KELLOGG
RURAL LEADERSHIP
PROGRAMME

Bringing New Zealand's Food Science to the World

Kellogg Rural Leadership Programme

Course 46 - 2022

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I wish to thank the Kellogg Programme Investing Partners for their continued support.

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1. Executive Summary

Background: food science in New Zealand is an important contributor of the Science and Innovation ecosystem and helps maintain a positive international reputation in this field. However, international stakeholders are looking in, the food crisis accentuated by a growing population is worsening and scrutiny is increasing across every sector. Thus, our food science sector must show clear direction, collaboration, and thought leadership. Therefore, New Zealand's science industry needs to be reshaped to help find solutions to the pending global food crisis identified by the United Nations and other organisations.

The COVID-19 pandemic presents an opportunity to restart the clock and implement some changes. Te Ara Paerangi Future Pathways' consultation is addressing a wide range of issues and looking at solutions while keeping an open mind and including many voices. This is an excellent step in the right direction and a welcome review of New Zealand's research system.

Internationally, New Zealand is described as harder to justify, far away and laid back. Moreover, New Zealand faces the issue of 'local is the new global', meaning that when available, most stakeholders would prefer to engage with a science provider closer to them geographically. However, commercial revenue for New Zealand's food science sector is not only important financially, but also critical to maintain a global reputation.

Method and Focus: this report focuses on international business development and ways to better integrate New Zealand's food science globally. The purpose of this research includes providing a clear picture of the New Zealand's food science ecosystem and the opportunities and challenges that organisations in the industry are facing.

This research was underpinned by two components. Firstly, a literature review to draw research, articles, industry reports and opinion pieces together to understand the current New Zealand science system, compare it with other models and identify some common challenges and opportunities. Secondly, a crucial part of the research consisted of semi structured interviews with food science providers. A compare and contrast analysis was undertaken. The interviews formed the basis of the recommendations and shaped the vision for New Zealand's food science strategy.

Recommendations: the recommendations have been drawn from readings and interviews, and can be summarized as:

- Support engagement among the science industry and enhance the collective mindset to capitalise on every expertise to create greater impact.
- Creation of a capability map to identify the focus areas and support world leading capability building.
- Promote the transition to a single overarching science institute.
- Leverage New Zealand's Science capability to focus on world leading expertise and attract international business, thus enhancing New Zealand's economy.

It's encouraging to see more and more collaborative projects in science, however this research suggests that only a whole sector change would accelerate the rate of exchange of scientific knowledge, increase the delivery outcome to answer global issues and keep New Zealand in a world leading position.

Ultimately, the aim is to draw insights and develop a bold vision and relative recommendations for the future of New Zealand's food science, to position the country as a leading knowledge and research provider in this sector, globally.

2. Acknowledgements

Firstly, I want to acknowledge the Rural Leaders and the Kellogg Programme team. It has been challenging to pull together such a programme over the last 2 years, but your determination has shown that anything is possible. You have been open to change at short notice and very nimble and professional in your approach. This, in itself, is a great leadership example. I'd like to show my appreciation to Chris Parsons, Scott Champion, Patrick Aldwell, Lisa Rogers and Annie Chant. Each of you brings something special to the programme and I thank you dearly for your support and passion.

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I also want to thank all of those that have contributed, your time was extremely valuable, and I hope you find something useful for you and/or your organisation in this report.

Finally, to cohort 46, thank you for the great discussions, laughs and encouragement. We have some incredibly smart and passionate people in our country! Thank you for your hard work and thank you for challenging the status quo. I know we'll see each other again!

"New Zealand is […] a geographically isolated country with a small population. We face challenges in accessing markets offshore and in the depth of financial and human resources available domestically. Over the last few decades New Zealand's productivity growth has been slower than in many other advanced economies. […] Innovation will be the main mechanism through which we lift New Zealanders' productivity, prosperity, and wellbeing. It will drive the generation of new ideas, approaches, and ways of producing products or delivering services, and their subsequent application and diffusion. We must lift productivity by intensifying knowledge production and ensuring effective and widespread up-take".

(Stephen Joyce, 2015).

3. Introduction

From the overall rethink of the science investment system in the 1980's to the creation of the Crown Research Institutes in 1992 (McGuinness et al, 2009), New Zealand has a rich history of deep and applied food science, well recognized within the research communities and the industry, which puts the country in a good position to address some major global issues.

By 2050, the world's population is expected to reach 9.7 billion (United Nations, 2019) and ensuring global food security will be a priority (Berners-Lee et al., 2018). It is only with an efficient, sustainable, and economically viable process, that we'll achieve changes in food production and consumption habits. While the nutrition must be adequate, the social, cultural, and economic aspects of new food products must be acceptable and accessible. Consequently, new approaches are needed to feed the current and future global population (Valoppi et al, 2021). Food science and technology can help address these problems by improving food production processes, including novel ingredients from more sustainable sources, and designing new highly accepted food products, as suggested by Valoppi et al (2021).

In the 2015 National Statement of Science Investment, Steven Joyce encapsulated the important of science and innovation by saying: '*Innovation will be the main mechanism through which we lift New Zealanders' productivity, prosperity, and wellbeing. It will drive the generation of new ideas, approaches, and ways of producing products or delivering services, and their subsequent application and diffusion*' (Joyce, 2015).

Science is expected to make contributions to the attainment of explicit societal goals and advance development. An inability to demonstrate impact can jeopardize support for public investments in science over the long term (MBIE, 2017).

The vision for 2025

"A highly dynamic science system that enriches New Zealand, making a more visible, measurable contribution to our productivity and wellbeing through excellent science"

(NSSI, 2015).

Part of the answer to this challenge is to ensure we take the right decision for New Zealand's food science system. A critical element is to find ways to better connect New Zealand's food science to the world. This implies a rethink of the model and boundaries we currently work with, and a prioritization of the areas of expertise. This report only mentions the strong domestic mandate of the New Zealand's science industry; it is acknowledged that the primary focus of the industry is to develop New Zealand's economy. However, this is not studied in this report.

In this report, we ultimately aim to showcase a model which makes it easy for international stakeholders to connect with New Zealand Science system. The approach allows easy collaboration across all science providers in order to provide solution to complex issues.

4. Aims and Objectives

The purpose of this report is to:

- Provide a clear picture of the New Zealand food science ecosystem and active food science providers.
- Outline the system in which they operate and its limitations.
- Identify New Zealand's unique selling proposition as defined by food science providers.
- Understand the opportunities and challenges the industry players are facing and where the need for change is required.
- Draw some common themes around the potential solutions provided by the semi structured interviews.
- Provide insights and develop a bold vision and relative recommendations for the future of New Zealand food science, to position New Zealand as a leading knowledge provider in food science, globally.

5. Method

The methodology was a balanced endeavour, using literature review, semi structured interviews, and thematic analysis as explained by Braun and Clarke (Braun et al, 2006).

An extensive literature review regarding science capability and connectivity in New Zealand was conducted. The collation of existing literature, industry reports, opinion pieces and articles was the first step in the process. The aim was to establish a good understanding of the food science system in New Zealand. Then, we focused on literature from after the start of the pandemic for part of the research. This criterion proved to be challenging and reduced drastically the number of suitable documents. Following the literature review, a question tree was developed to form the basis of the interviews and helped to identify the relevant people to perform the interviews. On a total of 11 interviews, all but one interview was conducted online (via TEAMS) and took approximately one hour each. In the first instance, all interviewees were sent an introduction email explaining the research project and the reasons for requesting their time and insights.

These interviews were critical in shaping this report as they allowed us to draw key views on New Zealand's unique selling proposition, as well as a key forces of change and subsequent recommendations for successful and sustainable New Zealand food science. This study focuses partly on New Zealand's unique selling proposition to ascertain whether we could leverage some intrinsic values to position New Zealand as a leading knowledge provider.We endeavoured to capture a wide range of voices from the sectors, from Crown Research institutes and pilot scale companies, through to universities and industry related partnerships.

At the start of each interview, we introduced each other and gave an overall brief of the project as well as the scope. We then proceeded to ask a variety of questions, based on the following six themes:

1	2	3
Outline of the science providers' capability	Views on New Zealand food science's Unique Selling Proposition	Understanding of how these unique selling propositions' are being leveraged
4	**5**	**6**
Understanding of food science providers' international network	Opinions on the forces of change, how New Zealand and its food science organisations navigate these	International business development opportunities and challenges faced by the industry partners

The 11 interviews had a major focus on understanding the current state of play of the science organisations and their thoughts on the New Zealand international positioning in food science as well as their strategy to increase connectivity.

