Vol 25 | No 2 | JUNE 2021 | ISSN 2463-3011

THE JOURNAL

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

FARMERS AS LAND ENVIRONMENT MANAGERS THE NEXT GENERATION OF RURAL PROFESSIONALS
LATEST IN PRECISION AGRICULTURE FARM DEBT MEDIATION SCHEME
WASP BIOCONTROL – NEW TOOLS TO FIX THIS PROBLEM THE KIWIFRUIT INDUSTRY – A STORY OF RECOVERY

nzipim NZ Institute of Primary Industry Management

NZIPIM ACKNOWLEDGES
THE SUPPORT OF OUR
STRATEGIC PARTNERS

NZ Institute of Primary Industry Management

JOURNAL

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

Volume 25
Number 2
June 2021
ISSN 2463-3011

COVER PHOTO
Supplied by Gwyn Morgan

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

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.
The Journal is a quality assured publication for rural professionals providing professional services within New Zealand's primary industries. The articles do not constitute advice. The Institute takes no responsibility for any decisions made based on the material in this publication. The opinions of the contributors are their own and not necessarily those of NZIPIM or the Editor.

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

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

ANNUAL SUBSCRIPTION RATES
$75+GST (NZ)
$100 (Australia)
$120 (other countries)

Contents

STEPHEN MACAULAY CEO

NZIPIM survey shows environmental issues top of mind for members

NZIPIM recently undertook a survey of its membership to gain their insights about key challenges and opportunities that exist in their dealings with farming clients, and to explore future on-farm research priorities. Based on the construction of the survey, we were also able to compare responses to NZIPIM's 2018 rural professional survey and identify changing areas of focus across different topic areas which are described in more detail below.

Over 280 members, representing around 25% of the membership, completed the 2021 survey.

The biggest challenges

We asked members to identify what they believed to be the biggest challenges faced by the primary industry sectors over the next three to five years. Top of mind for members was the ability for their clients to meet environmental challenges, which was a common theme throughout the survey. In categorising the responses to this question, 42% of all respondents raised 'compliance and regulation' as the biggest challenge facing the industry over the next three to five years, with members noting the challenges for farmers in meeting increased regulatory requirements set by local and central government, which compared to 37% from the 2018 survey.

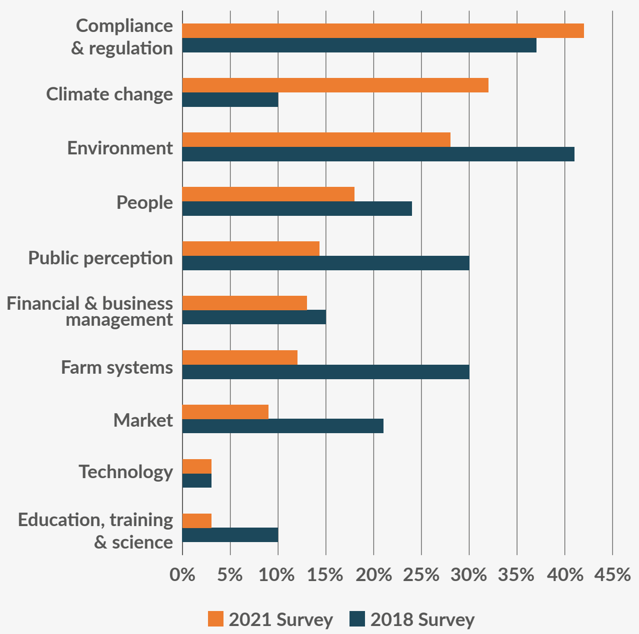


Figure 1: Biggest challenges over next 3–5 years

Heightened concern from members about adapting to climate change, particularly the challenges in reducing on-farm biogenic methane levels without undermining the profitability of farming businesses, saw it jump to second spot with 32% of all respondents rating this as one of the primary industry's biggest challenges (up from 10% in 2018). As expected, the 'environment' was rated as a big challenge by 28% of all respondents, with uncertainty around freshwater regulations a prominent theme in members' interactions with their clients (down from top place in 2018).

The fourth biggest challenge identified by 18% of all respondents was the ability to build human capability and capacity, both within the farm advisory services and rural profession, and on-farm (down from 24% in 2018). Concerns by members over public perception and the 'social licence to farm' was not ranked as highly compared to the 2018 survey, with 14% seeing this as a big challenge compared to 30% in 2018. Where 'farm systems' was identified by members, concerns were largely focused on the challenge of diversifying farm systems to adapt to environmental regulatory pressures.

The biggest opportunities for the primary industry

We asked participants to outline what they believed to be the biggest opportunities for the primary industry sectors over the next three to five years. By far the biggest opportunity identified by 51% of all respondents was in the market, up from 43% in 2018, with a large proportion focused on the need to increase the value of New Zealand's agri-food and fibre products in response to increased production constraints potentially supported by strong environmental credentials.

The environment, particularly improving water quality outcomes, was identified by 28% of all respondents as one of the biggest opportunities for the primary industry sectors (up from 14% in 2018). The next highest ranked opportunity was in the area of farm systems, with 22% of all respondents identifying big opportunities in diversifying farm systems and better optimising land use capability (down from 31% in 2018).

Thirteen percent of respondents believed big opportunities existed in technology, particularly its use to improve efficiency and productivity, and to help meet new regulatory requirements (down 22% in 2018). Adapting farm systems to climate change and leveraging upon New Zealand's carbon credentials was seen as a big opportunity by 12% of respondents, up from 4% in 2018.

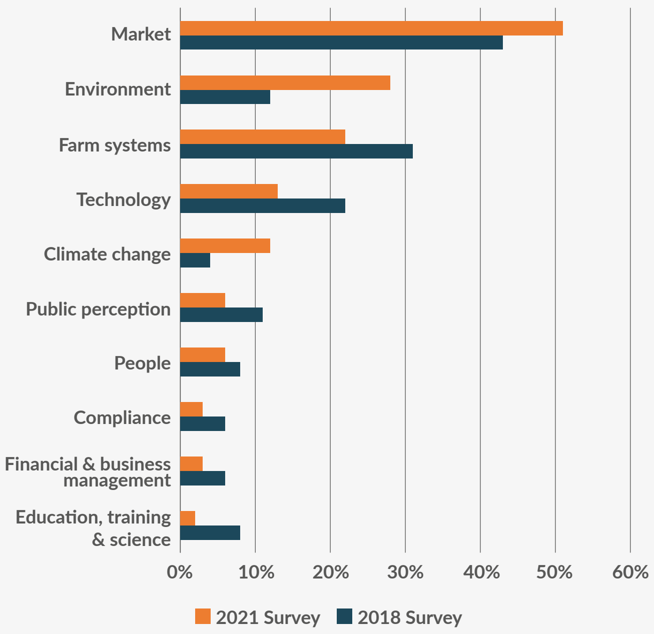


Figure 2: Biggest opportunities over next 3–5 years

Top three research priorities assessed by members

Members were asked to identify their top three research priorities that would make the most significant positive difference to the future of the primary industry sectors. Climate change was identified by 31% of respondents as their highest research priority, particularly in the area of applying practical on-farm solutions in reducing greenhouse gas emissions without undermining the financial viability of the business, which compared to 15% in the 2018 survey.

Overall, respondents ranked farm systems reasonably highly across the three research priorities, with 20% listing this as their highest research priority (down from 30% in 2018). Twenty-four percent of respondents ranked farm systems as their second research priority, with 30% ranking it third. Best use of land and future farm systems was a relatively common theme with respondents here.

Eighteen percent of respondents identified the environment as their first ranked research priority, with 25% and 14%, respectively, ranking it as their second and third research priority areas. Within this category, researching methods of improving water quality outcomes within a farm context and reducing nutrient losses were identified as key research priorities.

Conclusion

Environmental regulatory challenges, increasing compliance on-farm and climate change adaption did appear to be top of mind for farm advisors and rural professionals in completing NZIPIM's 2021 survey. In many ways, this reflects the increased weight of new environmental regulations faced by the farming community and adverse weather conditions occurring across the country at the moment.

In response to these challenges, and to increase the profitability of farming businesses, over half of all respondents saw opportunities in growing the value of our agri-food and fibre products in the market potentially underpinned by environmental and carbon credentials.

To help support farmers deal with increased requirements on their businesses, respondents believed greater research priorities should be placed on climate change research targeted at mitigating on-farm greenhouse gas emissions, and greater investment in farm systems research to support them in meeting increased environmental regulations, whilst enabling farmers to build sustainable and profitable business enterprises in the future.

I would like to thank members who completed the 2021 survey. J

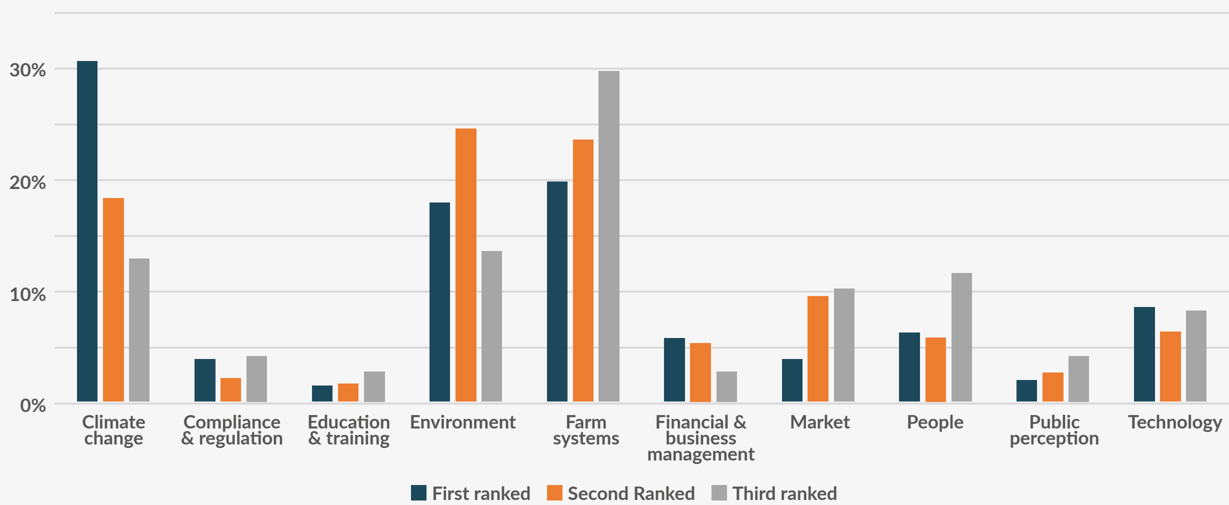


Figure 3: Top 3 ranked research priorities to make the most significant positive change

LOCHIE MACGILLIVRAY

FARMERS AS LAND ENVIRONMENT MANAGERS

Farmers are facing a wave of government centralised regulations, due in part to the sector's slow response in recognising and then mitigating the impact of agriculture on ecosystem degradation. This wave may force whole-farm changes that could be detrimental to New Zealand, yet there are options for farmers to take back the control of their sector.

Looking back in history

Farmers often consider that they have a generational and therefore a long-term approach to land management. However, with the Government's drive to enforce its national freshwater and biodiversity policies an outside observer might conclude that many farmers have not previously given any serious consideration to on-farm environment matters. The evidence tends to suggest otherwise.

The QEII National Trust has 4,700 protected sites across some 180,000 ha and the covenants for these land parcels have all been donated by their respective landowners. In 1941, 11 District Catchment Boards, comprised in part of local farmers, were established across the country whose objectives were to promote soil conservation, prevent and reduce erosion, and prevent flood damage. However, full national coverage was not achieved until 1967, bringing the total to 17 boards.

Until 1956, farmers were assisted with subsidised specific projects such as retirement fencing, windbreaks, debris dam construction, pasture furrows and tree-planting in gullies. By 1956, the Catchment Boards recognised that a whole-farm approach was needed when several projects were being undertaken at one time and farmers were encouraged to adopt a 'farm plan' over a set period, usually five years.

This work indicates that under some environmental and physical conditions the sediment risk from intensive winter cropping is miniscule, although such a cropping and grazing system would be a breach under the new regulation codes.

A farm plan was based on a land capability survey that was first carried out nationally in 1952 and formed the basis of Land Use Capability System (LUC), which is still in use today. The LUC system has two key components:

- A land resource inventory (LRI), which is an assessment of the land's physical factors
- A classification system where the landforms are divided into eight classes – four arable (crop-growing) and four non-arable.

The LRI and been updated over time with increasing levels of resolution, although at a national scale it is still coarse at 1:50,000.

The relative success of the Catchment Board schemes and farm plans can be observed by any drive through New Zealand hill country, noting the vast areas of wide-spaced plantings of both poplars and willows, along with earth works and retention dams.

However, the scale of the challenge was immense and in 1992 the LRI identified 3.7 million ha (or 33% of the North Island) that still required significant soil conservation to physically sustain pastoral land uses. Since this date there has been a large increase in the afforestation of hill country, and the reduction of sediment in our waterways remains a huge issue.

Increasing environmental problems

Natural rates of erosion in this country are high by world standards – New Zealand makes up ~0.1% of the global land mass yet discharges 1–2% of average annual sediment yields to the ocean. Erosion in New Zealand has been exacerbated by anthropogenic activities, such as deforestation, which reduced forest cover from approximately 50% of land area in 1840 to 18% by 1920.

This deforestation was recognised as early as the 1930s for being responsible for the increased flooding and soil erosion throughout the country. Post-deforestation soil loss on Taranaki hill country has been assessed and it was estimated in 1993 that there was an average soil depletion rate of 1.8 ± 0.5 mm in yr-1 off pastoral land. These findings were collaborated later in the 1990s and the early 2000s.

The increase of sedimentation, and a general decline in freshwater quality, has had a devastating impact on New Zealand's freshwater biodiversity. Our record of threatened aquatic species is unfortunately one of the world's worst – 68% of all native fish species are listed as threatened. Although only one species (the grayling) has become extinct, fish numbers and diversity have been in national decline for at least the last century and this decline has accelerated.

This acceleration can be seen from the increase in the number of species listed as threatened over a 13-year period:

- In 1992, the Department of Conservation (DOC) recorded in their publication *Classifying Species According to Threat of Extinction* 10 species as threatened
- In 2002, the number had risen to 16 species, and
- In 2005, 24 species were listed as threatened, a 140% increase.

In 2007, a new threat classification scheme was established, and under this system 68% of all extant native taxa and 76% of all non-diadromous taxa (fish that do not make migrations between the sea and freshwater) are considered threatened or at risk.

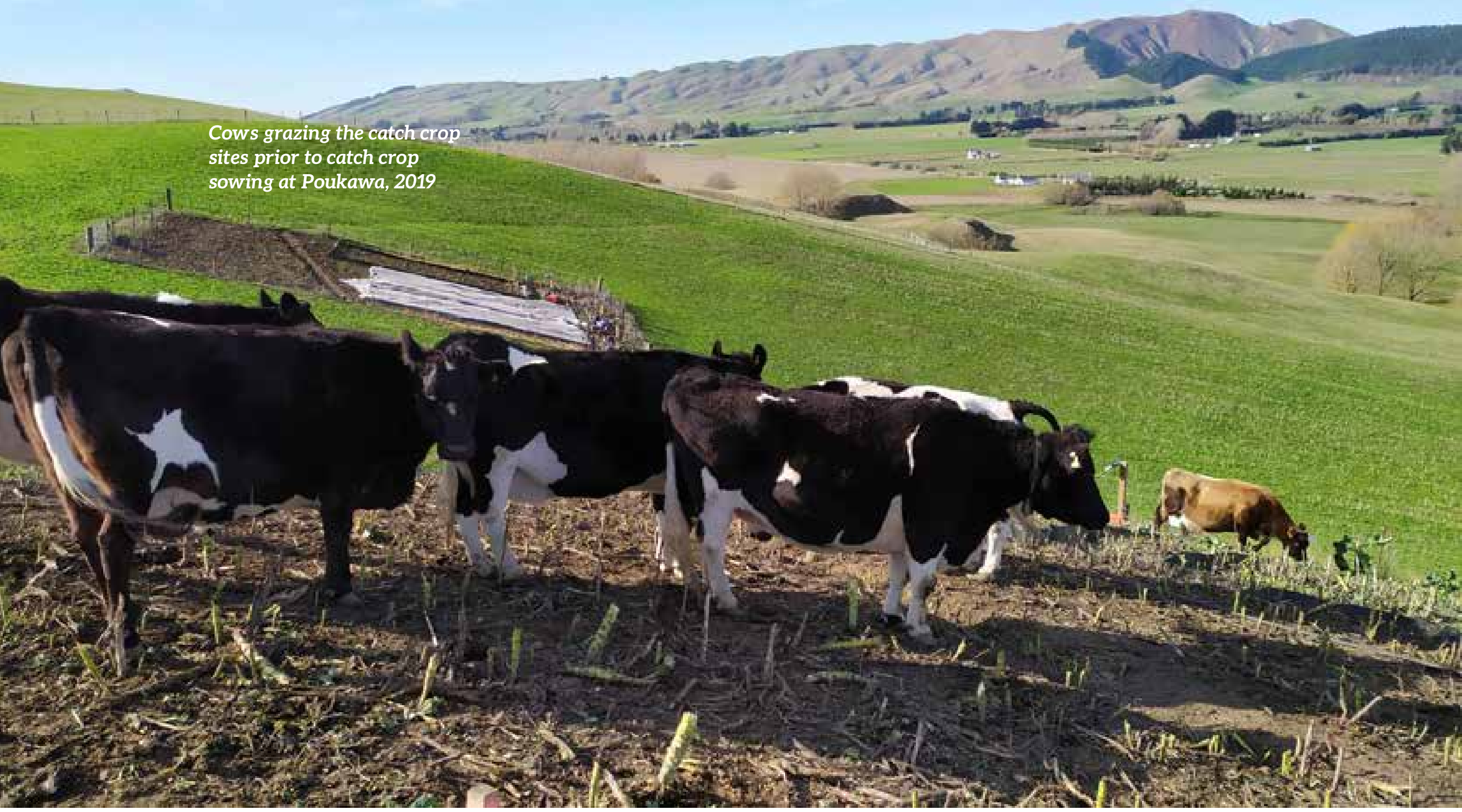
To summarise the findings on New Zealand agriculture, pastoral waterways generally have higher water yields, peak flows, nutrient levels, suspended sediment levels, faecal coliform numbers and water temperatures, as well as a lower faunal diversity, relative to forested waterways. Even at forestry harvest and the following three to five-year risk period, the indicators still amount to a lower impact on waterways overall relative to pastoral catchments.

