Focusing Aotearoa New Zealand's research for the future

Independent Strategic Panel

19 February 2024

Preface

Complex environmental, social, technological, geopolitical, and economic issues are generating a level of complexity, uncertainty and disruption that will be significant in our lifetimes. In the recent past, New Zealanders have experienced the many effects of the disruptions from COVID-19 and climate events.

By focusing our science, innovation, and technology on these complex challenges and seizing the opportunities that science provides we can enhance Aotearoa New Zealand's prosperity and produce meaningful benefits for all New Zealanders. We need to make choices so that we do not spread our resources too thinly and can make impactful shifts in critical areas.

An Independent Strategic Panel was brought together to provide recommendations on research areas to address the greatest challenges and opportunities for Aotearoa New Zealand. The Panel was motivated by the opportunity to achieve transformational impact by:

- increasing the scale of ambition and commitment to delivering outcomes for New Zealanders,
- focusing on tangible ambition areas that are open to solutions, and
- focusing all available expertise and resources to achieve awe-inspiring outcomes.

The Panel has identified challenges and opportunities for Aotearoa New Zealand and produced areas of ambition that can address our near term and longer-term outlook. These are areas:

- where we have or have the potential for deep research expertise, competitive advantage, and global leadership
- that address critical issues and opportunities unique to Aotearoa New Zealand that cannot be imported
- where without investment we risk losing our status as an advanced nation, with negative societal-wide consequences.

The Panel's advice provides the first step. Input from the science, innovation, and technology sector will be needed to refine these ambitions and realise their full potential.

Making progress towards any of the ambitions could contribute to the seismic shift in Aotearoa New Zealand's future trajectory that is envisaged by the Panel.

Contents

Executive Summary

Introduction

In August 2023, an Independent Strategic Panel (**the Panel**) was established to identify the most important challenges and opportunities for Aotearoa New Zealand, and make recommendations on the areas where our country's research activities should be focused to respond to these issues. The Panel comprised 11 members, including the chair, Sir Jerry Mateparae.

Benefits of focusing research to key areas

The Panel identified a range of benefits of focusing research to those areas where science, innovation, and technology (**SI&T**) can make a significant difference for Aotearoa New Zealand. The ambitions that have been identified will support the government to invest proactively in research that underpins strategic areas of national importance. They will also create impact in these areas by coordinating capability across the science, innovation, and technology system. This will ensure Aotearoa New Zealand is well-positioned to respond to emerging issues, takes advantage of scientific and technological developments, and extracts maximum value from our national research investment.

This is a once in a generation opportunity to revolutionise the SI&T system and drive research forward. The ambitions cover areas that could have the greatest potential for making meaningful change, and in some cases this change will be seismic.

Areas of ambition

The Panel identified twelve areas of ambition. These are grouped around four themes, although many ambitions fall under more than one theme, and all are interconnected.

The Panel considered that we need to maximise the impact that research can have to grow the economy of Aotearoa New Zealand. Our economy is relatively small and heavily reliant on the primary sector, so is vulnerable to climate change and other disruptions.

Developing new areas of advantage, while making the most of our primary sector, will enable **the economy to grow and become more productive, sustainable, and resilient**. To enable this quantum shift in delivery we need:

- Research that systemically identifies and quantifies areas of national economic vulnerability to climate change, natural disasters, and other disruptions and use this insight to **transform and diversify our industrial and commercial landscapes**. This would ensure they are better placed to thrive and assimilate global technological advances.

- Research around the **creation of a smart nation**. This would involve developing new national infrastructure and strategy, to systematically harvest, archive and interrogate the greatest possible spectrum of nationally generated data as well as generate new computational models and modelling capability. The objective would be to establish an accurate and predictive virtual "digital twin" for Aotearoa New

Zealand. This would ensure we are less reliant on less relevant overseas models, while providing national data sovereignty and strong basis for government to operate more efficiently in every facet of our infrastructure, society, and economy, enabling us to make faster, smarter decisions as a nation.

- Research that **supports the use of mātauranga Māori, taonga and the environment to achieve commercial aspirations and protect our nation's assets for future generations**. This would have significant economic benefits for Aotearoa New Zealand and enable deep local knowledge and mātauranga informed solutions to transform the management and structures of our water and land-based assets.

We need to utilise **research to support the continued growth and competitiveness** of our existing primary, manufacturing and industry sectors and spawn new enterprises. Strengthening our technological capabilities in these sectors will lift productivity, build, and support innovation and encourage entrepreneurism. Enabling more sustainable, productive land use will also mitigate against the impact of climate change, minimise our carbon and waste footprint and ensure smart, productive land use.

- Research focused on **creating the world's most sustainable food production system**, supported by the development of Aotearoa New Zealand's first national food strategy. This will enhance the health and wellbeing of our people and whenua by managing food supply, improving the competitiveness and profitability of food production, and supporting the transition to more technology-enabled, sustainable production systems.

- Research that **maximises the intergenerational productivity of our whenua**. This will lead to a better, more integrated systems approach to land use and increase productivity, while enhancing the natural resilience of our land and biodiversity to climate change, pests, disease, and other disruptions.

- Research that **prepares workers and workplaces for organisational transformation in the way we work and new types of working**. This will produce a more agile, resilient, digitally capable, engaged, productive, and climate smart generation, leading to increased productivity and growth in exportable systems.

Research is needed to **improve health and wellbeing outcomes, build healthy communities, and address stubborn inequalities**. Health and wellbeing are not simply the absence of disease or infirmity. They require the development of treatments, solutions, and preventative strategies to improve physical and mental well-being.