The objective of each interview was to compare and contrast the responses, which entails a categorisation of each response into themes, following the thematic analysis model as detailed by Braun and Clarke (Braun et al, 2006). Each theme was further refined and underpinned the findings and recommendations.

There were some limitations to this methodology, such as:

- Availability of interviewees.
- Requirements for literature no older than two years for some of the research.
- Maturing of the research project but need to follow the interview questions established at the start to compare answers.

Overall, these limitations were largely overcome and didn't impact on the goals of this research project.

6. Literature review - New Zealand Food Science Landscape

The New Zealand food science landscape is rich and contains at least 23 research and development providers. This diversity is essential for maintaining the capabilities across many different areas of work. However, it also creates complexity for international entities and New Zealand companies, as they need to work through all the different organisations to find the provider that may answer their needs.

The definition of food science from Potter and Hotchkiss (2012) is as follows: '*food science can be defined as the application of the basic sciences and engineering to study the fundamental physical, chemical and biochemical nature of foods and the principles of food processing*' (Potter et al, 2012). In this report, we define the boundaries within the New Zealand food science ecosystem as: food safety, food processing technology, material sciences, sensory science and food for health. This definition is limited to achieve the required outcomes in this report.

These areas of work are addressed by many players, from Universities, the New Zealand Food Innovation Network, Crown Research Institutes, partnerships (such as the New Zealand Food Safety Centre and High Value Nutrition), and start-ups.

Before we delve into the current landscape, it's important to signal one of the big evolutions of the science system in New Zealand dating back to the late 1980s. The reform that continued in the 1990s was aimed at bringing science and commerce closer together, giving additional efforts to areas of economic need, by engaging more heavily with the private sector. It was aimed at bringing 'new science' and 'applied science' closer together.

In the model created 30 years ago, the New Zealand government would continue funding the deep science, while the applied science had to be industry funded. This is a good model to drive better collaboration with industry and bridge the science/commercial gap.

However, it seems that the funding mechanism also created some unintended consequences such as competitivity for funding deep science, silos and in some cases, confusion. Finally, aspects of New Zealand knowledge-based capital, particularly in scientific Research and development (total research and development expenditure as a share of GDP) and the share of total research and development performed by businesses are among the lowest in the OECD (NSSI, 2015). This report is not going to expand on these aspects, but this element is important and should be brought to the attention of the readers.

Currently, two pillars underpin the government science investment (Science New Zealand, 2018):

Excellence	Impact
Transformation of New Zealand's economy, environment and society will be led by excellent science.	Referring to the connection with the 'real world'.

As per the Ministry of Business, Innovation and Employment's (MBIE) 2015 National Statement of Science Investment, we understand '*excellent science as the best people, a rigorous approach and optimum results'*. From the same report, we also understand that '*for us to overcome our economic and geographic obstacles, capitalise on our unique assets and characteristics, and deliver a prosperous future for all New Zealanders, this Government recognises that our science system needs to be not just good, but better than comparable countries'* (Joyce, 2015).

The New Zealand food science landscape can be described by its players, as per figure 1 below.

Figure 1 - The New Zealand food science and innovation ecosystem (Source: updated from Food HQ)

New Zealand food science landscape comprises

- Five Crown Research Institutes (CRI): AgResearch, Institute of Environmental Science and Research (ESR), Plant & Food Research, Scion and Manaaki Whenua Landcare Research. AgResearch and Plant & Food Research are the most active organisations in the food space. We have included a table with the Statement of Core purpose of these five CRI in appendices 1 (table 1, page 38).
- Four universities: Otago University, Lincoln University, Massey University and Auckland University.
- The New Zealand Food Innovation Network (as detailed in table 1 below)
- High Value Nutrition - National Science Challenge.
- Cawthron Institute (independent science organisation)
- Callaghan Innovation (Crown Agent)
- Partnerships (further details in Appendix 2, page 39):

  Food HQ
  The New Zealand-China Food protection Network
  Riddet Institute Centre of Research Excellence
  New Zealand Food Safety Science and Research Centre

As part of the New Zealand food science landscape, we have the New Zealand Food Innovation Network (NZFIN), which is critical in translating innovation into commercial opportunity. The network provides a range of options from product development to product

enhancement and upscaling. They are located at the heart of the actions, within their relevant expertise. Table 1 below details the expertise of each organisation within New Zealand Food Innovation Network.

Table 1 - New Zealand Food Innovation Network Members' Core Capabilities (source: New Zealand Food Innovation Network, 2022)

Trading Name	Focus	Capabilities
THE FOODBOWL	Processed/FMCG foods Space/equipment for hire Export registrations About 1000kg/shift	- Extrusion, Milling/blending - Liquids/beverage - High pressure processing - Freeze drying - General processing - Multiple packaging styles - Product development kitchen
FOODWAIKATO	Dairy and Infant formula About 500kg per hour Vegetable	- Spray dryer - Evaporator - Other dairy equipment - Packing - Powder (vegetable)
NZFIN-HAWKES BAY	All Food and Beverage	- Business Development - New Product Development
FOODPILOT	Dairy Fruit and Vegetables All Food and Beverage	- Same as FoodBowl (1/5th scale) - Same as Food Waikato (1/20th Scale) - Post harvest technologies - Process Optimisation - Meat and small goods pilot plant
FOODSOUTH	Processed/FMCG foods Space/equipment for hire Export registrations 20-200L batch size	- Mixing / Blending / Emulsifying - Extrusion - Freezing/Cooking/Baking - General Processing - Product Development - Technical and Business Development

The New Zealand Food Innovation Network has varying capacity and capabilities such as extrusion, freeze drying, etc. The members are all situated in the heart of where most related activities take place.

Each organisation has its own set of expertise and work together to guide innovators, start-ups and companies to reach the right partner to help them in the development of their products.

7. Findings and Discussion

7.1. New Zealand's Unique Selling Proposition

Generally, there are many attributes used to describe New Zealand uniqueness. However, we think that The New Zealand Story, led by New Zealand Tourism, New Zealand Trade and Enterprise and Education New Zealand, encapsulate the unique selling proposition beautifully in saying: *"New Zealand is a progressive nation of creative idea-makers delivering new solutions, while always caring for people and place. Our story is grounded in our values – it's who we are, what we stand for and what we offer the world. Good things come from our country and the more the world knows about these, the greater chance we have to grow our global reputation*" (New Zealand Story, 2013).

Kaitiaki, Integrity and Ingenuity are three pillars often used to describe New Zealand. This is putting the country in a good light for global research and development, however, based on the interviews, we start to wonder if it will be enough. New Zealand uniqueness isn't a tangible attribute which can make it difficult to convince organisations to work with us rather than using in house capability, own country's research and development providers or a neighbouring country.

The interviews detailed some interesting unique selling propositions. The range of answers was such that it was possible to cluster these into 3 main themes. With a special comment around the relationship skill.
The themes emerging from the interviews regarding the identification of New Zealand's unique selling propositions are:

- Remoteness
- Māori Culture
- Genuinely safe food

Another important element emerging from the interviews is the relationship skills of the people in the sector. It wasn't identified as a unique selling proposition per se, however, it has included as such below (section 7.1.4) because it is an important capability.

7.1.1. Remoteness

Figure 2 – NZ's remoteness
(Source: https://www.stock.adobe.com)

A valuable and obvious attribute for New Zealand is its remoteness. As mentioned in 4 interviews, this is an advantage for countries in the northern hemisphere, whether they want to continue trials all year around as the seasons are opposite, or whether they want some data analysed overnight for a time constraint project.

This unique selling proposition is advantageous and very useful in some instances, but these requirements are seldomly required and thus this attribute is limited. Furthermore, in many instances, the remoteness is a huge disadvantage as it doesn't allow for easy face to face interaction and creates a barrier for overseas companies to engage with New Zealand.

In the Global Pulse Check 2021 performed by One Picture for New Zealand Story, the terms 'Small', 'Far', 'Isolated', 'Quiet', 'Unprepared' are, amongst others, used by some countries to describe New Zealand. Germany, Japan and Dubai go as far as stating New Zealand is ‘increasingly hard to justify’; it's ‘rural’, ‘unprepared’, ‘isolated’ and ‘closed’ respectively (New Zealand Story, 2021).

The other argument is the food miles debate; but it’s proven that agricultural production in New Zealand can be much less damaging to the environment than in other countries, even considering the impact of transportation (Saunders et al, 2016). Further details on this in section 7.2.1 on page 19. However, this data is not widely known and understood which means that New Zealand must demonstrate the value in its story to justify its niche and premium prices (New Zealand Story, 2021). This topic is further developed in section 6.2.2.