The last 180 years of agricultural drive has degraded our waterways and diminished New Zealand's biodiversity, with some evidence indicating that this is occurring at an increasing rate. The challenge to the pastoral sector is to lift its environmental game, but still remain financially and socially viable.

The right solutions

Wholesale farm afforestation is not the answer, particularly when done for carbon credits and where there is no intention to ever harvest (often due to extraction costs or distance to port). This is likely to lead to the creation of a green desert not requiring any infrastructural support, devoid of any local community, and not contributing financially to society beyond its diminishing carbon revenues.

We need to clearly understand and identify the reasons for the decline in our ecosystems and why this demise has been accelerating. We must develop and implement effective planned solutions that reverse the real potential of a biodiversity collapse. We also need farmers to



Cows grazing the catch crop sites prior to catch crop sowing at Poukawa, 2019

believe in and endorse the benefits of these solutions in fully integrated and actively managed farm environment management plans (FEMPs), and not to see these as a compliance cost to be dusted off every few years for a renewal.

We then need to demonstrate to our end customers that pastoral farmers are also efficient and effective land environment managers. Numerous commentors have promoted the concept that farmers will get a premium for sustainable food production. There is a contra argument that the premium high-paying consumers of our product already expect the livestock to be ethically grown in a sustainable manner.

Problems with centralised decision-making

The reality is that much of the choice is being taken away from farmers as the Government centralises rules around farming activities. An issue with centralised decision-making is that it is a blunt tool with fixed recipe solutions. An example of one such rule is the timelines for crop re-establishment, irrespective of an array of other physical constraints and environs that should be considered.

Another example is the maximum areas of intensive winter grazing, irrespective of other variables, which again are not factored into the 'one size fits all' centralised remedy. This 'set in stone' regulatory response to New Zealand's environmental issues is too slow to adapt and change as new knowledge comes forth and the world around us rapidly evolves.

An example of problematic set rules and regulations has been seen in a Sustainable Farming Fund (SFF) funded catch crop trial conducted by AgFirst, Plant and Food and On Farm Research. The purpose of this trial is to assess the benefits of catch crops to mitigate sediment movement. The work is ongoing, but in the first year catch crop plots reduced sediment movement by up to 38% compared with the control plots. These plots were on a 28°–30° slope and winter grazed by cattle in June and July.

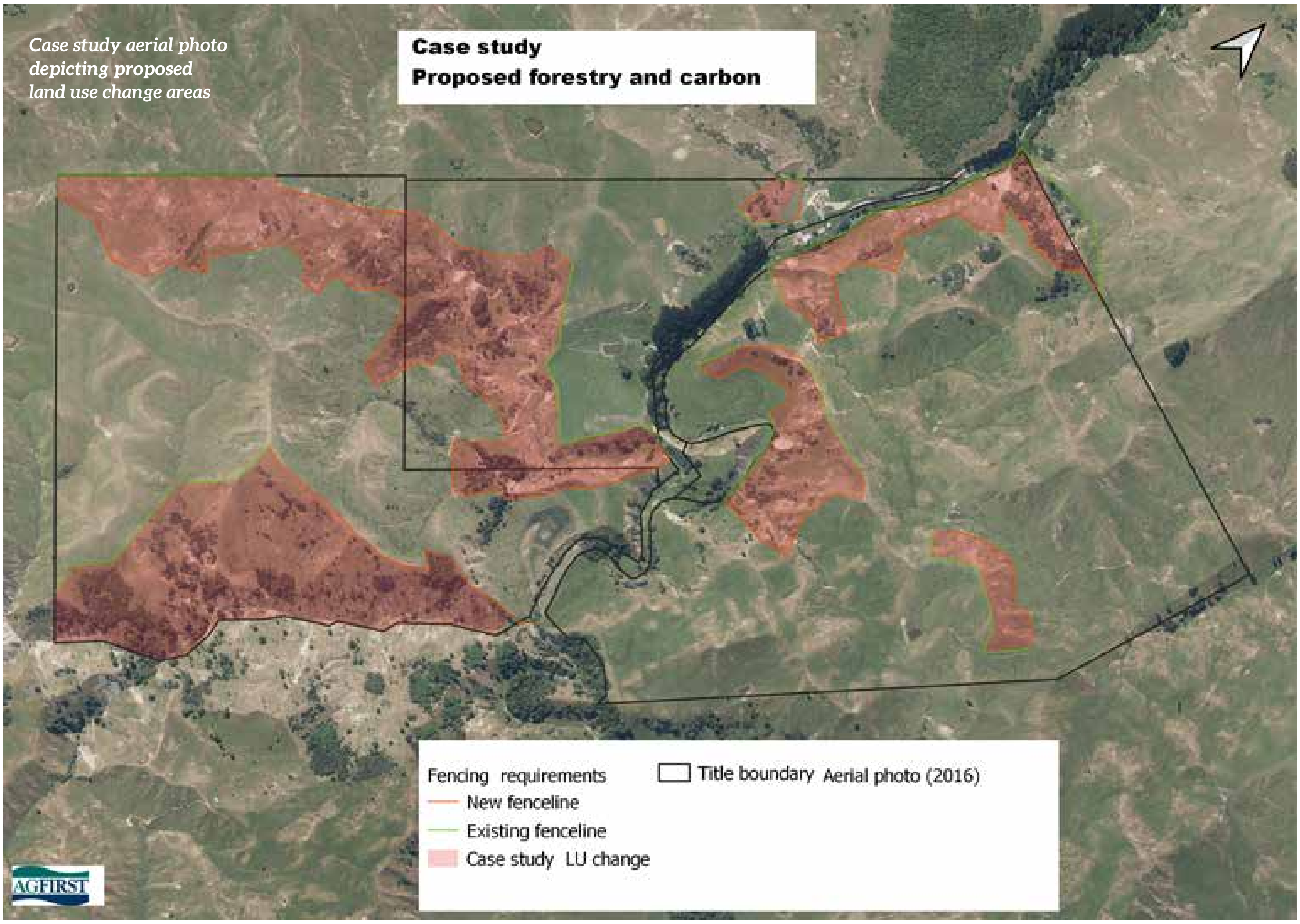
This showed a low amount of sediment movement, even in the control plot which was measured at 100 kg DW/ha of sediment movement. In the second year of trial data sediment movement from similar slopes was negligible, and the sediment traps had no sediment in them after a four-month bare soil exposure. This work indicates that under some environmental and physical conditions the sediment risk from intensive winter cropping is minuscule, although such a cropping and grazing system would be a breach under the new regulation codes.

Centralised regulations will limit New Zealand agriculture's ability to rapidly respond and this places us in a financially vulnerable position. However, the wider community seems prepared to take this risk in order to mitigate further ecosystem degradation.

Farmers back in control

The pastoral sector is not alone in finding itself in a paradoxical situation where increasing costs and a diminishing availability of resources means a degree of intensification is seemingly the best response. Indeed, the very presence of vertebrates will lead to some reduction in other ecosystems, and society needs to agree on what level of this interference is acceptable, but it also needs to understand the cost (both ecological and agricultural) of this level.

Had the farming sector been more aware of the escalating issue and then appropriately responded in time, then perhaps the sector could have remained in control of its own destiny.



To understand and mitigate the ecosystem decline farmers need to understand four key components and, in doing so, they could potentially take back the control of their sector:

- The compounding effects of intensification
- Their natural resource inventory
- Best practice and management of water bodies
- The developing role of precision agriculture.

The natural ecosystem has an ability to cope with some degree of intensification until it reaches a tipping point. At this time the system overload will affect the next part of the chain, potentially taking it to a further tipping point, and so on until the compounding effect causes an ecosystem further down the chain to collapse. Key to understanding this chain of events is the active monitoring of all aspects of the chain and an understanding of cause and effect.

There are many monitoring sites, mostly installed, maintained and recorded by regional councils. Farmers need to drive the resolution of this, and start monitoring their own inputs and outputs far more closely, at a minimum at a whole-farm level but preferably at a higher resolution. Only by doing this monitoring can any degree of active planning become precise. Working together as farmer collectives they will start to build a picture about what the impacts of management decisions truly are. This will become a far more concise driver then a central regulatory approach.

Catchment groups are already being set up across the country to try and achieve some environmental objectives. A risk that exists with the current wave is that although they may have good intentions, some groups have over 70 farmers. In such large groups there will be some wanting to drive change while others may take a wait and see approach.

Consequently, groups of this size may become unwieldy, with resulting slow and unfocused outputs, reinforcing the need to keep centralised regulations. To overcome this, farmers must in the first instance demonstrably take individual responsibility for the environmental outcomes on their own property. Understanding their own farm resource inventory will be key in developing sustainable low environmental impact solutions.

Farm system optimisation and the use of LUCs

The use of LUCs could be a principal driver in farm system optimisation. Understanding a farm's LRI and the ensuing LUCs to a paddock-scale level, or even higher, enables better systems optimisation. The current LUC systems have broad pasture stocking rate bands. When these bands are calibrated against actual results (even if at whole-farm level) an interesting observation is often found.

Recent work carried out under a Right Tree Right Place project for the Hawke's Bay Regional Council and the Tararua District Council analysed multiple case studies breaking the farms down to paddock LUC definitions.

			BASE	SCENARIO I LUC VII REMOVED FROM GRAZING	DIFFERENCE
Grazed pasture area (ha)			245	172	-$73
Change in grazed area			-	73	
Total annualised stock units			1,744	1,361	-$383
Average whole of farm stocking rate (grazed)			7.1	7.9	
Stock units removed/ha change				5.24	
Revenue	Sheep	Sales – Purchases	$100,204	$89,965	-$10,239
		Wool	$11,854	$9,069	-$2,785
		Total	$112,058	$99,034	-$13,024
	Beef	Sales – Purchases	$36,612	$28,402	-$8,210
	Total Revenue from Farming		**$148,670**	**$127,436**	**-$21,234**
	GFI/su		$85	$94	$8
	GFI/grazing ha		$607	$741	$134
Expenses	Wages	Wages & WoM*	$26,157	$20,419	-$5,738
	Stock	Animal Health	$5,043	$3,873	-$1,170
		Shearing	$10,014	$7,700	-$2,314
	Feed/crop/grazing	Conservation	$-	$-	$0
		Forage Crops	$-	$-	$0
		Regrassing	$-	$-	$0
	Fertiliser	Fertiliser (Excl. N & Lime)	$13,315	$8,895	-$4,420
		Lime	$1,397	$980	-$417
	Other farm working	Weed & Pest Control	$3,320	$2,331	-$989
		Vehicle Expenses	$5,618	$5,618	$0
		Fuel	$5,231	$4,383	-$848
		Repairs & Maintenance	$10,000	$9,500	-$500
		Freight & Cartage	$350	$350	$0
		Electricity	$1,500	$1,500	$0
		Other Expenses	$980	$688	-$292
	Standing charges	Administration Expenses	$5,836	$5,836	$0
		Insurance	$3,087	$3,087	$0
		ACC Levies	$1,531	$1,531	$0
		Rates	$4,165	$2,924	-$1,241
	Total Farm Working Expenses		**$97,544**	**$79,615**	**-$17,929**
	FWE/su		$56	$58	$3
	FWE/grazing ha		$398	$463	$65
					$0
	Depreciation		$9,173	$9,173	-$2,733
	Interest on livestock deployed		$14,299	$10,978	-$3,321
	Total Farm Expenses		**$121,016**	**$97,033**	**-$23,983**
					$0
Economic Farm Surplus (EFS)			**$27,654**	**$30,403**	**$2,749**
EFS/ha total land area			$113	$124	
EFS/ha grazed land			$113	$177	
Contribution of removed grazing land to base scenario			–	-$2,749	
- per ha				-$38	
Potential annualised carbon and forestry/ha				$283	
Annualised carbon and forestry return from scenario change				$20,623	
Carbon and Forestry Adjusted EFS				**$51,026**	
Adjusted EFS/ha				$208	
Total CO_2e generated from farming & forestry activities (t/year)			599	462	
CO_2e generated from farming & forestry activities (kgs/ha/year)			*2,444*	*1,886*	
Reduction in CO_2e generated due to scenario changes (t/year)				137	
% reduction				23%	
Reduction in CO_2e/combined ha (t/year)				1.87	
Nitrogen losses			1909	1528	
% reduction from base				20%	
Phosphate losses			66	52	

* Wages of Management

Figure 1: Case study analysis of some of the implications of retiring grazing land

The raft of regulatory changes and demands of farmers (including the national freshwater policy changes, biodiversity policies and agricultural greenhouse gas obligations) seem daunting to many, with some choosing that this is the time to exit farming.

A consistent finding was that there were land parcels on these farms that were giving negative financial returns, but this level of detail was unobserved by the farmers.

In general, the farmers tended to underestimate the production of the better classes of land and overestimate the poorer classes. A rule of thumb is that removing the poorer aspects of a farm from grazing (i.e. those land parcels carrying 5.0 stock units/ha or under) and a resultant increase by 0.5 stock units/ha on the better land classes, through subdivision and increased water reticulation, left the farm at a similar level of net financial surplus. In a number of cases this released 20–30% of the total farm area to be utilised for production forestry (with carbon) or for retirement to other land uses.

Case study results

This provided a potential win-win situation where farm profitability stayed similar or slightly reduced after the land use change, but this was more than offset by carbon revenue streams and long-term forestry returns from the land removed from pastoral systems. Also, the farms ranged from 18–23% in their reduction in CO_2E emissions and via Overseer modelling had up to a 20% reduction in nitrogen losses to water.

Long-term sediment losses to water would also be expected to be markedly reduced. The retirement of lands, along with wetland preservation and riparian plantings, would help maintain ecological corridors that are necessary for ecosystem health. Carbon equivalent revenues have in these instances provided a generational windfall, allowing for the re-development of the poorer land that otherwise might have stayed in a financially uneconomical and environmentally precarious agricultural production.

Water body management

The transfer of scientific knowledge to hill country farmers on water body management is a relatively new practice. Until recent times hill country farmers have been typically managing their soils, which had been the primary focus and interaction between Catchment Boards and councils, as opposed to trying to manage the water quality leaving individual farms.

The knowledge is now readily available, and the sector has been responding (some of it through mandatory FEMPs), but many farmers had for a number of years been excluding stock from waterways, retiring wetlands and planting riparian strips. The impact of this is both cumulative and evidence episodic. The raft of new regulations will have the greatest impact on this group of farmers, many of whom are going to be severely tested to stay financially viable. Some farmers at a certain age and stage in their farming life may take this opportunity to exit.

The market for land is strong and supported by carbon farms, so forcing the hand of these farmers may have long-term dire consequences for New Zealand Inc. The LUC process outlined above may offer some a respite, allowing farm succession or financing entry and retirement without wholesale land conversion.

Role of precision agriculture

Precision agriculture will have a role to play. One developing example is virtual fences, which may become the norm in a few years. This technology is well advanced and will enable geospatially derived virtual fence lines, which would deter stock access to undesired areas. The virtual fence line can be removed or altered to allow entrance under certain parameters. The cost of the individual units is now the most limiting factor (~$300/unit).

As the virtual fence line is animal-specific it means that very precise and detailed grazing systems can and will be employed. Not only does this level of control have massive environmental benefits, but it also facilitates precise feed rationing when feed is scarce on otherwise difficult-to-fence areas. Corridors could remain open to appropriate water sources. The adoption of such technology will significantly reduce the cost of land use change and will potentially revolutionise farming.

Conclusion

The raft of regulatory changes and demands of farmers (including the national freshwater policy changes, biodiversity policies and agricultural greenhouse gas obligations) seem daunting to many, with some choosing that this is the time to exit farming. Unfortunately, this may lead to whole-farm land use change, which in many case study instances is not the best financial outcome from a longer-term production perspective.

The need for changes in farm systems to reverse the trends in ecosystem degradation is clear. There are solutions, but the sector needs to lead this change rather than rely on regulatory measures, and also to reinstate the reputation of farmers as efficient and effective land environment managers.

Lochie MacGillivray is Director and Agribusiness Consultant at AgFirst based in Hastings. Email: lochie.macgillivray@agfirst.co.nz J

VICTORIA WESTBROOKE

THE NEXT GENERATION OF RURAL PROFESSIONALS

The primary sector will need more employees with tertiary-level skills and knowledge in the future. This article discusses the number of recent agriculture graduates and how students can gain the required expertise to contribute to the sector.

Future demand for graduates

The primary industries are expected to generate an additional 50,000 jobs in 2025 compared to 2012 (see www.mpi.govt.nz/dmsdocument/3893/direct). Many of these new jobs will require employees to have some level of formal training. People with degree-level skills will be required for 16,000 of the predicted additional 50,000 jobs. This represents a 13% increase in the number of jobs requiring employees with degree-level qualifications compared to 2012.

While the 2025 target is just four years away, it does indicate the skill level and number of employees required in the sector in the future. The degree-level skills will be required in a wide range of fields including engineering, agricultural science and farm systems, and human resource management.

Graduate numbers – a specialised land-based degree

The number of students graduating with a degree specialising in a 'land-based' field between 2010 and 2019 is shown in *Figure 1*. Most graduates specialised in either an agricultural science field or environmental studies. The number of agricultural science graduates steadily increased from 165 to 285 between 2010 and 2015 before fluctuating by 85 graduates over the next four years. In contrast, the number of environmental studies graduates steadily increased from 125 to 240 over the same period.

