEN MACAULAY CEO

Education in the primary industry: crossroads or crosshairs?

At a time when the primary industries are calling out for greater numbers of skilled and qualified individuals to work within them to grow the value of our primary products, the demand by individuals wanting to take up agricultural education and training opportunities is dropping.

Sadly we are witnessing declining student demand for agricultural vocational training for sub-degree courses on a scale we simply have not seen before. Faced with financial troubles, Taratahi Agricultural Training Centre was placed into interim liquidation in December 2018 on the back of deteriorating student demand for its courses and the need to pay back $8.6 million to the Government for courses it failed to deliver. Following Taratahi's liquidation, Telford was offered a one-year lifeline by the Southern Institute of Technology for 2019, but beyond this its future too remains unclear.

In reviewing the Primary ITO's annual reports there were just over 28,000 trainees registered with the organisation in 2017, a 9% drop from 2013. But what is more concerning is that the level of credits achieved by trainees over this period dropped significantly by 30%, which suggests that they are completing courses at a slower rate, or not bothering to complete them at all.

The demand for vocational training programmes within the agricultural industry has declined at a staggering rate over the last five years largely brought about by a strong economy with historically low unemployment, exacerbated by a highly urbanised New Zealand with little direct involvement with the primary industries. Vocational training programmes have an important place in our agricultural sector, as they offer training and upskilling opportunities both on-farm and further up the supply chain, as well as provide education pathways toward higher level undergraduate degrees.

In looking at our universities delivering agricultural-related courses, I have been advised that the number of Lincoln University graduates with agricultural-related degrees (BComAg, BAgSci) has remained reasonably static over the last five years – fortunately at their traditionally high levels. Massey University, by contrast, has produced far fewer agricultural graduates over the same period, which is now well off the relative highs of student enrolments following the high dairy payout in 2010/11. Concurrently, Waikato University has changed the structure of its degree programmes, with agribusiness now becoming a minor within other bachelor degrees.

The upshot is that the overall number of students and trainees being produced by our tertiary education providers is down from where it was five years ago, which casts serious doubt on the strategic targets outlined in the People Powered report launched in April 2014. Funded by the Ministry for Primary Industries and industry, the report undertook an in-depth analysis of the skills and capability required by the nation's primary industries to 2025 based on industry strategies and feedback from industry bodies, government agencies, professional bodies and education training providers. The report estimated that 44% of workers had a formal post-school qualification 2012 and by 2025 this will need to increase to 62% if we are to meet the expectations of industry and government in adding more value to our primary products.

While the demand for highly qualified individuals within the primary industries shows no sign of abating, market signals around the opportunities are simply not reaching secondary student leavers or individuals considering a career change on the scale needed to meet the strategic aspirations and targets identified by sector groups.

NZIPIM's Student Members see the opportunities within the agricultural sector, which was also highlighted in our recent student survey where 63% of respondents did not believe there were barriers to employment in the primary sector. But beyond those intimately familiar with the primary industries, the messaging is not getting out.

What the People Powered report showed, along with innumerable reports from other credible sources, is that there are many career opportunities within our primary industries. Yet we continue to fumble the ball in clearly articulating and motivating others to explore such opportunities, which is needed to drive learner demand and Tertiary Education Commission investment funding for agricultural qualifications and further training.

As it stands, the number of suitably qualified workers and professionals required to the year 2025 by our primary industries is woefully short of where we need to be. There is an imperative to respond to the primary sector's strategy for higher level qualifications and training opportunities in what is New Zealand's largest industry, and largest contributor to export income. The challenge offered by NZIPIM to the sector, the institutions and Government is to show collective leadership and commitment to providing enhanced education and training opportunities for motivated individuals within the primary industries, rather than sitting back waiting for the next bad headline of another closure or collapse among our tertiary education providers. J

IONA MCCARTHY

A BALANCED APPROACH TO FOREIGN OWNERSHIP OF NEW ZEALAND FARMLAND

Recent changes to Overseas Investment Office (OIO) approval criteria for foreign investors to purchase farmland is taking buyers from the market and this could have a negative effect on prices. Foreign investment has been greatest in forestry, horticulture and large-scale pastoral farms, and the benefits of foreign investment in these sectors may outweigh any negative impacts.

Changes to OIO approval criteria

Foreign ownership of New Zealand farmland surfaces as a controversial topic on a regular basis and was once again prominent in the political debate leading up to the 2017 election. Following an election campaign pledge, the Minister of Finance issued a Ministerial Rural Land Directive in November 2017 for the OIO to tighten approvals for rural land purchases by foreign interests.

The OIO is now placing more importance on these factors when reviewing applications for investment in rural land:

- Introduction of new technology
- Generating jobs
- Increased export receipts and processing
- Greater local participation.

This has effectively made it more difficult for foreign investors to purchase New Zealand farmland, as applications need to demonstrate clear alignment with the 2017 Ministerial Directive.

Effect on farmland values

OIO approval is more likely if an application involves a change to a higher land use, a significant level of New Zealand ownership, a number of new jobs or the development of export markets. Prior to the 2017 Ministerial Directive the OIO approved many applications based on increased farming efficiency; these would be unlikely to pass scrutiny now. These recent changes will lead to fewer potential buyers and a possible decrease in farmland values, but more detailed market analysis is needed to determine if this is likely.

Academic research on the determinants of farmland values have focused on farm returns, property attributes and location level data, with more recent interest in the inclusion of buyer characteristics in agricultural price models. International studies have shown that the type of relationship between buyer and seller has a statistically significant effect on price.

One study investigated how different types of buyers affect farmland price and found strong evidence of buyer-specific valuation of the land's productive and site characteristics. It is possible that overseas buyers have this same effect on the price of rural land in New Zealand and some anecdotal evidence supports this. There was debate around the sale price of the Crafar farms in 2012. The highest New Zealand bid reported was $171.5 million for the going concern, considerably lower than the price paid by Milk New Zealand of $165 million plus stock ($20-30 million).

Although Treasury concluded there was no strong evidence that foreigners were paying more than New Zealanders in 2004, this could have changed in recent years. A vendor is justified in expecting a premium from a foreign buyer, given the added risk of a sale proceeding and the time delay for OIO approval. Foreign buyers may well be prepared to pay a higher price than New Zealanders for a range of individual reasons.

Trends in sales volume

Investigation of the number of approvals for sale and the land areas involved provides some insight into the likely impact of foreign buyers on farmland value *(see Table 1)*.

OIO data shows a total gross land area of 2.5 million ha of sensitive land approved for sale to foreign ownership since 2005 with 0.837 million ha going into direct foreign ownership. Note that gross land area represents the total land area proposed to be acquired under consents granted and includes land proposed to be acquired by joint overseas and New Zealand interests. Net land area is the total land area transferred into foreign ownership. These two figures suggest that around 4.7% of urban, agricultural and forestry land in New Zealand has been involved in direct foreign ownership since 2005.

There has been a reduction in the number of freehold and leasehold approvals since 2017 and in the area of net freehold land sales. The significant leasehold sale in 2018 was the sale of Mount White Station (39,336 ha of Crown Pastoral lease) to permanent resident Lukas Travnick from the Czech Republic.

The forestry sector has dominated foreign investment in New Zealand land and this is likely to continue.

Table 1: Foreign investment in sensitive NZ land

	FREEHOLD SALES			LEASEHOLD SALES			TOTAL SALES	
	Number of approvals	Net land area (ha)	Gross land area (ha)	Number of approvals	Net land area (ha)	Gross land area (ha)	Total net (ha)	Total gross (ha)
2005	146	48,287	150,003	28	3,688	16,071	51,975	166,074
2006	115	198,574	295,041	30	71,934	101,921	270,508	396,962
2007	89	16,102	86,846	37	957	3,751	17,059	90,597
2008	98	13,842	32,578	28	24,854	37,984	38,696	70,562
2009	130	22,345	265,266	26	9,897	99,544	32,242	364,810
2010	80	17,040	111,014	22	14,790	28,925	31,830	139,939
2011	106	68,054	130,846	36	23,627	86,280	91,681	217,126
2012	89	33,517	43,080	21	353	8,554	33,870	51,634
2013	92	65,610	162,328	22	14,129	45,918	79,739	208,246
2014	114	26,467	38,362	31	1,373	2,671	27,840	41,033
2015	93	32,210	75,008	25	1,099	4,889	33,309	79,897
2016	87	25,010	362,132	37	14,849	103,731	39,859	465,863
2017	61	17,382	25,696	22	21,750	46,679	39,132	72,375
2018 to Nov	42	9,991	137,281	14	39,579	44,934	49,570	182,215
Total	**1,342**	**594,431**	**1,915,481**	**379**	**242,879**	**631,852**	**837,310**	**2,547,333**

Source: OIO

Table 2: Gross freehold land sales by industry

	FORESTRY		SHEEP AND BEEF		DAIRY		VINEYARD		ORCHARD		PIG/ POULTRY		HORSE	
Year	Hectares	Units	Hectares	Units	Hectares	Units	Hectares	Units	Hectares	Units	Hectares	Units	Hectares	Units
2005	48,167	5	2,172	3			337	8					119	3
2006	683	2	404	2			76	4	65	1			132	3
2007	49,621	7	12,138	9	347	2	125	9	62	2	540	1	39	4
2008	6,356	7	5,330	10	827	2	636	11			214	2		
2009	4,441	6	3,627	9	588	2	287	9	48	2	62	1	209	3
2010	30,530	8	3,587	10	5,057	12	507	7	36	1			49	3
2011	64,925	17	12,257	13	3,098	8	939	7	23	1	10	1	65	2
2012	24,231	14	4,077	11	11,559	25	216	5						
2013	91,572	8	45,103	16	3,957	8	801	5	122	2			7	1
2014	4,060	12	1,889	6	15,271	31	2,389	19	486	7				
2015	28,286	12	18,807	14	3,089	11	141	7	203	2	18	1	6	1
2016	149,575	11	18,609	4	1,700	4	609	3	581	11	213	2		
2017	12,085	6	2,888	6	1,066	3	391	5	56	7	358	5		
2018	53,730	6	2,415	3			161	2						
Total transactions 2005 to 2018	568,262	121	133,302	116	46,558	108	7,615	101	1,681	36	1,415	13	626	20
Total land area	1,710,000		8,544,410		2,624,075		37,129		27,327					
Percentage	33.2%		1.6%		1.8%		20.5%		6.1%					

Note: Orchard includes pipfruit, kiwifruit, avocado, olives and hops. Source: OIO, Statistics New Zealand, NZ Winegrowers, Horticulture NZ. For the OIO information, summaries of each rural and forestry land transaction were collated and duplicate transactions were only included once. No information is available for confidential approvals

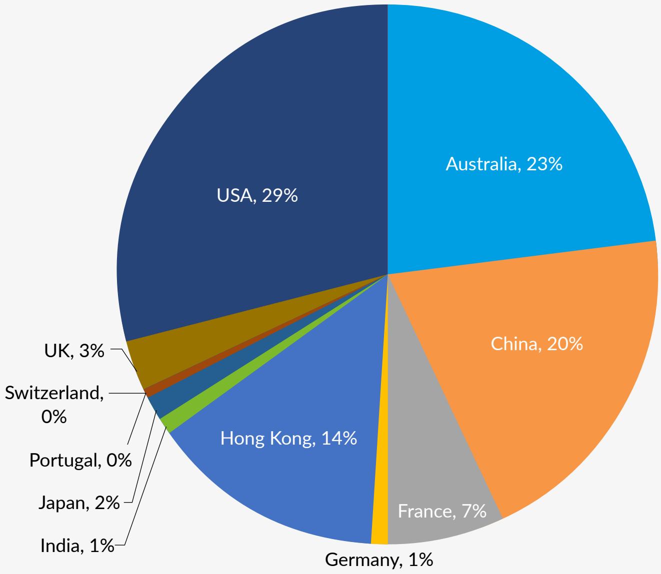

Figure 1: Viticulture sales 2005-2017 (freehold and leasehold land area, primary country ownership >95%)
Source: Analysis of OIO Decision Summaries

The OIO publishes Decision Summaries each month. Analysis of these summaries gives further insight into the nature of foreign investment in rural land in New Zealand. *Table 2* shows the gross amount of freehold land approved for sale across rural sectors since 2005 and compares the total approvals with current land use in each sector. Some of these transactions involve joint ventures with New Zealanders and there are additional approvals for sale of leasehold land that are not included here.

Forestry, viticulture and horticulture

The forestry sector has dominated foreign investment in New Zealand land and this is likely to continue.

Chinese investment makes up 38% of foreign purchases of dairy land since 2005, with the Milk New Zealand purchase of the Crafar farms in 2012 and the Synlait farm operation from 2014.

The Government has signalled that foreign investment that adds value to raw timber products and supports its One Billion Trees planting programme is encouraged. The forestry sector has the well-developed option of separating production from land ownership with leasehold tenure and sale of forestry rights. In addition to the 568,262 ha of freehold forestry land, around 70,000 ha of leasehold land was approved for sale between 2005 and 2018. This does not include forestry rights, which have only required OIO approval since 2018.

Viticulture has also had significant foreign investment, with around 20% of this land use in New Zealand involved in foreign investment since 2005. *Figures 1 and 2* give more detail on foreign investment in the viticulture sector. Major global wine and spirits companies (Constellation Brands, Pernod Ricard and Treasury Wine Estates) and investment funds (QWIL Investments and Global Ag Properties) dominate the market. This investment has brought large-scale planting, processing and increased access to international markets, and has arguably been key to the current strong position of the sector.

Horticulture has also seen considerable overseas investment. Foreign transactions since 2005 make up close to 17% of land in pipfruit (half of these transactions were for the leasehold interest), 15% of land in avocado,

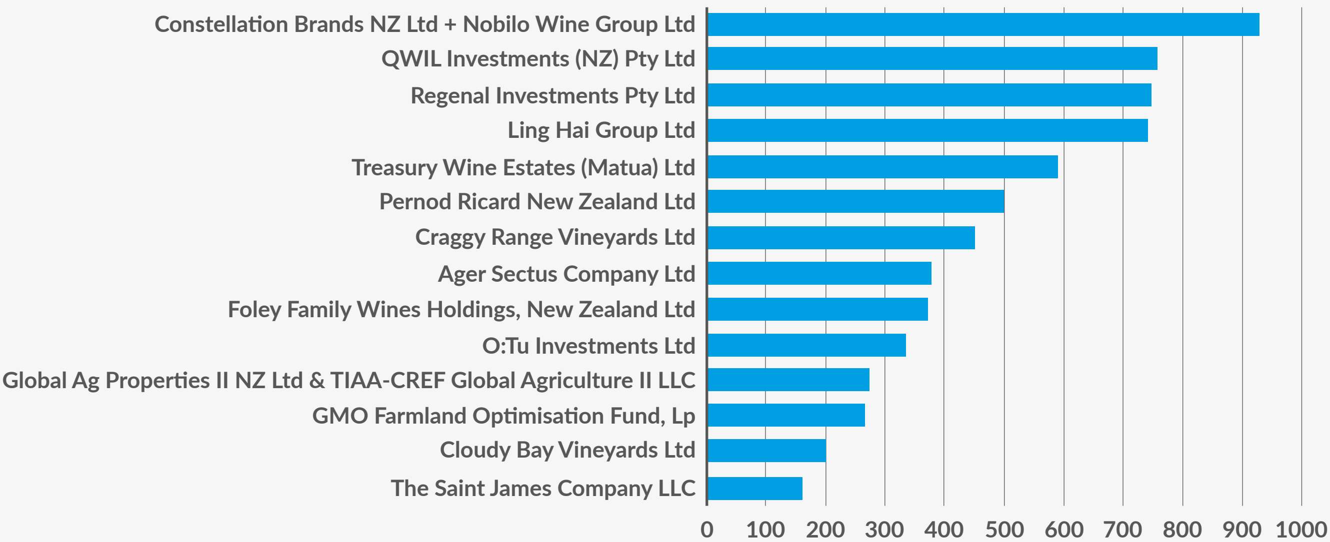

Figure 2: Key players viticulture (freehold and leasehold land area)
Source: Analysis of OIO Decision Summaries

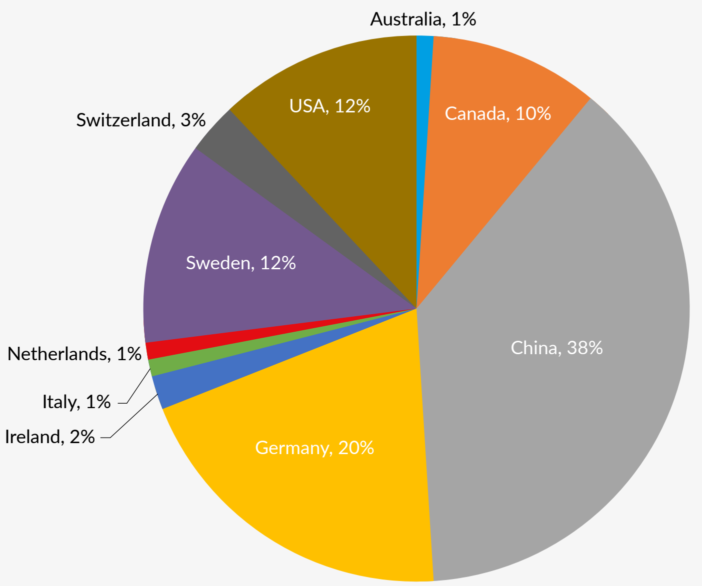

Figure 3: Dairy sales 2005-2017 (freehold land area, primary country ownership >95%)
Source: Analysis of OIO Decision Summaries

30% of land in hops, and 15% of land in tomato production. There is less overseas investment in kiwifruit (1.54%). Craigmore and Turners and Growers have been the dominant purchasers in the horticulture sector.

Total foreign ownership of dairy land is much less than the media attention indicates. Total dairy approvals to foreign buyers since 2005 only make up 1.8% of the land currently in dairy production. Chinese investment makes up 38% of foreign purchases of dairy land since 2005, with the Milk New Zealand purchase of the Crafar farms in 2012 and the Synlait farm operation from 2014 *(see Figures 3 and 4)*.

So, currently, less than 0.5% of New Zealand dairy farmland is in Chinese ownership. Craigmore Farming NZ Ltd is the second largest purchaser of dairy land. Two New Zealand farming families established this company and ownership now covers dairy, grazing, forestry and horticulture. New Zealanders control farming operations and the majority of shareholders are foreigners from a wide range of countries. Investment funds from Sweden, Germany, the US, Canada, Switzerland and the UK own most of the other larger foreign interests in dairy land.

Trends in sale price

Even though total foreign ownership of New Zealand pastoral farmland is low, foreign buyers can still have significant impact on price as annual market turnover tends to be low. *Table 3* shows a summary of dairy farm sales. In most years since 2005, the number of dairy sales to foreign interests makes up less than 10% of the total number of sales but there have been some years where large land areas were sold to foreign interests. In 2010, Dairy Farm Partnership purchased 1,760 ha of Ranfurly dairy farmland and German investment funds (DAH Beteiligungs and Aquila AgrarINVEST) purchased a number of farms in Southland and Canterbury.

