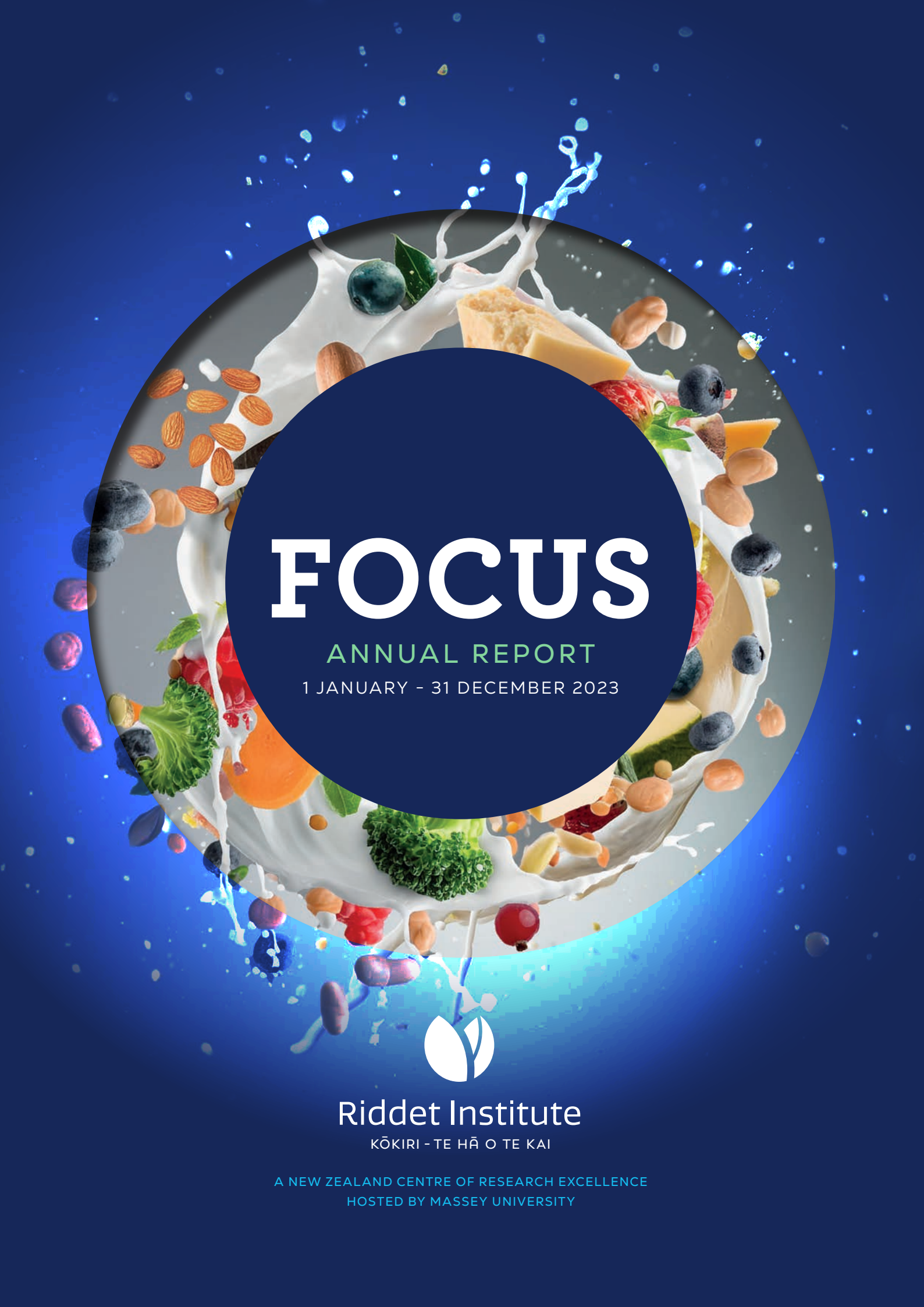


FOCUS

ANNUAL REPORT

1 JANUARY - 31 DECEMBER 2023

Riddet Institute

KŌKIRI - TE HĀ O TE KAI

A NEW ZEALAND CENTRE OF RESEARCH EXCELLENCE
HOSTED BY MASSEY UNIVERSITY

Our core values

The Riddet Institute operates under a set of core values:

Strive for excellence in all activities and endeavours.

Operate ethically and with integrity.

Be collaborative and inclusive, sharing knowledge and resources for mutual benefit.

Be committed to its responsibilities under Te Tiriti.

Embrace equity and diversity, and support inclusion.

Pursue research and training that supports both commercial and public good outcomes.

Create an enduring global network of scientists to facilitate knowledge transfer across disciplinary boundaries.

Our vision

The Riddet Institute will be the world's top institute in discovery-led research at the frontier of food materials science, nutrition and health, developing knowledge and skills for a vibrant food sector in Aotearoa New Zealand and helping to address the challenges facing the global food sector.

Contents

This report summarises the achievements and outputs of the Riddet Institute Centre of Research Excellence for the period 1 January 2023 to 31 December 2023

Te Kunenga ki Pūrehuroa Massey University

agresearch
āta mātai, mātai whetū

Plant & Food Research
Rangahau Ahumāra Kai

The University of Auckland
New Zealand
Te Whare Wānanga o Tāmaki Makaurau

University of Otago
Ōtākou Whakaihu Waka

Riddet Institute
Advancing Frontiers in Food Science

Riddet Institute
Kōkiri - Te Hā o te Kai

Chair's Report

Kia ora koutou,

Scientific research and education today are more important than ever as the ongoing revolution in communications technology enables whacky ideas to spread swiftly, readily taking root in multitudes of minds. Food, so important for our wellbeing, is not immune. Science is the best antidote.

The Riddet Institute's research continues to build our understanding of how food structure affects digestion and nutrient availability necessary for good health. The evidence being assembled, and the knowledge acquired, will help counter food fads that can cause such damage to our health.

In parts of the world the problem is more basic - inadequate nutrient availability from local diets. World-leading research on future foods at the Riddet Institute can change that, with innovative products developed from a wider range of sources with greater bio-availability of essential nutrients. It has the potential to add real value to our food exports.

To be part of this endeavour is a privilege. My first six months as Chair included the Riddet Institute hosting the biennial Food Structures, Digestion and Health international conference in collaboration with the Australian CSIRO. It was a global gathering of the finest minds in the field of food science.

A particular highlight was the Student Colloquium where dozens of the Riddet Institute's post-grad students, from all Riddet Institute partners and collaborators, presented summaries of their work. It was stunning stuff.

Altogether it reflected the global standing of the Riddet Institute and our Director, Distinguished Professor Harjinder Singh. His recognition as the leading food scientist in New Zealand in the 2023 Stanford rankings, not to mention top twenty in the world, is testament to that.

I am also fortunate to Chair an experienced Board, and I'd like to thank Mark Piper, CEO of Plant & Food Research, for his acting Chairmanship during the first six months of 2023 following the sad passing of Professor Stuart McCutcheon.

The number and quality of scientific papers and conference presentations by the Riddet Institute team in 2023 is a source of pride. I'm confident 2024 will see that outstanding work continue.

Ngā mihi

Rt Hon Sir Lockwood Smith
KNZM, PhD
Chair, Riddet Institute

Director's Report

Tēnā koutou katoa,

I am pleased to bring you this 2023 report about the year's achievements and the progress of our Centre of Research Excellence (CoRE) research programme.

We have had another notable year of research advances, and outstanding staff and student accomplishments. This report provides a summary of our activities and the highlights from our CoRE programme for 2023, and looks ahead to 2024, where we will reach the mid-point of our current research agenda.

Now more securely positioned in a post-Covid world, we saw a burst of international activity in 2023 as the world shook off the disruptions of the pandemic. We hosted visiting scientists and exchange students; international conferences and speaking engagements resumed their former frequency; and our investigators and researchers were in demand as keynote speakers in many different settings around the globe.

We hosted two international conferences – The International Symposium on Dietary Protein for Human Health in Utrecht, in the Netherlands, in September, and the Food Structures, Digestion and Health Conference in Queenstown in November – capping off a busy season showcasing our expertise in food to the world.

2023 also saw other significant highlights. In August we appointed a new Riddet Institute Board Chair, the Right Honourable Sir Lockwood Smith, whose rich background in politics, international diplomacy and agricultural science means he brings a fresh outlook to the board table. We look forward to Sir Lockwood's input in the years ahead.

The culmination of dedicated work and innovation led to the launch of our new alternative dairy spinout company Saber Foods, a company that thereafter attracted the interest of leading entrepreneurs and marketers. It has gone on to secure seed funding that will soon result in a range of products marketed internationally.

Another coup has been winning prestigious hosting rights to the 17th International Hydrocolloids Conference that will be held in Palmerston North in 2024, an event that will bring top food scientists, and global industry and business leaders to our city.

Further evidence of the calibre of our investigators and staff can also be seen in the international prizes our people have won, and by the continuing research funding awarded in 2023.

I would like to extend my thanks to all our staff, investigators, researchers, and students who have been integral to these achievements, and to our Board members and Science Advisory Panel who have supported our endeavours. Building upon our success, we have a growing sense of excitement about the years ahead as we continue to push the frontiers of food science into a more sustainable and prosperous future for New Zealand.

Harjinder Singh

PhD, FRSNZ, FIAFoST, FIFT, FNZIFST
Distinguished Professor
Director, Riddet Institute

Highlights

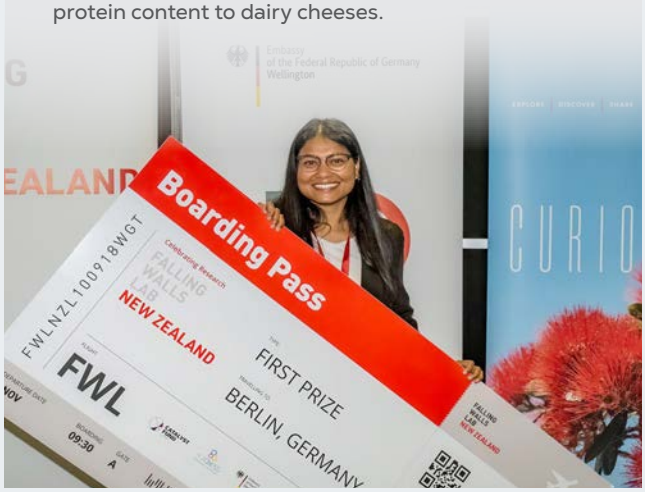
JANUARY → DECEMBER 2023

→ Latest dairy research shared at industry workshop

The Annual Dairy Industry Workshop co-hosted by the Riddet Institute and AgResearch was held in Palmerston North in early August 2023. Delegates from industry and academia discussed the current challenges facing the dairy industry, and future pathways for innovation. Pictured: Distinguished Professor Harjinder Singh speaking at the conference.

→ Award from Royal Society sends scientist to Europe

Dr Debashree Roy won the Falling Walls Lab New Zealand competition in September, securing a ticket to the world finals in Berlin, Germany in November. Dr Roy's three-minute presentation was on breaking the wall of plant-based cheeses, based on the Riddet Institute's patented technology for making protein-enriched plant-based cheeses with comparable protein content to dairy cheeses.



→ Riddet Institute Director leads New Zealand research rankings

Distinguished Professor Harjinder Singh was ranked the top food scientist in New Zealand by Stanford University in November 2023. Four out of the top five food scientists in the New Zealand rankings were associated with the Riddet Institute.

→ Emeritus Professor awarded prestigious medal

Emeritus Professor Clive Davies was awarded the prestigious Chemeca Medal in recognition of his contribution to Chemical Engineering over a five-decade career. Professor Davies is renowned for inventing devices that improve particle processing, flow measurement, and solids metering.

→ World-leading food scientists gather in Tāhuna Queenstown

The 7th Food Structures, Digestion and Health International Conference hosted by the Riddet Institute in association with CSIRO took place in Tāhuna Queenstown in November. The conference brought together 212 delegates from 12 countries with common interests in food science, physiology, engineering, and nutrition.

→ New Board Chair appointed

Former High Commissioner to the United Kingdom and Ireland, and Education Minister, the Right Honourable Sir Lockwood Smith commenced as the new Board Chair of the Riddet Institute in August.

→ "Milk Magic" workshop gets children excited about science

(From left) Dr Mike Boland, Dr Mahya Tavan and Patricia Soh ran a milk workshop at the Cawthron Inspire Festival in August. The annual festival in Nelson gives children the opportunity to get hands on with learning in STEAMS (Science, Technology, Engineering, Arts, Maths, and Society).

→ International Symposium on dietary protein co-hosted

The Riddet Institute co-hosted the International Symposium on Dietary Protein for Human Health in Utrecht, the Netherlands, in September. The symposium was a collaboration between the Riddet Institute, Food and Agriculture Organization, Rome, and Wageningen University and Research, in cooperation with the International Atomic Energy Agency, Austria.

Pictured, from left: Distinguished Professor Paul Moughan, Distinguished Professor Harjinder Singh, Ethan Cain, Dr Suzanne Hodgkinson, Dr Sylvia Chungchunlam, Dr Carlos Montoya, Natalie Ahlborn, Dr Janice Lim, Dr Alejandra Acevedo-Fani and Dr Andrew Fletcher.

→ Scientists win funding from the Health Research Council

- Professor Nicole Roy (left) and her team including Dr Meika Foster (second from left) were awarded **$1,174,972** to evaluate the effect of an Aotearoa NZ Diet for metabolic health on the gut microbiome.
- Dr Noha Nasef (third from left) won the Career Development Award to fund research into the dietary management of ulcerative colitis.
- Professor Lisa Te Morenga was awarded **$1,198,634** over 3 years for her project "Bringing manaakitanga to waitlists with tailored Smart Start letters".

Professor Nicole Roy

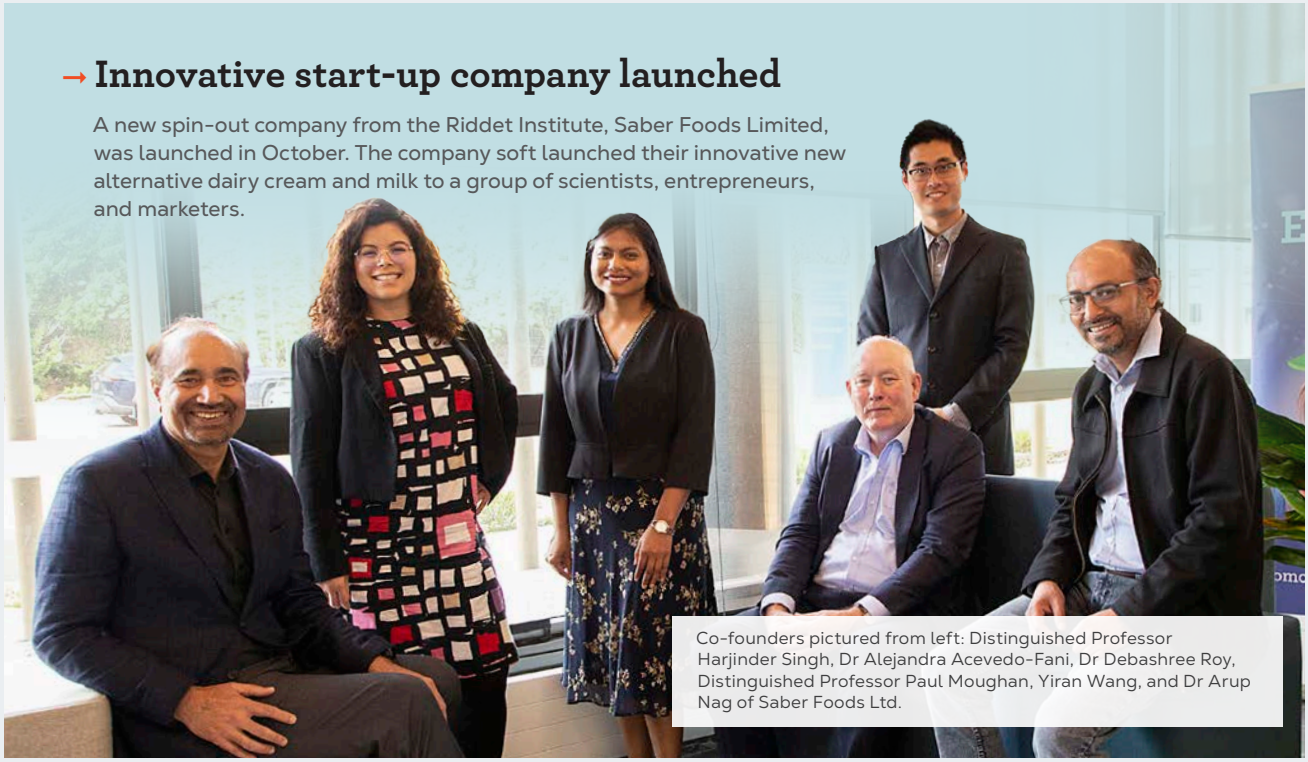
Dr MeikaFoster

Dr Noha Nasef

Professor Lisa Te Morenga

→ Innovative start-up company launched

A new spin-out company from the Riddet Institute, Saber Foods Limited, was launched in October. The company soft launched their innovative new alternative dairy cream and milk to a group of scientists, entrepreneurs, and marketers.



