Enhancing Food Integrity Innovation

Impacts from the 20-year SSIF and industry co-funded Food Integrity Programme

agresearch
āta mātai, mātai whetū

AgResearch plays a pivotal role in the ongoing Food Safety support for the New Zealand Meat Industry.

Scientists often don't like to blow their own trumpets. Our preference is to allow our research do the talking. We default to providing evidence and data to prove our worth, which is what the Food Systems Integrity Team at AgResearch has been successfully doing for nearly two decades. However, we thought it was time to tell our story; if you will, blow our trumpet, a little, by gathering the evidence, compiling the data and showing the impact our research has had, in and on behalf of New Zealand, and further afield.

Food safety science is essential for protecting public health, maintaining market access, enhancing consumer confidence, and supporting the continued growth and success of New Zealand's primary industries in the global marketplace.

To achieve all this takes a truly committed team effort. The Food Systems Integrity Team I have led at AgResearch is hard working, innovative and contains experts in transdisciplinary fields who collaborate with the best that overseas research has to offer. We have delivered real and lasting impact for New Zealand. We hope our story, in the following pages, does what we do best: delivers real and tangible examples of impactful science for the sector we serve.

GALE BRIGHTWELL
Science Team Leader - Food System Integrity, Associate Director - New Zealand Food Safety Science and Research Centre

The Meat Industry Association (MIA) is the industry body representing meat processing, marketers and exporters in New Zealand. Our industry prides itself on its science-based approach to food safety and managing risk and compliance for our product in both domestic and global markets. New Zealand exports over 90% of its red meat to over 110 markets around the world. We are the second largest exporter of goods in New Zealand, with products earning over 10.8billion in revenue in 2023.

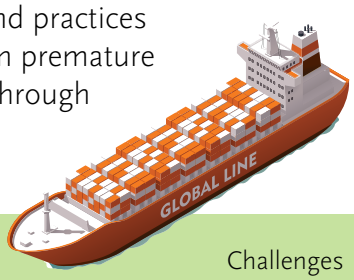
AgResearch has and continues to play a key role in supporting the science that underpins those exports; from providing the knowledge to push shelf life of chilled lamb to over 90 days, to effective interventions that remove bacterial contamination from carcasses, protecting trade to sensitive markets. This team has contributed to much of the innovation seen in our sector in the last 10-15 years.

Through close engagement with our individual members and the MIA itself, their meat science and microbial expertise form an essential part of the meat industry infrastructure and that collaboration is set to continue into the future.

KAYLENE LARKING
Partnership Manager - Meat Industry Association

Over the last 20 years, AgResearch's Food Integrity Programme has established a reputation for delivering quality science and genuine engagement with partners, building confidence and trust in the research undertaken by the team and the advice they provide.

Improvements in processes and practices have reduced product risk from premature spoilage and improve quality through extension of shelf life.



Shelf-life of beef enroute to Europe extended from

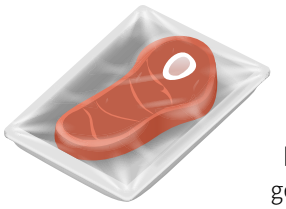
63 to **90+** days

Challenges associated with slow-steaming during transit overcome

Research into frozen meat defects (mould, freezer burn) prevented loss of **$100k**

Alternative packaging solutions still used today to maintain market access for commercial meat processor worth

$10m p.a.



Service testing for blown pack clostridia generated AgResearch

$800K

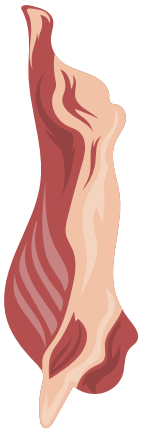
Responding to emergent food safety and regulatory issues that place New Zealand's exports and reputation at risk.

MPI introduced **US OMAR CCP Validation** after our success in retaining at risk export certification for meat processors

Creation and introduction of **Assurance GDS screen method** for testing carcasses reduces the likelihood of STEC detection at the US Border

Assisted meat processors in retaining certification to the value of

$100m



Protection of US bobby veal market valued at

$360m

over the last 10 years

We collaborated both in and outside of the industry

Educational Opportunities

Trapping activities

Planting events

Year 7/8 Lab visits

Water quality monitoring open days

Events and collaborations

MAI/AgResearch Annual Meat Workshop

Te Miro farm - a case study site for regenerative farming

NZFSSRC Annual Symposium, workshops and industry forums

Collaboration with indigenous communities

Contributed to global food safety policy

Citations of our research from overseas agencies such as:

World Health Organization

Ministry for Primary Industries

efsa

FOOD STANDARDS Australia • New Zealand

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

We built capacity and talent development within the research ecosystem

10 PhD candidates trained

3 MSc candidates supervised

6 Post-doctoral researchers engaged

fostering the next generation of scientific leaders

Over the last eight years we have contributed new insights in food safety science via...

100+ Peer reviewed journal articles

1/3 published in the top 10 food science journals

2 journal papers ranking in the top **4** most cited NZSSRC publications

In the last **3** years, **20** of these papers were collaborations with national and overseas partners

28 Citations in overseas policy documents

4 Book Chapters
13 Conference Papers
35 Conference Presentations
41 Stakeholder Reports

Partnerships

Policy document or paper citations

25 Media articles highlights the projects societal relevance

$41.7m p.a. from direct benefits back to industry from research outcomes

The programme produced

Science-based initiatives that have facilitated access to EU and US market

5+4

Technologies, solutions, and improved industry practices

- *Alternative packaging solutions*
- *Light-based sanitation technology*
- *Antimicrobial interventions*
- *Cold atmospheric plasma*

Maintaining access to markets worth **$1.6 billion**

ROI over the lifetime of the programme of **515% p.a.**

IP Licensing of cold plasma and hyperspectral imaging in *in vitro* meats could save up to **US $7 billion**