The Milk New Zealand purchase of the Crafar farms accounted for a large number, and significant land area, of foreign dairy sales in 2012. Taking the scale of dairy farms purchased into account, the total land area to foreign interest has been significant. Analysis of REINZ sales data indicates from 2010 to 2014 foreign buyers purchased between 15% and 53% of the total ha of dairy land sold annually. This sales data is published in DairyNZ statistics

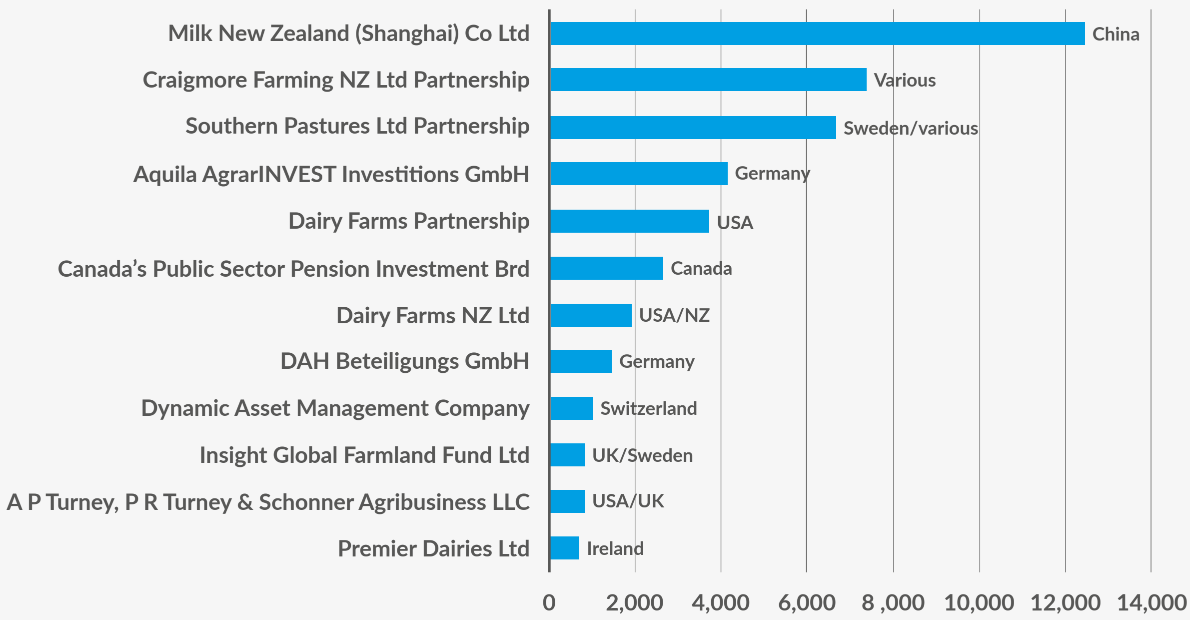

Figure 4: Key players dairy (freehold land area)
Source: Analysis of OIO Decision Summaries

Table 3: Dairy farm sales 2007-2017

	DAIRY SALES TO FOREIGN BUYERS						ALL DAIRY SALES QV data 2007-2009, REINZ data post-2009		
Year	Number total	Number units	FH land area	FH land area $known	$	Average $/ha	Number units	Average $/ha	Total hectares in dairy (NZ statistics)
2007	2	2	347	347	10,194,203	29,412	313	25,817	1,958,918
2008	2	2	827	827	19,563,750	23,656	305	32,719	
2009	5	2	588	211	8,227,644	39,060	102	28,944	
2010	12	12	5,057	5057	148,435,869	29,354	90	31,618	
2011	8	8	3,098	3098	82,327,000	26,573	143	32,726	
2012	4	25	11,559	11559	240,437,100	20,802	157	32,123	2,408,138
2013	8	8	3,957	3957	98,488,697	24,887	197	33,557	
2014	20	31	15,271	14306	381,494,030	26,666	312	36,369	
2015	7	11	3,089	2809	111,691,835	39,769	244	39,577	
2016	5	4	1,700	1700	42,894,000	25,225	192	36,557	2,624,075
2017	3	3	1,066	833	35,950,000	43,132	217	37,835	

Source: Analysis of OIO Decision Summaries

and extrapolates land area sold from the average size and number of units. These sales all involved a number of larger-scale properties.

Initial quantitative analysis on Southland dairy sales shows that foreign buyers have purchased significantly larger farms and indicates a price premium of 19%. While the statistical analysis is not very robust due to thin market data, this level of premium fits with anecdotal evidence. The low number of sales and the heterogeneous nature of farmland makes it very difficult to understand the impact without detailed knowledge of each transaction. Evidence from rural valuers working around New Zealand is the best way to get an accurate picture of a price premium paid by foreign investors and the impact of the 2017 Ministerial Directive on farmland price for each sector and region.

Benefits of foreign buyers

There have been recent media reports that interest from foreign buyers has declined since the 2017 Ministerial Directive (BusinessDesk, 2019) and media commentary about a consequent decline in dairy farm values. Given the importance of foreign investors in the large-scale dairy sector it is very likely that land prices will fall. This is at a time of ongoing volatility in milk prices that I understand were more volatile pre-2017, additional compliance costs, *Mycoplasma bovis*, and environmental and social pressure causing additional downward pressure on the dairy land market.

The flow-on effect from a drop in foreign money coming into a community will hit some regions more significantly. Local rural businesses, especially in the lower South Island, have benefited from large-scale developments that are now less likely to occur. A correction in the market may give more opportunities to young New Zealand farmers, but very few young farmers will be in the market for multi-million dollar farms. They will only benefit when or if a price correction flows down to smaller-scale units.

Foreign investment in pipfruit, viticulture and some of the more specialised smaller sectors has brought expertise that has enabled growth. Purchasers in these sectors tend to place greater emphasis on return on investment when making a purchase price decision. Also, a purchase generally involves considerable expenditure on development, often with a change to a more intensive land use and including packing or processing facilities.

There are benefits to New Zealanders beyond foreign owners' investment in farm development. Since 2005, 158 of 515 applications have listed provision of walking access as a condition of approval. The Wairoa Gorge mountain bike park and the Motatapu Track are two examples of many attractions that are now open to all New Zealanders. Eighty-five applications offered to sell riverbed to the Crown and six specifically mention conservation covenants. A New Zealand buyer would not have the same conditions on purchase.

Foreign investment in New Zealand farmland needs a balanced approach and an appreciation of the benefits of foreign investment along with the downside for those New Zealanders looking to compete on price against a foreign buyer. The OIO has a process for monitoring conditions of purchase to ensure delivery of benefits. As long as this process functions efficiently with the enforcement process used when necessary, the benefits of foreign investment may well outweigh the negative impacts.

Further reading

BusinessDesk. 11 February 2019. Clampdown on Foreign Farm Buyers Scares off Investors. *Otago Daily Times*. Retrieved from www.odt.co.nz/rural-life/rural-life-other/clampdown-foreign-farm-buyers-scares-investors.

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ANDREW CURTIS

IRRIGATION IN NEW ZEALAND – AN EVOLVING INDUSTRY

Andrew Curtis has been working in the New Zealand irrigation industry for almost 20 years, with 10 of these at the helm of IrrigationNZ. As he now transitions to a new consultancy role, he reflects on the considerable changes in the irrigation sector over this time. This article looks at where we have come from, where we are at, and where we are heading to.

Technology – the biggest change

Technology has been the biggest and most exciting change in the irrigation sector and much of this was initially triggered by the water metering regulations of 2010. Upon arriving at IrrigationNZ, we entered into a national discussion around implementing water metering. While Irrigation NZ was supportive of its compulsory introduction, others were arguing against it and stating that real-time measurement of data was too costly and there was no value. This certainly made for some interesting conversations.

Real-time measurement is now a given for all water takes, noting there are still some regions resisting, but they will hopefully see sense in the near future. While this provides information to the regulator for compliance purposes, its main benefit has been for improved irrigation performance. Sensor data used for irrigation decision-making, such as soil moisture or climate, can be easily telemetered with the water meter data in real-time. This was the game changer: 'If I have to do this water metering thing I might as well make the most of it.'

IrrigationNZ's recent summer student programmes in Canterbury and Hawke's Bay have shown irrigation decision-making technology uptake rates are now over 70%. However, there is the issue of technology rejection yet to work through, as there are too many businesses out there selling sensors as opposed to providing what is required. Despite this, you can visibly see the practice change when you drive between Christchurch and Ashburton soon after a rain event – 10 years ago most would still be irrigating, whereas now there are only a handful.

Over the next five years technology will likely take over human decision-making altogether. Variable rate irrigation systems for precision application are now commonplace, and it will not be long until autonomous irrigation systems informed by artificial intelligence and remote sensing will become the new norm.

As part of this change it is likely soil moisture sensors could become a thing of the past. Soil water budgets, where actual evapotranspiration is calculated at the sub-paddock scale by the normalised difference vegetation index (NDVI), infrared (IR) and other measurements, will soon become commercially available in New Zealand and make the application of precision irrigation much easier as a result.

The rapid pace of technology change is why we need to make sure any future regulations (whether market, collective or regulator-led) focus on quality monitoring systems being in place for irrigation decision-making and not compelling the type of monitoring system to be used.

Farmers adopting technology is a real example of how change can be successfully implemented over a short timeframe, bringing with it multiple benefits for all New Zealanders.

Schemes of the future

There has been massive change in the irrigation scheme infrastructure space over the last 10 years. Alongside over $1 billion being spent on modernisation (open channels to pipes and manual to automated control systems) there has been an increasing level of professionalism within the sector.

The investment in piping and automation has enabled on-demand water delivery, which in turn has allowed investment in more efficient irrigation systems on-farm. New Zealand is now one of the most advanced countries globally for scheme infrastructure automation – to the extent that where IrrigationNZ regularly hosts international experts, scheme and farming leaders from overseas they are always amazed by the innovation they see.

When I arrived at IrrigationNZ all irrigation schemes were both governed and managed by shareholder directors and racemen were the only staff. Almost all the large schemes now have general managers, operations managers and environmental managers alongside scheme operators. They have become much more aware and future-focused as a result. Independent directors are also now common, and boards largely focus on governance, although some farmer directors confuse their roles from time to time.

Scheme amalgamation is likely the next step and we have already seen this starting to occur in Mid and South Canterbury. Over the next decade this will continue, resulting in three or four super schemes managing over 60% of New Zealand's irrigation. Contrary to the current government's rhetoric, scale is a good thing. It allows for investment in water supply efficiency and also more easily provides support for shareholders who need to improve their environmental practice.

IRRIGATION IN NEW ZEALAND

- We only abstract 2% of our water resource in New Zealand and irrigation makes up just over 1% of the consumptive use
- We irrigate around 800,000 ha of land, and around 60% of this is for dairy, 20% for cropping and 5% for fruit and wine. The remaining 15% is used by sheep and beef farmers for pasture and cropping
- Around 30% of dairy production comes from irrigated properties, and 50% of arable crops and nearly all vegetable and fruit crops are irrigated
- Modern spray irrigation systems make up just over 60% of the irrigated area – only 6% still remains as flood irrigation and the balance is older spray systems.

New Zealand vineyards have some of the most efficient irrigation practices globally

Reliable irrigation is a vital management tool for North Island orchardists

Irrigation system change

Of New Zealand's now 800,000 ha of irrigation, less than 6% is left flood irrigated. There has been a huge (in excess of $1 billion) investment in upgrading to modern spray and drip systems over the last decade. Over 60% of New Zealand's irrigated area is now under center pivot, lateral and solid set for pasture and cropping systems and drip-micro for vegetable and permanent crops, which is unprecedented globally.

Of the modern irrigation systems drip-micro is by far the most efficient. New Zealand's dominant norwesterly weather pattern can significantly impact on the efficiency of spray systems, as the application is blown off target changing the intended distribution pattern.

There are a number of pasture and cropping trials currently occurring with drip, and to date these have proven to be extremely successful, providing the laterals are spaced correctly. The question is, over the next 20 years will drip begin to replace modern spray systems in New Zealand as it has in places like California and Israel? While the capital cost is double, the potential benefits from reducing nitrogen losses could more than make up for this.

The other system change that is now being explored in New Zealand, and one that we are behind the eight ball on internationally, is the use of fertigation (the injection of fertilisers into an irrigation system). We have made mistakes with fertigation over the past decade, trying to mix irrigation and fertigation events together when the two should be treated as separate applications.

The lack of a bulk liquid fertiliser supplier has also had negative results. As a consequence, urban myths began to circulate that fertigation does not work in New Zealand, despite the body of international research. However, evidence from some preliminary trials this season is showing production levels can be maintained using 30% less nitrogen – this comes from moving to a 'little and often' approach. The capital cost of installation also looks like it will be recouped within a season. A Master's project through Lincoln University will investigate the pros and cons of fertigation in much more detail over the next two years.

The environment

Both the national and regional discussions on how to manage nutrient losses from farming were just starting up as I arrived at IrrigationNZ. Water quality had been declining for a number of years and it would be fair to say some farmers had pushed their farming systems beyond sustainable limits. As a result, the first Freshwater Management National Policy Statement was promulgated in 2011 and we now await the fourth update to this with a degree of trepidation.

The limits regime we all now operate under is a result of the National Policy Statement. However, it is the implementation mechanism – the introduction of audited Farm Environment Plans (FEPs) – that focuses on the widespread adoption of good farming practice which is starting to make a difference. The declining trend seems to have halted in many areas and we are seeing early signs of water quality improvements. While this is a huge step in the right direction, and will help irrigators plan for regulatory change, good farming practice will not be enough in some at-risk catchments.

In these cases the only way to solve the problem is to look at it holistically as a catchment – and as a community. Recent overseas study tours to both Australia and the US have highlighted the need to bring catchment scale infrastructure into the mix, while also spending time clearly identifying the issues before coming up with solutions.

In many cases it could be more cost-effective to buy out and retire land or allocations in a particularly sensitive part of the catchment, rather than place blanket requirements across everyone. We also need to work through how we fund such solutions so that everyone who benefits contributes, as this is currently the elephant in the room.

To really get the water quality management system right we need to target the actual problem in the most cost-effective way. We have been very farm-focused in our thinking to date, for example, 'you will all decrease your nutrient losses by 20%.' This is largely driven by the focus of the Resource Management Act 1991 – individual effects-based. However, I am not sure this is either fair or targets the problem. I am concerned that new regulation, which is being influenced strongly by the environmental lobby, may ignore a more holistic and constructive approach.

The current water management regime in New Zealand needs a change of emphasis so that community-based solutions, including infrastructure, are considered alongside or preferably before regulatory constraints on-farm.

Public perception

It has been an uphill battle getting the good word out there about the significant changes occurring and the world-leading nature of the New Zealand irrigation industry, but progress has been made. The level of understanding about the benefits of water to agriculture are much more widely understood than a decade ago – so much so that freshwater rights are an increasingly political topic.

Much can be done if more farmers are willing to 'put their head above the parapet' and tell the story of their journey of change. This is not a fanfare, 'look what we've achieved', as very few will believe this. It is a humble, 'this is what we now realise and this is what we are now doing to address it.' Industry organisations can only do so much in this space as it is authenticity that is required with the wider public.

Telling the story of change from the grass roots is much more powerful than CEOs and board chairs constantly fronting the media. The only way to help educate the media, politicians and the public on the contribution irrigation makes to New Zealand is to share the story of how and why, and explain the important role of guardianship that farmers are now embracing.

It has been a decade of unprecedented change. The previous government was looking for a step change and they definitely got it from the irrigation sector, and the new government is starting to realise the change that is actually happening out there.

We have moved into a community-led environmental limits framework, and the available water for irrigation is increasingly managed on an 'as and when' basis informed by data from an array of sensors. Automation is here and artificial intelligence is not far away.

The current water management regime in New Zealand needs a change of emphasis so that community-based solutions, including infrastructure, are considered alongside or preferably before regulatory constraints on-farm. We also need to become more spatially and temporarily aware in our solutions, as many of our water quality issues will not be effectively solved without a targeted approach.

Finally, the farming community needs to stand up and talk openly about what they are doing to better manage water. The public does not want to be told the problems are fixed; they want to know that the farming community are once again the guardians of New Zealand's unique environment.

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DERRICK MOOT

OVERCOMING THE WEAKEST LINK IN PASTORAL FARMING – A LACK OF NITROGEN

This article describes the global importance of nitrogen for agricultural systems and how nitrogen deficiency has been overcome to transform pastoral farming in New Zealand in the last 20 years.

Feeding the world with finite land

All plants are nitrogen (N) deficient all the time – except those that fix N. This simple fact has shaped the direction of agriculture since Neolithic man first planted crops and started nitrate leaching about eight million years ago. Today the need for N to drive food production is central to feeding 7.5 billion people on a finite land resource. *Figure 1* shows that the world production of the staple grains increased significantly during the 'green revolution' as inorganic N use increased in the middle of last century.

Importance of N fertiliser

It is estimated that 50% of the people alive today owe their existence to the production and use of N fertiliser. The amount of inorganic N used in agricultural production continues to increase annually. Arguably the intensification of agriculture, enabled by the use of N fertiliser, has saved much of the natural world from destruction as more food is produced per unit of land area to meet the feed demand of the exponential increase in the human population.

If heeded, calls to limit the use of N fertiliser will inevitably lead to greater destruction of the natural world and human starvation. Similarly, meta-analyses show an average 20% yield reduction from inorganic food production systems. This means 20% more land would be required to produce the same amount of food if these systems were embraced globally. In short, N applied to land-based food production systems has fed the world's population and thus enabled the rapid rise in the standard of living, technological developments, the preservation of natural ecosystems, and led to the relative peace that exists today.

Role of N in plants

For agricultural scientists the challenge is to provide N to meet plant needs as sustainably as possible. The role of N in plants is well known – it is an essential macro-nutrient that drives photosynthesis. The more N present, the darker the green because more chlorophyll is present per unit of leaf area. However, it is actually the increase in leaf area that N promotes which is the most important factor that leads to increased yields.

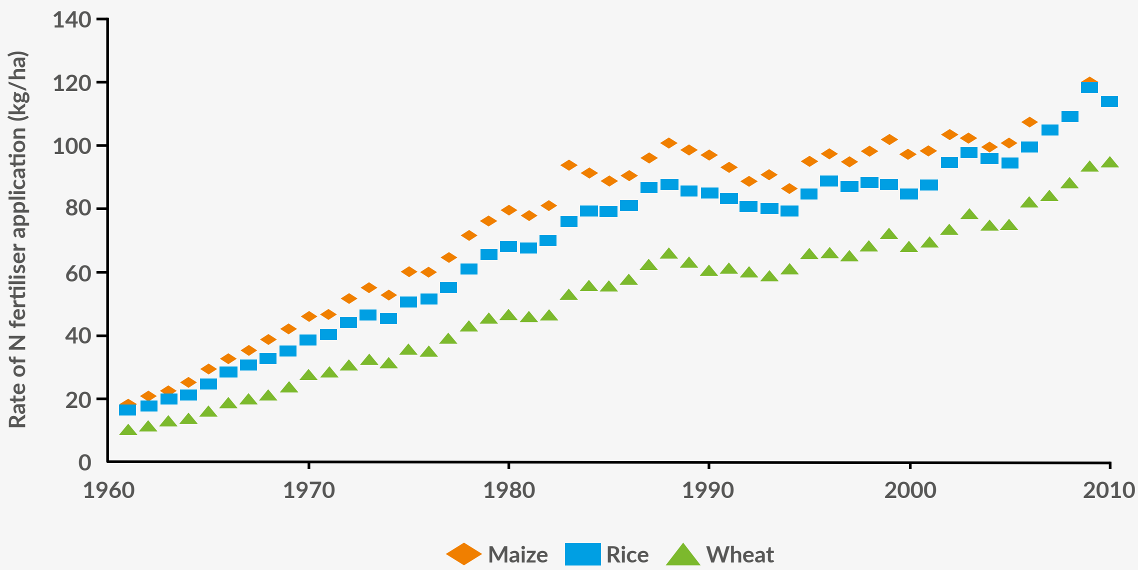

Figure 1: Trends in global averages of N fertiliser application rates in maize, rice and wheat.
Source: Ladha et al., 2016

Lucerne in flower

Leaf extension when a crop is first planted, or a pasture recovers after grazing, is the key to capturing all of the available light and therefore maximising the yield potential of any given environment. In practice we see the N response as taller darker leaves in a urine patch, or longer darker leaves in a wheat crop where N application encourages tiller survival and promotes grain quality.

Effects on pasture yield

Before 1990 the use of N fertiliser in New Zealand agricultural systems was low, but we have seen a rapid increase in the application of fertiliser, particularly with the expansion of the dairy industry ***(Figure 2)***. This was inevitable as flat land, with high yield potential, was converted from dryland sheep production to dairy farming.