Co-founders pictured from left: Distinguished Professor Harjinder Singh, Dr Alejandra Acevedo-Fani, Dr Debashree Roy, Distinguished Professor Paul Moughan, Yiran Wang, and Dr Arup Nag of Saber Foods Ltd.

→ Conference presentations highlight institute's research

107 Riddet Institute scientists and students presented at domestic and international conferences in 2023. 51 posters were also presented.

Pictured: Professor Aiqian Ye presenting at the 13th NIZO Dairy Conference Innovations in Milk Proteins in the Netherlands.

→ $10m awarded for MBIE project

The collaborative project between the Riddet Institute's Sustainable Nutrition Initiative® (SNi®), and iwi group Wakatū Incorporation was selected by the Ministry of Business, Innovation and Employment as a recipient for its 2024 Endeavour Fund round in September. The project combines indigenous knowledge and practices and science to safeguard food supply in Aotearoa New Zealand.

→ Social media followers grow

The institute exceeded

4000

followers on the Riddet Institute LinkedIn page.

→ Academic publishing tally impressive

186 journal articles

20 book chapters

3 books

were published in 2023.

Strategic

1 GLOBAL SCIENCE EXCELLENCE: Aotearoa New Zealand is recognised for its world-class expertise in food science and related disciplines.

15 Lectures from visiting scientists.

13 Overseas interns/PhD students.

2 International conferences hosted by the Riddet Institute.

186 Journal articles.

20 Book chapters published.

3 Books published.

2 New major (>$10M) collaborative research programmes established.

Riddet Institute scientists presented at **24** international conferences.

2 INNOVATION AND CAPABILITY BUILDING: A world-leading, innovative and sustainable food sector in Aotearoa New Zealand.

22 Postgraduate students commenced studies.

18 Postgraduate students completed their studies.

82% of graduates entered roles in research or industry.

17 Undergraduate students interned at the institute over the summer.

13 key industry strategic partners continue to work with the Riddet Institute on research projects.

Startup Saber Foods Ltd raised **$2.7m** in seed funding for its legume-based dairy alternatives.

$3.2m received from NZ industry in 2023.

3 INDUSTRY LEADERSHIP: A future-proofed and future-focused food sector in Aotearoa New Zealand that addresses local and global sustainability challenges.

An article co-written by a Riddet Institute scientist regarding lab-grown meat and the environment was republished → **92** times by international media.

228 news media articles featuring Riddet Institute research/expertise were published.

Riddet Institute researchers appeared on **15** radio, television or podcast interviews.

Dr Nick Smith (Research Officer) joined Dr Laura Domigan (Principal Investigator) in the Te Puna Whakaaronui Thought Leadership Group for New Zealand's Food and Fibre sector in June.

Impacts

JANUARY → DECEMBER 2023

4 MĀORI PARTNERSHIPS:

A stronger indigenous food sector in Aotearoa New Zealand, supporting improved outcomes for Māori.

Through the High Value Nutrition National Science Challenge, we have worked closely with Māori in their research planning and funding applications.

In Tāhuna Queenstown, we collaborated with Mana Tāhuna and Tāke Tuia Ltd to explore a strategic partnership aimed at increasing value from whenua and associated resources.

To facilitate innovation we have continued to extend our reach within the Māori agri-food sector, and to add breadth and depth to our relationships with Māori organisations, hapū and iwi.

The Riddet Institute and Riddet strategic partner Wakatū Incorporation together secured more than →

$10m

in funding from MBIE for a collaborative Endeavour Fund project.

4 Pūhoro STEMM Academy students interned with the institute to work on summer projects

5 EQUITY AND INCLUSION:

The food sector in Aotearoa New Zealand is more inclusive, diverse, and equitable, and provides more opportunities for Māori and Pacific People.

62% of our current postgraduate students and emerging scientists and

→ 53% of our staff are women.

79% of our postgraduate students are international.

3 Māori postgraduate students.

1 Pacific PhD student.

6 EDI events held in 2023.

7 Māori & **3** Pacific undergraduate students interned over the summer.

6 INFORMING CONSUMER CHOICE:

New nutritional indices of food and nutritional guidelines that provide more informed food choices for consumers.

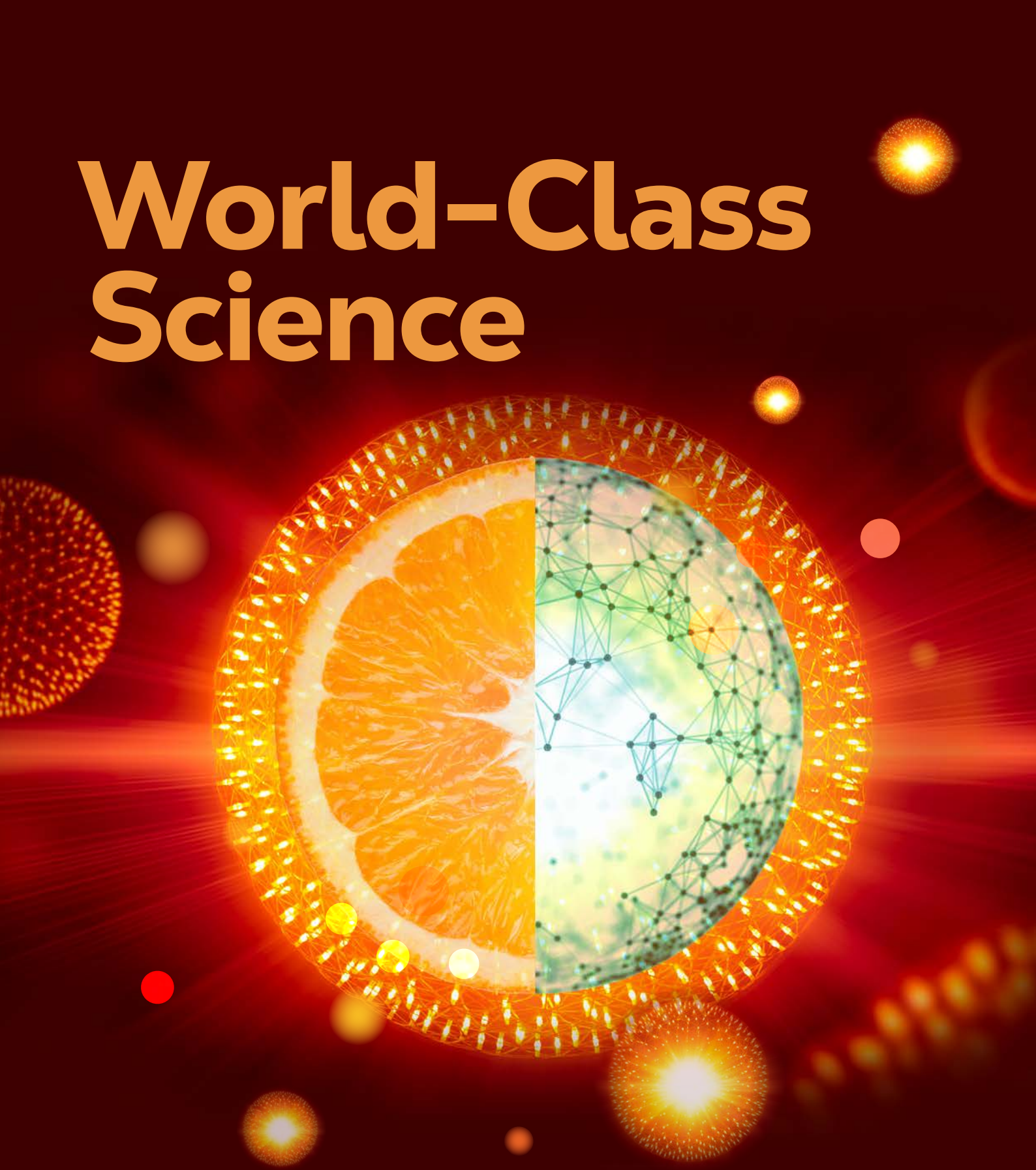
300 delegates attended the International Symposium on Dietary Protein for Human Health in the Netherlands, with 100 additional people accessing the online recordings.

As Co-chair of Health Coalition Aotearoa, Prof. Lisa Te Morenga (Principal Investigator) delivered a petition to Parliament calling for an expansion of the Ka Ora, Ka Ako Healthy School Lunches Programme in June.

Dr Hannah McKerchar (Affiliated Researcher) organised a series of interactive workshops for scientists and policymakers as an intern with the Office of the Prime Minister's Chief Science Advisor.

Prof. Elaine Rush (Associate Investigator) was appointed Life Member of the New Zealand Nutrition Foundation in September, after 18 years' service as Scientific Director.

World-Class Science



Aotearoa New Zealand is recognised for its world-class expertise in food science and related disciplines, enhancing its reputation as a trustworthy producer of high-quality food, and catalysing investment in food innovation and international collaborations in food research.

Research programme looks to a healthy future for humanity

RESEARCH PLAN FOR CORE 2021 - 2028

The Riddet Institute intends to generate the future knowledge and skills required to help address the unprecedented challenges and disruptions facing the food sector in a rapidly changing world. It aims to be the world's top institute in discovery-led research at the frontier of food materials science, nutrition and health, and will develop high calibre human capital to ensure rapid innovation, a vibrant food sector and long-lasting socioeconomic benefits for New Zealand.

The food sector is undergoing a significant transformation, with the need for more food, healthier food, less food wastage and sustainable low emission, resource-efficient production. This constitutes a complex challenge, providing both opportunities and risks for New Zealand's food-export-led economy. The Riddet Institute's contribution to this challenge is well recognised – it is internationally regarded as a leading centre of research and scholarship at the interface of food science and nutrition. It has undertaken ground-breaking, discovery-based research into the science of food structures and their complex interactions with nutrient absorption, metabolism and human health and wellbeing. It is an innovation engine for the New Zealand food industry.

The next generation of food products will need to address not only nutrition and health, but also the most pressing environmental and ethical issues of our time. Foods need to become more sustainable: environmentally, nutritionally, socially, and economically. This will require the introduction of new materials in the food chain, as well as the creation of foods that appeal to consumers and deliver their nutritional needs with less wastage. This could include novel crops, animal protein replacers, marine plants, and food materials from bioreactors. The Riddet Institute CoRE research programme comprises three interlinked research themes and two overarching supporting elements. Each theme has several tightly connected projects that are generating new knowledge in defined areas. Investigators work across themes and projects to collectively contribute to the overall vision of: **"Future Foods in Harmony with Nature".**

The vision of the Riddet Institute Centre of Research Excellence (CoRE) research programme is:

Future foods in harmony with nature

This vision provides the fundamental underpinning science to support tomorrow's innovations in advanced foods. These foods will be sustainable, support optimal nutrition, human health and wellbeing, and appeal to the preferences of tomorrow's global consumers.

THEMES

THEME 01:

FOOD STRUCTURE DESIGN AND NUTRIENT DELIVERY

THEME OVERVIEW / This research theme addresses one of the most important scientific challenges for optimising the nutritional value of sustainable foods, by unpacking what happens to the nutrients in food during processing and gastrointestinal digestion. Crucially, this theme integrates advanced computational and mathematical modelling, human clinical studies and microbiome science with food structure and digestion science to provide advanced knowledge. This research theme will completely transform current food design processes and food dietary guidelines, and ultimately give rise to a range of high value healthy foods. There are five research projects under this theme.

THEME 02:

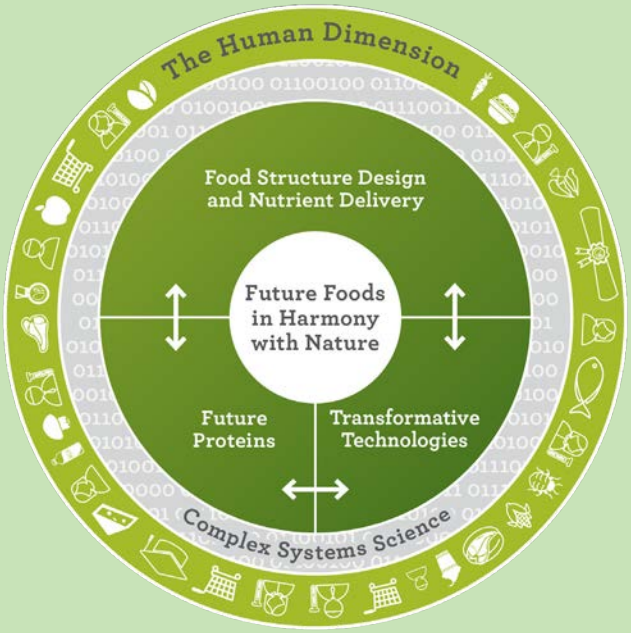
SUSTAINABLE FUTURE PROTEINS

THEME OVERVIEW / This research theme addresses the challenges of transitioning from animal proteins to more sustainable plant and other alternative proteins, driven by consumer perceptions around nutrition, health, animal welfare and the sustainability of food production. This transition can take place either by turning plant proteins into food products that mimic animal product functionality and nutritional quality or by consuming foods that contain some animal protein but proportionately more plant protein. The latter option becomes a sustainable alternative with a lower environmental footprint and it also provides significant opportunities for the New Zealand animal protein industry to become directly involved in the development of new products from diversified protein sources. There are three research projects under this theme.

THEME 03:

TRANSFORMATIONAL TECHNOLOGIES

THEME OVERVIEW / The intersections of food, biotechnology, digital technologies and robotics are beginning to disrupt and transform the global food industry. 'Food Tech' is now considered to be the final frontier of disruptive innovation. New and emerging technologies are being harnessed to design new ways to produce and consume food, responding to both consumer trends and an imperative to improve sustainability and human health. Many of the innovations are based on the use of synthetic biology and bioengineering approaches to produce animal protein foods in non-traditional ways, leading to the emergence of synthetic, cultured and engineered foods. There are two research projects under this theme.



Future foods in harmony with nature

Pictured is the graphic depiction of the three research projects (in second ring in centre), with the overarching themes: The Human Dimension, and Complex Systems Science around the outside rings.

To understand and predict the behaviour of food systems, we are adopting an overarching *complex systems science* approach to our research themes and embedding the *human dimension* in our research

Dr Alejandra Acevedo-Fani, left, with Prof Gail Bornhorst with a gastric simulator machine.

THEME 01. Nutrient release linked to the state and structure of food

PROJECT 1.2 FOOD STRUCTURE MODIFICATION IN THE DIGESTIVE TRACT

Research on what happens to food in the digestive system when we eat is entering a new phase. Currently, food nutritional quality is typically defined only by food composition, but scientists are now looking at the critical role of the structure of foods in digestion and nutrient utilisation. From studies on individual foods, such as milk, pasta or semolina, the team is also now moving to acquiring understanding of more complex foods that resemble meals as well as new foods that we will soon consume more often.

