

National **SCIENCE** Challenges

OUR LAND AND WATER

.....
Toitū te Whenua,
Toiora te Wai



RESEARCH BOOK 2018
Our Land and Water

OUR LAND
AND WATER

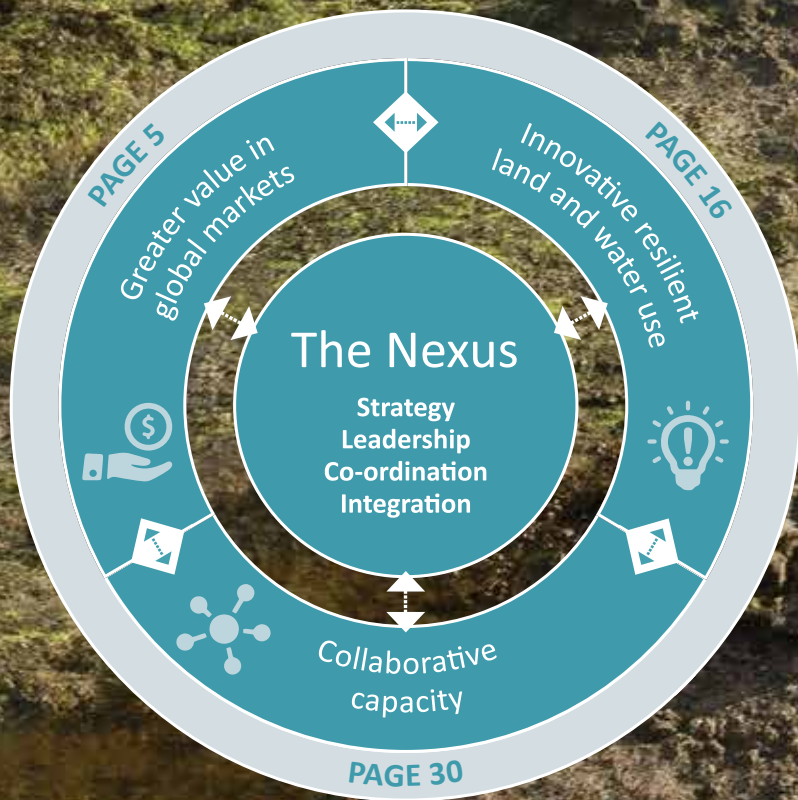
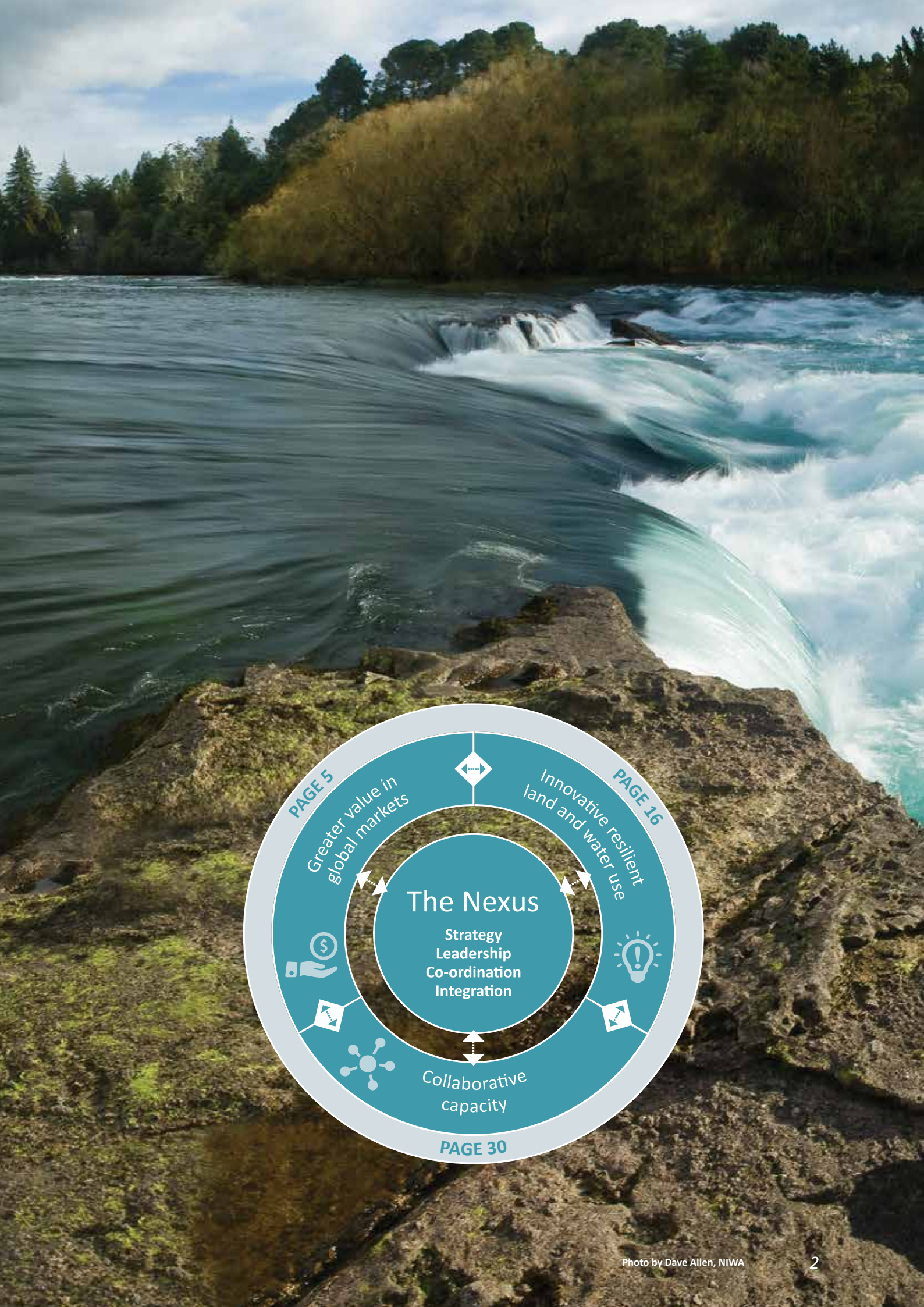
Toitū te Whenua, Toiora te Wai

- National Science Challenge has the aim of enhancing primary sector production and productivity while maintaining and improving our land and water quality for future generations.