Table 1 shows those original dryland pastures produced about 6 t/DM/ha, but when water was applied from irrigation the annual production increased to 10 t/DM/ha/yr. It was only when N was added with irrigation that the environmental yield potential of over 20 t/DM/ha/yr was achieved.

Table 1: Total annual DM yield (t/DM/ha/yr) of irrigated (I) or dryland (D) pastures grown with (+N) or without (-N) non-limiting N fertiliser at Lincoln University, Canterbury, NZ.

TREATMENT	ANNUAL YIELD (T/DM/HA)
I+N	21.9
I-N	9.8
D+N	15.8
D-N	6.0

Source: Mills et al., 2009

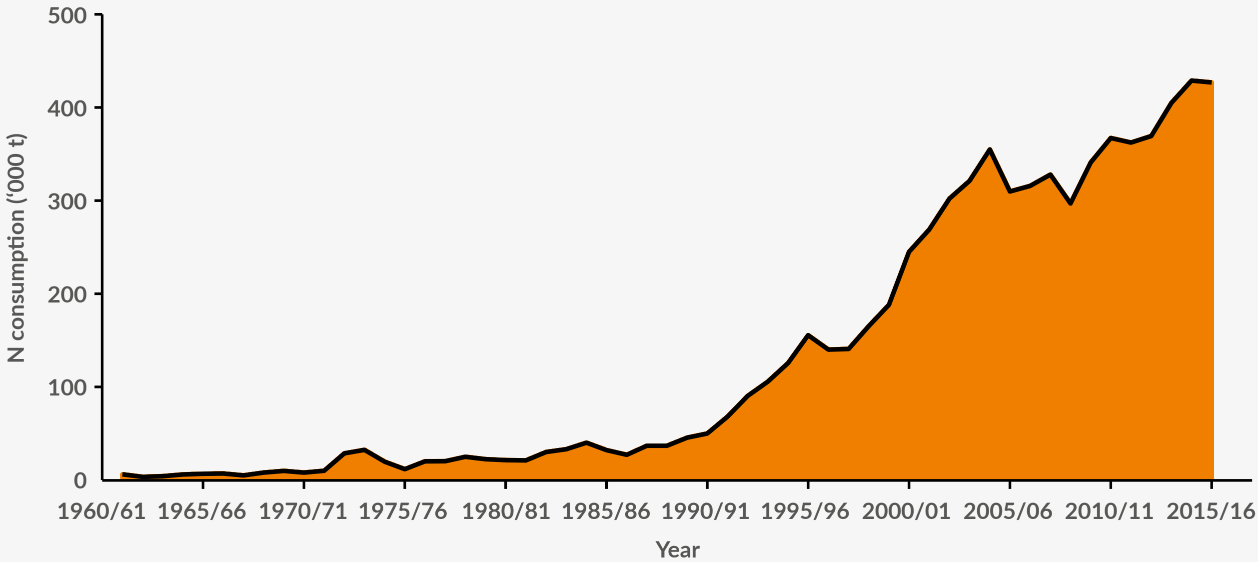

Figure 2: Change in nitrogen consumption ('000 t) in NZ from 1961/62 to 2015/16
Source: Data provided by the NZ Fertiliser Association

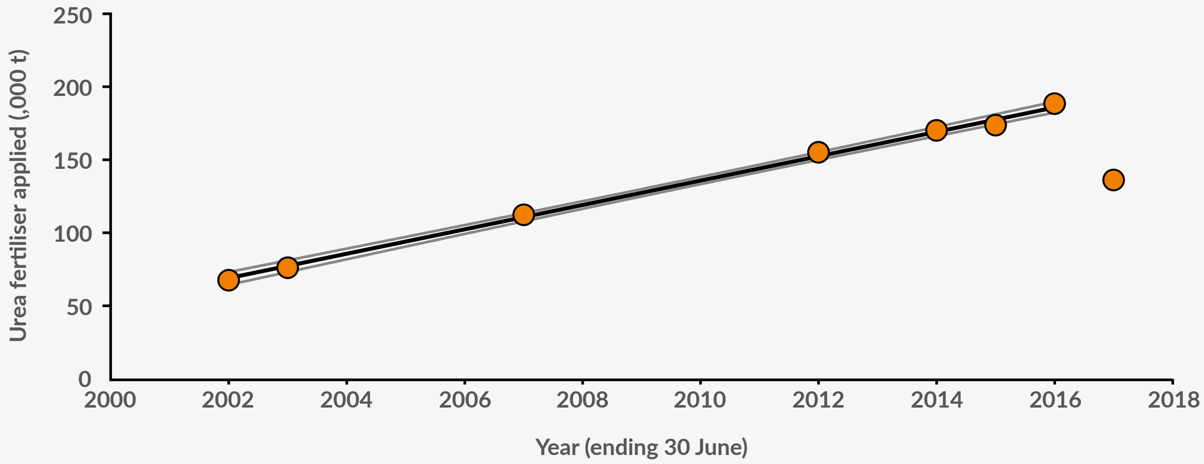

Figure 3: Urea fertiliser (,000 t) applied in Canterbury, NZ from 2002 to 2017
Source: Data from Statistics New Zealand

Assuming that herbage is about 3.5% N, then ~700 kg N is required from all sources (mineralisation, fixation animal returns and N fixation) to meet the pasture demand. This yield response has led to an increase in N fertiliser use in Canterbury alone of approximately 8,500 t/yr every year between 2002 and 2016 *(Figure 3)*. When applied appropriately, this N fertiliser aids recovery after grazing and ensures light interception is maximised. There are inevitable losses of N to the atmosphere through volatilisation when it is applied. However, most N loss in dairy systems comes from the high N loading in urine patches which is in excess of the plant's demand, and this has been well documented elsewhere.

The application of inorganic N pushes the balance of a traditional ryegrass/white clover pasture towards the grass component. The incursion of clover root weevil also targeted the clover and for many dairy farmers clover is now a bonus when it appears in their ryegrass dominant, N fertilised pastures. As shown by Gerald Cosgrove in 2005, white clover content in dairy pastures needs to be above 30% to promote significant responses in milk production and for many farmers the variability of its presence has led to greater reliance on inorganic N.

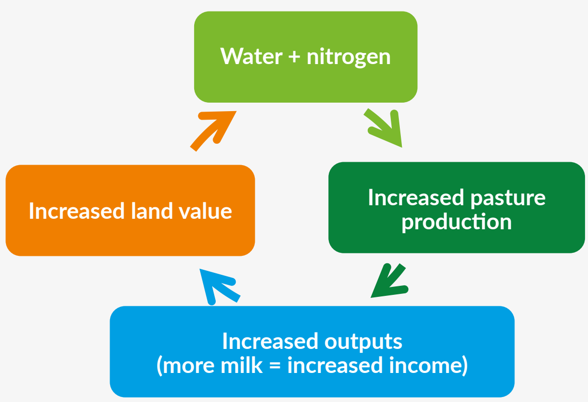

Figure 4: Intensification loop between inputs and product outputs

Biological limits of production systems

A feature of the high yields generated from N fertiliser is that it creates an intensification loop *(Figure 4)*. The higher pasture yield promotes milk production and therefore higher financial returns. In a market situation the consequence is higher land prices which, to maintain the required levels of return, lock in the need for high levels of N fertiliser to maintain production and returns on investment. This intensification has driven land prices in Canterbury, and their recent levelling off *(Figure 5)* has in part been because the biological limits of these production systems have been attained.

The same biological limits that have been overcome by inorganic N use on dairy farms apply in sheep, beef and deer farming. The inability to control grazing as effectively as on dairy farms means that these systems are often low in legumes, which are preferentially grazed during set stocking, and thus pastures become grass (carbon) dominant. They frequently develop a thatch of dead material overlying the soil surface. As noted by Fasi et al. in 2008, this reduces N cycling and means single N fertiliser applications can produce up to 40 kg DM/kg/N applied, which is significantly higher than the 10:1 ratio expected in higher fertility dairy pastures.

The extent of N response can be seen from the data in *Table 1*. The 15.8 t/DM/ha produced from only the addition of N fertiliser shows the yield potential of Canterbury dryland pastures without the addition of any water. Similar significant yield gaps exist on all hill and high country farms where the utilisation of available water is severely limited by N supply. Challenging farmers to focus on using that available water as efficiently as possible through the introduction of appropriate legumes has been the focus of the Dryland Pastures Research team at Lincoln University for the last 20 years.

The overriding driver of our research focus has been to consistently grow lambs at ~300 g/hd/day from birth for 100 days to ensure they are ready for slaughter before the summer dry kicks in. This has been achieved

Plantain and red clover

Subclover florets

Red clover

White clover

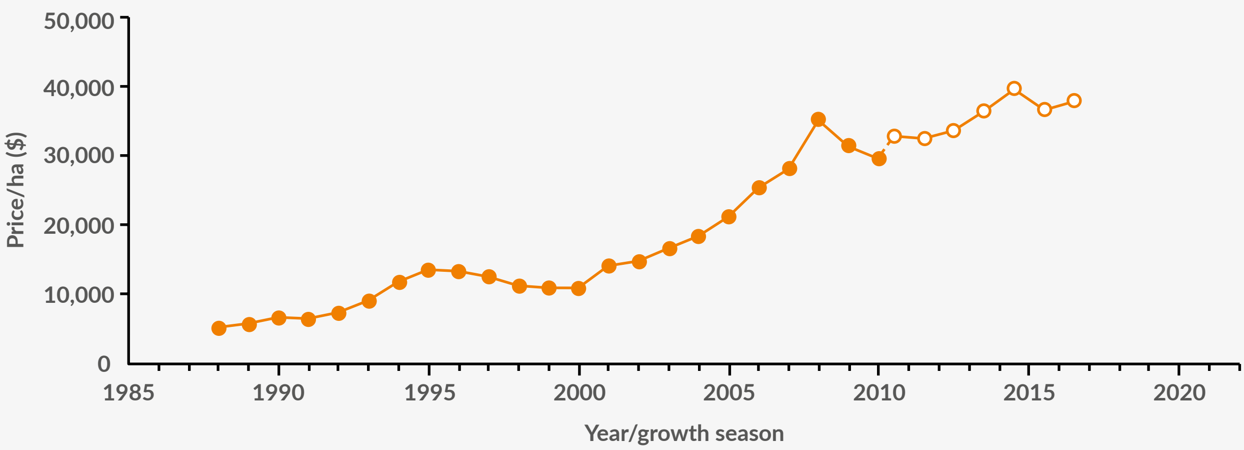

Figure 5: Change in the price ($/ha) of dairy land in NZ

Source: Data from DairyNZ New Zealand Dairy Statistics (www.dairynz.co.nz/publications/dairy-industry/). (QV.co.nz 1988-2010, REINZ 2009/10-2016/17)

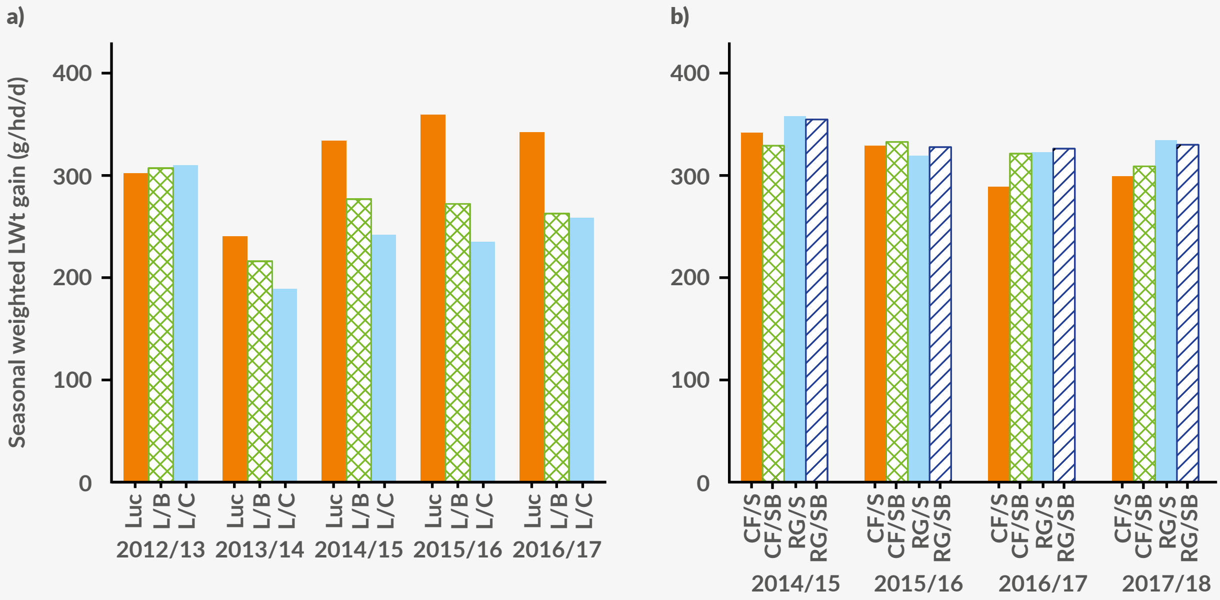

Figure 6: Weighted seasonal liveweight gain (g/hd/d) of twin lambs prior to weaning grazing: a) dryland lucerne monocultures (L), lucerne/brome (L/B) or lucerne/cocksfoot (L/C) mixes over five years; and b) grazing dryland cocksfoot (CF) or ryegrass (RG) pastures established with subterranean clover (S) or subterranean and balansa clovers (SB) at Ashley Dene, Canterbury

The success of implementing a legume-based grazing system takes longer than the immediate fix to a short-term pasture deficit situation provided by N fertiliser. Once the whole system has been developed, however, the production rewards are tangible and locked in at a relatively low cost.

on very stony Lismore soils at Ashley Dene, which are soils with some of the lowest water-holding capacities in New Zealand, using lucerne and subclover-based pastures *(Figures 6a and b)*. These results highlight the potential that exists for large areas of dryland farming in New Zealand.

Lucerne

Taking the fundamental principle 'all plants are N deficient all the time – except those that fix N' – the research focus has been on determining which legume is most appropriate for the situation and how do we make it thrive? Also, importantly, how can we create farm systems to allow farmers to make money from it?

The high-profile success at Bonavaree of a lucerne-based system is highlighted in *Table 2*. In this case Doug Avery became a farmer of water – by utilising the legume that he already knew grew successfully in his environment. The herbage production advantage came from having a deep-rooted legume that is never N deficient, so maximises the available soil water, particularly in spring. Therefore, it always grows more than N deficient grass-based pastures in the same environment. The direct feeding of lucerne to ewes and lambs required significant management changes, but is now routine across this and many other dryland farms.

Table 2: Changes in key performance indicators of farms system productivity at Bonavaree in Marlborough over a 10-year period resulting from transformational change based on a move to direct grazing of dryland lucerne and landscape farming practices

	2002	2012	CHANGE
Land area (ha)	1,100	1,800	↑ 64%
Sheep numbers	3,724	4,158	↑ 12%
Lambing (%)	117	145	↑ 24%
Lamb weights (kg)	13.3	19	↑ 43%
Lamb sold (kg)	38,324	74,460	↑ 94%
Wool (kg)	18,317	20,869	↑ 14%
Sheep:cattle	70:30	50:50	
Gross trading profit (ha)	$317	$792	↑ 149%

Source: Moot & Avery, 2013

Lucerne was grazed by many farmers in New Zealand in the 1980s, but this was usually by weaned lambs after a first cut for hay. Therefore, the benefits to ewes grazing lucerne and rumen adjustment by lambs were limited. The animal performance results were less compelling than is possible with the more flexible lucerne management advocated today. The higher feeding value of the lucerne over N deficient grass provides a protein-rich feed source for lactating ewes and then weaned lambs.

We need to make legumes thrive to overcome the weakest link in our pastoral systems – a lack of N. The meat, milk and wool that result are simply a by-product of overcoming that weakest link, which allows animals to be fed more effectively.

The ewes retain their condition through lactation and then are heavier than they were historically at tupping. The additional ewe weight leads to greater conception and increased lambing percentages. The system has required new skills to manage a high-quality forage and maintain flexible stocking policies to take advantage of the additional feed grown in wetter-than-average summers.

Advantages of legume-based grazing systems

The success of implementing a legume-based grazing system takes longer than the immediate fix to a short-term pasture deficit situation provided by N fertiliser. Once the whole system has been developed, however, the production rewards are tangible and locked in at a relatively low cost. This can be illustrated graphically by the changes that have occurred at Bog Roy Station near Otematata (420 mm rainfall) over the last decade *(Figure 7)*.

Initially, the system changed to direct feeding merino ewes and lambs on lucerne. The production benefits saw an immediate lift from 2008 to 2011, with an extra 20 tonnes of weaned lambs, but little change in ewe numbers. The lucerne grazing meant the ewes were being better fed during lactation so lambs grew faster and were heavier at weaning for sale. A flow-on effect is then seen in the next three years when more ewes were mated and at heavier weights, because there was more feed grown across the farm, particularly on the hills when the lucerne was being grazed.

As the areas of lucerne grew, there was a need to set stock the lucerne for a short period during lambing, and new management skills were required. In this case, set stocking is carefully managed for a short period of time to avoid compromising the lucerne. By 2016, 50 tonnes more lamb meat was weaned than in 2008, and an existing small irrigation consent has been transferred to allow the development of a centre pivot irrigated block that can be used for finishing those weaned lambs. The system has evolved over 10 years, with reduced supplementary feed made and fewer animals retained over winter. Direct feeding of lucerne now drives animal production and it is planted wherever possible.

Subclover

In dryland areas where the cultivation of lucerne is not possible, managing hill country through targeted grazing management can also achieve impressive results. In Marlborough, David and Jo Grigg at Tempello identified subclover as the legume of choice to provide the high-quality feed and N input their predominantly uncultivatable hill country required.

They report similar success with increased lamb weights, and higher condition ewes and cattle providing a buffering role to deal with unruly explosions of pasture growth in late spring and summer. Their template can be replicated across other dryland properties, where subdivision and stock water are the keys to being able to improve pasture legume content and therefore pasture quality. They

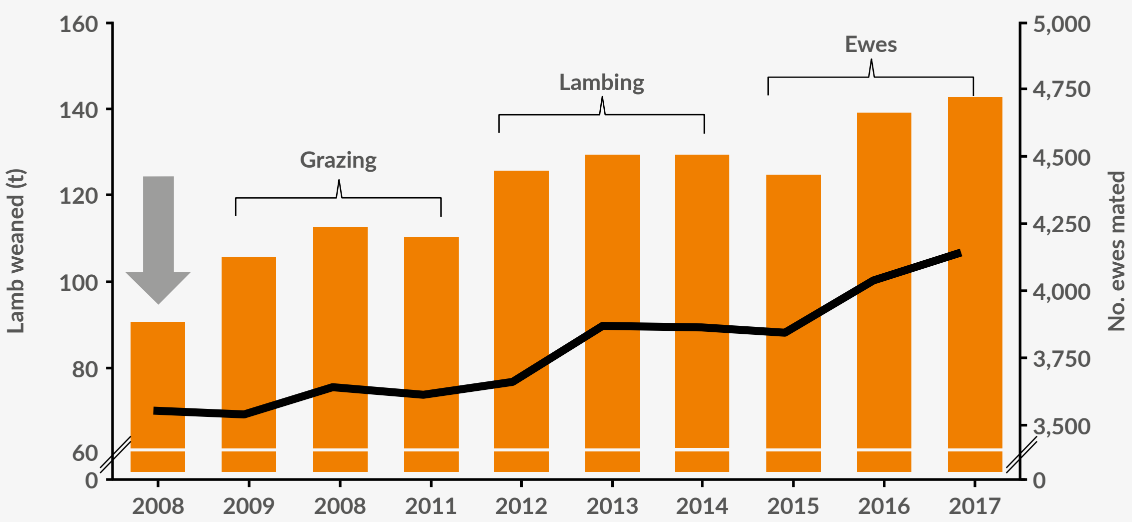

Figure 7: Transformational changes in lamb meat (t/yr) produced and the number of ewes mated at Bog Roy Station from 2008 to 2017 in response to integrating a lucerne-dominant grazing system and modifying grazing management to enhance system performance. The grey arrow indicates baseline production from a grass dominant system prior to initiating change

Table 3: Change in production parameters at Tempello in Marlborough from 2001 to 2016

	CORRIE/POLL DORSET FLOCK			90% CORRIE FLOCK*
Production measure	2001	2003	2007	2016
Ewe tupping weight (average kg/hd)	63	65	71	70
MA scanning %	145	148	165	178
2T and MA lambing %	128	128	138	135
Lamb growth rate pre-wean (g/hd/day)	250	374	345	295
Average lamb weaning weight (kg/hd)	27	30.9	33	35
Lamb weight/ewe weaned (kg)	34.5	39.5	45.5	47.3
% prime at weaning (over 32 kg/hd)	50	75	85	89
SU wintered/ha	8.2			11.5

returned an extra 16 t/yr of meat, with an increase in mixed age ewe lambing percentage, the ability to carry more stock, improved lamb growth rates and weights leading to 89% prime (>32 kg) lambs at weaning *(Table 3)*.