Led by Principal Investigators Dr Alejandra Acevedo-Fani and Professor Gail Bornhorst, the 'Food structure modification in the digestive tract' project under research Theme 01 seeks to understand how complex foods interact during digestion. Much of the previous work has centred around *in vitro* studies that simulate human digestion, with most studies conducted on single foods. However, more comprehensive knowledge of human digestion is needed to understand the implications of the food structure on the uptake of nutrients during digestion. This knowledge will empower the development of new foods and food ingredients to enhance human health.

For example, PhD students and postdoctoral researchers in this project are investigating protein structures from new plant-based materials that could be used as novel food ingredients. Postdoctoral researcher Dr Thomas Do has developed a new way to isolate intact protein bodies from hemp seeds. This eco-friendly protein extraction method retains the natural structures in which proteins are packed into seeds. It represents a promising strategy to optimise plant protein digestibility and uptake by our body. Similarly, PhD student Sihan Ma has produced hybrid protein ingredients using hemp proteins and milk proteins with a more balanced amino acid composition than previously possible. The behaviour of these novel food structures during digestion is currently under investigation.

Work has also been done on the connection between the state and structure of food materials in the stomach to the release of nutrients. Research done in 2023, in collaboration with UC Davis, has looked at solid foods such as apple, cantaloupe, chickpeas, bread, extruded rice snacks and egg white hydrogels to link the structure of these foods to their breakdown in the stomach and their macronutrient release. To achieve this, micro-computed tomography (x-ray imaging) was used to visualise and quantify aspects of the food structure before and during digestion. In a related project, PhD student Crisline Alhambra is investigating the breakdown behaviour, and nutrient release and absorption of combinations of carbohydrate- and protein-based solid foods that aim to mimic a more realistic mixed meal. Work is ongoing to understand changes in food breakdown behaviour of these solid foods individually and in combination. Overall, this information will allow us to modulate food structures and food combinations as part of mixed meals for targeted food breakdown behaviour.

Human medical imaging used in digestion simulators

THEME 01.

PROJECT 1.3
THE HUMAN DIGESTOME

A central focus of the Riddet Institute research programme is the design and construction of an integrated model of the human gastrointestinal tract (GIT). Led by Principal Investigators Professor John Bronlund and Professor Leo Cheng, this research combines the development of physical (*in vitro*) digestion simulators and computational models to further understand food breakdown in the GIT. The stomach is a critical part of the food digestion process, and simulating its muscular contractions and mixing has been essential to the accurate development of physical and computational GIT models. In 2023, medical imaging techniques were used to aid understanding of the stomach's contractions, and to quantify motility and contraction parameters.

From magnetic resonance imaging (MRI) scans of 10 healthy volunteers, researchers Nima Hosseini and Nadun Palmada created 3D models of the gastric motility patterns of each individual subject and utilised these models to analyse the flow and mixing using computational fluid dynamics. These individualised computational models will help understand the impact of individual differences on food behaviour in the stomach.

This may ultimately help us design foods for specific populations or individuals with impaired gastric motility.

Complementary to the computational modelling of the human stomach, a new generation stomach simulator has been designed and manufactured, which has a more anatomically realistic shape, stronger antral contractions, and an ability to control gastric temperature and secretions. Stomach emptying of different food products can be observed, and has been shown to match well with previous experimental studies. Development of advanced control systems to modulate gastric secretions in response to the specific meal pH and to control the gastric emptying are currently underway.

Additional research aims to validate the gastric food breakdown, mixing, and emptying behaviour with *in vivo* data collected in this project and in collaboration with another project that characterises changes in food structure during digestion (see page 19). Use of these advanced *in vitro* models will be critical in our endeavours to design functional food products to promote human health with controlled food breakdown behaviour.

THEME 02:

Innovating future foods with plant proteins

PROJECT 2.1 NOVEL PROCESSING

In an innovative project to enhance the future of food products, Professor Indra Oey (University of Otago), Dr Kevin Sutton (Plant & Food Research – PFR) and their team of experts are exploring the techno-functional and nutritional potential of plant-based proteins. The objective is to investigate how emerging food processing technologies can modify plant-based protein structures to improve their functional properties. Another, longer-term goal of the project is to support New Zealand plant-based food manufacturers to transition from highly refined protein ingredients to less-refined plant materials.

Jervee Punzalan (PhD student) supervised by Profs. Oey and Keith Gordon, is working closely with Dr Sutton and Dr Gert-Jan Moggré (PFR) to utilise advanced techniques such as micro near-infrared (microNIR) and Fourier-transform near-infrared (FT-NIR) to characterise the molecular aspects of semi-refined flaxseed proteins. A wider collaboration with institutions such as the Dodd Walls Centre for Photonic and Quantum Technologies and MacDiarmid Institute for Advanced Materials and Nanotechnology is enhancing the understanding of protein functionalities and properties. PhD student Nicholas Horlacher is working with Dr Moggré to explore non-thermal pasteurisation techniques and various lactic acid bacterial strains to create gelled structures from plant proteins, which could lead to new plant-based 'fermented' products. Other PhD students are working with PFR scientists on new applications of food processing techniques such as pulsed electric field (PEF) and high-pressure processing (HPP) to transform protein and starch properties, enhancing their functional applications in food products.

As part of this project, new imaging techniques are being developed to evaluate the quality of bread made from whole faba bean flour and protein isolate. These methods are being expanded to other structured food materials and plant proteins with varying levels of refinement. The aim of another PhD study, co-supervised by Prof. Oey and PFR food scientists Dr Esther Kim and Mr Marco Morgenstern, is to develop new plant-based food prototypes and assess their sensory and nutritional properties. Studies are underway to understand the textural perception of vegan pasta enriched with pea protein isolate, with a significant focus on consumer preferences and nutritional outcomes.

This research aims to produce high-quality food products rich in fibre and micronutrients, improve raw material utilisation, reduce energy and water consumption, reduce waste, and offer healthier products.

THEME 02:

PROJECT 2.3
FUTURE PROTEINS AND CONSUMER ENGAGEMENT

Preserving culture and looking after the future key to Māori food messaging

How does Māori messaging on plant-based foods impact consumer perceptions?

PhD student and Riddet Institute Māori Scholar Summer Wright (Ngāti Maniapoto) is exploring this issue as part of the Ministry of Business, Innovation, and Employment (MBIE) Future Foods Catalyst project Te Rangahau Taha Wheako mō ngā Kai o Āpōpō, The Consumer Dimensions of Future Foods.

In 2023, with the support of two Pūhoro STEMM Academy students Rubi Te Rangi Smith (Rangitāne o Manawatū) and Genevieve Bell (Te Ātiawa), a qualitative content analysis was conducted across the majority of Māori food and beverage packaging on the market. The goal of this research was to determine elements on product packaging that are used by Māori businesses to communicate their value proposition to consumers.

The study found that provenance (where and how food is produced) and the use of te reo Māori are the most common types of content used by Māori businesses on their food and beverage packaging. Place-based provenance messaging can assert a Māori identity and communicate specific histories and traditions.

"Commoditising indigenous culture and language on product packaging may present some challenges, such as difficulties in managing authenticity and protecting intellectual property and traditional knowledge," Summer says.

However, after this research it was still unclear how consumers related to these different types of messaging on Māori products.

Summer then conducted in-depth interviews with people in both Aotearoa NZ and Singapore, where part of the project's research team is based. Summer notes that Singapore is a market of interest to Māori businesses, and therefore provides a good comparison and contrast to critical consumer attitudes in Aotearoa NZ.

People who consider social and environmental impacts of buying products were chosen for the interviews. "I used a qualitative technique called laddering that digs into peoples' personal value systems to reveal the basis of their attitudes towards a product attribute," Summer explains.

The interviews were completed in December 2023.

Preliminary insights reveal that Aotearoa NZ consumers have a more polarised view of Māori messaging compared to their Singaporean counterparts, from extremely supportive of Indigenous enterprise, to outright hostile. Summer observed that this likely reflects broader social trends happening right now in the country.

Singaporeans were also more likely than New Zealanders to value preserving culture and tradition, which they also saw reflected in the Māori messaging.

Overall, the interviews showed that people in both Aotearoa NZ and Singapore hold values for looking after the future, and they saw these values reflected in Māori messaging on products.

The goal is to help Māori organisations fine-tune their brand messaging and how they communicate the value of their plant-based food products in domestic and Singaporean markets.

Summer Wright, Rubi Te Rangi Smith.

Will eating lab-grown proteins cause meat allergies?

THEME 03:

PROJECT 3.1
CELL BASED PRODUCTION

A project under Theme 03 aims to define patterns of allergen expression in cultured mammalian muscle cells. Cell-based meats are a promising alternative to traditional meats, with the potential to significantly reduce the global impact of meat production. But consumer trust in the new technology needs to be established. While allergy to meat is uncommon, proving that allergenicity does not increase in cultured meat is important when presenting potential lab-grown products to the consumer.

PhD student Hamish Trlin aims to do just that through his research into the allergenicity of cultured proteins.

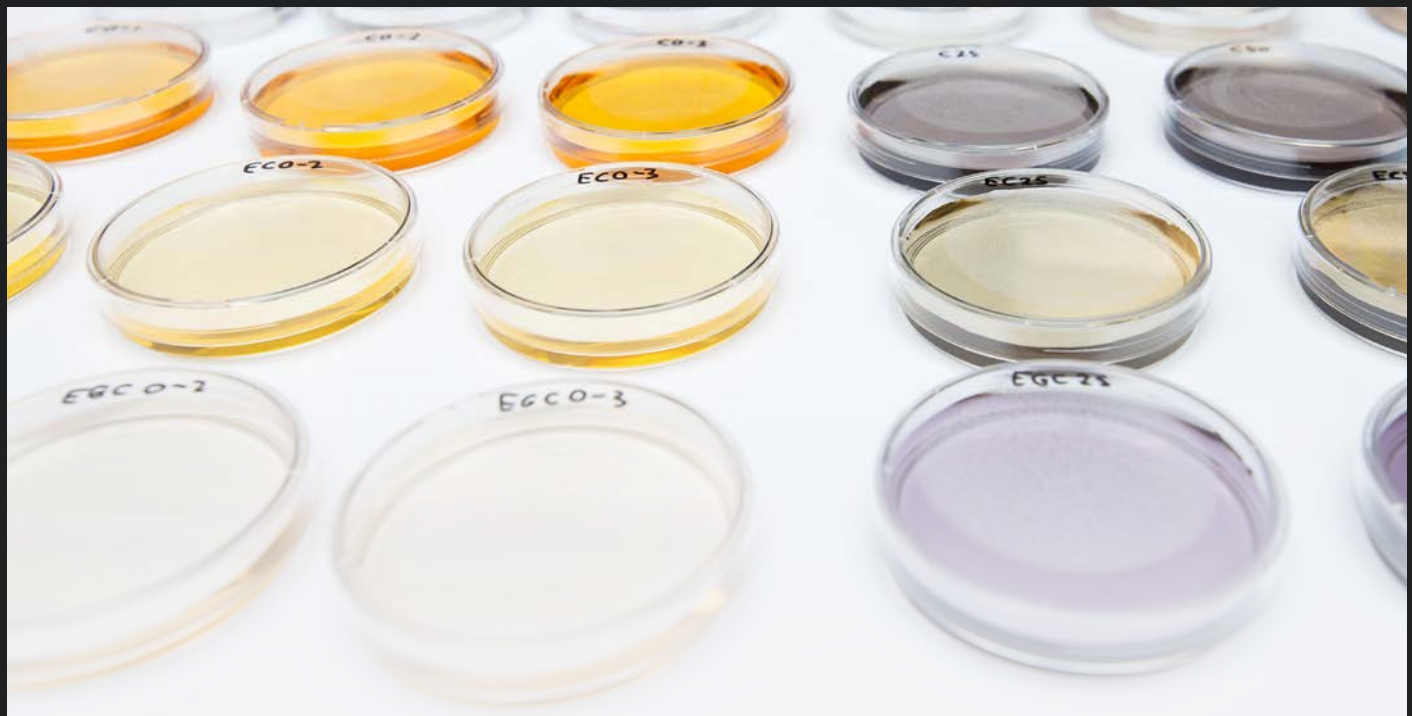
In 2023, Hamish went to Wageningen University & Research in the Netherlands to work with key scientists in the Bioscience and Food Chemistry research laboratories. His experiments have focused on profiling the general protein expression patterns of cultured cells and the types of glycan modifications that decorate the proteins. Hamish has also worked on quantifying the recognition of allergens by the immune system of people with a known allergy to beef.

Using protein mass spectrometry data, Hamish compared a database of known proteins against the specific proteins present in cultured samples at various stages throughout the culturing process and traditional proteins you can buy from the butcher. By better understanding the differences in protein expression patterns between these samples, it will also be possible to track the changes in the relative expression of known allergens.

While the research is ongoing, initial results support the hypothesis that serum albumins – what often triggers allergic responses to meat – are significantly less prevalent in cultured samples than in traditional meat. By changing the growth media, which contain serum albumins themselves, future experiments aim to show that serum albumins could be reduced even further or possibly eliminated completely.

Preliminary results using serum from humans who are allergic to beef show that there is less recognition of allergens using the cultured cells, supporting the idea that serum albumins are in low concentrations in these samples. Conversely, for those with a general red meat allergy there is an increase in recognition of allergens, suggesting that alpha gal, the allergen responsible for a general red meat allergy, is being upregulated in cultured cells. However, increased recognition of an allergen does not necessarily correlate to a more severe allergy.

The research team also aims to identify other proteins in the samples that have undergone drastic changes in expression and determine whether these could impact allergenicity as well.



Bacteria shows promise in food protein production

THEME 03:

PROJECT 3.2 RECOMBINANT TECHNOLOGY FOR FOOD PRODUCTION

The use of microorganisms in the production of foods and beverages, such as bread, cheese, wine, or beer, dates to ancient times. But modern scientific methods mean they hold even more potential: microorganisms like bacteria, yeasts, algae, and fungi can now be precisely altered to produce food. This technology unlocks new food systems, such as engineered ingredients that lack allergens, and ingredients for ideal nutrition.

Professors Renwick Dobson and Emily Parker are leading current research using microbial systems (bacteria, yeasts and algae) for protein production. These microbes have many advantages for the production of novel foods that will have economic value, and research is progressing in multiple areas.

Specific research falls into five categories:

- Oleosins are a group of proteins found in plant seed oil bodies. These are being expressed from bacteria and plants to define their biological role, their structure, and their use in the formation of nanoparticles.
- Brazzein is a sweet protein found in West African fruit that is 100,000 times sweeter than glucose. Working with Dr Davide Mercadante (University of Auckland), the team are engineering the brazzin protein so it can withstand heat in food production. The proteins will be isolated and purified using GRAS (generally recognised as safe) bacterial systems.
- Rubisco is a plant protein that can support mammalian cell growth. Postgraduate studies by students Weihan Zhang and Ang Jin are focused on defining the organic compounds that are bound to rubisco during the isolation from plants with a view to making microcarriers to grow cells.
- Bacillus Proteases. Postgraduate students Aimee Harper and Matt Walker are characterising recombinant Bacillus lactis proteases so they can eventually be used to ferment plant proteins.
- Human serum albumin. In collaboration with Dr Rachel Wood, from the University of Canterbury's Chemical Processing Engineering department, the team are using this human blood protein to work on growing mammalian cells for food.

These five areas include collaborations with the MBIE Catalyst Future Foods Project, Daisy Labs, Callaghan Innovation, OpoBio, and the Biomolecular Interaction Centre at the University of Canterbury.

The effort to find new methods and media for expressing and purifying proteins is to reduce the costs of lab-grown cell production. Future proteins will include fibroblast growth factor 2 and myoglobin using algal systems.

The team will also explore other novel sources of ingredients for bacterial growth media, such as potato waste streams.