The way we use and manage our land and water will be transformed by: deriving greater value in global markets; using land and water in innovative and resilient ways, and by building collaborative capacity. These drivers, along with research to connect them, form the three themes Challenge research addresses.

The Māori title is “Toitu te Whenua, Toiora te Wai”. Toitu te Whenua – let the permanence of land remain intact; Toiora te Wai – let water abound. The title is an adaption of the Māori proverb, “toitū te whenua, whatungarongaro te tangata” – land is permanent while people come and go.

Images within this research book have been provided by our Challenge parties



Our vision

New Zealand is world-renowned for integrated and successful land-based primary production systems, supported by healthy land and water and capable people.





Our mission

To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations, we will have delivered on the following aspirational impacts:

- ▶ The New Zealand primary sector will sustain higher economic growth through participation in global value chains that are generating new products, services and market segments that are aligned with and validated against stakeholder environmental, social and cultural values.
- ▶ New Zealand land users and regulators have a menu of tested technologies coupled with new innovative land use options and land and water use practices that achieve primary production growth targets within community and regulatory limits.
- ▶ Individual land and water users, communities, and iwi will have the social processes, data, tools and increased capacity to agree and implement co-developed solutions. These solutions will produce mutual benefits to meet their aspirations and achieve sustainable outcomes by operating within agreed resource limits.

Successful collaboration is at the heart of the Challenge. Only through collaboration will we create a New Zealand environment we can all be proud of. The Challenge involves science, innovators, producers and communities working together.

Co-innovation will increase the potential for the Challenge's research results to be adopted and implemented. Co-innovation in this Challenge means individual land managers, primary production sectors, iwi, communities, policymakers and scientists all working collectively to identify priority issues and create enduring solutions.



NZ earns approximately **\$37 billion** from primary sector exports, but these same products are sold in international markets for an estimated **\$250 billion**. That means that as a country we're only capturing about a **seventh of the value** of some of our nation's best produce.

"New Zealand has a culture, particularly in the pastoral sector, of being **low-cost, rather than high value**, and I don't think anything from New Zealand should be low-cost."

- Caroline Saunders, Lincoln University

The problem is that we've sold food for the last couple of hundred years without ever internalising the **environmental costs** of producing it, so we've convinced consumers that food is really cheap. Now suddenly, we're turning around and saying that those costs **must be paid.**"

- Mike Barton, Taupo Beef



Greater value in global markets

Integrating Value Chains 7

The Matrix 8

Credence attributes on-farm 9

Product Eutrophication Footprinting 10

Enabling transformation to a bioeconomy 11

Indicators working group 12

Trust and social licence 14



INTEGRATING VALUE CHAINS

Research began

January 2017

Challenge funding

\$1,700,000

Research theme

Greater value from global markets

Programme contact

Paul Dalziel,
Lincoln University

Since such a large share of New Zealand agri-food production is exported it is essential for the primary sector's prospects to understand how value chains can share value and incentivise land use practices.

Value chain thinking is grounded in the concept that the final customer is the final arbiter of value and so everything firms do along a value chain from producer to retailer should aim to add value to the consumer's experience. A market oriented value chain can be conceptualised as the pursuit of a common vision, based on trust and collaboration, aligning strategies, structures and processes on what the consumer values, throughout the entire value chain system, with a focus on creating value.

This research is investigating how value chains better share value (economic, environmental, social and cultural) from consumer to producer and incentivise land use practices that relieve tensions between national and international drivers.

This research is testing whether our "world-renowned" reputation will allow New Zealand producers and processors to capture higher returns for their agri-food exports.

The research is being supervised by an Advisory Board of representatives from at least eight end-users of the research. You can stay updated with the results of this programme on AERU's Interactive Dashboard accessible at www.lincoln.ac.nz/aeru/mer.



THE MATRIX

Research began

May 2016

Challenge funding

\$250,000

Research theme

Greater value from global markets

Programme contact

Tim Driver,
Lincoln University

This research developed an overview of international and domestic drivers and issues that are of relevance to the New Zealand primary sector. The knowledge is built into a priorities matrix to assist the Challenge in targeting investment into areas of highest potential impact. Areas of impact relate to a hierarchy of national and international issues.

The Matrix is a document that includes the use of a total of 650 unique sources of information (494 international and 156 domestic) of academic, industry/sector, regulatory and legislative origin. This work examines solutions where international consumption drivers align with domestic drivers that relate to land use change and practice. Analysis of more than 30 drivers for Asia, US and Europe highlighted key differences compared with New Zealand.

Domestically, environmental drivers were found to be the most likely to affect land use change and practice, with social drivers considered to have the least likely effect. Biosecurity, soil quality, water use and quality were the most important domestic environmental drivers, along with agricultural and trade policy.