Red and white clover with plantain

For moister areas, or for irrigated finishing farms, the combination of red and white clover offers the same opportunity as the other legumes in a dryland environment. The animal production gains from summer feeding of plantain-based pastures with these legumes have been well documented by Professor Peter Kemp's group at Massey University. What is often missed in examining animal production in controlled on-station environments is the earlier production from all legumes in spring than frequently occurs from N deficient pastures in hill country.

Recently, John Chapman at Inverary Station in the Ashburton Gorge highlighted this earlier-than-expected growth of his red clover-based pastures as an unexpected benefit of his development programme. His flat free-draining land is suitable for lucerne, but the heavier, wetter hills utilise red clover. By oversowing pure legumes on sprayed-off steeper hill country, after initially breaking down the grass thatch with stock, he is able to minimise soil erosion, control thistles and then introduce plantain or cocksfoot in later years to extend the life of his renovated 'spray and delay' pastures.

N deficiency a major impediment

These examples of legume-based farming systems are all based on recognising that N deficiency is the major impediment to hill country sheep and beef farming – and actually all farming systems as outlined above. As noted by Lucas et al. in 2010, the legumes consistently fix about 30 kg/N per tonne of above-ground legume grown and provide feed with an ME of greater than 11 MJ/kg DM and crude protein above 24% for most of the year.

Legumes do not require additional N fertiliser, but it can be used on the shoulders of production seasons to boost grass growth, provided the extra feed grown is eaten and not left to shade the legumes. There are a range of other legumes now available on the market including arrowleaf, balansa and Persian clovers, and farmers will determine which (if any) of them are suitable for their farm situation.

It should be noted that lucerne and subclover, which have transformed many dryland farms in the last 15 years, have been around for many years. I was reminded of this by the Minister for Primary Industries when meeting him recently. I was too polite to respond that it is not the plant by itself that produces a transformation – it is the farm system that is developed around it.

We need to make legumes thrive to overcome the weakest link in our pastoral systems – a lack of N. The meat, milk and wool that result are simply a by-product of overcoming that weakest link, which allows animals to be fed more effectively. The opportunities exist for further legume development, particularly on sheep and beef farms, and this is the focus of a recent Beef + Lamb NZ funded programme on 'Regenerating Hill Country' which is the basis of our current research.

Re-engaging with legumes appears to be the lowest hanging fruit for much of our pastoral landscapes – it remains to be seen how abundantly we are able and allowed to pick it.

Acknowledgements

Data presented in *Figures 6a* and *b* was undertaken as part of Phase II of the Pastoral 21 programme, funded by the Ministry for Business, Innovation and Employment, DairyNZ, Beef + Lamb NZ; and Fonterra, and the Ministry for Primary Industries, the Sustainable Farming Fund and Mr Roland Stead.

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ANDREW BURTT AND ROB DAVISON

SHEEP INDUSTRY UPDATE 2019

This article provides an update on the current state of the sheep industry in New Zealand. It looks at livestock numbers and production, pastoral land use, exports, exchange rates, trade policy and the outlook for the future.

New Zealand livestock numbers and production

New Zealand's sheep population is under 30 million, which is more than 50% lower than it was in the early 1990s and reasonably small by international standards, but that is a one-dimensional view of trends in the industry *(see Figure 1)*. It misses the point that productivity has improved steadily over that time. While the change in numbers is routinely quoted by industry commentators and media, it overlooks the continued innovation and responsiveness of farmers to market signals.

Lamb production is just 5% lower than in 1990-91 from a sheep flock that is over 50% lower as farmers have adopted many types of technology. This change has resulted in a substantial reduction in greenhouse gas (GHG) output from the sector, which is over 30% lower than in 1990-91. We expect sheep numbers to stabilise over the next few years.

Markets for sheepmeat (and beef) are firm to strong. Confidence in the industry – supported by good returns for livestock – is expected to be expressed in more lambs being retained as replacements following the large lamb and mutton offtake in 2017-18.

Pastoral land use

Overall, between 1990-91 and 2017-18, the area of pastoral land fell by about 3.2 million ha *(see Figure 2)*. The expansion of the dairy herd approximately matched the switch of pastoral land from sheep and beef production to dairy. At 2017-18, pastoral land used for dairying totalled an estimated 2.29 million ha compared to 1.35 million ha in 1990-91.

The decrease in area for sheep and beef farmland is more difficult to explain because there are a number of factors that explain the change. There was a 34% decrease between 1990-91 and 2017-18, which amounts to 4.2 million ha of sheep, beef, goat and deer land, to an estimated 8.3 million ha.

We estimate that the latter land use change is spread amongst:

- Blanket forestry
- Extensive marginal pasture land that has been closed for conservation
- Marginal land that has reverted to scrub and bush
- Urban encroachment, especially from smallholding lifestyle blocks near towns and cities around Auckland, Hamilton and Christchurch
- Viticulture and horticulture
- Conservation under QEII National Trust covenants.

Exports

Australia and New Zealand account for over 80% of the international sheepmeat trade, excluding intra-EU trade. Tighter mutton supply has driven competition for 'value' cuts of lamb and growth in the value of higher-value cuts, such as loins, has continued.

There have been some substantial changes in the direction of New Zealand's exports of both lamb and mutton over recent years. Continued tight supplies of mutton from New Zealand and Australia, and a depreciation of the NZD relative to key currencies, are driving sheep prices.

As with lamb, ahead of the 2017-18 season there was some uncertainty about prospects in markets, particularly China, which accounts for about two-thirds of New Zealand mutton exports. But prices continued to strengthen – there was a 21% increase in in-market prices.

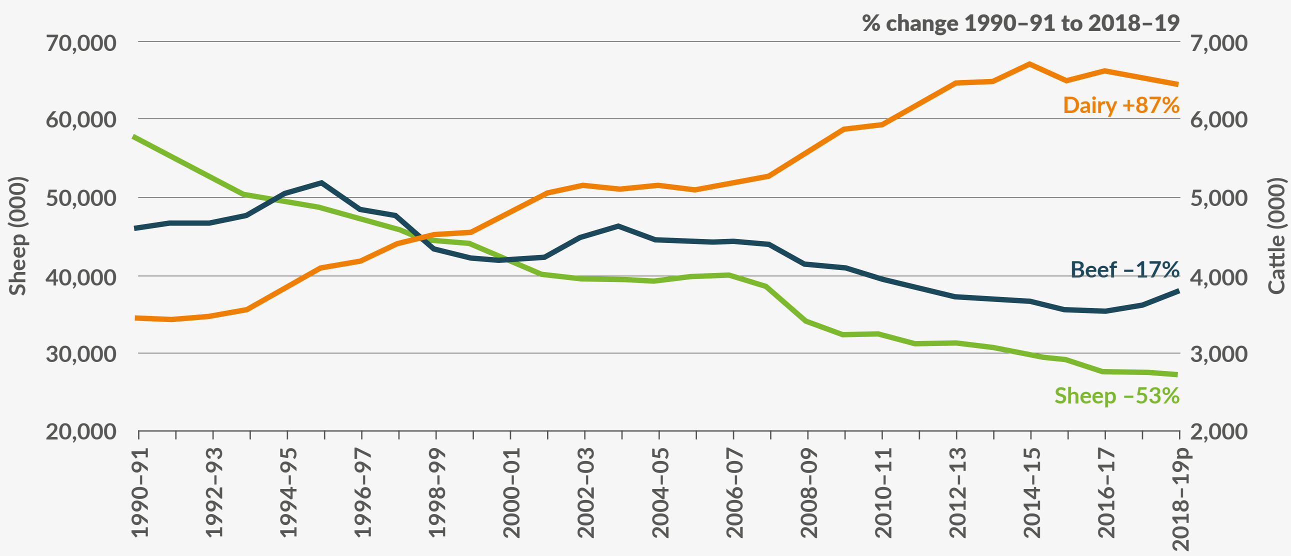

Figure 1: NZ sheep and cattle numbers (1990-91 to 2018-19)
Source: Beef + Lamb New Zealand Economic Service | Statistics New Zealand

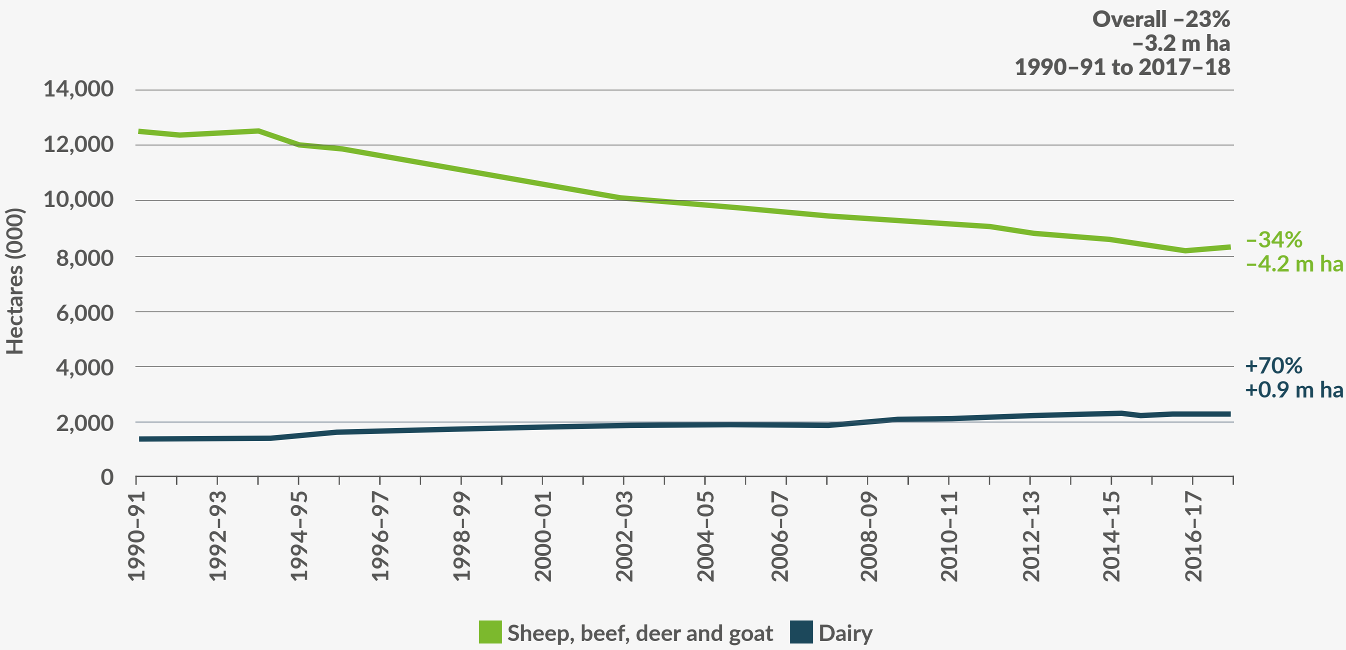

Figure 2: Pastoral land use in NZ
Source: Beef + Lamb New Zealand Economic Service | Statistics New Zealand

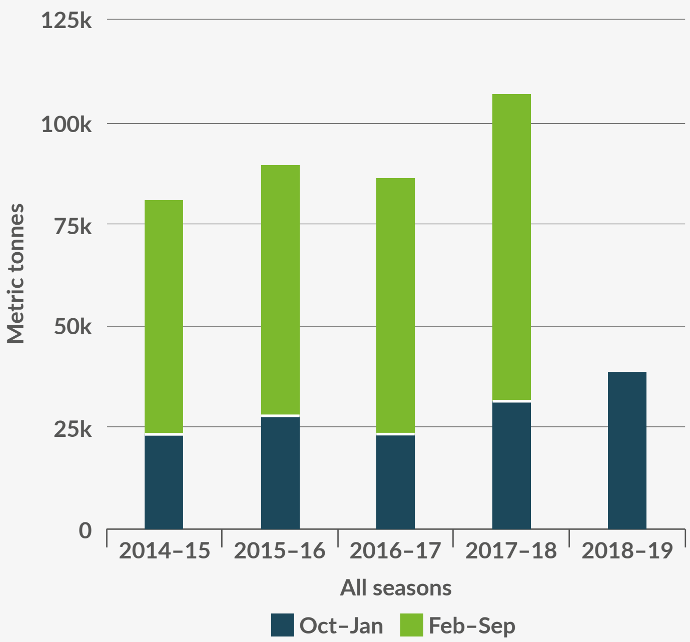

Figure 3: NZ lamb exports to China (volume)
Source: B+LNZ Economic Service

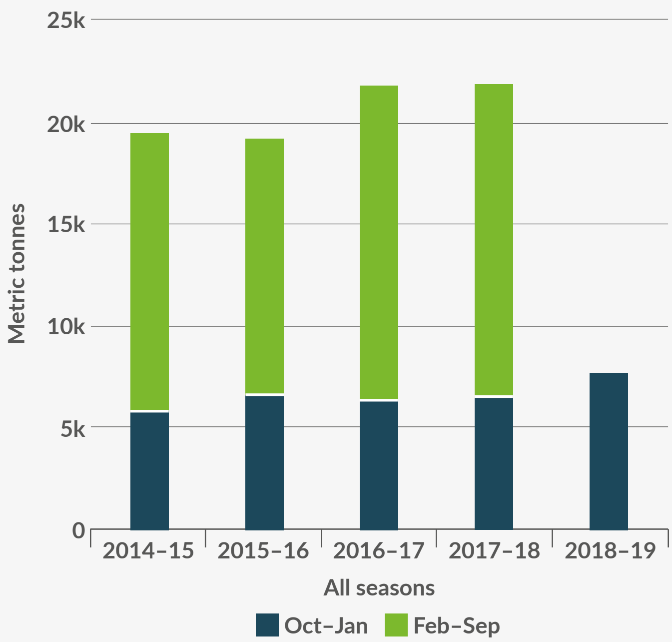

Figure 4: NZ lamb exports to the US (volume)
Source: B+LNZ Economic Service

Since then the business with China has continued to grow as a result of a number of factors including:

- Strengthening New Zealand exporter relationships with their Chinese counterparts
- Some substitution of (high-priced) lamb by mutton
- Improved confidence that non-tariff barriers will be less of a risk
- Concerns about the extent of African Swine Fever (ASF) in pigs in China
- China's demand for sheepmeat continuing to outpace increases in its domestic production.

In 2017-18, China was the largest market for New Zealand lamb by volume and value (see ***Figures 3 and 5*** for volume and ***Figures 4 and 6*** for value). These figures show exports for the first four months of the season in blue and the subsequent period in green.

Readers can do further analysis of meat exports using the interactive Meat Export Tool on Beef + Land NZ's website.

Exchange rates

Sterling depreciated sharply soon after the Brexit referendum in June 2016, which put pressure on meat prices (and food prices generally). However, what happens

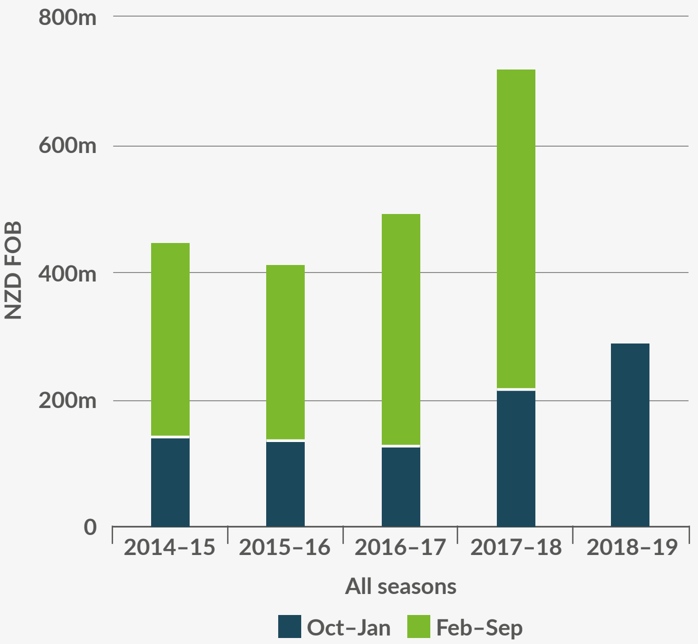

Figure 5: NZ lamb exports to China (value)
Source: B+LNZ Economic Service

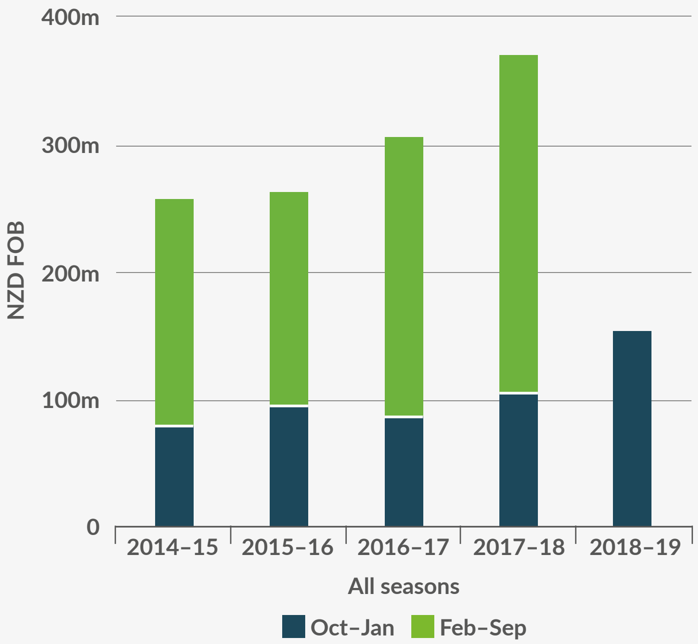

Figure 6: NZ lamb exports to the US (value)
Source: B+LNZ Economic Service

Australia and New Zealand account for over 80% of the international sheepmeat trade, excluding intra-EU trade.

on 29 March 2019, which is when Brexit is scheduled to occur, still remains far from certain.

The direction of the USD, which is by far the most important currency in which New Zealand meat is traded, remains somewhat uncertain. On the one hand, the US economy continues to grow strongly by historical standards and the US central bank (the Federal Reserve) has signalled it will raise interest rates. This would expect to result in the USD strengthening further, although after the late January meeting of the Federal Open Market Committee (FOMC) Chairman Jerome Powell said the bank would be 'patient'. On the other hand, there is some uncertainty about the impact on currency values of the trade war and reduced Chinese foreign direct investment in the US.

Our outlook is for the NZD to depreciate against the three major currencies in which New Zealand meat is traded – the USD, GBP and EUR – with small depreciations against the GBP and EUR and a bigger depreciation against the USD.