- Research to **develop an advanced healthcare system** that is supported by smart, exportable medical technology, biotechnology and artificial intelligence-supported solutions to enable low cost, accessible and trusted data-driven decisions and services. By supporting high quality healthcare for all New Zealanders, this ambition will help build healthy and resilient communities.

- Research to **ensure individuals and communities are engaged and connected digitally and socially, can thrive, and enjoy improved levels of wellbeing**. This

will create a more resilient cultural fabric, strengthen the voice of the community, and harness diverse communities as a space for innovation and productivity.

- Research that **transforms our cities into sustainable, net zero global drivers of innovation and creativity**. This will enhance economic potential and transform our cities and towns into more liveable areas that can be the foundation of thriving and resilient communities and economies.

We need to take advantage of research to **build Aotearoa New Zealand's capacity to respond to environmental change**, so that we can pass on a healthy and thriving natural environment to future generations.

- Research that **improves our resilience to natural hazards** using new technologies and innovative approaches to the way we manage these threats and challenges. This will ensure that Aotearoa New Zealand has world-leading tools and structures in place to detect, quantify and in some cases forecast natural hazards, as well as identify the exposure and risk to developing urban areas.

- Research focused on **examining the cumulative impacts, tipping points and health of rivers, lakes, wetlands, and estuaries in Aotearoa New Zealand** in the face of mounting pressures. This will enable evidence based decision-making and ensure there are more places to swim, fish, and gather mahinga kai, and our needs for clean drinking water and irrigation are met.

- Research to **preserve the health of the ocean and safeguard the thriving biodiversity of its marine ecosystem**. This will ensure fisheries and aquaculture are productive and sustainable, while both preserving our natural environment and expanding our economy.

Next steps

The panel is mindful that further engagement is needed to focus the ambitions and identify specific research questions to maximise the potential of the SI&T system so that it makes a significant difference to Aotearoa New Zealand.

The Panel is aware that the SI&T system is board and covers many other research areas that are not raised in this report. The Panel's aspiration is that the ideas raised in this report offer valuable conversation starters for Ministers, government agencies and sector experts that will enable them to develop the focus areas further.

1 Introduction

The SI&T system needs to meet the challenges and make the most of the opportunities that lie ahead for Aotearoa New Zealand. Establishing areas to focus our research efforts will enable the government to build on our broad platform of research and concentrate funding and activities on the most important social, cultural, environmental, health and economic challenges and opportunities for Aotearoa New Zealand.

In August 2023, the Minister of Research, Science and Innovation commissioned an Independent Strategic Panel to recommend a portfolio of National Research Priorities to Government. These are key areas to focus research in response to the opportunities and challenges for our nation where research can make a difference.

1.1 Membership of the Panel

The members of the Panel are:

- Tā/Sir Jerry Mateparae (Ngāti Tūwharetoa, Ngāti Kahungunu) – Chair
- Michael Ahie (Taranaki, Ngāruahine, Ngāti Ruanui)
- Distinguished Professor Dame Jane Harding
- Hōne McGregor (Te Ātiawa, Ngāti Rārua, Rangitāne, Ngāti Raukawa, Ngāti Kere, Te Whānau-a-Apanui)
- Ian Short
- Dr Sean Simpson
- Distinguished Professor Linda Tuhiwai Smith (Ngāti Awa, Ngāti Porou)
- Professor Low Teck Seng
- Associate Professor Yvonne Te Ruki Rangi o Tangaroa Underhill-Sem
- Charlotte Walshe
- Professor Dame Juliet Gerrard (ex officio member)

1.2 Terms of Reference

Under their Terms of Reference, the Panel was asked to identify the challenges and opportunities that are most important to Aotearoa New Zealand that research can address. They were also requested to provide the Government with recommendations on the areas where our country's research activities should be focused to respond to these issues.

Although the Panel was established by the Ministry of Business, Innovation and Employment (**MBIE**), the Terms of Reference made it clear that the Panel was independent and had a free hand to choose what they considered to be the most important challenges and opportunities that research could address – recognising that the final selection will ultimately be a matter for the Government. However, the focus areas needed to be transformative and satisfy the following criteria:

- have impact
- honour Te Tiriti o Waitangi / Treaty of Waitangi

- be long-term and enduring
- contribute to wellbeing and public good
- have relevance to Aotearoa New Zealand
- enhance international connectedness.

In addition to these criteria, the Panel felt that it was important to consider how research might be harnessed to improve productivity.

1.3 How we went about our work

While each member of the Panel brought different skills and expertise to this work, all the members had a strategic, independent, and whole-of-country perspective. Collectively, the members had leadership experience, an understanding of the Aotearoa New Zealand context (including experience implementing or giving effect to Te Tiriti o Waitangi) and the contribution that SI&T can bring to productivity and wellbeing. Panel members also had international perspectives that helped identify challenges and opportunities common to other countries.

The Panel commenced its work by discussing the process it would apply to reach its conclusions and recommendations. It then received analysis and advice, provided by government agencies with direction from a cross-agency steering group. The advice outlined Aotearoa New Zealand's research landscape, the strategic context within which the opportunities and challenges operate, and potential areas of strategic importance where research can make a difference. When preparing this material, the agencies engaged with Te Tiriti partners and specific stakeholder groups, including Pacific peoples, relevant sector experts, strategic thinkers, and international and futures experts.