Internationally, agricultural and trade policy were considered important drivers, especially from the US and Europe. Key environmental drivers included water quality and quantity, air quality, biosecurity and biodiversity, chemical residues, sustainable supply and pasture-based production methods. The research found that the likelihood of these various international environmental drivers affecting land use practice and change in New Zealand varied between regions.

This work has provided a foundational understanding of international and national drivers and issues and their importance to the primary sector. These foundations will change where investment is made in primary sector research related to economic growth, social, cultural and environmental interactions.



CREDESCENCE ATTRIBUTES ON-FARM

Research began

July 2017

Challenge funding

\$350,000

Research theme

Greater value from global markets

Programme contact

Gina Lucci,
AgResearch

One approach to increase the profitability of land use is to capture more value by aligning production systems to deliver valued credence attributes that consumers have demonstrated a willingness to pay for.

Credence attributes are aspects of consumer products that are not explicit at the point of purchase, such as food safety, environmental stewardship, animal welfare and cultural authenticity. If these values can be realised and shared among the members of the value chain, this can motivate changes in land use and/or land management to deliver the credence attributes.

This research investigates what practical changes delivering credence attributes will require on the ground, what it will cost, the effect it will have on production and the impact it will have on the environment.

Findings will estimate the extent to which recognised attributes will benefit the environment and therefore inform policy. It may also expose the need to develop new attributes that deliver to both increasing value and sustainability.

This project delivers a framework for assessing the economic and environmental impacts of delivering specific credence attributes that will incentivise sustainable and profitable land use.



PRODUCT EUTROPHICATION FOOTPRINTING

Research began

January 2017

Challenge funding

\$215,500

Research theme

Greater value from global markets

Programme contact

Stewart Ledgard,
AgResearch

The European Commission may head towards a requirement for all products supplied to Europe including data about their environmental footprint. It is therefore important that we understand how New Zealand agricultural products rate relative to other countries, how relevant other countries methods are to ours, what the hotspots for water quality might be and how can we reduce the footprint.

The research team undertaking this work were already involved in preliminary testing of the European Product Environmental Footprinting programme for dairy and red meat products from New Zealand. This testing highlighted issues relating to water quality indicators for eutrophication and the need to understand their use and relevance.

Eutrophication is the excessive richness of nutrients in water bodies, frequently due to run-off from the land, which can cause undesirable growths of plant life, including slimes and water weeds.

Scientists are working with international researchers on this project to develop eutrophication indicators for product value chains that are relevant to

New Zealand and compliant with the future update of the European Product Environmental Footprinting methodology. A stakeholder support document for future application of this method in New Zealand will also be created to ensure the transfer of these indicators and their application to local stakeholders for benchmarking or eco-design of local primary products.

The research uses New Zealand case study products (meat exported to Europe) produced in major catchments (e.g. Lake Taupo, Waikato River) to understand water quality hotspots and opportunities to illustrate the benefits of New Zealand products marketed globally. Rather than being considered as a regulatory constraint, environmental footprint reporting can potentially be used to access markets and enhance product returns.

ENABLING TRANSFORMATION TO A BIOECONOMY

Research began

March 2017

Challenge funding

\$70,000

Research theme

Greater value from global markets

Programme contact

Anita Wreford,
SCION

This think-piece explored the potential value of a rural bioeconomy - what it could look like and the potential to position New Zealand's primary sector to become a major player in the global bioeconomy.

The 2009 OECD call for a global transition towards a bioeconomy has resulted in a number of nations adopting national or regional strategies to develop their bioeconomy. New Zealand's large biological resource base and a well-established cultural heritage in farm production, especially a global dominance in livestock production, should make it well-positioned for bioeconomy-based wealth creation. However, ecological and societal limits require the current economic farming model to be re-evaluated. Using a transformation lens, in conjunction with a bioeconomy framework, this research investigated what is required for New Zealand to transform into a fully functioning bioeconomy.

The development of the bioeconomy provides significant economic opportunities as well as the potential to address many of the environmental challenges facing New Zealand. These challenges include the depletion of natural resources and the negative impacts of environmental pressures, such as climate change.

At the same time it can create a myriad of economic opportunities through the science, design and development of production and processing facilities and entirely new integrated and resilient industries.

This research identified several critical elements of a bioeconomy that are either not fully developed in New Zealand or are clearly lacking, most notably finance, governance and the need for public engagement in policy. Conclusions from the research note that to enable New Zealand to realise the potential opportunity the bioeconomy offers, a more integrated and cohesive primary sector model is required. This model will need to go beyond tweaking the existing (livestock and primary-based) regime towards supporting and developing new niche production sectors, based on a clear vision jointly conceived with wider society.



Photo by SCION

INDICATORS WORKING GROUP

Research began

April 2017

Challenge funding

\$200,000

Research theme

Greater value from global markets

Programme contact

Bill Kaye-Blake,
PricewaterhouseCoopers

This programme of work is helping the primary sectors predict and deliver indicators that are relevant to, and could influence land use practice. The New Zealand public sector has international national and local reporting obligations, many with overlapping information needs, generating a multitude of indices, metrics and indicators. This work facilitates and seeks to harmonise the measures required to meet these obligations.

This working group assembles and synthesises material to act as a central source of indicator information. In doing so it provides direction and insight for both internal Challenge audiences and external stakeholders. All current information on indicators from this group is available on the Challenge website.

Outputs of this work include primary research on minimum thresholds of community resilience, to be delivered to the TempAg international research network. This working group will also analyse the appropriate indicators for the United Nations Sustainable Development Goals and potential pathways for achieving these goals.