PROJECT HD1: MĀTAURANGA KAI FOCUSES ON MĀORI ASPIRATIONS IN FOOD AND HUMAN HEALTH, COMBINING BOTH TRADITIONAL AND CONTEMPORARY STRANDS OF KNOWLEDGE.

The Human Dimension

Mātauranga kai connection fostered through social media

Fresh kina/sea urchin.

While trying to document the mātauranga (knowledge) between traditional kai (food) and oranga (a holistic concept of wellbeing) in past generations, Principal Investigator Professor Lisa Te Morenga, Postdoctoral Research Fellow Dr Nikki Renall and PhD Student Asher Regan found that archival materials and academic writings were dominated by European accounts. Those writings still have a large influence on how we think about Māori kai today.

Looking to access Māori experiences, the researchers expanded their analysis from written sources to a more contemporary platform – Tik Tok, an app for short-form videos.

Their focus shifted to exploring how Māori identity is strengthened through kai, and how traditional foods are defined and valued. The research showed that local foods that were collected, gathered, and hunted, such as kaimoana (seafood), were the most strongly valued as traditional foods. Post-colonisation heritage foods or meals also held a central place in contemporary Māori cuisine.

Boil-up – a dish comprising cheap cuts of introduced red meats boiled in salted water with potatoes, kumara, greens (either native or introduced) and wheat dumplings, and hāngī – a method of cooking these same ingredients but in an earth oven (or modern gas steamer) were seen on Tik Tok as uniquely Māori dishes even though red meat and potatoes are foods that were introduced to Māori by European explorers.

The culmination of this research is captured in a draft book chapter on the history of Māori kai in Aotearoa New Zealand. Drawing upon the insights from the Tik Tok analysis, as well as the scant archival records and some in-depth interviews with kaumatua (Māori elders) and a focus group, the chapter is part of the forthcoming book entitled "In Pursuit of Health in the Pacific."

A revelation from the study is the pivotal role played by TikTok as a platform for Māori individuals to engage positively with one another, fostering the sharing of mātauranga and tikanga (protocols), thereby expressing and reinforcing Māori identity. The mātauranga of Māori kai is part tradition but also a lot about adaptation (to new foods) and the cultural values around how food is shared and enjoyed with whānau. In essence, TikTok emerges as a dynamic space facilitating the celebration, development, and dissemination of Māori cultural knowledge and practices.

Asher Regan (left) with chef Joe McLeod at the Tohunga Tūmau Matariki dinner.

Kai, connection, and community – the influence of chefs on Māori well-being

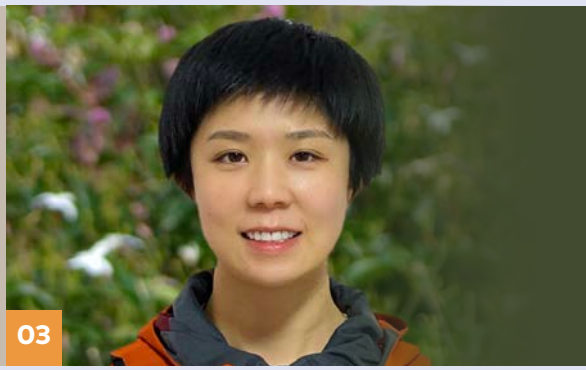
How does traditional and contemporary kai Māori contribute to the health and well-being of Māori? That's what PhD student Asher Regan is attempting to understand with his research under the Human Dimension Project.

The importance of kai (food) in well-being goes beyond nutrition. Kai fosters cultural connection and stronger ties to family and community.

The presence of kai Māori in mainstream consciousness has increased over the past few decades, led by talented Māori chefs. With the introduction of Matariki as a public holiday in Aotearoa New Zealand, as well as other numerous festivals celebrating the nation's heritage, the interest in kai Māori continues to grow.

Asher is working alongside Māori chefs to understand how they are able to influence discourse in Aotearoa New Zealand using kai Māori to benefit the well-being of Māori.

Student Discoveries



01: SYED UBAID ULLAH SHAH

Fermentation explored to enhance nutrition

Food insecurity and chronic health diseases like diabetes, obesity, and cardiovascular disease are becoming more prevalent as the global population increases. Massey University PhD student Syed Ubaid Ullah Shah is exploring how alternative protein from pasture legumes could address these issues.

By using fermentation, Ubaid aims to overcome the limitations of pasture legumes, such as lucerne (Medicago sativa) and red clover (Trifolium pratense), to turn them into a nutritional food source.

The research has shown that unfermented pasture legume seeds have impressive nutritional profiles, with a high crude protein content that surpasses many conventional edible legumes. Pasture legumes also exhibit excellent mineral availability, with potassium, phosphorus, iron, and zinc levels exceeding soybeans and other legumes. Promisingly, pasture legume seeds can be fermented using lactobacillus starter cultures without the need for external nutrients.

The seeds exhibit higher levels of total phenols and flavonoids compared to other edible legumes.

The nutritional benefits of these legumes, as well as the antioxidant activity which increases post-fermentation, highlights their potential for feeding the growing population while addressing nutritional and health concerns.

02: NICHOLAS HORLACHER

Improving digestibility and taste of plant-based protein alternatives

Plant-based protein rich foods are sought out by consumers for alternatives to their favourite dairy products such as milk and yoghurt.

However, not all the protein in these alternatives can be absorbed by the human body as readily as dairy due to the complex structure of plant protein and the presence of antinutrients.

PhD student Nicholas Horlacher, from the University of Otago, is exploring this issue. He has created a beverage using oats and pea protein and processed it using a combination of methods such as thermal pasteurisation, pulsed electric field treatment and lactic acid fermentation.

This allowed the creation of plant yoghurts with novel textures based on plant protein gelation.

A static in vitro digestibility protocol was applied together with a quantification of key antinutrients, simulating the release of amino acids during digestion.

The aim is to identify potential hindrances to digestion for different treatment combinations so that plant-based alternatives can be improved for both digestibility and taste.

03: BONING MAO

Hybrid dairy-meat analogues easier to digest than soy dairy-meat analogues

Plant-based proteins have become more of a staple on supermarket shelves over the past few years, but the way they are processed affects their nutritional benefits.

Massey University PhD student Boning Mao is exploring the fibrillation mechanisms of plant protein during thermomechanical processes to compare the digestive characteristics of soy-based meat analogues (SBMA) and hybrid beef.

Boning's experiments show that the SBMA lack the same levels of taurine as hybrid beef, but that it could provide all essential amino acids for a plant-based diet. Using the human gastric simulator, the hybrid beef samples consistently exhibited lower pH levels during digestion compared to the SBMA. The digesta of hybrid beef displayed significant accumulation of a white, flocculent precipitate after one hour of digestion, likely attributed to the higher fat content in the hybrid beef sample. By contrast, the SBMA had more sedimentation and breakdown less than the hybrid beef during simulated gastric digestion. Results suggest that the proteins in hybrid beef are more easily digested than that of SBMA, with a significant ($P < 0.05$) difference observed at 60 and 180 minutes.

04: SIHAN MA

Hybrid plant and dairy proteins show promise for food applications

Hempseed protein, while rich in essential amino acids, faces challenges such as low water dispersibility and thermal instability, limiting its application in food ingredients. Sihan Ma's PhD project at Massey University aims to overcome these limitations by investigating methods to create hybrid protein microparticles through the combination of hempseed protein with milk protein.

By studying the interaction, functionality, and digestion behaviour of these protein combinations, Sihan is searching for novel approaches that enhance the functional properties of hempseed protein to provide a sustainable solution that expands its potential utilisation in food products.

In 2023, Sihan investigated the intricate dynamics of protein interactions, particularly focusing on the interplay between hemp protein particles and whey or casein during heating processes. Results have shown a significant breakthrough: the formation of heat-stable hybrid particles. These particles can be utilised as new food ingredients, offering enhanced stability during heat processing compared to hemp protein alone. Their resilience to heat-induced aggregation is a key property to consider, for instance, when designing plant-based pasteurised or UHT treated foods.

05: PETER PRENDERGAST

Bacterial composition of the gut microbiome key to understanding celiac disease

When people with celiac disease (CD) eat gluten, their immune system attacks the gut microbiome. University of Canterbury PhD student Peter Prendergast is researching how specific bacterial compositions impact gluten digestion and the cocktail of gluten peptides produced during this process for people with CD.

Using 16S RNA sequencing, Peter has defined the gut microbiome composition of the participants in his study. He has found a distinct shift in composition indicating gut dysbiosis in both the active celiac disease group (at diagnosis) and the treated celiac disease group (six months post-diagnosis on a gluten-free diet). The study also identified significant reductions in key probiotics like Bifidobacterium and Lactobacillus.

By developing a stool metabolomics method, Peter is able to extract and quantify water-soluble stool metabolites. This has enabled him to identify bacterial-related metabolites, whose levels are altered in response to both active and treated celiac disease.

This linkage between bacterial compositions and functional pathways within the host offers valuable insights into the disease's mechanisms and potential improved diagnostic and therapeutic approaches.

06: SHIEN PING ONG

Digestive and health impacts of cow, sheep, and goat's milk in older women

Milk is an important source of nutrients and can be especially useful for meeting the nutritional needs of the older population.

There is a growing interest in ruminant milks other than cow's milk, such as sheep or goat's milk, which is believed to confer additional health and digestive benefits. However, many of these claims remain unsubstantiated by human studies.

PhD student Shien Ping Ong at the University of Otago is carrying out a dietary intervention in which older women aged 60-80 years consume two cups of cow, sheep, or goat's milk for 12 weeks alongside their regular diet.

Ping's research investigates how this milk supplementation affects the digestive comfort and nutritional status of older women.

She is also exploring the impacts of milk supplementation on cardiometabolic health, functional health, mood and sleep, and the composition of the gut microbiome.

In 2023, Ping and her colleagues successfully recruited 165 women from two sites in Dunedin and Christchurch and commenced their trials.

The research aims to inform recommendations on milk consumption for older women to enhance their nutritional wellbeing and overall health.

Impact

Future-proofing the Aotearoa New Zealand food sector: developing capability, creating, and transferring knowledge and addressing local and global sustainability challenges.

Scientists and policymakers connect at interactive workshops

Connecting scientists to policymakers can be difficult, but **Dr Hannah McKerchar** (Affiliated Researcher) is working to close the bridge between the research and policy worlds as an intern in the Office of the Prime Minister's Chief Science Advisor. Dr McKerchar has developed resources for researchers including animations, policy brief templates, and a booklet on impacting policy.

In 2023, she went further to organise two forums as an informal opportunity for researchers and policymakers to connect. In September, the science and government worlds combined in Wellington and Christchurch to discuss navigating the complexities of building strong connections between evidence and policy. Two more forums are scheduled for Dunedin and Auckland in early 2024.

Professor advocates for the health of all New Zealanders

Professor Lisa Te Morenga co-chairs the Health Coalition Aotearoa and works to improve people's lives by reducing harm from tobacco, alcohol and unhealthy food.

Professor Lisa Te Morenga (Ngapuhi, Ngāti Whātua Ōrakei, Te Uri o Hau, Te Rarawa) is working hard to make us all healthier.

She works to protect and improve the health of all New Zealanders through her role at the Health Coalition Aotearoa (HCA), in addition to her fulltime work as Professor of nutrition and Māori health at Massey University and her research at the Riddet Institute.

> "The things people really struggle with in terms of a healthy diet is affordability and access to food, which is socially determined."

The HCA works to reduce harm from tobacco, alcohol, and unhealthy food, and to advance equitable health outcomes in Aotearoa New Zealand. Since 2022, Prof Te Morenga has been a co-chair of the voluntary organisation made up of health experts, professionals, academics, NGOs and community leaders. She co-chairs with HCA health researcher Professor Boyd Swinburn.

"Basically, it's a coalition of experts who do it for love."

Prevention and evidence-based policy change are key pillars of the HCA. A guiding principle is to be Te Tiriti-led.

"When we advocate, we take a Te-Tiriti-centred approach, making sure that the needs and health aspirations of our Māori whānau are not undermined by the policies we recommend," Prof Te Morenga says. "This requires us to actively listen to Māori. It means no one loses out because public health policies that improve health for Māori improve health for everyone.

"A lot of people benefit from the Māori way of doing things. It's often more holistic and focused on the family or community as opposed to the individual. Lots of people and different ethnic communities in New Zealand can relate to this approach."

Prof Te Morenga says food is a core issue to health, and helping people consume more healthy food is not just about them knowing the best food to eat. The easy availability of unhealthy options can undo all this knowledge.

"The things people really struggle with in terms of a healthy diet is affordability and access to food, which is socially determined," she says.

"People focus too much on the knowledge side, and far too little on the food environments in which people live, and all the marketing of unhealthy foods, and the expense of healthy foods. Yes, you need knowledge, but we need to be able to enact or apply that knowledge, too.

"People who don't have cars, supermarkets in walking distance or even well-equipped kitchens need to be able to access affordable, healthy, shelf-stable food, too."

She says the Riddet Institute is doing valuable research into how the foods we produce in New Zealand can be as nutritious as possible with maximum nutrient bioavailability, while also minimising environmental impacts and waste.

A priority for the HCA in 2023 was to see the healthy school lunch programme expanded when its trial ended. Prof Te Morenga says the school lunches in the programme are carefully constructed to be healthy, as well as providing opportunities for local food producers to be involved.

"A programme that teaches kids to enjoy healthy foods, it's looking after future markets for food producers as well."

Prof Te Morenga says the HCA work is a way to make practical changes to the food environments in New Zealand and provide real impact.

"I might write a paper, and academics – and maybe policymakers – might read it. But the advocacy work gets our research evidence in front of the policymakers so we can try and make changes that improve people's lives."

SPOTLIGHT ON

Māori and Pacific

PŪHORO STAFF AND STUDENTS:

Front row: Cody Garton
Middle row: Shahanna Tahere, Meg MacGregor-Dunn, Alice Boyd, Rubi Smith.
Back row: Navarone Watson, Jade Beazley, Jessica Matthews, Apiata Tipene, Kemp Reweti.

Empowering Rangatahi Māori in STEMM

The Riddet Institute/Pūhoro STEMM Academy partnership continued to flourish during the summer of 2023/24 to provide five rangatahi Māori studying STEM(M) related fields an opportunity to apply their learning in a real-world context. The Riddet Institute and Pūhoro have had a collaborative relationship since 2019, which includes supporting Pūhoro's highly successful summer internship programme .

The internship aims to facilitate the journey of the tauira (students) on their academic pathway to STEM(M) careers, by providing a supportive network and hands-on experiences in their fields of interest.

Three of the Pūhoro students returned to the institute this year after previous internships, enabling them to continue to build on their existing relationships and research skills.

The interns worked on a variety of different research projects including supporting Ngāti Kuia to analyse the potency and bioactiveness of kānuka, analysing perceptions of Māori branding attributes on food products, understanding how mamaku can be turned into a powdered dietary supplement, assessing the digestibility of plant-based substrates, and endolysin bioparticles for dental applications.

Postgraduate research looks at nutrition, gut health and packaging

PhD student **Summer Wright** *(Ngāti Maniapoto)* is doing qualitative research on consumer engagement with Māori messaging on plant-based foods. Her research will help Māori organisations fine-tune their brand messaging in Aotearoa New Zealand.

Asher Brooke *(Ngati Porou)* is researching the effects of milk oligosaccharides on the microbiota for her Master's thesis.

Simone Frame *(Ngāti Maniapoto/Ngāti Kahungunu)* is a Master's student investigating Aotearoa New Zealand banana varieties and their impact on infant gut microbiota.

Salanieta Naliva *(Fiji)* is doing her PhD on determinants of nutrition and health risks associated with malnutrition in older adults in Fiji. Her research will directly help improve the lives of Pacific people.

Some of the SNi team in November 2023. Pictured, from left: (Back row) Professor Warren McNabb, Justine Coomson, Patricia Soh, Raquel Lozano, Manouk Beuving, Professor Jeremy Hill, Hannah Ramsay. (Front row) Ejovi Abafe, Dr Nick Smith, Dr Mahya Tavan.