However, there are many silver linings outlined in the Global Pulse check 2021, notably the digitization of communication pathways which has allowed New Zealand to overcome its remoteness and brought the country closer to the rest of the world (New Zealand Story, 2021).

7.1.2. Māori Culture

Figure 3 – Māori Totem
(Source: https://www.stock.adobe.com)

Some speakers during the Kellogg programme have mentioned the Māori Mihi and culture, as a unique attribute of New Zealand. This unique selling proposition was echoed by 5 interviewees.

Part of the unique value proposition provided by the Māori culture is the long-term view that is prevalent in most decisions. As addressed earlier, the New Zealand science system is working within political boundaries which don't always allow for a long-term view, the need for economic return is shadowing part of this message. Nevertheless, to address inter-organisational, global, and wicked problems (i.e., problems that are unique, large, and complex), a long-term view is critical (Ritel et al, 1973). For this reason alone, we believe the integration of the Māori view in all science endeavour is important. It’s the view of one interviewee in particular that the Māori voice and process must be owned and driven by Māori people, to ensure genuine and authentic guidance, and the whole programme design must be following these guidelines, not only parts of it.

This unique selling proposition is important and forms part of New Zealand’s image, however, this attribute hasn’t been analysed in this report. This decision was made consciously as we believe that other experts are better placed to address this topic. However, this unique selling proposition must stay in our mind as it’ll form an integral part of science projects.

7.1.3. Genuinely safe food.

The safety of the food produced in New Zealand was one of the unique selling proposition that mostly all interviewees mentioned. It is clearly on the mind of all our food science players.

New Zealand food safety science is a strength of the New Zealand export mechanism. New Zealand has truly achieved high levels of success of the regulatory systems for delivering safe food (Interviewee, 2022). This has played in New Zealand's favour from a market access standpoint and has allowed exporters to maintain these market connections on a trust and confidence basis. It's a successful commercial outcome that has been made possible by government-to-government agreement and policies (Interviewee, 2022). And to close the loop, it's critical to mention that beyond the regulatory work, the science underpinning these regulatory systems has been key to the trust model and keeps proving its value.

As Derek Robinson explains: *'The reality is that we are more dependent on our customers to buy from us than they are on us to supply them, so we must continue to provide safe products with high levels of assurance to maintain our trading partners' confidence and goodwill'* (King, 2006)

"New Zealand is so isolated, there is little doubt that preservation and food safety are paramount."

(Interviewee, 2022).

New Zealand is also commonly described as a country that can produce high quality produce with integrity (New Zealand Story, 2021). However, we must get our domestic story right to present a compelling and convincing case on the global scene.

7.1.4. Relationships

The relationship skills demonstrated by New Zealanders in the science sector is another key point emerging from the interviews. This element hasn't been listed as a theme as it was identified throughout the interviews but not as a unique selling proposition, but it was included as it is an important element.
In the interviews, New Zealanders are generally categorized as easy going and personable. However, following the COVID-19 pandemic, the study performed by NZTE outlined that other countries describe New Zealanders as 'relaxed and happy', but 'isolated and closed' and demonstrate 'progressive leadership but rural and unprepared'. We must remember that these negatives attributes have become apparent after the pandemic, when New Zealand borders were still closed. Nevertheless, we must be aware of the view from overseas countries and ensure we 'debunk' these perceptions. We'll never be able to stop people thinking of New Zealand as an isolated country, due to its location, but we can help make it a welcoming and thought leading country.

Unfortunately, some interviewees are adamant that the current science structure has deteriorated the positive relationship attribute of the country, mainly due to the competitive behaviour of the science providers. This has also increased the lack of trust from industry to the science network, due partly to the intellectual property appropriation. Entrepreneurs and industry players tend to keep innovation and new product close to their chest by fear of having to compromise the appropriation of their intellectual property. Therefore, there is a real decline in the scaling up of ideas (Interviewee, 2022).

The internal relationship issues encountered within New Zealand's science industry has an impact on our ability to develop new business as there is little incentive for collaboration, but individual research and development entities are unlikely to be able to meet the requirements of an entire programme of work. However, this trend mentioned during the interviews seems to be going in the right direction. We see an increased number of joint projects, with entities such as the 'National Science Challenge' making the collaboration aspect a pre-requisite.

"Communication and responsiveness are key to building trust and trust is more important now than ever. New Zealand is seen as a transparent and stable country."

(New Zealand Trade and Enterprise, 2021).

7.2. Main forces of change

As well as being aware of the New Zealand food science landscape and its ramifications across the global food ecosystem, we must address the elephant in the room. The reactivity, rather than proactivity, of the science sector was identified several times throughout the interviews. Many explanations can attempt to justify this behaviour, however we'll focus on identifying these important forces of change, as highlighted by the interviews, which will help with developing a proactive approach.

The 'Century of the Environment' is a term that was first introduced during one of the interviews and it certainly summarises well many of the conversations held throughout the composition of this report. Globally, we witness the creation of major multi-country projects, the development of major policy changes like He Waka Eke Noa and Three Waters, which will transform farming and food production like it did in 1980s in New Zealand. It is also believed by some interviewees that it'll become, or should become, a supermarket requirement to prove that the food has been ethically sourced, environmentally friendly and verified.

A critical force of change signalled by various literature is the complexity of the need of each market. The issues are compounding with population growth, prosperity shifts, limitation of land use for food production, climate change and scarce fossil fuel (Wageningen, 2014). A clear force of change is the realisation that the issues addressed are bigger than one organisation alone. Science organisations must naturally shift to a co-creation model in order to create value to develop innovative solutions to today's ever so complex challenges (Lusch et al, 2010).

Three main forces of change have been identified as priorities:

- Climate Change
- Food Miles
- Alternative Protein

7.2.1. Climate Change and Food Miles

Figure 4 - Climate change withered tree and dry earth (Source: https://www.stock.adobe.com)

The food miles debate has been at play for at least 20 years but coupled with the World Economic Forum scenario of 'local is the new global' and the seemingly never-ending pandemic, this debate is increasingly front-of-mind for conscious international consumers (Global Agenda, 2017). Even though some New Zealand produce (such as lamb) exported to the other side of the world create less emissions than lamb produced and consumed within the UK, the perception is that it's not energy efficient because it's produced far away (Saunders et al, 2006). Unfortunately, it's very difficult to address these perceptions, which don't consider the total energy use used to produce a lamb in New Zealand's pastoral grazing system, but focus solely on the distance food travelled to market (Saunders et al, 2006). An industry speaker during the Kellogg Programme mentioned that '*perception is what matters, for better or for worse'*.

This debate is closely linked with the food science discussion as it allows to focus our attention on the type of activity we engage in. The New Zealand food science industry should support value added produce and innovation to step away from commodity, but it should also support technology, waste management and preservation technology (longer shelf life, better packaging etc).

One of our first interview was critical as it outlined that, as a small country, our top priority should be to offer produce that would stay fresh for longer than any other produce in the world. It is important to note that sea transport of fresh goods takes an average of three to four weeks to reach the United States of America and four to six weeks to reach the United Kingdom and the Middle East. The distance New Zealand's produce must travel explains why New Zealand has achieved such high degree of success on regulatory systems for delivering safe food, as mentioned in section 6.1.3 on page 16. There is no doubt that preservation should be our top expertise.

The most important action regarding the food miles discussion is around education. It is about educating people about Life Cycle Analysis and showing that meat from New Zealand, even consumed in the United Kingdom is not absurd. This concept is explained at length in a report from Caroline Saunders (et al, 2006).

7.2.2. Alternative Protein

Innovations in food science and technology can ensure the availability of acceptable, adequate, and nutritious food, and can help shape the behaviour of consumers toward a more sustainable diet

(Valoppi et al, 2021).

Alternative protein to meat protein has existed since 965 AD in the form of tofu and was widely used in China (Shurtleff et al, 2014). From the 14th century it became commonly used in the Asian market. Alternative proteins aren't new. They equated to $620 million in retail sales in the United States of America in 2014 (Shurtleff et al, 2014).

Alternative protein is described in the history of meat alternatives as '*a meatless food that has approximately the same taste, appearance, and texture of a related food made from meat, poultry, fish or shellfish*' (Shurtleff et al, 2014).

Alternative proteins are a vibrant and exciting space where New Zealand would benefit from maintaining high quality capability to keep up with the technological development around the world. There are three types of alternatives proteins:

- Plant based
- Precision fermentation
- Cell culturing

Ultimately this is an area that is evolving fast, many interested parties are putting a lot of effort into new product development. The technologies and innovations in this space are scaling up. New Zealand can either be in the fringe of it, or we could make a conscious decision to pull time, resources, and investment in this area to make a leading hub. It would be in the best interest of New Zealand food science to stay at the top of its game in this sector. This would allow better understanding of upcoming opportunities in the alternative proteins space, and quicker scaling up of ideas within New Zealand.