TRUST AND SOCIAL LICENCE

Research began

July 2017

Challenge funding

\$110,000

Research theme

Greater value from global markets

Programme contact

Peter Edwards,
SCION


This research examined trust between government, industry, community and media and its effect on communities' acceptance of resource-based activities. Increasing societal expectations and awareness have meant the primary sector has never before been so intensively scrutinised by the public. Across agriculture, forestry and fishing, resource development is becoming increasingly intensified, facing domestic and international pressures.

Social licence to operate has become an increasingly important issue. Without a social licence to operate, litigation, direct and indirect conflict and regulation generated through a loss of confidence may reduce competitiveness, hinder expansion and, in some cases, lead to closure for companies.

Understanding the value of building trust is of particular importance in the post-truth era, which is characterised by populist appeals to emotion and the proliferation of information and mis-information. Post-truth is understood to significantly damage the foundations of trust that is required in a healthy society.

Therefore, social licence across the primary sector has become critically important to the future competitiveness of New Zealand's primary sector, particularly its ability to implement transformational innovation.

The project delivered insights into how and why communities trust (or distrust) primary sector resource developments, and this can be used by the industry to review their practices and work towards building trust with communities where needed. This research provides a foundation for further work on building new approaches to developing and maintaining social licence.



"Land might be capable of having an activity on it, but is it suitable?
If we put the right kind of land uses in the most suitable country, that will
minimise our footprint."

- Robyn Dynes, AgResearch

"People are beginning to realise that the **technology is robust**,
and that the support's there to **help people work** through the process.
Because data is fine, but you need to know how to turn it into **good decisions**
that are **financially and environmentally sustainable**,
which go hand in hand they're not exclusive."

- Craigie Mackenzie, Greenvale Pastures

When you **build the health of your landscape**, suddenly all these good things
happen; the waterways clear up, you get pollination, your stock have shelter, they're healthier, so you're spending
less on inputs. You can build a system which is **less risky, more resilient**, and still
returns **higher productivity** per input. And it secures **environmental gains**."

- Chris Perley, University of Otago

"We often hear about our top farmers who are optimising their production, but there's a step beyond optimising
for production, to **optimising for the environment** they're in."

- Robyn Dynes, AgResearch



Innovative and resilient land and water use

Sources and Flows	17
Land-use Suitability	18
Next Generation Systems	19
Assessing the yield and load of contaminants with stream order	20
Interoperable Modelling	21
Innovative Agricultural Microbiomes	22
Faecal source tracking	23
Cascade of soil erosion to river sediment	24
Physiographic Environments of New Zealand (PENZ)	26
Benign denitrification in groundwaters	26
Measuring Groundwater Denitrification	27

SOURCES AND FLOWS

Research began

October 2016

Challenge funding

\$3,150,000

Research theme

Innovative and resilient land and water use

Programme contact

Diana Selbie,
AgResearch and
MS Srinivasan, NIWA



Photo by Dave Allen, NIWA

We already know that on average 55% of nutrients lost from productive land uses in New Zealand are transferred as they make their way through catchments to the sea. But the proportions of these nutrients that are converted or immobilised vary widely across and between landscapes. Different soils, landscapes and water pathways vary at a range of scales in their ability to produce, transfer and reduce contaminants. This affects the land's suitability for different types and intensities of land uses.

Limits being set on land uses by regulators to safeguard the life-supporting capacity of fresh waters and the associated health of people and communities need to take into account the differences in attenuation between contaminant sources, and sites where water quality objectives are set. With appropriate knowledge, productive enterprises will have the opportunity to adapt and tailor their land use and management practices to work within the attenuation capacity of their landscape.

This research is evaluating a range of tactical and strategic mitigation measures to reduce mobilisation and transport and increase attenuation efficiency. Working alongside the Land Use Suitability programme this research maps landscape risk factors to the risks to the receiving water, this means land users can manage the risks their investment poses to desired catchment values and dynamic sensitivities.

The outcomes of this programme will support more informed decision-making on investment in land use activities. Land managers and regulators will be able to identify the inherent risks of generating unacceptable environment pressures from particular land uses in a range of landscapes. This research will allow land managers and regulators to identify the critical contaminants that will result in environmental impact from specific land uses and locations, as well as acceptable limits of discharge, to enable the most cost-effective and appropriate levels of mitigation for their enterprise. At a larger catchment scale, this work identifies contaminants have potential headroom to allow for increased production within environmental constraints, opportunities to improve environmental outcomes in the context of current agricultural investment, or where catchment re-design utilising low environmental footprint land use options are required.

In practice, the research outcomes will allow land managers to have increased the profitability and yield of productive land uses within the allowable limits by using the tools developed to understand the "off-farm" environmental risks associated with a specific area of land. These tools can also be used to guide investment decisions on the appropriate mix of land use and management practices, and mitigation options to achieve the desired outcomes for the catchment.



Photo by Dave Allen, NIWA

LAND-USE SUITABILITY

Research began

June 2016

Challenge funding

\$2,750,000

Research theme

Innovative and resilient land and water use

Programme contact

Scott Larned,
NIWA

The need for simultaneous improvements in primary sector productivity and in environmental performance are driving changes in land and water policy and management in New Zealand. These changes have been encapsulated in the phrase “managing within limits”. Managing within limits refers to managing resource use for sustainable production, without exceeding limits such as water takes and contaminant discharges. Implementing these changes will require a shift from the traditional focus on land-use

capability for production, to a broader view that accounts for land-use effects on economic, environmental, social and cultural values at whole-catchment scales. We call this broader view ‘land-use suitability’.