The Panel also received advice on areas of interest to Māori with relevance to science, innovation, and technology covering several broad domain areas – environment; identity/culture; social, health and wellbeing; economy; and education. This information was important for developing the recommended focus areas.

The Panel held three workshops attended by all members to identify the challenges and opportunities that are most important to Aotearoa New Zealand, identifying areas of ambitions for focusing our research efforts. The ambitions were then assessed to ensure they are transformative and align at a high level with the criteria. This report is the outcome of that work and has a focus on high level strategic ambitions where research can make a difference. It does not drill down into specific research questions.

1.3.1 Acknowledgements

The Panel thanks the government agencies and cross-agency steering group who helped prepare the papers for us to consider as well as those who shaped the information on Aotearoa New Zealand's strategic context and analysis on sector specific issues. We also acknowledge the input from the departmental Chief Science Advisors.

Panel members are grateful for the support from Prue Williams, General Manager of the Future Research Systems branch at MBIE, and her team.

2 Context for our work

When developing their recommendations, the Panel considered reports from government agencies working under the direction of a cross-agency steering group on the current state of the SI&T system in Aotearoa New Zealand as well as the features of the country's strategic landscape and sector specific issues.

2.1 Aotearoa New Zealand's Research Landscape

The Panel was advised that the SI&T system has served the country well since it was designed in the 1990s. Crown Research Institutes, universities and other tertiary providers, and independent research organisations have undertaken a wide range of groundbreaking research that has supported our social, cultural, environmental, health and economic wellbeing. New Zealanders have benefited from the impactful work that our dedicated, world-class researchers and innovators have undertaken in their academic fields.

While there is much to be proud of about the quality of our current SI&T system, it does not always set up our researchers and innovators for success. The system is small relative to the size of our economy, and resources are spread too thin. There is no overarching strategy that optimally harnesses the skills and capabilities of our researchers and innovators towards our evolving national needs. Funding is concentrated in traditional areas of strength, rather than being directed toward emerging areas that really matter to Aotearoa New Zealand. Funding priorities, institutional constraints and misalignment of incentives hinder collaboration, and stifle the translation of funded research into entrepreneurial or commercial outcomes. The Panel was also advised that the links between businesses and research organisations are much weaker than in comparable economies.

The Panel considers that areas of ambition are needed to direct our research, science, innovation, and technology resources. These areas will create a high degree of future focus for connectivity, alignment, and coordination across the SI&T system, enabling researchers and innovators to collaborate on projects that are relevant and meet the most important challenges and opportunities for Aotearoa New Zealand.

2.2 Aotearoa New Zealand's Strategic Context

When developing their recommendations, the Panel considered aspects of Aotearoa New Zealand's strategic context that will impact the areas of focus, including the unique features of our strategic landscape, Te Tiriti o Waitangi and our relationship with the Pacific region and its peoples. These matters present opportunities to extend our competitive advantage and lead efforts to solve these pressing challenges informed by focused research.

2.2.1 Unique opportunities and challenges

The Panel heard that there are several distinctive features of Aotearoa New Zealand's strategic landscape that offer opportunities and challenges. For instance, Māori as tāngata whenua bring cultural and societal difference, unique wisdom, diversity, and resilience to our society and international standing.

Our system of government is also an advantage. Having a small, single chamber legislature, and proportionally representational Parliament, with most authority vested centrally as opposed to locally, allows us to respond quickly and decisively to natural hazards and other disruptive events. We are also able to regulate quickly and effectively, which enables us to stand up systems quickly to support emerging technologies and innovative industries.

Aotearoa New Zealand is overwhelming urban with four out of five people living in urban areas. One quarter of New Zealanders were born overseas, which is relatively high compared internationally. However, our ability to attract immigrants is advantageous, because the skills, knowledge and experience they bring enrich the country's culture and economy, as well as offer different perspectives on how we respond to global issues.

Our physical location means that import and export costs are high. However, we are far away from most external conflicts, and securing our physical borders is less of a problem. While climate change will disrupt our physical geography, we are likely to be impacted differently than other countries although the increasing frequency of extreme weather events with heavy rainfall is already challenging the resilience of our infrastructure and primary production sectors.

The country also has a high propensity to suffer natural hazards due to our geology. The way we live in our environment also poses risk, as many people reside and continue to build in high-risk areas, such as around the coast, on steep slopes, fault lines, reclaimed land, and flood plains. These risks are escalating as the climate changes.

Aotearoa New Zealand has many of the features of modern advanced economies, including universal education, welfare, healthcare, and relatively well-maintained infrastructure. However, income and wealth are not evenly distributed in our society. For instance, many children face persistent disadvantage and experience life differently to much of the population. These children are more likely to fall behind in many areas of wellbeing and development, with effects that continue to limit their opportunities later in life.

The Panel was advised that we have a poor track record when it comes to innovation. This is a concern especially in areas where Aotearoa New Zealand needs to make changes to address existential threats or quickly adopt technology and processes developed overseas. The exception is our primary industries, where process innovation is more widespread and has increased our productive capacity significantly.

2.2.2 Te Tiriti o Waitangi

Te Tiriti o Waitangi envisages equal rights will be afforded to all New Zealanders, yet the Panel heard that Māori are under-represented at all levels in our research workforce. They are often excluded from governance and decision-making in the public research system and there have been low levels of investment in Māori research activity.

The Panel was advised of the importance of ensuring that the SI&T system is more responsive to the interests and values of Māori across the country. Te Tiriti o Waitangi needs to be placed at the centre of efforts to build a SI&T system that provides equitable opportunities for Māori to pursue their values and interests. This will strengthen the role of Māori and increase Māori representation and capability across the SI&T system, support

kaitiaki to protect and develop mātauranga Māori, and improve outcomes for Māori achieved through the SI&T system.