7.3. New Zealand's International Food Science Collaboration

All interviews highlighted that the COVID-19 pandemic has shaken the grounds of our international relationships due to our inability to connect face to face. The changing environment within our stakeholders' organisations and reprioritisation of focus areas meant that the connection was weak. For many stakeholders, one of the most affecting elements has been the movement of staff. It has become common to lose the connection with an organisation due to one person leaving the company.

This issue is partly the reason for developing a strategic document relating to the integration of New Zealand food science internationally. The realisation of our reliance on person-to-person relationship for organisation wide engagement.

One interesting surprise from the interviews was that many organisations' international activities seem difficult to ascertain. There are naturally many forms of international activities

at play, notably through one-on-one relationship with scientists, either due to their place of birth, or previous work.

Over half the interviewees mentioned that there are many successful scientist-to-scientist relationships. This is important and should remain that way. There are also very successful government driven initiatives that bear very fruitful international outcomes. We have many examples of great research and partnerships created over the years.

However, this is sometimes described by industry people as an ad hoc strategy, driven at the organisation level. While these can create good outcomes, they don't often create long term research opportunity. Some of the interviews outlined the confusion felt by international stakeholders when looking at the science landscape in New Zealand. There is no obvious front door to the industry, meaning that each stakeholder would have to do extensive research prior to engaging with the relevant New Zealand's food science organisation. This is a huge barrier to collaboration and international activities in general.

In 2022, New Zealand's international network has been weakened after over two years of border closure. In the Global Pulse Check survey, performed in 2021, it was outlined that New Zealand is seen as a 'far away country' (New Zealand Story, 2021).

After a well-managed COVID-19 response (Organisation for Economic Co-operation and Development, 2022), New Zealand has a fantastic opportunity to re-engage with the world in a positive, strong, and compelling manner. We must develop our domestic story in a way that portrays New Zealand as a truly unique value proposition. To do so, we have to show cohesion. We are too small to compete against each other domestically to engage with international stakeholders.

This natural reset post-COVID-19 is an opportunity for New Zealand to go out and engage at various levels to demonstrate our varied capability, not at a personal level, not at an organisational level but as a country. New Zealand food science must be presented as a whole package. When the stakeholder is on board, we can delve down to the type of collaboration required to achieve this particular project. Success would be based on the diversity of the collaboration and the value co-creation at play with all parties involved.

7.3.1. Case study of a successful collaboration

There are many examples of successful international projects. We'd like to draw your attention to one as it highlights how a project can be transformed into a long-term relationship.

The project was established between Bright Dairy & Food Limited and AgResearch. The aim was to help them get a better understanding of the differences between their infant formula product and Chinese mothers' milk.

We have listed below what made this project a success:

- A good fit: AgResearch has considerable experience in chemical analysis of foods, including human and ruminant milks. Therefore, AgResearch was capable to perform this project. They have experts who conducted the in-depth analysis of nutritional compounds in milk and leveraged their world leading capability in metabolomics. The stakeholder was very happy with the outcome of the project and acknowledged it.
- Excellent project management and delivery: the milestones were performed on time and the stakeholder was updated regularly via monthly progress meetings, as well as face to face meetings in China.

- Good communication and quick response: AgResearch put some additional resources to facilitate the communication in different languages and provide support.
- Research outcomes: quality joined publications and provision of scientific evidence for Bright Dairy & Food Limited's products.

This could be applied at a larger scale, including multi-parties and be as successful as the above example.

7.3.2. Challenges for science providers in New Zealand

Figure 5 - Kiwi fruit orchard
(Source: https://www.stock.adobe.com)

The major hurdle encountered by organisations with international stakeholders is the intellectual property. This topic is commonly bound by confidentiality clauses, it is therefore difficult to provide actual example. However, one example in the public domain is the scandal around illegally grown SunGold Kiwi fruit in the Sichuan province in China. The basis of Zespri's model is a 'single desk marketer', meaning that all growers must sell their fruit to the company. In this instance, Zespri lost the control of the variety, therefore they lost the intellectual property. Moreover, the concern at the time was around the quality of the product, while not meeting Zespri's specifications, this had the potential to damage the SunGold brand at a global level. Zespri managed these issues well and turned this challenging situation into an opportunity by using the Chinese-grown kiwifruit as an off season supply to ensure year around availability.

While these situations are not common, it's obviously a major concern for all research and development providers. As illustrated above, it's not only the issue of intellectual property, but it can also have dramatic and global consequences on a whole brand.

7.4. Strategies for a 'New Zealand Food Science Institute'

The findings and discussion addressed in the following section are the result of a compare and contrast exercise between the semi structured interviews and the literature review. It also involves critical thinking and additional information discovered whilst compiling this report.

A single New Zealand science institute would entail a single-entry door followed by multiple secondary doors. It would allow international stakeholders to engage with the New Zealand science institute and be directed to the correct science department, or 'sector', with the initial enquiry already translated into the relevant terms for the science team. This option provides many positive outcomes:

- Simplification of the engagement process for our stakeholders,
- Simplification of the marketing process at the New Zealand end,
- Allow scientists to focus on delivering their science and innovation.

Currently the model is fragmented and confusing to our stakeholders, particularly internationally as they have a limited understanding of the New Zealand system. Therefore, we must ensure the development and maintenance of our international engagement, via better and more targeted marketing, to have a sustainable science system.

While there are many challenges to the implementation and adoption of such model, there are more risks to the industry to remain at the status quo.

2022 is proving to be an interesting year for the New Zealand Science sector with Te Ara Paerangi Future Pathways green paper signalling that Crown Research Institutes and Callaghan Innovation are going to be re-evaluated. It's expected that the outcome of this consultation will see a major reorganisation of the science ecosystem. It's believed that the land-based research players (Plant and Food Research, AgResearch, Manaaki Whenua-Landcare Research and Scion) could be made into one organisation, centred around Lincoln University. However, in anticipation of the release of this document, we shall keep signalling relevant strategies and recommendations. Whichever way this green paper goes, we are better placed if we challenge the current state and get ready for change. Therefore, the development of this strategy is timely and could encourage the outcome of the green paper.

"Our international network has plenty of room for growing and strengthening, which could be achieved via direct engagement, knowledge sharing and collaboration"

– Interviewee, 2022

The New Zealand Food Innovation Network is building its domestic and international network across similar science & innovation food hubs, such as Ngawha Innovation and Enterprise Park and Singapore Food Plant.

7.4.1. Value Co-creation

As outlined under the forces of change section, the complexity of the needs of each market is forcing organisations to work together. The realisation that one organisation doesn't have the depth of knowledge and expertise to address complex scientific and societal issues (Lusch et al, 2010) is opening the door for the process of co-creation.

The biggest challenge in value co-creation processes is the loss of defined intellectual property and market share ownership. The other issue is the stakeholder capture of their share of value (Reypens et al, 2016). Often these three elements alone are enough to stop the process in its tracks. Consequently, the value co-creation process must be implemented like a virtuous cycle.

The process includes two pillars, as described by Charlotte Reypens (et al, 2016):

Value Creation	Value Capture
Co-ordination, consultation, and compromise	Anticipation, assessment, and application.

For these types of processes, the research question and the roles must be very clear and focus on outcomes. However, it seems like a reasonable task and a more suited process to deal with "wicked problems". We always like to remind ourselves that if it was easy, it'd already have been addressed and solved. These issues are complex, and they will be answered by a multi-party network.

As the value capture and ownership of intellectual property and patents is a major barrier for the implementation of such processes, it is critical to delve into the value leveraging element. Simply put, the 'win-win' situation is when the collaboration allows each partner to receive access to resources and capabilities that they would otherwise not have (Dentoni et al, 2015). Additionally, value can be leveraged through network-level and stakeholder-level processes.

As shown in figure 6, both public and private organisations are part of this virtuous cycle, thus they both contribute resources to the collaboration (Reypens et al, 2016). The same author explains that '*these resources were recombined through the value co-creation processes of coordination, consultation, and compromise, to co-create innovation, knowledge, and relational outcomes. This virtuous cycle created growth opportunities for individual organizations and the overall partnership'* (Reypens et al, 2016). Furthermore, this process allowed partners to address issues they couldn't have resolved on their own, by leveraging their investment and value capture through this process (Dentoni et al, 2015).