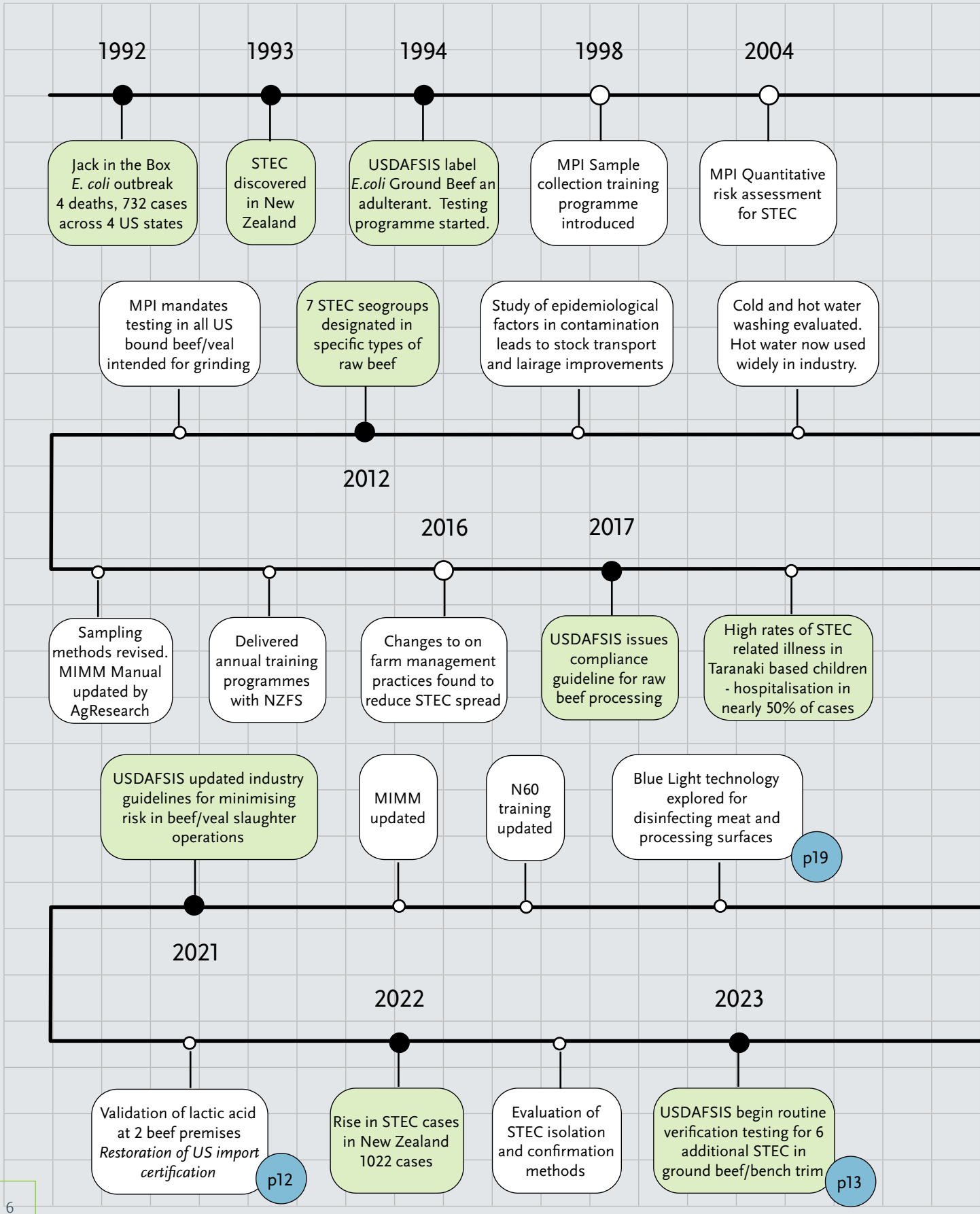
Won awards

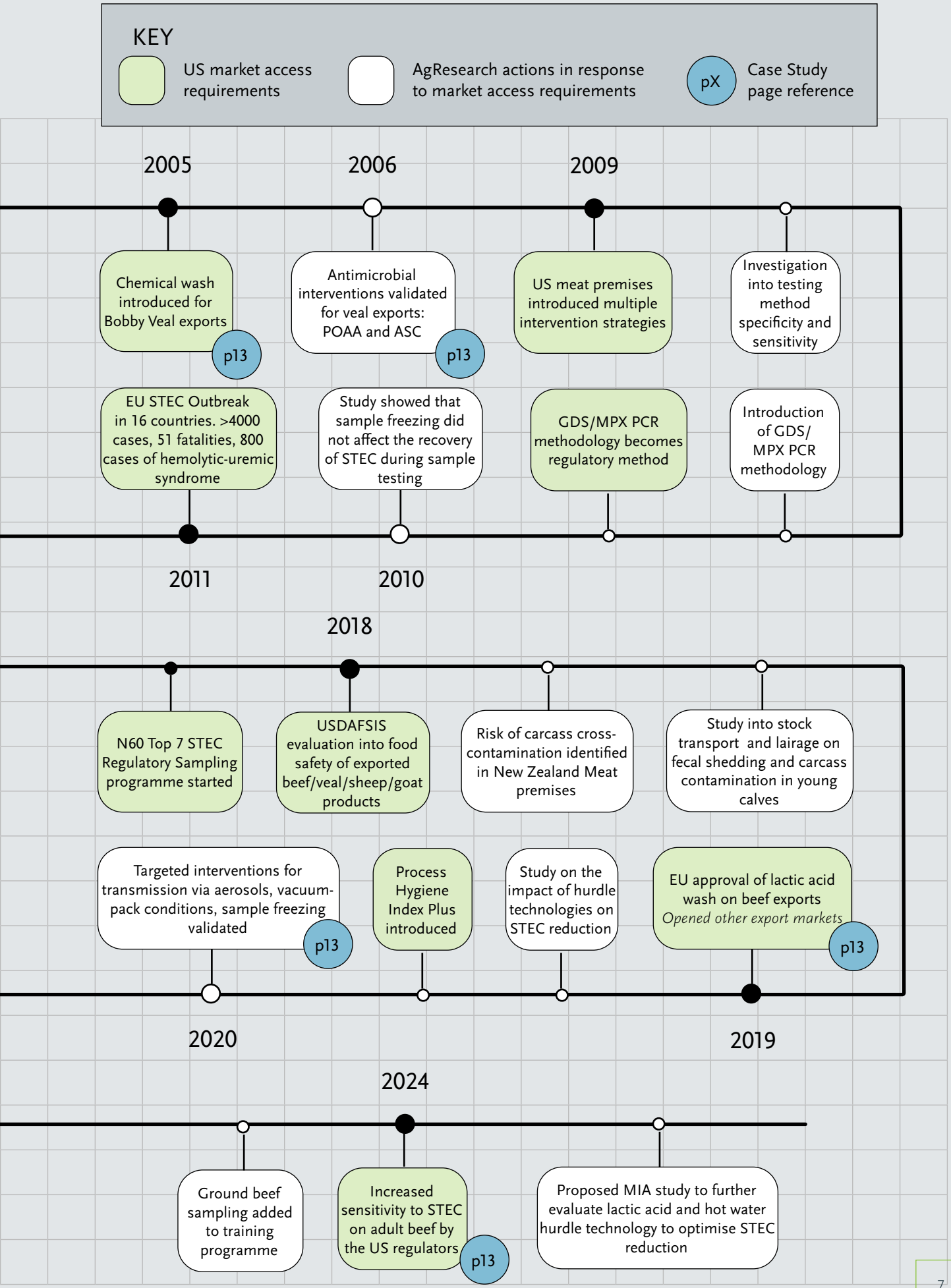
1	1	1	1	3	1
NZFSSRC PhD Scholarship	Basil Jarvis AMI Award for food safety	Kia Niwha Leader Fellowship	AgriFutures Grow Catalyst Programme	KiwiNet New Zealand Emerging Innovator Awards	AMI Global Ambassador Oceania Pacific