The number of graduates from the farm management and agribusiness, horticulture and viticulture, forestry, and other and mixed fields is much lower, with between 0 and 85 graduates for each field of study over the same period. There has been a decrease in the number of

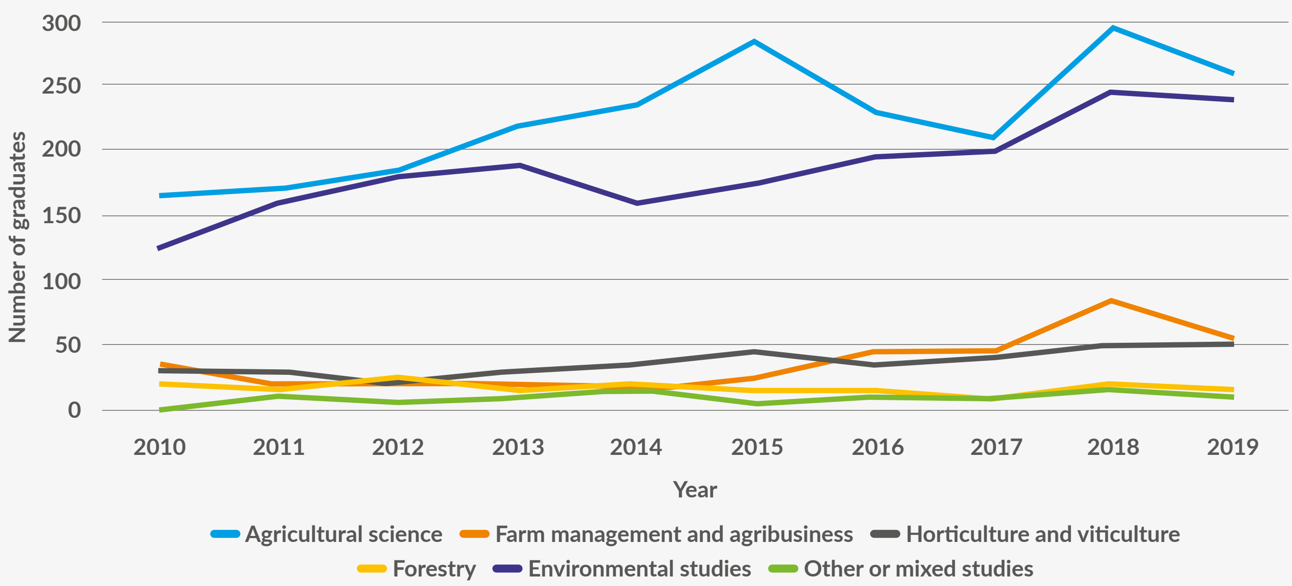


Figure 1: Predominant field(s) of study of land-based graduates (both domestic and international) at NZQA level 7 (Bachelor's degree)
Source: www.educationcounts.govt.nz/statistics/retention_and_achievement

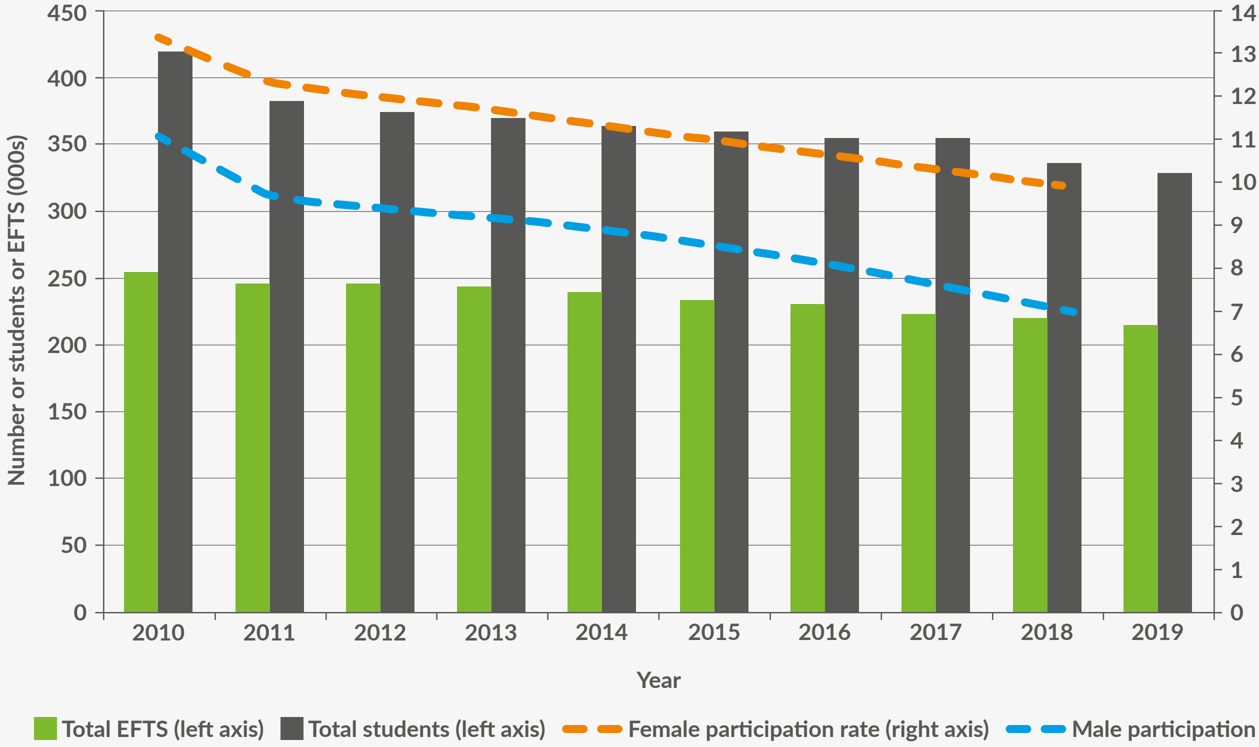


Figure 2: Domestic student enrolments, EFTS and participation rates 2010–2019

Source: www.educationcounts.govt.nz/statistics/tertiary-participation

graduates in both the agricultural science (35%) and farm management and agribusiness (30%) fields between 2018 and 2019, but enrolments in both are lifting.

The number of graduates available for employment in the primary industries each year is difficult to estimate. Students have a range of options available to them after graduation. Some may return to work on family farms, while others may choose to work outside the agricultural sector. In pre-COVID-19 times there was also adventure to be had traveling and working overseas. Overall, the number of land-based graduates is low. Graduates with non-land-based degrees also work in the sector. However, the number of graduates available overall is likely to be modest in comparison with the predicted number of jobs requiring tertiary-level skill in 2025.

An option to increase the number of students graduating with a degree specialising in a land-based field is to increase the number starting or enrolling. University recruitment teams visit secondary schools to encourage students to study agriculture at the tertiary level. This encouragement can include taking recent graduates to schools to discuss agriculture and possible career options with students from Years 10 to 13, but the number of domestic students enrolling in universities has been decreasing over the past 10 years *(Figure 2)*. Competition between vocational and tertiary pathways and also different sectors of the economy for 'young bright minds' is intense.

Agricultural and horticultural science as a subject is available at all NZQA levels (1 to 3). The subject is offered at some secondary schools, but there can be a traditional perception that this is not a pathway to tertiary studies. Recently, the subject 'agribusiness' (available at NZQA levels 2 and 3) has been introduced at some schools with the aim of encouraging students to continue their studies at university. The primary sector needs to provide an attractive career path to encourage secondary students, with the support of their parents, to study land-based courses at university.

Students' background also influences the field they choose to study. A recent survey of agricultural graduates from Lincoln University found that 62% came from a rural background, with a further 24% reporting a combined rural-urban background. This is not new, just a continuation of students from rural areas studying agriculture, with an accompanying desire to attract more students from urban and semi-urban backgrounds.

The number of students studying at tertiary level varies, depending on the other opportunities available. There have been reports of a lift in the numbers studying agriculture in the last two years. With the COVID-19

Graduates need an in-depth knowledge of the range of farming systems operated in New Zealand in different environmental, social and financial conditions.

travel restrictions, there is not the opportunity to travel overseas to work on farms either pre- or post-university. There is also the opportunity to encourage 'career changers' to study agriculture at university. Career changers many have lost their job due to COVID-19, or may have worked in the sector for a number of years and be looking for the next step in their career.

Attracting those who have already worked in the sector has the advantage of building on their existing agricultural knowledge and retaining them within the industry. The challenges for career changers are adapting to academic study and managing work plus study, or the financial cost of study alone. The number of students studying agriculture (both from secondary school and career changers) can be supported by industry and government initiatives, such as the fees-free scheme.

Knowledge and skills required by graduates

Universities enable students to gain fundamental knowledge. Employers perceive this knowledge to be either in one or two key areas or across a broader range of subject areas, depending on the student and the degree they have undertaken. To work successfully in the agriculture sector, employers would prefer graduates to have an understanding of the agricultural and agribusiness sector (both at the farm and business-to-business level), and also knowledge around international trends that may influence farming systems in the future.

Employers are looking for graduates with broad knowledge across a wide range of subject areas and farming systems, in short, a preference for generalists. They would encourage students to broaden out their knowledge and skills from their immediate area of interest. While students may specialise in a subject area, it is important to also have a knowledge of and be able to contribute to other subject areas.

It is the application of the fundamental knowledge of farming systems that is key, for example, in identifying where an option could work well for one farmer in their particular farming situation but not for another. It is not only interpreting scientific or trial data, but how it could work in a particular farming system. To be able to do this, graduates need an in-depth knowledge of the range of farming systems operated in New Zealand in different environmental, social and financial conditions. Different situations could include:

- Environmental conditions, such as droughts or under specific nitrate leaching conditions
- Financial fluctuations, such as high and low product prices, or
- Different social situations, such as farms with high and low labour requirements.

Graduates need both hard and soft skills and knowledge. Examples of hard or technical knowledge and skills are the ability to do feed budgeting, compile financial budgets and

Lincoln degree students on a farm visit. Photo courtesy of Alistair Black, Lincoln University

Table 1: Lincoln University agriculture students' preferred future career by role, subject area and sector

ROLE	%	SUBJECT	%	SECTOR	%
Rural professional	40	Husbandry	55	Sheep/beef/deer	55
On-farm	35	Financial	19	No preference	20
Technical field officer	10	Other	10	Dairy	12
Other	8	People	9	Arable	8
Public or industry body	4	Environmental	4	Other	5
Researcher	3	Engineering	3		

construct models of farming systems. Within the sector there is a demand for graduates with strong interpersonal or soft skills, in particular, those who can build rapport with and maintain professional relationships with a wide range of people including farmers, researchers and policy analysts.

Soft skills can also include the ability to negotiate, and to relate to and work with people when they are in a strong and healthy position and also in more challenging situations. The importance of soft skills is illustrated with the example of questioning and listening skills. Students can tend to fall into one of two groups regarding these two key soft skills. For instance, they may have these two skills but be low on confidence. They may be able to build a clear picture of the farming system or issue they are working with via questioning and listening, but not have the confidence to offer suggestions. Or, alternatively, graduates may not have the skills at the desired level but have more confidence, so are at risk of offering suggestions based on an incomplete picture of the system or issue.

Graduates' preferred career roles

As part of a wider study at Lincoln University, students in agricultural courses were surveyed to find out about their preferred future career *(Table 1)*. Most respondents would prefer to work either as a rural professional (40%) or on-farm (35%). For their preferred subject area, over half (55%) of the students would like to work in the husbandry or livestock/plant production area. Despite students rating 'protecting the environment' as a very important goal, very few (4%) were looking to specialise in the environmental area. Slightly more students (9%) were aiming to work in the 'people' area, despite this also being an important topic for the sector.

Students' job preferences can and do change over the course of their studies and they may not be able to obtain their favoured job on graduation. Realistically, graduates adapt to the job market of the time. However, the results do highlight students' preferred work areas and the low proportion aiming to specialise in two areas that are currently important to the sector – 'environment' and 'people'.

In a separate study, recent graduates from Lincoln University were asked to identify ways in which a university could help them transition to full-time employment. First, graduates reported that universities should help them to select the right degree and individual courses to equip them with the knowledge and insight to work in the sector. Second, graduates recognised that undertaking practical work alongside their academic studies provided additional awareness of what to expect when working in the industry. Third, graduates would have liked more information on what is expected when working as a full-time employee.

Selecting the right degree and courses and providing insight into an industry are traditional roles for tertiary institutions, but 'what to expect as a full-time employee' is less so. The role of universities is generally described as research, knowledge exchange and teaching. Teaching provides students with the opportunity to gain the fundamental knowledge and skills. A strength has been in providing students with technical or so-called hard skills, such as managing the requirements of different crops or analysing sets of farm business accounts and introducing them to computer programmes such as Overseer[FM].

Students are looking for an awareness of what to expect when working in the sector, and employers are seeking graduates who can apply their knowledge to the range of farming systems in different situations. Both aspects can be taught via case studies, but are most effective when students can work in industry in real-life situations, as occurs during practical work. Undertaking practical work also allows students to develop their soft skills. Soft skills can be practised by students completing work in groups during their university studies, but again are most effective when taught in real-world situations.

Three types of learning

Sources of knowledge and learning have been classified into three main groups by UNESCO: formal and non-formal education and informal learning.

Formal education

Formal education provided by universities, polytechnics and industry training organisations (ITOs) is an intentional, continuous pathway leading to a formal qualification. This meets the needs of students wanting a recognised

The primary industries will need more employees with degree-level skills and knowledge in the coming years.

qualification, with individual courses providing a solid base for their future career. Traditionally, this education has been provided via lectures, tutorials, laboratories, and field trips and multi-day field tours.

Non-formal education

Non-formal education is also provided via institutions and is usually an alternative or is complementary to formal education. This learning is lower intensity and results in no formal qualification. Industry bodies providing learning opportunities (such as Deer Industry New Zealand's 'The Big Deer Tour' and DairyNZ's undergraduate scholarships programme) are examples of non-formal learning. Often these opportunities are only available to a small number of selected students.

Informal learning

In contrast, informal learning takes place within families, communities and workplaces and involves learning by doing and learning with peers, often in a community of practice. This also includes learning that takes place while a student is completing practical work as part of their degree.

Traditionally, the focus has been on formal education and the accompanying qualification, but the combination of all three types of learning is the optimum for students. Formal education provides them with the fundamental knowledge, and with some application and knowledge of the industry. Both non-formal and informal learning provide further opportunity for students to apply their knowledge in the real world, develop their soft skills, and also provide additional insights about the industry and expectations around working in the sector.

Conclusion

The primary industries will need more employees with degree-level skills and knowledge in the coming years. These employees will come from two key sources: attracting school leavers to study agriculture or related courses at degree-level; and career changers wanting to upskill to a tertiary-level qualification.

A combination of learning approaches – formal education (lectures, tutorials and field trips), non-formal education (that accompanies university studies) and informal learning (that occurs while students are undertaking practical work) – is optimum to prepare students to work in the sector. The combination of these approaches allows students to apply the hard skills gained in their studies to real-world farming situations and also allows them to grow their soft or interpersonal skills.

Victoria Westbrooke is a Senior Lecturer in Farm Management and Agribusiness at Lincoln University based in Canterbury. Email: victoria.westbrooke@lincoln.ac.nz J

Lincoln degree students on a field tour of cattle, potato and maize farm

CHRIS GLASSEY, GRANT WILLS, MIKE DODD, KIERAN MCCAHON AND DAVID CHAPMAN

LONG-TERM CENTRAL WAIKATO SUMMER-AUTUMN RAINFALL AND PASTURE GROWTH TRENDS

Farmers in the upper North Island have been claiming more frequent drier years. Through an investigation carried out by our research team we have supported them byexamining long-term rainfall, soil moisture stress and pasture growth trends (both measured and modelled) for summer-autumn months over the past 60 to 70 years at two Waikato locations. This article details the results of this research.

Are conditions for pasture growth changing over time?

Farmers in the upper North Island are increasingly voicing concerns that summers and autumns in recent years are becoming more variable and tending to be drier and warmer than normal. They claim it is becoming more challenging to maintain pasture growth. Farmers are also noticing increasing costs and effort involved in maintaining their pasture base and this is reflected in costs recorded by dairy industry economic surveys.

This between-year variability for summers, which are often dry, means that recent dry years need to be placed in an historical context to help identify the right adaptation strategies for the future dairy forage base in the region. The objective for our study was to see if there was data to support these concerns of increased variability between summers and whether there are more than normal recent drier years.

We had long-term pasture growth measurements for two Waikato dairy farms located at Ruakura/Scott farm

Contrasting pastures on the same farm (Dargaville, NARF) recovering post-drought 22 April 2021. On the left ryegrass pasture three years after resowing. On the right well-managed kikuyu pasture. Photos courtesy of Kim Robinson, AgFirst

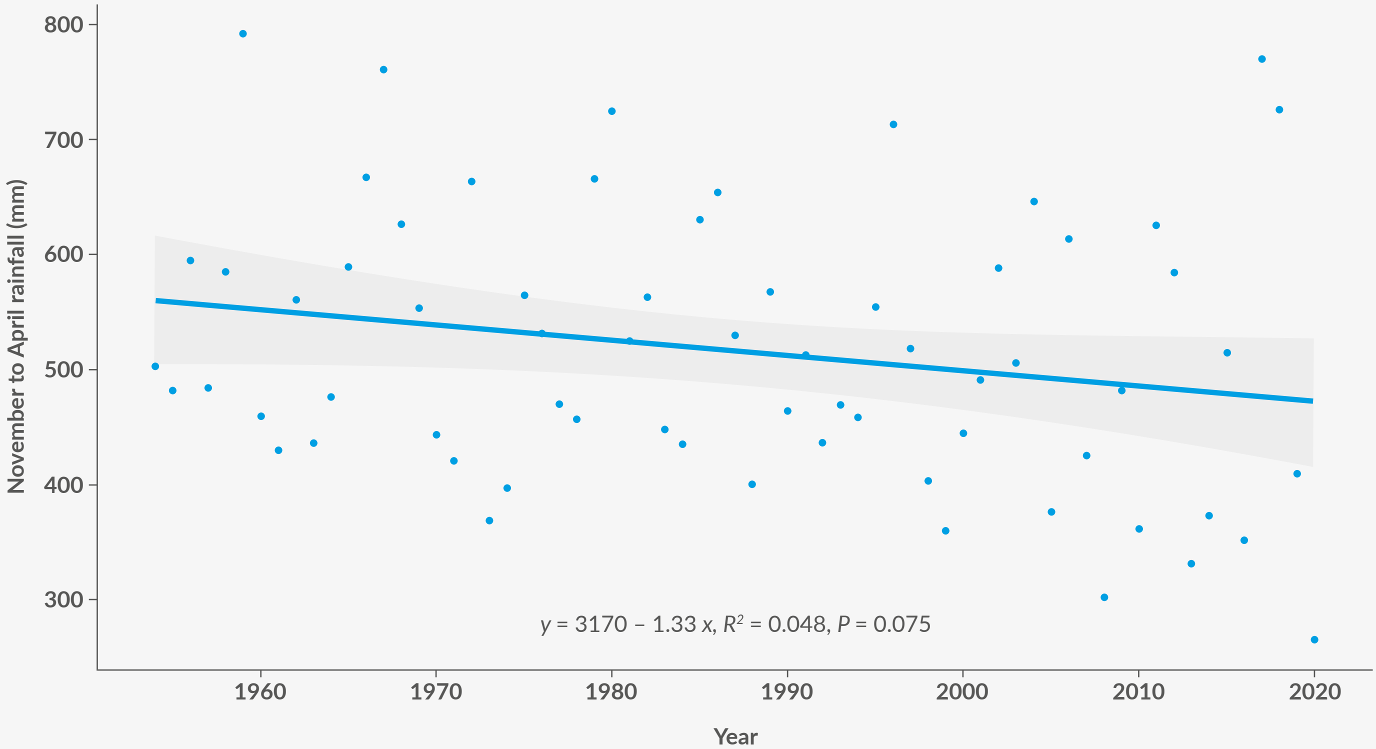


Figure 1: Summer–autumn rainfall (Nov–Apr) for Ruakura climate station from 1954–2020. Grey bands are 95% confidence intervals

Table 1: Mean summer–autumn rainfall at Ruakura (Nov–Apr, mm), 1954–2020 by decade. Includes standard deviation (SD) from mean and CV%

DECADAL VARIABILITY		DECADE							
		1950	1960	1970	1980	1990	2000	2010	Overall mean
November–April rainfall	Mean	574	556	498	548	489	488	505	516
	SD	118	109	105	103	97	108	164	119
	CV%	21	20	21	19	20	22	32	23

near Hamilton and Paratu Road between Morrinsville and Matamata. For these sites we investigated long-term rainfall, soil moisture stress and pasture growth trends (both measured and modelled) for the summer-autumn months (November to April) for the past 60 to 70 years.