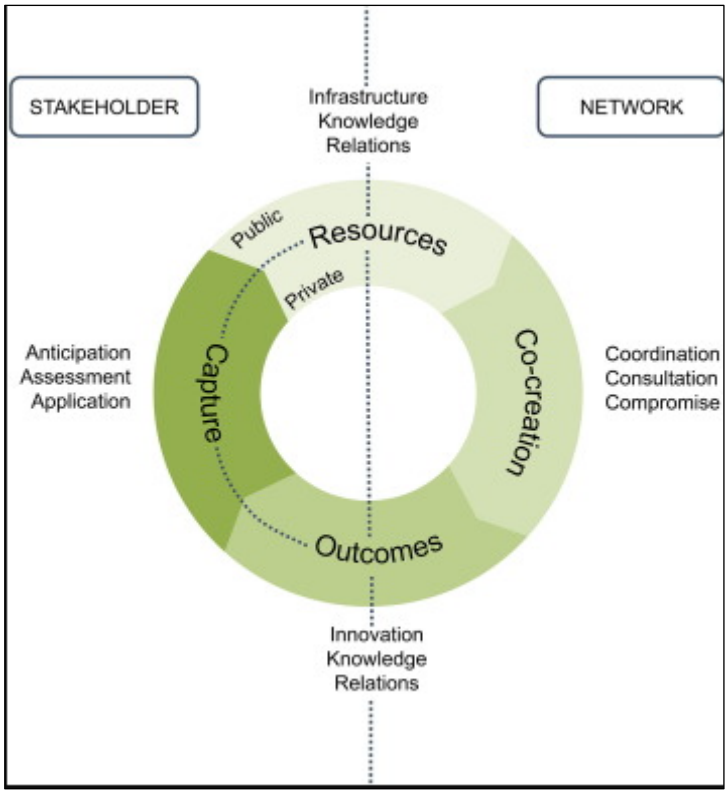

Figure 6 - Cyclical process framework of value leveraging
(Source: Reypens et al, 2016)

The Wageningen Model is a good example for a New Zealand food science industry. Wageningen University & Research (WUR) was one of the smallest University in Holland but is now ranked as one of the world's top universities in the world. Their mission is very clear: '*To explore the potential of nature to improve the quality of life'. And they believe it is to be 'achieved together with industry, governments and research institutions around the world'*. They are also very good at large scale cooperation in public-private partnerships. They are in deep science as well as applied science and they attract significant European funding as their value is proven year after year (Wageningen University & Research, 2014).
What makes Wageningen University & Research a great model is that they have a strong domestic mandate as well as an international focus. It is worth noting that the international activity is split into two areas:

- Higher values research services to advanced economies
- Development of agricultural systems in emerging economies

Wageningen University & Research's model could be adapted for New Zealand setting. In essence, New Zealand's science system also has a strong domestic mandate, with a primary focus around the development of New Zealand economy. The international focus (generally in the commercial space) varied from one organisation to another and shows the lack of alignment.

Cross Sector Partnership is underpinned by the co-creation of dynamic capabilities (Dentoni et al, 2015). Moreover, as described in the Impact of Science discussion paper, '*Science is by its nature about discovery, generating new knowledge and applying knowledge. Whole networks of scientists and collaborators generate knowledge, making it challenging to establish inputs and attribution. This is especially the case for a small country like New Zealand (MBIE, 2017).*

To address the issue of input and attribution we suggest one model of creation and appropriation of value in collaborative relationships as outlined by Stephen Wagner (et al, 2010). It involves multiple hypothesis organised from H1 to H7, as per figure 7 below.

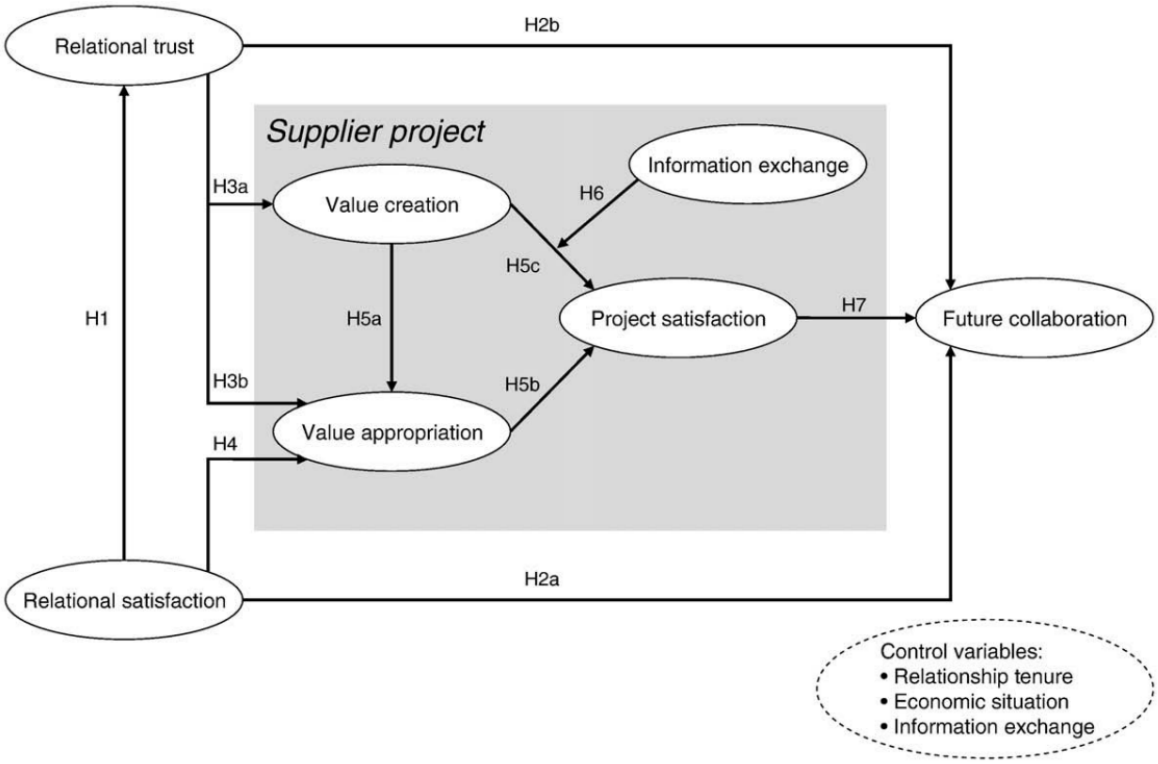

Figure 7 - Value creation and appropriation as focal variables
(Source: Wagner et al, 2010)

Each hypothesis is described below (Wagner et al, 2010):

- H1. Relational satisfaction has a positive impact on relational trust.
- H2a. Relational satisfaction has a positive impact on the company's future collaboration intent.
- H2b. Relational trust has a positive impact on the company's future collaboration intent. Therefore,
- H3a. Relational trust has a positive impact on value creation.
- H3b. Relational trust has a positive impact on value appropriation.
- H4. Relational satisfaction has a negative impact on value appropriation.
- H5a. Value creation has a positive impact on value appropriation.
- H5b. Value appropriation has a positive impact on the focal partner's level of project satisfaction.
- H5c. Given H5a and H5b, value creation has a negative direct impact on the focal partner's level of project satisfaction.
- H6. Information exchange positively moderates the direct link between value creation and project satisfaction.
- H7. Project satisfaction has a positive impact on future collaboration intentions.

In summary, positive strategic outcomes are underpinned by relational trust and helps create value in ways that a transactional relationship could not effectively create or share among partners (Palmatier et al., 2006). Commitment, trust, relationship satisfaction and relationship quality are identified as customer-focused relational mediators. It is also suggested that trust strongly relates with expectation of continuity (Verma et al, 2015).

It is no surprise that relationship quality, relationship satisfaction and relationship trust, if positive, should increase further intentions in collaborative and strategic partnerships. However, multi-party collaboration aims to create and capture superior value (Wagner and al, 2010), and so they should. Organisations' expectations are higher when working collaboratively. Moreover, in the food science sector, the 'co-design' element is something providers strive to perform but it adds many levels of complexity, and they must ensure that the outcome is greater than if it was done under one organisation alone.

Although this value creation and appropriation concept seems key in better preparing organisations for multi-partners collaboration, the research to do it right is relatively scarce (Wagner et al, 2010). By nature, projects participants are competitive, and they will always look at the slice of the pie they can claim, but also the other parties' value capture. Implementing systematic, transparent, and frequent communication, will help mitigate this as it positively impacts the link between value creation and project satisfaction (H5c). This is key to ongoing relationships.

The last piece of the model, H7 Project Satisfaction, is key to further collaboration. The continuity and reproduction of collaboration will only occur if the initial project and engagement has met their expectations (Wagner et al, 2010).