as well as others

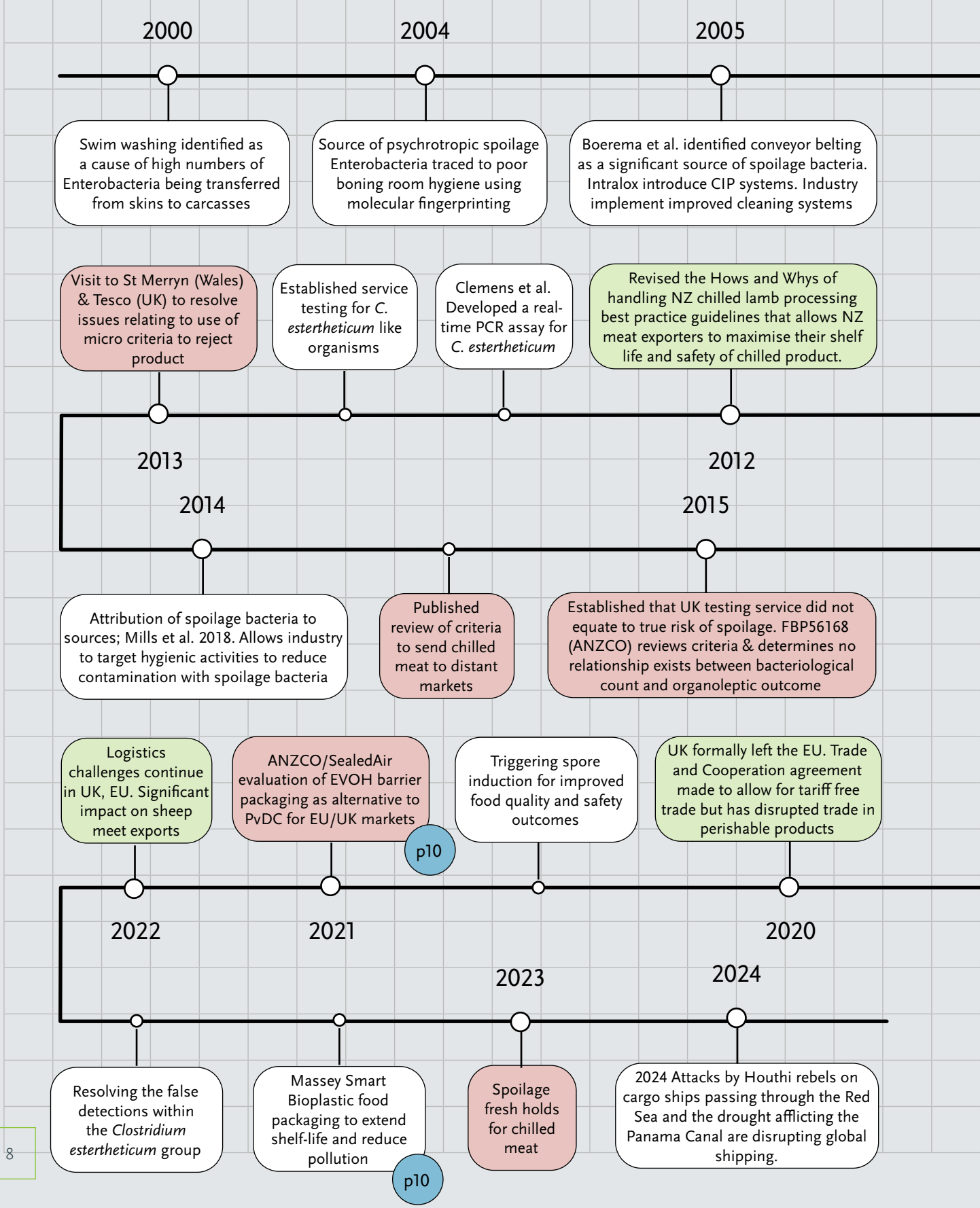
1 Securing Market Access

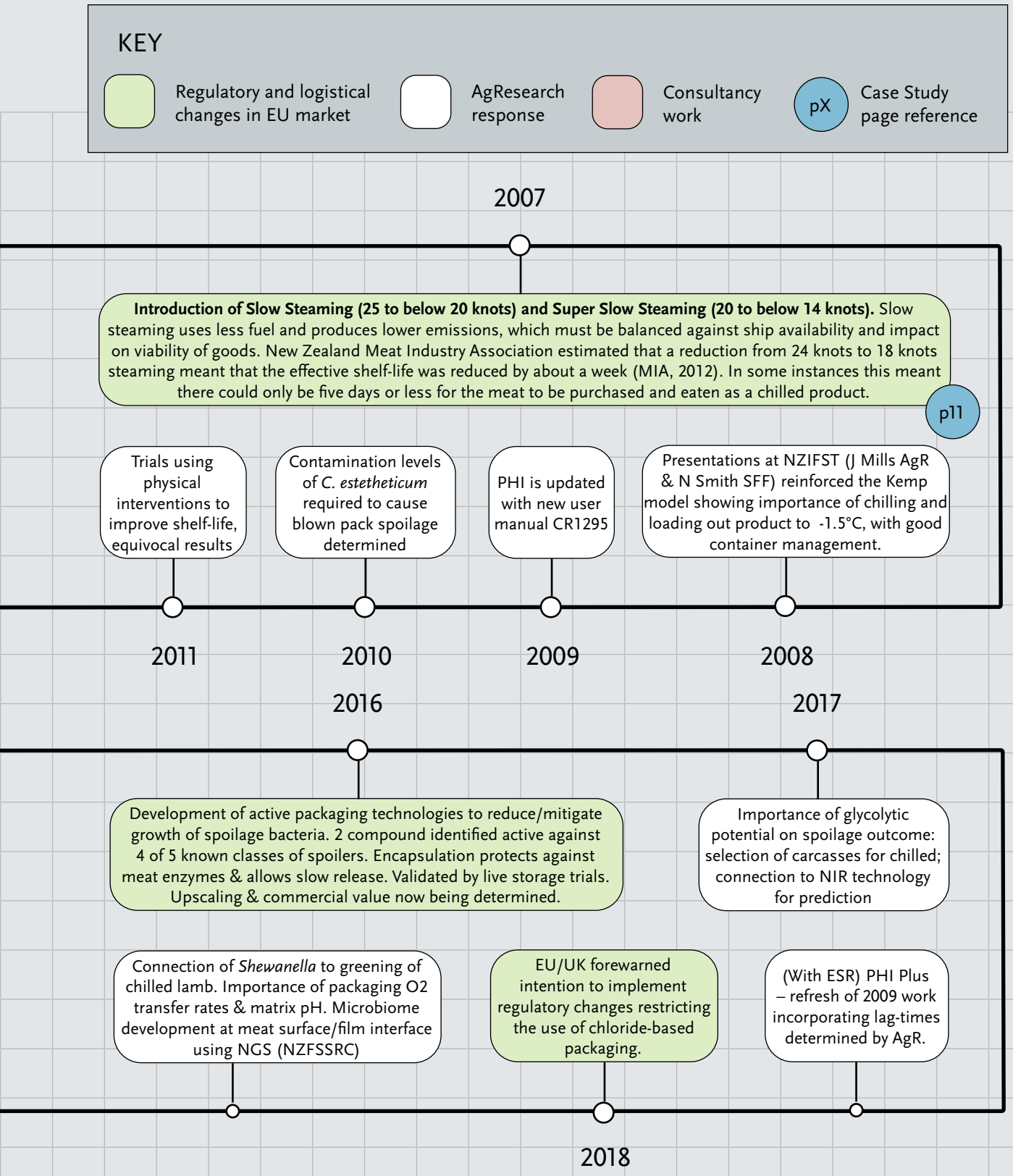
Innovations in Packaging, Shelf Life, and Food Safety for New Zealand's Meat Exports