Land Use Suitability tools intend to contribute to two important functions in the government and primary sectors - land-use effects management and land evaluation. Land-use effects management is a function of central and local government, and is strongly influenced by regional and catchment plans that set out policies and rules needed to regulate contaminant discharges and deliver on land use-dependent objectives. In contrast, land evaluation refers to assessments of land parcels in terms of their potential for specific land uses. Land evaluations are undertaken by a range of stakeholders with interests in the profitability of use of land parcels including: land owners, investors, banks and rural professionals.

The research combines information from three processes: contaminant losses from land-use, responses of receiving environments to contaminant

loading and the use of intervention systems to increase receiving environment resilience. A distinguishing characteristic of this concept is feedback from receiving environments to upstream land parcels that are contaminant sources. The feedback includes the economic, environmental, social and cultural values present in receiving environments, the contaminants to which those values are vulnerable and physical conditions in the receiving environment.

The first tools developed in this programme take the form of a classification system based on national-scale environmental datasets and the primary use of the Land Use Suitability classification will be as a screening tool. The first application of Land Use Suitability is being referred to as, Productivity within Environmental Constraints (PEC). A prototype GIS-based tool for analysing land-water systems in terms of three PEC indicators is currently in development.



NEXT GENERATION SYSTEMS

Research began

July 2016

Challenge funding

\$2,000,000

Research theme

Innovative and resilient
land and water use

Programme contact

Robyn Dynes,
AgResearch

Primary production industries are constantly changing in response to external factors like new market opportunities, consumer demands, technological innovation and changing community expectations of social and environmental outcomes associated with the primary sector. These external forces for change are likely to intensify over the next 10 years.

Next generation land-based primary production systems will be critical to enable primary producers to double the value of New Zealand export returns while improving environmental performance. These systems may consist of one or more different land uses within a business enterprise or catchment. Land managers will need new land use options and new ways to select and configure their enterprise mix to simultaneously meet their business goals, those of the catchment and international markets.

This programme partners with innovative businesses undertaking transformational change to their systems. This programme provides a framework to enable critical assessment of transformational land use systems and use science from across the Challenge to address barriers to adoption of new systems.

This research identifies barriers to next generation systems evaluation and adoption which require investment in research.

This research team has developed a framework to identify and evaluate the transformational “next generation” farming systems that will be needed to increase value and environmental performance from New Zealand’s primary sector. This research lets us compare the strengths, weaknesses and suitability (at landowner level) of alternatives to current primary production systems. It can also determine the likelihood of uptake based on multiple factors that influence land use decisions. Adoption of next generation systems will depend on land-owners’ goals and objectives, and factors like spatial variation in climate and topography, regulatory pressures and localised opportunities.



ASSESSING THE YIELD AND LOAD OF CONTAMINANTS WITH STREAM ORDER

Research began

January 2017

Challenge funding

\$50,000

Research theme

Innovative and resilient
land and water use

Programme contact

Richard McDowell,
AgResearch

This research programme set out to determine the load (kg/yr) of catchment contaminants that come from large or small streams, and if excluding livestock from large streams (> 1-m wide, >30-cm deep) in flat catchments used for pastoral grazing would substantially decrease the load of catchment contaminants. Results from this research showed that contaminants from small streams catchments dominated by agriculture contribute significantly to the load of freshwater contaminants.

A decade of concentration and flow data (1998-2009) were used to calculate catchment load and yields (load per catchment area) of nitrogen and phosphorus, suspended sediment and *Escherichia coli* at 728 water quality monitoring sites. These data were combined with catchment characteristics (e.g., climate, topography, geology, land cover) and stream order (relative stream size) in statistical models to aid in the prediction of mean annual loads and yields across New Zealand. On average, the yields of all contaminants increased with increasing stream order in catchments dominated by agriculture. Loads from low-order small streams (< 1-m wide, <30-cm deep), in flat

catchments dominated by pasture accounted for an average of 77% of the national load across all contaminants.

These data suggest that fencing of larger streams will likely affect, on average, 23% of the national contaminant load, and for further reduction, additional mitigations should be implemented to reduce the amount of contaminants entering small streams. This work is being used by local government to determine policy to improve the quality of freshwater. For example, Taranaki Regional Council has committed to fencing more streams than those covered by central government's recently proposed stock exclusion regulations.



INTEROPERABLE MODELLING

Research began

February 2017

Challenge funding

\$900,000

Research theme

Innovative and resilient
land and water use

Programme contact

Sandy Elliot,
NIWA

This programme aims to develop a modelling system populated with models which draws on national datasets and is implemented in an interoperable modelling framework. This modelling system will be used nationally for integrated and spatial assessment of economic, production and environmental implications of land use and land use change. Uses of the system will include assessment and accounting of productivity potential and water quality contaminant dynamics at farm and catchment scales.

The overall programme will focus on fully implementing and demonstrating the initial set of models and data within the framework. The outcome of this programme will see a range of modelling groups have collaboratively defined a fit-for-purpose set of models and associated data sources, with a clear approved path for implementation and commitment by co-funders to implement the models and provide resources. Programme success will see a set of integrated models having been set up within an interoperable modelling system with stakeholders engaged with the development and use of the system to meet collective land and water management objectives.

Technical and governance groups have been formed for this research programme. The technical group have completed a technical workshop to inform framework selection and the Governance group have narrowed objectives and discussed funding arrangements.

The workshop to evaluate and select a framework also identified the necessary data sources and model functionalities that will need to be incorporated into the project. Existing models that demonstrate each the required functionalities have been identified and evaluated to determine which of these should be prioritised for inclusion in the programme. This team have now made a choice of framework and are putting a work plan in place.



