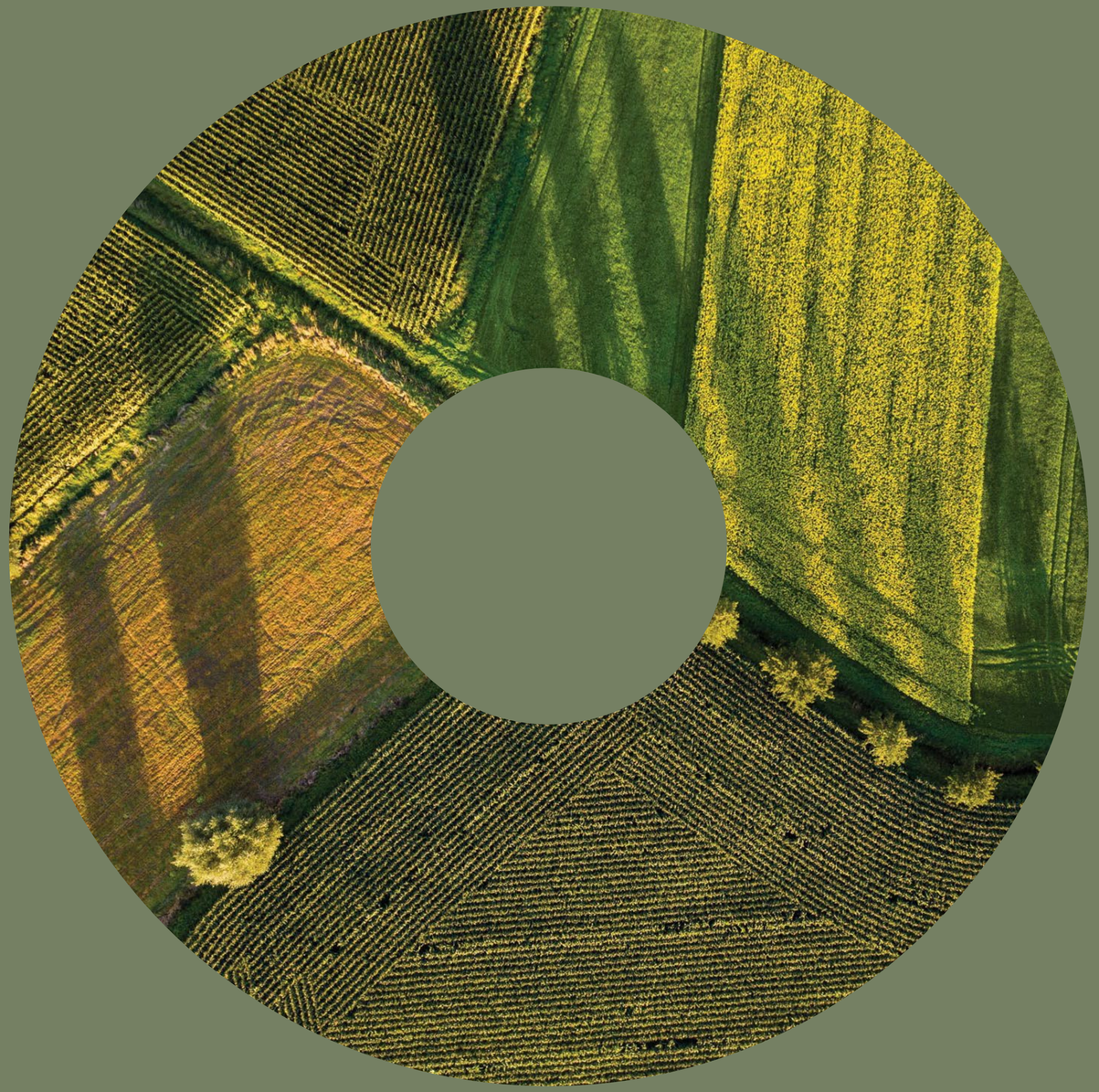


The Aotearoa Circle

Agriculture Sector Climate Change Adaptation Roadmap

Mihi

Tukua te wairua, māna e whakahaumanu, e whakaroa te rerehua o Aotearoa mō ngā uri whakaheke.

Hei arataki i ā mātou mahi me tā mātou whāinga matua kia hono ai te ira tangata ki te taiao.

Tōia mai rā te kaha me te ngākau pono kia hatutū tahi ai tātou ki ngā āwhā arahi kia ora aka te ao tukupū.

Kia poipoia mō āke tonu atu.

Whakamaua kia tina, Hui e! Tāiki e!

Greeting

Release the spirit, to restore Aotearoa's beauty for future generations.

To guide our work and purpose in connecting people with the environment.

Let us draw in strength and integrity to meet the headwinds of today and lead for a better planet.

Ensuring it is nurtured forever.

United we affirm!

Whakatauki

Toitū te ahu whenua Pūmau ai te kākano	Sustain the cultivation of the land Hold on to the seed
Toitū te ahu moana Pūmau I te hua	Sustain the cultivation of the oceans Hold on to the essence
Toitū te ahu ngākau Pūmau ai te aroha	Sustain human growth Hold on to the compassion

Co-chairs letter

Climate change is happening now. The tragic impacts of Cyclone Gabrielle have brought this into starkly devastating focus.

This means we need to adapt to the impact that it will have, at the same time as we attempt to mitigate its worsening. The actions need to be accelerated.

For too long the discussions have been about whether or not climate change is real, whether it is man-made or not, whether it will be as bad as predicted or not. It has been wasted years whilst we waited for the evidence to present itself squarely on our doorsteps with calamitous results.

We wish it wasn't here, but it is and action is needed. We need to take that action to avoid the worst scenario. We need to set ourselves up with the best information, deep wisdom, and kōrero to adapt to whatever future may unfold.

Action is required now, and the below whakataukī can be considered as a call to action – don't just wish for it, do something about it.

Aotearoa New Zealand's farmers, growers and foresters are used to weather. It's what they deal with on a daily basis, and continually have to plan around it. What the scenarios identify is how the extremes will become more extreme and more frequent. More droughts, more heavy rain, more heat, more cold. This impacts on crops, on animals, on ability to sow, to harvest, to birth, and the impacts on community, whanau and individual resilience are already being tested.

He manako te koura i kore ai

Wishing for a crayfish won't get you a crayfish

Our agricultural sector will be at the forefront of the impacts of a changing climate. For many in agriculture, this is not just their business, but their home. This is why this work has been so important.

We started this process in April 2022 and set ourselves an ambitious task to prepare scenarios and a roadmap within a year. Pulling together a Leadership Group and a Technical Expert Group from across the sectors and across the supply chain including horticulture, dairy, forestry, livestock, regulators and strategy specialists has been a journey of understanding for all involved. The scenarios have been confronting, and have forced some discussions about land use, about options, and most importantly about what can be done to adapt and to prevent the worst results from occurring. Some participants have been well ahead on that journey of knowledge and were able to share their path, others were just starting out. As with many things, the kōrero or dialogue and collaboration process has been as important as the outcome.

Putting the foundation of Te Taiao at the heart of what we do has been important. To work with nature, rather than against her. Te Taiao can be a taniwha - fierce and strong. We need to be taniwha in our resolve to address the issues we know already, and what will come - to adapt from where we are, to where we as a sector and people of the land need to be.

The plan now has a greater sense of urgency. Many of our regions and communities have been deeply affected in 2023 already. The roadmap for the sector to avoid the most egregious outcomes is not easy, nor importantly is it independent of time. We can lean on the knowledge of those who have walked before us. We have adopted a framework inspired by tangata whenua values to drive the actions we commit to in our journey ahead.

We have also been very intentional in approaching this with a lens of business risk relating to the climate-related financial disclosures requirements. We specifically call on business leaders to boldly enter these discussions with their suppliers, to build knowledge, awareness and support.

The close relationship between mitigation and adaptation was explored in many sessions in the development of the scenarios and roadmap, especially when adaptation may mean switching to another land use due to a changing climate, or planting for erosion control. These are not easy or comfortable discussions, but the more we understand the context, hopefully the more armed we can all be to make decisions and take action.

All those involved in the process, and the Secretariat, cannot be thanked enough for their contribution to developing the Agriculture Sector Climate Change Scenarios and Adaptation Roadmap. This cross-section of people validates the content and provides confidence in the ability to bring the roadmap to life.

This can be uncomfortable, which is why this document needs to be taken up and used around management tables, board tables, in staff rooms, in marae, and town halls around the motu. We can either sit on our hands and ignore the facts, or we can give it our all and be an example of what can be achieved, which is what our agriculture sector has done time and again.

Our scenarios look forward to assessing what "might be". It would be a tragedy if in 50 years our descendants look back and say "I wish they'd had courage and vision".

Mauri Ora.

Jenny Cameron
MPI

Craig Ellison
Ngāi Tahu Holdings

Project governance

The working group for this project consisted of a tiered governance structure which reflected the diversity of the agriculture sector.

The **Co-chairs** provided governance and oversight of the project and its outputs. The Co-chairs' responsibilities included providing final sign off on members of the Leadership Group and Technical Expert Group, final sign off of outputs and acting, together with the Leadership Group, as the spokespeople for the project to ministers, the media and other key stakeholders.

The **Leadership Group (LG) s**et the ambition for the project and guided and reviewed the work of the Technical Expert Group (TEG). They are leaders in their field and brought mana to the project. The group met on a regular basis to provide input and feedback to the TEG and agree on key decisions throughout the project.

The **Technical Expert Group (TEG)** included technical experts across climate science, the agriculture sector, policy and sustainable finance. The TEG has undertaken key research, stakeholder engagement and development of the Adaptation Roadmap, and ensured co-design with te ao Māori.

The Aotearoa Circle contracted PwC New Zealand to support the development of climate scenarios and an Adaptation Roadmap for the agriculture sector. PwC acted as secretariat, offering climate change expertise, workshop facilitation, report writing, and assisting the development of the adaptation strategy.