KEY
US market access requirements
AgResearch actions in response to market access requirements
pX
Case Study page reference
2005
Chemical wash introduced for Bobby Veal exports
p13
EU STEC Outbreak in 16 countries. >4000 cases, 51 fatalities, 800 cases of hemolytic-uremic syndrome
2006
Antimicrobial interventions validated for veal exports: POAA and ASC
p13
Study showed that sample freezing did not affect the recovery of STEC during sample testing
2009
US meat premises introduced multiple intervention strategies
GDS/MPX PCR methodology becomes regulatory method
Investigation into testing method specificity and sensitivity
Introduction of GDS/ MPX PCR methodology
2011
2010
2018
N60 Top 7 STEC Regulatory Sampling programme started
USDAFSIS evaluation into food safety of exported beef/veal/sheep/goat products
Risk of carcass cross-contamination identified in New Zealand Meat premises
Study into stock transport and lairage on fecal shedding and carcass contamination in young calves
Targeted interventions for transmission via aerosols, vacuum-pack conditions, sample freezing validated
p13
Process Hygiene Index Plus introduced
Study on the impact of hurdle technologies on STEC reduction
EU approval of lactic acid wash on beef exports
Opened other export markets
p13
2020
2019
2024
Ground beef sampling added to training programme
Increased sensitivity to STEC on adult beef by the US regulators
p13
Proposed MIA study to further evaluate lactic acid and hot water hurdle technology to optimise STEC reduction

2 Export of chilled lamb to the EU





Information provided enables New Zealand meat exporters to improve hygiene during processing and transportation and also tighten control of temperature in order to achieve shelf-life extension (Ritchie, 2014). This increase in initial shelf-life offsets the effect of slow steaming, extending shelf-life from 63 days (2001), to 70 days (2014) to 84-90 days (2022).

AgResearch's Food Integrity team has supported the meat processing and export industry for decades, focusing on:

- *Implementing incremental process improvements to reduce product risk and enhance quality.*
- *Addressing emergent food safety and regulatory issues to protect New Zealand's exports and reputation.*
- *Two significant beneficiaries are exporters to the USA beef market (especially bobby calf exporters) and chilled lamb exports to the EU. Across five case studies, the estimated annual economic benefit to New Zealand totals $41.7 million, with a total investment in the programme of $8.1m (over 20 years), the annual return on investment is 515%.*

Implementation of Incremental Process Improvements to Reduce Product Risk and Enhance Quality

Process improvements have been implemented to reduce product risk related to premature spoilage and improved quality by extending shelf life.

Alternative packaging solutions

Traditional meat packaging materials, such as vinyl and vinylidene chloride polymers, offer antimicrobial benefits but pose significant environmental and health risks. In 2018, the European Union (EU) announced plans to ban these chemicals in the Packaging & Packaging Waste Regulation (PPWR), to be introduced by 2024/25. Similarly, the US has indicated plans to eliminate the use of vinyl chloride-based polymers. This has prompted major supermarket chains to move away from such packaging, posing a threat to New Zealand's chilled lamb exports.

A major New Zealand supplier to the EU lamb market funded testing of PVdC packaging against two alternative materials—one locally sourced and the other from Belgium. Testing methods were developed through the SSIF Food Integrity programme, simulating shipping conditions in chilled meat storage over 12 weeks at Te Ohu Rangahau Kai. Food safety metrics were measured throughout the period, showing no significant microbiological changes. While the Belgian material provided optimal organoleptic results, the locally sourced option was also deemed acceptable.

The company and other meat processors have adopted both alternative packaging options based on market requirements.

This change has protected their 25% market share in the EU/UK lamb export market, valued at approximately $90 million, and has enabled cost savings through the use of domestic packaging materials.

Protection of the Chilled Lamb EU and UK market against changing logistics practices

Chilled meat commands premium prices compared to frozen meat but faces challenges due to its delicate nature and limited shelf life. Slow steaming practices on container ships result in extended transit times, risking quality issues and product loss for chilled meat exports, particularly to remote markets such as the EU and UK.

Research supported by Foundation for Research, Science and Technology funding, MIA and SSIF focused on meat microbial ecology, shelf life, and the development of antimicrobial solutions. Additional commercial funding, primarily from individual companies, facilitated investigations into specific issues and mitigation strategies.

The team's research identified factors contributing to meat spoilage and processing practices that enhanced shelf life in chilled meat. Significant findings included precise correlations between temperature and pH, as well as the thermodynamics of meat in chilled containers. It underscored the importance of precise temperature management during container loading to maximise shelf life without freezing. Assuming our meat defect research prevented defects in one container, this saved approximately $100,000 per container load and allowed continued trade with the affected customer.

Over two decades, industry improvements have extended chilled vacuum-packed lamb shelf life from 63 to at least 77 days, with some cases reaching 90 days. AgResearch's contributions have likely influenced industry practices, such as investment in blast chilling equipment.

Chilled lamb exports to the EU and UK, which command a 25% premium over frozen meat, retained a market worth $81 million in 2023 and $2.5 billion over 20 years. Assuming AgResearch's research contributed to 20% of the extended shelf life, the program's benefits amounted to $498 million over two decades, averaging $25 million annually.

Consultancy Services Following Product Quality and Safety Issues

When supply chain issues arise, overseas customers and regulators demand assurances about the cause of product defects and the effectiveness of mitigations.

Assuming our meat defect research prevented defects in one container, this saved approximately $100,000 per container load and allowed continued trade with the affected customer.

Export companies often lack the scientific expertise and independence to address these concerns. A notable instance involved two New Zealand processing plants detecting Shiga toxin-producing *Escherichia coli* (STEC), jeopardising their exports to the USA due to stringent Overseas Market Access Requirements (OMARs).

AgResearch received $51,000 funding from three New Zealand meat processors for STEC-related research, along with other consulting projects. We validated the efficacy of antimicrobial interventions at the two meat plants, allowing them to resume exports. This was the first application of the US validation procedure in New Zealand, and we established the parameters for this process.

Our capability to respond to industry needs stems from foundational work in the SSIF and MIA Programmes, which cover STEC isolation, identification, transmission, and risk. This expertise enables AgResearch to design and execute 'on-plant' research projects and perform carcass-level challenge trials. We are now the primary provider in New Zealand for validating 'on-plant' interventions to meet US OMARs. While the risk of STEC contamination in adult beef is currently considered low, these studies demonstrate potential impacts if US sensitivity to STEC prevalence increases and whole carcass antimicrobial interventions become mandatory across the industry.

New Zealand has 34 beef exporting plants.

Assuming the two STEC-affected plants produce a proportional share of beef exported to the US, and this beef achieves a 20% higher price than alternatives, the ability to sell into the US market yields benefits of approximately $9 million annually, depending on export prices and volumes. Following our work, MPI introduced comprehensive criteria for future reinstatement into the US export market. In a separate study, we researched the causes of frozen meat defects, such as mould and freezer burn, in shipments to the US.

Antimicrobial Interventions for the US Bobby Veal Market

The USDA-FSIS considers manufacturing meat and table cuts as 'adulterated' if they contain any of the 'Top 7' serogroups of STEC. Unlike adult beef, veal is deemed to have a higher risk, with adulteration classified as 'reasonably likely to occur'. This classification requires whole carcass antimicrobial interventions for veal products destined for the US market. Standard interventions used for adult cattle are, however, not suitable for small bobby calf carcasses.

Work to validate suitable interventions was funded by the MIA and MPI, building on fundamental science funded by FRST (now transitioned into SSIF) with an investment of approximately $4 million of funding over 20 years. We developed low-pressure application parameters at a pilot scale and established Critical Control Points (CCPs) for various interventions, including steam vacuuming, acidified sodium chlorite (ASC), lactic acid, and hot water. We also found that peroxyacetic acid (POAA) was ineffective as an intervention; subsequently, suppliers improved the activity of POAA with the addition of a chelating agent, although it is no longer used by industry except for surface sanitation.

