Science Plan

September 2019

agresearch

āta mātai, mātai whetū

Contents

Foreword

The AgResearch Science Plan aims to be the cornerstone to our organisation's strategic and operational thinking and activities across the science and science support space.

Critical drivers for the Science Plan include:

How do we provide the organisation with quantitative science and innovation targets; i.e. "what does success look like"?
Action: Agree to key Impact Measures and Key Performance Indicators over the next 5-10 years.

Where are there particular synergies that differentiate AgResearch via the Plan?
Action: Actively create larger, cross-cutting, trans-disciplinary initiatives that bring science (and non-science) capabilities together.

How do we maximise the value of our science and innovation support capacity?
Action: Leverage our research/business support systems to make science delivery more efficient.

How do we use the Plan to accelerate deployment and impact of our science?
Action: Use design principles to proactively create a robust and future-focused Innovation Pipeline.

How do we use the Plan to create a Culture of Innovation Excellence?
Action: Seek new means to empower, engage and excite our staff across the organisation.

To support these drivers, the Plan introduces a series of quantitative and process-oriented measures that can be used to i) operationalise the Plan, ii) direct decision-making on science investment priorities, iii) define the core elements of science delivery structure and iv) provide a robust framework to communicate and demonstrate current and future value of AgResearch to stakeholders:

Impact Metrics – a series of longer-term parameters for each of the Science Objectives that quantify the expected outcomes for each Objective at a sector, regional or national level.

Key Performance Indicators – define AgResearch's relative contribution over time for each focus area in the Challenge Target/Objective matrix.

- What is an intermediate metric we can define, prioritise and measure to demonstrate the contribution the target Objective will deliver to the overall Quantitative Impact Metric for the Challenge.

Capability and Capacity Maps – a capability and capacity mapping methodology (including status, risk analysis and trajectory) defined across the Science Teams and infrastructure:

- Covers science disciplines, technical specialities/ proficiencies and priorities for future recruitment/ procurement
- Identify succession challenges in priority spaces
- Identify key in-house differentiators to foster and sustain strategic partnerships.

Partnership Selection Criteria – provide selection criteria and a formal process for formation of external science and sector collaborations that future-proof deliverability of the Science Plan.

Values-driven Science Culture – defines processes and performance criteria to enhance integrative capability and a Culture of Innovation Excellence within AgResearch:

- Optimising science creation, delivery and deployment systems and structures
- Opportunities to generate virtual and physical collaborative spaces
- Investment strategies to sustain a healthy Innovation Pipeline.

Strategic context

Five interconnected, global mega-trends (Fig. 1; identified by the AgResearch Science Advisory Panel) are driving the future economic and environmental sustainability of our food production systems and, therefore, our sectoral and national prosperity:

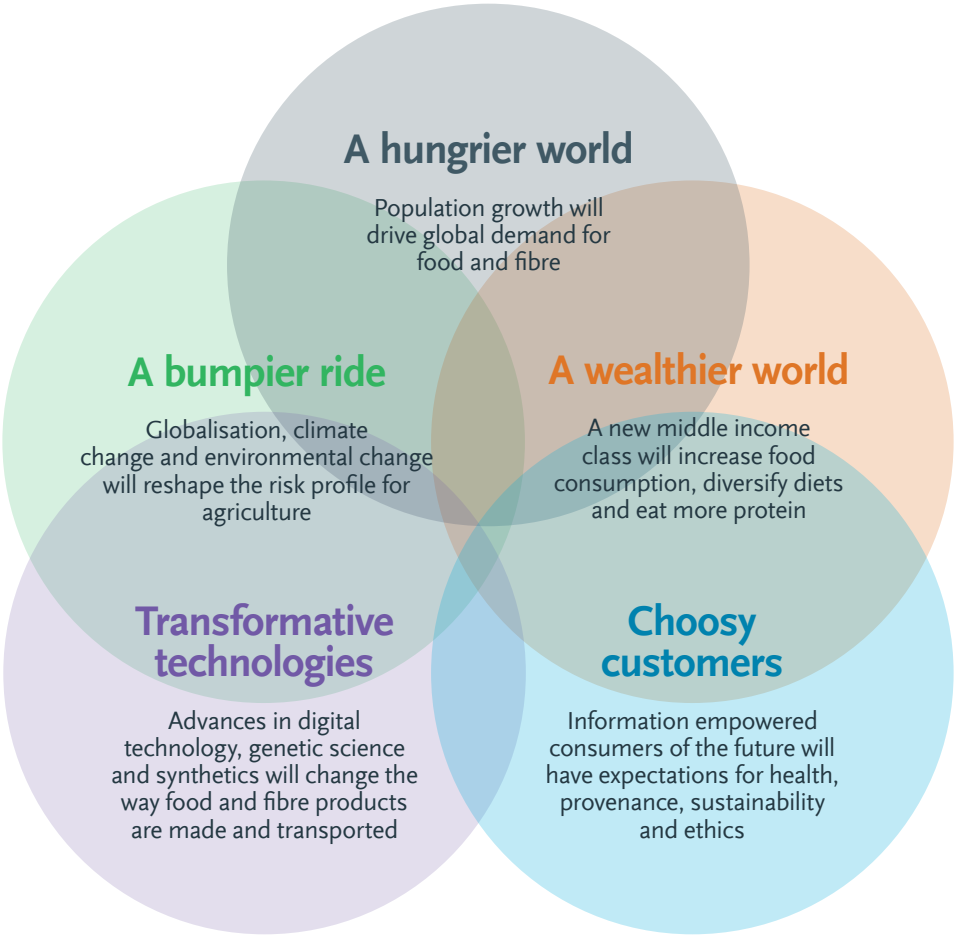


Figure 1: Global mega-trends in food production systems

These mega-trends have direct consequences for the innovation ecosystem we inhabit:

- The environmental costs of food production are inconsistent with what our global customers and local society value. We must improve water quality, act on climate change, reduce soil erosion, and better support our iconic biodiversity for the benefit of future generations. Essentially, we must adopt the philosophy of kaitiakitanga.
- New technologies and production systems are entering the global food business society and science with disruptive technologies and products like synthetic foods and plant-based "meats and milks".
- Changing consumer views and preferences towards food include preferences around meat consumption, the desire for full traceability of food from pasture to plate, animal welfare, transparency of environmental footprint, as well as growing expectations about the personalisation of nutrition and well-being.

Within the context of this rapidly changing world, there is urgency for AgResearch to drive transformation in our traditional food production systems.

Protecting and enhancing New Zealand's global brand as a producer of the world's most sought-after high value food products is essential if we are to earn our way in the world and support the prosperity we all aspire to.

Our Science Plan has been designed to drive prosperity by transforming agriculture within this context

The AgResearch Science Plan reflects a 'whole of value chain' approach, which acknowledges the complexity of the challenges and opportunities across global, national, regional and local scales; the diversity of existing and new actors in the agricultural innovation system; the availability of new scientific tools; and the focus on contributing to positive impacts.

The following **Overarching Principles** summarise the strategic goals inherent to the Science Plan:

A. **Protected, enhanced and sustained natural resources** – our land use must operate within natural resource boundaries at the global and local scale.

B. **Prosperous land-based enterprises** – New Zealand's regions still depend on primary production to deliver inclusive and equitable wellbeing that flows on to national benefit.

C. **Added-value foods and bio-based products that meet consumer needs** – transform volume-based production systems into value-based systems where producers share in the generated economic benefits.

Challenge Targets

National-level "Challenge Targets" – with a 2030 delivery date – have been developed to specifically align to our Overarching Principles. These are aspirational goals which will require effort from a range of organisations, but to which AgResearch can make a significant and leading contribution:

Net zero losses and emissions

We must design land use systems that mitigate losses of contaminants to waterways while circulating nutrients within and between systems to capture environmental and economic benefits. As per the recent PCE report, capturing C through trees will not be a long-term solution. We will need mitigations to reduce GHG emissions *per se*. The challenge is to design land-use mixes and transition pathways to meet net zero losses and emissions targets while ensuring prosperous communities.