Key programme has global impact for sustainable nutrition

The Sustainable Nutrition Initiative® (SNi) has expanded its influence both nationally and internationally in 2023, furthering its mission of making scientific evidence accessible to improve global nutrition. The SNi project is led by Professor Warren McNabb and is an aligned programme at the Riddet Institute.

Its work on an upcoming Aotearoa-New Zealand National Model secured more than $10 million in funding from the NZ Ministry of Business, Innovation & Employment, which was a significant achievement. The Endeavour Fund project, "Kai anamata mō Aotearoa – exploring future food system scenarios and impacts", is co-led between the Riddet Institute and Wakatū Incorporation, in collaboration with Lincoln University, AgResearch, University of Canterbury and Manaaki Whenua Landcare Research. The five-year project aims to identify equitable and resilient food systems to reduce Aotearoa New Zealand's vulnerability to climate change and economic pressures.

The SNi team is increasingly being recognised for its expertise on data modelling in relation to food systems, nutrition and food security.

Multiple interactive tools are being developed for launch in 2024: the Nutrient Trade Model, which looks at the flow of nutrients from global food trade; the iOTA Model®, an optimisation tool for sustainable, healthy diets for individuals; and updated versions of the DELTA Model®, which incorporate modules reflecting inequitable food distribution and cellular agriculture into the existing model of the global food system.

The SNi team has grown to 11 scientists, staff, and PhD students, and has hosted 12 young aspiring scientists, from visiting international PhD and Masters students to summer interns.

SNi researchers were invited to present their work around the world this year, including in the Netherlands, the United States, the United Kingdom, Denmark, Australia and Ireland, as well as in New Zealand. They presented at 20 conferences and gave many invited talks to key industry organisations. International collaborations also involved hosting Dr Ty Beal from GAIN, an eminent American researcher in global nutrition and systems sciences. Dr Nick Smith, Research Officer, is also part of Te Puna Whakaaronui Thought Leaders Group committed to meeting some of the greatest food challenges faced today.

Research from the SNi team is gaining traction in international media. Dr Mahya Tavan and Patricia Soh's Iron Awareness Week article was published by The Conversation with over 27,000 reads. An article on lab-grown meat and its impact on the environment, co-written by Dr Mahya Tavan and Professor Paul Wood (Monash University, Australia), was republished 92 times by outlets with a combined reach of roughly 10.75 million. Four articles by the SNi team were published in significant scientific journals, covering calcium bioavailability, plant-based protein adequacy, the evolution of the global food trade network, and the role of meat in the human diet.

International symposium showcases latest protein research

The Riddet Institute cohort that attended the symposium. From left, Dist. Prof Paul Moughan, Dist. Prof Harjinder Singh, Ethan Cain, Dr Suzanne Hodgkinson, Dr Sylvia Chungchunlam, Dr Carlos Montoya, Natalie Ahlborn, Dr Janice Lim, Dr Alejandra Acevedo-Fani and Dr Andrew Fletcher.

The world's leading experts in dietary proteins met in Utrecht in September 2023 at an international symposium co-organised by the Riddet Institute, the Food and Agriculture Organization of the United Nations (FAO) and Wageningen University & Research, in cooperation with the International Atomic Energy Agency (IAEA). Distinguished Professor Paul Moughan, chaired the 2023 International Symposium on Dietary Protein for Human Health.

> "The symposium provided a technical update on recent scientific developments of critical importance concerning the role of protein in human nutrition, health and well-being"

The symposium addressed the nutritional needs of a burgeoning world population, where current protein guidelines are flawed and new techniques are revealing gaps in global nutrition.

Along with Dist. Prof Moughan, a leading authority on protein and nutrition, seven Riddet Institute scientists gave presentations at the event. A total of 51 scientists spoke at the three-day summit which reached 400 delegates, 300 in-person and a further 100 online.

Much of the data collected by scientists over the last 10 years on protein and amino acid digestibility has been spearheaded at the Riddet Institute by Dist. Prof Moughan and Dr Suzanne Hodgkinson. The outcome of that research, called DIAAS (Digestible Indispensable Amino Acids Score), is a new scoring methodology that evaluates amino acid absorption from protein foods. It is set to replace the existing guidelines and rewrite the nutritional textbook.

FAO nutrition officer Maria Xipsiti said the forum was an opportunity to reflect on advances in the scientific understanding of dietary protein.

"The symposium provided a technical update on recent scientific developments of critical importance concerning the role of protein in human nutrition, health and well-being," Ms Xipsiti said.

She said the research presented would be key to achieving a United Nations sustainable development goal of zero hunger by 2030, as well as bringing the protein database closer.

Dist. Prof Moughan said the DIAAS protein work will help stave off malnutrition and is critical to future food security.

International Atomic Energy Agency (IAEA) nutrition specialist Dr Victor Owino said alternative protein sources such as underutilised crops, edible insects, microbial protein, microalgae, myocoprotein and cultured foods can help feed the world.

There was unanimous resolve among symposium attendees that protein and its quality were central to human health, and the need for the new database was urgent. The development of a protein quality database will be jointly managed by FAO and the IAEA.

INTERNATIONAL SCIENCE EXCELLENCE

RESEARCH COLLABORATION AND CONSORTIA

The Riddet Institute's investigators routinely collaborate with world-leading international research groups. The following ongoing collaborations provided additional capability and strength to the Institute's research programme:

*** International University Consortium of Food Science & Nutrition (IUCoFSN)**
This consortium is a formal food science research collaboration between The University of Leeds, Riddet Institute/ Massey University, Wageningen University and Zhejiang Gongshang University of China. As IUCoFSN did not hold a conference in 2023, Professor Aiqian Ye visited Zhejiang Gongshang University in Hangzhou, China, in May to present a seminar on 'Intragastric restructuring of milk protein gels: influence on the digestive outcomes'.

*** Wageningen University and Research, The Netherlands**
The Institute has had a long-term collaboration with Wageningen UR, the top ranked university in the world in the field of agriculture (QS Rankings 2020).

*** New Zealand Singapore Future Foods Research Programme**
Riddet Institute investigators are involved in four collaborative projects exploring the potential for novel foods and food technologies, funded by the Ministry of Business, Innovation and Employment (MBIE) and the Agency for Science, Technology and Research (A*STAR) in Singapore.

*** INFOGEST**
This programme involves researchers from around the globe and seeks to provide a focal point for research and methodologies in digestion models.

*** PROTEOS Research Consortium**
Proteos is a collaboration between the Riddet Institute, Wageningen UR (Netherlands), the University of Illinois (USA) and AgroParisTech (France) to characterise the nutritional quality of food proteins.

*** CSIRO**
The Institute continues to collaborate with CSIRO in mounting the highly successful Food Structures Digestion and Health (FSDH) international conferences held alternately in New Zealand and Australia.

*** INRAE, France**
INRAE is France's national research institute for Agriculture, Food and Environment and has longstanding links with the Riddet Institute. A high-level INRAE delegation to New Zealand in March was jointly hosted by the Riddet Institute, AgResearch, Massey University and Plant & Food Research. Riddet Institute researcher Dr Alejandra Acevedo-Fani visited the INRAE laboratory in September to connect with the INFoGEST network.

*** University College Cork, Ireland**
PhD student Ethan Cain, funded through a Walsh Fellowship provided by Teagasc, is working on a joint project and spent most of 2023 on placement in Ireland.

World-leading food scientists gather in Tāhuna Queenstown for 7th International FSDH 2023

FOOD STRUCTURES, DIGESTION AND HEALTH
INTERNATIONAL CONFERENCE 2023
TĀHUNA QUEENSTOWN, 14-17 NOVEMBER 2023
Future foods in harmony with nature

The 2023 Food Structures, Digestion and Health (FSDH) International Conference brought leading food scientists from around the world to picturesque Tāhuna Queenstown in November. FSDH conference was initiated by the Riddet Institute and is now held alternately in New Zealand and Australia every second year in collaboration with CSIRO.

The conference brought together 212 delegates from 12 countries with common interests in food science, food processing, and nutrition.

Held from 14-17 November 2023, it centred on the latest scientific discoveries for optimising the nutritional value of sustainable foods by unpacking the hierarchy of complex structures occurring in foods and modifications during processing and gastrointestinal digestion.

After the previous FSDH was held online in 2021, there was a buzz amongst the scientists who were able to connect with colleagues in person once again.

Conference delegates were officially welcomed to Tāhuna Queenstown by Kaumātua Darren Rewi (Ngāi/Kai Tahu, Mana Tāhuna Māori Trust, Tāke Tuia Ltd) on the Tuesday evening. With the picturesque view over Lake Wakatipu, Darren shared the cultural narratives of the whenua (land) and the tāngata (people) of the area.

The conference included a Master Class, which highlighted topics from the fundamentals of food structure, ultra-processed foods, and novel food processing, to where to next for *in vitro* models for digestion of complex meals, and challenges and opportunities in nutritional sciences. Kaumātua Darren and Kemp Reweti (Manahautū/CEO Pūhoro STEMM Academy) added to the Master Class with a session on values-led models of education, research, and business from a Māori perspective.

Over the three days at FSDH, international scientists from industry and academia spoke to global food challenges, sustainable nutrition and food systems, human digestion, and redefining dietary guidelines.

A highlight of FSDH is always the conference dinner, and this year was no exception. The evening started with a sailing on the historic TSS Earnslaw across Lake Wakatipu to Walter Peak Station for a gourmet BBQ buffet dinner, followed by a farm show of shearing and herding sheep.

"The 2023 FSDH International Conference emerged as a resounding success, uniting global experts in a collaborative pursuit of food science and nutrition," Dr Alejandra Acevedo-Fani, Chair of the Scientific Committee said. With vibrant discussions, invaluable networking opportunities, and pioneering research shared, the conference exceeded all expectations.

She said FSDH 2023 offered the opportunity to form new networks, establish research collaborations and partnerships, and develop joint research initiatives. "Thanks to our valued sponsors and excellent speakers, the week was full of great scientific debate and discussions, and the insight shared covered a wide range of research into the future of food and nutrition, not just in Aotearoa New Zealand, but globally as well."

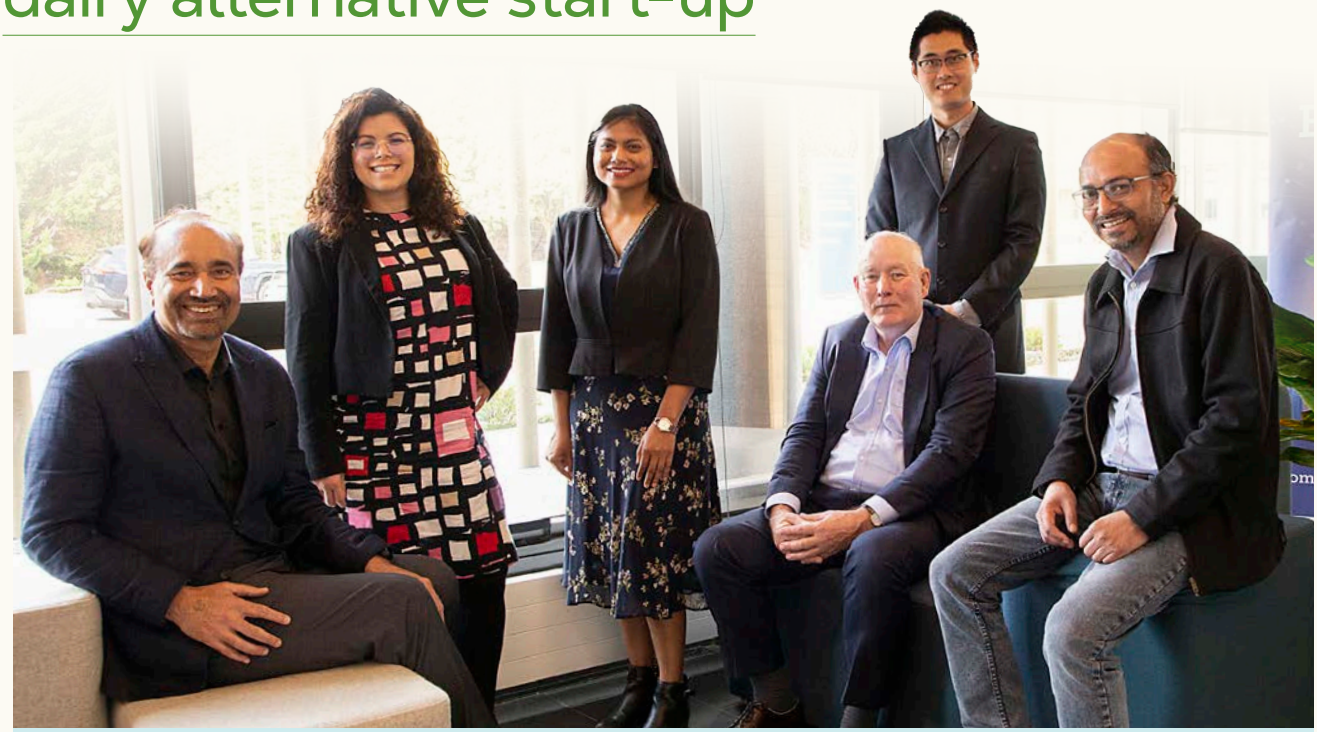
Top international food scientists heading to Palmerston North in 2024

In November 2024, the Riddet Institute is hosting the 17th International Hydrocolloids Conference at Massey University in collaboration with the International Hydrocolloids Society based in Canada.

The theme of the conference is "Future Hydrocolloids for Sustainable Food and Living Solutions". Within this theme, the conference will showcase the latest science and innovations, featuring insightful discussions and presentations from international experts on topics including the behaviour of food biopolymers during digestion, hydrocolloid design for delivering optimal nutrition, bioactive polysaccharides and human health, and future sustainable sources of natural hydrocolloids for food and non-food applications, including functional hydrocolloids for plant-based dairy and meat alternatives.

The conference will provide excellent networking opportunities and a chance to connect with international industry and business leaders.

Scientific innovation leads to new dairy alternative start-up



Saber Foods Limited inventors, from left, Distinguished Professor Harjinder Singh, Dr Alejandra Acevedo-Fani, Dr Debashree Roy, Distinguished Professor Paul Moughan, Yiran Wang and Dr Arup Nag.

Making a palatable milk or cream from a bad-tasting bean used to be impossible. But then the Riddet Institute Food Innovation Team put their exceptional scientific abilities to work: Four years later a new start-up was born.

"We are doing amazing, innovative science, leading to start-up companies and many commercial partnerships. Our science is the catalyst for creating these opportunities for New Zealand."

Saber Foods Limited was launched in 2023 to cater for the plant-based milk market, a segment expected to be worth $40 billion by 2040. Riddet Institute Director Dist. Prof Harjinder Singh says consumers were increasingly seeking sustainable, ethical and healthy alternatives to animal-based foods.

Food Innovation Team leader Dr Arup Nag was one of the team of six scientists who invented the new technology. He says the food scientists were observing with interest the rapid growth in plant-based dairy alternatives, and they identified an important gap in the alt-dairy offerings.

"Many of the existing plant-based products offered little in the way of nutritional benefits," Dr Nag says. "Some contained allergens, or they had limited practical use as a food ingredient."

The team began the search for a new alternative dairy ingredient among plant sources. They explored multiple plants and eventually found something unique – a little-known legume that was highly nutritious, environmentally friendly and could be converted into beverages. The legume ticked nearly all the boxes: it consisted of 25 per cent protein, was rich in minerals and vitamins, low in fat and had excellent sustainability credentials. But it did not taste good.

"This was the challenge – it was completely unpalatable," says co-inventor Dr Debashree Roy. "We needed to fix it and find out how to convert the legume into something people would like and want to consume."

The breakthrough came with a novel fermentation technology that was able to manipulate the flavour, taste and texture. This was a turning point, and two patents were taken out on the technology and the plant material to protect the intellectual property on the invention.