All plants processing bobby calves now use the treatment processes and parameters we established, with MPI-mandated CCPs. This has helped retain the US market for bobby calf veal, primarily sold as manufacturing beef. The US is the largest market for manufacturing beef exports, paying approximately 13% higher prices compared to the average export price. Without this market, much of the ~25,000 tons exported annually would likely be redirected to lower-value uses such as pet food

We estimate the benefits of retaining the US market to be around $7.6 million annually based on 50% of US boneless frozen bobby veal exports redirected to pet food, reducing product value from $9.39/kg to $4.50/kg.

The remaining 50% redirected to alternative markets, achieving 13% lower prices.$498 million over two decades, averaging $25 million annually.

Critical Control Points (CCP) for Shiga Toxin-Producing *Escherichia coli* (STEC) in adult beef

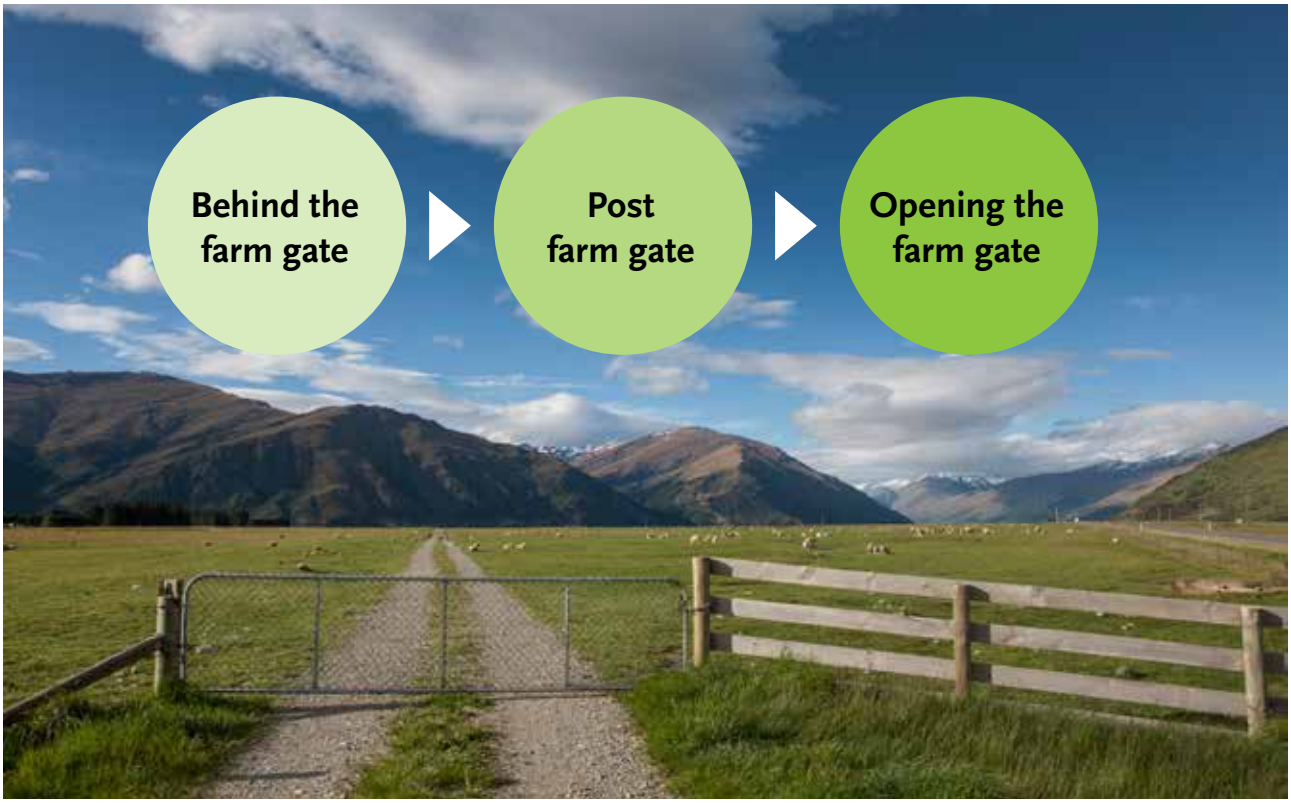
Critical Control Points (CCPs) are essential for identifying and managing significant food safety hazards. STEC in beef is a continuing concern for New Zealand and its regulators (MPI), given the stringent import testing standards of the United States. The USDA-FSIS verifies compliance through overseas market access requirements (OMAR) and arrival testing in the US.

MPI funded two related projects on the impact of freezing on STEC survival and plating methods, totaling $279,000. This research built on our ability to model freezing profiles and developed unique knowledge on STEC culture methods through SSIF and industry programs.

We demonstrated that chilling and freezing curves alone cannot reliably serve as CCPs against STEC, as these processes do not sufficiently eliminate the hazard. A follow-up MPI project showed that current plating methodologies for detecting STEC could be improved with dilution and spread plating.

Improved detection in NZ reduces the risk of contaminated consignments being released and reaching the US, thereby preventing potential delisting of premises in the >$1 billion adult manufacturing beef market.

Emerging Innovation from Farm to Fork: Keeping Markets Safe and Minimising Environmental Impact



Climate change presents considerable risks to food safety and biodiversity. Increased temperatures and extreme weather events heighten the chances of foodborne illnesses and disrupt food supply chains. Concurrently, climate-induced habitat loss, species displacement, and altered ecological interactions threaten biodiversity, causing ecosystem imbalances and reduced resilience.

Addressing these challenges requires comprehensive strategies that integrate sustainable agricultural practices, robust food safety protocols, and conservation efforts to protect and restore ecosystems. We are pioneering the development of a 'Smart Technology/Knowledge Platform' that revolutionises food preservation and sanitisation, addressing both food safety and market access concerns for New Zealand products. Our cutting-edge platform employs emerging technologies with minimal environmental impact, significantly reduced water usage, and a chemical-free approach. These technologies are also applicable to enhancing biosecurity, and animal and public health.

BEHIND THE FARM GATE

Combating Facial Eczema in Dairy Cattle Using Safe and Natural Compounds: A One Health Approach

Senior Scientist Tanu Gupta (right) with her research advisor Steve Bayler from Massey Farms in Palmerston North.

Facial eczema (FE) is a global issue affecting pasture animals in countries such as New Zealand, Australia, South Africa, the United States, and European Union nations. With global warming, the prevalence of FE is expected to rise. FE causes significant economic losses in dairy cattle through weight loss, reduced milk yield, and increased mortality. In New Zealand alone, FE causes an annual financial loss exceeding $100 million. Current preventive and therapeutic measures against FE involve substances that are highly toxic to animals, humans, and the environment. Recognizing the severity of the problem, the New Zealand government has recently allocated $332 million for FE research, specifically targeting advanced diagnostic methods and vaccine development.

Our research, led by Senior Scientist Tanu Gupta, is dedicated to implementing a sustainable and environmentally friendly approach to combating FE on farms. Our experiments have demonstrated significant anti-fungal activity of a bioactive compound against the fungus responsible for FE. We are working towards developing a product utilising this compound, which is water-soluble and can be easily sprayed on pastures as a preventive measure, rather than relying on animal feed additives. Additionally, this compound is Generally Recognized as Safe (GRAS).