To be more responsive to their needs and values, Māori need to be involved throughout the process of developing and evolving the focus areas, as sector experts, strategic experts and Tiriti partners. In addition, the ambitions should:

- promote effective partnerships and suitable representation of Māori across SI&T workforces, governance, leadership, and management.
- recognise the need to invest in mātauranga and the promotion of a thriving ecosystem of Māori-led and community-led research activity.
- acknowledge the rights, interests, duties and responsibilities of Māori in the allocation of resources to achieve research, science, innovation and technology aspirations.

2.2.3 Relationship with the Pacific and Pacific Peoples

Aotearoa New Zealand's connections with the Pacific and Pacific Peoples shape our identity, influence our security, and contribute to our prosperity. We share economic, security and trade interests, and marine territory with our Pacific neighbours. The wellbeing of the people of Aotearoa New Zealand, its economy and environment is interdependent with the wellbeing of the Pacific region.

The surrounding ocean connects and provides us with diverse opportunities for intergenerational and indigenous wellbeing. Its resources are the backbone for Pacific economies and cultures to thrive collectively, while Pacific Peoples' connection to the ocean and land enshrines a deep sense of environmental stewardship.

Pacific Peoples play an increasingly important role in our economy, particularly young Pacific people. However, many of our domestic systems, such as economic participation, income, employment, are failing Pacific Peoples living in the country. We heard there are opportunities to improve the economic potential of Pacific communities. This would contribute to increased productivity and deliver wider economic benefit for individuals, communities, regions, and the country as a whole.

The Panel was advised that there are several shared challenges and opportunities across the Pacific and for Aotearoa New Zealand. The most notable are climate change and migration; however, declining biodiversity and increased threats from invasive species weaken healthy ecosystems, which are fundamental to the resilience and environmental, economic, and social wellbeing of countries in the Pacific region.

2.3 Global issues impacting Aotearoa New Zealand

The Panel also received advice on a range of the global challenges that have implications for Aotearoa New Zealand, including climate change and irreparable impacts to the environment, persistent inequities for certain population groups, and global economic and geopolitical change. These issues are likely to create social, technological, political, and

economic issues that will generate a level of complexity, uncertainty and disruption that will be significant for our country. The issues are summarised below.

2.3.1 Climate change

As the impacts of climate change increase, we can expect to live with more volatile climate, putting pressure on our food and water resources, our unique flora and fauna, and where people can live in Aotearoa New Zealand.

Climate change poses a risk to the social, cultural, spiritual, and economic wellbeing of Māori from loss and degradation of lands and waters, as well as cultural assets such as marae, due to ongoing sea-level rise and changes in rainfall including drought. It has implications for our relationships with, responsibilities to the Pacific region. It is also likely to lead to a loss of species and biodiversity due to greater climate variability, biosecurity incursions and ongoing sea-level rise.

2.3.2 Access to resources

Changing global conditions, particularly the ongoing effects of climate change, evolving geostrategic pressures and in some cases, armed conflicts, can exacerbate several drivers of instability. This can fuel issues such as access to energy, water, food, and other scarce resources, with resulting impacts on starvation, poverty and inequity, large population movements, and land and border disputes. These effects will disrupt the livelihoods of many communities and exacerbate underlying social, economic, or political tensions.

Food habits are also changing. There is a shift towards reduced meat and dairy consumption for environmental, health and other reasons. Additionally, the effects of climate change are having a significant impact on food production and land use sustainability. Loss of relevance as a food producer is a challenge. Aotearoa New Zealand needs to strategically invest in climate resilient foods and food production systems that cater to merging and future markets.

The Panel was advised that some supply chains that our country relies on may face challenges, exacerbated by climate change, the changing technological landscape, and geopolitical shifts. Sustainable and innovative solutions will be vital to ensure we continue to have a resilient and cost-stable supply chain both internally and external to Aotearoa New Zealand.

2.3.3 Health challenges

Globally, healthcare expenditure continues to show an upward trajectory, which will be exacerbated as new health challenges emerge. These include widening health disparities, increasing rates of mental health and addiction challenges, increasing chronic diseases, as well as outbreaks of infectious disease and antimicrobial resistance. Chronic diseases reduce overall healthy life expectancy and require healthcare over longer durations of a person’s life.

Pandemics also pose significant threats to public health, social stability, and economic well-being. COVID-19 highlighted the need for accurate predictive models and simulation tools to support decision-making, resource allocation, and intervention strategies. However, there

are many opportunities to develop new technological solutions for all areas of our healthcare system.

The Panel heard that Aotearoa New Zealand's current healthcare system is not adequately prepared for the future and needs to adapt to cope with these challenges. Digital health data is more available now and advancement in analytics and new technologies offer opportunities to ensure our healthcare system is affordable and equitable.

2.3.4 Digital transformation and emerging technologies

Digital transformation is happening at a rapid pace. The speed of technological innovation is also increasing. New and evolving technologies are being advanced across a wide range of areas – from artificial intelligence (AI), robotics, 6G cellular communications, quantum computing, DNA sequencing, blockchain technology, and immersive virtual reality, fusion power, and more. Given the productivity benefits, governments are also using digital technologies to deliver many core services, including education, healthcare, and general support around services like tax administration.

Aotearoa New Zealand needs to better leverage the full potential of digital and technological innovation. At the same time, we need to ensure that the transformation and uptake of new technologies is inclusive and considered in the evolving future of work.