From there, senior scientist and co-inventor Dr Alejandra Acevedo-Fani says, there was a lot of further lab work and analysis on the nutritional and functional profile of the product, sensory evaluations and a scale up to produce it at the Riddet Institute's on-site pilot plant. The "milk" or "cream" could be whipped up to top the best

banoffee pie, frothed for an espresso or substituted for numerous milk products, many with functional properties that went beyond their dairy lookalikes. The formulations were also stable when subjected to pasterisation and UHT processes.

The huge potential of the product was identified, and outside expertise was then engaged with Motif in Wellington to help develop a business case for investors.

At the same time the Innovation Team conducted a large scale-up trial at Tetra Pak in Singapore, producing commercial prototypes to present to prospective business partners.

Dist. Prof Singh says it was immediately obvious the product had considerable commercial potential. The team enjoyed exceptional investor engagement by demonstrating a strong intellectual property position and the high-quality prototypes. Also positive was the feedback the team received when the product was taken to the Institute of Food Technologists (IFT) food Startups Pavilion in Chicago in 2023.

With the help of Massey Ventures Limited, a spin-out company was then formed, called Saber Foods Limited. Attracting $2.7million in seed funding capital from Icehouse Ventures, the company was launched in October 2023.

Dist. Prof Singh says the Riddet Institute is creating new entrepreneurial opportunities for emerging scientists in New Zealand. He was immensely proud of the results of the Riddet Institute Food Innovation Team's hard work and dedication in creating Saber.

"We are doing amazing, innovative science, leading to start-up companies and many commercial partnerships. Our science is the catalyst for creating these opportunities for New Zealand."

The Riddet Institute Food Innovation team comprises six scientists, Dist. Prof Harjinder Singh, Dr Alejandra Acevedo-Fani, Dr Debashree Roy, Dist. Prof Paul Moughan, Yiran Wang and Dr Arup Nag. Saber soon rebranded as AndFoods and took on Alex Devereaux as the CEO, appointing Arup Nag as CTO. Work is now accelerating on commercialising the new products and bringing them to the market.

The Riddet Institute is supporting R&D for business

Often the research and discoveries made at the Riddet Institute today become the new food products of tomorrow.

The Riddet Institute Food Innovation Team supports innovation and commercialisation by seeking collaborations and funding that can turn promising new research findings into patented products. Previous successful commercialisation activities have included FerriPro™ iron encapsulation technology licensed to Nestlé, and several products developed for the Alpha Group (via the Massey-Alpha Natural Nutraceuticals Research Centre).

The Riddet Institute is increasingly working with start-up companies to provide expert advice, or research and development (R&D) to support the creation of novel technologies and products. Recent start-ups the Institute has supported include:

Miruku is an international collaboration that intersects future food, biotech and agriculture, with the Riddet Institute contributing its expertise in protein functionality, and food applications. This biotech start-up aims to produce dairy products using molecular farming techniques with plant cells to produce proteins, fats, and sugars. The technology would effectively circumvent dairy farming to make animal-free dairy foods and beverages.

Opo Bio is a business-to-business spin-out company specialising in providing cell lines for cultivated meat production. Founded by Riddet Institute researchers, the company arose in part from research undertaken at the Riddet Institute. Their first product, primary bovine muscle cells (Opo-Moo) is available for researchers to purchase and has been developed from disease-free premium New Zealand livestock.

Unlocking protein from the leaves of plants is the aim of Leaft, a start-up focusing on lowering the carbon footprint of food production and enabling the world to produce enough food for a growing population. Rubisco is a protein present in green leaves that is essential for photosynthesis; animals can digest it but humans cannot. Launched in 2019, Leaft is working on extracting the protein and turning it into food products, without animal intermediaries.

The Riddet Institute works with key stakeholders to achieve impact, including its Strategic Industry Partners:

Zespri KIWIFRUIT · Fonterra · ALPHA GROUP · douglas nutrition · goodman fielder · WAKATŪ INCORPORATION · NUKU kite PUKU

Aligned Programmes

Food research projects benefit economy and build knowledge

Industry funding for aligned Riddet Institute research projects increased in 2023, representing a rise in confidence in Riddet Institute activities. Overall funding was down on the year before, dipping slightly to $6.7 million, due the completion of some multi-year projects. Significant new funding from government sources has since been allocated and will be recorded in the Riddet Institute's 2024 report.

The original research in food science and nutrition being done at the Riddet Institute and its connections with food companies is making an impact in the New Zealand food sector. These research projects (listed below), and the connections made from them, will transfer advanced knowledge and innovation, building skills for New Zealand's economic benefit.

The Sustainable Nutrition Initiative® (SNi) Programme is gaining significant recognition nationally and internationally, and continues to grow in size, up to a team of eleven.

Its influence has also grown with new funding received from industry and government in New Zealand and internationally. SNi comprises data and modelling programmes to enable better understanding of the food system and the opportunities to sustainably feed the global population, national and regional populations, and individuals. It aims to generate new insights into sustainable food systems and diets based on best available evidence.

The initiative is led from the Riddet Institute by Prof Warren McNabb, in collaboration with other industry participants and experts, including the newly established International Advisory Group. The Group boasts an array of world-leading experts who are committed to improving global nutrition: Rangimarie Hunia (Chair, Ngāti Whātua Ōrakei Whai Maia), Prof Manny Noakes (formerly CSIRO), Dr Jason Clay (WWF), Dr Samuel Thevasagayam (the Bill & Melinda Gates Foundation), Jeroen Dijkman (Nestlé Institute of Agricultural Sciences), Berry Martin (formerly Rabobank Group), and Lain Jager (Thought Leaders Group, Te Puna Whakaaronui).

MBIE Catalyst programmes

In addition, the Riddet Institute contributed to several programmes funded by the Ministry of Business, Innovation and Employment (MBIE) which had significant industry involvement. Examples include:

→ **Professor Joanne Hort** (Principal Investigator, Massey University) is leading Te Rangahau Taha Wheako mō ngā Kai o Āpōpō: The Consumer Dimension of Future Foods, which involves a number of NZ industry partners: NZ Algae Innovation, Goodman Fielder, Fonterra, Movers in Hemp Innovation (MiHI), Wakatū Incorporation, NUKU ki te Puku™, Vince and Food Nation.

→ **Dr Arup Nag and Dist. Prof Harjinder Singh** collaborate with the Cawthron Institute-led programme to investigate the potential of the red seaweed, Karengo, and the microalga, Chlorella, as everyday alternative protein sources.

→ **Dr David Everett** (Principal Investigator, AgResearch) is a senior investigator on the project co-led by Dr Linda Samuelsson (AgResearch) and Dr James Chan (A*STAR, Singapore) on the cooking and processing of seaweed to improve consumer acceptance, protein digestion and nutrient bioavailability.

→ **Dr Laura Domigan** (Associate Investigator) leads a team exploring the development of successful hybrid foods using plant proteins (soy bean and pea) and cultured livestock cells (including cattle, sheep, deer and pig).

Milks Mean More

The New Zealand Milks Mean More programme (NZ3M), led by the Riddet Institute and funded by MBIE (2018-2022), involves multiple New Zealand dairy companies and most of the Riddet CoRE partners. NZ3M is an in-depth interdisciplinary research project to understand the key impacts of dairy components from different ruminant sources in providing better nutritional and health outcomes. The project is supported by the A2 Milk Company, Blue River Dairy, Cilantro Cheese, The Dairy Goat Cooperative, Fonterra, Goodman Fielder, Kingsmeade Cheese, Mataura Valley Milk, Pāmu (Landcorp Farming), Maui Milk, Miraka, NIG Nutritionals, Spring Sheep Milk Co, Synlait, Tatua and Waiu Dairy.

New products being investigated with High-Value Nutrition (HVN) National Science Challenge

The Riddet Institute was the lead research partner for the government's High-Value Nutrition (HVN) Science of Food programme. The programme is led by Distinguished Professor Harjinder Singh and Senior Research Scientist Dr Ali Rashidinejad. The Institute also supports the wider HVN programmes and HVN industry stakeholders with food science capability, knowledge sharing, and facilitates the development of new products for clinical evaluation.

Projects continuing or completed in 2023:

- With Calocurb Limited to develop a functional food ingredient from hops, for potential use in calorie control food products. This project will continue into 2024 with work on incorporating the delivery system into selected food models.
- In a Māori-led partnership with Wakatū Inc. and Chia Sisters on their 'Tūhauora' clinical research project, led by the University of Auckland, the Riddet Institute involved looking at developing a dried ingredient from the taonga species kawakawa and exploring products for the Japan market.

A project on New Zealand-grown cherries puts the cherry on top for health benefits.

- With NIG Nutritionals, an investigation of powdered milk consumption (bovine, ovine, caprine) in an elderly cohort has been completed. The clinical trial was done at the University of Otago and some *in vitro* analysis of the digestion of whole milk powders was carried out at the Riddet Institute in 2023. This research is in collaboration with the MBIE-funded NZ3M programme, led by the Riddet Institute, and also involves Miraka and Spring Sheep Dairy.
- In a Māori-led partnership with Te Taiao Innovations Limited, research into freeze-dried mamaku as a smoothie ingredient with potential metabolic health benefits (aligned with a wider programme of research into mamaku led by Plant & Food Research with Nga Uri o te Ngahere Trust). This project was completed in March 2023.
- With Zoffee Limited, exploring a Native New Zealand coffee alternative. Completed in 2023, this project resulted in the development of a caffeine-free coffee alternative.
- With Cherri Global Health & Manufacturing Limited, research establishing the bioactive baseline for New Zealand cherries, with a possible future focus on cherry waste.
- With NewFish, a $50,000 research project to establish the quality of protein in paua. An *in vitro* DIAAS assay was completed to measure the quality of the protein.

Protein database comes from Proteos programme

The Riddet Institute spearheads an international collaborative research team in the Proteos programme, led by Dist Prof Paul Moughan and Dr Suzanne Hodgkinson. The second phase of the programme to develop a global database of protein quality from commonly consumed foods was funded in 2021 by a consortium of international food companies led by the Global Dairy Platform. The funding amounted to US$1.5M over two years.

OTHER RESEARCH PROJECTS

- Work is continuing on a MBIE-funded research on "New Infant Formula Emulsions", by Associate Investigators Dr Caroline Thum and Dr Simon Loveday.
- Dr Alejandra Acevedo-Fani leads a $476,000 project with Fonterra investigating milk ingredient behaviour during digestion for infant nutrition.
- Also involving infant nutrition, a project with Inner Mongolia Dairy Technology Research Institute Co. Ltd is being led by Associate Investigator Dr Suzanne Hodgkinson to determine the content of digestible amino acids in breast milk and evaluate the protein quality of infant formulas.
- In its third year of four years, a project assessing the quality and nutritional potential of proteins extracted from Irish marine, meat and dairy sources is underway, with Dr Suzanne Hodgkinson project leader for a Walsh Fellowship in collaboration with Teagasc, Ireland.
- A project examining the digestibility of different calcium sources is led Dr Suzanne Hodgkinson and funded by DSM International.

Our People

The Riddet Institute seeks to celebrate diversity at all levels of our organisation. We are committed to the proactive development of staff and students in the Institute and the inclusion of people from under-represented groups. We consider that a culture embracing equity and diversity is intrinsic to better science and innovation.

Dr Debashree Roy won the ticket to represent New Zealand.

Innovative research on plant-based cheeses sends scientist to Berlin

Postdoctoral fellow Dr Debashree Roy eclipsed 21 other participants from around New Zealand and the Pacific Islands to win the Falling Walls Lab Aotearoa New Zealand finals in Wellington on 5 September 2023. Dr Roy's presentation was on "Breaking the wall of plant-based cheese based" on patented technology created by the Riddet Institute food innovation team.

Falling Walls is an interdisciplinary pitch competition to showcase the next generation of students and early-career professionals. In a three-minute presentation, participants present their innovative research, business model, or initiative, showcasing a breakthrough that creates a positive impact on science and society.

PhD student Vitor Geniselli Da Silva also made it through the highly competitive preliminary round to the finals in Wellington, and presented his research on "Breaking the wall of the infant microbiome".

As the winner, Dr Roy was chosen to represent Aotearoa New Zealand in Berlin, Germany in November at the Falling Walls Foundation Science Summit. Dr Roy was one of 100 scientists competing in the Emerging Talents category from 64 countries around the world.

International research rankings put Riddet Institute at the top of food science in New Zealand

Stanford University's international research rankings released in November placed Riddet Institute Director Distinguished Professor Harjinder Singh as the top food scientist in New Zealand.

The rankings list the 2 per cent most influential scientists in the world in different disciplines. Dist. Prof Harjinder Singh is the highest-ranked food scientist in New Zealand, the second-highest in Australasia, and 19th in the world, in the discipline of food science and technology. He is internationally ranked 3781 out of the top 210,198 scientists across all science disciplines.

Eleven Riddet Institute researchers ranked in the top 20 food scientists in New Zealand. Dr Sara R. Jaeger, Professor Aiqian Ye, Distinguished Professor Paul J. Moughan, Dr Li Day, Distinguished Professor R. Paul Singh, Professor Indrawati Oey, Professor Phil Bremer, Dr Mike Boland, Dr Barbara Burlingame, and Professor Matt Golding were all noted for their significant contributions to the field. Associate Investigator Dr Skelte Anema was ranked second in New Zealand in dairy and animal science.

In the annual Stanford University rankings, scientists are ranked in order of the number of publications they have authored and the frequency with which they are cited by others. There are 210,198 global scientists in the top 2 per cent and the rankings are widely used as a measure of research excellence and impact. The 2023 Stanford rankings, published by Elsevier, are collated over a scientist's entire career, updated to the end of 2022.


Distinguished Professor Harjinder Singh

Summer students get a taste for food and nutrition research

The Riddet Institute hosted 17 summer interns in various locations.

Alice Boyd (Ngāti Kahungunu, Ngāti Porou) researched endolysin bioparticles for dental applications (Massey University/ Pūhoro STEMM Academy).

Amie Gooding (Te Ati Awa) investigated preparing future leaders in nutrition (University of Otago).

Ana Gibson (NZ European Pākehā / Samoan) explored food waste in universities in the Pacific (University of Otago).

Chu (Quinn) Vy, Daniel Shippey, and Jacob Knight interned on SNi projects including the environmental impact of fermentation produced food ingredients, DELTA Model® sensitivity analysis, and protein quality in vegan diets (Massey University).

Cody Garton (Tainui) researched the antimicrobial potential of kānuka/mānuka products (AgResearch/Pūhoro STEMM Academy).

Dharmesh Bhula compared the structural differences of hempseed protein bodies and their protein fractions on digestion behaviour (Massey University).

Irris Jermaine Tiare Etches (Cook Island Māori/Fijian) investigated seaweed-based foliar spray preparation and green lip mussels from a key Marlborough Sounds kelp and mussel farm (University of Otago).

Jeongsu (Erik) Yoo explored alternate product ideas for cheese whey liquid (AgResearch/Massey University).

Jinxin Zhang researched the effect of pH on the formation of heat-induced hempseed proteins and whey proteins complex (Massey University).

Meg MacGregor-Dunn (Māuapoko) assessed the digestibility of plant-based substrates in an *in vitro* model (Massey University/Pūhoro STEMM Academy).

Millie Harland (Ngāti Kahu) researched dietary intakes of older Olympians (University of Otago).

Pelenitina Vao (Tongan) investigated the effects of eating apples in individuals with an inflammatory bowel disorder (Massey University).

Rubi Te Rangi Smith (Rangitāne o Manawatū) considered Te Ao Māori provenance and values in food and beverage products for domestic and export markets (Massey University/Pūhoro STEMM Academy).

Shahanna Tahere (Ngāti Raukawa, Whakatōhea, Te Arawa, Ngāpuhi) worked with company Te Mauri AIO on their Te Rongoā te Mamaku project (Massey University/Pūhoro STEMM Academy).