We aim to bridge the gap between research and development and commercialisation by collaborating with various agrichemical companies to create a revenue-generating pathway. Several agrichemical companies have expressed strong interest in adopting this compound to formulate a product against FE, and we are actively working on developing robust intellectual property in this area. These companies have also conveyed concerns about other fungi and bacteria affecting various crops and are eager to collaborate with us to find solutions using these compounds. Given the broad-spectrum efficacy of this research, the revenue potential is significant and attractive to many agribusinesses. Utilising these compounds in product formulation will enhance the value and productivity of our agricultural systems by safeguarding animal, human, and environmental health. We are leaders in New Zealand, working towards developing a product with natural bioactive compounds to combat FE.

The project was originally funded by SSIF Food Integrity and now a KiwiNet Tier 1 initiative, awaiting Tier 2 approval.

Environmental Work at Te Miro Farm

Environmental work at Te Miro Farm, an organic and regenerative dairy farm near the source of the Manawatū River, focuses on restoring ecosystems and fostering cultural reconnection. The Drysdale whānau's holistic farming approach, which emphasizes healthy animals, soils, people, and rivers, aligns with the cultural significance of the site. Over five years, Te Miro Farm has become a learning hub for mana whenua (Te Kāuru hapū Collective) and kaimahi environmental groups (Taiao Ora Contracting) involved in riparian planting, pest management, and weed control. Community participation, including that of local schoolchildren, in water quality assessments has helped interweave Western science with traditional cultural health indices, enhancing environmental understanding and stewardship.

A significant innovation in this project is the use of environmental DNA (eDNA) analysis to assess the ecological health of waterways in partnership with Wilderlab, an eDNA testing laboratory. This technique complements traditional water quality metrics, offering a comprehensive view of biodiversity. Notably, novel biodiversity metrics were highly influenced by changes in water quality, and cattle and deer eDNA read data were significant predictors of freshwater *E. coli* contamination levels. These findings have been shared with regional councils (Horizons) and central government (DoC, MfE, MPI) through conference presentations and project fact sheets. In total, fourteen kaimahi/rangatahi across three Māori environment groups received training to undertake eDNA sampling. Two workshops hosted by Wilderlab and attended by mana whenua facilitated knowledge sharing among all partners, informing sustainable farming practices and strategies for engaging with additional catchment communities.

This project was funded by SSIF Food Integrity and the Our Land and Water National Science Challenge, emphasising capacity building through a partnership with Pūhoro STEMM Charitable Trust. Since 2017, the team has hosted ten rangatahi for summer internships, providing opportunities to engage in both lab-based and fieldwork training, blending mātauranga Māori with Western science.

Development of a One Health Approach for *Campylobacter*

SSIF-funded research has significantly advanced our understanding of the within-herd transmission of *C. jejuni*, risk factors, and genetic evolution of *C. jejuni* in bovids, identifying effective mitigation practices to reduce its incidence in pasture-based herds. This improves public health and animal productivity. By comparing *C. jejuni* occurrence in dairy cattle, wildlife, and the farm environment, the research highlighted grazed pasture as a critical reservoir for horizontal transmission. Genotyping analysis underscored wild birds' role in disseminating ruminant-adapted *C. jejuni* genotypes through supplementary feed and in introducing new genotypes into the herds. The work also found associations between animal immunity and behavioural traits with *C. jejuni* excretion. These insights suggest that improving animal health and welfare through management practices can effectively reduce *C. jejuni* excretion in pasture-based herds.

Economically, the research is significant, as ruminant-associated campylobacteriosis costs the New Zealand economy approximately $17 million annually, excluding costs due to water outbreaks. Reducing *C. jejuni* incidence in dairy cattle could lower healthcare costs associated with human infections and minimize primary industry productivity losses. Our research has illustrated a possible pathway towards developing a One Health approach that would be adopted by farmers.

POST FARM GATE

Cold Plasma and Hyperspectral Imaging in In Vitro Meats

Despite being world-leaders in agriculture, New Zealand is a very late starter in the burgeoning business of cellular agriculture. The foothold we currently have is in cell line production, which, based on New Zealand's existing premium GE-free germplasm lines, is a significant window of opportunity for development. This pioneering project explores the cutting-edge use of cold plasma technology to control contamination in cell-based protein foods, effectively eliminating the need for antibiotics to maintain sterility. Additionally, we are developing an advanced real-time monitoring system utilising hyperspectral imaging (HSI) and machine learning (ML) to rapidly detect contamination.

We propose to plasma activate cell cultures and the media used during the manufacture of cell-based protein foods, thus removing the need to use antibiotics to maintain sterility. Further, we propose to develop a real-time monitoring system based on HSI and ML to rapidly identify contaminating microorganisms directly or indirectly via changes in media composition. ML is one of the most promising and powerful techniques for real-time applications as it enables rapid analysis of hyperspectral images of substances with high accuracy and robustness.

The research will create an advantage for New Zealand's cellular agriculture industry by leveraging world-leading complementary skills in food safety, spectral imaging, and data analytics within the research team. The use of cold plasma and HSI with ML is a novel approach to provide better food safety for cellular-based protein production systems. This research will generate knowledge-intensive tools to support the growth of New Zealand's cell-based food industries that are more sustainable, chemical-free, antibiotic-free, safer, and ethically attractive to environmentally conscious consumers. New Zealand is in a unique position, where a national programme for cellular foods would create further advantages compared with those overseas.

This project was originally funded through SSIF Food Integrity as in now a Smart Idea.

Light-Based Sanitisation Technology

The focus on food safety to avoid foodborne disease outbreaks and reduce food waste is growing the need for effective fruit and vegetable cleaning technology. In 2023, the fresh produce cleaning market was valued at USD $9.3 billion and is growing at a CAGR of 10.50% through 2030. Worldwide, unsafe food causes 600 million cases of foodborne diseases and an average of 420,000 deaths annually. In New Zealand, a recall process in the food manufacturing industry costs on average $10 million, not including potential decreases in sales, reputational damage, and brand crisis management.

The use of dual far-UVC (222 nm) and blue LED (405 nm) based sanitation technology is a world-first and is led by researchers at AgResearch. Light disinfection, along with innovative washing techniques using plasma-activated water, could reduce the likelihood of disease outbreaks, reduce product recalls due to microbial contamination, and reduce the use of chemical interventions that are expensive and damaging to manufacturing equipment. UVC technology is actively being adopted by New Zealand food industries, and it won't be long before far-UVC and blue LED light disinfection catches up. Alternative light wavelengths offer many advantages over traditional UVC, including being safer for human use, less damaging on plastics, more energy-efficient, and less likely to cause microbial resistance. Further investment in dual light technology could position New Zealand as a leader in fresh produce cleaning, with the potential for a large overseas market through the licensing of IP, design, implementation, and maintenance of technology, and food safety consultation.

This project was originally funded through SSIF Food Integrity and now a KiwiNet Emerging Innovator initiative.

OPENING THE FARM GATE

Digital Solutions to Ensure Food Safety and Market Access

This project is a collaborative effort involving key players in the New Zealand sheep and beef industry, aimed at enhancing food safety and market responsiveness through digital innovation. In its initial scoping phase, the project achieved an unprecedented mapping of food safety-relevant datasets across the red meat supply chain, uncovering opportunities for a holistic 'farm to fork' approach. Stakeholder workshops revealed the immense value of integrating these datasets for agile market adaptation, while also addressing challenges related to data definition, curation, and ownership. A co-designed case study on drought-related food safety risks in the beef chain has been designed to illustrate the practical advantages of such data integration.