The Leadership Group

This kaupapa is lead by a collaboration of industry professionals

Tim Myers
Norwood

Charlotte Rutherford
Fonterra

Kate Beddoe
Silver Fern Farms

Kerensa Johnston
Wakatū Incorporation

David Chin
LIC

Craig Pattison
ChalknTalk

Dr Paul Johnstone
Plant and Food Research

Dr Abby Thompson
Food HQ

Nick Allison
Carrfields

Geoff Smith
Scales Corporation

Rachel Depree
Zespri

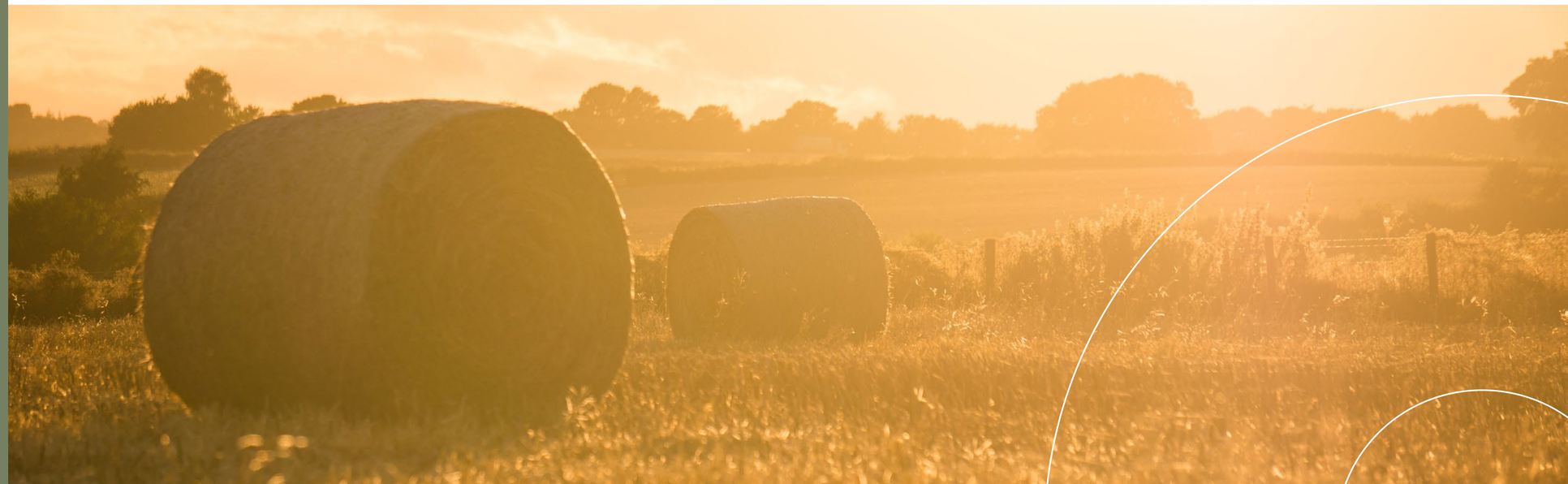
Mark Leslie
Pāmu

John Morgan
NIWA

Mavis Mullins
EPA

Siobhan O'Connor
FENWICK

Dr Fiona Carswell
Manaaki Whenua
Landcare Research



Contents

Key Concepts and Definitions

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Indigenous practices / knowledge

The understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For many indigenous peoples, indigenous knowledge informs decision making about fundamental aspects of life, from day-to-day activities to longer-term actions. This knowledge is integral to cultural complexes, which also include language, systems of classification, resource use practices, social interactions, values, ritual and spirituality. These distinctive ways of knowing are important facets of the world's cultural diversity.[1]

Kaitiakitanga

Guardianship and protection of our natural, built and cultural resources for the benefit of current and future generations.

Mauri

Life principle, life force, vital essence, special nature, a material symbol of a life principle, source of emotions – the essential quality and vitality of a being or entity.

Protein diversification

The transformation of existing and future portfolio composition by shifting away from an over-reliance on resource-intensive animal proteins towards lower impact protein ingredients and products. These can include plant-based, cell-cultured, fungal-based and whole-plant alternatives to meat, dairy, seafood and other animal proteins.[2]

Regenerative practices / regenerative agriculture

An approach to land management that recognises how all aspects of agriculture are connected through a network. This differs from a linear view of agriculture as a supply chain. The principles behind regenerative agriculture are meant to restore soil and ecosystem health, address inequality and leave our land, waters and climate in better shape for future generations.[3]

Resilience / resilient practices

The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, by responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it allows systems to maintain their capacity to adapt, learn and/or transform.[4]

Sustainable finance

Sustainable finance is the process of taking due account of environmental, social and governance (ESG) considerations when making investment decisions in the financial sector, leading to increased longer-term investments into sustainable economic activities and projects.[5]

Sustainability / sustainable practices

Describes conditions where natural and human systems can persist. Ecosystems continuously function, biodiversity is high, natural resources are recycled and, in society, people successfully apply justice and equity.[6]

Rangatiratanga

Upholding the mana of the people in all we do, empowering ourselves and those around us and leading by example.

Taiao

The land, water, climate, and biodiversity that contains and surrounds us all.

Te Ao Māori

The Māori world view and interconnectedness of living and non-living entities.

Whakataukī

Māori proverb or formulaic saying. Whakatauki creates meaning in our story.

1 Ministry for the Environment. (2022). *Aotearoa New Zealand's first national adaptation plan.*
2 Jo Raven. (2020). *The Road to Protein Diversification for Global Food Companies.* FAIRR Initiative.
3 Ibid #1
4 Ibid #1
5 European Commission. (2023). *Overview of sustainable finance.*
6 Ibid #1

Context and Objectives

Context and Objectives

The challenge

Agriculture is New Zealand's largest sector of the tradeable economy, but it is vulnerable to the impacts of climate change. More frequent extreme weather events, such as recent cyclone damage across large parts of the North Island, flooding in the West Coast and Marlborough regions of New Zealand, prolonged droughts in areas such as Northland and the Hawke's Bay, and late frosts that can damage fruit harvests all impact on food production to some degree.

In New Zealand, much of the public and private sector climate change action to date has focused on mitigation to meet our international and domestic targets. However, as the agriculture sector faces unprecedented levels of climate change it needs to build resilience, deepen its awareness of the risks that climate change presents and further understand how climate change will impact food production under different temperature scenarios and associated impacts. To do this successfully, the sector must come together like it hasn't before.

The opportunity

As the sector continues to experience disruption from climate change on a more regular basis, there is an increasingly urgent need to create a roadmap for change. The Agriculture Sector Climate Change Scenarios and Adaptation Roadmap can support the industry's ability to respond to the impending challenges of climate change. It can also provide tools for industry and sector participants (farmers and growers) to develop an adaptive, resilient and sustainable industry that will continue to flourish in an uncertain and ever-changing world.

The outcomes from this work build on New Zealand's first National Adaptation Plan (NAP) that was released in 2022: this work provides support to sector stakeholders to respond to the policies and measures set out in the NAP. At the same time, sector level risk assessment and scenario analysis is being encouraged by the External Reporting Board (XRB) under the mandatory Climate-related Disclosures (CRD) regime. This work provides a useful reference for companies captured by the regime.

In order to enable the CRD disclosures, the XRB has developed standards and guidance for climate reporting entities (CREs). The XRB has encouraged sectors to collaborate to develop shared sector-level climate scenarios. This collaborative approach supports the development of robust scenarios that are decision-relevant for the agriculture sector and will enable a level of consistency and comparability across individual sector participants. It also provides a platform to bring the sector together to consider the future and how to embed sustainability in operations, while building resilience to climate change.

Objectives

The following overarching objectives guided the development of the Agriculture Sector Climate Change Scenarios and Adaptation Roadmap.

1

Translate climate and socioeconomic projections into operational, commercial and social implications for the sector.

Output:
Agriculture sector-relevant climate scenarios, and sub-sector specific risks and opportunities identified, to support the sector in considering future climate change outcomes and implications.

2

Give visibility to the challenges faced by the sector in developing and implementing their approach to climate change adaptation.

Output:
A clear understanding of the barriers to adaptation and the implications of those challenges.

3

Highlight opportunities and recommend actions for addressing the challenges and supporting the sector to adapt.

Output:
A practical and pragmatic Adaptation Roadmap that prioritises the actions that will have the greatest impact in supporting the sector's adaptation to climate change.

Defining the agriculture sector

New Zealand's agriculture sector is diverse and extensive and is worth $55bn per year in export revenue to the economy. In 2022, the food and fibre sector accounted for 81.4% of our trade and 10.7% of GDP.[7] Core participants in the agriculture sector include farmers and growers providing "the world's most discerning consumers with outstanding, ethically-produced food, natural fibres, drinks, co- and bioproducts."[8] In addition, there are participants that provide crucial inputs to the sector and participants providing logistics and other essential services.

Due to its complexity, it was necessary to define the New Zealand agriculture sector to ensure this work was relevant to as many industry players as possible. The agriculture sector value chain as defined for this work is captured in Figure 1. This figure reflects the consensus reached to determine the large elements of the agriculture value chain but may not be exhaustive.

Figure 1: Agriculture sector value chain

	Core Agriculture		Beyond Agriculture		
Inputs	Production	Processing	Logistics	Service Providers	Waste Disposal
Equipment (incl. feed) Fertiliser Seeds Irrigation Labour Finance Animal Genetics Energy Agriculture Advisory Services	Beef / Sheep / Deer Dairy Horticulture Crop Forestry Pig Poultry Nurseries Viticulture	Slaughterhouses Packhouses Dairy Processors Machinery Suppliers Packaging Food Manufacturers	Freight Traders / Exporters Storage Cold Chain	Food Retailers International Markets Food Services Consultants, Land / Stock Agents Wholesalers	Waste Management
Influencers	Local Government	Central Government	Primary Sector Relevant Ministers	Industry Bodies	Regional Economic Development Agencies
	International Markets	Tangata Whenua	International Think Tanks	Farm Consultants	International Bodies
Wider value chain	Mana Whenua	Nature	Customers	Communities of NZ	Research Institutes
	Workforce	Finance Institutes	Brand NZ	Infrastructure	

7 Ministry for Primary Industries. (2022). *Situation and Outlook for Primary Industries.*
8 Fit for a Better World. (2022). *Accelerating our economic potential. Ministry for Primary Industries.*

The agriculture sector subsystems

Dairy

Around 50,000 people are employed in the dairy farming sector, on and off farms generating $3.4 billion in wages in 2019. The sector is a significant employer in many districts, for example accounting for up to a third of jobs in Waimate and a quarter in South Taranaki and Otorohanga. Dairy farmers spend approximately $15b in New Zealand, while processors purchase $8b of goods and services in New Zealand.[9] The sector directly contributes $10.2b to New Zealand's economy each year. Dairy export revenue is forecast to increase by 6% to reach $23.3b in the year to 30 June 2023.[10]

Sheep and beef

New Zealand's red meat industry employs approximately 92,000 people and earns around $4.6b in household income. The sector contributes nearly $12b to New Zealand's GDP and red meat exports account for 16% of New Zealand's total exports.[11] The industry makes up 12% of the regional economy in Otago and Southland, and 10% in Taranaki and Manawatu/Wanganui. Export revenue is forecast to increase 1% to $12.4b in the year to 30 June 2023.[12]

Broad acre cropping

Broad acre cropping, or arable production, adds about $1b of value to the New Zealand economy each year, delivering about $5b to the wider food industry in raw materials. Arable farming operates on 131,000 hectares of New Zealand land and employs people throughout New Zealand. Arable export revenue is forecast to increase 5% to $265m in the year to 30 June 2023.[13]

Horticulture

Horticulture includes fruits, vegetables and garden crops and ornamental plants. The sector employs over 60,000 people annually and is worth more than $6b to the New Zealand economy. Horticulture employs people in fruit and vegetable growing, harvesting, production, distribution and marketing within New Zealand and globally. Horticulture export revenue is forecast to increase 5% to $7.1b in the year to 30 June 2023.[14]

Forestry

Forestry employs around 35,000 people in wood production, processing and the commercial sector. Wood products are worth $6.7b in exports to New Zealand, making up 1.6% of GDP. Forestry exports are forecast to increase to $6.6b in the year to 30 June 2023.[15]

9 DairyNZ. (2020). *New analysis highlights dairy's economic contribution.* NZ Herald. DairyNZ Submission to the Productivity Commission Inquiry. (2020). *Immigration, Productivity and Wellbeing Inquiry.* Sense Partners. (2020). *Dairy's economic contribution: 2020 update.* New Zealand Productivity Commission. (2020). *The dairy sector in New Zealand: Extending the boundaries.*
10 Ministry for Primary Industries. (2022). *Situation and outlook for primary industries.*
11 Beef + Lamb New Zealand, Meat Industry Association of New Zealand. (2020). *The red meat industry's contribution to New Zealand's economic and social wellbeing.*
12 Ibid. #10
13 Ibid. #10
14 HortNZ. (2023). *Jobs & labour.* Horticulture New Zealand.
15 Ministry for Primary Industries. (2022). *Forestry and wood processing data.*

Te Ao Māori Framework

Traditionally, a whakataukī was wisdom passed down through the ages, as guidelines in speeches or at less formal occasions. It should embody the values, wisdom and wit of tangata whenua, and be concise to convey key messages. The Agriculture Sector Climate Change Scenarios and Adaptation Roadmap is an important document, so it is entirely appropriate that two whakataukī have been used to open and close this Te Ao Māori framework.