Yi Ding explored the impact on serum protein on whippability of dairy creams (Massey University).

Student creativity shines at Colloquium

The winners of the Student Colloquium presentations. From left, Patricia Soh (third place), Jacqueline Tonkie (first place), and Aylin Şen (second place).

The annual Riddet Institute Student Colloquium was held in Tāhuna Queenstown this year in November before the Food Structures, Digestion and Health International Conference. It brought together our postgraduate students from across the country to share research and be inspired by guest speakers.

Forty-two students competed in a 90-second thesis video competition showcasing their in research and their creativity. There was everything from Pixar-style animations to videos of students' research in action.In what was a very tight competition, judges awarded Jacqueline Tonkie first place, with her animated presentation on "Complementary feeding to nourish and support the developing infant". There was an audible response from the audience when her video came on screen, and there was great enjoyment at the cartoon versions of Jacqueline and her supervisors.

In a close second was 2022's winner Aylin Şen, with her clear and interesting explanation of her topic "New functionalities from plant oil bodies for food applications". In third place was Patricia Soh, whose animated video explaining "Protein quality in vegan diets" conveyed clearly the importance of her research and entertained the audience. A highly commended mention went to Xuan Dong, who included videos of herself in the lab for her video on "Sustainable solutions: Unveiling the science behind hempseed protein".

"To capture the essence of a PhD in 90 seconds is a challenge in itself," says Riddet Institute Board Chair, Rt Hon Sir Lockwood Smith, who awarded the prizes. "Yet, the enthusiasm of the students and the attention-grabbing professionalism of each video was a revelation. The presentations demonstrated the educational strength, research capacity and international influence of the Riddet Institute."

The second half of the colloquium featured presentations from Ira Bing (Miruku Ltd), Tomás Ribeiro (University of Otago), and Associate Professor Lisa Te Morenga (Health Coalition Aotearoa), covering topics from commercial opportunities in food innovation, managing IP, and effective advocacy.

Graduates head to a wide range of careers

Many of our students and emerging scientists go on to a career in food research or the food industry. We prepare our young scientists for this through industry-ready training. Some students and staff who have recently started careers in industry and research are highlighted below.

ANKITA JENA

Research Scientist, Fonterra.

Ankita Jena's PhD was entitled "Ruminants' milk in early postnatal brain development in a pig model of the human infant." Ankita graduated in 2023, and found her experience at the Riddet Institute enriching. One of her highlights was interacting with other PhD students and scientists from diverse nationalities and cultural backgrounds. Ankita found the national and international collaboration opportunities invaluable and strengthened her research abilities. Ankita is now working as a Research Scientist at the Fonterra Research and Development Centre. In this role, she delves into the intricate relationship between dairy products and health through computational biology. The role allows Ankita to apply the knowledge and expertise from her PhD at the Riddet Institute to real-world problems.

TACIANA LUNELLI

Target Evaluator (Biosecurity), Ministry for Primary Industries, Aotearoa New Zealand.

Taciana Lunelli's PhD research focused on emulsion-based delivery systems to improve gut and brain bioaccessibility of curcumin in relation to Alzheimer's disease prevention. Through her study she became passionate about the topic and started a part-time job with Alzheimers Manawatū leading a project on digital fluency and online resources during the Covid-19 lockdowns. Since graduating, Taciana is now working for the Ministry for Primary Industries (MPI) as a Target Evaluator in biosecurity. As part of her role, Taciana assesses items being imported into Aotearoa New Zealand, checking for compliance and issuing directions. Though not directly related to food science, Taciana enjoys working with her team at MPI and plans to move into a food compliance role in the future.

HAROON JAMSHAID QAZI

Lecturer, Department of Food Science and Human Nutrition, University of Veterinary and Animal Sciences, Pakistan

Haroon Jamshaid Qazi's PhD focused on understanding different food structure modifications in the gastrointestinal environment and their impact on the delivery of encapsulated lipophilic bioactive compounds. Following the successful completion of his doctoral studies, Haroon served as a Junior Research Officer at the Riddet Institute, where he made significant contributions to various projects centred around dairy and plant proteins. Haroon observed that the supportive culture in the Riddet Institute has not only fostered collaboration but also facilitated personal growth and development. Currently, Haroon serves as a Lecturer at the Department of Food Science and Human Nutrition at the University of Veterinary and Animal Sciences, Pakistan. In this role, he is actively engaged in lecturing and mentoring undergraduate and postgraduate students in the areas of food and nutritional sciences. Leveraging his doctoral expertise, he actively contributes to the enhancement of departmental facilities, aspiring to integrate cutting-edge techniques and methodologies acquired during his PhD.

LAURA PAYLING

Animal Science Lead at Biofractal, Portugal

Laura Payling's PhD explored the links between human breath methane, dietary fibre digestion, and the gut microbiota. Laura was president of the Riddet Institute student society, which exposed her to leadership opportunities and developed skills outside of research that have helped with her career progression. She chose to do her studies at the Riddet Institute based on its reputation for interesting research and the varied career paths of its graduates into both academia and industry. Since finishing her study, Laura has moved to Portugal and joined the animal science division for an innovative startup, Biofractal, which uses complex biological data, advanced data science, and digital technology to improve animal health and sustainability outcomes. The skills she gained while at the Riddet Institute, particularly working with systems, have transferred to her new role where she connects science, animal science applications, and people.

Student Success

Our students and postdoctoral fellows achieve at the highest level. Some outstanding student achievements from 2023 are:

Doctoral students outstanding in their field

Two PhD students were included in the University Dean's list of Exceptional Doctoral Theses in 2023: **Lirong Cheng,** left (Massey University) and **Mengxiao Wang** (Massey University).

Aylin Şen wins the oral presentation prize at the DOF symposium held at Monash University, Melbourne.

PhD research excellence recognised with awards

Akashdeep Beniwal received the Wiley Top Downloaded Article (in the first 12 months), for a previously published paper entitled: "Meat analogs: Protein restructuring during thermomechanical processing".

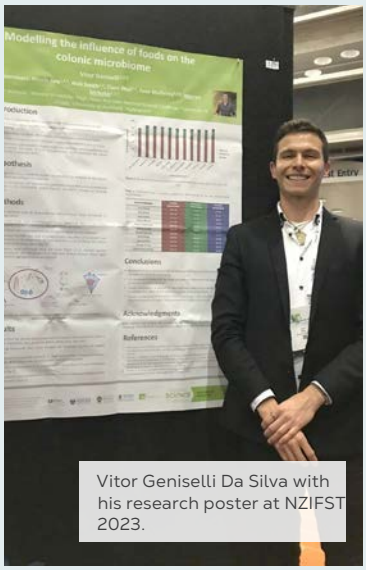
Aylin Şen won 'Best Oral Presentation' at the recent DOF 10th International Symposium on 'Delivery of Functionality in Complex Food Systems', Melbourne, in October 2023.

Catherine Maidment was awarded 2nd place in the Massey University 3 Minute Thesis competition in September.

Patricia Soh was the oral presentation runner up at the Nutrition Society Conference, Auckland, November.

Mengxiao Wang came 2nd in the Poster Competition at FSDH Conference, Queenstown, November.

Qayyum Shehzad was the winner of Zero Hunger theme, 4th Commonwealth Chemistry poster presentation, December.



Vitor Geniselli Da Silva with his research poster at NZIFST 2023.

PhD student getting his research out across the country

Vitor Geniselli Da Silva has had a productive year sharing his research. Vitor is in the second year of his PhD at Massey University researching foods to optimise the colonic microbiome for our lifelong health and wellbeing. In July, Vitor came 3rd in the 3 Minute Pitch competition at the NZIFST Conference in Dunedin. He was also amongst the finalists of the Massey University 3 Minute Thesis Competition, which provides a great opportunity for doctoral students to engage in research communication activities and accelerate their writing.

At the start of September, Vitor was selected for the Falling Walls Lab Aotearoa New Zealand event at the NZ Royal Society Wellington for his presentation on "Breaking the Wall the Infant Microbiome". Being selected to be one of only 21 finalists from around New Zealand and the Pacific Islands is a significant achievement and recognition of not only his excellent research but also his strong communication skills.

Funds awarded to students to attend international conferences

A number of students were awarded Riddet Institute Student Conference Awards to present their research at international conferences in 2023:

- **Natalie Ahlborn** presented at the International Symposium on Dietary Protein for Human Health, Utrecht, Netherlands.
- **Catherine Maidment** presented at the Joint 11th Asia Oceania Human Proteome Organisation (AOHUPO) and 7th Asia Oceania Agricultural Proteomics Organisation (AOAPO) Congress, Singapore.
- **Nabil Parkar** presented at Digestive Disease Week (DDW) 2023, Chicago, USA.
- **Mengxiao Yang** presented at the 13th NIZO Dairy Conference 2023, Arnhem, Netherlands.
- **Mariero Gawat** presented at the 10th International Symposium on 'Delivery of Functionality (DOF) in Complex Food Systems', Melbourne, Australia.

Awards and achievements

Our investigators are high-achieving researchers in their fields. The following investigators, students, and other personnel gained recognition during 2023.

NAME	AWARD/APPOINTMENT
Dr Alejandra Acevedo-Fani (Principal Investigator	→ Awarded funding grant from the MBIE Endeavour Round, September 2023, for AgResearch/ Riddet Institute/Plant & Food Research collaborative project entitled: "Plant-Based Food Ingredients: a Systems Approach to Sustainable Design" (5 years, $12M). → Appointed Principal Investigator of the Riddet Institute. → Appointed Chair of the Scientific Committee of the "Food Structures, Digestion and Health" international conference. → Appointed as Guest Editor of Special Issue in *Foods* (Impact Factor 5.2) with Dr Mike Boland and Dr Lovedeep Kaur, titled "Food Proteins: Processing, Interactions, Functionality and Bioavailability".
Prof Gail Bornhorst (Principal Investigator)	→ Awarded funding by the US Department of Agriculture, June 2023, of USD$594,000 for a project entitled: 'Enhancing functionality of plant proteins: Engineering novel structures and developing a predictive framework for food product development'.
Dr Lirong Cheng (Postdoctoral Fellow)	→ Awarded one of 30 Young Scientist Travel Awards to attend the Joint 11th AOHUPO and 7th AOAPO Congress in conjunction with SSMS 2023, in Singapore, 8-10 May 2023.
Dr Sylvia Chungchunlam (Research Officer)	→ Received funding of USD$52,000 from the Global Dairy Platform and the US Dairy Export Council to lead a research project entitled: 'Are animal-sourced foods needed for affordable diets: the dynamic modelling of nutritionally adequate least-cost diets in developing countries using a Linear Programming approach'. This project also involves Dist. Prof Paul Moughan. → Appointed as Guest Editor (2023) for the Special Research Topic "Dietary Protein for Human Health", *Frontiers in Nutrition*.
Dr Renwick Dobson (Principal Investigator)	→ Appointed to the new *Sustainable Food Proteins* journal, as Editorial Advisory Board member, April 2023.
Dr Laura Domigan (Principal Investigator)	→ Finalist for the BNZ Researcher Entrepreneur Award at the 2023 Kiwinet Awards, September 2023.
Dr Amanda Dupas de Matos (Postdoctoral Fellow)	→ Appointed as Review Editor on the Editorial Board of *Food Characterization* (specialty section of *Frontiers in Food Science and Technology*), 2 May 2023. → Promoted to the rank of Senior Research Officer (Massey University).
Dr Suzanne Hodgkinson (Associate Investigator)	→ Awarded funding grant from the MBIE Endeavour Round, September 2023, for AgResearch/ Riddet Institute/Plant & Food Research collaborative project entitled: "Plant-Based Food Ingredients: a Systems Approach to Sustainable Design" (5 years, $12M).
Dr Lovedeep Kaur (Associate Investigator)	→ Promoted to the rank of Associate Professor (Massey University).
Prof Warren McNabb (Principal Investigator)	→ Awarded funding grant from the MBIE Endeavour Round, September 2023, for the SNi collaboration with Wakatū Incorporation. Project entitled: "Kai anamata mō Aotearoa – exploring future food system scenarios and impacts" (5 years, $10M).
Dr Hannah McKerchar (Postdoctoral Fellow)	→ Won first prize for her poster presentation at the Australasian Research Managers Society (ARMS) Conference in Sydney, 6-8 September 2023.
Dist. Prof Paul Moughan (Principal Investigator)	→ Invited to be Global Advisor to the Bill and Melinda Gates Foundation (April 2023) and participated in the Gates Foundation workshop on alternative proteins for maternal nutrition, London, 17-19 April 2023. → Appointed as Director, Saber Foods Limited, August 2023. → Appointed as Guest Editor (2023) for the Special Research Topic "Dietary Protein for Human Health", *Frontiers in Nutrition*. Drs Sylvia Chungchunlam and Suzanne Hodgkinson are also Guest Editors.

NAME	AWARD/APPOINTMENT
Dr Noha Nasef (Postdoctoral Fellow)	→ Awarded a HRC Career Development Award from worth $140,000 for a project entitled 'Utility of dietary management for ulcerative colitis'. She will work in collaboration with gastroenterologists at Te Whatu Ora (MidCentral). → Awarded funding from the Palmerston North Medical Research Foundation to support a clinical trial on the effect of apple on colitis. The funding is $10,000 for one year.
Prof Indrawati Oey (Principal Investigator)	→ Was a named investigator on a Smart Idea grant – Project Title: "New Zealand seaweed: a tissue engineering opportunity" (2 years, NZ$1M).
Dr Olivia Ogilvie (Affiliated Researcher)	→ Finalist for the Momentum Student Entrepreneur Award at the 2023 Kiwinet Awards, September 2023.
Prof David Rowlands (Associate Investigator)	→ Awarded $93,000 from Wool Industrial Research Limited for his project on Improving Sensory Attributes of Wool Derived Keratin Protein. It is aligned with CoRE Project 2.2.
Dr Debashree Roy (Postdoctoral Fellow)	→ Won the Falling Walls Lab Aotearoa New Zealand competition at the New Zealand Royal Society Wellington, 5 September 2023, for her presentation on "Breaking the Wall of Plant-based Cheeses". Dr Roy represented New Zealand at the Falling Walls Lab & Science Summit 2023 in Berlin, 5-9 November 2023.
Prof Nicole Roy (Principal Investigator)	→ Awarded a project grant from the Health Research Council (HRC), June 2023, for 'Effect of an Aotearoa New Zealand diet for metabolic health on the gut microbiome' (3 years, $1,174,971).
Prof Elaine Rush (Associate Investigator)	→ Appointed as Guest Editor for the *Journal of the Royal Society of New Zealand* special issue, with a focus on a Sustainable Food System in Aotearoa which meets the dietary needs of our population, May 2023. → Appointed Life Member of the New Zealand Nutrition Foundation, after 18 years' service as Scientific Director of the New Zealand Nutrition Foundation, September 2023.
Dist. Prof Harjinder Singh (Director)	→ Invited to join the assessment panel for the Royal Society Te Apārangi 2023 Charles Fleming Publishing Award (April 2023), the 2023 MacDiarmid Medal and Hamilton Award, May 2023. → Finalist for the BNZ Researcher Entrepreneur Award at the 2023 Kiwinet Awards (September 2023). → Appointed as Director, Saber Foods Limited, August 2023.
Prof Jaspreet Singh (Associate Investigator)	→ Appointed to the rank of Professor at Massey University.
Dr Nick Smith (Research Officer)	→ Invited to join the Te Puna Whakaaronui Thought Leadership Group (June 2023). → Awarded funding grant from the MBIE Endeavour Round, September 2023, for the SNi collaboration with Wakatū Incorporation. Project entitled: "Kai anamata mō Aotearoa – exploring future food system scenarios and impacts" (5 years, $10M).
Assoc Prof Lisa Te Morenga (Principal Investigator)	→ Awarded a Massey University Supervisor Research Medal, December 2023.
Prof Peter Xu (Principal Investigator)	→ Awarded an extension of twelve months for the US Food & Drug Administration (FDA) project 'In-Vitro Tools to Simulate Chewing of Pharmaceutical Opioid Drug Products', USD$210,000 (1 October 2023 – 30 September 2024). This project was originally funded for two years (1 October 2021 – 30 September 2023) USD$345,000.
Prof Aiqian Ye (Principal Investigator)	→ Awarded funding grant from the MBIE Endeavour Round, September 2023, for AgResearch/Riddet Institute/Plant & Food Research collaborative project entitled: "Plant-Based Food Ingredients: a Systems Approach to Sustainable Design" (5 years, $12M).
Assoc Prof Michelle Yoo (Affiliated Researcher)	→ Promoted to the rank of Professor (AUT).