From the discussion held with industry players, there is a sense of comfort in the New Zealand science industry performing well in relational trust. However, the quality of the representation seems to be average, and sometime poor. These insights highlight an important gap in our science landscape. In fact, the quality of representation is critical and failure at that level usually means it is difficult to enter the process of value creation and appropriation. This means that each hypothesis can be performed well, as described earlier, but the quality of the initial communication and translation of the need is paramount to success and continuity.

The quality of representation is important and must be underpinned by easy collaterals highlighting the capabilities on offer.

The latter point leads to the alignment element of the report. As illustrated earlier, New Zealand food science seems to come across as a confusing sector, with varied capabilities. However, we believe there is a need to align the core purpose of the 'New Zealand Food Science Institute' to put in place targeted marketing, which would lead to better and faster outcomes.

7.4.2. Better Strategic Alignment

The semi structured interviews highlighted clear themes around the need for better alignment within the food science industry. The themes have been classified into four areas:

- **Food Strategy**: development of a structured and collaborative strategy whereby we select a limited number of areas of expertise and become world leaders in these targeted areas. This food strategy would be underpinned by…
  - **…Relevant investment**: Investment of resources, time, and funding towards making world leading capability in these sectors of activity. This food strategy would require…
    - **…Better communication**: we must be able to articulate what we are good at (and invest in these areas), and what we don't do. This food strategy would excel in…
      - **…Public and private sector linkages** given the nature of the wicked problems that need to be addressed.

Multisector approaches are not limited to collaborations between public sectors, they are also relevant to the linkages between the public and private sectors (Thomas et al, 2011).

The outcome of such strategy would ultimately be the creation of a New Zealand Science Inc or more commonly referred to as **NZ Inc** (New Zealand Inc). Similarly, to Wageningen University & Research, one of the goals is to have one point of entry.

New Zealand Inc must be at the critical juncture point, addressing the requirements to meet consumer and market needs whilst also meeting the sustainability demand of our planet. '*One where innovation and technology can combine to create a sustainable circularity and supply chain efficiency in meeting the needs of both global food demand and sustainability for the planet'* (Interviewee, 2022).

The implementation of these four themes should start with a capability mapping exercise for the whole science system. It's obvious that until there is a clear, holistic and comprehensive view of the capabilities available in New Zealand food science, it'll be extremely difficult to develop a strategy.

The capability mapping would allow the identification of:

- The strong areas of expertise, which may form the basis for our future world leading (limited) range of science areas.
- The weak but critical areas of science, thus highlighting the gaps and requirements to address these.
- The obsolete or irrelevant areas of science, which may be reshaped to fit with New Zealand's food strategy.

Whilst daunting, the capability mapping exercise is believed to be a crucial part of the success for international business development.

Ultimately, New Zealand's food science strategy will be part of the wider New Zealand's Science Strategy and will fall in the 'Open-source sustainability' scenario as described in the Future of Global food systems (Global Agenda, 2017). The key element to this scenario is government embracing international trade, subject to responsible practices. In this scenario, policies would enable food value chain to be more transparent, addressing inequality across the value chain.

These potential futures as described in the Global Agenda, reveals that many of their most concerning elements are a product of inaction – highlighting the dangers of a "business-as-

usual" approach. It is, therefore, imperative for leaders to take a systems-level view, examining the implications of all stakeholders' choices for the future of food systems. These can inform structural changes and individual choices to secure a more positive future for food systems (Global Agenda, 2017).

One strategy developed in this project is the concept of 'Sister organisations'. This approach is based on a solid capability map, selective areas of expertise and two-way investments. These pre-requisites allow the correct matching of each New Zealand's food science entities with relevant international organisation. This is a simple concept which has been trialled a few times, however it has never been successful across the whole industry. It is believed that lack of alignment and investment are the source of the failure. However, with this strategy in place, expertise and alignment would be very clear and the benefit for the sister organisation would be much greater due to the scope of the network. Under the New Zealand Inc approach, they would benefit from every partner within the science system, although have an allocated sisters' organisation aligned with their core purpose.

7.4.3. Government investment

Figure 8 - New Zealand Parliament buildings (Source: https://www.stock.adobe.com)

In most instances, interviewees expressed their opinion about the lack of investment in Research and capability building which makes our science sector weaker overtime.

It resonated with Mariana Mazzucato's (2022) discussion on Radio New Zealand, particularly when she mentioned the following: *'It's not enough to say that we need public investment, we need to better understand what it means to create, drive and nurture public institutions that are public orientated […] Build purpose orientated organisations in the public sector, working alongside the private sector'*. She also states that early investment from the government is crucial to stimulate whole industries, '*Focusing on big inspirational challenges creates new markets, instead of just fixing and tinkering with existing markets'* (Mazzucato, 2022).

Unlike industries such as kiwifruit or apple and pears production which are managed coherently by an entity, respectively Zespri and NZ Apples & Pears Inc; the current New Zealand food science public sector is granular. This is partly because of varied funding options and makes it difficult to source commercial funding for further research and development, notably in the gap between discovery and commercialisation. Furthermore, there is no commodity levies Act applied to the science sector, which is available to individual crops.

However, it is easy and unproductive to mention the lack of investment. A better approach is to look at how we ended up in the current state and seek for ways to remedy and improve this situation. It is also important to note that local and central governments are working through complex issues and following long processes to plan and achieve a positive outcome for most.

7.5. A Bold Vision for New Zealand Science Sector

It is important to note that the New Zealand's food science strategy is aimed at developing international reach, but an essential part of the development of this initiative is also to support New Zealand's primary industries. The science sector in New Zealand has a strong domestic mandate, and it should remain that way.

MBIE (2022) has developed an Industry Transformation Plan as part of the Primary Sector Council, which includes the food and beverage sector. This is a demonstration of the attention this sector requires; it shows some dedication and progress.

7.5.1. Collective mindset

An interviewee suggested to clearly define each science organisations' value proposition, compare them, map the areas of friction, describe out to manage these transparently and honestly. Finally, it was also proposed to implement a relevant digital platform for the science eco-system as a collaboration and engagement tool. This is a relevant comment in the context of this research project, and is aligned with the capability mapping exercise has visioned for this strategy.

a. **Single point of entry** – In this scenario, we'd need a single point of contact/entry for stakeholder. We then remove any ambiguity and confusion and take the leg work out of the process for international stakeholder. Underpinned by the capability map, the enquiry would then flow down to the correct team in the correct organisation. This gets closer to the Wageningen Model and would also allow good transparency and ease of reporting and account management. For this model to work, we'd need full transparency on researchers' international relations through their work, organic relationships and informal networks developed through the years. As well as providing a clear starting point, it'd also provide scale across the board (resources, intellectual property, etc.) and therefore systems optimisation and generate further opportunities. This model would rely on consistent capability across the limited science areas of expertise.

b. **Pipeline of talents –** Within the chosen field of expertise, we must ensure continuity of the sector of capabilities. The stability of the pipeline of talents would allow for …

c. **…Enhanced systems and frameworks:** leveraging expertise across all facilities and regroup them under sector to allow refinement of operating systems. This will be further simplified by the single-entry point of all enquiries. As mentioned earlier, this model relies on consistent capability, which can only be achieved by…

d. **…Capability building,** education and upskilling of the teams in all facilities through sharing of capability and access to industry experts. The open network model is also critical to …

e. **…Ensure a global reach** (via a secure commercial path to market amongst other means). In the end, the goal is to support New Zealand's economy, but this will be achieved partly by the international reach and global position. This structure is achievable if all industry players work together, which will therefore allow for an …

f. **…Acceleration of outcomes**: access to broader expertise across all facilities can increase the speed/quality of the trials and commercial outcomes for enterprises.

7.5.2. Draw on New Zealand's science reputation.

The unique selling propositions identified throughout the interview process (i.e. Remoteness, Māori Culture and Genuinely safe food) are important and certainly define New Zealand. However, they are insufficient to use as a tangible marketing tool. Hence the need to develop a New Zealand food science strategy, integrate a value creation and appropriation model and leverage the food safety attribute and relationship skills to collaborate better and become the exemplar. Throughout the development of this research project, it became clear that instead of using unique selling propositions, it would be more strategical to leverage New Zealand's science reputation, established over the last 30+ years. The existing, and upcoming science capability, is knowledge rich and can, collaboratively, solve many of today's problems.
New Zealand science's reputation has a legacy that must be protected. One way to enable that is to apply the strategy highlighted earlier (specific and narrow field of expertise, single entry point, development of the pipeline of talents, streamlined processes and global reach), and to ensure complete awareness of the forces of change (particularly the ones within the scope of the area of expertise).