2.3.5 Demographics and social cohesion

Like many high-income countries, Aotearoa New Zealand is characterised by an ageing population and high rate of migration. Baby boomers are boosting the population aged over 65, from 600,000 in 2013 to well over a million in the early 2030's. Population growth is also occurring disproportionately in certain demographics and some regions, such as the upper part of the North Island. Climate related migration, from in and around the Pacific, may contribute to increasing changes in our populations. These increasing and changing population dynamics may lead to poorer outcomes later in life putting pressure on our welfare, health, and support systems as an increasing number of older people experience hardship, vulnerability, and disadvantage.

While Aotearoa New Zealand's level of generalised trust is comparatively high, it has trended down over time. Social cohesion is also under pressure from the changing nature of the information environment. While the emergence of advanced information technologies has created new opportunities, they also create issues of trust and foreign influence on information and cybersecurity is a growing national security risk, in Aotearoa New Zealand and the Pacific.

2.3.6 Geopolitical tensions

An increase in geostrategic competition and pressure on multilateral rules and norms is creating uncertainty. Some national interest agendas are becoming decoupled from an assumption of "stronger together" and are leaning towards increasing populist nationalism and greater protectionism. The Panel heard that supply chains experiences during COVID-19 coupled with a need to stimulate domestic economies post pandemic is driving a China-Western decoupling, notably in the United States.

2.3.7 Environmental degradation and biodiversity loss

Biodiversity is rapidly declining around the world, with around one million animal and plant species facing extinction – more than ever before in human history. Because ecosystems are connected, the decline or degradation of biodiversity and ecosystems on land can have negative impacts on marine and freshwater environments, and vice versa. Floods, drought, and heatwaves intensified by climate change and human activities cost the economy millions of dollars every year. Degraded ecosystems and pollution threaten taonga species, biodiversity, and livelihoods.

Aotearoa New Zealand has a unique and abundant biodiversity that is nationally and globally important. We have a duty of care towards the animals, plants, fungi, and microbes that are found here to ensure that they remain healthy and thriving.

2.4 Benefits of focusing research to key areas

Aotearoa New Zealand would benefit from focusing our research efforts to key areas. The SI&T system is vital to ensuring our nation can flourish. Establishing focus areas will support the government to invest proactively in research and innovation that supports strategic areas of national importance. They will enable a pathway to impact in these areas by coordinating capability across the SI&T system, leveraging our strengthens in areas we can lead, enabling society-wide transformation.

The Panel's recommendations for the potential focus areas could ensure Aotearoa New Zealand is well-positioned to respond to emerging issues, takes advantage of scientific and technological developments including building on existing expertise, and extracts maximum value from our national research investment. While capital funding will be critical to achieving the ambition that the focus areas offer, investment in these areas would transform the relevant systems, processes, and capabilities.

The recent economic and social disruptions caused by COVID-19, geopolitical tensions, and climate events have raised our awareness of the importance of science, innovation and technology and the role of research in developing new areas of advantage has never been higher. This is a once-in-a-generation opportunity to build on our broad base and revolutionise and drive the SI&T system forward, ensuring it has a large-scale impact on productivity, economic opportunity, and resilience.

The proposed focus areas for our research efforts cover areas that will have the greatest potential for meaningful impact, and in some cases this will be seismic. The Panel acknowledges that there is an evolving set of other research areas that would benefit from government investment, so recommends the focus areas are reviewed periodically. This would allow for new initiatives to be included and ensure that issues being addressed continue to be the most pressing for Aotearoa New Zealand, thereby avoiding 'locking in' ambitions of the past.

3 Areas of ambition

The Panel has identified twelve areas of ambition for Aotearoa New Zealand where science, innovation and technology can make a significant difference. These ambitions have been grouped around four broad themes to create greater value from investments.

For each focus area, the Panel has set out its ambition, along with a summary of why they are important and the benefit that the research would bring to Aotearoa New Zealand. Many ambitions sit under more than one theme, and all are interconnected. Specific research programmes for investment may well sit under several focus areas.

3.1 Growing the economy

The Panel considers it important to maximise the impact that research can have to grow the economy and productivity of Aotearoa New Zealand.

Our economy is relatively small and heavily reliant on the primary sector, which means that it is vulnerable to environmental conditions, changes in technology and disruptions in supply chains. Developing new areas of advantage, while making the most of our primary sector, will enable the economy to become more productive, sustainable, and resilient. This has long been recognised but the SI&T system has often lacked the significant focussed investment required for delivery of outcomes. To enable this quantum shift in delivery we propose the following ambitions.

3.1.1 Transforming our industrial and commercial landscape

> To systematically identify and quantify areas of national economic vulnerability to climate change and other disruptions and use this insight to guide the transformation and diversification of our industrial and commercial landscape, ensuring they are better placed to thrive and assimilate global technological advances.

Background: Aotearoa New Zealand's economy is small relative to other developed countries and is heavily reliant on the primary sector, which accounts for 60 percent of land use and at least a quarter of employment. This makes it vulnerable to sudden shocks and changes over time (such as changing consumer sentiment, geopolitical upheaval, and technological change). To grow our economy, we need both a productive, sustainable primary sector and diversification into new commercial industries, some of which will benefit from existing areas of strength. We also need to electrify industry and transform to a low carbon economy.