We found evidence to support the farmers' concerns, although we add that we are not climate scientists so our analysis and interpretation of the data could potentially be enhanced through the application of climate science. Our investigating team includes pasture agronomists, farm systems specialists and a dairy farmer with a long history of keeping pasture growth records. The results are set out below.

Rainfall

Monthly rainfall totals for November to April (inclusive) from 1954 to 2020 were collected from the Ruakura climate station (NIWA 26177 EWS). The six months from November to April were chosen as the months where it was most likely that the interaction between rainfall and potential evapotranspiration (ET) creates soil moisture deficits that affect pasture growth. This was called the summer-autumn period and aligns with the November-January and February-April months as defined for the upper North Island for the DairyNZ Forage value index.

Cumulative rainfall for November to April measured at Ruakura from 1954 to 2020 was highly variable (mean 516 mm, range 265 mm to 792 mm). Despite this variability there was a negative linear trend for lower rainfall (-1.3 mm/year, P=0.075) over time *(Figure 1)*. The most recent decade showed greater variability in summer-autumn rainfall, with the Coefficient of Variation (CV) increasing from consistently being between 19-22% to 32% *(Table 1)*.

The variability between years dominates this data, making the detection of trends difficult with the linear trend only approaching significance. The chosen time period for analysis, and the influence of individual year data points for the time sequence of available data, can influence the sensitivity of a linear regression. Add to this the fact that rainfall on its own does not tell the full story in relation to pasture growth, due to its uneven distribution throughout the time period and its interaction with evapotranspiration also affecting pasture growth through soil moisture deficits. We clearly needed more information.

This was provided by using interpolated climate data from the NIWA Virtual Climate Network (VCN), which uses daily NIWA climate station records to estimate values for a network

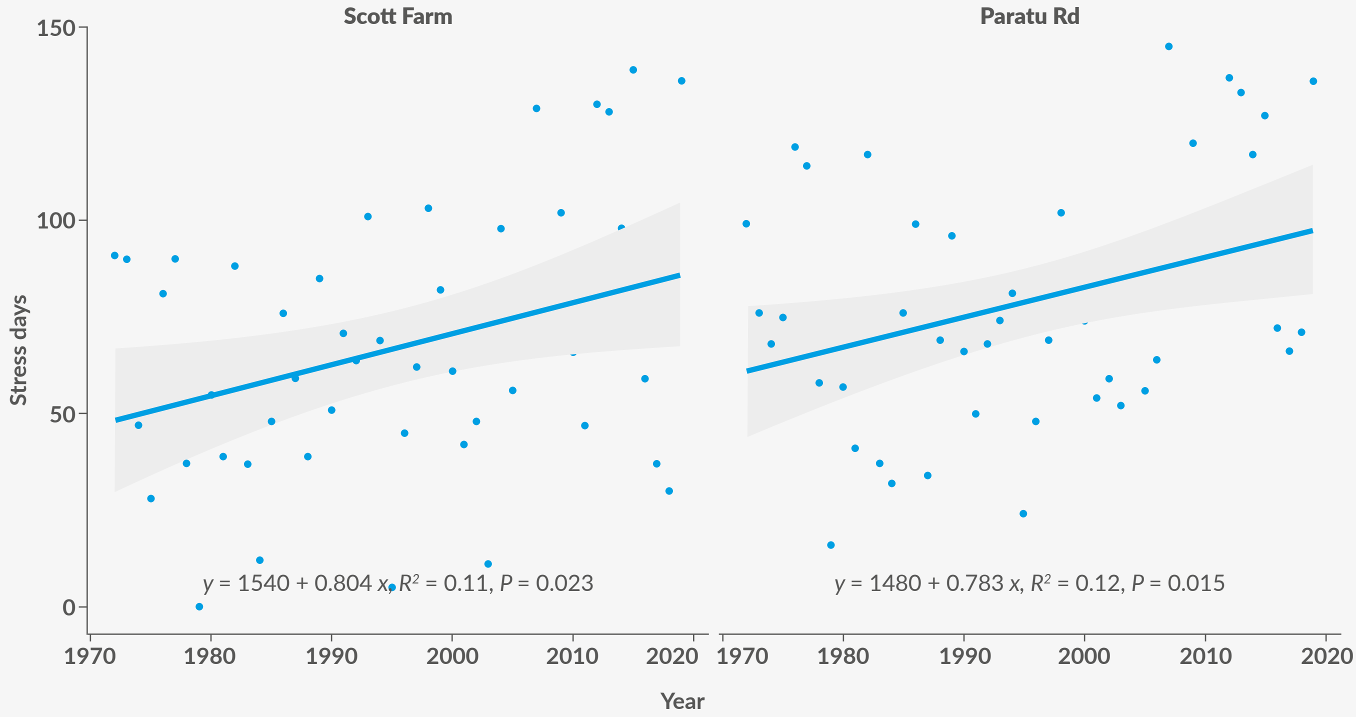


Figure 2: Trends for cumulative number of moisture stress days in summer–autumn (Nov–Apr) calculated from VCN climate data sites representing Scott Farm and Paratu Road. Grey bands represent 95% confidence intervals

Table 2: Statistical significance (P values) of linear trends in cumulative Nov–Apr rainfall, moisture stress index, and pasture growth (both modelled and measured net herbage accumulation, HA) for two locations in Waikato

VARIABLE	LOCATION	
	SCOTT FARM	PARATU ROAD
Measured rainfall	0.075 (-1.3 mm/year, 1954–2020)	Not measured
Interpolated rainfall[1]	0.06 (-1.75mm/year, 1960–2020)	0.03 (-1.99mm/year, 1960–2020)
Moisture stress days	0.02 (+0.8 days/year, 1972–2020)	0.015 (+0.78 days/year, 1972–2020)
Simulated net HA	0.03 (-64kg DM/ha/year, 1977–2020)	0.03 (-63kg DM/ha/year, 1977–2020)
Measured net HA	NS (1979–2020)	NS (1995–2020)

[1] *Virtual Climate Network*

Note: Years for which data were available are indicated in brackets. Differences were considered significant at P <0.05 and a trend declared at P <0.10

of sites across New Zealand on a 5 km grid. VCN data from 1960 to 2020 for the grid node nearest to the Paratu Road farm (latitude 37.4511 south, longitude 175.3842 east), and another grid node nearest to Ruakura/Scott Farm (latitude 37.4606 south, longitude 175.2200 east), were examined for long-term rainfall, soil moisture deficits and temperature trends over six months from November to April. We also examined rainfall and soil moisture trends for each individual month within that period (1960 to 2020).

There was a trend toward lower interpolated summer-autumn rainfall over the past six decades (*Table 2*, -1.75mm/year) for Scott Farm and a statistically significant decline at Paratu Road (*Table 2*, -1.99 mm/year). Both sites showed the same increase in variability between years in the most recent decade as the Ruakura data.

Soil moisture deficit stress days

Using the VCN data we calculated a daily soil moisture balance for summer-autumn based on incoming daily rainfall (mm) minus daily potential evapotranspiration (PET, mm), and a fixed available soil water capacity (Profile Available Water, PAW). PAW is the amount of water in the soil 'reservoir' that plants can use. From this we determined the number of 'stress days' for each year where plant roots take up water with increasing difficulty and plant growth is restricted.

There was a significant linear increase in soil moisture stress days per year (~+0.8 days per year) from 1972 to 2020 at both sites *(Table 2, Figure 2)*. We then examined each individual month for these summer-autumn months for any trends. Linear regression analysis of stress days by

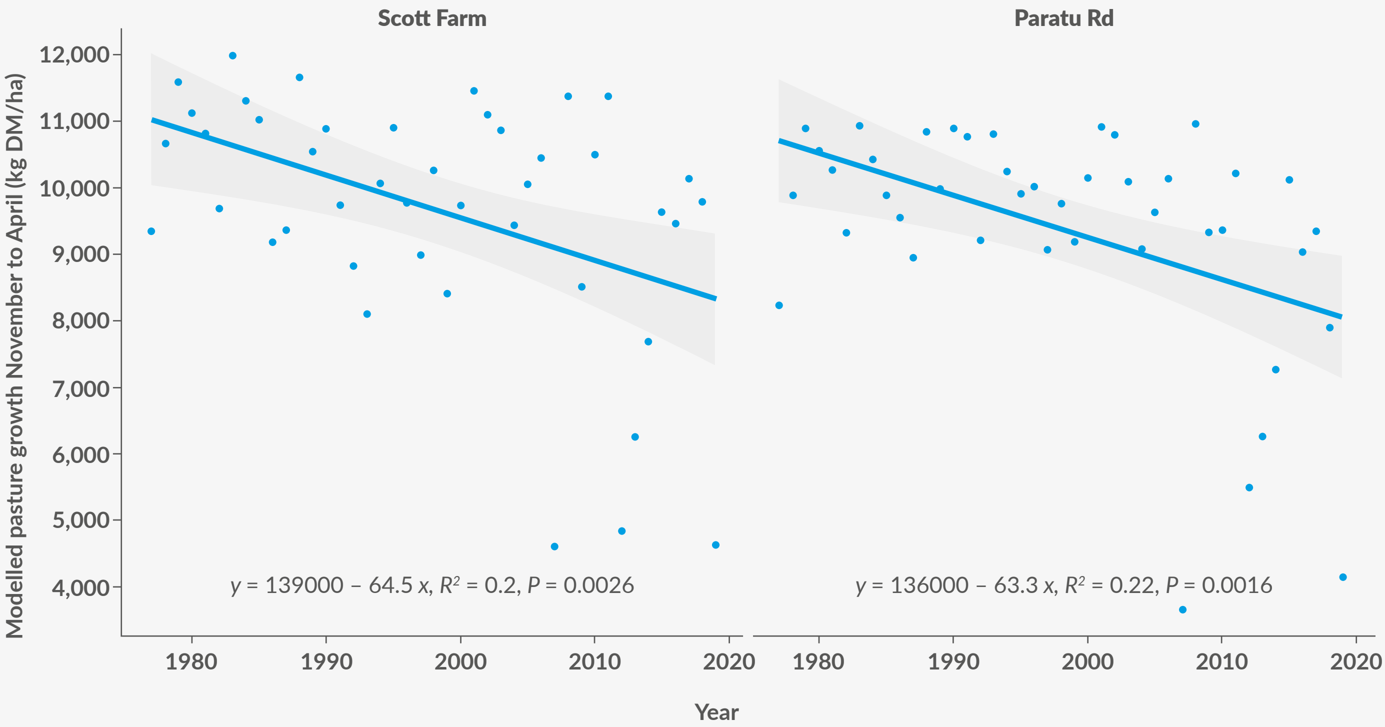


Figure 3: Predicted summer–autumn net HA (Nov–Apr) from 1977–2020 for Scott Farm and Paratu Road. Shaded areas are 95% confidence intervals. The linear regression from the pasture growth model predicted a significant decline in summer–autumn pasture growth over time at both locations

Table 3: Linear trends (slope) and statistical significance (P value) by month for summer–autumn moisture stress days at Scott Farm and Paratu Road, 1972–2020

			MONTH					
Linear trend by month			Nov	Dec	Jan	Feb	Mar	Apr
Stress days	Scott Farm	P value	0.044	<0.001	0.025	NS	NS	NS
		slope	+0.07	+0.3	+0.25	+0.02	+0.08	+0.02
	Paratu Road	P value	0.004	0.081	0.038	NS	NS	NS
		slope	+0.20	+0.18	+0.22	+0.02	+0.09	+0.11

NS = not significant

individual month showed significant increases over time for November, December and January at Scott Farm, and for November and January at Paratu Road, with a trend toward an increase in December at Paratu Road *(Table 3)*.

Simulated pasture growth – herbage accumulation (HA)

Long-term pasture growth potential for summer-autumn at these two locations was examined using 43 years of VCN data and simulating climate-driven pasture production with a pasture growth model. We used the Rezare pasture growth forecaster to simulate daily pasture growth potential from November 1977 to May 2020, based on the availability of daily weather data from the VCN sites. The model utilises information on farm type, geographical location, plant available water, daily weather, fertiliser and irrigation inputs to generate daily changes in pasture biomass.

For the two locations, the site-specific input data for the model included the daily weather file from the nearest VCN node and the soil PAW from S-Map (https://smap.landcareresearch.co.nz/) for the predominant soil type on each farm. For Scott Farm, the PAW was set at 198 mm (Matangi silt loam) and for Paratu Road the PAW was set at 133 mm for (Te Rahu silt loam).

The model predicted a significant linear decline for summer-autumn pasture growth from 1977 to 2020 for both VCN nodes representing Scott Farm and Paratu Road *(Table 2, Figure 3)*. However, the linear component only explained 20% (Scott Farm) and 22% (Paratu Road) of the overall variation in predicted cumulative summer-autumn HA *(Figure 3)*. We used another statistical technique, locally weighted polynomial regression (LOWESS), which indicated that most of the decline in predicted pasture growth occurred from the mid-1990s to 2020.

This study suggests that many farmers near these two locations have experienced increased variability of summer-autumn rainfall in recent years.

Measured pasture growth – HA

Mean pasture growth or November to April inclusive measured during the Ruakura No. 2 Dairy and Scott Farm sequence was 9.4 t DM/ha ±1.4 SD over 41 years. At Paratu Road, mean pasture growth for November to April was 7.1 t DM/ha ±1.6 SD over 26 years *(Figure 4)*. Inter-annual variation of pasture growth was greater at Paratu Road (CV=22%) compared with Ruakura/Scott Farm (CV=14%). There was no significant linear trend over time in measured summer-autumn pasture growth for either site *(Table 2, Figure 4)*.

Discussion

This study suggests that many farmers near these two locations have experienced increased variability of summer-autumn rainfall in recent years, which is also accompanied by increased frequency of summer-autumn soil moisture deficits. Adaptation strategies will be needed to mitigate these trends, should they continue. A distinct trend towards higher values of drought indices over a 72-year period, including the region covered in our analysis, has previously been reported by NIWA scientists.

Future climate change projections for New Zealand, prepared for the Ministry of Environment, point to:

- Temperature increases, particularly in summer-autumn
- More frequent hot days
- Precipitation decreases in northern and eastern regions
- Increased drought severity.

Both measured and modelled pasture growth were used for this study, noting that data for measured pasture growth over periods greater than three to five years are sparse. Models enabled us to extend the period of analysis and consider the effects of climate and soil type in isolation from pasture management. We also note that four decades is still a relatively short time from which to draw firm conclusions, given the existence of decadal-scale climate patterns (Interdecadal Pacific Oscillation described by NIWA scientists in 2002).