7.5.3. Vision of the science sector

The vision for a New Zealand food science strategy was developed by putting all the elements of this report together, and looking at various models around the world, including Wageningen University and Research. The vision of the strategy was then adapted to suit New Zealand's parameters. This strategy was developed for food science; however, it could be adopted by the science industry as a whole. It's strongly recommended that the shift include the whole science industry as it'll allow for a better implementation and greater outcomes.

The strategy will be structured as a joint venture of all relevant research and development partners. The joint venture will be called New Zealand Science Inc. Each organisation will commit human resources, and their premises to the development of this strategy. As pictured in figure 9 below, New Zealand Science Inc (New Zealand Inc) will be a consortia of all public research and development providers. This entity will become the front door of New Zealand Science domestically and internationally; thus simplifying the process for all stakeholders. This initiative will also encourage individual innovation providers to engage and align to the areas of strategic interest, as it'll help them leverage their ideas through a strong and recognised system.

The capability map is critical to the implementation of this strategy and will be a searchable database. This database will form the basis of the decision around the areas of expertise for the science industry going forward.
Under this strategy, open innovation will be accelerated as the relevant capability will be working together to increase output and impact. It'll enhance public and private opportunities by removing some barriers, notably the funding process. Ultimately, the new strategy will align areas of work and funding to keep and create relevant project in order to continue knowledge assimilation and world leading science. Funding is a critical step and will need to follow a consultation process to conclude on the best model. The funding model will aim to remove the competitive behaviour and incentivise collaboration to address important issues, while being aligned to the selected areas of expertise.
The new science structure would provide a clear entry point for New Zealand primary industries, private companies, government, international stakeholders, etc. Therefore, it will fast track their ability to connect with the correct science provider as their enquiries will be going through the scanning process of the whole industry to respond to their need.

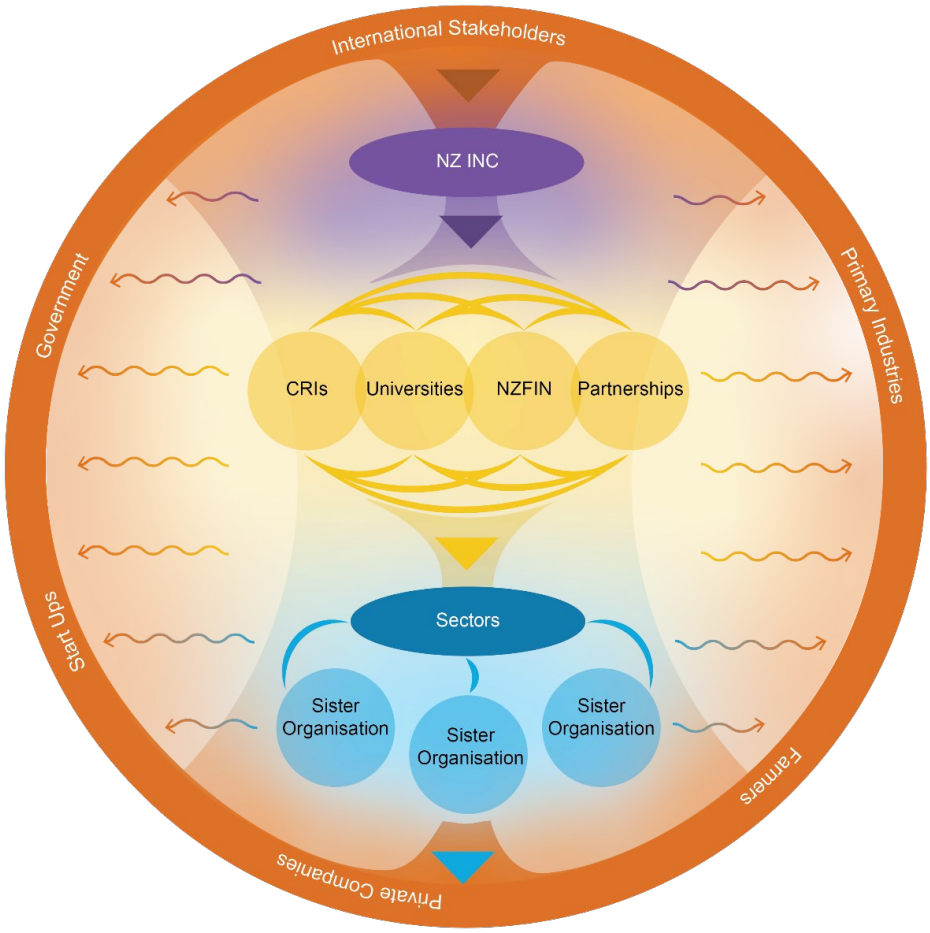

Figure 9 - Vision of New Zealand's food science sector (Source: Coralie de La Fage).

The revised science system would allow for greater and faster delivery due to all the enquiries and collaboration decisions being made at a centralised science Institute. This strategy reduces the competitive aspect of the current science system.

This strategy would fit into the science system in New Zealand and could be implemented, in stages, by 2030.

The vision and its pre-requisite are explained below.

- Each request, whether it be from farmers, private companies, primary industries, government, or international stakeholders, would be dealt with at the New Zealand Inc level.
- Each science provider sits under the New Zealand Inc and project will be allocated to them via New Zealand Inc entity.
- Each area of expertise may not fit within an organisation, it could be that it includes capability from different science providers. This is a likely scenario and a welcome possibility. The areas of expertise will be called ‘sectors’ and inter organisations capabilities would be pulled under this umbrella, while remaining an employee of their science entity.
- Pre-requisites:
  - The capability mapping exercise must have been completed.
  - The selection of the top areas of expertise must be clear.
  - Each ‘Sector’ would have an international sister’s organisation.

8. Conclusions

The global food crisis is looming over planet Earth. It's recognized that it's time for a global shift and many are trying to address it. In New Zealand, several consultations are underway to develop better ways of working and doing science (i.e. Te Ara Paerangi, He Waka Eke Noa (He Waka Eke Noa, 2022)). However, a stronger, more streamlined, and efficient science system seems like a logical starting point. The current competitivity and lack of alignment of New Zealand's science providers is a major brake for innovation and overall impact.

There are many great examples of good science models around the world, such as Wageningen University & Research in the Netherlands. New Zealand has a huge opportunity to have a bigger impact on the global scene and it is recommended that the country follows some of these examples.

Developing and implementing a new bold Science Strategy is key to reignite our science excellence and reposition New Zealand as a world leading science provider. Implementing a NZ Inc vision would open many opportunities and ensure complete alignment of the science organistions in New Zealand.

There is a sense of urgency around the development of such a vision as global issues are increasing. To find solutions to these issues, New Zealand has a key opportunity to develop collaboration with the rest of the world, to align goals and targets. The first step is to get a New Zealand Inc model in place, thus creating a science institute representing the whole of New Zealand science capability. It would show a sense of unity and coordination, pushing New Zealand up the rank of world leading science provider.

We encourage and acknowledge all partnerships and cross organisation projects and would continue stressing the importance of implementing a bold new vision, under New Zealand Inc name. For the good of New Zealand, for the good of the rest of world and the upcoming generations.

A new science strategy as defined in section 7.5.3, could be developed and implemented by 2030. Creating an open Research, Development and Science Hub in New Zealand, involving all industry partners, is the answer to the Science of Tomorrow.

It is important to acknowledge the benefit this strategy would have on international business development, but also the major upside for NZ's primary industries, farming community, private companies, and start-ups.

9. Recommendations and Next Steps

The implementation of the New Zealand's food science strategy entails to put in place the following:

1. Support engagement within the science sector and enhance collective mindset

In the first instance, each industry players must continue and encourage further cross-Crown Research Institute and cross-industry discussion and collaboration. This is already happening in small pockets, but we must continue to reinforce these activities so that this approach will become the new norm and will help implement the broader science strategy. This can be achieved by using value capture and value creation parameters which will be clarify and agreed upon at the onset.

2. Create a capability Map

The creation of a capability database will involve open and direct conversation with all science industry players. The database will include locations, facilities, equipment, processes, expertise and scientists' details. It is expected that compiling a comprehensive and completed science capability database will take time and effort. With a compelling business case, some funding will be made available through the government budget, however it is also not unreasonable to assume that the industry may pull some resources into this project.
The database will be made available and form the basis of the decision making around allocating work, drafting proposals, and responding to external enquiries. The database will therefore form the basis of the new science institute.

3. Create an overarching science institute

The strategy would require to:

- Create a joint venture.