Research Benefits: Undertaking research that transforms our industrial and commercial landscape will enable us to systematically identify areas of national economic vulnerability to climate change and other challenges. This will guide the transformation and diversification of our industrial and commercial landscapes, leading to a more productive, sustainable, and resilient economy. We will be in a better position to take advantage of advances in technology and concentrate resources and investment in areas where we are competing successfully in global markets.

This ambition is enabling, transformative, and inter-connected with many of the other focus areas that are discussed below, including 'smart nation', 'creating the world's most sustainable food system', 'innovative and affordable healthcare' and 'net zero, liveable cities and towns'.

3.1.2 Smart nation

To develop new national infrastructure and strategy to systematically harvest, archive and interrogate the greatest possible spectrum of nationally generated data as well as generate new computational models and modelling capability, as a basis to operate more efficiently in every facet of our society and economy and make faster, smarter decisions as a nation.

Background: Data is a key resource in Aotearoa New Zealand. It enables our businesses to grow and develop new sources of competitive advantage, and allows government agencies to have more informed policymaking, service delivery and operations. The systematic collection of cross sectoral data and the establishment of national data warehousing and data curation capacity will be a key foundation upon which we derive insights, build intelligent systems, and ensure national data sovereignty. However, there is often a lack of awareness on how data can be used, how to improve the quantity and quality of datasets and how to fuse data from different sources for new insights.

Research Benefits: Research around the creation of a smart nation will enable us to develop new national infrastructure and strategy to systematically harvest, archive and interrogate the greatest possible spectrum of nationally generated data as well as generate new computational models and modelling capability. This would enable us to establish an accurate and predictive virtual "digital twin" for Aotearoa New Zealand that assimilates, and curates our national datasets to enable data driven decisions for health, social outcomes, and disaster preparedness and response. It would also reduce our dependency on overseas models less suited to our needs and vulnerable to external strategic influence. We will be able to operate more efficiently in every facet of our society and economy and make faster, smarter decisions as a nation. Treating data well is particularly relevant for Māori, who see data as a living taonga. It is important that we explore ways to better protect the data sovereignty of indigenous communities.

This ambition is enabling and supports the objectives of most of the other focus areas. In particular, it is essential to supporting those ambitions that seek to create more resilience and turbocharge research across many sectors.

3.1.3 Embedding a robust Mātauranga Māori system of knowledge and thinking that accelerates our economy, society, and culture

> To support the use of mātauranga Māori, taonga and the environment to achieve our commercial aspirations and protect our nation's assets for future generations.

Background: Mātauranga Māori is a knowledge base that is an essential to our national culture and identity and is crucial to the success of Māori and iwi economic and cultural development, especially in research that is specific to place.

Research Benefits: To ensure our nation benefits from this system of evolving knowledge now and into the future, we need to invest in research to support businesses to use mātauranga Māori, taonga and the environment to achieve our commercial aspirations. This would accelerate our economy, society, and culture, and strengthen the perception that we are a world leader in indigenous expertise. The economic benefits for Aotearoa New Zealand would be significant. This ambition would help diversify our exports and develop Māori data sovereignty frameworks to protect our assets for future generations. It would also enable deep local knowledge and mātauranga informed solutions to transform the management and structures of our water and land-based assets and ensure that mātauranga Māori retains its integrity and flourishes for the benefit of all New Zealanders.

This ambition is enabling and supports the objectives of most of the other focus areas being recommended.

3.2 Build stronger, more resilient productive sectors

The Panel considers it important to utilise research to support the continued growth and competitiveness of our existing primary, manufacturing, and industry sectors and spawn new enterprises.

Strengthening our technological capabilities in our productive sectors will lift productivity, build and support innovation and encourage entrepreneurism. This will provide direct benefits to our country such as attracting and retaining talent in Aotearoa New Zealand, strengthening the job market and knowledge transfer, as well as open these sectors to new markets and maintain supply chain resilience. Enabling more sustainable, productive land use will also mitigate against the impact of climate change, minimise our carbon and waste footprint and ensure smart and productive land use. This area of research covers the following ambitions.

3.2.1 Creating the world's most sustainable food system

To create the world's most sustainable food production system, supported by the development of Aotearoa New Zealand's first national food strategy, that enhances the health and wellbeing of our people and whenua by managing food supply, improving the competitiveness and profitability of food production, and supporting the transition to more technology-enabled sustainable production systems.

Background: As the global population continues to grow, so does the demand for nutritious, and affordable food, both from the land and the sea. The food supply chain is being significantly impacted by climate change, multilateral trading systems, geopolitics, the requirements of sustainability, and digitalisation. While the food sector contributes to our identity and strength as a nation, it generates the largest share of greenhouse gas emission and is affected by competing land and sea uses, and increased demand for ethical food production. At the same time, there has been an increase in the rate of change of diets of consumers and diet related illnesses.

Research Benefits: Research will help modernise, strengthen, and transform our food production system into one that is more sustainable and enhances the health and well-being of our people and whenua. It will assist the development of an integrated national food strategy to address our food challenges, create new and diverse supply chains, and drive a thriving export economy. This will help improve the competitiveness and profitability of food production, support the transition to more technology-enabled sustainable production systems, encourage diversification of the rural economy and enhance the quality of life in rural areas.

This ambition would support our existing clean, green image as well as Māori views around sourcing and production of food and its interrelations with the land and the oceans. Accordingly, the research needs to be supported and informed by mātauranga Māori, and data generated from the 'smart nation' ambition.

3.2.2 Sustainable, productive land use

To maximise the intergenerational productivity of our whenua through employing an integrated systems approach to land use and increase productivity while enhancing the natural resilience of our land and biodiversity to climate change, pests, disease, and other disruptions.