Trade policy

Brexit

What the final outcome will be on Brexit has caused much uncertainty in all types of businesses that are conducted with the EU28 and the UK. The deadline for Brexit is fast looming and the situation is so fluid that it is impossible to forecast what will happen. Beef + Lamb New Zealand is working with the New Zealand Meat Board, the Meat Industry Association (MIA), processing companies and the New Zealand Government to prepare for all scenarios as the uncertainty continues.

In late January, the UK Parliament voted down the agreement that Prime Minister Theresa May negotiated with the EU in late 2018. Subsequently, there were votes on numerous amendments to the agreement. The major stumbling block is the so-called Irish backstop, which is effectively how the border between Ireland and Northern Ireland will be treated. The EU has been clear since the draft agreement was released (in late 2018) that the agreement is the best achievable and is not up for re-negotiation. As a result, Theresa May has stated that the EU has 'limited appetite' for changes, but must now try and find a solution to the backstop.

New Zealand's position, which was reiterated by Prime Minister Jacinda Adern during her recent visit to the UK, is that this country should be no worse off as a result of Brexit. She believes that both the UK and the EU need to honour their legal obligations and commitments under the WTO.

There is still a lot of uncertainty in this process, and while it is inevitable there will be more clarity in the coming weeks there is also a very real chance that negotiations with the EU and UK will continue until the 11th hour.

The US

The longest government shutdown in history ended in late January. President Trump announced he had agreed with Nancy Pelosi, the (Democrat) Leader of the House of Representatives, to re-open the government while talks continued to address security on the border between the US and Mexico. The next milestone date was 15 February 2019 and a further shutdown was averted. While neither directly affects New Zealand's sheepmeat production or exports, it provides uncertainty in international markets.

Meanwhile, the US and China continue to negotiate trade and economic issues, although there are some signs about increased market access for agricultural products, particularly crops such as soybeans.

The US and EU are negotiating a free trade agreement (FTA). The EU has announced it does not want agriculture included in the FTA, which is unacceptable to the US.

After withdrawing from the Trans-Pacific Partnership Agreement (TPP), which later became the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and entered into force at the end of December 2018, the US is negotiating an FTA with Japan.

All these and other agreements, such as the US-Mexico-Canada Agreement (USMCA) that is intended to replace the North American Free Trade Agreement (NAFTA), will have an impact on agricultural trade.

Outlook

Lamb prices

The weighted average price for the all grades of prime lambs across the 2018-19 season is expected to be around $140/head. Beef + Lamb New Zealand Economic Service information shows the average for the first quarter of the season approached $150/head.

Globally strong demand for lamb continues, supplies are limited, and this is combined with a 'grass market' in some areas and dry in others in New Zealand, particularly in the North Island. As a result, the increase is primarily driven by a strong December quarter, when the volume exported was lower than in 2017-18, but value per tonne was higher. Feed conditions were more favourable in the December quarter of 2018-19, which resulted in heavier carcass weights, but most significantly a relatively weaker NZD supported higher prices.

The number of lambs processed in the December quarter was down on 2017-18 by nearly 9%, and the total lamb supply is expected to be down 5% for the entire season. Australian lamb supplies remain tight. There are some concerns being expressed about the uncertainties resulting from the geopolitical situation – specifically Brexit and the US-China relationship – although how those are resolved remains far from clear. There is some indication of a downturn in economic prospects in France and Germany. However, overall, their currencies are stronger against the NZD.

Combining all these factors, the average per-head lamb price is forecast to increase 3.7% in 2018-19.

Wool prices

Weak demand from China continues to underpin the low wool prices. The bright spot for wool remains the fine segment, in which the average export value was up an exceptional 58% in 2017-18, and a further increase is expected for 2018-19.

For 2018-19, the outlook for crossbred wool prices remains bearish despite a weaker exchange rate. Crossbred wools are tending to be longer in staple with less shearing in response to prices – for the final product and for shearing. The relatively wet, hot season to date has resulted in poor colour in fleeces, which is a discount factor. That said, shorter wools resulting from shearing for animal health reasons and which are of good colour have been reported as receiving higher prices than the majority of the crossbred clip. Some improved demand is expected for lamb's wool of good colour.

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Figure 7: Weighted average price for prime lambs in NZ
Source: B+LNZ Economic Service | Statistics New Zealand

JACQUELINE ROWARTH

GLYPHOSATE USAGE – PROS, CONS AND ALTERNATIVES

Glyphosate is the most commonly used herbicide globally. Its use has been linked to cancer, environmental damage and antibiotic resistance. This article examines why there is confusion about its safety, and the research that supports glyphosate as a more effective and safer option than the available alternatives.

Call for ban

People are right to be wary about chemicals – but fear of synthetic chemicals (termed 'chemophobia') is increasing and taking hold of people's understanding, or rather misunderstanding. The fear is increasing despite the fact that the chemical companies spend a considerable amount of money on research and development, releasing chemicals only after rigorous testing both for health impacts and target effectiveness. No user or consumer wants to be exposed to anything that might lead to health problems and chemical companies do not wish to end up in court.

The chemical industry has been estimated to spend over $300 million per product on research and development before a chemical is released (https://croplife.org/wp-content/uploads/2016/04/Cost-of-CP-report-FINAL.pdf). Human health is at the forefront of concerns, and environmental protection authorities and agencies around the world are focused on ensuring protective guidelines to reduce the risk to operators.

Glyphosate (commonly sold as Roundup) has been at the centre of many debates, in part because of increased use. It is now the most commonly used herbicide globally. It is also frequently associated with the advent of genetically modified (GM) crops. It is used as a herbicide, both in New Zealand and globally, in many situations and not just for GM crops. Concerns over its use has led many, most notably the Green Party, to call for a ban.

Californian court case

Fears were heightened in August last year by the Californian ruling on glyphosate which implicated a groundsman's non-Hodgkins lymphoma diagnosis to his use of the chemical. The jury decided that glyphosate was a plausible contributing factor and the plaintiff did not have to prove that the chemical did cause the cancer. Monsanto was ordered to pay the equivalent of over NZ$400 million. Monsanto appealed the verdict.

In October 2018 a Superior Court Judge, Suzanne Bolanos, partially overturned the verdict. Judge Bolanos let stand the jury's finding that Roundup caused Johnson's cancer, but decided that the punitive damage award of $367 million was too high and offered a choice – accept $57 million in punitive damages or submit to a new trial on the punitive damages. The compensatory damages of $57 million would remain intact either way (see http://theconversation.com/roundup-weed-killer-lawsuit-hits-a-snag-but-monsanto-is-not-off-the-hook-105559).

Chemical spills into waterways have been associated with aquatic organism deaths. When glyphosate is used as recommended, which includes avoidance of waterways, no effects have been recorded.

This ruling clearly did not absolve either Monsanto or glyphosate of blame and arguments about banning its use continue globally. Despite headlines suggesting an increasing number of countries are becoming glyphosate-free, the reality appears to be different and involves restrictions and/or investigating alternatives in specific areas (see www.baumhedlundlaw.com/toxic-tort-law/monsanto-roundup-lawsuit/where-is-glyphosate-banned/), as well as more frequent re-assessments of approval (e.g. in Europe).

Opposing views caused by different terms of reference

In 2015, two reports from credible organisations were released. One categorised glyphosate as a 'probable human carcinogen' and the other stated that 'on the available scientific evidence, there are no grounds to classify the controversial herbicide, glyphosate, as a carcinogen, as a mutagen or as toxic for reproduction.'

The difference in the outcome reflects the difference in the terms of reference for the organisations. The first glyphosate report was by the independent International Agency for Research on Cancer (IARC) and involved 17 experts who reviewed all published peer-reviewed literature. IARC identifies hazards and does not take into account the likelihood of exposure to the substance, so it does not address the risk of exposure. IARC's list of known carcinogens (Category 1) includes alcoholic beverages, tobacco, solar radiation and wood dust. The probable carcinogens (Category 2A) include shift work, processed meat, frying and red meat, as well as glyphosate.

The second report concluding that glyphosate was safe to use, as long as guidelines on use were followed, was from the European Chemicals Agency (ECHA) Committee for Risk Assessment. ECHA's investigation involved an extensive evaluation of all the information available, including human evidence and 'the weight of the evidence' of animal studies.

Since the reports were released considerable mud-slinging has occurred, including suggestions that contributors to the IARC report were conflicted and that significant evidence was ignored. Hence the debates about use continue.

Evidence for human effects

All chemicals have the potential to cause harm if ingested at high enough doses. The American Cancer Society has explained that:

> ***... carcinogens do not cause cancer at all times, under all circumstances. Some may only be carcinogenic if a person ingests it, for example, as opposed to touching it; some may cause cancer only in people with a certain genetic makeup; some agents may lead to cancer after only a very small exposure, while others might require intense exposure over many years.***

The ongoing concern about sugar is a case in point. Sugar is not toxic, but eaten in large quantities can lead to obesity and other negative consequences. Obesity was reported to be responsible for 3.9% of cancers worldwide last year.

Alcohol (IARC Category 1) causes 3.6% of all cancers and 3.5% of cancer-related deaths. In contrast, studies of agricultural workers and their families in America published at the end of 2017 in the *Journal of the National Cancer Institute* found that, 'glyphosate was not statistically significantly associated with cancer at any site.' The research involved almost 55,000 people, 83% of whom used glyphosate.

The authors noted an increased, but not statistically significant, risk of acute myeloid leukaemia (AML) in the highest exposure quartile compared with 'never users'. AML can arise during non-Hodgkin's lymphoma treatment. Note that the study could not assess whether the 55,000 people studied did or did not follow the guidelines for use designed to minimise risk. Following the Californian court case, Dr Andrew Kniss, Professor of Weed Science at the University of Wyoming, calculated that 97% of people with non-Hodgkin's lymphoma have had no exposure to glyphosate.

Also following the case, the Environmental Working Group (EWG) released a non-peer reviewed study claiming that parents were serving their children breakfast with a 'dose of the weed-killing poison.' This story was circulated widely in the media and increased public fear. American experts examined the report and concluded that, 'A bowl of cheerios, or a daily bowl over months or even many years, won't endanger your health. Why? Because we are talking about minuscule amounts of glyphosate – well below the levels that would be considered dangerous.'

Other concerns

Soil and water organisms

Some reports exist of decreases in soil organism activity after glyphosate application. Given a reduction in food source because of the death of plants, this is not surprising. It is also to be expected that the soil organism

profile will change with repeated use of glyphosate because use tends to be associated with specific crops and crop rotations. Chemical spills into waterways have been associated with aquatic organism deaths. When glyphosate is used as recommended, which includes avoidance of waterways, no effects have been recorded.

Antibiotic resistance

Research on antibiotic resistance at the University of Canterbury has implicated glyphosate, but medical scientists have another theory centering around increased antibiotic use in humans.

A review produced by the Ministry of Health and the Ministry for Primary Industries in 2017 pointed out that, 'New Zealand communities have increased their consumption of antimicrobials by as much as 49% between 2006 and 2014.' The review also showed that the level of consumption in New Zealand is high in comparison with many other European countries. New Zealanders average approximately 26 defined daily doses per day, in comparison with 21 for the UK, 16 for Germany and 11 for The Netherlands.

Antibiotic resistance in New Zealand is relatively low, but is emerging and spreading. Research identifies several reasons, the first being inappropriate use of antimicrobials, which includes overuse of broad spectrum antibiotics such as topical antibiotics.

Transmission of resistant organisms in both community and health care settings is also a factor, as is the importation of resistant pathogens from areas where multi-drug-resistant organisms are endemic. In various countries, including some in the Asian sub-continent, antibiotic drugs are available without prescription.

A fourth issue identified is environmental and genetic factors that increase the viability of multi-drug-resistant bacteria. Professor Heinemann (University of Canterbury) has been writing about this possibility for some time, citing the use of antibiotics in animals and chemical use in the environment as factors. New Zealand has the third lowest use of animal antibiotics in the OECD.

The Ministry of Health and the Ministry for Primary Industries review suggests that this reflects the strong regulatory controls on the use of antimicrobial agents, which limit prescribing and dispensing to the veterinary profession. It also says that, 'animal husbandry systems are relatively low in intensity.' A further factor is ongoing government and industry investment in initiatives to limit antimicrobial resistance.

Glyphosate and benefits of no-till farming

Glyphosate acts through the plant system and the effect lasts for several months. Glyphosate is used in cropping as part of seed bed preparation and is particularly important as a replacement for traditional ploughing, which buries many emerging weeds. No-till farming reduces tractor time and hence fossil fuel consumption, as well as soil compaction. Without cultivation the soil organic matter – and all the soil organisms within it – are maintained and the potential for soil loss through erosion is reduced.

In the US the adoption of minimum-tillage and no-till cropping resulted in a 43% reduction in soil erosion between 1982 and 2003. Further, crop residue in no-till farming increases water infiltration into, and reduces evaporation from, the soil. This means there is less run-off of water and a reduced potential to lose fertilisers and pesticides in run-off water. No-till is considered an integral component of sustainable intensification (see https://geneticliteracyproject.org/2018/12/20/can-we-meet-a-growing-need-for-food-without-destroying-our-environment/?mc_cid=fdb79b9fb1&mc_eid=5165fc44e1).

Alternatives to glyphosate

Alternatives to glyphosate are available but questions remain about safety, effectiveness and cost.

Vinegar (acetic acid) and other acids and oils

Vinegar has been promoted in the New Zealand media. Like lemon juice (citric acid), at sufficient concentration it burns leaf cells and destroys the tops of plants. Boiling water, steam, or flames will do the same. However, the roots will often survive and in some plants that means regeneration of leaves will occur.

In response to ratepayer concerns about the use of glyphosate, Bristol Council in the UK spent a year comparing various ways of controlling weeds. The Council report states, 'For acetic acid and hand weeding the weeds started re-emerging within a month. On comparison sites treated with glyphosate, the weediness scores stayed low for five to six months.'

Researchers calculated that it would cost at least three times as much to spray the city with vinegar on a monthly basis than use glyphosate, and concluded that this cost would be financially 'prohibitive'. Further concerns included corrosion in the equipment due to the acidic nature of vinegar and a much greater requirement in terms of protective clothing for the operators than that required for glyphosate.

Pelargonic acid (a chemical found in several plants and therefore considered 'natural' like vinegar and lemon juice) gave immediate or short-term suppression of growth of vegetation, as did clove oil in a study in Massachusetts. The suppression lasted for three to six weeks after which growth was not distinguishable from untreated vegetation. Again, a requirement for repeated applications was noted.

The research also reported that formulations of citric-acetic acid or a citrus-derived product (limonene) gave no control or only weak suppression of vegetative growth soon after application, and no suppression was evident after three to six weeks. A similar suppression time was noted for steam, hot water and torching.

Paraquat

Paraquat is effective and does have uses in agriculture (e.g. in lucerne production or in rotation with glyphosate), but it is highly toxic. The lethal ingestion dose of paraquat in humans is 35 mg/kg. No lethal ingestion dose has been reported for glyphosate, although there are warnings about immediate treatment if splashed in the eye.

Consequences of a ban

Glyphosate is integral to the use of GM crops grown overseas and in many cases they have been modified to allow its use. In general, GM crops outyield their conventional counterparts. Last year a comprehensive review examined 6,000 studies published over two decades and concluded that, 'GMO corn increased yields up to 25% and dramatically decreased dangerous food contaminants.' In primary production, whether GM or not, banning glyphosate would reduce food availability and hence increase prices.

A report for the UK Crop Protection Association by Oxford Economics researchers forecast a reduction in area of 20% for wheat grown and 37% for oilseed rape (canola) if glyphosate was banned. Further, yields on the reduced area were forecast to decrease – 12% for wheat and 14% for oilseed rape. Labour productivity would decrease by 10% and earnings before interest, tax, depreciation and amortisation (EBITDA) would reduce by 13.9%. This in a country where the Department of Environment, Food and Rural Affairs indicates that only 25% of farms actually make money from farming (see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/683972/future-farming-environment-).

A report from Germany has suggested that, 'where the cultivation of certain crops is no longer profitable, their production would either need to be subsidised, or farmers would need to switch to the cultivation of other crops.'

In New Zealand the impact could be considerable, both for costs to the farmer, which would not be cushioned by subsidies as they might be (as indicated by the German report) in the Northern Hemisphere, and prices to the consumer. Increasing costs could put farmers out of business unless the costs could be passed to the consumer. However, increasing prices could render New Zealand produce uncompetitive on the global market – and so the economy would be at risk.

There could also be a negative impact on the environment. The impact would be on soil quality as no-till cultivation practices would not be possible, alongside increased greenhouse gas (GHG) emissions due to increased fossil fuel, and increased chemical requirements sometimes requiring several passes across a paddock (hence increasing GHGs still more), and also increasing soil compaction which then requires more cultivation post-crop.

Loss of competitiveness in food production and the potential to affect global food prices were highlighted in the European reports because of the knock-on effects for the economy. For New Zealand, with the bulk of food exported, competitiveness is important. However, so is minimising erosion and GHG production while maximising soil quality, including organic matter.

Conclusion

All chemicals should be handled with care at all times, and 'care' means reading the instructions. It is possible to produce food without using glyphosate – organic producers manage. Their food does, however, tend to be more expensive than that produced conventionally.

The question of whether consumers will be prepared to pay the price for glyphosate-free production, and accept that there will also be both positive and negative environmental implications, remains. An alternative is that they accept the European Chemicals Agency ruling that the available scientific evidence did not meet the criteria to classify glyphosate as a carcinogen, as a mutagen or as toxic for reproduction. In combination with the results from the US research on 55,000 agricultural workers, consumers should feel reassured that the chemicals approved for use are safe when used as directed.

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JANE CHRYSTAL

LOW-COST WINTERING FOR SOUTHERN FARMERS

Wintering dairy cows on crop has environmental implications for water quality and off-paddock solutions can be costly. This article looks at an innovative low-cost alternative that uses brassica crops and has the potential to reduce losses of nitrogen to water by up to 25%.

Impact on water quality

Dairy farmers in southern New Zealand are coming under increasing scrutiny over the impact of off-paddock wintering systems on water quality. The traditional low-cost system of grazing cows on brassica crops 24/7 over winter has several potential environmental impacts, including relatively large losses of nitrogen (N) to water. Currently, available alternatives that use barns or wintering pads to house cows are costly and can come with their own effluent management challenges.

Until recently there has not been a low-cost system that captures effluent while allowing the animals to graze crops. Recent research has explored the possibility of using an alternative low-cost wintering pad system that allows for on-off grazing of brassica crops and captures much of the excreta that would otherwise be deposited in the field. Preliminary findings suggest such a system could reduce N losses to water by up to 25%.

Pros and cons of current system

Winter is an important season in New Zealand pastoral dairy farm systems as it is the period of late pregnancy when cows are not milking and pasture growth rates are very low. In the southern South Island wintering usually encompasses a 10-week period from late May until calving in early August. During this period farmers commonly graze cows on brassica crops to allow pasture covers to increase for the start of spring and to have cows at targeted body condition scores.

The benefits of this system are that brassica crops are a relatively low cost and reliable source of winter feed that can be grazed at high stocking densities and it does not require large capital inputs. However, it has some downsides. Grazing at high stocking densities during winter, combined with high winter rainfall, can result in relatively large transfers of contaminants such as N, phosphorus (P), faecal microbes (measured by *E. coli*) and sediment to water.

The relative magnitude of these losses depends, among other factors, on soil drainage attributes, soil strength and slope. Brassica-based wintering systems are therefore coming under increased scrutiny, particularly from regional councils and regulatory bodies. This has prompted some dairy farmers to use off-paddock systems, such as barns or wintering pads, for dairy cow wintering. These have benefits in that they remove cows from paddocks at a time of the year when the risk of contaminant loss to water is high. Effluent is captured and stored and applied to land at more favourable times of the year when the risk of nutrient losses is reduced.