Every farm in NZ is profitable and benefiting regional growth

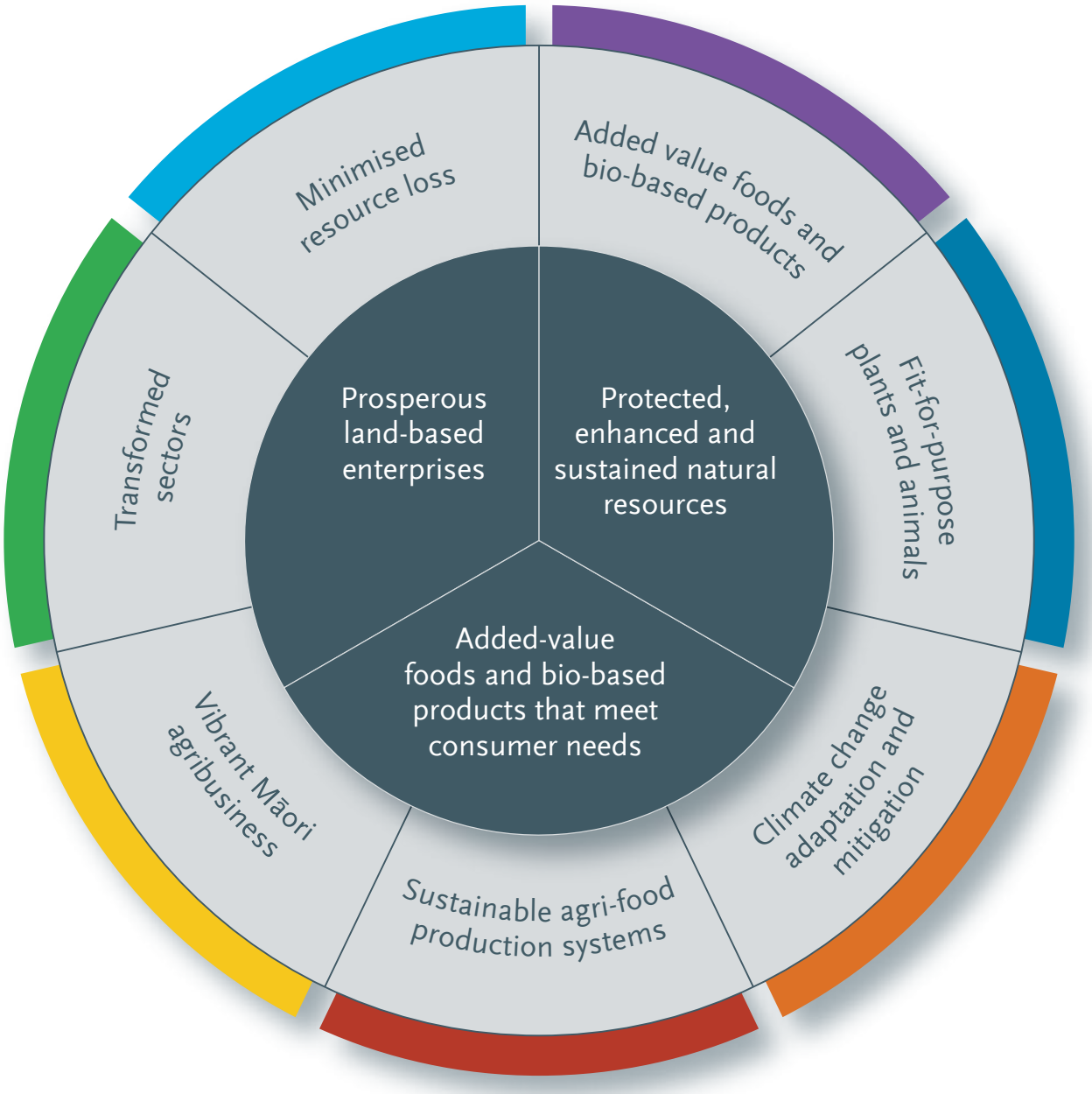
There is no one target measure that describes a prosperous and sustainable community; they are identified through a portfolio of economic, environmental, social and cultural well-being indicators. Examples of these include: increased investment, diversity of small and medium business, innovation being valued, educated workforce, high employment, people who are proud and have a sense of community, healthy families, strong infrastructure and healthy rivers, etc.

NZ food & beverage exports >$50 billion p.a.

This challenge relates to shifting the balance from a current reliance on commodity-based exports to a more sustainable balance with added-value product exports. This will be achieved through influencing the behaviour of consumers by building trust that the product they purchase delivers the desired benefits via science-based verification systems.