For our measured pasture growth, at both locations, we were unable to detect any significant trends over time *(Figure 4)*. This contrasts with the simulated summer-autumn pasture growth *(Figure 3)*. Simulated cumulative NHA (kg DM/ha) for November–April fell broadly within

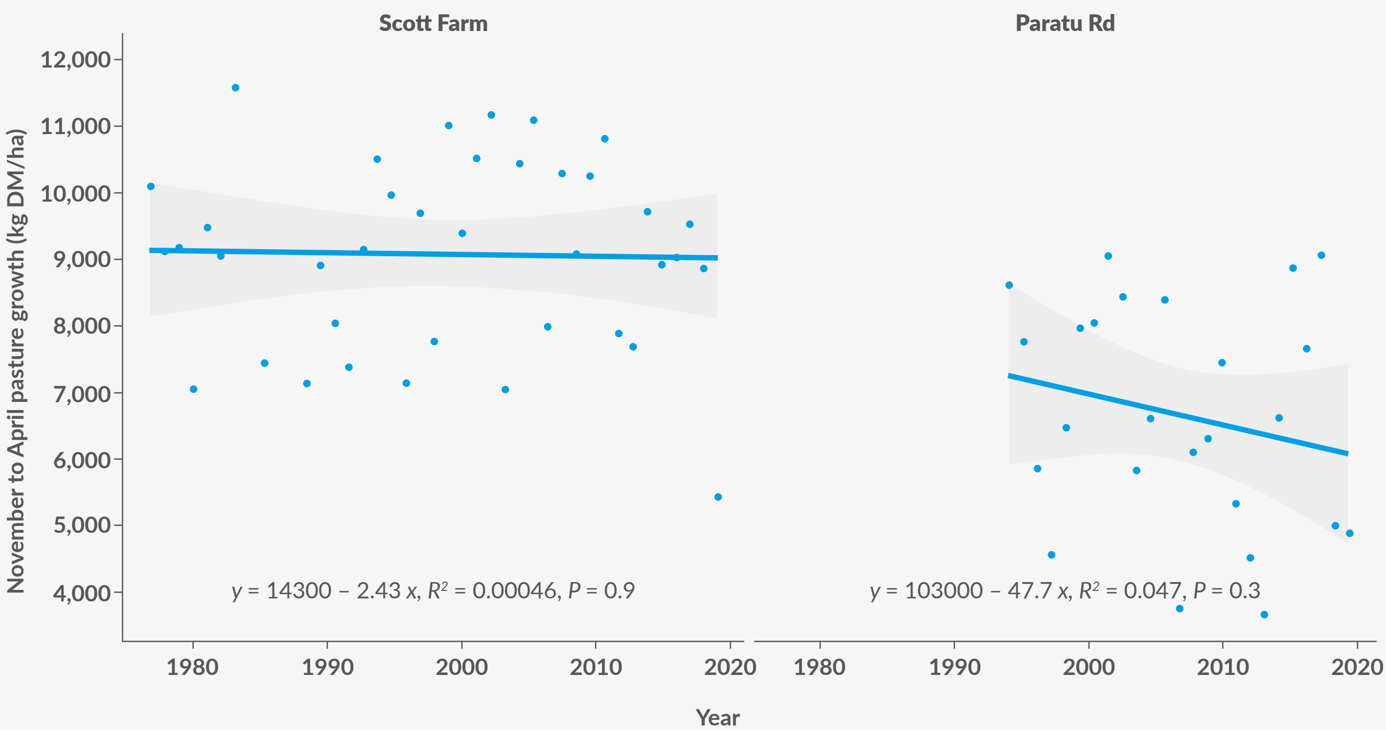


Figure 4: Measured summer–autumn net HA (Nov–Apr, kg DM/ha) for Ruakura/Scott Farm (1979–2020) and Paratu Road (1995–2020). Shaded areas are 95% confidence intervals

In situations where variability in summer-autumn growing conditions is placing perennial ryegrass pastures under significant stress and threatening their persistence, there is also a cost of 'doing nothing' as farmers become trapped in a cycle of re-grassing and re-cropping.

the range measured at Scott Farm (5000-12,000 kg DM/ha). For Paratu Road the model predicted higher pasture growth (by ~2000 kg DM/ha on average) than the measured data for the three decadal periods that were able to be compared.

A possible explanation for the dissimilarity in the long-term trend between measured and simulated data sets is that the pasture growth model uses only local environmental conditions (weather and soil) in its predictions. Whereas on-farm measurements of pasture growth will also be influenced up or down by other factors, such as reducing feed demand by culling, N applications, supplement use, rotation length and managing grazing intensity.

The significant decline in summer-autumn pasture growth predicted by the model perhaps confirms that the trends found for declining summer-autumn rainfall, including November, at both farms are creating challenges for managing feed supply and feed demand for Waikato dairy farmers, especially on soil types with lower PAW (e.g. Paratu Road).

Farm management practices have been adapted over time at the Paratu Road farm in response to the variability in farm-specific summer-autumn pasture growth measurements. These include:

- An increase in weed spraying because of more *Setaria pumilia* (Poir.) yellow bristle grass) and other C4 grasses
- Increased use of winter-active ryegrass cultivars such as 'Shogun' integrated with a summer cropping programme
- Use of three Herd Homes™ in summer to help control post-grazing residuals and mitigate heat stress for cows
- Increased imported feed in the last 12 years to mitigate the variability of pasture production
- A change (four years ago) to 25% of the herd starting calving in March, with a winter milk contract, which matches the measurements of winter pasture growth being much more reliable than in summer
- Nitrogen fertiliser use being reduced to about 120 kg N/ha per year, which is largely confined to spring (or autumn) when soil moisture is most reliable.

Some of these changes, such as use of the Herd Homes™ and more imported feed, provide options for tactical management of pastures over late spring-summer-autumn to, for example, prevent over-grazing and support pasture persistence. However, farm system adaptations, such as those mentioned above, bring additional costs into the farm system. In situations where variability in summer-autumn growing conditions is placing perennial ryegrass pastures under significant stress and threatening their persistence, there is also a cost of 'doing nothing' as farmers become trapped in a cycle of re-grassing and re-cropping.

Practical implications

This study suggests that farmers near the locations examined are likely to have experienced increased variability and frequency of summer moisture deficits, which our pasture growth modelling shows is likely to have been accompanied by a declining trend over time in pasture accumulation rates.

Depending on their farm's risk profile for ryegrass/clover pasture resilience, farmers in the upper North Island will need to explore alternatives to perennial ryegrass to maintain their future home-grown feed-base, or adapt their pasture management to cope with the increasing risk of summer moisture deficit.

The integration of VCN data with pasture growth models appears to be an opportunity to help farmers understand how their local climate is behaving and should inform farm management decisions that help them cope with the increasing risk of summer soil moisture deficits. Adding more sophisticated analysis, such as thermal time accumulation and other statistical methods, could add increased certainty to these messages.

Acknowledgements

Grant Wills provided 26 years of monthly pasture growth data for his dairy farm at Paratu Road, near Matamata. Barbara Kuhn-Sherlock provided valuable statistical advice. We are also grateful to the many technicians who have contributed to the collection and storage of monthly pasture growth data over the years at Ruakura No. 2 dairy and Scott Farm.

Chris Glassey is a Farms Systems Specialist at DairyNZ in Hamilton, Grant Wills is a dairy farmer, Mike Dodd is a Senior Scientist at AgResearch in Palmerston North, Kieran McCahon is a Solutions and Development Specialist at DairyNZ in Northland and David Chapman is a Principal Scientist at DairyNZ in Lincoln. Corresponding author: chris.glassey@dairynz.co.nz

JOHN AUSTIN

Receiving stock data from halter on your phone

THE POINT OF PRECISION AGRICULTURE

This article looks at the growing area of precision ag in New Zealand, including benefits such as for yield monitoring, soil mapping, spreading fertiliser and planting, herd and stock control, and 'no fencing farming'.

I once saw on the front cover of a *Furrow* magazine a photo of an elderly bearded farmer in his bib overalls hoeing his crop. You could tell that farmer knew every inch of his ground and every small plant that grew from it. I can see that same picture of intimate knowledge and management of the land and crops through precision ag, which I have been involved with in New Zealand since its inception here in the early 1980s.

Yield monitoring

When precision ag first began, farmers and contractors were only just beginning to realise the potential of yield monitors in identifying different crop yields and showing where they came from. Now with the progression of modern technology we can also gather moisture content and crop quality information from these monitors.

Not only can these monitors do this, but modern forage harvesters and balers can report on crop yield and crop quality. These maps that our machines and monitors generate have become vitally important in the agricultural industry. They aid farmers in rationing out the harvest, and also help identify the good and the not so good areas of their land that need to be investigated.

Fertiliser spreaders can be programmed to avoid spreading near waterways, which keeps the living organisms beneath the surface of the water alive and healthy.

Soil mapping and testing

Nice straight rows, no steering, less overlap, finer implement control, guidance, improved quality, efficiency and less driver/operator fatigue are only some of the benefits of precision ag. By mapping the soil, we can go back through the data or watch it coming in from the farm to an office in real time. This allows both farmers and agronomists to see that that the results vary with different areas of ground.

Keeping a record of what the soil levels are in all areas means it is possible to see from year to year, or season to season, what we need to work on or what needs a one-off top-up due to weather conditions etc. We can see where the ground is holding more moisture and compare it with where it has little moisture in order to work out why it is the way it is. You could possibly follow up such a comparison by having some contouring on the pasture done, and then be able to compare the production and moisture from before the contouring versus after it to see what physical difference it made to the overall crop.

Through this technology we can see the pH and the sulphur levels, so fertiliser can be adjusted to ensure the seed being planted has all the nutrients it needs to give the optimum yield at harvest. This, in turn, also benefits the stock that consume the crop if it is for stock supplements or stock dietary requirements.

Spreading fertiliser and planting

When it comes to spreading fertiliser, over-application and under-application have been a problem for many years. With the introduction of precision ag we can be more certain that we are applying what is needed, where it is needed, rather than doing a blanket application. In turn, this is great for the environment, and excellent for both the future yield and the bank balance.

Fertiliser spreaders can be programmed to avoid spreading near waterways, which keeps the living organisms beneath the surface of the water alive and healthy. The GPS guidance can show where we are placing tillage and fertiliser in the planting zone, and chemicals when side dresser spraying. This then enables us to follow the same lines, control traffic and boost the efficiency of the fertiliser by banding.

With planters, the monitors watch for skips and overlaps, control and automatically adjust down force, and alert for GPS stops. They keep control of how much seed and chemicals are being released into the soil to help guarantee that none of the 3–10% excess use goes unaccounted for. More soil mapping capabilities are now available, with monitors showing the soil temperature, soil moisture and organic matter. When planting, there is now the opportunity to adjust

Future autonomous John Deere tractor

Drone crop spraying

Using a GPS enabled stock halter, the animal is warned verbally through a speaker on the halter when they are approaching a pre-designed boundary. A small encouragement is administered if the animal continues to approach to discourage it from crossing over the virtual 'fence'.

depth to find moisture, to adjust down pressure, to adjust population and even the opportunity to change the seed. All of this aids in the efficiency of the planting and strengthens and increases the overall final yield.

Benefits for agricultural contractors

When it comes to precision ag, it isn't only the farmers, plants and stock that will benefit from the use of these monitors and GPS systems, but agricultural contractors as well. As the managing director of an agricultural contracting company myself, I know how hard it is to keep up with the general maintenance and service on our equipment, and anything that means these tasks can be done less often will save both money and time.

Using this technology will ensure that every second on the tractor's hour meter will count. Every metre of ground that is cultivated, planted or sprayed will be accounted for. Working the ground more precisely, avoiding second passes, having less tractor idling time, cutting down the hours the tractor and the gear behind it work, all cut down on the amount of services and maintenance we need to organise.

Drones and satellites

Drones and satellites are both becoming more popular as useful tools as they allow the farmer to access crop and pasture data with minimal damage to the crop below. Drone spraying is also becoming more popular, as it allows access to spray areas more precisely, missing areas that are growing well and not in need of any chemical assistance and focusing on those that need the help. It also allows them to spot spray crops upon finding nuisance weeds throughout an otherwise good harvest, and is becoming the less invasive and more accurate way to control weeds.

Herd and stock control

Herd and stock control are other areas of farming that can be improved by precision ag. In most ways, herd recording and tracking technology is no different to that of the combine yield monitor. Tracking stock via halter GPS will give the kind of insights and efficiency that a combine or tractor monitor will. The halters will help farmers ensure that the field/paddock their stock enter is of the right proportions for the herd's grazing needs. By being able to track the stock, we can learn and understand why they choose to graze where they do and why they avoid the areas of the pasture they seem to. Farmers will be able to study the data and work out exactly what they need to improve to achieve better herd management and production.

No fencing farming

Using this herd management area of precision ag, the concept of 'no fencing farming' is becoming a reality for some farmers, starting in Australia and now practised in New Zealand. Using a GPS enabled stock halter, the animal is warned verbally through a speaker on the halter when they are approaching a pre-designed boundary. A small encouragement is administered if the animal continues to approach to discourage it from crossing over the virtual 'fence'.

Halter cow management from your phone

A farmer can draw a shape on a map on either a tablet or an app that will automatically adjust the halter to the herd's new boundaries. This excellent new piece of technology will save farmers thousands of dollars in the construction and upkeep of physical fences, and save farm labourers from going out to move temporary fences as the stock graze in the process of strip-grazing or break-feeding.

Farmers also gain back the ground they lose while fencing or performing maintenance on their fences and the ground lost when the fence is in place. A lack of physical fences will also benefit agricultural contractors as wider, more open spaces are an easier canvas to work on than smaller fenced-in areas. Precision ag will therefore benefit contractors as much as the farmers who will no longer have to stop to open and close gates upon the entry and exit of paddocks.

Irrigation and robotic lawnmowers

Many have farmed through a particularly dry season and know just how important irrigation can be to a dry or cracked ground. A rain autonomous irrigator is another precision ag tool. The machine senses the crop's needs by weather, water/moisture, nutrient or spray sensors and will automatically work out what the crop requires and adjust the machine to fill the need.

In dry land Australia, knowing how much water you have in the irrigation pond could be the making or breaking of a farmer's crop. This is why mapping out the ponds with sensors and alerting the farmer or manager about how many hundreds or thousands of litres of water is left is such valuable information. Soil probes buried underneath the surface of the ground (showing the soil moisture) are key in an irrigation plan to help a farmer achieve optimum results on their land.

Similar to automatic robotic vacuum cleaners are automatic robotic lawnmowers. Autonomous machinery in general is becoming more and more popular. There are machines that automatically spray vineyards and fields, feed out the correct amount of supplement on feed pads to animals, and automatically spread both manure and fertiliser. The future is automated and autonomous.

In many areas of precision ag the data coming towards the farmer and agricultural contractor is immense and sometimes complex.

Analysing the data

In many areas of precision ag the data coming towards the farmer and agricultural contractor is immense and sometimes complex. Finding the right software platform can be a challenge, but is key in organising and understanding the data so we can reap the most benefit from this new technology.

We need to be accepting information from multiple sensors on multiple different machines at once, sending them and make the necessary changes. The software needs to be able to interpret the data and report it to the user in an easy-to-understand format. It must also be able to provide proof-of-placement and keep these records. Either it must be able to keep the information stored, or be able to be easily exported to be stored as annual reports for the next season's reference. Ideally, the software must also be used to make application prescriptions or decision-making reports for the driver/operator, as well as the manager in charge.

Advice for rural professionals

Precision ag is definitely not a 'one-size-fits-all' approach. All of the data we now have flowing in and out to people and machines (thanks to precision ag) is helping to push us closer and closer to that farmer working that hoe – just on a much larger scale. Every business and every farm will have at least one point of precision needed to hit their goal and even to exceed it – making it a better, more sustainable, and more productive farm or business.

As a rural professional you can find out from the farmer what their goal is. What is the key information they seem to be missing? What information could they gather that would make their season more productive or give them that much better yield or result they have been wanting? Whatever area of the agricultural industry people find themselves in, precision ag has something of use and benefit for the future.

John Austin is Managing Director of John Austin Ltd based in Te Awamutu. Email: john. austin@johnaustinltd.co.nz J

THE FARM DEBT MEDIATION SCHEME HELPING FARMERS IN DEBT

The Farm Debt Mediation Scheme is a new initiative from the Ministry for Primary Industries (MPI). Gwyn Morgan, Manager of the Scheme, discusses how it is aimed at facilitating the hard discussions between a primary sector business under significant financial pressure and their creditor with the assistance of an independent mediator.

Uncertain agribusiness environment

The skills required by New Zealand's almost 40,000 farmers and growers to run their agribusinesses are constantly changing. Climate challenges, new regulations and an evolving finance sector have spurred food and fibre producers to upskill to remain viable. Farmers and growers have also had to lift their financial capabilities or pay for professional advice.

More extreme weather leads to uncertain growing conditions and the current COVID-19 pandemic has impacted supply chains. As a result, the usual business variables for the primary sector have become more unpredictable and significantly harder to navigate. Farmers and their businesses have needed to become more resilient and able to withstand frequent fluctuations in income and profitability.

Establishment and purpose

The Farm Debt Mediation Act (2019) became law in December 2019.The Ministry for Primary Industries (MPI) designed, built, staffed and launched the Farm Debt Mediation Scheme on 1 July 2020. It is based on similar debt mediation schemes for primary producers operating in Australia.

Farm debt in New Zealand was $62.8 billion in 2020, up 270% on 20 years ago.

The scheme helps farmers and other primary producers struggling with debt. It uses neutral and independent mediators provided by Resolution Institute (RI) and the Arbitrators and Mediators Institute of New Zealand (AMINZ) to help farmers and their creditors work through debt issues.

One of the key drivers of the scheme's successful design and implementation was the team approach taken with MPI's key partners, RI and AMINZ, specialist mediation agencies already working in the rural space.

AMINZ and RI are responsible for training, assessing and overseeing the mediators and MPI oversees the scheme and the processes of mediation. Almost 40 mediators have been authorised to offer services under the programme and they are located throughout New Zealand. The aim is to provide a negotiation process that is structured, confidential and impartial to help farmers and creditors agree on how to proceed.

How the scheme works

The scheme covers debts owed by a primary production business in connection with primary production activities This includes loans secured against farmland, farm machinery and livestock, harvested crops and wool.

The mediation scheme aims to promote the long-term viability and resilience of farm businesses. This will also help the primary sector as a whole by supporting farmers to manage financial stress. It promotes positive mental health and resilience in rural communities.

Farm debt in New Zealand was $62.8 billion in 2020, up 270% on 20 years ago. Farmers are vulnerable to conditions outside of their control, such as droughts, floods and falls in commodity prices. The failure of a farm business can lead to the farmer and their family losing both their business and home.

Mediation provides the opportunity to resolve disputes in a more affordable and practical way than through the courts or by arbitration. The scheme was introduced to provide a fairer system and has early intervention as a focus to help avoid property foreclosure. The failure of one farm can have big flow-on effects for rural communities and finding solutions to debt issues is in the best interests of all parties.

The scheme helps address the power imbalance that can occur between farmers and lenders. Creditors are required to offer mediation to farmers or growers who default on payments before they take enforcement action.

Mediation process and cost

Bringing a neutral, independent mediator into a room to work with both parties can help save a business or lead to a dignified exit. A mediator can help get both parties talking again. Often the lender may not be fully aware of the pressures a farmer is under.

The process enables 'without prejudice' conversations about what the future might look like for the farmer. Under the Farm Debt Mediation Act 2019, secured creditors must offer mediation before taking any debt enforcement action against farmers and eligible primary production businesses. Farmers can ask for mediation at any time.