Background: The land across Aotearoa New Zealand is finite and in demand. Some land is particularly good for food and fibre production, but if that land becomes unavailable for agriculture (because we have built houses on it), other less productive land will need to be used. This can involve the use of more fertiliser and irrigation to ensure good yields, but risks damaging the quality and health of the soil, as well as the wider environment.

Research Benefits: Research on the impacts of our land use and management for food and fibre production, forestry, cities, and urban and coastal planning is important for maximising intergenerational productivity and sustainability. This will lead a better, more integrated

decision-making strategies in the context of potentially conflicting demands between development, the environment and land and waste management, as well as create resilience to climate change, pests, and disease as well as other disruptions.

This ambition needs to be supported and informed by mātauranga Māori and has connections with and can be integrated with several other focus areas including 'smart nation' and 'creating the world's most sustainable food system'.

3.2.3 Agile Learners and Workers

To prepare workers and workplaces for organisational transformation in the way we work and new types of work by producing a more agile, resilient, digitally capable, engaged, productive, and climate smart generation.

Background: Aotearoa New Zealand is undergoing a fundamental transformation in the way people work. Automation and "thinking machines" are replacing human tasks, changing the skills that organisations are looking for in their people. We cannot sit back and wait for events to unfold. We need to understand the growing needs of and opportunities for people entering the workforce as well as workers of all ages to prepare for the fundamental changes to the way of working and new types of work because of advancing global digitalisation and AI trends.

Research Benefits: Research could support workers and workplaces to prepare for this organisational transformation. Developing a greater understanding of the future of work will support communities and help to produce an agile, resilient, digitally capable, engaged, productive, and climate smart generation. This will lead to increased productivity and growth in exportable systems and processes of education and training.

This ambition is enabling, transformative, and supports the objectives of most of the recommended focus areas.

3.3 Support and enhance health and wellbeing

We need to utilise research to improve health and wellbeing outcomes, build healthy communities, and address stubborn inequalities.

Health and wellbeing are not simply the absence of disease or infirmity. They require the development of treatments, solutions, and preventative strategies to improve physical and mental wellbeing in smart, cost effective ways. Health research is interdisciplinary and has both social and economic impacts across wider society. For this reason, the following ambitions fall within this theme.

3.3.1 Innovative and affordable healthcare for all

To develop an advanced healthcare system that is supported by smart, exportable medical technology, biotechnology and artificial intelligence-supported solutions to enable low cost, accessible and trusted data-driven decisions and services.

Background: Improving health and wellbeing of all people at all ages is a prerequisite to building and sustaining productive and prosperous communities. Despite improvements in healthcare, persistent limitations and inequities in health and wellbeing outcomes still exist. Until this is addressed, the major causes of early death or disability such as communicable and non-communicable diseases, chronic pain and disability, oral health, and mental distress and suicide will not significantly change, especially for those most at risk. At the same time, we have a growing and ageing population, increasing demand for finite and increasingly unaffordable resources, and a limited healthcare workforce.

Research Benefits: Research directed towards developing an advanced healthcare system that is supported by smart, exportable medical technology, biotechnology and artificial intelligence-supported solutions will enable low-cost, accessible and trusted data-driven decisions and services, while also raising productivity and providing economic opportunities for Aotearoa New Zealand. By improving and achieving equity and health outcomes for all New Zealanders, this ambition will help build healthy and resilient communities.

This ambition needs to be supported and informed by mātauranga Māori, and data generated from the 'smart nation' ambition.

3.3.2 Towards resilient connected educated whanau and communities

To ensure individuals and communities are engaged and connected digitally and socially, can thrive, and enjoy improved levels of productivity and wellbeing.

Background: Educational success contributes to individual, community and national wellbeing. However, there are persistent and longstanding challenges in education that need to be overcome – especially for Māori, Pacific Peoples, people with disabilities and those from materially challenging backgrounds. These challenges occur at all levels (early childhood care, schooling and tertiary) and can be conceptualised in terms of presence, participation and progress.

Research Benefits: Research will contribute to supporting individuals and communities that are engaged and connected digitally and socially, can thrive, and enjoy improved levels of wellbeing. It will create a more resilient cultural fabric, strengthen the voice of the community, and harness diverse communities as a space for innovation and productivity. An educated whanau and community will also lead to more positive outcomes for diverse communities, improve engagement with democratic institutions, and reduce the misinformation that undermines our democratic institutions.

This ambition is connected to the focus areas relating to health and cities/towns and would benefit from being supported and informed by mātauranga Māori.

3.3.3 Net zero, liveable cities and towns

> To transform our cities and towns into sustainable, net zero global drivers of innovation and creativity and the home of thriving, resilient economies and communities that retain and attract people essential for a thriving Aotearoa New Zealand.

Background: More than 90% of our population live in urban areas. Many of our biggest challenges and opportunities are found in our urban areas and will be resolved here too. Cities offer live opportunities to design, test and implement solutions that deliver multiple benefits due to their density, including in areas such as climate adaptation and mitigation, health and wellbeing and he application of integrated decision-making. Modern, efficient, and liveable cities and towns will minimise many of these challenges and offer avenues to exploit some of our biggest opportunities.