INNOVATIVE AGRICULTURAL MICROBIOMES

Research began

July 2017

Challenge funding

\$1,800,000

Research theme

Innovative and resilient land and water use

Programme contact

Graeme Attwood,
AgResearch

Microbiomes are the microbes in a community and/or the full collection of genes of all the microbes in a community. Microbiomes involved in agricultural processes are linked by geochemical cycles, which are the pathways that chemical elements take in the surface of the earth.

In New Zealand dairy production systems pasture and animal productivity are strongly influenced by various inputs to the nitrogen cycle. These include atmospheric nitrogen fixed by legumes, recycled dairy cow effluent and the addition of nitrogenous

fertilisers. Each of these nitrogen sources are made available through the action of microbes; via nitrogen-fixing bacteria associated with plants, protein-, peptide-, and amino acid-degrading bacteria in the rumen and by ammonifying and nitrifying bacteria in the soil. The key to productive and sustainable dairy farming is the balanced and efficient use of these nitrogen sources and an understanding of the contribution of these microbiomes is likely to realise significant additional gains in soil, plant, and animal productivity as well as a reduced environmental footprint.

This programme tests whether efficient use of nitrogen in a ryegrass/white clover dairy production system is controlled by the composition, activity and interaction between soil, plant and animal microbiomes that mediate nitrogen transactions in these environments.

This research will provide a better understanding of microbiome structure and environmental function, and the implications for farm system productivity and sustainability. The novel meta-microbiome approach in this research including the data generated and the analysis

procedures developed will underpin future research in the area.

To our knowledge, this research will be the first time multiple microbiome structures and activities have been defined in a dairy farm. The outcome of this programme will provide the microbial community profiles of the microbes present in each of the 10 microbiomes analysed from matched samples sourced from animals, plants and soils which make up a dairy grazing system. This work is using agricultural microbiome information to develop new technologies to drive greater agricultural productivity and reduced environmental impacts. An anticipated output from these microbiome data will be marker genes that are correlated with productivity and/or sustainable practices that will provide supporting evidence for product verification schemes to show that New Zealand's pastoral farming systems are natural and sustainable.

FAECAL SOURCE TRACKING

Research began

July 2017

Challenge funding

\$250,000

Research theme

Innovative and resilient
land and water use

Programme contact

Adrian Cookson,
AgResearch



Escherichia coli naturally occur in the gastro-intestinal tract of warm-blooded animals, and worldwide it remains the preferred indicator of faecal contamination for water quality monitoring. However, recent studies have demonstrated that non-pathogenic *E.coli* may survive and grow in soil and water. This research tests if these naturalised non-pathogenic *E.coli* in soil and water contribute to the failure of waterways to meet water quality standards in the absence of faecal contamination.

This research identifies the potential sources of faecal contamination impacting waterways to ensure appropriate and targeted mitigation steps are implemented for appropriate land use and to reduce stakeholder risk. The research identifies sample sites is co-developed with regional authorities and Iwi, who together define protocols

for sampling and undertake research. The programme uses high throughput sequencing methods to identify the potential sources of faecal contamination impacting waterways and the co-development of tools for assessing land-use suitability.

This research team is busy undertaking sampling visits in several regions across the country alongside communities engaging with local organisations, Iwi and kura along the way. More than eight sampling visits have now been undertaken resulting in 106 samples from a variety of sources (water, sediment, soil, biofilm and faecal) and 324 bacterial isolates.

This programme will address faecal source tracking over current routine culture methods and provide benefits for regional authorities through more robust risk assessments and targeted mitigation strategies. This research aims to provide significant improvements to water quality standards that benefit Tangata

Whenua and address human health and recreational values.

The success of this programme will be measured through an increased participation of regional councils in the co-development of research strategies and tools for assessing land-use suitability. With the co-development of a shared vision this work provides Iwi and local communities with an increased sense of shared ownership, participation and empowerment in land and water use decisions. By identifying and partnering with local Iwi having mana whenua with waterways and sample sites, this work provides a robust timetable for providing increased social capital amongst catchment communities that have a cultural and historic attachment to our target waterways. The research will also contribute to the evidence base required to ensure New Zealand's water quality standards for "swimmability" are appropriately protective of human health.

CASCADE OF SOIL EROSION TO RIVER SEDIMENT

Research began

January 2017

Challenge funding

\$400,000

Research theme

Innovative and resilient
land and water use

Programme contact

John Dymond,
Manaaki Whenua



Photo by Dave Allen, NIWA

Soil erosion and sediment in rivers are major environmental problems. Tools are required to enable land managers and water users, communities and iwi to set water quality targets associated with sediment. Current catchment models of soil erosion and sedimentation relate land use management to sediment in rivers through long-term mean annual loads. If soil conservation is implemented or land is afforested, then sediment loads will reduce by a known amount. However, the impact of sediment loads on freshwater sediment attributes which affect freshwater ecology directly is not fully understood. These are attributes such as: water clarity, embeddedness and euphotic depth (the layer closer to the surface that receives enough light for photosynthesis to occur).

It is necessary to understand and quantify how sediment concentration relates to river flows. Primary sources of sediment and intermediate stores need to be identified spatially, and transport from them modelled on a daily basis. This research tests if it's possible to develop physically based equations of soil erosion and sediment transport at the landscape scale.