The creation of a joint venture will be managed by the leadership team of each science providers. It'll therefore be a concerted effort and will be aligned to the overall strategy. The joint venture will be called New Zealand Science Inc, and shorten to New Zealand Inc domestically. In the first instance, it'll include the below partners:

All Crown Research Institutes: AgResearch, Institute of Environmental Science and Research, Plant & Food Research, Scion, National Institute of Water and Atmospheric Research Ltd, Institute of Geological and Nuclear Sciences Ltd and Manaaki Whenua Landcare Research.

All universities: Otago University, Lincoln University, Massey University Auckland University and Otago University.

All relevant partnerships, such as: The New Zealand Food Innovation Network. Cawthron, Callaghan Innovation, Food HQ, The New Zealand-China Food protection Network, Riddet Institute Centre of Research Excellence, New Zealand Food Safety Science and Research Center. The National Science Challenges are not included as they are coming to an end in 2024.

- Appoint a board upon creation, to manage the joint venture. These appointments will be decided by the senior leadership team of each science providers.

- The New Zealand Inc board will then appoint a chief scientist per sector. The sectors will be aligned to the chosen fields of expertise. The sector chief scientist will be the main interaction point between the organisations and New Zealand Inc.

- The New Zealand Inc board and the sector chief scientist will allocate human resources and equipment, in agreement with all individual senior leadership teams. The allocation of human resources will be based on numbers of resources available at each science organisations, ensuring reasonable resources left to run

each entity effectively, which will also help imbed the new collaborative strategy at the organisation level.

- Keep each science provider as they stand, but with a revised strategy underpinned by an open, transparent, and aligned agenda.

Once these steps are completed, all enquiries can start flowing through the joint venture and be filtered down for execution.
The merging of resources from each science organisations into the New Zealand Inc entity may seem like a complicated task. However, it could be made relatively simple by detailing all resources required to operate the New Zealand Inc entity and allocating time and resources accordingly.

4. Develop a systematic process for enquiries and proposal

All science related enquiries, contracting, negotiations, marketing, business development, engagement and proposals would be dealt with at the New Zealand Inc level. Thus, requiring most of the legal force, account managers, commercialization people to be shifted to this entity. New Zealand Inc would then filter the projects down to science providers, stating the required collaborations and timeframes. The process of filtering enquiries will be managed by account managers and commercialisation managers, categorised by sector and then analysed by the sector chief scientists. A work plan will be put in place, and the collaboration requirement will be defined, based on the knowledge and expertise required.
Under the proposed strategy, each enquiry will follow the same process. This will ensure full transparency and depth in all enquiries' response. Moreover, Scientists will spend less time writing up proposal as the clarity and strength from the whole industry working together will enable support groups to take on much more of this time-consuming work.
Finally, one set of feedback and discussion between the NZ Inc and the partners required to collaborate for a project will be standard in order to achieve the best outcome.

5. Attract international business and enhance NZ economy

a. The identification and engagement of the sister organisations is an important parameter of the strategy. These will be identify following a process whereby both organisations are aligned and willing to put equal effort into the partnership. The identification will be done at the organisation level and endorsed by New Zealand Inc board. Delegations will be going annually to each entity and developing their own relationship as well as creating new business via joint extension activities. It will provide opportunity for secondments of scientists and further engagement in market. This is key to the international footprint of New Zealand science going forward. Leveraging sisters' organisations will help remove barriers to commercial uptake as they will vehicle the same message, underpinned by in market New Zealand scientists.
b. From an international standpoint, NZ would stand stronger by showing a united Science Institute, simplifying the marketing approach and demonstrating the ability to address a range of topics at the highest levels. The New Zealand Inc entity will work closely with New Zealand Trade and Enterprises (NZTE) and Government to Government (G2G), to proactively market the capabilities available and hold the New Zealand Inc's flag up on behalf of the science industry. These government organisations will be equipped to provide a clear and strong international message.
c. New Zealand's economy will benefit from this new science system by leveraging the consortia and increasing innovation outputs and impacts. This structure will also reduce barrier for domestic public-private collaboration, thus enhancing New Zealand economies by sharing knowledge, science and innovation more easily and focusing on impactful and world leading expertise.

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11. Table of figures

12. Appendices

Appendices 1: Crown Research Institutes' Statement of Core Purpose

Each Crown research Institutes has a specific goal, we used their statements of Core Purpose to detail the differences (MBIE website).

Legal Name	Trading Name	Statement of Core Purpose
AgResearch Ltd	AgResearch	AgResearch's purpose is to enhance the value, productivity and profitability of New Zealand's pastoral, agri-food and agri-technology sector value chains to contribute to economic growth and beneficial environmental and social outcomes for New Zealand.
Institute of Environmental Science and Research Ltd	ESR	ESR's purpose is to deliver world class knowledge, research and laboratory services to help New Zealand get the most out of its investment in science and innovation. ESR use the power of science to help its partners and clients solve complex problems and protect people and products in New Zealand, and around the world. ESR's science lies behind the decisions that safeguard people's health, protect our food-based economy, improve the safety of our freshwater and groundwater resources and provide the justice sector with expert forensic science.
Landcare Research New Zealand Ltd	Manaaki Whenua Landcare Research	Landcare Research's purpose is to drive innovation in New Zealand's management of terrestrial biodiversity and land resources to both protect and enhance the terrestrial environment and grow New Zealand's prosperity.
The New Zealand Institute for Plant and Food Research Ltd	Plant & Food Research	Plant & Food Research's purpose is to enhance the value and productivity of New Zealand's horticultural, arable, seafood and food and beverage industries to contribute to economic growth and the environmental and social prosperity of New Zealand.
New Zealand Forest Research Institute Ltd	Scion	Scion's purpose is to drive innovation and growth from New Zealand's forestry, wood product and wood-derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand.

Table 2 - Crown research Institutes' Statement of Core Purpose (Source: MBIE, 2021).

Appendices 2: Details of some food science partnerships.

Further details regarding some of the partnerships in the food science industry.

- Food HQ is a partnership centred around food science and comprising AgResearch, Plant and Food research, The factory, Riddet Institute, ESR, Cawthon, CEDA, Fonterra, Massey University, New Zealand Food Safety Science and Research Centre, Palmerston North City Council, Manawatu District Council, B.linc, and Sprout. Created in 2013, Food HQ has a clear goal, 'to grow food and beverage innovation by connecting the science and business of food' (https://www.foodhq.com/about-us). It also aims to offer expertise across the value chain to support the food and beverage industry.
- The New Zealand-China Food Protection Network, created in 2016. It is one of three collaborations with China. The New Zealand-China Food Protection Network is funded by MBIE, involves nine research partners: AgResearch, Plant & Food Research, ESR, Cawthon Institute, University of Otago, the University of Auckland, Auckland University of Technology, Scion, and Massey University. The latter is also the host. One of the objectives of this network is to strengthen connection between both countries, in areas of food safety and security research. (https://www.crcc.nz/food-protection).
- The Agricultural Growth Partnership (AGP) initiated by MPI, is a network of public agencies and private organisations. This public-private partnership is key, as it allows MPI to understand the needs and interests of industry and align these into cooperation activities that benefit New Zealand's primary sector by developing links with the science community in China (e.g., training programme.) These activities in the food space are also extending to Japan and Brazil.
- Riddet Institute Centre of research Excellence has 5 partners, Massey University, AgResearch, Plant and Food Research, Auckland University and Otago University. It has four main areas of expertise, human nutrition, gastrointestinal biology, novel food processing and food material science (Riddet Institute, 2022).

Appendices 3: Interview questions

1. In terms of New Zealand International network, what do you think is New Zealand unique selling proposition in food science?
2. Question two is in two parts:
    a. How does New Zealand leverage this unique selling proposition?
    b. How well does New Zealand do it?
3. What are your organisation's three main food science capabilities?
4. Question four is in two parts:
    a. Do you customise your organisation food science offering based on your market or some other basis?
    b. How does your organisation do this?
5. How would you describe your organisation's international network?
6. How do you expand, develop, and maintain your networks?
7. In terms of food science innovation, how would you describe the forces of change?
8. How did you adapt your organisation international strategy to address these forces of change?
9. In terms of your international partners, how would you define your organisation three main areas of work?

Abbreviations

NZ - New Zealand
USP - Unique Selling Proposition
R&D - Research and Development
UK – United Kingdom
USA – United States of America
IP – Intellectual Property
NZFIN – New Zealand Food Innovation Network
WUR – Wageningen University & Research
MBIE – Ministry of Business, Innovation and Employment
CRI – Crown Research Institute
GDP – Gross Domestic Product
NZTE – New Zealand Trade and Enterprise
G2G – Government to Government
OECD - Organisation for Economic Co-operation and Development