The Farm Debt Mediation Scheme is less expensive for the farmer or grower. Once both sides agree to mediation, they have up to 60 working days to complete the process. The farmer selects three mediators from an authorised list and then the creditor chooses one.

The average cost of farm debt mediation is $6,000 (including GST). The cost is shared between the farmer and the creditor, but the maximum amount a farmer or grower is required to pay is $2,000 (including GST) and hardship funding is available.

Performance to date

It is important to remember it is still early days for the scheme. The process takes time and allows mediation to include tikanga principles. Once the farmer and lender agree to mediation, they have up to three months to work through the process.

To date, there have been 42 mediation requests between parties, with the majority of these being in the third quarter of this financial year from January to March 2021. Most of these requests have come to a conclusion and the remainder are going through the process.

Who can access the scheme?

The scheme is open to people involved in a primary production business. This means anyone primarily producing unprocessed materials, e.g. through agriculture, horticulture, aquaculture, or apiculture farming activities. Sharemilking in the dairy sector is included. It is not available for lifestyle block farming, forestry, mining, wild harvest fishing, or the hunting or trapping of animals. The scheme also excludes any business that primarily provides materials or labour as a service to the primary sector.

Farm Debt Mediation Hardship Fund

The Farm Debt Mediation Hardship Fund helps farmers who want to use the scheme but cannot afford the cost of the mediator and/or preparing for mediation. Farmers in extreme hardship can apply to have the mediation paid for by MPI.

The fund can provide up to $2,000 (including GST) for the cost of the authorised mediator. Up to $5,000 (including GST) is also available to cover other additional costs associated with mediation, such as preparing accurate accounts, or a legal review, through a recognised professional. This means up to $7,000 (including GST) of direct support is on offer

To date, there have been 42 mediation requests between parties. Most of these requests have come to a conclusion and the remainder are going through the process.

to a business facing financial difficulty. By the end of January 2021, three applications had been received from farmers or growers for hardship funding.

Other support services

In addition to the Farm Debt Mediation Scheme, MPI is initiating other support services aimed at intervening earlier (prior to default) to lift farmer financial resilience and literacy for those who need it.

Farm Business Advice Support Fund

The Farm Business Advice Support Fund was launched by the National Council of Rural Support Trusts (RSTs) and New Zealand Bankers' Association in February 2020. The initiative, which is funded equally by banks and the Government (MPI), offers support for farmers struggling with farm debt.

The fund is managed by RSTs and they take applications from, or on behalf of, farmers who might qualify for assistance. It provides up to $6,000 to pay for financial or business advice from an independent consultant. The consultant will provide a report, which will be given to the farmer and their bank. This initiative involves ASB, ANZ, BNZ, Heartland Bank, Rabobank, SBS Bank, TSB and Westpac.

To date, 44 farmers have used this service and it has prevented some of these businesses from going into a mediation situation. Early intervention is best for both parties to help mitigate key risks and build resilience.

Financial capability

The Agri-Women's Development Trust (AWDT) has been contracted to research, design and deliver the financial risk management training course for farmers from March to August 2021.

Up to 130 women and men are expected to take part in the course, which will be piloted with sheep, beef, dairy, arable and horticulture businesses in Hawke's Bay, Manawatū, Bay of Plenty, Canterbury, Otago and Southland.

MPI will be looking to grow its services to move more into the 'prevention space' and assist primary sector businesses to make changes to reduce their risk profile in this rapidly changing economic environment.

Role of rural professionals in helping farmers reduce risk profile

Rural professionals have a key role in this space as they often have close relationships with business owners and are best placed to have discussions around seeking advice early. Helping business owners to realise something needs to change is where rural professionals can offer their expertise.

Understanding how the Farm Debt Mediation Scheme and other support services work, and knowing where to refer farmers and growers with specific needs, is vital. If you are unsure of how farm debt mediation works, you are encouraged to call or refer clients to our Farm Debt Mediation Scheme office through the MPI hotline (0800 00 83 33) or email address (info@mpi.govt.nz). All calls and emails are treated confidentially and we are happy to clarify processes with you.

Further information

More information about the Farm Debt Mediation Scheme can be found on the MPI website: www.mpi.govt.nz/funding-and-programmes/farming/the-farm-debt-mediation-scheme-2/

Gwyn Morgan is the Manager of the Farm Debt Mediation Scheme at MPI based in Hamilton.
Email: gwyn.morgan@mpi.co.nz

SANDY SCARROW

THE KIWIFRUIT INDUSTRY NINE YEARS ON

A STORY OF RECOVERY

Following the devastation cause by the bacterial disease Psa, the kiwifruit industry has made a significant recovery. This article looks at that recovery and some of the factors that contributed to it.

The worst and the best of times

There were the worst of times and these may be the best of times. A misquote of Dickens that describes the changes that have happened in the kiwifruit industry over the past 10 years. When I wrote an article on the kiwifruit industry for this Journal nine years ago, it was a story of an industry struggling with difficult times. We were struggling with an incursion of the bacterial disease *Pseudomonas syringae* pv *actinidiae*, known as Psa. Vines were dying, orchard values dropped and many, including horticultural consultants, were looking at career alternatives.

The story of recovery is one that has many lessons for other primary sector industries, and this article touches on some of them as it describes what has happened over the last few years. The lessons include:

- The value of strong industry leadership
- The value of a respected research and extension network
- The value of a strategically-focused research programme, including the new varieties programme.

Late season gold stringing

The kiwifruit industry is booming. Currently the industry is just in the middle of a difficult, but record-breaking, harvest.

Current boom

The kiwifruit industry is booming. Orchards are selling for unheard of prices and orchard gate returns (OGRs) for both the Gold3 licensed variety and the traditional green Hayward variety are at an all-time high. Currently the industry is just in the middle of a difficult, but record-breaking, harvest. ***Figure 1*** gives the volume of exports of the main varieties that Zespri markets, and also shows that Gold3 volumes now exceed those of Green volumes.

In 2019, the Gold3 harvest exceeded that of the Green variety, with the 2021 Gold3 harvest expected to exceed 100 million trays. Green organic volumes have remained relatively static, while the variety tipped to replace the unlicensed Hayward variety, Green 14, simply hasn't fired and growers have gradually moved out of it.

A more interesting story is the growth in income received per tray for Gold3 (even as supply increases). The anxiety felt as the industry went into the sales season in 2020, given the potential impacts of COVID-19, was misplaced. Harvest was able to continue throughout the New Zealand COVID-19 lockdown and marketing activities pivoted to increase the focus on online channels. The demand for the product increased, with the consumer seeing the value of this fruit as being protective against illness.

The two graphs in ***Figure 2*** show increasing average income for both Green and Gold3. The area in Gold3

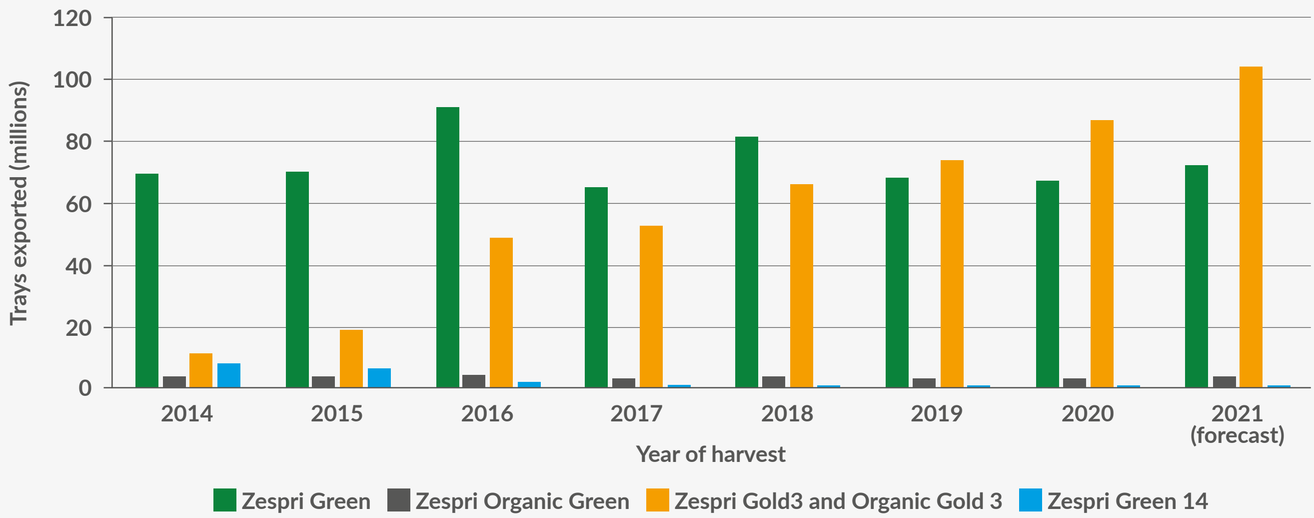


Figure 1: Volume of kiwifruit exports 2014–2021

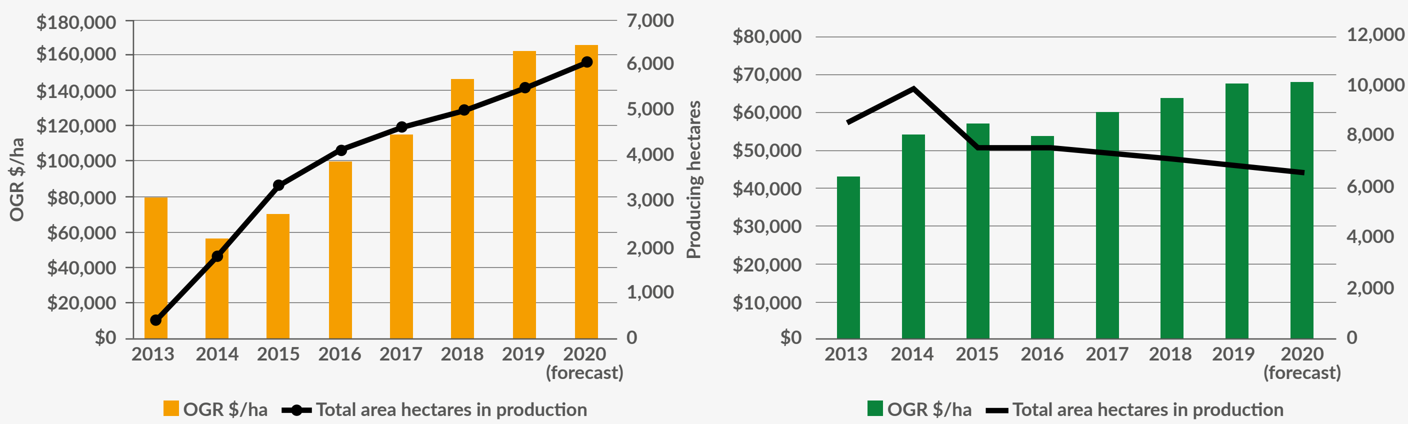


Figure 2: Average orchard gate returns (OGR $/ha) for Gold3 and Hayward orchards and area planted

Harvest was able to continue throughout the New Zealand COVID-19 lockdown and marketing activities pivoted to increase the focus on online channels.

is increasing to be around that of the area planted in Hayward. The significant difference is that the area in Hayward has been reducing. It is only in the last one or two years that new plantings of Hayward have occurred.

The OGR figure represented in these graphs is analogous to farm gate return in the farming sector. It represents all the money that the grower receives to pay for on orchard expenses, debt servicing and drawings. Depending on the growing system, on orchard costs can range between $35,000/ha and $55,000/ha. The net return to the grower after growing expenses (even for Hayward) is better than most primary sector industries. Note a 'hectare' is the area actually occupied by the kiwifruit canopy, called a 'canopy hectare'.

Kiwifruit breeding programme

The picture is of an industry doing incredibly well, but this did not happen by accident. When Psa hit, the Gold variety that dominated the industry at the time, Hort16A, was not able to respond. Genetic analysis determined that the variety did not have the gene present to switch on its defense mechanisms against the bacteria. However, the kiwifruit industry, supported by public funding and the fees generated from sales of the Hort16A licence, had in place a strategy of plant breeding.

Plant and Food Research describes the kiwifruit breeding programme as the largest one in the world. Through this programme there were at least three new varieties already in pre-commercial trials on orchards when Psa hit. One of these varieties, Gold3, was quickly seen as being a viable replacement for Hort16A, despite tolerance to Psa not being an attribute previously considered in the breeding programme. The industry quickly converted over to this variety by stump grafting this new bud wood into their existing rootstocks and the recovery has been phenomenal.

Canopy of green kiwifruit

Zespri licences

To be able to produce Gold3 a grower must tender for a licence through a Zespri-run process. Zespri aims to release sufficient licences to gradually increase supply of the fruit as they grow demand, aiming to keep demand ahead of growth in supply. Over the past few years, Zespri has released 700 ha of Gold3 licences for conventional production and a further 50 ha for organic production. The tender process itself has shown some interesting trends, as the average price paid for the Gold3 licence continues to increase. The demand for licences, measured in the unrequited tenders, continues to exceed the supply.

Results from the 2021 tender round for Gold3 licences have just been released. The median price paid for a Gold3 licence (exclusive of GST) in May 2021 was $550,000/ha, with the full offering of 700 ha of licences being sold, which is a significant jump up from the 2020 median price.

Table 1 shows increasing prices for a licence and demand is significantly exceeding the hectares of licences being made available. Most significantly, the tender process can result in the prospective purchaser missing out on a licence if the price they bid is below the required price. We believe that the impact of many growers missing out on a licence this year means the price that growers are prepared to pay will remain high in the next tender rounds.

The rising median licence price is given in *Figure 3*, which shows the trend line has a significant slope upwards.

Table 1: Conventional Gold3 licence tenders for 2016–2021

ITEM	2016 RESULTS	2017 RESULTS	2018 RESULTS	2019 RESULTS	2020 RESULTS	2021 RESULTS
Median price $/ha	$171,000	$235,000	$265,108	$ 290,000	$400,023	$550,000
Minimum accepted price $/ha	$142,000	$221,000	$233,333	$148,206	$378,900	$525,000
Total area available (allocated)	400 (400)	400 (400)	700 (700)	700 (700)	700 (700)	700 (700)
Total hectares bid for (ha)	1,359	1,277	1,079	1,681	1,660	1,511
Unrequited bids (ha)	959	877	379	981	960	811

Source: Various Zespri Kiwifliers

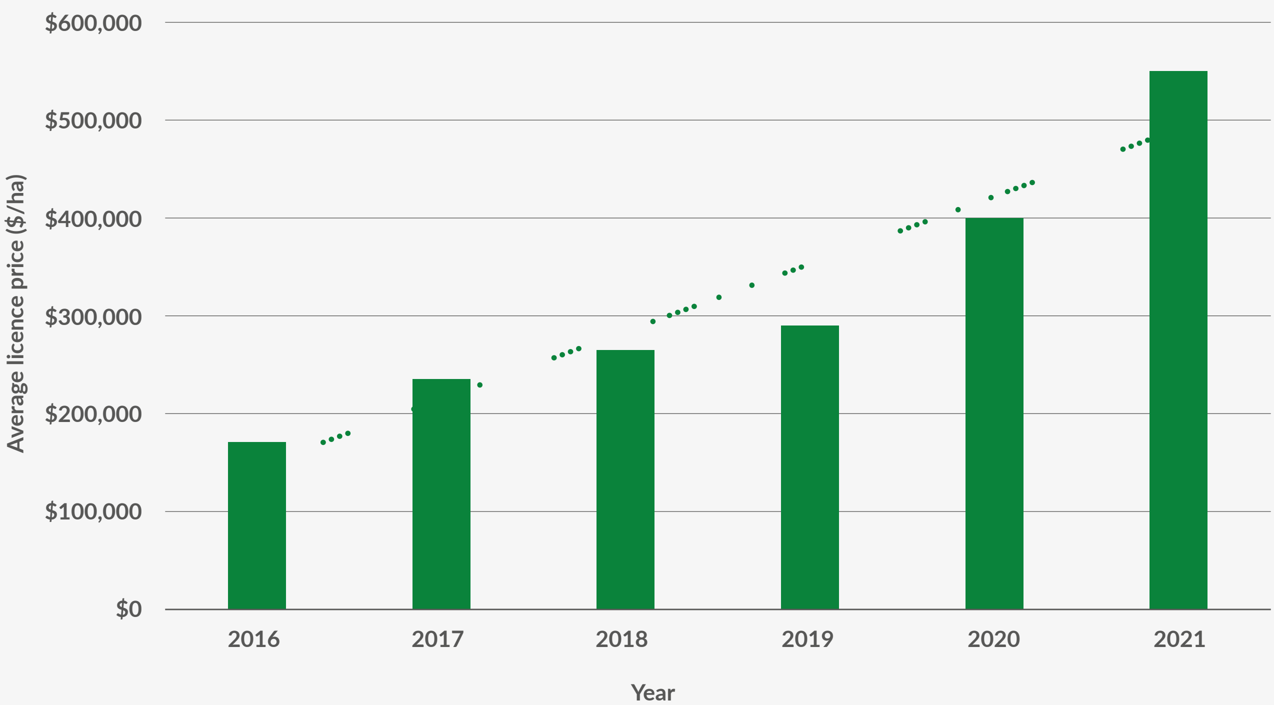


Figure 3: Median successful Gold3 licence price

Red kiwifruit.
Source: Zespri

There has been a significant lift in orchard price on the back of confidence in the industry, supported by the high returns growers are achieving per hectare.

Increase in orchard values

Orchard values have also increased significantly. A widely reported sale in 2012 resulted in a total price of $3.8 million for a 68 ha orchard (see www.nzherald.co.nz/bay-of-plenty-times/news/underselling-an-orchard-costs-real-estate-agent-1m/JOYB6YGHXL6I5HB4SADGAY7TDY/). The orchard was a mixture of varieties, but predominantly Gold3. This equates to a sale price of around $56,000/ha.

Details of the actual price paid per hectare, exclusive of buildings, is not easily extracted. The same real estate agent involved in this sale was recently reported on Radio NZ as selling a Gold3 orchard for $1.75 million/ha. There has been a significant lift in orchard price on the back of confidence in the industry, supported by the high returns growers are achieving per hectare.