He manako te koura i kore ai

Wishing for a crayfish won't get you a crayfish

Climate change is happening now. It needs hard work and deep wisdom to diminish the environmental, societal, and business impacts. The measures recommended by this Adaptation Roadmap will go some way to see the extremes avoided. This work recommends an eyes wide open approach to scenarios as the indicators of how Aotearoa New Zealand may be affected in the short and medium term. The roadmap for the sector to avoid the most egregious outcomes is not easy, nor importantly is it independent of time. Action is required now, and the above whakataukī can be considered as a call to action - **don't just wish for it, do something about it**.

This framework builds on the Te Ao Māori framework that was adopted by the Mana Kai initiative, using a crayfish trap as the symbology. It is a Māori view that the connections are real and significant between our food system, the land, our natural and altered environments, and the people. The Aotearoa Circle launched the Mana Kai Initiative last year, a national conversation to ensure we enhance and protect Aotearoa New Zealand's food systems. With kōrero at its core, Mana Kai is grounded in Te Ao Māori wisdom. A Mana Kai Framework has been developed as a starting point for kōrero. The framework is outlined below. [16]

Mana o te Whenua
Natural energy of the environment

Mana o te Whenua focuses on the environmental factors that impact on the production of food, both in the wild and through human assistance (i.e. agriculture, horticulture etc). Mana Whenua also factors in the need for humanity to change behaviour to ensure we tackle environmental issues, particularly climate.

Whenua is the physical manifestation of Atua. Through our shared genealogy we are related to the environment and must treat it in a way we would expect to be treated in a familial relationship. It is through the communication with and treatment of the Mana o te Whenua that we practise true kaitiakitanga through guardianship and giving back to the natural world.

Mana Kai
Sustenance from food

The connection of Atua like Tangaroa with the ocean and Rongo for cultivated food is an essential part of how we pay deference to the environment, for what it provides and our relationship as food producers with the food we produce.

As an example, a farmer will have a respect for the land that may not be obvious to environmentalists, but is a respect based on the knowledge of their land, localised climatic factors and the relationship they have with special places on their farm. This all contributes to Mana Kai, and often farmers have taken direct steps to improve mana whenua.

Likewise, respect for animals may be strongly evident as part of the slaughter process for animals. This also contributes to Mana Kai because there is a consciousness associated with the mana of living things and knowing that you are taking a life, a respect and connection between Tuakana-Teina moves past theory where we make the death a quick and humane death.

Mana o te Tangata
Harvesting and fair distribution of food

Mana o te Tangata, in this context, is about how we care for each other and the importance of fair distribution. Mana of te Tangata focuses on the need to care for the whole of humanity and ensure that there are no groups of people disadvantaged or forgotten throughout the food system.

Mana o te Tangata aligns with the Sustainable Development Goals of the United Nations. In fact, Mana Kai necessitates that societal goals and food goals are the same and not different. This will require a whole of system approach rather than only a food system approach.

16 The Aotearoa Circle. (2022). *Mana Kai initiative.*

"Our challenge is to transform from manaia to taniwha, from passive guardians to fierce advocates for the changes we endorse."

The Agriculture Sector Climate Change Scenarios and Adaptation Roadmap acknowledges Mana Kai's work and has used it as a basis and inspirational guide for this Te Ao Māori framework.

The Adaptation Roadmap is a kōrero or dialogue and collaboration, involving all parts of our agriculture sector value chain, from farmers to regulators, advisors, and suppliers. It asks them to consider a range of scenarios that might occur, and to prepare the sector for how it might and indeed, should respond. Scenario analysis is a useful method to test and retest thinking and readiness for action. We embrace enhancing our awareness of the now by looking forward - to embrace the view of mana - for the land, for the people, and for the future. Data will drive the positioning of where we are, and where we need to be. The sense of respect and connection to our environment will drive the desire to restore the mauri. The sector leadership has the opportunity to craft strategies and importantly, actions to secure and restore the mauri.

That drive cannot be passive: we need to be taniwha in our advocacy - deeply caring yet strong, fierce and ambitious in desire to protect and adapt from where we are, to where we as a sector and people of the land need to be. Manaia can be a symbol of guardianship, of the fruits of the land and the labour of the people. The challenge was to see ourselves (the leaders in this work) as the guardians or manaia, but not accepting of that title or role. Taniwha are often assumed to be the 'monsters' of Māori mythos, but taniwha are also hugely powerful protectors of places, tribal taonga and tribal members. They are fierce, resolute and determined and their presence brings peace and security. Our challenge is to transform from manaia to taniwha, from passive guardians to fierce advocates for the changes we endorse. The gift of the taniwha is time. We must not squander it. We must have the ambition to test our vision and implement it. **The taniwha is not 'giving' us our ambition - it is demanding we take it!**

If this framework instils a sense of urgency, it goes some way to achieve the goals and aspirations embedded in the mana of land, people and food. We nourish the soul as well as the puku! For a long time the agriculture sector, through the intensification of agriculture practices, has been syphoning off the mauri of the whenua, and the consequences of that are becoming more apparent. Encouragingly, there are some practitioners who are finding ways to balance the environmental (mauri) and business drivers. Those practices need to be shared and listened to. The imperative to restore the mauri must drive us all, and we need to assess the actions we have taken (or not taken) and ask ourselves - **does what we do advance restoration?**

We cannot simply sit back and wish for technology to solve it all, technology will no doubt be a great help, but it is not our crayfish.

Like the Mana Kai framework, there is a whakapapa that looks forward and back; to endure it needs to evolve and grow. It is not a stratagem for prohibition or preservation but rather an approach of optimism and challenge that is inclusive and strong.

As we opened, so too shall we close with an appropriate whakataukī.

Toitū te ahu whenua
Pūmau ai te kākano

Toitū te ahu moana
Pūmau I te hua

Toitū te ahu ngākau
Pūmau ai te aroha

Sustain the cultivation
of the land
Hold on to the seed

Sustain the cultivation
of the oceans
Hold on to the essence

Sustain human growth
Hold on to the compassion

Te Taiao guiding principles

In the way that we have borrowed our Te Ao Māori framework from Mana Kai to ensure this scenario analysis and adaptation roadmap is connected to New Zealand's food system, we have borrowed our guiding principles from 'Fit for a Better World'. Fit for a Better World is the vision created for New Zealand's primary sector founded on the wellbeing of Te Taiao, the natural world, and genuine and transformative partnerships. Te Taiao represents a deep relationship of respect and reciprocity with the natural world.[17]

By adopting the guiding principles of Te Taiao, we will ensure the Adaptation Roadmap we have developed puts the wellbeing of the natural world at its heart. It will ensure that we focus on the impact and influence of all our actions, as we follow the pathway to transformative change across our agriculture sector and drive the desire to restore the mauri of our land. To drive real commitment and to preserve the integrity of Te Taiao, leadership is required.

The foundations of Te Taiao are three kawenata (principles) that guide everything we do and four pou (pillars) that help us understand the different realms of Te Taiao and their interconnectedness.

Taiao ora, Tangata ora

If the natural world is healthy, so too are the people

17 Fit for a Better World. (2022). *Taiao.*

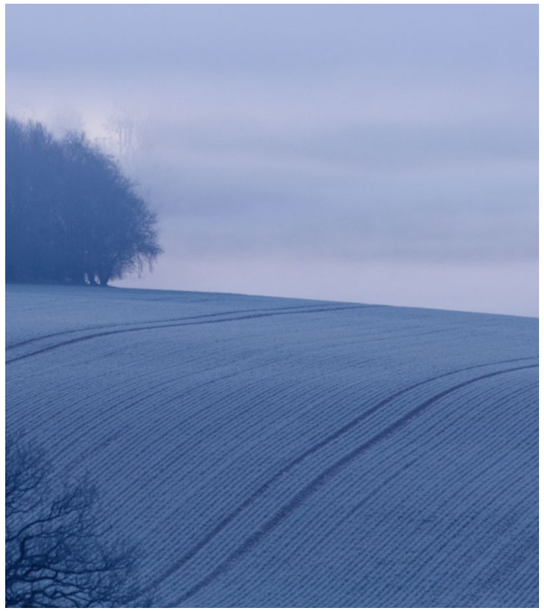
Figure 2: The guiding principles of Te Taiao

Adaptation Roadmap

Why adaptation is important

The agriculture sector is already having to grapple with worsening climate extremes and disruption. These will be exacerbated and will have a greater negative impact across the whole agriculture sector value chain as the frequency of extreme weather events increases.

Weeks of heavy rain in early 2022 followed by Cyclone Dovi caused widespread damage to arable crops all across New Zealand. Farmers in Canterbury and the Wairarapa reported that up to 50% of pea crops were destroyed, and the harvest of vegetables in Hawke's Bay was interrupted. As a result, crop yields and quality were greatly reduced for many growers.[18]



Icy weather devastated crops in late 2022, with kiwifruit growers among the most concerned for their harvests. A number of orchards were wiped out by frost, testing the resilience of growers and significantly impacting income for the industry.[19]

T&G Global forecasted a loss of up to $5 million for the financial year ending December 2022, due to a number of factors causing fruit quality issues. Heavy rain during harvest caused rapid deterioration to the quality of apples, along with supply chain disruptions.[20]

18 Murphy, S. (2022). *Farmers despair as cyclone, weeks of rain ruin arable crops.* NZ Herald.
19 Hall, C. (2022). *Frost wipes out kiwifruit crops, income and jeopardises harvest volumes.* NZ Herald.
20 NZ Herald. (2022). *Heavy rain takes the shine off T&G's Envy apples, sees loss.*

The agriculture sector needs to adapt

The impacts of climate change are already being felt across the New Zealand agriculture sector. In the past year alone, floods have caused widespread damage to farmland, feed crops and baleage in Tairāwhiti and Hawke's Bay[21] and droughts in Southland have prompted intense water restrictions.[22] Both of these 'medium-scale adverse events' have triggered monetary support from the Government for farmers and growers in the regions. Climate projections show that the frequency and severity of extreme weather events will increase in the future, even if we rapidly reduce emissions. Farmers and growers across the country will face increasing pressure from intense rainfall, drought, floods, fire and extreme winds.