AWARDS AND ACHIEVEMENTS CONTINUED...

NAME	UNIVERSITY	AWARD/APPOINTMENT NAME
Akashdeep Beniwal	Massey University	→ Received the Wiley Top Downloaded Article (in the first 12 months), for a previously published paper entitled: "Meat analogs: Protein restructuring during thermomechanical processing".
Lirong Cheng	Massey University	→ Included in the Deans List of Exceptional Theses.
Vitor Geniselli da Silva	Massey University	→ Selected for the Falling Walls Lab Aotearoa New Zealand event in NZ Royal Society Wellington, 5 September 2023 for his presentation on "Breaking the Wall the Infant Microbiome". → Finalist in the Massey University 3 Minute Thesis competition, September 2023.
Catherine Maidment	Massey University	→ Awarded 2nd place in the place in the Massey University 3 Minute Thesis competition, September 2023.
Aylin Şen	Massey University	→ Won 'Best Oral Presentation' at the DOF 10th International Symposium on 'Delivery of Functionality in Complex Food Systems', Melbourne, October 2023. → Awarded 2nd place in the Student Colloquium 2023 Video competition, Queenstown, November 2023.
Qayyum Shehzad	Massey University	→ Won the Zero Hunger theme in the 4th Commonwealth Chemistry Poster Competition.
Patricia Soh	Massey University	→ Awarded the Oral Presentation runner up at the Nutrition Society Conference, Auckland, November 2023. → Awarded 3rd place in the Student Colloquium 2023 Video competition, Queenstown, November 2023.
Jacqueline Tonkie	Massey University	→ Won the Ansley Te Hiwi student communicator award for her winning video at the Riddet Institute Student Colloquium, Queenstown, November 2023.
Mengxiao Wang	Massey University	→ Won 2nd place in the Poster Competition at the FSDH International Conference, Queenstown, November 2023.

A still from the winning video by Jacqueline Tonkie.

Keynote and invited presentations at conferences

Investigators gave several keynote and invited presentations at international and domestic conferences and events, as follows:

NAME	TITLE	EVENT	VENUE/DATE
Dist. Prof Paul Moughan	Plenary session: Dietary proteins in human nutrition – Recent advances	The International Life Science Institute (ILSI) Region's Protein Symposium 2023 "Protein Science – Translating the Fundamentals and State-of-the-art Knowledge for Nutrition, Health & Sustainability"	Singapore, 21-22 February 2023
Dist. Prof Harjinder Singh	Sustainable technologies to enhance delivery and bioavailability of nutrients and bioactives in food	Institute of Food Technologists (IFT) Roundtable Speakers Meeting on Enabling Food & Nutrition Security Through Processing Technologies to Sustainably Preserve Nutritional Quality	Online, 14-15 March 2023
Prof Warren McNabb	Moving from food security to nutrition security	BOMA/E Tipu IFAMA 2023	Christchurch, 17-20 June 2023
Dame Juliet Gerrard	Food waste: A global and local problem	NZIFST Conference	Dunedin, 5-7 July 2023
Prof Indrawati Oey	Enhancing the nutritional and sensory properties of legumes through innovative food processing technology	NZIFST Conference	Dunedin, 5-7 July 2023
Dr Mei Peng	Effects of olfactory and gustatory perception on food choices and macronutrient intake	NZIFST Conference	Dunedin, 5-7 July 2023
Prof Nicole Roy	Microbiota-gut-brain axis: new opportunities for dietary interventions	NZIFST Conference	Dunedin, 5-7 July 2023
Prof Warren McNabb	How do structures in milk function within foods, and their impact on human digestion and nutritive value following processing?	NZIFST Conference	Dunedin, 5-7 July 2023
Dr Suzanne Hodgkinson	Nutritional quality of protein in foods	World Dairy Industry Conference	Hohhot, China, 4-7 August 2023
Prof Warren McNabb	Red meat and global nutrition	Red Meat Sector Conference	Auckland, 6-7 August 2023
Prof Joanne Hort	The changing environment is just a click away. Including Hort. J: Digital immersion: Why and When	International Pangborn Sensory Science Symposium	Nantes , France, 19-24 August 2023
Dist. Prof Paul Moughan	Welcome Address Review of progress in describing dietary protein quality and DIAAS – 10 years on	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023
Dr Suzanne Hodgkinson	Amino acid digestibility/availability definitions and conventional oro-ileal determination in humans	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023
Dist. Prof R Paul Singh	Advances in the design of physical models to study food digestion in the gastrointestinal tract	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023
Prof Robert Wolfe	Describing protein quality: an overview	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023
Dr Barbara Burlingame	Global food sustainability - the UN 2030 agenda and beyond	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023
Dr Andrew Fletcher	Food protein – a global nutrient context	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023
Dr Sylvia Chungchunlam	Food protein sources – the affordability dimension	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023

AWARDS AND ACHIEVEMENTS CONTINUED...

Warren McNabb speaking at BOMA-E Tipu


Jeremy Hill giving IFST Lecture


Alejandra Acevedo-Fani presenting at FSDH

NAME	TITLE	EVENT	VENUE/DATE
Dist. Prof Harjinder Singh	Closing Address	International Symposium: Dietary Protein for Human Health	Utrecht, The Netherlands, 14-16 September 2023
Prof Indrawati Oey	Use of innovative food processing technology to improve the nutritional and sensory properties of legumes	14th Asian Congress of Nutrition (ACN)	Chengdu, China, 14th-17th September 2023
Dist. Prof Paul Moughan	Review of progress in describing dietary protein quality and DIAAS – 10 years on	FrieslandCampina	The Netherlands, 21 September 2023
Prof Jeremy Hill	Surviving in a hostile world: The need for food science and technology	Institute of Food Science and Technology UK Annual Lecture	London Parliamentary Buildings, 10 October 2023
Dist. Prof Paul Moughan	Non starch polysaccharides and human health	Alpha Forum and Conference, Alpha Group	Fujian, Ningde, China, 10-15 October 2023
Prof Aiqian Ye	Characteristics of milk proteins from different ruminant species: the composition and processing impacts on coagulation properties and digestion	13th NIZO Dairy Conference 2023	Arnhem, Netherlands, 17-20 October 2023
Dist. Prof Paul Moughan	Food sustainability/Protein digestion	FAO World Food Forum	Youth Side Event, Rome (Virtual), 20 October 2023
Dist. Prof Paul Moughan	The link between diet quality and social inequality	UN Committee on World Food Security (CFS) Side Event	Rome, 26 October 2023
Prof Indrawati Oey	Novel food processing – opportunities for research and industry	Food Structures, Digestion and Health International Conference	Queenstown, 15-17 November 2023
Prof Gail Bornhorst	*In vitro* models for digestion of complex meals: Where do we go from here? Development of dynamic *in vitro* models and correlation to *in vivo* studies	Food Structures, Digestion and Health International Conference	Queenstown, 15-17 November 2023
Prof Robert R. Wolfe	Optimal vs required dietary protein intake in different populations. Is "personalised" nutrition feasible?	Food Structures, Digestion and Health International Conference	Queenstown, 15-17 November 2023
Prof Lisa Te Morenga	Effective advocacy – Lessons from Health Coalition Aotearoa Panel discussion: Food structure and nutrition – redefining dietary guidelines and food labelling for improved health outcomes	Food Structures, Digestion and Health International Conference	Queenstown, 15-17 November 2023
Dr Alejandra Acevedo-Fani	How much do we know about the interactions of bioactive substances and the milk matrix within the GIT?	Food Structures, Digestion and Health International Conference	Queenstown, 15-17 November 2023
Dr Laura Domigan	Cell-based meat production and Aotearoa	Food Structures, Digestion and Health International Conference	Queenstown, 15-17 November 2023
Dist. Prof Paul Moughan, Prof Jeremy Hill, Dr Laura Domigan	Panel discussion: Traditional and novel animal and plant proteins: A future perspective	Food Structures, Digestion and Health International Conference	Queenstown, 15-17 November 2023
Prof Nicole Roy	Diet, gut physiology, and the microbiota-gut-brain axis	Nutrition Society of New Zealand and Nutrition Society Australia Conference 2023	Auckland, 28 November – 1 December 2023
Dr Nick Smith	Nutrient trade in Oceania	Nutrition Society of New Zealand and Nutrition Society Australia Conference 2023	Auckland, 28 November – 1 December 2023
Dr Andrew Fletcher	Sustainable Diet Modelling	Australian Blue Economy CRC	Australia, 6 December 2023

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Plant & Food Research

Prof Jim Metson
University Of Auckland

Miriana Stephens
Wakatū Incorporation

Prof Jan Thomas
Massey University

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University of Otago

Dr Greg Murison
University of Auckland

Dr Jocelyn Eason
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Dr Li Day
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Footnotes: **1** Appointed 2023 **2** Resigned 2023 **3** Riddet Fellows are senior researchers who have been Riddet Institute investigators and whose contribution to the Institute is recognised through this special status. They may retain involvement in the CoRE programme through advisory or supervisory roles **4** While holding Fellow status Prof Gerrard does not act as project leader or participate in any funding applications **5** Affiliated Researchers contribute significantly to the CoRE research programme and other aligned research programmes but do not hold Investigator status.

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Continuing study

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Xudong Wang
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Continuing study

Prasadini Wasana Withanage
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Continuing study

Jie Long Jerome Wong
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Summer Wright
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Chengyi Yang
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Continuing study

Mengxiao Yang
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Asher Brook
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Kuan Yu Chiang
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Simone Frame
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Georgia Patching
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Withdrawn

Anubhavi Singh
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Weihan Zhang
University of Canterbury
Continuing study

Financial Report

INCOME AND EXPENDITURE OF CORE FUNDS

		BUDGET 2023 $000	ACTUAL 2023 $000
Income			
	CoRE Funding	5,100	5,100
	Surplus/Deficit carried forward	2,102	3,787
	Funds contributed by collaborative partners	0	253
	Total Income	**7,202**	**8,887**
Expenditure			
Salaries	**Total Salaries & Salary-related costs**	**1,374**	**1,469**
	as % of Total Expenditure	*26%*	*30%*
Other Costs			
Indirect Costs	Overheads	1,570	1,498
	as % of Total Expenditure	*30%*	*31%*
Direct Costs	Project Costs	665	373
	as % of Total Expenditure	*13%*	*8%*
	Travel	307	259
	as % of Total Expenditure	*6%*	*5%*
	Postgraduate students	1,330	994
	as % of Total Expenditure	*25%*	*21%*
	Equipment depreciation/rental	0	0
	as % of Total Expenditure	*0%*	*0%*
	Subcontractor(s) specified	17	262
	as % of Total Expenditure	*0%*	*5%*
	Extraordinary Expenditure	0	0
	as % of Total Expenditure	*0.0%*	*0.0%*
	Total Other Costs	**3,889**	**3,385**
	as % of Total Expenditure	*74%*	*70%*
Total CoRE Expenditure	**Total Expenses**	**5,263**	**4,854**
Net Surplus/(Deficit) - annual		(164)	246
Net Surplus/(Deficit) - cumulative		1,939	4,286

CO-FUNDING

		2023 ($000)
Government Funding	National Science Challenges	718
	Other MBIE	2,593
	Callaghan Innovation	-
	Health Research Council	54
	Marsden	-
	Non-vote	-
Non-Government Funding	Domestic	2,105
	International - Private Sector	1,121
	International - Public Sector	81
	University/Host/Partner support	-
	Total	**6,671**

SUMMARY OF DATA

VALUE OF CoRE FUNDING FROM TEC		$5.1 MILLION
FTEs by category	Principal Investigators	2.2
	Associate Investigators	0.7
	Postdoctoral Fellows	3.9
	Research technicians	2.3
	Administrative/support	2.8
	Research students	37 (approx.)
	TOTAL	**78.9**
Headcounts by category	Principal Investigators	28
	Associate Investigators	49
	Postdoctoral Fellows	18
	Research technicians	Not collected
	Administrative/support	12
	Research students	94
	TOTAL	**202**
Peer-reviewed research outputs by type	Books	3
	Book chapters	20
	Journal articles	186
	Invited conference/keynote presentations	37
	Prizes and distinctions	See pgs 43 and 44
Commercial activities	Number of licences	Not collected
	Income from licences	Not collected
	Patent applications	Not collected
	Patents granted	1
	Invention disclosures	Not collected
	Spinouts	1
	Capitalisation value of spinouts	Not collected
Students studying at CoRE by level	Doctoral degree	83
	Other	11
	TOTAL	**94**
Number of students completing qualifications by category	Doctoral degree	14
	Master's degree	2
	Other	-
	TOTAL	**16**
Number of graduates by immediate post-study destination	Further study in NZ	-
	Further study overseas	-
	Employed in NZ in Māori organisation	-
	Employed in NZ other	12
	Employed overseas	2
	Unknown	2
	Other	-
	TOTAL	**16**

Scientific Publications 2023

Peer-Reviewed Journal Articles

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Abeywickrema, S., & Peng, M. (2023). The role of tableware size in healthy eating - Effects on downstream food intake. *Foods*, *12*(6), 1230.

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Agarwal, D., Kim, E. H., Feng, L., Wade, C., Moggre, G. J., Morgenstern, M. P., & Hedderley, D. I. (2023). Microstructure, rheological and water mobility behaviour of plant-based protein isolates (pea and quinoa) and locust bean gum mixtures. *Food Research International*, *164*, 112311.

Ahlborn, N. G., Montoya, C. A., Hodgkinson, S. M., Dave, A., Ye, A., Samuelsson, L. M., Roy, N. C., & McNabb, W. C. (2023). Heat treatment and homogenization of bovine milk loosened gastric curd structure and increased gastric emptying in growing pigs. *Food Hydrocolloids*, *137*, 108380.

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Ahmmed, M. K., Hachem, M., Ahmmed, F., Rashidinejad, A., Oz, F., Bekhit, A. A., Carne, A., & Bekhit, A. E. A. (2023). Marine fish-derived lysophosphatidylcholine: Properties, extraction, quantification, and brain health application. *Molecules*, *28*(7), 3088.

Ajala, A., Kaur, L., Lee, S. J., & Singh, J. (2023). Native and processed legume seed microstructure and its influence on starch digestion and glycaemic features: A review. *Trends in Food Science & Technology*, *133*, 65-74.

Alighaleh, S., Cheng, L. K., Angeli-Gordon, T. R., O'Grady, G., & Paskaranandavadivel, N. (2023). Optimization of gastric pacing parameters using high-resolution mapping. *IEEE Transactions on Biomedical Engineering*, *70*(10), 2964-2971.

Amoah, I., Cairncross, C., & Rush, E. (2023). Vegetable-enriched bread: Pilot and feasibility study of measurement of changes in skin carotenoid concentrations by reflection spectroscopy as a biomarker of vegetable intake. *Food Science and Nutrition*, *11*(6), 3376-3384.

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Castro, C. B., Dias, C. B., Hillebrandt, H., Sohrabi, H. R., Chatterjee, P., Shah, T. M., Fuller, S. J., Garg, M. L., & Martins, R. N. (2023). Medium-chain fatty acids for the prevention or treatment of Alzheimer's disease: a systematic review and meta-analysis. *Nutrition Reviews*, *81*(9), 1144-1162.

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