Utilising Bayesian network modeling and expert elicitation, we developed a visual tool that engages stakeholders in evaluating diverse information sources. We also introduced the concept of 'data entities' to aid users in managing and integrating varied complex datasets efficiently. This approach enabled stakeholders to learn effective strategies for assessing source credibility, reliability, and identifying informational gaps. Consequently, it generates evidence-based insights that can be shared with partners throughout the value chain, including providers and consumers.

By ensuring that research questions were driven by meat industry stakeholders, this project guarantees that the research and its outcomes are highly relevant and beneficial. The collaborative effort is set to significantly enhance the industry's capacity to address food safety risks and optimise decision-making processes across the beef supply chain, delivering substantial economic and strategic value.

This project was funded by NZBIDA, SSIF, and Discovery.

Leveraging Web Scraping and Social Media for Food Safety

AI is becoming a powerful tool to enhance food safety across the entire supply chain, from farm to fork. By leveraging advanced analytics, real-time monitoring, predictive capabilities, and automated inspections, AI is helping to ensure that food products are safe, high-quality, and free from contaminants. We have researched the use of online data, including posts on social media, as tools to monitor foodborne illnesses and their association with weather events. We found significant correlation between weather events (e.g., rainfall) and the number of online messages associated with foodborne illness. Moreover, the peak of online messages associated with foodborne illness preceded the reported peak of foodborne outbreaks, demonstrating its potential for early detection of outbreaks. By leveraging web scraping and social media surveillance, we can gather real-time data to identify the incidence of foodborne diseases worldwide, assess risks, and relate these incidences to weather events. This provides the industry with a new way to prevent and mitigate the risk of foodborne microorganisms entering the food supply chain. Our innovative approach to using online surveillance tools will significantly enhance New Zealand's ability to monitor and respond to foodborne illness outbreaks, ensuring that our country continues to produce the best food in the world. Early detection enables preventive actions to take place before the problem enters the NZ food chain.

This project was funded by SSIF Food Integrity.

Educational Opportunities

Collaboration with Te Miro farm

The research programme was committed to working with schools to raise awareness of environmental issues and to empower students to become stewards of their local ecosystems. To do so we collaborated with Te Miro, a regenerative farm where we could give school students the opportunity to see regenerative farming in action and to get involved with water quality monitoring, pest trapping and tree planting.

Laboratory visits

The research programme was committed to inspiring the next generation of scientists, inviting local schools to visit our laboratories to learn basic laboratory techniques and gain an understanding of careers in science and research .

Resources

The research programme was committed to taking information into schools, for those who couldn't visit our laboratories or case study farms. We produced educational materials based on the programme's research including videos on water quality, regenerative farming practices, and food integrity and kits for in-school sample training to enable students to develop their practical laboratory skills.

Supporting our next generation of science leaders

Rose Collis

I began my journey at AgResearch as a summer intern at the Hopkirk Research Institute in the Food System Integrity Team. This internship, supported by the SSIF, allowed me to gain valuable experience in field sampling, microbiology and molecular-biology skills, and ignited my passion for research. I was fortunate to continue with the Food System Integrity Team and completed a Master of Science and a PhD in Veterinary Science through Massey University. My studies were funded by the Massey University Masters Scholarship and the inaugural New Zealand Food Safety Science and Research Centre PhD Scholarship respectively, with additional research funding from the SSIF. This support enabled me to develop technical skills in microbial genomics, antimicrobial resistance, metagenomics and bioinformatics. The support and mentorship I received from the Food System Integrity Team, particularly by my supervisor Dr Adrian Cookson, were invaluable for my success in my post-graduate study, with my PhD earning a place on the Massey University's Dean's List of Exceptional Doctoral Theses in 2022.

Following my PhD, I began a post-doctoral position and led the development of Nanopore long-read sequencing and bioinformatic analysis for the SSIF "Food Integrity Kaupapa Health" project, enhancing microbial water quality assessments and pathogen detection. This project provided the opportunity for capability building and enabled me to hone my long-read sequencing and bioinformatics skills. I have also been supported to present my research to a wide range of audiences including oral and poster presentations at scientific conferences, the Primary Production Select Committee at Parliament and to various community groups. In 2023, I received the AgResearch Student Award, attending the Annual Microbiology Society 2024 Conference in Edinburgh, Scotland, where I presented my first overseas oral presentation. This opportunity expanded my overseas networks and fostered future collaborations. Through the SSIF "Food Integrity Kaupapa Health" project, I have had the opportunity to work with and encourage our tamariki and rangatahi to engage with science, an area I am passionate about. I was recently awarded a prestigious Kia Niwha Leader Fellowship from Te Niwha, and the leadership and technical skills, along with the collaborations that have been developed while being mentored in the Food System Integrity Team will greatly support me in this next chapter of my research journey.

Amanda Gardner

My leadership journey has recently reached a significant milestone with my elevation to the position of scientist from my previous role as a research associate. This advancement was achieved despite not having a PhD which is usually required for a scientist role, is the culmination of a dedicated four-year tenure during which I spearheaded numerous research endeavours exploring the efficacy of Far-UVC and Blue LED light in disinfecting viruses and bacterial pathogens. Throughout this period, I had the opportunity to collaborate on and lead technical experiments for numerous SSIF programmes, including Food Integrity, Microbial Ecology and Shelf Life, Food Omics, Blue LEDs, and Calf Rearing Practices. Under the guidance of my team and programme leader, Gale Brightwell, and other senior scientists, I gained invaluable insights and mentorship that have been pivotal in my development within the lab with my technical capabilities in microbiology, molecular biology, and genomics.

Through their encouragement and guidance, I presented our work with Far-UVC and blue LED light at the Overseas Conference for Far-UVC science and Technology in New York 2023 and St Andrews, Scotland in 2024. These opportunities expanded my overseas networks and provided opportunities for future collaborations. Furthermore, I have published scholarly articles as the primary author in the journals Viruses, Applied Microbiology and Meat Science and our work on far-UVC and blue Led light was highlighted in over 10 different science publications such as Microbiology Magazine, IEEE spectrum, and Physics World. Through the SSIF programmes I have had opportunities to cultivate a robust network of stakeholders including dairy companies such as Westland Milk Products, on farm with dairy and beef farmers, meat plants including CMP Rangitikei, Alliance and Oamaru Meats, and light technology companies such as EnergyLine, Vertex and Ibex.

My journey has been further enriched by being honoured with a KiwiNet Emerging Innovator award. This accolade has facilitated the transition of my research endeavours with light disinfection and plasma-activated water from laboratory-centric pursuits to tangible industry contributions through commercialisation. The associated workshops, mentoring, and learning opportunities have been instrumental in refining my competencies in networking, proposal composition, market validation, and customer engagement in emerging technology. This recognition has bolstered my self-assurance, confidence, and leadership skills, laying a solid foundation for future achievements.

Reflecting on my journey, the support from AgResearch's SSIF Food Integrity Programme and the diverse research opportunities have been integral to my growth. These experiences have not only enhanced my scientific acumen but also shaped my leadership capabilities, enabling me to contribute meaningfully to the scientific community and beyond.