Crops and livestock depend on reliable atmospheric conditions. Extreme weather events, gradual warming and changing seasonality all impact on our ability to grow crops and pasture. Although vulnerability to the physical impacts of climate change varies across the country, the entire sector must come together to develop coherent principles, systems and objectives that enable farmers, growers and organisations to build resilience to climate change.

The sector faces unique challenges

The challenges facing the sector are recognised in a number of industry and government initiatives, including the MPI-funded SLMACC research programme and the Fit for a Better World programme, which aims to ensure New Zealand's agriculture sector can continue to grow while reducing its environmental footprint. According to the *Fit for a Better World 2022 Progress Update,*[23] over $400 million in funding was provided by government and industry to support "projects that deliver economic, environmental and social benefits" between June 2018 and May 2022.

Reducing methane emissions is a significant challenge for the New Zealand agriculture sector. Methane makes up half of New Zealand's gross emissions, mainly from enteric fermentation in ruminant livestock. Under the Climate Change Response Act (CCRA), the Government has set a target of a 24-47% reduction of biogenic methane on 2017 levels by 2050 with an interim reduction target of 10% by 2030.

The Government has recently consulted on a proposal 'He Waka Eke Noa'[24] to work together with farmers and growers on practical solutions to reduce Aotearoa's emissions and build resilience to climate change. Under the proposal, farmers and growers would be required to report on and pay for their on-farm emissions. They would also get credit for on-farm sequestration. Although the sector has some time to prepare for these changes, it's important that farmers, growers, and organisations are planning ahead so they are ready when the pricing system comes into force.

We have the tools to adapt

There is a vast range of knowledge and experience across the sector which means it is well-placed to adapt to climate change. By coming together, the sector has taken its first critical step on this journey. This must continue. The adaptation strategy set out in this report cannot be implemented by any individual organisation or small group of organisations. On-farm support services for growers and farmers already exist[25] to bring together farmers and growers across the country, iwi/Māori, government and science providers; maintaining and future proofing such services will ensure these objectives are met. Information and knowledge gaps that have been identified can be filled by such cross-sector collaborations and clear guidance from science providers, and inclusive policy making can ensure sector buy-in for regulatory or legislative reform. However, the Adaptation Roadmap needs to be Industry-led.

This roadmap provides an initial, high-level guide for tackling these challenges. It will no doubt require updating and tweaking in the future. With a collaborative and dynamic sector, we can achieve this.

21 O'Connor, Hon D. (2022). *Government supports flood-affected Tairāwhiti and Hawke's Bay farmers and growers.* Beehive.govt.nz.
22 Otago Daily Times. (2022). *Govt support for Otago-Southland as drought declared.*
23 Fit for a Better World. (2022). *Progress update. Ministry for Primary Industries.*
24 He Waka Eke Noa. (2022). *He Waka Eke Noa.*
25 Ministry for Primary Industries. (2023). *On Farm Support: a service for farmers and growers.*

Critical elements for adaptation planning

The scenario analysis highlights the need for the sector to think long term about how it responds to climate change. Adaptation needs to be enduring and dynamic and will involve tough decisions. Through the scenario analysis, a number of **plausible pathways** were identified that can help the sector deal with climate change. Embedding these pathways in future planning will help the sector to create a flexible and robust set of strategies. The list below contains the plausible pathways which have been used to inform the Adaptation Roadmap:

1. People are key to the prosperity of the sector.
2. Access to water must be managed well. Forward planning is essential.
3. The physical impacts of climate change will influence how the sector operates.
4. Consumer attitudes are changing. The balance of food productions and methods could change.
5. Land use will require an integrated systems thinking approach.
6. Perceptions of the sector are important to its success.
7. Access to capital and insurance will change.
8. Balancing food production, carbon sequestration and biodiversity management is critical.
9. Not all farms and corporations will endure in their current state.
10. Investment to support transition and adaptation planning is needed now.

Challenges facing the agriculture sector

Throughout the scenario development process undertaken in developing this report, stakeholders from the sector were encouraged to consider and articulate the greatest challenges that it is likely to face under a changing climate. It was critical that the sector rank the challenges so that the most important ones could inform the objectives and tangible actions in the Adaptation Roadmap. The top challenges are listed here.

Ensuring the sector is informed and planning to respond to climate change.

Continuing to attract talent and labour and build capability.

Ensuring equitable access to water to maintain productivity and sustainable land use due to the impacts of a changing climate.

Seizing opportunities and creating new markets and value chains.

Encouraging continued investment in the sector.

Fostering a positive, sustainable image for the sector.

Providing tools to build resilience to the impacts (physical/social/psychological) of climate change.

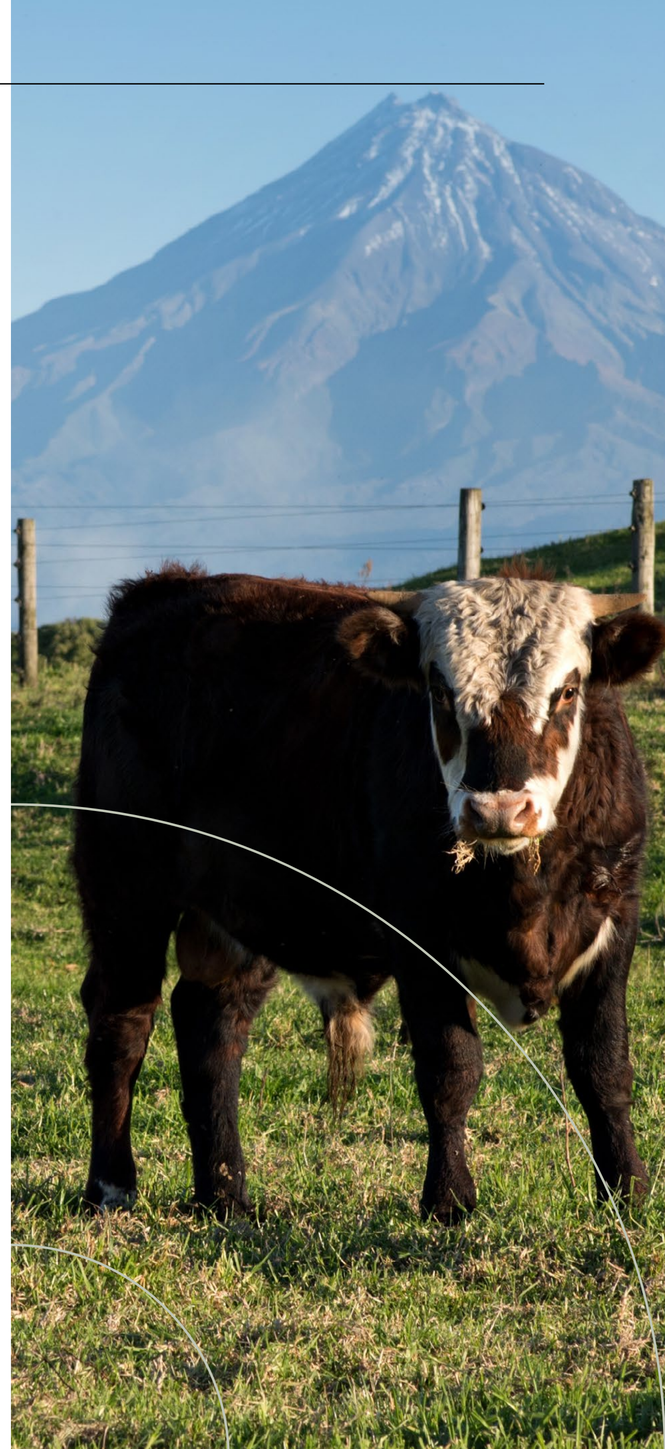
Maintaining a balance of sustainable food production and carbon sequestration.

Preparing the sector for land-use change and diversification to adapt to climate change while maintaining food production and food security.

Being resilient to volatile international markets.

Incentivising innovation and uptake of technology through funding, investment and knowledge dissemination to be resilient to a changing climate.

Ensuring resilient and reliable supply chains.



Building the Adaptation Roadmap

The challenges facing the sector do not appear and should not be managed in isolation. To build an effective Adaptation Roadmap it is essential we understand the key risks the sector faces, how these risks could evolve over the coming decades, the impacts they could generate and the challenges these could create for the sector. The scenario analysis process allowed us to build up this strong evidence base for developing the Adaptation Roadmap.

The Adaptation Roadmap in the following section has been developed to directly address the challenges and risks faced by the agriculture sector. By understanding the challenges and risks it faces, and taking action to adapt to them, the sector can become more resilient to the impacts of climate change.

Figures 3 and 4 show the interconnection of each stage of our work in developing both scenario analysis and the Adaptation Roadmap.

Please note, this figure is an example only. This does not reflect all five goals of the Adaptation Roadmap.

Figure 3: The journey to build the Adaptation Roadmap; how the physical risks are linked to the challenges and built into the Adaptation Roadmap