However, wintering barns and wintering pad facilities also have their downsides. They generate large volumes of effluent which need to be managed. While they do reduce contaminant loss to water where production is not increased, farmers often intensify production to offset the high capital costs of building these facilities, potentially eroding some or all of the environmental benefits.

The reality is that the grazing of low-cost winter crops affords considerable financial advantage to dairy farmers in the south of New Zealand. However, depending on soil type, climate, topography and management, leaving cows on-paddock can cause major soil degradation and affect animal welfare where they are in muddy paddocks for extended periods. Farmers in southern New Zealand may therefore need to take cows off-paddock for winter, but this adds significant complexity to the farm system *(see Figure 1)*, not least of all because of the need to capture and store effluent.

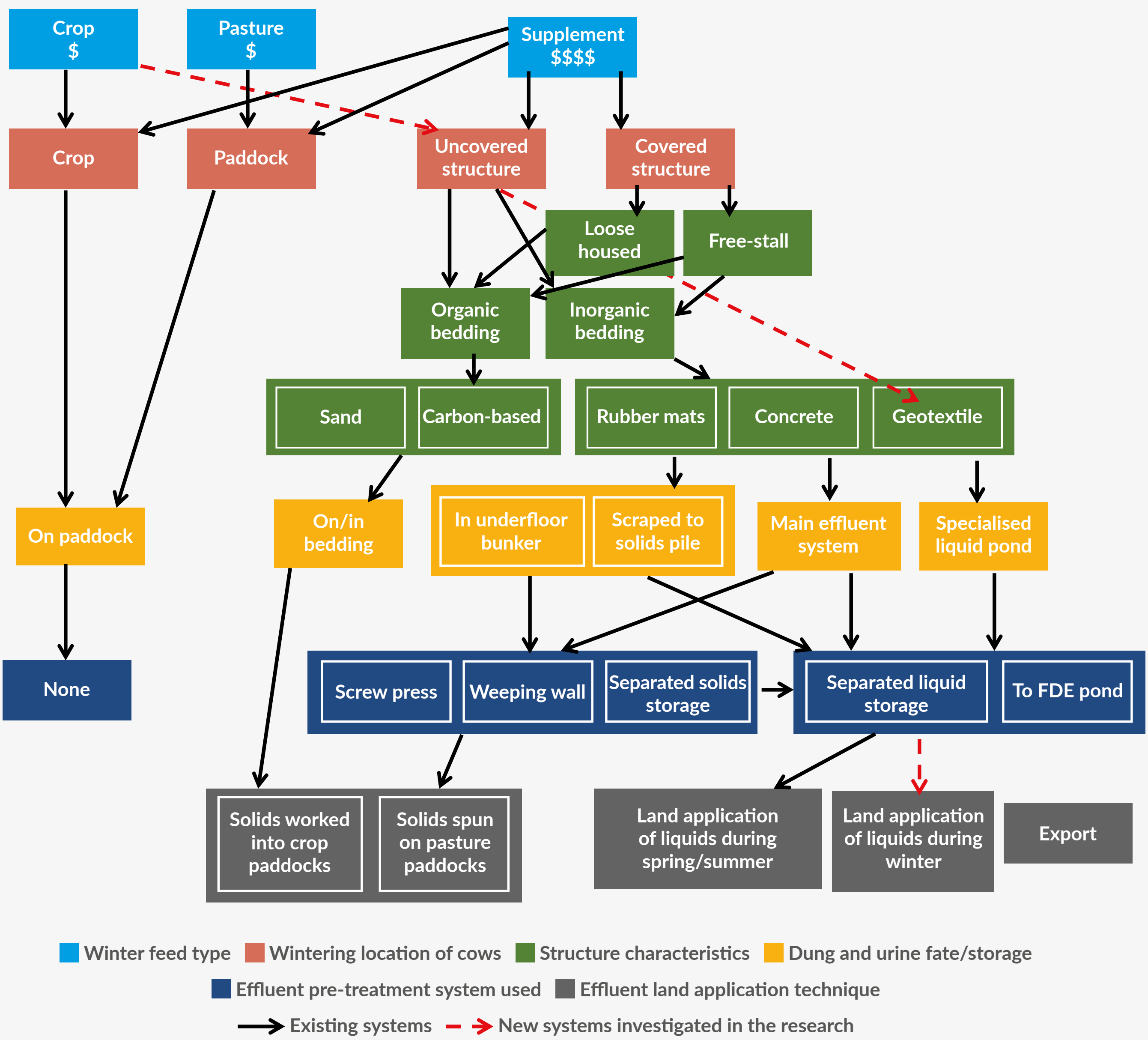

Figure 1: Wintering system

Developing a low-cost pad wintering system

A key research focus was to find a feasible solution that combines the low-cost advantages of winter crop grazing with the environmental, effluent capture and animal welfare benefits of barns and wintering pad facilities.

We investigated the feasibility of a winter crop grazing system incorporating a stand-off pad to reduce urinary N returns to the paddock, and this was evaluated over a two-year period. The designed system was a lower cost alternative to barns and wintering facilities that allowed cows to stand off-paddock for a significant proportion of the day, while still enabling them to be grazed on the low-cost brassica crop.

The pad uses an impermeable effluent liner (overlain with a cow comfort surface that helps protect the liner) to capture effluent deposited on the pad surface. This facility can be moved around the farm in different years as the location of the forage crop paddock changes. Minimal effluent storage was required as we developed a low-rate, low-depth system of applying liquid effluent to pasture in neighbouring paddocks during winter.

How we got there

We carried out a range of experiments and modelling exercises to determine the most feasible design and use practices. Key to the success of the concept of the pad was the ability of the impermeable layer to successfully capture effluent deposited on the pad surface. The pad surface also needed to have a comfortable lying surface with enough grip to ensure cows did not slip over in wet conditions. After trialling three different materials, we found the best surface was a geotextile fabric that provided adequate cow comfort while drawing moisture away from the pad surface. This material was also reasonably affordable.

The next stage of the experiment was to build a pad with the geotextile surface and use it to accommodate a mob of 20 cows for 18 hours per day. A second mob of 20 control cows was wintered on crop 24 hours per day. Each cow had an allowance of 8.5 m² of lying surface on the pad, meeting industry recommendations for a loose-housed barn system with or without grazing.

Table 1: Pros and cons of the different surfaces trialled for use as a pad surface

SURFACE	PROS	CONS
Geotextile 	• Non-slippery • Easy to roll out • Takes moisture out of dung • Cost <$20/m²	• Needs to be secured in place • Questions about cow comfort – lying times may not reach industry minimum target of eight hours per day • May require a harder surface
Rolled rubber 	• Easy to unroll	• Too slippery for cows – animal welfare issue – not suitable as a surface for this purpose • Cost $59/m²
Interlocking matting 	• Easy to lock together • Locks become more secure with cow traffic • Liquid flows through cracks to sub-layer	• May require a flat surface • Cost $85/m² • Questions about slipperiness in heavy rain

The cows had a water trough in one corner of the pad and a bale feeder in the centre. Cows were released onto a brassica crop at 9am. The cows remained on crop for six hours and then returned to the pad. Collected liquid effluent was pumped from a small sump and spread over neighbouring pasture. Effluent solids were scraped from the pad daily into a stone trap before being removed by tractor to a concrete storage pad, which took around 20 minutes each day.

Liquid effluent management

A solution was needed for the problem of managing liquid effluent when the pad is located away from an effluent pond. The practice of applying liquid effluent to pasture over winter using a low-rate, low-depth effluent sprinkler system was therefore evaluated in experimental and modelling studies that quantified losses of N, P and *E. coli* in drainage and surface run-off flows.

The purpose of this approach was to determine if such a system could reduce winter effluent storage requirements, thus avoiding much of the cost of building or retrofitting existing effluent systems when installing off-paddock facilities. Experiments quantified N, P and *E. coli* losses to water when effluent was applied at different depths to land over winter.

These measurements were made on a deep silt loam that was imperfectly drained. Providing due consideration was given to rainfall and wind speed thresholds, research conducted by AgResearch found that 1-2 mm of effluent could be applied per day without causing large losses of effluent contaminants in drainage (or surface run-off).

Modelling analysis showed that losses will vary depending on soil type, rainfall etc. A decision tree depicting the relative risk of applying liquid effluent using a low-rate, low-depth method in a range of scenarios was generated (*see Figure 2*).

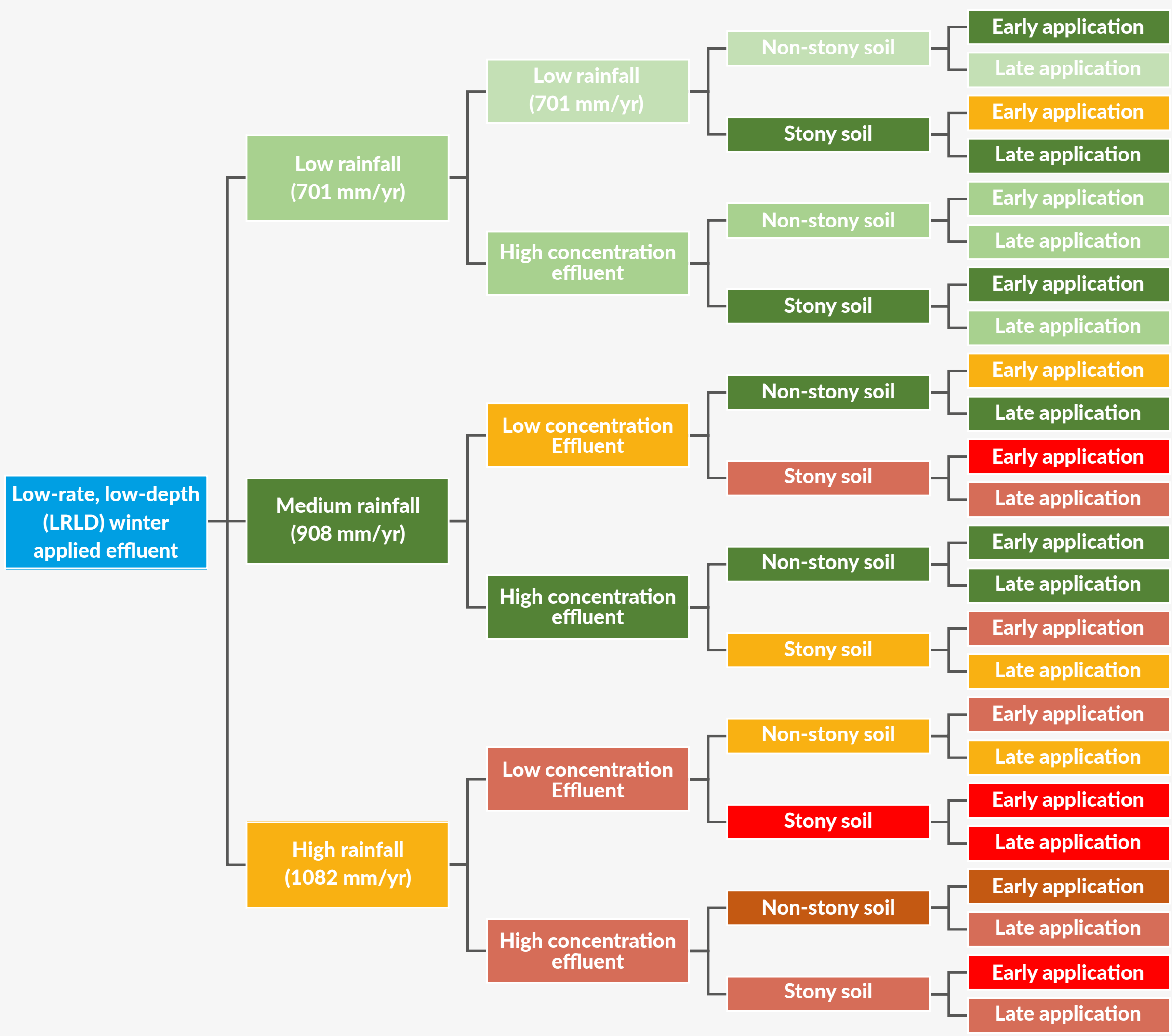

Figure 2: Decision tree of the relative risks of N leaching losses associated with applying the low-rate, low-depth irrigation system under different scenarios (red is high risk, amber some risk, green low risk)

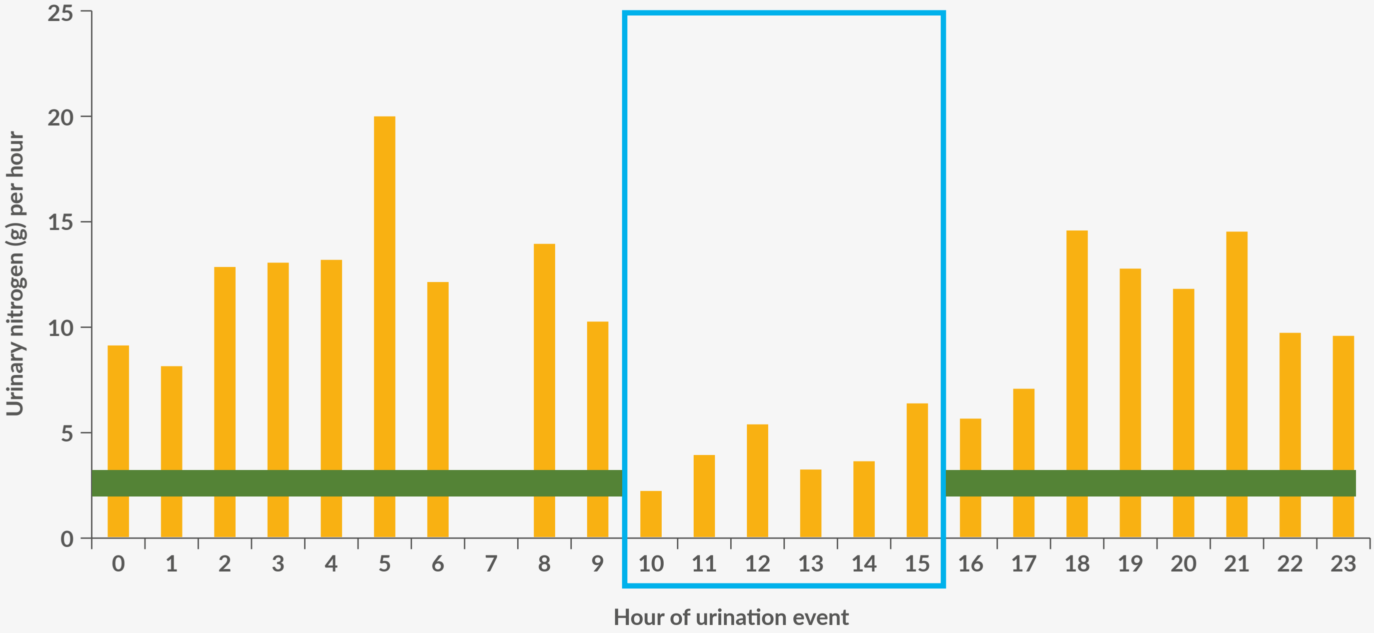

Figure 3: Average amount of N excreted at different times during a 24-hour period for pad animals (average of 200 events from 14 cows), with an average urine concentration of 8.6 g N per urination event. The blue box depicts the period of time cows were on the crop paddock and the green bar the time ad lib baleage or hay was offered

Cows urinate around 10 times per day, producing a total of about 20 litres per day at an average of two litres per urination. N outputs in the urine ranged between 60 g and 200 g per cow per day.

Looking at *Figure 2*, low concentration effluent (total N around 100 mg N L-1) would be similar to farm dairy effluent (FDE) at a high concentration similar to effluent obtained from a pad (around 2,000 mg/N/L-1). Early application relates to the first two weeks of June and late application from 15 June onwards, which assumes a constant maximum N load over the scenarios.

Key discoveries

Daily nutrition intake

It is known that cows can consume their daily crop allowance in six hours. We discovered that the body condition score of cows grazing the crop for six hours did not differ to that of cows grazed on crop 24/7.

Daily urination patterns

Cows urinate around 10 times per day, producing a total of about 20 litres per day at an average of two litres per urination. N outputs in the urine ranged between 60 g a nd 200 g per cow per day. We observed a distinct pattern in cow urination. Cows produced the largest volume and most concentrated urine on waking each morning. The lowest levels of urinary N excretion were in the six-hour period between around 10am and 4pm (*Figure 3*).

Farmers may be able to use this pattern to their advantage. By scheduling the six-hour grazing period for animals for this period of the day, utilising the pad system for the remainder of the time, urinary N deposited in the paddock could potentially be restricted to as little as 9% of total daily winter excretion. That is, by putting cows on the pad system for 75% of the 24-hour cycle (18 hours), farmers can capture more than 75% (we measured 91%) of their daily urinary N output.

Animal welfare

We observed that cows did not like muddy, wet crop paddocks. Lying times are an important indicator of animal welfare, and we noticed that during a heavy rainfall event some cows did not lie down in the field for 48 hours. In contrast, during this weather event cows on the pad lay down more often and for longer.

However, in a dry paddock cows lay down longer than those on the pad. Further research at Lincoln University using a geotextile pad surface showed that this surface has the second longest lying times of all the pad surfaces tested (8.8 hours per day).

Model outputs indicated that N losses from the pad system were similar to those modelled for the barn under most situations. The pad system was significantly cheaper than the barn system.

Soil damage

Heavy grazing during wet conditions results in significant soil pugging damage. As hypothesised, our tests showed there was less pugging when the cows were in the paddock for only six hours a day compared to 24/7.

Comparing N leaching loss and costs across systems

N leaching losses (kg N/ha/yr) from wintering dairy cows in three systems were modelled (using a range of models as described below) for three systems:

- Traditional crop grazing ('control')
- A wintering barn
- The new pad system combining six hours of crop grazing, 18 hours standing-off on the pad and winter-applied effluent.

Model outputs indicated that N losses from the pad system were similar to those modelled for the barn under most situations. Exceptions were noted for very stony, highly permeable soils, where N leaching from the pad system was greater than for barn wintering. Losses of N to water were between 5% and 25% lower than for the traditional crop grazing scenario, and the wide range observed was due to the contrasting soils and climates that were modelled.

The pad system was significantly cheaper than the barn system:

- The annualised cost of wintering cows on the pad system was estimated at $235 per cow, which contrasted with the barn system for which the annualised cost was $430 per cow
- The capital costs of pad and barn wintering systems were estimated at $335 and $3,500 per cow, respectively.

Models used

Farmax (v7.0.0.97) was used to model the different scenarios. Initially each scenario was run in Farmax to check feasibility and to gain production data that was then used in Overseer. In addition, for the low-rate, low-depth winter-applied effluent the Agricultural Production System SIMulator (APSIM) model (v7.7 r3615) was used. Where Overseer did not accurately estimate losses from winter-applied effluent (due to a lack of calibration data), the final results were adjusted to account for APSIM-generated results for the effluent component of the whole farm nutrient loss.

What does this mean?

Overall, the study demonstrates the potential of the pad system as a low-cost alternative to off-paddock wintering that reduces both soil damage and contaminant losses to water compared to traditional winter grazing systems. The pad system described enables winter crop grazing to occur by taking advantage of the fact that animals can consume the feed they require in six hours. Tailoring the timing of the grazing to the period of the day when cow N excretion is lowest further reduces N leaching losses.

This was an initial 'proof of concept' experiment using a small pad for 20 cows. On a typical sized dairy herd (the average Southland herd is 594 cows) it would be envisaged that there would be multiple pads housing around 100 cows each. Each pad would have its own effluent sump. The pads could be located together or spread around the farm. Lincoln University's Ashley Dene farm successfully housed around 80 cows on a geotextile surface over winter. Alternatively, fewer pads could be used in a more tactical fashion, for example, while a proportion of the herd grazed the most vulnerable parts of the farm (i.e. the wettest, stoniest or steepest areas).

If the surface area of the pad or the volume of rainfall increases then more effluent will be captured and this will have implications for the size of the sump, the volume of effluent to be applied and the application area. However, this effluent is likely to be more dilute and, according to *Figure 2*, have fewer risks associated with application.