Leadership important

As mentioned, there are some lessons to take from the Psa experience. The leadership that was shown through this difficult time was significant. Organisations representing kiwifruit growers worked with the Government to find solutions. Zespri, NZ Kiwifruit Growers Incorporated (NZKGI), Horticulture New Zealand, the Bay of Plenty Rural Support Trust and the rapidly formed Kiwifruit Vine Health rallied to find solutions to the problem, including specific engagement with Māori growing organisations.

Furthermore, leadership was shown by a rural BOP accountant, Trudi Ballantyne, to ensure some tax anomalies were corrected to allow for growers to manage the financial aspects of the crisis. Many of the leaders of the time have moved on to other roles, but their leadership through this difficult time has been acknowledged. Key aspects were:

- The leadership to ensure that the kiwifruit breeding programme was in place years before, and luckily provided a variety that was able to replace Hort16A, must be recognised. Other industries, without this strategic focus, may not have recovered as quickly or at all
- The leadership to approach the Government and work collectively to find a solution
- The leadership to ensure that the psychosocial aspects of grower and worker welfare were taken care of. NZKGI and the Rural Support Trust provided a multi-pronged approach to this, which is useful to consider in future crises
- The collective leadership to work with banks, Inland Revenue and other government agencies to minimise the financial harm that could have accrued from this event.

Need to build resilience

The crisis is now well in the past. However, it is timely to remind those involved in the industry that we are currently in the good times. It is important to acknowledge this and do what can be done, while cashflow is strong, to build resilience into the kiwifruit sector.

Sandy Scarrow is Horticultural Consultant at Fruition Horticulture (BOP) Ltd based in Tauranga. Email: sandyscarrow@fruition.net.nz J

MAKE YOUR SMART IDEA A REALITY

APPLY FOR THE RURAL PROFESSIONALS FUND

Do you have an innovative idea that could create real change for Kiwi farmers? Rural professionals are encouraged to team up with farmers to apply for $75,000 funding to rapidly test smart ideas and share the results.

Rural professionals are again invited to team up with farmers to test exciting and innovative ideas that could lead to significant improvements in farming systems.

The Rural Professionals Fund, established in 2020 by the Our Land and Water National Science Challenge, will soon be opening a second round of funding to support projects that will benefit farming communities.

Last year, the fund received 31 applications, and 15 projects were funded (see them at ourlandandwater.nz/rural-pro-fund-2020). The funded projects encompassed a wide variety of farm systems, industries and ideas, tackling questions including:

- Does pure, clean drinking water improve milk production in cows?
- Does regenerative-style farming produce higher quality meat?
- Should we grow more trees in pastures?
- How do farmers make land-use change decisions?

The second round of the Rural Professionals Fund will invest up to $75,000 in projects that will rapidly test ideas and innovations within a short nine-month timeframe. Projects must align with the Our Land and Water objective: to improve Aotearoa's land and water quality for future generations, while enhancing the value of the primary sector to New Zealand.

'We want to see concepts emerge that can generate evidence and move into action quickly,' explains Richard McDowell, chief scientist for Our Land and Water. 'The Rural Professionals Fund allows us to quickly explore a lot of options, and encourage and resource more innovators and entrepreneurs to test their good ideas.'

'We are particularly interested in projects that will help to diversify land use and practices, effect behavioural change and create new ways of doing things across the agri-food and fibre system.'

Project teams must include a rural professional who is a member of the NZIPIM, and a farmer or grower. The team also must include a person with relevant scientific or technical expertise – and unlike last year's funding round, this time the science/technical expert can be the rural professional

Communicating the results of both successful and unsuccessful projects to the wider rural profession and farming community is a crucial part of the process, says Stephen Macaulay, CEO of NZIPIM. 'If projects show promising results they could apply for other research funding for further examination. Should the opposite occur, we can fail fast, learn from the experience and move on to the next exciting prospect.'

The application form will be available soon. Sign up for email notification at ourlandandwater.nz/news-events/. Applications will be due in mid-August, will be reviewed by NZIPIM and the Our Land and Water National Science Challenge, and successful projects will begin in October 2021.

WHAT TYPE OF PROJECTS WILL BE CONSIDERED?

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

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

BOB BROWN

WASP BIOCONTROL
NEW TOOLS FOR NEW ZEALAND'S INVASIVE WASP PROBLEMS

Invasive non-native wasps are a growing economic and environmental problem for New Zealand, particularly in forested areas of the upper South Island. Manaaki Whenua – Landcare Research is researching and deploying new biocontrol agents to help win the war on wasps and this article outlines their approach to this.

German and common wasps

German and common wasps (*Vespula* species) are social wasp species that have spread rapidly throughout the country since being introduced into New Zealand. During the summer 'wasp season' their numbers can grow so large that they are a serious pest in urban, rural and natural ecosystems. They can spoil people's enjoyment of the outdoors and pose a health risk. Wasps also affect the profitability and safety of industries such as beekeeping, horticulture, forestry and tourism.

Social wasps construct a nest in which a caste system develops, typically with a queen laying eggs, male drones and workers, the latter taking care of the developing larvae, foraging for resources and nest defence. There are no native social wasps in New Zealand, which is unusual compared to other parts of the world.

The German wasp (*Vespula germanica*) is native to Europe and northern Africa. It was first found at an air force base near Hamilton in 1945, and it has been suggested that hibernating queens arrived in New Zealand in crates of aircraft parts from Europe after the Second World War. Although considerable efforts were made to eradicate nests, German wasps spread very quickly and within a few years were found in most of the North Island and parts of the upper South Island.

German wasp queen (Vespula germanica)

Wasp nest beetle (*Metoecus paradoxus*)

Volucella larvae that have left a wasp nest to overwinter in soil

The common wasp (*V. vulgaris*) is native to Europe and parts of Asia (Pakistan and northern China). This species was also introduced to Australia and, more recently, Argentina. Single specimens of the common wasp were recorded in New Zealand in 1921 and 1945, but it did not establish fully until around 1980. After this it rapidly spread throughout New Zealand, and almost completely displaced the German wasp from beech forests in the upper South Island because of its superior competitiveness.

New Zealand has the highest densities of these wasps in the world and both species can form very large colonies of several thousand individuals. Both also typically nest in holes in the ground, but nests are also found in rotten logs or stumps, in forest litter and in trees. In urban areas they nest in hollow walls, attics or aerial locations (e.g. under eaves or hanging from rafters).

German wasp nests are grey and constructed with fibres from structurally sound wood, whereas common wasp nests are brown in colour and made from the pulp of rotting wood. German wasps have the capacity to maintain large overwintering nests, whereas the common wasp colonies die in winter. In beech forest with honeydew the biomass of social wasps (about 1,100 g/ha) is greater than that of all the native birds, upsetting the balance of native ecosystems.

Wasp predation and damage

Vespula wasps are generalist predators that attack a wide variety of arthropods, including honeybees, butterflies, flies and spiders, but they will also scavenge for protein from animal carcasses and dustbins. Where they are invasive, these wasps have detrimental effects on normal ecosystem functioning, food webs and the behaviour of native birds. The predation rate of wasps on native invertebrates is believed to be so high that some species are at risk of extinction.

Wasps also have a significant impact on New Zealand's beekeeping industry, with wasp damage being regularly ranked as the third or fourth highest cause of colony loss in beehives (see the *NZ Colony Loss Survey* in the 'Further reading' section). Together with their disruption of the enjoyment of the outdoors and recreational activities, and the health risks of stings, it is estimated that wasps cost New Zealand up to $130 million annually in damage and management.

New biocontrol tools

Approval process

Fortunately, new biocontrol tools are about to be released to control both types of wasp. The Tasman District Council, acting on behalf of the Vespula Biocontrol Action Group, applied to the Environmental Protection Agency (EPA) in September 2020 seeking permission for two new wasp biocontrol agents to be released in New Zealand – a beetle and a hoverfly. The application is prepared and managed by Manaaki Whenua – Landcare Research.

The process for obtaining an EPA biocontrol approval is long and painstaking and involves collaboration with many different groups. For this approval process, stakeholders included South Island iwi, Department of Conservation staff, regional councils, the QEII National Trust, the NZ Landcare Trust, the Ecological Society of NZ, Federated Farmers, the Royal Forest and Bird Protection Society of NZ, the NZ Entomological Society, the NZ Forest Owners Association, Apiculture NZ and District Health Boards.

Public submissions were also invited and a great deal of scientific research was done to ensure that the new biocontrol agents are completely specific to the target organism, do not attack any other organism, and also do not harbour any diseases or parasites that could attack them. The EPA's decision to allow the new biocontrol agents was notified on 16 February 2021, some five years after the first science was begun.

Wasp nest beetle

The wasp nest beetle, *Metoecus paradoxus*, is a medium-sized beetle (8–12 mm) native to Europe and the UK that parasitises the brood of *Vespula* wasps. Larvae of *M. paradoxus* enter wasp nests after attaching themselves to the bodies of foraging *Vespula* wasps, and once inside the larvae locate and consume one *Vespula* wasp grub each. Feeding continues until they are ready to pupate and they emerge as adults around the same time as their host would have completed its life-cycle.

Female hoverfly (Volucella inanis)

10 FACTS ABOUT WASPS

1. The German wasp (*Vespula germanica*) was first found near Hamilton in 1945 and the common wasp (*Vespula vulgaris*) has been in New Zealand since 1978.
2. The beech forests at the top of the South Island have the highest densities of wasps in the world, but they are also found in many other habitats across New Zealand.
3. On average, there are 12 nests per hectare in beech forests, which is about 10,000 foraging wasps per hectare at any given time.
4. The highest number of nests recorded was 50–60 nests per hectare, the equivalent of 25–30 nests on a football field.
5. The largest nest ever found was four metres high and contained about four million cells.
6. There is a greater biomass of wasps (3.8 kg per hectare) in beech forest than all the native birds plus stoats and rodents put together.
7. The public voted wasps as the 'most disliked wildlife', along with rats, because they spoil the enjoyment of outdoor recreational activities.
8. Wasps destroy or seriously damage 8–9% of honeybee hives in New Zealand each year.
9. Wasps affect native food webs and negatively affect the behaviour of native birds.
10. The predation rate of wasps on some native invertebrates is so high that the probability of their populations surviving through the wasp season is virtually nil.

Hoverfly

The hoverfly *Volucella inanis*, native to Europe, the UK and northern Asia, also parasitises the brood of *Vespula* species, but each larva attacks more than one wasp grub. The *V. inanis* larva squeezes its way to the bottom of the brood cell of a large wasp grub and begins feeding on the posterior end of the grub, which severely compromises its vitality.

The *V. inanis* larvae then seek a second wasp grub in the pre-pupal stage. Once the larva locates an appropriate wasp grub, it makes its way to the bottom of the brood cell and waits for it to close the cell with silk. Once the cell is sealed, the *V. inanis* larva feeds until it is ready to pupate, effectively killing the wasp grub.

Planned releases

In October 2021, Manaaki Whenua – Landcare Research will be receiving insects from the UK into its insect containment facility and will then keep a careful eye on progress over the coming years. In the first year of a typical biocontrol release about 30–40% of the insects are released, with the remainder kept in containment to start a mass rearing programme.

For this wasp biocontrol programme, the first releases will be planned for the Tasman District. Like other biocontrol programmes, the impacts on wasp numbers may take several years before they are obvious. As the mass rearing develops, the aim is to release tens of thousands of agents at multiple sites per year. This strategy should not only ensure the establishment of the agents, but also shorten the timeframe between establishment and being able to show effects on the populations of invasive wasps. Ideally, funding allowing, we could demonstrate positive impacts at several release study sites within five to 10 years.

Funding

The project, currently in its last year of funding, has been supported by the MPI Sustainable Farming Fund (now Sustainable Food and Fibre Futures), with contributions from several regional councils and from primary industry organisations such as Federated Farmers, ApiNZ and Beef + Lamb NZ. Further funding is needed to continue the work into the future.

Further reading

For *NZ Colony Loss Survey* see: www.landcareresearch.co.nz/discover-our-research/environment/sustainable-society-and-policy/nz-colony-loss-survey/2020-colony-loss-survey/

Dr Bob Brown is a Researcher in Biocontrol & Molecular Ecology at Manaaki Whenua – Landcare Research. Email: brownb@landcareresearch.co.nz

ANNE LEE

CleatTech effluent treatment systems are providing water for washdown

THE SCIENCE AND COMMERCIAL BENEFITS OF A FARM DAIRY EFFLUENT TREATMENT PROCESS

Clarifying farm dairy effluent to separate out 'clean' water is reducing pressure on effluent storage and cutting back freshwater use, but it is also having other on-farm and environmental benefits. This article looks at what farmers and scientists are saying.

Overview

The development of a process to treat farm dairy effluent (FDE) – settling out the solid particles to produce clarified water – can provide multiple benefits to farmers through a significant reduction in FDE storage requirements, reduced water usage in farm dairy washdown, a significant cut in potential phosphorus (P) losses and *Escherichia coli* (*E. coli*) contamination, as well as labour savings.

Developed at Lincoln University by Professors Keith Cameron and Hong Di, the process has been scaled up from benchtop 'jar' studies to tanks, pilot farms, and is now being used commercially on six dairy farms and four transport operations. Agricultural trucking companies also face issues with water costs and storage capacity for truck washdown material that contains animal faeces and urine.

The ability to separate out the clarified water component and eliminate almost all bacteria from FDE and washdown has enabled it to be used as recycled water for further washdown in farm dairy yards and truck washes. This saves from 66–70% of freshwater usage for yard washdown per year for dairy farms currently using the system.

Farmers using the system have reported savings in water use and electricity pumping costs and labour requirements through reduced time spent applying farm dairy effluent to land.

The remaining treated FDE is reduced in volume by about two-thirds based on research results and farmer experience, but is still liquid enough to be applied through the usual effluent spreading systems. Several published scientific studies have proven the system both reduces P leaching losses (shown to occur in lighter soils), without affecting the amount of P in the treated FDE eventually available for plant growth, and cuts *E. coli* levels in the treated FDE.

Farmers using the system have reported savings in water use and electricity pumping costs and labour requirements through reduced time spent applying FDE to land. The current capital cost of the system is $98,500 GST exclusive and includes a clarification tank, coagulant tank and telemetered controller, plus a sump pump. Farmers might need to pay additional costs for remedial earth works and pads for the tanks if required before installation, a storage tank for clarified water, and electrical and plumbing costs to enable the use of clarified water in farm dairy washdown. The average cost of this over six dairy units that have installed the system to date has been $15,000 to $25,000.

There is also an annual cost of coagulant at $1.40/L GST exclusive plus freight to farm. The annual cost of coagulant varies, depending on how much FDE is produced. On a typical 400 cow farm, milking twice-a-day over 270 days, the annual coagulant costs would be about $7,600 to $9,450, depending on whether all the effluent is treated or just enough to create the clarified water needed for washdown.

The reduction in treated FDE volume gives greater headroom in their storage facilities, and the reduction in potential losses of both P and bacteria to water are seen as significant benefits, particularly in areas with specific sensitivities. Where a farm was considering increasing effluent storage capacity, the capital cost of the system should be compared with the cost of building 66% more additional storage capacity for FDE.

The science of the floc – a recap

FDE is mostly water (99%) with colloids, the fine solids component, making up the rest. Those colloids are a combination of solid faecal matter (containing nutrients including P and nitrogen), bacteria such as *E. coli*, soil particles and washdown chemicals. Colloids are in suspension and are too light to settle out on their own. They also have an overall negative charge which makes them repel each other, maintaining them in suspension.

The addition of a coagulant – an accepted and widespread practice in many municipal drinking water supply treatments – acts in this case by neutralising the negative charge on the colloids, allowing them to come together. Several coagulants are approved for use in water supplies in New Zealand. Cameron and Di tested several of these coagulants with FDE at a 'jar' level in the lab and found the coagulant polyferric sulphate $Fe_2(SO_4)_3$ (PFS) to be an effective agent.

PFS is approved by the US Food and Drug Administration as a food additive, and an independent report commissioned in New Zealand as to its environmental safety and health risk concluded it posed no consumer risk. PFS has an overall positive charge, allowing colloids to combine, giving them a heavier mass that causes them to sink and settle out of the solution. This process is known as flocculation.

Some of the PFS also combines with hydroxyl ions in the FDE solution to create ferric hydroxide. This creates a 'sweep floc' mechanism that causes the growing colloid particles to swirl down in a cork-screw motion, increasing the speed with which the solid colloids settle out. The rate at which the coagulant is added to the FDE is vital to maintaining effective flocculation – too much and too fast and the colloids will start repelling each other again. FDE characteristics vary between farms and during the season on the same farm.

To ensure the correct flow of coagulant, large tank and pilot farm studies were carried out. Algorithms determined through experimentation calculate how much coagulant should be injected for the volume of FDE to be treated. The pilot studies resulted in the development of a system whereby, after a brief period (minutes), the turbidity of the contents of the clarification tank is sampled and tested to determine a nephelometric turbidity unit (NTU) reading.

Additional volumes of coagulant may need to be added to the tank to optimise the flocculation and sweep floc process to achieve the desired NTU reading. At the target NTU reading, flocculation is complete and the FDE is separated into clear liquid in the top two-thirds of the tank and treated effluent at the bottom.

The good, the bad and the ugly – what does the science say?