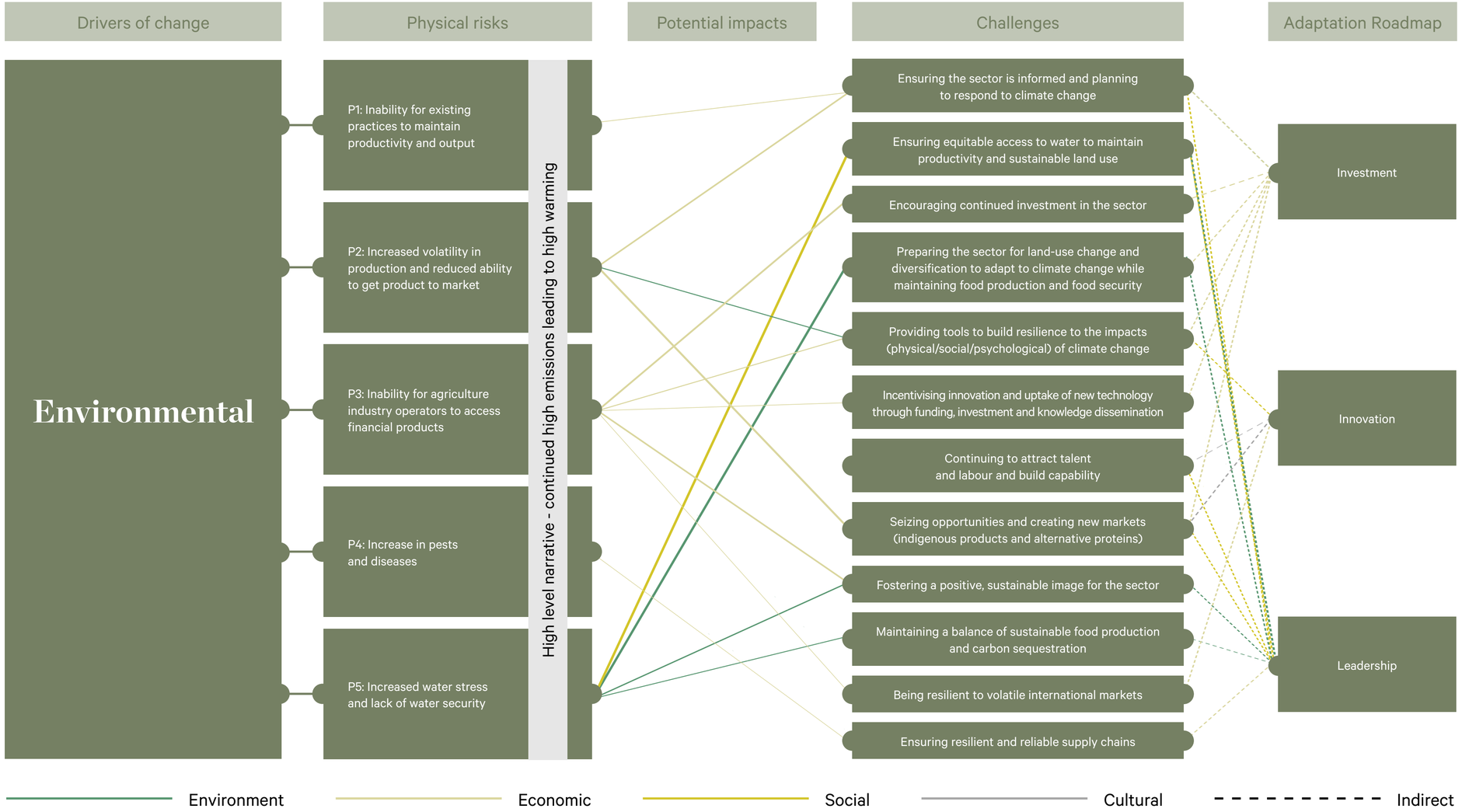
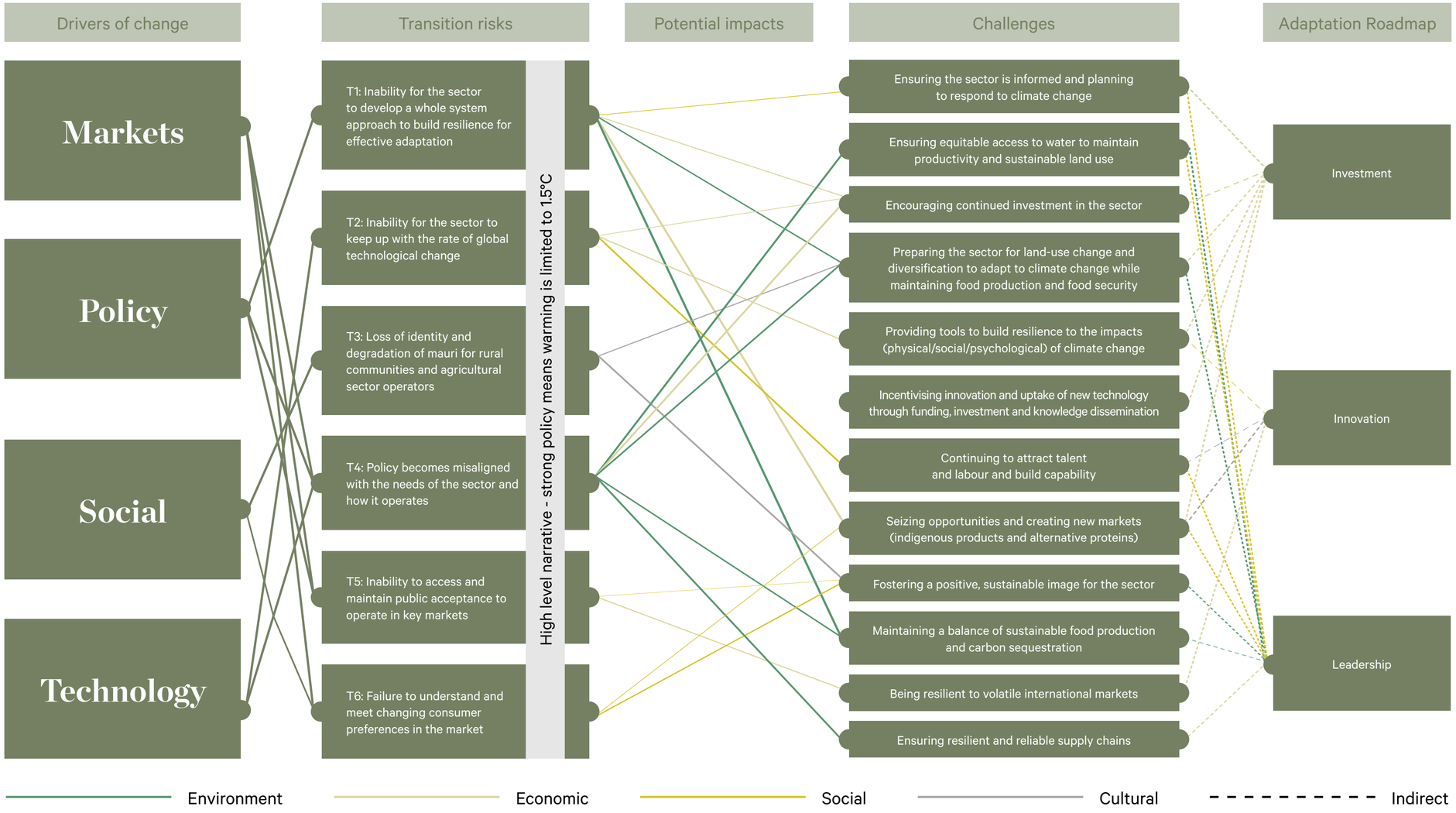


Figure 4: The journey to build the Adaptation Roadmap; how the transition risks are linked to the challenges and built into the Adaptation Roadmap

Please note, this figure is an example only. This does not reflect all five goals of the Adaptation Roadmap.



Our guiding principles

When the roadmap is followed, the agriculture sector, and the farmers and growers that work to sustain and replenish the land will have their mauri enhanced, not depleted. The Fit For a Better World principles remind us that the answers we need for our future are already to be found in our surroundings. All we have to do is understand the impact and influence of our actions and drive the desire to restore the mauri of our land. The principles are a symbol of hope.

Our vision, mission and goals

Our vision **is to have a sustainable, climate resilient food system that builds prosperous and thriving communities.**

Our mission **is to ensure our sector is equipped with the tools and capability to enable successful adaptation to the impacts of climate change.**

Our goals

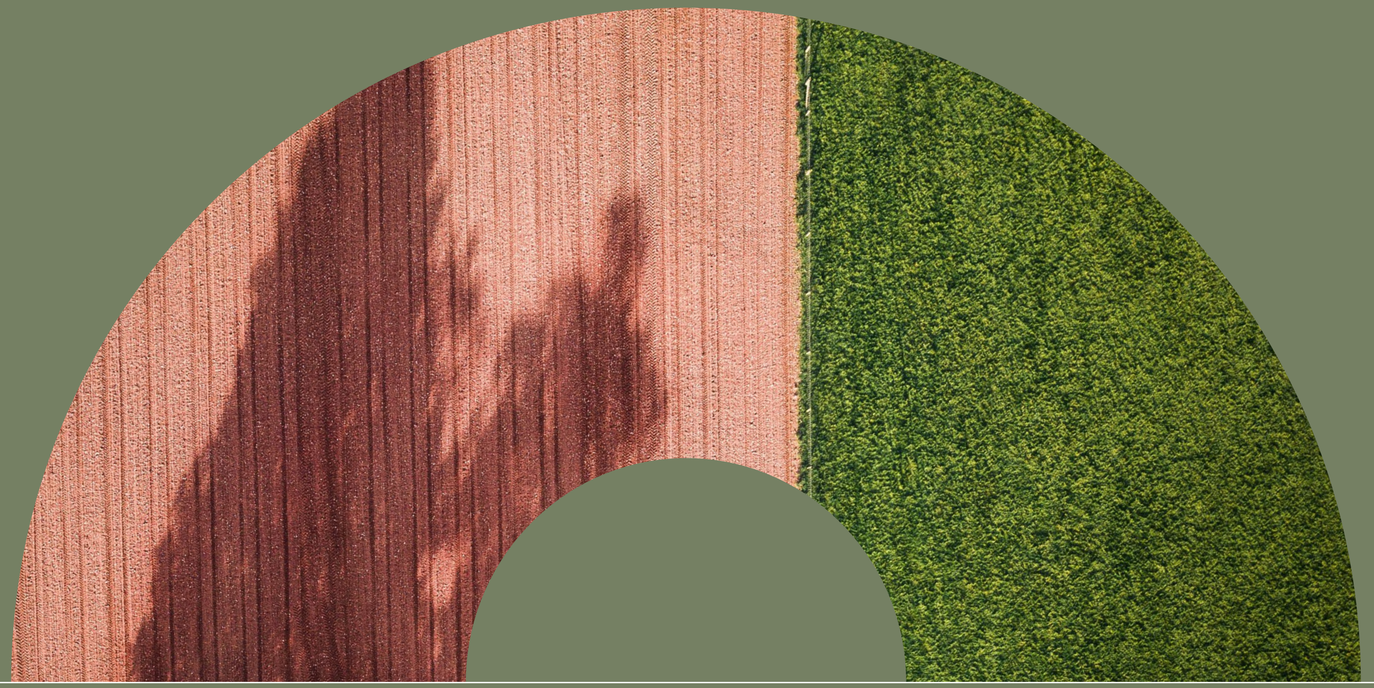
Goal 1: Enhanced knowledge and capability

Goal 2: Effective investment

Goal 3: Strategic use of data and technology

Goal 4: Industry-led innovation

Goal 5: Collaborative and resilient leadership



The Roadmap

Summary of Roadmap

The Leadership Group has worked together to develop a set of agreed actions to build resilience to climate change across the agriculture sector. In coming together, they have demonstrated a desire to set their own agenda for adaptation. The Roadmap builds upon the Climate Scenarios to emphasise the connection between the actions we are taking now and the consequences we are seeking to avoid, but may be subject to.

This Roadmap is not considered an exhaustive list of actions, but a starting point from which more transformative activity can urgently evolve. The use of the term 'stakeholders' within this Adaptation Roadmap is an indication of which members of society would need to be involved and included. This does not formalise the ownership or responsibility of the actions within the Roadmap. Iwi, hapu and Māori business representation are critical stakeholders with the opportunity to lead, engage with, or be involved in all recommended actions across the Roadmap, and as a priority when initiating the actions.

Goals, objectives and outcomes

	Goals	Objectives	Outcomes
	**1. Enhanced knowledge and capability**	Climate change adaptation knowledge, skills, and case studies are accessible for the sector.	The agriculture sector has the educational resources available for climate adaptation and can prioritise and direct investment decisions towards those most at risk of climate change.
	**2. Effective investment**	Capital is available and used effectively towards adaptation with embedded good governance to build resilience, change practices, reduce risk, and support stakeholders.	Funding is available and accessible for the agriculture sector to innovate, diversify, and accelerate adaptation to climate change.
	**3. Strategic use of data and technology**	Actions and implementation are empowered through the capture, analysis, and integration of relevant data.	The agriculture sector are equipped with the data, tools, and technologies to assess adaptation performance, retrieve industry-level insights, and inform decision making.
	**4. Industry-led innovation**	The sector takes advantage of innovative opportunities, such as ecosystem services and modern genetic technologies to lead the sector's adaptation response.	The agriculture sector is prepared with the skills and innovative technologies they need to prosper in a changing climate.
	**5. Collaborative and resilient leadership**	Leadership embraces diverse voices, generates meaningful outcomes, and works towards the same goals both within the sector, and across the whole food system.	The agriculture sector has a distinct, clear and coherent voice and takes a systems-led approach to protect and enhance the whole food system.