Ultimately, winter cropping does not need to be banned to achieve improved water quality outcomes. It is a cost-effective system so let's not 'throw the baby out with the bathwater'. It is just a matter of thinking about 'how' and 'where' to crop and 'how' to feed it to animals, and 'what' to do with the animals once they have eaten their daily allowance.

Acknowledgements

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KEITH C. CAMERON AND HONG J. DI

Professors Keith Cameron and Hong Di at the ClearTech® pilot plant on Lincoln University Dairy Farm

DEVELOPMENT OF A NEW ENVIRONMENTAL METHOD TO TREAT FARM DAIRY EFFLUENT

A new method has been developed to treat farm dairy effluent, to help farmers reduce the environmental risks from land application of effluent and to recycle water to wash the dairy farm yard.

Aim of project

In response to farmer requests to help them improve their effluent management system and reduce their risk exposure, a joint research project known as the ClearTech® development was undertaken by Lincoln University and Ravensdown Ltd. The aim of this project was to develop a new effluent treatment system that would:

- Significantly reduce the volume of effluent that needs to be irrigated or stored each day
- Reduce the risk of contamination of rivers, lakes and groundwater from effluent irrigation
- Produce water that could be recycled more safely to wash the farm yard.

Adverse impacts of dairy farming on water quality

There is increasing public and government concern about the adverse impacts that dairy farming can have on water quality. Land application of farm dairy effluent (FDE) can contaminate (both directly and indirectly) rivers, lakes and groundwater with phosphorus (P) and nitrogen (N), as well as micro-organisms such as *E. coli*. The New Zealand Dairy Industry recognises these concerns and the first Commitment of the Dairy Industry Strategy 'Dairy Tomorrow' is that: 'We will protect and nurture the environment for future generations' and 'Lead efforts to improve the health of our rivers and streams ...'

The management of FDE is a risk to the farm business and is stressful for farmers. Maximum penalties under the Resource Management Act 1991 (RMA) are severe, with fines of up to $300,000 for an individual, $600,000 for a company, and/or a prison term of up to two years. These are criminal convictions and, if found guilty, the farmer gets a criminal record.

On average about 70 litres of effluent is produced per cow per day from the water that is used to wash the farm yard, milking parlour and milking equipment. Therefore, the average New Zealand dairy farm with around 400 cows produces about 28,000 litres of FDE per day and, over a typical 270 day milking season this amounts to more than 7,500,000 litres of effluent produced per year.

FDE mostly consists of water, urine, dung, soil, feed, cleaning chemicals and milk. The solids content of FDE is low (around 0.9%) and the majority of the FDE is water (around 99%). FDE contains a large number of pathogenic bacteria, which can pose a risk to humans if it leaks from soil into water during irrigation of the FDE.

New effluent treatment method

The new ClearTech® method for treating FDE is based on established engineering processes that are used in municipal water and waste water treatment plants around the world. This primary treatment process involves 'coagulation and flocculation', which is used to remove fine colloidal material (e.g. soil, dung, organic matter) from the effluent and produce clarified water. The fine colloidal particles in effluent are not heavy enough themselves to settle out of water under gravity.

The colloidal particles are also negatively charged so they also repel each other causing them to remain in suspension. The addition of a coagulant to the effluent neutralises the negative electrical charges on the surfaces of colloids, allowing the particles to form into 'flocs' that have sufficient mass to settle out of the water under gravity (***Figure 1***). The coagulant can also create a mechanism called 'sweep floc', which enhances the process and helps stick the colloids together.

Multiple types of coagulant are used in the treatment of drinking water and waste water and each has specific advantages and disadvantages. Our research has found that polyferric sulphate (PFS) is a very effective coagulant for use in treating FDE. Health studies have shown that drinking water treated with PFS is safe for human consumption. In addition, ferric sulphate is approved by the US Food and Drug Administration (FDA) as a food additive and is also affirmed as 'generally recognised as safe' (GRAS) for human consumption by the FDA. Iron is an essential dietary element and ferric sulphate is used to increase the iron content of, and add flavour, to food.

Research and development programme

The research and development programme consisted of six inter-linked projects:

- Initial laboratory work
- Large-scale tank testing
- Lysimeter study
- Soil microbial biology tests and gas measurements
- Pasture trial
- Pilot plant development and testing.

Effluent treated with polyferric sulphate in the lab

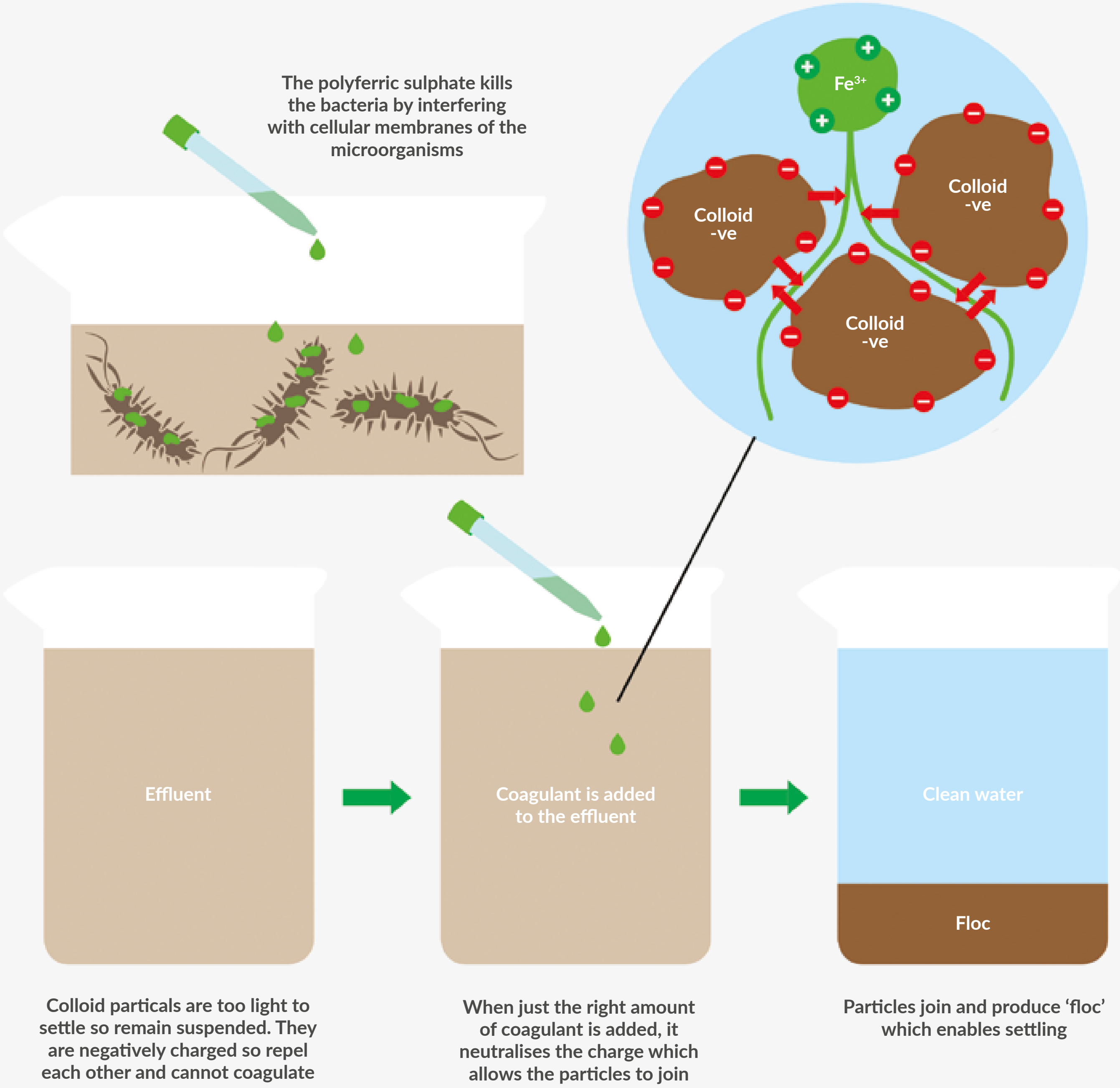

Figure 1: Coagulation and flocculation mechanisms treat the effluent, clarify the water and kill the bugs
Source: Ravensdown Ltd

Laboratory start

Standard water treatment laboratory testing procedures were used to identify the most effective type of coagulant and the most effective rate of coagulant to use. To be successful, the addition of the coagulant must be delivered at exactly the correct dose to ensure the colloids coagulate. Too little, the colloids stay suspended in the liquid. Too much, and the particles again repel each other causing them to stay in suspension.

FDE samples were collected from multiple farms in Canterbury throughout the year. The turbidity of each effluent was measured in order to calculate how much coagulant was required to treat each particular effluent sample. Turbidity is an indicator of the amount of solids present in the effluent and the average turbidity of 75 effluents was found to be 2,096 nephelometric turbidity units (NTU).

Following treatment with the optimum dosage rate of coagulant, this was significantly reduced to an average NTU of 6.3 (± 0.5) in the clarified water. This represents an average reduction in NTU of greater than 99.5% and provided evidence of the effectiveness of the PFS coagulant to clarify FDE. Importantly, these effluent samples were collected throughout the milking season (August to May) and are thus representative of the seasonal range of effluent compositions (i.e. containing different amounts of solids, milk, detergents, acids and other cleaning fluids).

Scale up to large tank trials

The research was scaled up using 300 litre tank trials with FDE collected from six different farms in Canterbury. Treatment of FDE in the large tank trials showed that the turbidity was significantly reduced from an average of 2,214 NTU in the untreated FDE down to 17 NTU in the clarified water, representing a 99% reduction in turbidity (*Table 1*). River and lake water in New Zealand often has an NTU value of about 25.

Lower bacterial risk

There was a significant reduction in *E.coli* concentration from an average of 247,718 coliform units (cfu) per 100 mL in the untreated FDE down to 55 cfu per 100 mL in the clarified water, representing a 99.98% reduction (*Table 1*). This occurs because the coagulant kills the bacteria by breaking the cellular membrane around the microorganism. In addition, the 'sweep floc' mechanism also captures the microorganisms from the effluent liquid and traps them inside the floc. This was an outstanding result, but what was more surprising was that the *E. coli* numbers in the treated effluent at the bottom of the tank were also reduced by up to 91%. This makes the treated effluent much safer to irrigate because it is less likely to cause leaching of microorganisms into rivers, lakes and groundwater.

Lysimeter studies carried out concurrently confirmed that this was indeed the case, with significantly less numbers of *E. coli* leached from pasture soil that received treated effluent, compared to the leaching loss from pasture soil that received untreated effluent. Indeed, the *E. coli* losses from the treated effluent lysimeters were not significantly different to the losses from lysimeters that received freshwater irrigation (*Figure 2*).

Lower phosphate contamination risk

Total-P concentration was reduced from an average of 35.3 g/m^3 in the untreated effluent down to 0.4 g/m^3 in the clarified water, representing a 99% reduction. Importantly, the dissolved reactive phosphate (DRP) concentration was significantly reduced from an average of 9.7 in the untreated effluent down to 0.02 g/m^3 in the clarified water, representing a 99% reduction. The DRP concentration was also significantly reduced from an average of 9.7 in the untreated effluent down to 0.03 g/m^3 in the treated effluent, representing a 99% reduction (*Table 1*).

The lysimeter trial confirmed that the total-P leaching loss from the treated effluent lysimeters (0.26 kg P/ha) was significantly lower than the total-P loss from the untreated effluent lysimeters (1.75 kg P/ha) (*Figure 3*). The DRP loss from the treated effluent (0.009 kg P/ha) was also significantly lower than from the untreated effluent lysimeters (0.034 kg P/ha).

These direct measurements of leaching loss indicate that there would be a considerable reduction in risk of P leaching from effluent areas if the effluent was treated with this new process.

Table 1: Average parameter values for untreated farm dairy effluent, clarified water and treated effluent produced by treatment of the farm dairy effluent and polyferric sulphate in the large tank studies

	UNTREATED FARM DAIRY EFFLUENT	CLARIFIED WATER	TREATED EFFLUENT	DIFFERENCE BETWEEN UNTREATED FARM DAIRY EFFLUENT AND CLARIFIED WATER	DIFFERENCE BETWEEN UNTREATED FARM DAIRY EFFLUENT AND TREATED EFFLUENT
	Mean	Mean	Mean	Significance	Significance
Turbidity (NTU)	2,214	17	6,361	***	***
E. coli (cfu 100ml^{-1})	247,718	55	22,816	***	*
Total-N (g m^{-3})	200	87	447	***	***
NH4-N (g m^{-3})	56	43	55	*	NS
Total-P (g m^{-3})	35.27	0.44	111.80	***	***
DRP (g m^{-3})	9.68	0.02	0.03	***	***
K (g m^{-3})	198	182	195	*	NS
S (g m^{-3})	28.20	224.97	320.97	***	***
pH	7.89	5.35	5.24	***	***
Solids (g m^{-3})	3,173	24	8,961	***	***
Water (%)	99.7	100.0	99.1	***	***

*Note: Statistically significant differences between untreated farm dairy effluent and the clarified water or the treated effluent are shown at p <0.001 as ***, p <0.01 as **, p <0.05 as * and no significant difference as NS.*
Source: Adapted from Cameron & Di, 2019, Journal of Soils & Sediments, doi.org/10.1007/s11368-018-02227-w

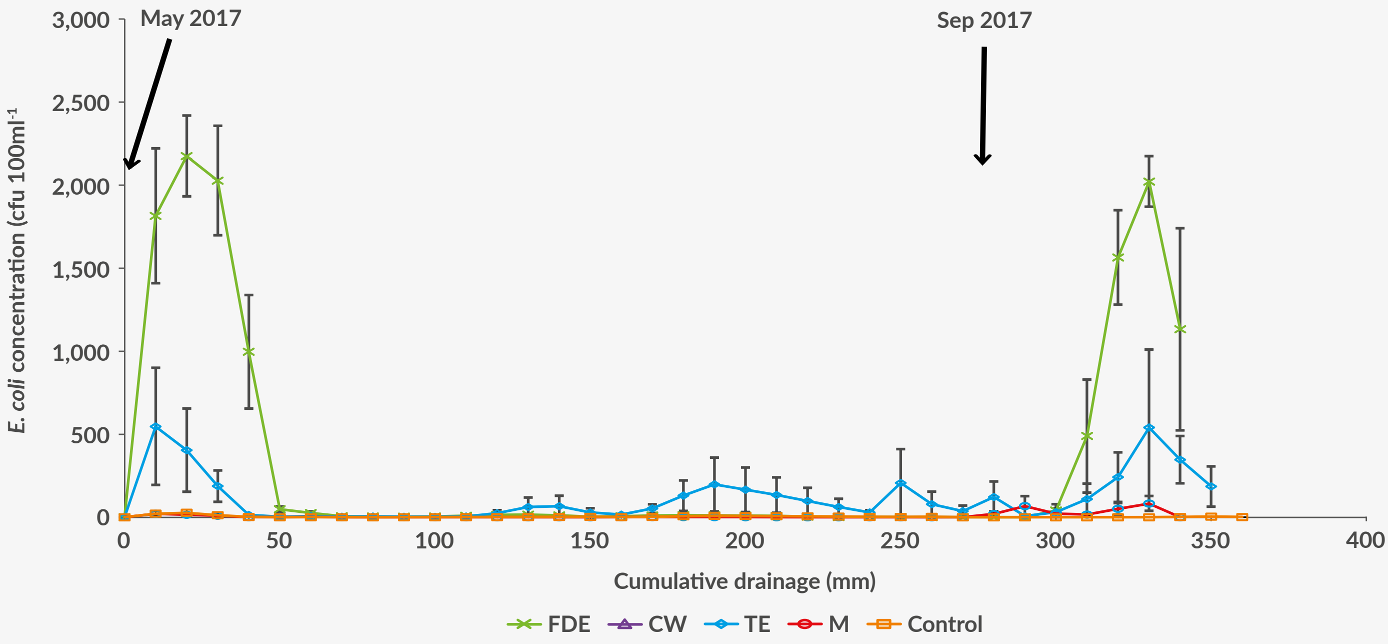

Figure 2: Average leachate *E. coli* concentrations in drainage water from the lysimeters: FDE = untreated farm dairy effluent, CW = clarified water, TE = treated effluent, M = mixture of CW and TE, control = water only

Source: Adapted from Wang, Di, Cameron and Li, 2019, Journal of Soils and Sediments, doi.org/10.1007/s11368-018-02228-9

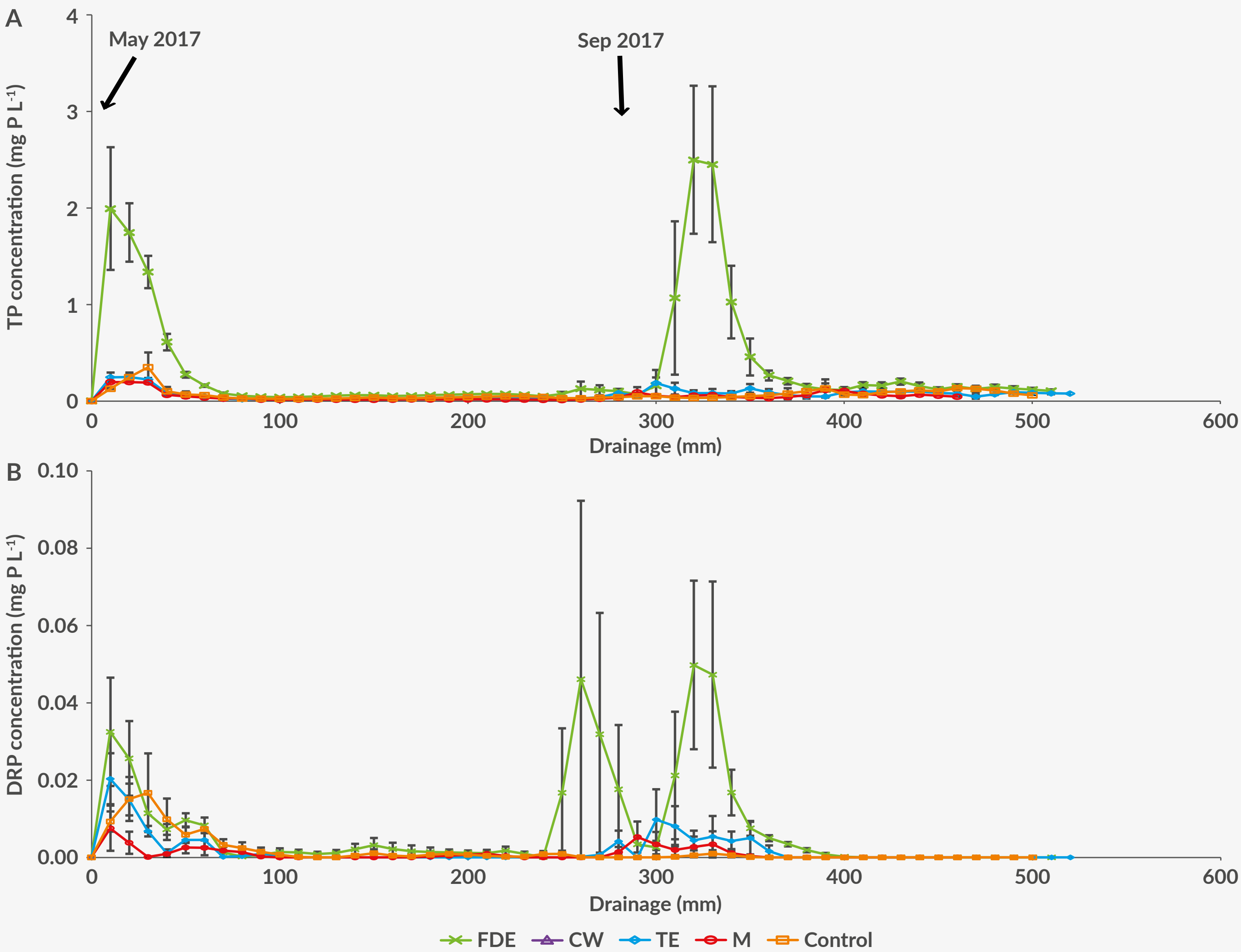

Figure 3: Average leachate total phosphorus (TP) and dissolved reactive phosphate (DRP) concentrations in the drainage water from the lysimeters: FDE = untreated farm dairy effluent, CW = clarified water, TE = treated effluent, M = mixture of CW and TE, control = water only

Source: Adapted from Wang, Di, Cameron and Li, 2019, Journal of Soils and Sediments, doi.org/10.1007/s11368-018-02228-9

The new treatment plant system could be retrofitted into existing farm infrastructure.