Tanu Gupta

My leadership journey began as a postdoctoral researcher with AgResearch, where I volunteered to gain experience in bacterial biofilm in infant formula milk and creating knock-out mutants. With invaluable support and guidance from team leader Gale Brightwell, I transitioned to a scientist role, focusing on-farm factors affecting milk safety and strategies to mitigate STEC contamination on meat carcasses. This role enabled collaborations with the Meat Industry Association and established strong connections with farmers and industry stakeholders. The SSIF Food Integrity programme has offered me diverse research opportunities which have been integral to my growth. These experiences have not only enhanced my scientific acumen but also shaped my leadership capabilities, enabling me to contribute meaningfully to the scientific community and beyond. For example, presenting at overseas conferences, such as the 19th Overseas Conference of Women Engineers and Scientists in 2023, and serving as the Global Ambassador for Oceania Pacific for Applied Microbiology Overseas, have allowed me to represent New Zealand on the global stage.

Throughout my career, I have been honoured with several awards, including the President's Award from the Society for Applied Microbiology (2016), the Young Scientist Award from the Federation of European Microbiological Societies (2018), and the H.M. Russel Award in New Zealand (2021). These recognitions allowed me to attend overseas conferences, showcase my research, and represent AgResearch and New Zealand globally, fostering collaborations and learning from overseas peers. Collaborating with overseas scientists is a privilege and I continuously seek new partnerships to advance food safety. Over the past seven years, my research has focused on novel peptides and metabolites with antimicrobial properties and my dedication to this field earned me the Basil Jarvis Award for Food Safety and Security in 2022.

Inspired by the mentorship and support I've received, I am passionate about giving back and I have supervised over 10 students, helping them succeed in their careers. This experience, enriched by the mentorship I received, earned me the American Society for Microbiology Future Leadership Mentoring Fellowship in 2023. Leading my mentoring group, I initiated discussions and meetings to support fellow mentors and mentees. Recently, I developed an interest in bridging science and commercialisation, proposing a product to reduce facial eczema in animals. This innovation won me the KiwiNet Emerging Innovator Award and made me a finalist in the AgriFutures Grow Australia Women in Agriculture competition.

Delphine Rapp

My leadership journey started at AgResearch's Ruakura campus as a postdoctoral researcher looking at on-farm transmission of Campylobacter and its effects on water quality. Following this I joined the Food Integrity team and moved to the Hopkirk Research Institute. Here I have recently embarked on a transformative leadership journey supported by NZBIDA (New Zealand Bioeconomy In a Digital Age) and SSIF Food Integrity engaging with a diverse group of meat industry stakeholders to develop a digital analytic platform. This platform integrates and analyses the complex information generated along the food supply chain, positioning the NZ meat industry to respond effectively to future food safety risks.

Through guided discussions and collaborative efforts, researchers and stakeholders have made significant strides in developing a common understanding of integrating food-safety relevant data. I have learned invaluable lessons along this journey, particularly in understanding the intricacies and challenges of data integration across diverse aspects of the supply chain. This has enabled me to hone my ability to facilitate discussions and guide stakeholders towards consensus, ensuring that all stakeholder voices and needs are heard. This cultivates an environment where stakeholders feel empowered to share their insights and concerns, enabling these to be incorporated into the development of solutions, and leading to the identification of key values and barriers in data integration.

The journey has also been a learning experience in terms of adapting and refining the approach based on stakeholder feedback and industry insights. My leadership has been instrumental in navigating these complexities and ensuring that the platform not only meets but exceeds the expectations of industry stakeholders. I foster a collaborative approach in the spirit of innovation and shared ownership among stakeholders, paving the way for future advancements in food safety management and decision-making processes within the sheep and beef industry.

20 Years of Collaboration and Innovation in Food Safety: Our Gratitude

As we celebrate the 20th anniversary of our Food Safety Innovation Programme we reflect on the incredible journey we've undertaken and the milestones we've achieved. We extend our deepest gratitude to our team members, both past and present – your expertise and passion have driven us to continuously improve and to adapt to the ever-evolving challenges in food safety.

We also acknowledge the invaluable support and collaboration from our partners and stakeholders – your partnership has been crucial in translating our research and innovations into practical solutions that benefit NZ.

We are also grateful for the support from regulatory bodies and government agencies – your guidance and standards have provided a framework that has enabled us to achieve and maintain excellence in food safety. Your collaboration has ensured that our innovations meet the highest regulatory requirements, protecting New Zealand's access to key markets.

Most importantly, we thank AgResearch for their invaluable support and the SSIF funding that has enabled us to advance this critical work. AgResearch's commitment has been instrumental in driving innovation and fostering collaboration within the New Zealand meat industry, ensuring our efforts are impactful and aligned with industry needs.

The programme team comprises researchers from Food System Integrity, Food Informatics, Food Chemistry and Structure, and Rumen Microbiology, bringing together capability in food and environmental microbiology, spectral imaging, big data, analytics including bioinformatics, community relationships and Vision Mātauranga.

We are the sole laboratory in New Zealand with the proficiency to isolate and propagate blown-pack Clostridia, a capability shared by fewer than five entities worldwide. Additionally, we hold exclusive expertise in conducting cold temperature incubation, isolation, and characterization of meat spoilage organisms and pathogens under cooling and freezing conditions, a capability unmatched elsewhere in New Zealand.

Our infrastructure uniquely allows for the modeling and simulation of chilling, freezing profiles, and cold storage of meats at both laboratory and pilot scales. We are also equipped to conduct challenge testing under containment conditions, reinforcing our position as the sole entity with such comprehensive capabilities in the field.

Where necessary we have worked with partners with complementary skills to enhance and extend our research capability, specifically Plant and Food Research for their expertise in cold plasma research, Massey University, ESR and NIWA for their expertise in microbial water quality assessment, and also, in the case of Massey University for their expertise in food safety and spoilage, and epidemiology, CSIRO for collaboration on verification systems for provenance, Callaghan Innovation for support from the National Measurement Standards Laboratory and Wilderlab for their with expertise in eDNA analysis to assess catchment biodiversity.

This research programme has been highly collaborative, working with iwi (Rangitane O Tamaki nui a Rua and Rangitane O Wairarapa), government and government affiliated organisations (China New Zealand Food Protection Network, FIET, MPI, NZFSSRC), universities (University of Auckland, University of Canterbury, Massey University, and University of Otago), other CRIs (ESR, NIWA, Plant and Food, Scion), industry and industry associations, (meat and dairy processing companies, the Meat Industry Association, LED manufacturers Energy Light), research organisations (AsureQuality, Callaghan Innovation, Wilderlab) and overseas universities and research organisations (University of Alberta, CSIRO, Teagsac, American Meat Science Association).

This report has been compiled by Gale Brightwell, John Mills, Adrian Cookson, Tanu Gupta, Delphine Rapp, Mariza Gomez Reis, Shuyan Wu, Aswathi Soni, Marlon dos Reis, Amanda Gardner, Faith Palevich, Rose Collis, Marie Moinet, Nik Palevich, Kwang Subharat, Virgina Thomas, Greg Ford, Alice Baillie, and Robert Fletcher. It assesses the contribution to impact by AgResearch's 'Enhancing Food Integrity Innovation' programme and also acknowledges the contribution of funders, collaborators, partners and stakeholders. This report has been endorsed by the Meat Industry Association, who have been a major supporter of this research.

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www.agresearch.co.nz

For more information please contact

Gale Brightwell
Science Team Leader - Food System Integrity
gale.brightwell@agresearch.co.nz