Challenges addressed

- Ensuring the sector is informed and planning to respond to climate change.
- Providing tools to build resilience to the impacts (physical/social/psychological) of climate change.
- Continuing to attract talent and labour and build capability.
- Preparing the sector for land-use change and diversification to adapt to climate change while maintaining food production and food security.

Goal 1: Enhanced knowledge and capability

Objective	Actions	Time horizon	Outcomes	Stakeholders
Climate change adaptation knowledge, skills, and case studies are accessible for the sector.	**Vulnerability assessment** Undertake an assessment of the agriculture sector to identify the production systems and regions likely to be most vulnerable to climate change (overlaying sector-level climate scenario analysis). This builds upon existing data sources and connects with activity currently underway in the sector. ***Existing activity includes:*** *MfE First national climate change risk assessment for New Zealand*	Immediate (0-12 months)	The sector has a clear understanding of needs based on sub-sector and geography, to prioritise investment decisions for those most at risk of climate change.	Agriculture sector businesses Government agencies (including MPI and MfE) Industry organisations (including training bodies) Iwi and Māori agribusinesses The Aotearoa Circle
	Education and extension Collaboratively develop open-access climate change adaptation modules that are available in multiple formats including online, delivered through in-person workshops, and embed a tailored whenua Māori programme. Integrate content delivery with existing extension group activities, such as discussion and catchment groups to encourage a nationally coordinated but locally delivered approach. ***Existing activity includes:*** *MPI Māori Agribusiness Extension (MABx) programme* *NZIPIM and NZAGRC Climate change seminars for rural professionals*	Medium term (12-24 months)	The sector has a range of educational resources available to access tools for climate adaptation.	
	Adaptation plan development Two-three businesses in each key subsector of the agriculture sector develop and publish their climate change adaptation plans. Where relevant, this should take a whole of farm system approach aligned with Integrated Farm Planning and provide case studies to illustrate best practice for organisations of varying sizes. ***Existing activity includes:*** *Zespri Climate change adaptation plan* *MfE National adaptation plan*	Medium term (12-24 months)	The sector has a broad suite of climate adaptation plan examples publicly available to empower organisations to develop their own adaptation plans.	

Challenges addressed

- Encouraging continued investment in the sector.
- Ensuring the sector is informed and planning to respond to climate change.
- Preparing the sector for land-use change and diversification to adapt to climate change while maintaining food production and food security.
- Incentivising innovation and uptake of technology through funding, investment and knowledge dissemination to be resilient to a changing climate.
- Seizing opportunities and creating new markets and value chains.

Goal 2: Effective investment

Objective	Actions	Time horizon	Outcomes	Stakeholders
Capital is available and used effectively towards adaptation with embedded good governance to build resilience, change practices, reduce risk, and support stakeholders.	**Strategic climate change adaptation funding alignment** Strategically align existing and future funding from industry and Government to ensure it is accessible for climate change adaptation investments and implementation. This should include private capital, trusts, and foundations, in addition to the establishment of blended finance mechanisms. Investment areas include (but are not limited to) funding for R&D and implementation related to production system diversification, acceleration of alternative protein entrepreneurship, especially where integrated with existing production systems, and the development and delivery of climate change adaptation tools and technologies. ***Existing activity includes:*** *MPI Sustainable Food and Fibre Futures Fund and Sustainable Land Management and Climate Change Adaptation Programme*	Ongoing	Funding is available and accessible for the sector to innovate, diversify, and accelerate adaptation to climate change through existing and future mechanisms.	All major New Zealand Agri-banks Government Agencies (MPI, MfE, RBNZ, MBIE-FMA) Industry organisations Iwi and Māori agribusinesses Landowner and small agribusiness representation The Aotearoa Circle
	Enhanced access to climate change adaptation capital Create a working group focused on rapidly scaling accessible and fit-for-purpose funding to enable climate change adaptation investment through an extension of existing banking-system lending offerings, including the development of a climate change adaptation funding standard. ***Existing activity includes:*** *Green loan categories and Sustainability Linked Loans by banking providers*	Medium term (12-24 months)	Agribusinesses including owner-operated farmers and producers are able to access lower-cost capital for the purposes of climate change adaptation.	

Challenges addressed

Ensuring the sector is informed and planning to respond to climate change.

Ensuring equitable access to water to maintain productivity and sustainable land use due to the impacts of a changing climate.

Providing tools to build resilience to the impacts (physical/social/psychological) of climate change.

Preparing the sector for land-use change and diversification to adapt to climate change while maintaining food production and food security.

Maintaining a balance of sustainable food production and carbon sequestration.

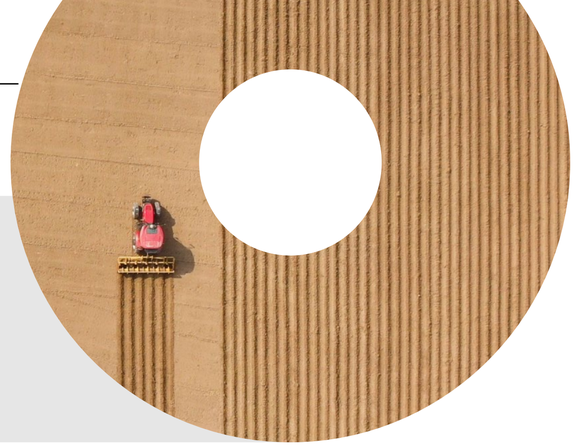
Goal 3: Strategic use of data and technology

Objective	Actions	Time horizon	Outcomes	Stakeholders
Actions and implementation are empowered through the capture, analysis, and integration of relevant data.	**Sector and research institute data partnership** Establish a partnership agreement and data platform/process between the relevant research institutes and sector businesses for access to climate change (and other relevant) data. Prioritise solutions which ensure the economic viability of data providers and receivers, whilst hastening data-led decision making in the sector.	Immediate (6-12 months)	The partnership improves the efficiency of data access to accelerate analysis and innovation in relation to climate change adaptation.	Agritech New Zealand Crown Research Institutes (including NIWA, Manaaki Whenua - Landcare Research, Agresearch, Plant and Food Research, Scion) Government Agencies (including MPI, MfE and MBIE) Iwi and Māori agribusinesses Landowner and small agribusiness representation Science New Zealand Trust Alliance New Zealand, The Aotearoa Agri Data Syndicate
	Adaptation indicators, tracking and forecasting Gather relevant data that supports adaptation indicators for the sector, with an emphasis on considering physical climate changes, risk assessment and response, and incorporate in forecasting systems. Agree indicators to measure, track and report progress on climate variables, impacts, and the sector's adaptation response. Explore funding sources to enable scale-up of implementation tools and activities. ***Existing activity includes:*** *NIWA Our Future Climate web tool*	Medium term (12-24 months)	Businesses across the sector are equipped with the data to assess their climate change adaptation performance, retrieve industry-level insights, and understand opportunities to improve their resilience.	
	Data interoperability Invest in initiatives to bring together existing tools and databases that support tactical (in-season responses) and strategic (multi-year, what if) decision making for climate change analysis and adaptation at a sector, regional and farmer/grower level. ***Existing activity includes:*** *Agritech NZ Agricultural Data Interoperability, Trust Alliance New Zealand and the Aotearoa New Zealand Agri Data Syndicate*	Long term (24-36 months)	Accessibility, efficiency, and usability of tools and technologies are enhanced to enable sector participants to leverage data and inform both tactical and strategic decision making.	

Challenges addressed

- Incentivising innovation and uptake of technology through funding, investment and knowledge dissemination to be resilient to a changing climate.
- Preparing the sector for land-use change and diversification to adapt to climate change while maintaining food production and food security.
- Continuing to attract talent and labour and build capability.
- Seizing opportunities and creating new markets and value chains.
- Being resilient to volatile international markets.

Goal 4: Industry-led innovation



Objective	Actions	Time horizon	Outcomes	Stakeholders
The sector takes advantage of innovative opportunities, such as ecosystem services and modern genetic technologies to lead the sector's adaptation response.	**Ecosystem services** Establish a nationally coordinated and internationally recognised system for rewarding and economically incentivising landowners and agribusinesses for their ecosystem services. Leverage existing global and local examples for the enhancement of biodiversity, reduction in environmental footprint, controlling of erosion, protection of waterways and investment in other areas of climate change adaptation. ***Existing activity includes:*** *The Toha Network* *Pāmu SFFF ecosystem services project*	Medium term (12-24 months)	Agribusinesses are recognised and rewarded for delivering improved nature outcomes including enhancing biodiversity and climate change resilience. This covers the effective management and enhancement of existing areas, and land use change where appropriate.	Agriculture sector businesses Government agencies (including DoC, MPI, and MfE) Industry organisations Iwi and Māori agribusinesses New Zealand public Te Puna Whakaaronui The Aotearoa Circle
	Biotechnology (modern genetic technologies) Develop an education supplement which communicates the scientific evidence, opportunities, potential benefits, and key considerations of using modern genetic technologies with a focus on climate change adaptation and environmental impact. Building on existing economic analysis and perspectives, inform a pathway with a clear end-result of modernising Aotearoa New Zealand's stance on the interpretation and use of modern genetic technologies in the food system and if required, steps to enable their use. ***Existing activity includes:*** *Te Puna Whakaaronui, WELL_NZ: Modern genetic technology – what it is and how it is regulated* *Royal Society Te Apārangi Gene Editing in Aotearoa*	Immediate (6-12 months) Medium term (12-24 months)	The sector has a clear understanding of the role of modern genetic technologies in the sector's future, including opportunities to optimise climate change resilience, maximise sector value, and provide clear messaging both to the New Zealand public and international stakeholders.	

Challenges addressed

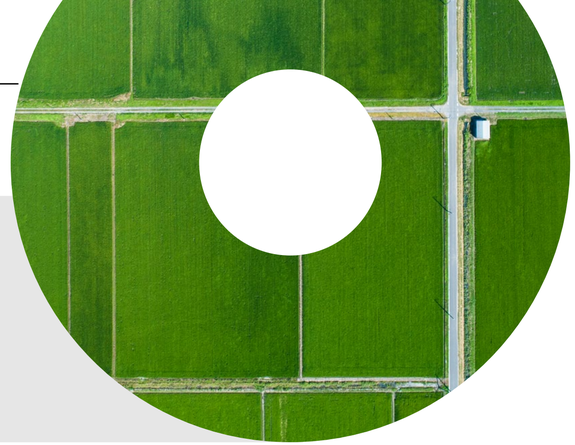
Maintaining a balance of sustainable food production and carbon sequestration.

Ensuring resilient and reliable supply chains.

Fostering a positive, sustainable image for the sector.

Continuing to attract talent and labour and build capability.