An event-based sediment model is being used by this project team to show maximum discharges relationship with sediment concentration. The event-based sediment model incorporates maximum discharge into the SedNetNZ model (which predicts land management effects on erosion and sediment yield)

as a first attempt at an event based model for understanding sediment movement through a river catchment in a single storm event. The model will now be developed to further constrain the areas activated during a storm event using rainfall radar information as well as obtaining direct measurements from small successive tributaries during storm events.

The models developed in this programme will enable regional councils and central government to evaluate the impact of land-use change and management on sediment yield of catchments, and to plan soil conservation work at multiple scales. The models will also assist in reducing the estimated \$120 million per annum expenditure needed to deal with erosion/sediment issues. Most importantly, these models will enable users to explicitly evaluate the impact of sediment yields on freshwater sediment attributes.

The models will contribute to the ability of users to link land use with receiving waters and provide a greater range of tools to evaluate land-use suitability. This enables better matching of land use with the productive, environmental, social and cultural values of land and water resources.



PHYSIOGRAPHIC ENVIRONMENTS OF NEW ZEALAND (PENZ)

Research began

July 2017

Challenge funding

\$100,000

Research theme

Innovative and resilient land and water use

Programme contact

Clint Rissman,
e3Scientific

The physiographic approach seeks to explain 'how' and 'why' shallow groundwater and surface water quality varies across different landscapes, even when there are similar land uses or pressures in a catchment. Understanding the environmental attributes that drive variations in water quality outcomes and risk is critical for targeting implementation of water quality management strategies and hence the environmental sustainability of primary production across New Zealand.

This project provides a map that explains these drivers of water quality across the whole of New Zealand. The development of physiographic environments involves identifying the relevant

environmental attributes controlling spatial variance in water quality signals; extraction, integration and remapping of the key attributes from pre-existing spatial frameworks, and classifying attribute layers using water quality data. The result of this work will provide a national scale spatial layer, or physiographic layer for aligned use with the Land Use Suitability and Sources and Flows work programmes.

The collaborative partnership commitments in this project from across the country (including Regional Councils) continues to grow. A successful bid in the Sustainable Farming Fund has now extended this project into the farm extension space.

BENIGN DENITRIFICATION IN GROUNDWATERS

Research began

January 2017

Challenge funding

\$170,000

Research theme

Innovative and resilient land and water use

Programme contact

Ranvir Singh,
Massey University

This programme research assesses the transport and transformation of leached nitrogen from farms to river via shallow groundwater in the Manawatu and Rangitikei river catchments. This work aims to create a rapid and cost effective technique to measure and map complete benign subsurface denitrification hotspots in New Zealand agricultural catchments.

The impact of nitrate leaching from agricultural soils strongly depends on its transport and potential attenuation reduction in flow pathways to receiving water bodies. Denitrification – a microbial mediated process - is being considered as a potential

nitrate attenuation process in groundwaters, reducing impacts of leached nitrate from farms to surface waters. Subsurface denitrification is important and provides a beneficial ecosystem service but if it is incomplete could result in the release of nitrous oxide (a harmful greenhouse gas) rather than dinitrogen (an inert and harmless gas making up 78% of the atmosphere). This team of researchers is investigating and developing a cost-effective and practical technique to accurately assess denitrification processes and their end-products (nitrous oxide and/or dinitrogen) in shallow groundwaters.

MEASURING GROUNDWATER DENITRIFICATION

Research began

January 2017

Challenge funding

\$230,900

Research theme

Innovative and resilient
land and water use

Programme contact

Uwe Morgensten,
GNS Science

Nitrate is the most pervasive groundwater contaminant with around 40% of long-term groundwater monitoring sites showing above-natural concentrations. Denitrification is a natural process that is mediated by microorganisms by which dissolved nitrate is reduced eventually to nitrogen gas.

This process has potential for significant reductions in nitrate loads within groundwater systems, and therefore to reduce the nitrogen loads into receiving water bodies such as groundwater-fed streams, springs and lakes.

No quantitative and direct measurement technique for measuring the extent of this denitrification process is currently available in New Zealand.

This research programme has developed and validated a methodology for measuring dissolved neon. The concentration of excess nitrogen can now be derived, allowing for the extent of denitrification in groundwater systems to be quantified.





"All people can relate to the idea of a **sustainable model**
and connecting better with the **source of their food**"

- Merata Kawharu, University of Otago

"**Naku te rourou nau te rourou ka ora ai te iwi**

- With your basket and my basket the people will live"

- Maori proverb





Collaborative Capacity

Collaboration Lab	31
Mauri Whenua Ora	32
Communicating Kaitiakitanga	33
Toitu te Whenua, Toitu te Kōira, Toitu te Tikanga - Whenua, Life, Values!	33

COLLABORATION LAB

Research began

November 2016

Challenge funding

\$1,500,000

Research theme

Collaborative Capacity

Programme contact

Melissa Robson-Williams,
Manaaki Whenua

The value of collaboration has begun to be recognised in New Zealand. Social science research over the past twenty years has emphasised the importance of collaboration for achieving successful outcomes in complex systems. However, there are still gaps in our understanding; there is insufficient long-term evaluation of collaborative approaches, there is a scarcity of studies on how researchers undertake interdisciplinary research, translating concepts of collaboration into practice has proven very difficult and there is a lack of important information about Māori participation in collaborative processes.

In New Zealand, adversarial processes have dominated natural resource decision-making processes, leading to stalemate and inaction. The magnitude and complexity of the challenges in New Zealand's land and water sectors require science and society to work in



completely new ways, requiring new models of engagement and science-society interaction. One of these new ways of working is collaboration. The research in the Collaboration Lab programme will help to address the gaps mentioned above.