Soil molecular biology and nitrous oxide gas measurement trials

Detailed soil microcosm studies were conducted to determine the effects of applying the clarified water or treated effluent on key microbial communities responsible for nitrogen cycling in soil. The results showed that there were no differences in soil nitrifying and denitrifying microbial communities when clarified water or treated effluent was applied to soil compared to the application of untreated effluent.

There was also no significant difference in the amount of nitrous oxide emitted between the treated effluent, clarified water and the untreated effluent when applied to soil. These results are important because they demonstrate that the application of clarified water or treated effluent will not increase nitrous oxide emissions, nor adversely affect the key soil microbial communities involved in nitrogen cycling in soil.

Pasture trial

The dry matter produced from the application of the clarified water (16.5 t DM/ha/y) or treated effluent (16.1 t DM/ha/y) was not significantly different to that from the untreated effluent (16.2 t DM/ha/y). The pasture trial also showed that there was no significant difference in plant P concentration or P uptake by pasture plants grown on the clarified water or treated effluent plots compared to the untreated FDE plots. This is important because the reduction in DRP concentration, which will reduce the risk of P transfer from soil into water, can be done without reducing P availability to plants, P uptake by plants, or plant dry matter production.

The pasture trial did detect a slightly higher concentration of iron (Fe) in the plant material due to the Fe in the PFS coagulant and the fact that most of this Fe accumulates in the treated effluent material. The average Fe concentration in the treated effluent plant material of around 250 mg Fe/kg DM is within the range of concentrations of Fe reported in New Zealand pastures, which range from 41 to 3850 mg Fe/kg DM. As noted above, ferric sulphate is approved by the FDA as a food additive for human consumption, so a slightly elevated Fe concentration in food products derived from pastures receiving treated effluent should not pose a health concern.

Pilot plant trials

Two pilot plants were constructed to scale up the laboratory and large tank trials and test the effectiveness of the coagulation technology at farm scale.

Pilot plant #1: Static in-line mixer

The first pilot plant was constructed on the Lincoln University Research Dairy Farm using a 'static in-line mixer' system. The NTU of the clarified water was significantly reduced from an average of 1,864 down to 51 NTU, representing a 97% reduction. The *E coli* concentration was significantly reduced from an average of 379,647 down to 9 cfu per 100 mL, representing a 99.99% reduction.

The total-P concentration in the clarified water was significantly reduced from an average of 31.8 down to 1.8 g/m^3, representing a 94% reduction, and the DRP concentration was significantly reduced from 16.5 down to 0.09 g/m^3, representing a 99.5% reduction. The total-N concentration in the clarified water was significantly reduced each day from an average of 200 down to 61 g/m^3, representing a 70% reduction.

Pilot plant #2: Sequencing batch reactor

The second pilot plant was constructed as a sequencing batch reactor (SBR) on the Lincoln University Dairy Farm. The average turbidity of the untreated FDE was significantly reduced from 2,947 down to 16 NTU, representing a reduction of 99.5%.

The SBR treated 26,000 litres of FDE per run, producing approximately 15,000 litres of clarified water each time, leaving a reduced volume of effluent (11,000 litres) needing to be stored or irrigated. This reduction in the volume of effluent to be stored (i.e. from 26,000 litres down to 11,000 litres) could more than double the number of days of effluent storage capacity available in the pond. The volume of clarified water produced (15,000 litres) was greater than the average volume of water (around 7,000 litres) required each milking to wash the farm yard on an average New Zealand dairy farm milking 400 cows.

This increase in the number of days of effluent storage could help reduce the risk of effluent breaches because the pond will not fill so quickly. It could also enable the farmer to have a greater opportunity to apply the effluent at a time that avoids the risk of surface ponding occurring. Increasing the number of days of pond storage could potentially reduce the risk of nitrogen leaching, by delaying effluent application until spring when plant uptake of nitrogen is higher.

Logan Bowler of DairyNZ estimates that reducing the volume of effluent going to the pond by 50% could save as many as 74 shifts of the irrigator per year on a typical 400 cow farm, freeing staff for other duties on the farm.

The new treatment plant system could be retrofitted into existing farm infrastructure, as illustrated in *Figure 4*.

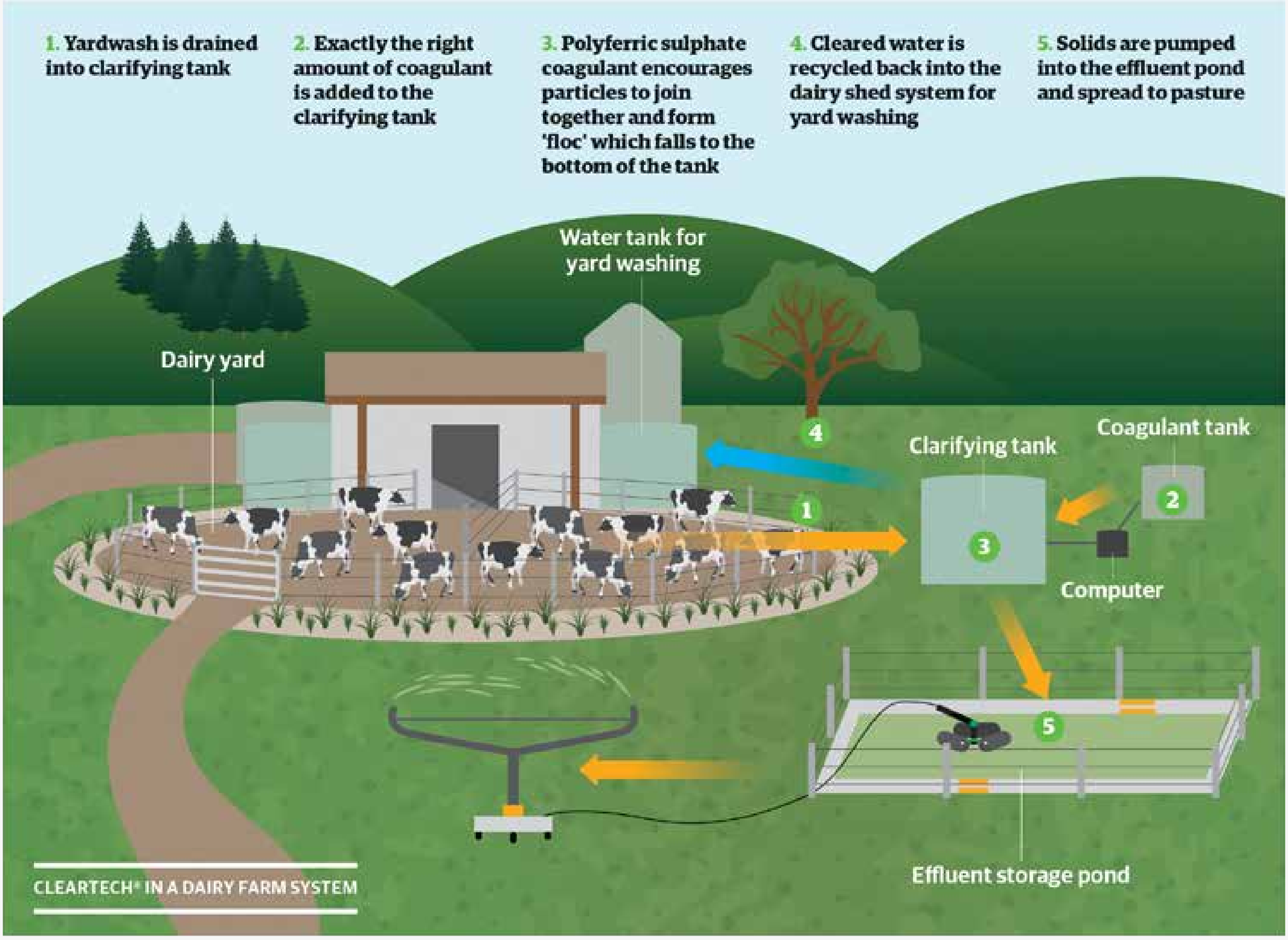

Figure 4: Conceptual diagram of the ClearTech® system installed on typical dairy farm
Source: Ravensdown Ltd

Summary

The key opportunities/benefits of this new method of treating FDE are:

- Double (or potentially triple) the number of days of storage in existing ponds. This could reduce the risk of a consent breach, improve the timing of effluent application to reduce environmental impacts, and could help meet FEP audit requirements for effluent storage
- Reduce time shifting the effluent irrigator. This could mean fewer runs of the irrigator and thus free up staff time for other duties
- Reduce risk of *E. coli* and phosphate pollution of water. This could help meet the New Zealand Dairy Industry Strategy of 'leading efforts to improve the health of our rivers and streams', and could also help meet the Government strategy for freshwater goals, as well as help improve public perception of the New Zealand dairy industry
- Reduce water use at the farm dairy through recycling water to wash the yard. This could save water and cost.

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TOM WARD

Horehound weed

AUSSIE MOTHS BATTLE HOREHOUND

Farmers afflicted with the production-limiting weed horehound received an early Christmas present last year with the release of two bio-control agents into the North Canterbury and the Mackenzie Basin.

Horehound infestation problem

Once established it is hoped that the bio-control agents – two moths – will reduce horehound infestations to manageable levels. The release of the moths were something of a victory for Mackenzie Country farmer Snow Loxton who led the campaign. As owner of Sawdon Station near Lake Tekapo, he discovered two moths that had been used on horehound in Australia as bio-control agents (parasites). The two moths are the Plume (foliar feeder) and the Clearwing (root feeder), both introduced to Australia from Europe.

Horehound has long been a nuisance to farmers in dry and semi-arid parts of New Zealand. Its seeds form burrs, which damage wool, and it infests lucerne crops in which it is costly and difficult to spray out. The plant has an alkaloid taste so is unpalatable to livestock, taints meat if animals are forced to eat it, and can be a fire hazard. However, horehound is valued by herbalists, and it is assumed the herb was introduced to New Zealand for that purpose.

In New Zealand, the Horehound Biocontrol Group (HBG) was formed to investigate the possible introduction of the moths from Australia. The project began in November 2017 with a Landcare report to the HBG, and on 7 December 2018 the Ministry for Primary Industries (MPI) agreed to allow the release of the moths.

Plume and Clearwing moths

The two moths inflict significant damage to different parts of the plant:

- The Plume moth larvae defoliate the stem, reducing the amount of seed produced
- The Clearwing moth, feeding on the roots, disrupts the vascular flow and introduces infection from pathogens.

Spraying and mechanical control, while very effective to above-ground horehound, are not only expensive but severely affect other desirable species. These techniques frequently open the ground to erosion and infestation by noxious weeds, the principal offender often being horehound itself. In contrast, horehound in a state weakened by insect attack is vulnerable to competition from tussock and cocksfoot.

Establishing the moths

The Environmental Protection Authority (EPA) disagreed with herbalists that a reduced supply of wild horehound would adversely affect their business. By 21 December 2018 releases at 13 sites had been completed, five of the Clearwing and eight of the Plume, spread from Marlborough to the Mackenzie Country.

Establishing the Plume moth is easy – sprinkle the larvae on fresh horehound stems and leaves, then scatter the mixture on established, healthy horehound plants. Establishing the Clearwing moth is much more difficult – the freshly laid eggs from the larvae held in confinement were glued to toothpicks and the toothpicks were then glued to cut horehound stems at 800 per site. This was a major achievement requiring many volunteers. In the future it is expected infected plants will be dug up and transported to a new site.

Weed's prevalence

The weed is not as problematic in Europe where farming conditions are different, but also where horehound has always had competition from specific insects and diseases.

In Victoria, six million ha were infected with horehound by 1980, including 3.5% of conservation lands. The establishment of the moth in Australia was confirmed in 2001. By 2003, more than 50% of the original release sites were infested by the larvae. In Australia, there did not appear to be any measurable economic benefits by 2008, but by 2012 it was suggested no other control would be required.

Survey results and costs

There has not been a formal review of the moth release in Australia. However, in November 2018, Snow Loxton and Australian entomologist John Weiss, who managed the moth release in Australia 20 years ago, observed many of the moth release sites in Victoria and South Australia and were impressed with the reduction in horehound in these areas.

Box leaving Australia with horehound moth larvae destined for New Zealand

In New Zealand, the 2017-2018 HBG survey results showed 112,000 ha of hill and high country (nearly all of this is in the South Island and including 5,700 ha of lucerne) to be infested with horehound, with 98,000 ha of this area assessed to be under non-chemical control.

Total costs of control (chemical and non-chemical) were assessed at $3.35 million p.a., and with another $3.5 million in lost production the annual costs would total $6.85 million. This is a conservative figure due to no allowance being made for increased wool processing costs and for the opportunity costs of avoiding lucerne. The area of horehound is expected to double every three years on the surveyed farms.

Successes and failures

Biological control will not eradicate the target weed (nor should it as that would kill off the agent), but may reduce the weed to levels at which control is not required. One indication of the potential efficacy of the moth release is the level of release and initial establishment, which in New Zealand is very high.

In Australia, there were some significant failures of establishment, in part due to the difficulties of bringing the agent (moth larvae) from the Northern Hemisphere. Also, our horehound is healthier (greener for longer), encouraging better establishment of the moths. Although rapid expansion occurs when the air temperature is above 22°C, the health of the target plant population is seen as more important.

Biocontrol has been very successful where other grasses can outcompete with a weakening horehound and is not so good among native vegetation. Further releases in the spring of 2019 are expected to spread the moth throughout the country.

Beyond control of horehound, Snow Loxton is warning farmers to avoid planting lucerne in horehound infested paddocks for 10 years, as the horehound seed will continue to germinate for that period of time.

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NZIPIM PROFILE

KATE SCOTT

This profile looks at the career of Kate Scott, Executive Director of Landpro based in Central Otago.

An interest in policy and processes

Growing up in rural Taranaki typically means that you will have some link to agriculture, which is the case for Kate Scott, whose early life began in the cowshed and fields of South Taranaki. From an early age, she was usually found helping on the farm most days after school and on weekends and holidays too. At the end of her schooling, and unsure of what direction to follow, she went to Victoria University and in 2001 completed a degree in Geography and Political Science.

Political Science wasn't what Kate set out to study initially, but it became one of her most valuable qualifications, teaching her to understand the motivations around the decisions people make, as well as information and policy processes.

After finishing university an opportunity to continue with her summer job at the Ballance Agri-Nutrients Kapuni manufacturing plant came up. Following this job she moved into private consultancy where she was involved in a wide variety of district and regional planning projects, both small and large scale. Kate found that she liked helping people navigate the challenges of the regulatory process by focusing on finding solutions that worked for all parties.

A shift to Central Otago

In 2006, Kate and her husband Scott Levings had the opportunity to change direction completely by shifting to the South Island to manage the 650 cow dairy farm her parents owned at Ettrick. Scott had come from an engineering background and he went on to win the Dairy Industry Awards Otago Farm Manager of the Year.

Kate and Scott have since moved off-farm, but still continue to be heavily involved in agriculture on a daily basis from their home in Bannockburn, Central Otago. With an outlook towards the Kawarau River, Lake Dunstan and Pisa Range, they find this area a great place to raise their three sons aged eight, four and three.

Creation of Landpro

In 2007, Kate stepped away from the farm to start Landpro, building on the work she had been doing in the resource consenting space. Landpro started as a small planning and surveying consultancy, mainly servicing the primary industries. Since 2007, the company has grown to around 45 people with offices throughout New Zealand.

These days Landpro has also grown to provide environmental science, geospatial and aerial mapping services in addition to the traditional planning and surveying offering. Landpro also has a shed full of equipment to help them with their work, including a Cessna 337 aircraft.

Landpro's work continues to be largely focused on the primary industries. They are working with clients and regional authorities to navigate the changing demands of land use

Landpro's work continues to be largely focused on the primary industries. They are working with clients and regional authorities to navigate the changing demands of land use change and water quality/quantity issues.

change and water quality/quantity issues. Their role as advisors in the agri-enviro space has become more important over the last few years as farmers, in particular, grapple with increasing regulation and compliance. Kate says that the greatest reward from their role is being able to work with clients to achieve a win-win for them and the environment.

Kate is passionate about the rural sector, and the opportunities for agriculture in New Zealand, but believes we need to find ways to facilitate better environmental outcomes alongside enabling ongoing sustainable rural businesses.

Nuffield Scholarship

In 2018, she was awarded a Nuffield Scholarship, which has enabled her to spend 12 months travelling to Europe, the US, Mexico, Canada, Brazil and Japan. As a result, she has written a a research report looking at ways we can utilise policy and technology to try and reduce the environmental footprint of agriculture.

Kate describes the Nuffield Scholarship travel experience as being 'positively disruptive' in terms of seeing how other countries are also addressing the challenges of agriculture and the environment. In her view, New Zealand agriculture is punching well above its weight in both its understanding of the impacts of its activities on the environment and also in its recognition of the need to change the way we farm to reduce our impacts if we are to continue to be both sustainable and successful. This was certainly not the case in all the places that she visited last year.

It is also her view that just because we have come to a point of understanding, it doesn't mean we have got to where we need to be in solving the impacts of agriculture on the environment. She believes we remain a long way from where we need to be, but we have at least started down that path.

She also feels that we need to focus on working more collaboratively if we are to build on this momentum of change and find positive world-leading solutions for agriculture and the environment. Kate believes the opportunities for New Zealand are huge if we can find a way to work together and balance the importance of the environment alongside the need for world class food production.

Industry and other involvement

Over the years Kate has been involved in a variety of industry-related roles, both with a focus on the rural sector and within the community. She is currently a trustee of the Central Otago Community Housing Trust and a founding committee member of the NZIPIM Otago Branch.

Kate also occasionally plays squash and helps off the court as a committee member.

Positive about the future of agriculture

Despite the often negative rhetoric that currently surrounds agriculture in this country, Kate remains positive about its future. She is also optimistic about the ability for New Zealand to be a world leader in the agri-enviro space, even if this means at times an uncertain journey of transformative change in the way in which we undertake our activities to reduce impacts on the environment.

She believes that New Zealand agriculture will be able to meet the demands of our communities and our consumers by setting high standards and consistently meeting these. However, to enable this to happen we need to start by working together.

Achieving agri-environmental sustainability

In Kate's view the path towards achieving agri-environmental sustainability needs to be focused on five key objectives:

1. Identifying clear goals

   We need long-term ambitious goals that define what agriculture in New Zealand will look like in the future, what we will value, who our customers will be, and how our communities and our environment will look.

2. Taking a holistic approach

   We need to encompass a holistic, outward-looking approach to agriculture and the environment. Engaging all of New Zealand will be critical to finding solutions.

3. Evidence-based decision-making

   We need to support our goals, decisions, processes and policies based on robust, informed debate that is supported by clear evidence.

4. Technology

   We cannot sit back and wait for technology to solve our challenges, as technology will not do this on its own. We must continue to encourage innovation and find new tools that help guide our decision-making and enable better environmental outcomes.

5. Enabling policy incentives

   We need to shift to a proactive regulatory approach where regulation and policy become the incentive rather than the punishment.

These objectives have come about from the work Kate has undertaken as part of her Nuffield Scholarship, and will form part of her final Nuffield Report expected to be published later this year.

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