Goal 5: Collaborative and resilient leadership



Objective	Actions	Time horizon	Outcomes	Stakeholders
Leadership embraces diverse voices, generates meaningful outcomes, and works towards the same goals both within the sector, and across the whole food system.	**Aotearoa National Food Strategy Pathway** Continue to develop a systems-led approach to the food system across the public and private sector, leveraging the Mana Kai food system framework and other sector initiatives to enable the development of a future Aotearoa New Zealand National Food System Strategy. ***Existing activity includes:*** *Mana Kai, The Purpose and Values of Aotearoa New Zealand's Food System*	Medium term (12-24 months)	The Government and sector are able to use the framework to guide a systems-led approach to decision making, initiatives, and activity, encouraging multi-disciplinary thinking and consideration of opportunities to protect and enhance all aspects of the whole food system.	Agriculture sector businesses Government agencies (including MPI and MfE) Industry organisations Iwi and Māori agribusinesses The Aotearoa Circle
	Attract and retain sector engagement Enable sector-level coordinated engagement directly with the Aotearoa New Zealand public to highlight the importance of the agriculture sector to the country and communicate the challenges and opportunities that are presented by climate change adaptation. ***Existing activity includes:*** *MPI Opportunity Grows Here campaign*	Medium term (12-24 months)	The sector has a distinct, clear and coherent voice within the Aotearoa New Zealand public which through transparent communication is able to encourage direct positive engagement in the sector.	

Appendices

APPENDIX ONE: Our approach

Workshops

Kick-off Hui: 23 June 2022
The kick-off meeting involved the PwC Secretariat team, the Co-Chairs and the Leadership Group. This meeting confirmed: the project scope; working definition of the agriculture sector and subsystems; initiative objectives; programme structure; work plan; accountabilities; governance structure; and ways of working.

Risk Workshop: 8 July 2022
The Secretariat hosted and facilitated a climate-related risk identification workshop with the Technical Expert Group of the Agriculture Adaptation Roadmap workstream. This workshop identified the top physical and transition risks for the agriculture sector and its subsystems.

Scenarios Workshop: 12 August 2022
The Secretariat hosted and facilitated a climate scenarios workshop with the Technical Expert Group of the Agriculture Adaptation Roadmap workstream. This workshop developed a set of plausible climate change scenarios for the agriculture sector.

Impacts and Challenges Workshop: 9 September 2022
The Secretariat hosted and facilitated an impacts and challenges workshop with the Technical Expert Group of the Agriculture Adaptation Roadmap workstream. This workshop identified the potential impacts and challenges of climate change on the agriculture sector based on the three scenarios: **Tū-ā-pae (Orderly)** Stance in order, step in succession, **Tū-ā-hopo (Disorderly)** Misstep, **Tū-ā-tapape (Hothouse)** Faltered step, to fall.

Opportunities and Roadmap Workshops: 30 September, 7 October, and 13 October 2022
The Secretariat hosted and facilitated three climate change opportunities and roadmap workshops with all work streams of the Agriculture Adaptation Roadmap. These took place in Auckland, Wellington and Christchurch. These workshops identified the key opportunities for the agriculture sector, building on the work to establish the challenges. The opportunities were taken to agree on sector goals and objectives for the Adaptation Roadmap, landing the vision mission and key milestones, and exploring these across time horizons.

Consultation and review

Following each workshop, the co-chairs and LG were consulted on the outcomes. Feedback on the outcomes was integrated and fed into the final outputs.

Scenario development

PwC developed and utilised a comprehensive risk assessment approach, combining insights from best practice such as the Task Force on Climate-Related Financial Disclosures and the ISO14090:2019 - Adaptation to climate change standards, to develop a tailored and fit for purpose approach for this unique piece of work.

Our approach allowed us to create a comprehensive understanding of the most material climate related risks and the top drivers of change that influence the sector before building the scenarios. This enhanced our understanding of how the risks then impacted the sector and the challenges that may present.

The steps taken were as follows:

1. **Identification of the most significant climate-related risks:** The top physical and transition risks were determined through discussions with the TEG and subsequently agreed with the LG and Co-chairs.
2. **Development of a risk and scenario analysis model:** The most significant physical risks and most significant transition risks were voted on and agreed to by the governance groups. These 11 top risks were then used to create a 'scenario structure', whereby the range of scenarios covered the range of possible manifestations of each top risk. To ensure comparability and consistency with XRB requirements, we then reconciled these axes with the scenario framework set out by the Network for Greening the Financial System (NGFS)[26]. Establishing this framework allowed us to develop climate scenarios that capture a broad range of plausible outcomes for the sector.
3. **Identification of key drivers of change and development of scenario narratives:** With an understanding of the climate-related risks facing the agriculture sector and scenario characteristics established, we worked with the TEG to identify the top drivers of change that influence the sector. Drivers of change are broad-scale factors that influence the sector and often create risks and opportunities. Once the key drivers of change were identified, they were then used to develop scenario narratives that reflect critical influences on the sector. We then built out the scenario narratives using information from global and national reference scenarios and climate data. Reference scenario information was taken from scenarios developed by the NGFS, the Climate Change Commission and the International Energy Agency, and information included in Shared Socioeconomic Pathways and reported by the Intergovernmental Panel on Climate Change. We also used climate data from the National Institute for Water and Atmospheric Research.

Key elements of the project

Risk assessment

The most significant physical and transition risks for New Zealand's agriculture sector were identified. These were used to create the scenario framework.

Scenario analysis

Three climate scenarios were explored. Twelve drivers of change and how they manifest under each of the three scenarios created the basis for the development of scenario narratives. The narratives build a picture of what the world may look like under each scenario.

Impact, consequences and challenges

The challenges experienced by industry participants were collated and articulated, including the impact of doing nothing about climate change.

Opportunities

We evaluated the opportunities that the changing climate may bring to the agriculture sector, including an opportunity to build in regenerative thinking.

Adaptation roadmap

We collectively agreed pragmatic and tangible adaptation actions that support the sector to transition with the effects of climate change and allow the sector to make confident and coordinated decisions.

26 Network for Greening the Financial System. (2020). *Technical document: Guide to climate scenario analysis for central banks and supervisors.* NGFS.

APPENDIX TWO: Acknowledgements

The Agriculture Sector Climate Change Scenarios and Adaptation Roadmap has been created through the voluntary efforts of the following individuals. We would like to formally acknowledge each member of the Leadership Group, Technical Expert Group, and all others involved for their time and effort. We would also like to thank The Aotearoa Circle Rangatahi Advisory Panel for their contribution.

Co-Chairs

- Jenny Cameron - Ministry for Primary Industries (MPI)
- Craig Ellison - Ngāi Tahu Holdings

Leadership Group

- Tim Myers - Norwood
- David Chin - Livestock Improvement Corporation (LIC)
- Charlotte Rutherford - Fonterra
- Kate Beddoe - Silver Fern Farms
- Geoff Smith - Scales Corporation
- Kerensa Johnston - Wakatū Incorporation
- Rachel Depree - Zespri
- Craig Pattison - ChalknTalk
- John Morgan - National Institue for Water and Atmospheric Research (NIWA)
- Dr Paul Johnstone - Plant and Food Research
- Dr Abby Thompson - Food HQ
- Nick Allison - Carrfields
- Dr Fiona Carswell - Manaaki Whenua - Landcare Research
- Siobhan O'Connor - Fenwick
- Mark Leslie - Pāmu (Landcorp)
- Mavis Mullins - Environmental Protection Agency (EPA)

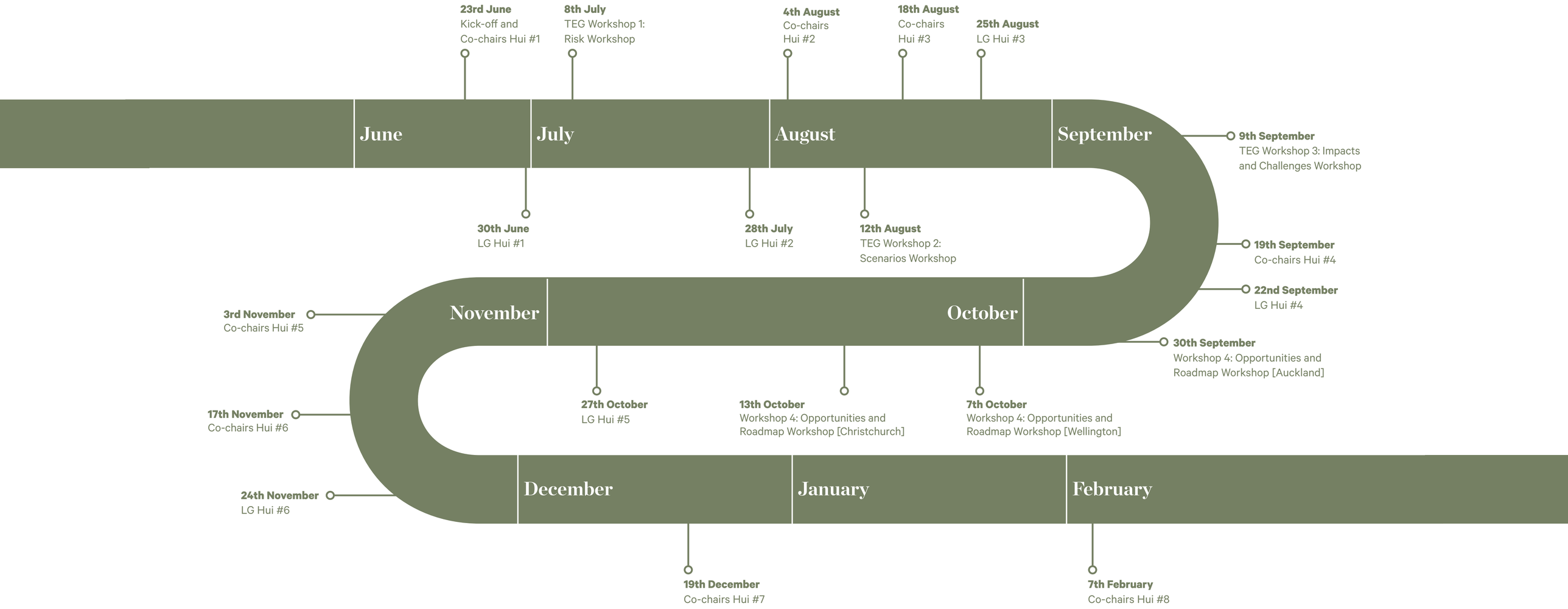
Technical Expert Group

- Jason Rolfe - Dairy Trust Taranaki
- Claudia Lyons - MBIE (Northland)
- Keith Zhang - MPI
- Phil Wiles - NIWA
- Craige MacKenzie - Vantage NZ
- Paul Mudge - Manaaki Whenua - Landcare Research
- Anne Probert - Venture Taranaki
- Roger Dungan - Scion
- Anna Galvan - Te Hono
- Amanda Dick - PGG Wrightson
- Brian Harrison - PGG Wrightson
- Allanah Kidd - Ravensdown
- Scott Champion - Primary Purpose
- Mackenzie Nicol - MPI
- Sam Ragnarsson - Ministry for the Environment (MfE)
- Emma Blott - LIC
- Ivan Lawrie - Foundation for Arable Research Inc. (FAR)
- David Mead - MfE
- Ngaio Neumegen - Zespri
- Courtney Simpson - T&G Global
- Will Burrett - Ngāi Tahu Farming
- Belinda Storey - Climate Sigma, Pāmu (Landcorp)
- Anna Rathe - Horticulture New Zealand
- Liam O'Sullivan - Sona Chosta Ltd
- Stuart Taylor - Craigmore Sustainables
- Fiona Acheson - New Zealand Trade and Enterprise (NZTE)
- Simon Love - AsureQuality
- Belinda Miller - TUR - NZ Forest Service
- Carla Harris - Silver Fern Farms
- Sharleen Gargiulo - Foodstuffs
- Finn Ross - Future Farmers NZ
- Nicky Solomon - NZ Food Innovation Network
- Penny Tricker - Plant and Food Research
- Ailsa Robertson - Horticulture New Zealand
- Edwin Massey - New Zealand Winegrowers
- Sam Bridgman - Pāmu (Landcorp)
- Michael Van Zijl - Financial Markets Authority (FMA)
- Tony Wright - Comvita
- Magnus Williams - Countdown
- Karen Lavin - Climate Change Commission
- Annabel McAleer - Our Land and Water NSC
- Jenika Phipps - FMA
- Sarah Dobson - A.S. Wilcox
- Michelle Sands - Horticulture New Zealand
- Sophia Murphy - MPI
- Holly Brown - Comvita
- Marc Lubbers - Plant and Food Research
- Lisa Blackstock - Comvita
- Jenny Webster Brown - Our Land and Water NSC
- Travis Ryan-Salter - Carrfields
- Lee Stewart - Fonterra
- Graham Sevicke-Jones - Manaaki Whenua - Landcare Research
- Claire McClintock - MPI