Three projects within this programme of work are together building an enhanced understanding of collaborative practice, weaving together centuries of focused practice in Māori tikanga and the leading innovative edge of current collaborative practice from multiple fields to form new mātauranga, or practical wisdom. This research aims to improve collaborative practice, improve knowledge around the impacts of collaboration and identify the characteristics of effective interdisciplinary research. A model for supporting collaborative dialogue is currently being trialled with practitioners and groups have now established to test Māori models of collaboration.

A provisional model of key variables in collaborative practice is also being developed by this research team.

The overall outcomes of the Collaboration Lab are that collaboration practitioners such as facilitators, farmers, iwi and scientists will be more effective at participating and leading collaborations. This research will also support decision-makers make more informed decisions relating to collaborative processes, and reinforce that interdisciplinary research has enhanced impact at addressing problems of land and water management.

MAURI WHENUA ORA

Research began

July 2016

Challenge funding

\$2,000,000

Research theme

Collaborative Capacity

Programme contact

Merata Kawharu,
Otago University

This project is about unlocking the potential of Māori land by advancing new production systems and market opportunities, and translating the learning from this to other regions.

The greater context for this work sees many kin groups facing unprecedented phases of economic development through Treaty claim settlements and new entrepreneurial ventures. Treaty claims are major issues for Taitokerau land claimants who are on the cusp, or have just reached settlement. But kin communities today are no longer simply 'local'; they are resident worldwide and are not necessarily attached to, or involved in their lands.

Meaningful developments within the primary sector require us to address these complex social realities and balance them with economic and environmental issues.

Māori agribusiness is highly complex and requires collective thinking guided by communities themselves. An underpinning question facing communities is: what is the right land optimisation for our people now so that they can set in place the right kind of legacy for their descendants? This research is investigating this question through collaborative social and environmental science and community expertise.

At its heart, this programme responds directly to Vision Mātauranga to the fullest extent possible while delivering three key research outcomes. The research has outcomes which include the development of a shared, multi-iwi led innovation which results in enterprise owners and descendant communities being better positioned to lead and operate land innovation within environmental, cultural and economic parameters.

A comprehensive economic platform will be created which results in regional Māori representative groups being able to progress their own land schemes and develop improved decision-making with the aid of new science and tools. Another key outcome is a socio-cultural indigenous micro economy concept 'Pā to Plate' (enterprise to descendant consumer study), resulting in a new micro-economy model being developed that captures the optimal land qualities and community values, including cultural and economic wellbeing.

Close to 100 per cent of survey respondents in the initial research stages of the micro economy concept have suggested they would like to purchase produce from an initiative like 'Pā to Plate'. The results also showed that many were willing to pay more for it or add a koha to the asking price. Next steps will include finding a low-cost distribution model.

Each focus area is uncovering specific environmental, economic and cultural value points to advance productivity from land use that optimises productive earnings with cultural and societal needs. This is collectively contributing towards developing a broader Taitokerau land and people advancement and wellbeing strategy.



Photo by Dave Allen, NIWA

COMMUNICATING KAITIAKITANGA

Research began

December 2017

Challenge funding

\$248,190

Research theme

Collaborative Capacity

Programme contact

Jo Smith,
Victoria University

Kaitiakitanga values of guardianship and responsibility can make a crucial contribution to New Zealand's agriculture and food sectors. We currently face global ecological, political and economic challenges that intersect with an emerging post-Treaty era Māori economy within a persisting colonial present. The Māori agricultural sector is a crucial site for developing future-focused solutions that are productive economically, while also ensuring that future generations can benefit from the natural resources underpinning agriculture.

A key outcome of this research is to imagine ways Māori science (kaitiakitanga tools) on the ground could innovate the Māori agribusiness sector,

which itself provides productive and successful models for balancing economic, cultural and environmental outcomes.

This project explores a "ki utu ki tai" (a whole of landscape) epistemological standpoint that assumes kaitiakitanga as a guiding norm to develop a theoretical framework for thinking about agricultural productivity differently. Focusing on one specific outcome of agricultural practices – the production and consumption of food – this research seeks to tell a Māori land, food and water story that challenges existing assumptions about supply chains beginning with producers and ending with consumers.

TOITU TE WHENUA, TOITU TE KOIRA, TOITU TE TIKANGA - WHENUA, LIFE, VALUES!

Research began

December 2017

Challenge funding

\$249,931

Research theme

Collaborative Capacity

Programme contact

John Reid,
University of Canterbury

This project will develop an indicator suite to measure and represent (using infographics) the opportunities and constraints Māori agribusinesses experience between competing market, legislative, cultural, and social drivers.

The final output will be an online tool that enables Māori agribusinesses to gather data against indicators relevant to them and generate an infographic report that makes explicit the trade-offs and synergies.

This will assist Māori agribusiness in embedding strategic decisions within a kaupapa Māori framework that optimises economic, social, and environmental outcomes.

This proposal is a collaboration involving senior investigators of Ngā Pae o te Māramatanga.

The project will provide a 'snapshot' of Māori agribusiness in New Zealand, or more particularly the current constraints their operations are faced with, and the opportunities that are available to support their growth.

This work will create and offer Māori agribusiness novel infographics for analysing and communicating the tensions and synergies within their operations. This project will provide Māori agribusinesses with mechanisms for measuring tensions and synergies between different opportunities, drivers and pressures.



Challenge Parties



Photos above by Dave Allen, NIWA

Contact Us
E: ourlandandwater@agresearch.co.nz

Learn More
W: www.ourlandandwater.co.nz



twitter.com/OurLandandWater
facebook.com/Our-Land-and-Water