Research Benefits: Research is essential to support our understanding of complex city systems and the design and implementation of solutions. We need to know how integrated, transdisciplinary planning and infrastructure can be used to make the most of our resources and build resilience. The role that cities and towns can play accelerating climate action towards net-zero needs to be explored along with the symbiotic relationship they have with the surrounding rural areas and the rest of the country. It will also be important to examine circular approaches to construction and retrofitting of our built environment so that they drive efficiency and innovation. Using creativity and entrepreneurial activity as a foundation, this research needs to include a focus on livability through a local lens, including more bio-diverse and green urban areas; as well as how to create clean, safe, and affordable mobility and connected and thriving diverse communities. The better use of smart and digital technologies will enable our built environment, transport, energy, waste, water and essential services, such as health and education, to be more efficient and responsive to the needs of our people and businesses.

This ambition is strongly aligned with and a critical support for most of the other focus areas.

3.4 Healthy and thriving natural environment

We need to take advantage of research to build Aotearoa New Zealand's capacity to respond to environmental change, so that we can pass on a healthy and thriving natural environment to future generations. There are many factors that influence the environment, ranging from climate change to population. These factors affect terrestrial, marine, rural, and urban systems in Aotearoa New Zealand. This theme covers the following ambitions.

3.4.1 Lives and livelihoods protected from natural hazards

To improve our resilience to natural hazards using new technologies and innovative approaches to the way we manage these threats and challenges.

Background: Aotearoa New Zealand faces an accumulation of challenges to our way of life, with the potential that these issues will have serious social, economic, and environmental impacts. Natural hazards also have significant cultural impacts associated with the loss of access to traditional food gathering sites and sacred places, including urupā, many of which are being unearthed by flooding. Employing smart data, new technologies and innovative approaches to natural hazard resilience will improve the way we manage these threats and challenges.

Research Benefits: Research should be directed towards building a robust evidence base that provides awareness, knowledge, and intelligence on natural hazard risk. Improvements in natural-hazard risk modelling, earth observation, and machine learning has the potential to re-shape national hazard assessment, aiding in more complete and accurate assessments of hazard risk and exposure, which will be invaluable to businesses, communities, and individuals. By supporting work in this field, we can ensure that Aotearoa New Zealand has world-leading resilient tools and structures in place to detect, quantify and in some cases forecast natural hazards, as well as identify the exposure and risk to developing urban areas. This ambition would also strengthen our international reputation for resilience to natural hazards.

This ambition will be reliant on data generated from the 'smart nation' ambition and is supported and informed by mātauranga Māori.

3.4.2 Healthy waters (te mauri o te wai)

To strengthen the health of rivers, lakes, wetlands, and estuaries in Aotearoa New Zealand so there are more places to swim, fish, and gather mahinga kai, and our needs for clean drinking water and irrigation are met.

Background: The rivers, lakes, wetlands, and estuaries of Aotearoa New Zealand are critical to our societal health and wellbeing, as they are important sources of food, recreation, and biodiversity. Yet all are under threat from climate change, pollution, and land-use change. An estimated 45% of our river length is unsuitable for swimming, each year there are more than 4,200 wastewater overflows due to wet weather events or blockages, 90% of wetlands (which offer protection against flood and storms) have been drained, 42% of our river network is inaccessible to native migratory fish, and 76% of native fish species face extinction.

Research Benefits: Researching the cumulative impacts, tipping points and health of our waters in the face of mounting pressures is vital. We need to embrace technology and data that enable world class monitoring of the state and trend of our natural environment and safe drinking water. Without this information we will lack the evidence base for informed decision

making. We also need to develop tools to deal with our existing invasive species and protect against incursions of new organisms.

As part of this ambition, we need to ensure that our primary sector and natural environment work sustainably and in partnership. Accordingly, it is connected the focus areas falling within the growing the economy theme, including mātauranga Māori, which will be crucial to its success.

3.4.3 Healthy, productive and sustainable oceans

To preserve the health of the ocean and safeguard the thriving biodiversity of its marine ecosystem by ensuring fisheries and aquaculture are productive and sustainable, while both preserving our natural environment and expanding our economy.

Background: Aotearoa New Zealand's marine and coastal ecosystems have significant ecological, economic, cultural, and social value, and a source of numerous resources heavily utilised by humans and other species. Yet they face a range of anthropogenic threats, including climate change and the impact of different land-use types on coastal water quality. Pollution with microplastics and other marine debris is another major issue. Fisheries and aquaculture provide significant economic and cultural value to New Zealand, as they are vital sources of food, income, and livelihood. It is important that we ensure these industries are sustainable and maintain the health of the ocean and thriving biodiversity of our marine ecosystem, while expanding our economy.

Research Benefits: Research will help fill existing knowledge gaps and make greater contributions to marine science, conservation, sustainable use, and marine management. It will help ensure the thriving productivity and biodiversity of our oceans, preserve the marine ecosystem, and provide greater resilience to warming oceans. Improving our understanding of the marine environment will also offer opportunities that arise from our very large Economic Exclusion Zone. This could include innovative aquaculture to expand the production of high-quality products at the lowest possible cost and the development of offshore renewable energy. This could also include understanding how to work alongside our kin in the Pacific region.

This ambition is connected to the focus areas falling within the growing the economy theme.

4 Next steps

The Panel is mindful that engagement with various experts and users of research is needed to focus the ambitions and identify specific research questions to maximise the potential of the SI&T system so that it makes a difference to Aotearoa New Zealand.

The Panel is aware that the SI&T system is board and covers many other research areas that are not raised in this report. The Panel's aspiration is that the ideas raised in this report offer valuable conversation starters for Ministers, government agencies and sector experts that will enable them to develop the focus areas further. Panel members would be happy to serve in any future work to fucus the ambitions, as appropriate.