Secretariat (PwC)

- Annabell Chartres
- Dr Victoria Hatton
- Dominic Thorn
- Ethan Kay
- Phoebe McCartie
- Electra Scott
- Jade Collins

APPENDIX THREE: Project timeline



References

Anderson, B., Mackintosh, A.N., Dadić, R., Oerlemans, J., Zammit, C., Doughty, A., Sood, A., & Mullan, B. (2021). Modelled response of debris-covered and lake-calving glaciers to climate change, Kā Tiritiri o te Moana/Southern Alps, New Zealand. *Global and Planetary Change, 205, 103593.*

Beef + Lamb New Zealand, Meat Industry Association of New Zealand. (2020). *The red meat industry's contribution to New Zealand's economic and social wellbeing*. https://beeflambnz.com/sites/default/files/news-docs/NZRM-Industry-summary.pdf

Chappell, P. R. (2013). *The climate and weather of Hawke's Bay.* NIWA Science and Technology Series 58, 44.

Chappell, P.R. (2016). *The climate and weather of Gisborne*. NIWA Science and Technology Series 70, 40.

DairyNZ. (2020). *New analysis highlights dairy's economic contribution*. NZ Herald. https://www.nzherald.co.nz/the-country/dairy/new-analysis-highlights-dairys-economic-contribution/6FQGHJYRKCGFRIEWGY7P4EFYAU/

DairyNZ Submission to the Productivity Commission Inquiry. (2020): *Immigration, Productivity and Wellbeing Inquiry*. https://www.productivity.govt.nz/assets/Submission-Documents/immigration-settings/Sub-043-DairyNZ.pdf

European Commission. (2023). *Overview of sustainable finance*. https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en

External Reporting Board. (2022). *Aotearoa New Zealand Climate Standards*. https://www.xrb.govt.nz/standards/climate-related-disclosures/aotearoa-new-zealand-climate-standards/

External Reporting Board. (2022). *Scenario analysis: Getting started at the sector level*. https://www.xrb.govt.nz/dmsdocument/4532

Fit for a Better World. (2022). *Accelerating our economic potential*. Ministry for Primary Industries. https://fitforabetterworld.org.nz/assets/publications/fit-for-a-better-world-roadmap.pdf

Fit for a Better World. (2022). *Progress update*. Ministry for Primary Industries. https://fitforabetterworld.org.nz/assets/publications/2022-Fit-for-a-Better-World-progress-update.pdf

Fit for a Better World. (2022). *Taiao*. Ministry for Primary Industries. https://fitforabetterworld.org.nz/taiao/

Frame, B., Lawrence, J., Ausseil, A., Reisinger, A., & Daigneault, A. (2018). Adapting global shared socio-economic pathways for national and local scenarios. *Climate Risk Management*, 21, 39-51.

Hall, C. (2022). *Frost wipes out kiwifruit crops, income and jeopardises harvest volumes*. NZ Herald. https://www.nzherald.co.nz/bay-of-plenty-times/news/frost-wipes-out-kiwifruit-crops-income-and-jeopardises-harvest-volumes/5FEQV7IVRXEPW5RLDZSKX3JKJ4/

He Pou a Rangi. (2021). *Ināia tonu nei: a low emissions future for Aotearoa*. Climate Change Commission. https://www.climatecommission.govt.nz/public/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa.pdf

He Pou a Rangi. (2021). *Scenarios dataset for the Commission's 2021 Final Advice (output from ENZ model)*. Climate Change Commission. https://www.climatecommission.govt.nz/public/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa/Modelling-files/Scenarios-dataset-2021-final-advice.xlsx

He Waka Eke Noa. (2022). *He Waka Eke Noa*. https://hewakaekenoa.nz/

HortNZ. (2023). *Jobs & labour*. Horticulture New Zealand. https://www.hortnz.co.nz/people-jobs-and-labour/

International Energy Agency. (2022). *Global energy and climate model*. IEA. https://www.iea.org/reports/global-energy-and-climate-model

Macara, G.R. (2016). *The climate and weather of Canterbury*. NIWA Science and Technology Series 68, 44.

Ministry for Primary Industries. (2022). *Forestry and wood processing data*. https://www.mpi.govt.nz/forestry/forest-industry-and-workforce/forestry-wood-processing-data/

Ministry for Primary Industries. (2022). *Situation and outlook for primary industries*. https://www.mpi.govt.nz/resources-and-forms/economic-intelligence/situation-and-outlook-for-primary-industries/

Ministry for Primary Industries. (2023). *On Farm Support: a service for farmers and growers*. https://www.mpi.govt.nz/agriculture/farm-management-the-environment-and-land-use/on-farm-support-a-service-for-farmers-and-growers/

Ministry for the Environment. (2018). *Climate change projections for New Zealand*. https://environment.govt.nz/publications/climate-change-projections-for-new-zealand/

Ministry for the Environment. (2022). *Aotearoa New Zealand's first national adaptation plan*. https://environment.govt.nz/assets/publications/climate-change/MFE-AoG-20664-GF-National-Adaptation-Plan-2022-WEB.pdf

Ministry for the Environment. (2022). *First national climate change risk assessment for New Zealand*. https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/adapting-to-climate-change/first-national-climate-change-risk-assessment-for-new-zealand/

Ministry for the Environment. (2022). *Interim guidance on the use of new sea-level rise projections*. https://environment.govt.nz/publications/interim-guidance-on-the-use-of-new-sea-level-rise-projections/

Ministry of Business, Innovation and Employment. (2020). *Regional fact sheet: Canterbury*. https://www.mbie.govt.nz/dmsdocument/11444-regional-factsheet-canterbury-pdf

Ministry of Business, Innovation and Employment. (2020). *Regional fact sheet: Gisborne*. https://www.mbie.govt.nz/dmsdocument/11445-regional-factsheet-gisborne-pdf

Ministry of Business, Innovation and Employment. (2020). *Regional fact sheet: Hawke's Bay*. https://www.mbie.govt.nz/dmsdocument/11446-regional-factsheet-hawkes-bay-pdf

Murphy, S. (2022). *Farmers despair as cyclone, weeks of rain ruin arable crops*. NZ Herald. https://www.nzherald.co.nz/the-country/news/farmers-despair-as-cyclone-weeks-of-rain-ruin-arable-crops/JDYPE4KH7X6MY3RFDGUH3PL57I/

Network for Greening the Financial System. (2020). *Technical document: Guide to climate scenario analysis for central banks and supervisors*. NGFS. https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_scenario_analysis_final.pdf

New Zealand Productivity Commission. (2020). *The dairy sector in New Zealand: Extending the boundaries*. https://www.productivity.govt.nz/research/the-dairy-sector-in-new-zealand/

New Zealand Treasury. (2021). *CBAx tool user guidance*. https://www.treasury.govt.nz/publications/guide/cbax-tool-user-guidance

NZ Herald. (2022). *Heavy rain takes the shine off T&G's Envy apples, sees loss*. https://www.nzherald.co.nz/business/heavy-rain-takes-the-shine-off-tgs-envy-apples-sees-loss/XFZIEF37K5GQTP3BL5GBJA34FQ/

O'Connor, Hon D. (2022). *Government supports flood-affected Tairāwhiti and Hawke's Bay farmers and growers*. Beehive.govt.nz. https://www.beehive.govt.nz/release/government-supports-flood-affected-tair%C4%81whiti-and-hawke%E2%80%99s-bay-farmers-and-growers

Otago Daily Times. (2022). *Govt support for Otago-Southland as drought declared*. https://www.odt.co.nz/rural-life/rural-life-other/govt-support-otago-southland-drought-declared

Raven, J. (2020). *The road to protein diversification for global food companies*. FAIRR Initiative. https://www.fairr.org/article/the-road-to-protein-diversification-for-global-food-companies/

Riahi, K. et al. (2017). The shared socioeconomic pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, 42, 153-168.

Sense Partners. (2020). *Dairy's economic contribution: 2020 update*. https://www.dcanz.com/UserFiles/DCANZ/File/Dairy%20economic%20contribution%20slides%20_Sense%20Partners%20August%202020.pdf

Stats NZ. (2022). *National population projections: 2022(base)* - 2073. https://www.stats.govt.nz/information-releases/national-population-projections-2022base2073/

Task Force on Climate-Related Financial Disclosures. (2020). *Guidance on scenario analysis for non-financial companies*. https://assets.bbhub.io/company/sites/60/2020/09/2020-TCFD_Guidance-Scenario-Analysis-Guidance.pdf

Task Force on Climate-Related Financial Disclosures. (2017). *The use of scenario analysis in disclosure of climate-related risks and opportunities*. https://assets.bbhub.io/company/sites/60/2020/10/FINAL-TCFD-Technical-Supplement-062917.pdf

The Aotearoa Circle. (2022). *Mana Kai initiative*. https://www.theaotearoacircle.nz/mana-kai-initiative

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The task at hand is an urgent one.

The Aotearoa Circle's goal is big. There is mounting concern at the degradation of our natural resources and the risks and uncertainties this presents to future generations of New Zealanders.

The Aotearoa Circle is a voluntary initiative bringing together leaders from the public and private sectors to investigate the state of our natural resources, and to commit to priority actions that will halt and reverse their decline.

"We know what is happening, we know what we must do – now, we must simply do it."
Sir Rob Fenwick

You can find out more about The Aotearoa Circle, the evolution of this workstream, and other sector workstreams on our website: https://www.theaotearoacircle.nz/

The Aotearoa Circle

Mā te Kaitiakitanga ko te Tōnuitanga
Prosperity Through Guardianship