Farm dairy effluent is a source of nutrients, and the clarification process does not reduce nutrient levels in the treated effluent. Repeated studies have shown, as expected, no significant negative effect on plant growth by applying treated versus untreated FDE. Studies by

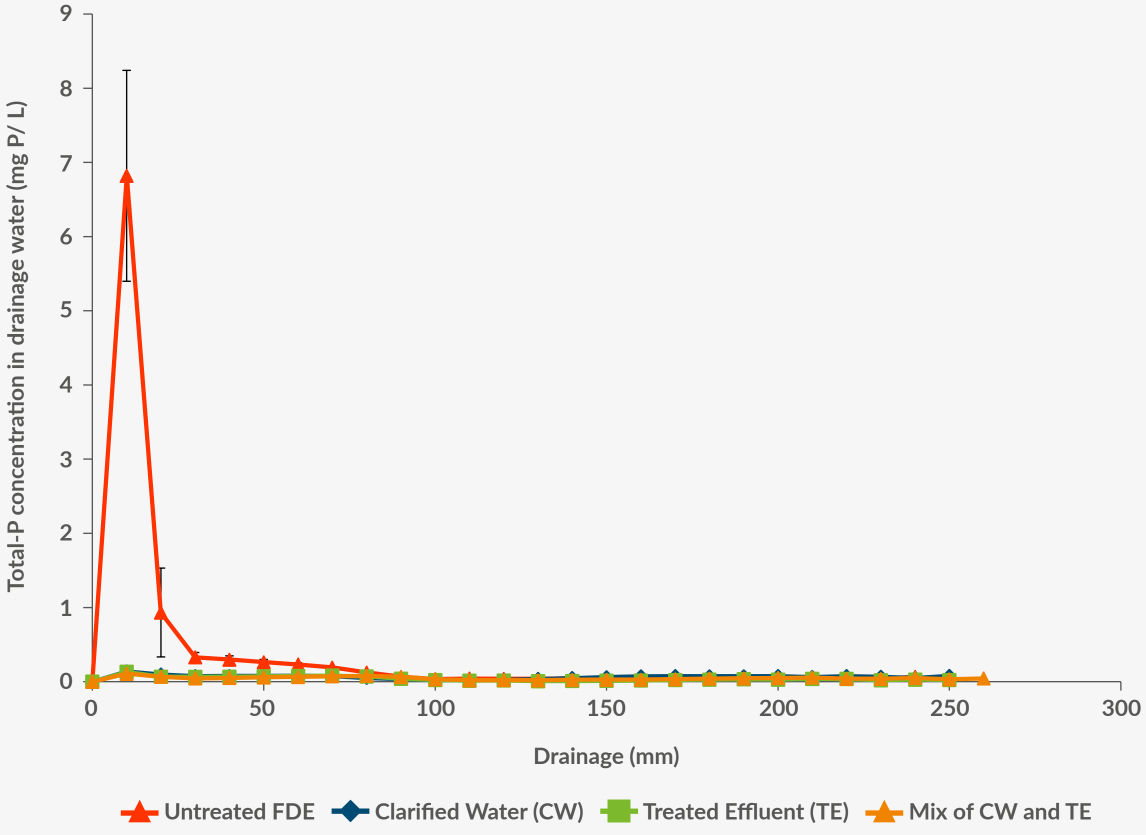


Figure 1: Concentration of total-P in drainage water from soil lysimeters showing effectiveness of ClearTech in reducing the risk of P leaching loss from effluent areas on dairy farms (Chisholm et al., 2020, *NZ Journal of Agricultural Research*), https://doi.org/10.1080/00288233.2020.1814823

Cameron and Di found total-P levels of 35.27g/m³ in untreated FDE and 111.80g/m³ in treated FDE due to its more concentrated nature.

The total-P is dramatically lower in the clarified water that is used to wash the yard (0.44g/m³), but this recycled water is eventually mixed with the treated effluent again before application to the land, ensuring there is no P lost during effluent irrigation. Investigations conclude that iron from the coagulant and P present in the untreated FDE also react to form more stable iron phosphate compounds in the treated FDE, which becomes plant available at a slower rate.

Other researchers have found that leaching losses of dissolved reactive P (DRP) and total-P were 95% lower in leachate collected from lysimeters after treated FDE was applied compared with the untreated FDE. In areas with light, shallow soils or areas with tile drainage, this could provide a substantial reduction in the environmental impact of dairy farming on rivers and lakes.

Another 2019 study that reviewed 14 years' worth of data from LUDF (2001–2015), found that on shallow Eyre soils where FDE had been applied P losses were six times higher than non-FDE areas on the same soil type, despite best practice application being followed. Another study found no DRP losses in leachate at all following the application of clarified water and a 99% reduction in DRP losses following the application of treated effluent ***(Figure 1)***. This study also allayed concerns of iron losses to groundwater. It was found there were no significant differences in iron leachate losses from lysimeters where treated FDE was applied compared with a control (freshwater application) or where untreated FDE had been applied.

E. coli

Peer reviewed, published research findings from Lincoln University have shown *E. coli* is all but eliminated in the clarified water produced after the coagulant has been added and the flocculation process completed. Cameron and Di's work published in 2019 showed *E. coli* levels were reduced by 99.8% in the pilot treatment plant and 99.9% in a large tank study compared with the untreated FDE. There was also a 91% reduction in *E. coli* in the treated FDE (the resulting floc) compared with untreated FDE.

The dramatic reduction in clarified water puts the *E. coli* levels at 90% below the critical level set for recreational purposes, making it safer to handle than greenwash water in dairy yard washdown.

Lysimeter studies being carried out on treated effluent

E. coli is all but eliminated in the clarified water produced after the coagulant has been added and the flocculation process completed.

The bacteria are killed in two ways:

- The PFS interferes with the surface of the cellular membrane around the micro-organism
- The bacteria in FDE become trapped and are tightly held between the colloids as they come together during the flocculation process which kills the bacteria.

Greenhouse gases (GHGs)

A third set of studies published in 2018 also looked at any effect on GHG emissions and denitrifying bacteria in soils. These studies found no difference in nitrous oxide emissions by applying treated compared with untreated FDE. There was no significant difference in populations of denitrifying bacteria as a result of applying the treated FDE either. So while it doesn't lower nitrous oxide GHG emissions from soil, it doesn't make them any worse.

How does it stack up?

The system is currently being used on six dairy farms and the numbers are showing that in practice it is operating as the science says it should. Thorneycroft Dairy Farm near Geraldine is owned by Neil and Margaret Campbell. The 240 ha, 800 cow farm sits adjacent to a Community Drinking Water Protection Zone. These zones are found nationwide in areas where community drinking water is drawn from. Following the Havelock North drinking water contamination disaster, these zones now have restrictive rules to protect water quality.

The science behind the clarification system and practical results of using it, such as extended storage and *E. coli* reductions, have been presented to five regional councils – Waikato, Canterbury, Southland, Otago and Hawke's Bay. The Campbells went through a consent renewal process and found the new clarification system was well received and understood by the council.

While cows are still out in the paddock most of the time, naturally returning their waste to the soil, it is the capturing of FDE, storage of it, and spreading it back onto paddocks where councils see potential for pollution through loss to waterways, overflow and ponding. At Thorneycroft the enhanced storage due to a lower volume of FDE and reduction in *E. coli* have been the major benefits. However, there have been real gains in the improved efficiency of washdown, with a reconfiguration of the mainline around the yard and the

Thorneycroft Farm in Geraldine

The system is currently being used on six dairy farms and the numbers are showing that in practice it is operating as the science says it should.

addition of an extra pump halving the time spent on yard washdown.

The ability to retrofit the system to an existing FDE system is a major benefit. In Thorneycroft's situation, this involved positioning the 30,000 L clarification tank, control unit and coagulant reservoir tank next to the existing Enviro-Saucer and Permastore holding tank. An additional 30,000 L clarified water storage tank was positioned next to the farm dairy and is linked to the washdown system, which includes a pump, two hand-held hoses and a backing gate washdown system.

Results – two farms

Thorneycroft

Savings

- Labour savings: Thorneycroft reduced the annual FDE volume from 26,176 m^3 to 10,470 m^3 of treated FDE, allowing irrigation runs for the travelling irrigator to be cut by 88 runs per annum
- At two hours per run and conservatively costing that at $20/hour (minimum wage) the saving is $3,520/year
- Pumping savings: reduced treated FDE to pump saves an estimated $2,619/year in electricity costs and pump maintenance
- Freshwater pumping: savings due to recycling water for washdown estimated at $136/year because of shallow water at Thorneycroft, but which can be up to $1,000/year in deeper well situations.

Costs

- Capital cost: the clarification tank, coagulant tank and controller plus a sump pump – $98,500 excluding GST
- Equipment cost: a clarified water-holding tank, an additional pump, electrical work and plumbing to alter the washdown systems, pads for the tank – total cost $75,000
- Operating cost: for the coagulant – for 800 cows milking 270 days the cost to treat effluent at $1.40/L coagulant will range from $15,200 to $18,900, depending on whether the system is treating all the FDE or just enough to produce recycled water for washdown (in Thorneycroft's case this $18,900)
- Extra electricity and pumping cost: $1,505/year for Thorneycroft.

While farmers have found annual savings for labour, electricity and freshwater, a major benefit they commonly report is the peace of mind gained from additional storage and scientifically proven improved environmental outcomes.

Table 1: Effects of clarification system on Thorneycroft effluent management and freshwater use

	NO EFFLUENT TREATMENT	WITH TREATMENT	% REDUCTION
Annual FDE volume*	26,176 m^3	10,470	60%
Travelling irrigator runs	146 runs/yr	58 runs/yr	60%
Travelling irrigator labour	292 hrs/yr	116 hrs/yr	60%
Annual yard freshwater use per yr**	26,611 m^3/yr	7870 m^3/yr	67%
Annual yard freshwater use per cow	105l/cow/day	35l/cow/day	67%
Effluent irrigation start date***	16 August	7 September	22d extension

**This is the volume of FDE requiring storage and irrigation to pasture*
***The difference in annual freshwater usage and FDE produced is due to rainfall and solids*
****DairyNZ Effluent Storage Calculator indication of when spring effluent irrigation can start with 90% probability of adequate storage*

Greenpark

Greenpark Dairy Farm is in the Selwyn district in the vicinity of Te Waihora Lake Ellesmere. The high water table in the area and heavy soils mean effluent storage requirements are high. Protection against P loss in this zone is a priority.

The farm milks 540 cows and produces an average of about 14,500 L FDE/day with cows milked once-a-day through the spring and autumn. Owner Tom Mason says that over the years, through different ownerships and growth phases, the infrastructure has been added to include an Enviro Saucer with 22 m^3 usable volume, and two Kliptanks with total holding capacity of 825 m^3. While that was adequate storage for consenting purposes he was increasingly concerned that a long, wet winter and spring period could delay the ability to spread effluent, particularly at the start of the season putting storage capacity and compliance in jeopardy.

The ability to cut FDE volume by 66% from 5,890 m^3 to 3,049 m^3, thereby significantly extending storage capacity from 40 to 116 milking days and delaying the need for irrigation of FDE, was a big drawcard. So too was the reduction in more readily lost P and *E. coli* given the farm's proximity to the lake and the extensive drainage systems in the area.

Remedial earth works including pads for storage tanks, a clarified water storage tank, plumbing to take the clarified water through the backing gate, a hand-held hose, the addition of a pump and electrician costs were all in addition to the capital cost of the system.

Savings

- Labour savings: reduced FDE has meant about 117 fewer irrigation runs of the travelling irrigator and 58 fewer days where the travelling irrigator is in use
- At two hours per run and $20/hour the labour savings equate to about $4,662/year
- Freshwater savings: use of the clarified water as recycled yard washdown water saves an estimated 2.885 million litres of water
- Pumping, electricity savings: reduced pumping of FDE – estimated at 79 hours/year.

Costs

- Greenpark Dairy Farm did not face the initial capital cost but has a monthly lease cost (this option is no longer available)
- Coagulant costs: the farm produces less FDE volume than a 540 cow farm milking twice-a-day because of the once-a-day system used in spring and autumn. A total of 6,375 L of coagulant is used each year and at $1.40/L the total annual cost is $8,925 over 270 days
- Remedial earth works, clarified water storage tank, plumbing and electricity, additional pump $25,000.

Conclusion

The clarification system has both an initial capital and annual operational costs. While farmers have found annual savings for labour, electricity and freshwater, a major benefit they commonly report is the peace of mind gained from additional storage and scientifically proven improved environmental outcomes.

Further reading

Cameron, Keith and Di, Hong. (Jan 2019). *Journal of Soils and Sediments*, doi.org/10.1007/s11368-018-02227-w

Anne Lee is an agricultural science writer based in Canterbury who has researched this article for Ravensdown Ltd. Email: anne.totarasprings@gmail.com J

PITA ALEXANDER

This profile looks at the life and career of Pita Alexander, NZIPIM member and Director of Alexanders, an agribusiness accountancy and advice firm based in Christchurch.

Early life and education

Pita, now 80, grew up in Dunedin and was the oldest of four children. The family soon moved to Rotorua and then Christchurch. His father had been through the Depression and was therefore ultra-conservative about finance. Despite their difficult economic circumstances, his mother ensured he stayed at school beyond 15 years. However, like many other boys at the time he had several paper delivery runs and was leasing land and growing potatoes at 14, all the while keeping up his schoolwork. Many of his school holidays were spent working at Island Hills Station, inland from Culverden, for his mother's cousin's family and this started his love of farming.

Out of school Pita gained the New Zealand Under 16 Table Tennis title in 1955 and the Canterbury High School Tennis title in 1958. Later (in 1961 and 1962) he was to go on to win the New Zealand Universities Table Tennis Singles title. However, after leaving Lincoln he decided to get serious about life and stopped playing both sports. He spent three years on seven farms around New Zealand and then did a Diploma of Agriculture and Diploma of Valuation and Farm Management at Lincoln College (now Lincoln University).

Over the last 48 years he has trained and employed 21 young accountants who are now out on their own or with a similar practice.

After leaving Lincoln at the end of 1963 he worked for the State Advances Corporation (later called the Rural Bank Limited) in Christchurch. His father was excited and said that one day he could perhaps be a District Appraiser – in his eyes a government job was close to the top of the tree.

During this period Pita was leasing land 1 km from home and growing potatoes. These were planted by hand and dug by hand – a total of 2 ha for three years. It was very hard work for him and one other person and they took 20 apple boxes each day into the Christchurch Market at 6am for many months. Around this time Pita and his brother Kipp also purchased two women's hairdressing salons. He says it was a natural fit as Kipp looked after the staff and he looked after the finances, one of these ventures being soundly profitable for 15 years.

Pita enjoyed his work but wanted to do a Bachelor of Commerce degree at Canterbury University part-time. The most senior boss at the State Advances Corporation head office in Wellington was against this move – he said that they had only had one Appraiser do a B. Com like this and he had left the Corporation after a year or so – his name was Wilson Whineray. But Pita persisted part-time and gained his degree in 1972.

Agricultural accounting

He then spent five years with Pyne Gould Guinness Limited in Christchurch in their Trust Department. The work involved trust accounting, estate planning, farm accounting and farm credit control. During this time he also completed a rural valuation qualification. It was here he found out how much he enjoyed working one-to-one with farming couples and made the decision that this was what he wanted to do for the rest of his working life.

Pita then went out on his own as a Specialist Farm Accountant in 1972 with the support of his wife Maureen, but at the time this was something of a business risk. He had financial reserves for about six months and spent the first year working from home in Christchurch. He spent from 1972 to 1975 financial trouble-shooting for banks, stock firms, insurance companies and several private parties. He found it to be a very valuable experience, but quite stressful and hard on the family. He worked on saving around 30% of net earnings from the 1972 start because he believed there were no inflation gains in an accountancy practice so any capital gains needed to be made outside of it.

Maureen's parents had eight small preserving jars in their kitchen above the sink – a separate jar each for rates, electricity, insurances, mortgage, food, clothing, car and unforeseen. Pita never forgot this – her father worked at the Railways and it was their approach to budgeting and it worked well.

Pita always wanted a family-sized practice and did not aspire to a big practice or large corporate business. His two children – Paul (a Chartered Accountant) and Jane (a Clinical Psychologist) – both worked in the practice in various roles for some years. Paul is still a Director. Pita feels he has always been lucky with the quality of his employees and work colleagues and has wanted them to do well in their lives.

Having started as a sole practitioner about 48 years ago he has therefore experienced the 'boom and bust' cycles of farming. He wants agribusinesses to succeed and is dedicated to the financial success of his clients. Many young farming accountants have benefited under his tutelage. Over the last 48 years he has trained and employed 21 young accountants who are now out on their own or with a similar practice.

Pita's contribution to farming has been recognised with several awards, including an ONZM honour in 2010.

There have been difficult times as well. Pita lost his personal share in three buildings in the 2011 Christchurch earthquake. One was 11 storeys and the other seven, but everyone in these buildings (500 approximately) walked out without injury. He found it a very stressful time, despite being well insured. This was also the year that Maureen sadly passed away. Like many others Pita also lost his house in the earthquake.

Business lessons learned

Pita says he is still getting a lot of job satisfaction in helping farming and business couples. Over the years he has learnt a number of lessons:

- Unrealistic expectations are a major impediment to progress. Historically low interest rates are just as bad as historically high interest rates – both mean top-class business capital decision-making is crucial
- Around 93% of a farm's maximum production is where the maximum profitability tends to be (the last 7% of production income is very often exceeded by the marginal costs, let alone any allowances for the extra management stress and strain)
- Regarding the allocation of capital cash resources – invest – do not just buy 'stuff'
- If you can't explain something on one sheet of A4 paper, then it is probably too complicated
- If you can, learn from other people's mistakes
- Some people will never listen and this just has to be accepted
- A good network is crucial for peer reviewing, another point of view and left-field thinking
- People with a good sense of humour are so much better to work with
- People can get over problems – Pita had a bad stutter at school, but lost this over time and now has empathy for this and late developers
- There is no halfway house when it comes to top advice – if you find your advisors difficult, it is probably because they are good advisors and stand up to you
- Look back from time to time to learn, but don't dwell on your past – your future is where you still have a chance to prove yourself.

Since 1972, Pita has had many opportunities to share these lessons. He has given numerous addresses at farming and business conferences, seminars and field days – 528 in New Zealand, 103 in Australia, two in the US and one in the UK.

Farm Study Tours

Pita is also fond of traveling and is well known for his Farm Study Tours. Over the last 12 years he has been to the US and Canada seven times, and enjoys driving in North America and talking to people generally, as well as farmers and bankers. These trips are extensive and can involve anywhere from 20,000 to 30,000 km of travel. He always takes farming clients and friends with him to share the driving, the experience and the learning. He has also driven around the outside of Australia three times with farming clients.

ONZM award

Pita's contribution to farming has been recognised with several awards, including an ONZM honour in 2010 and the Lincoln University Bledisloe Medal in 1990.

Fellowship award

Pita has also recently been awarded a Fellowship by Chartered Accountants Australia and New Zealand for outstanding career achievements and contributions to the profession.

Email: pita@alexanders.net.nz J

Working for the good of the Rural Profession

NZ Institute of Primary Industry Management

www.nzipim.co.nz