Our Science Objectives

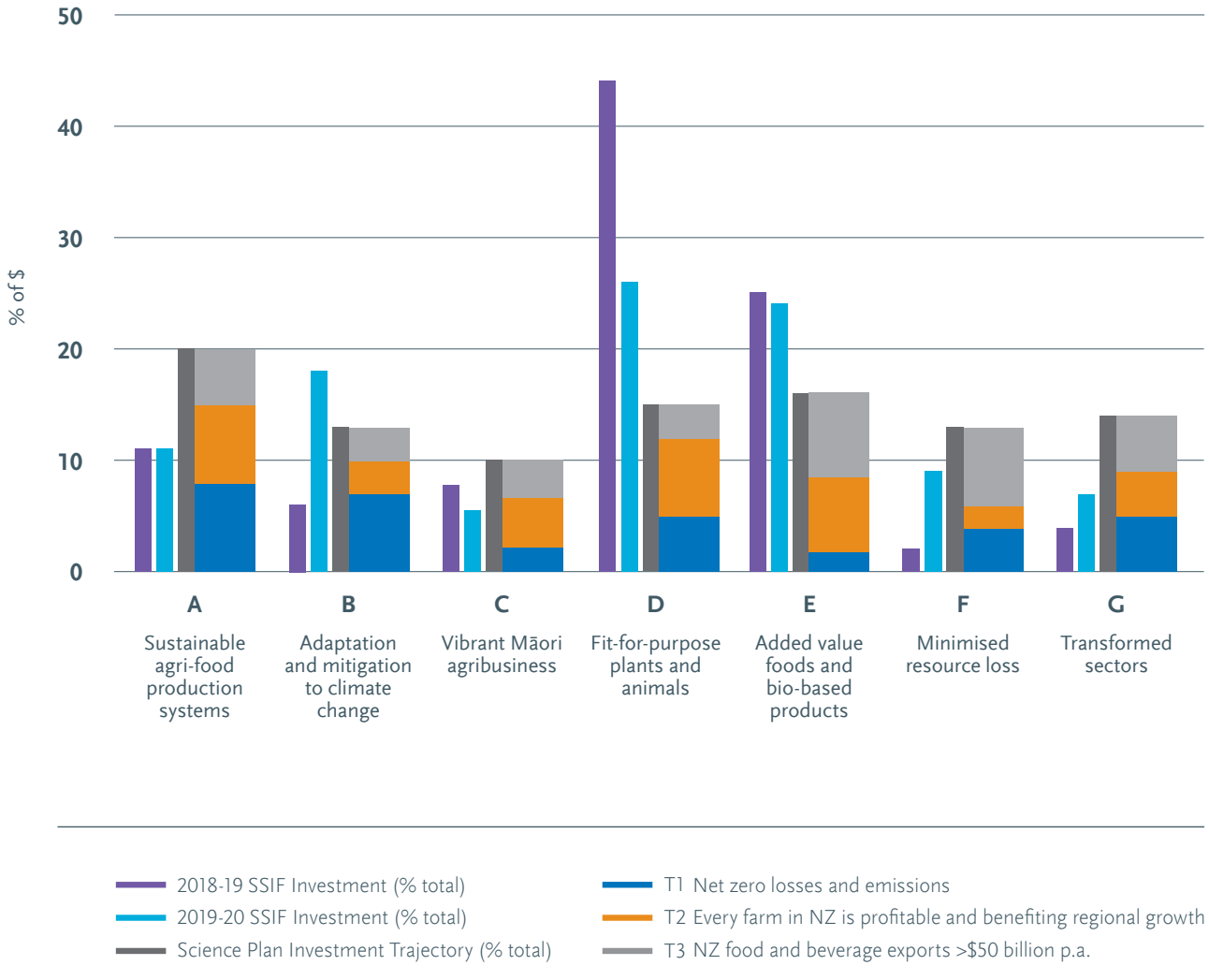
Seven highly interconnected Science Objectives guide the areas of activity required to deliver the Plan. Specific quantitative impact metrics have been developed for each of these Objectives.



Alignment of Science Objectives to Challenge Targets

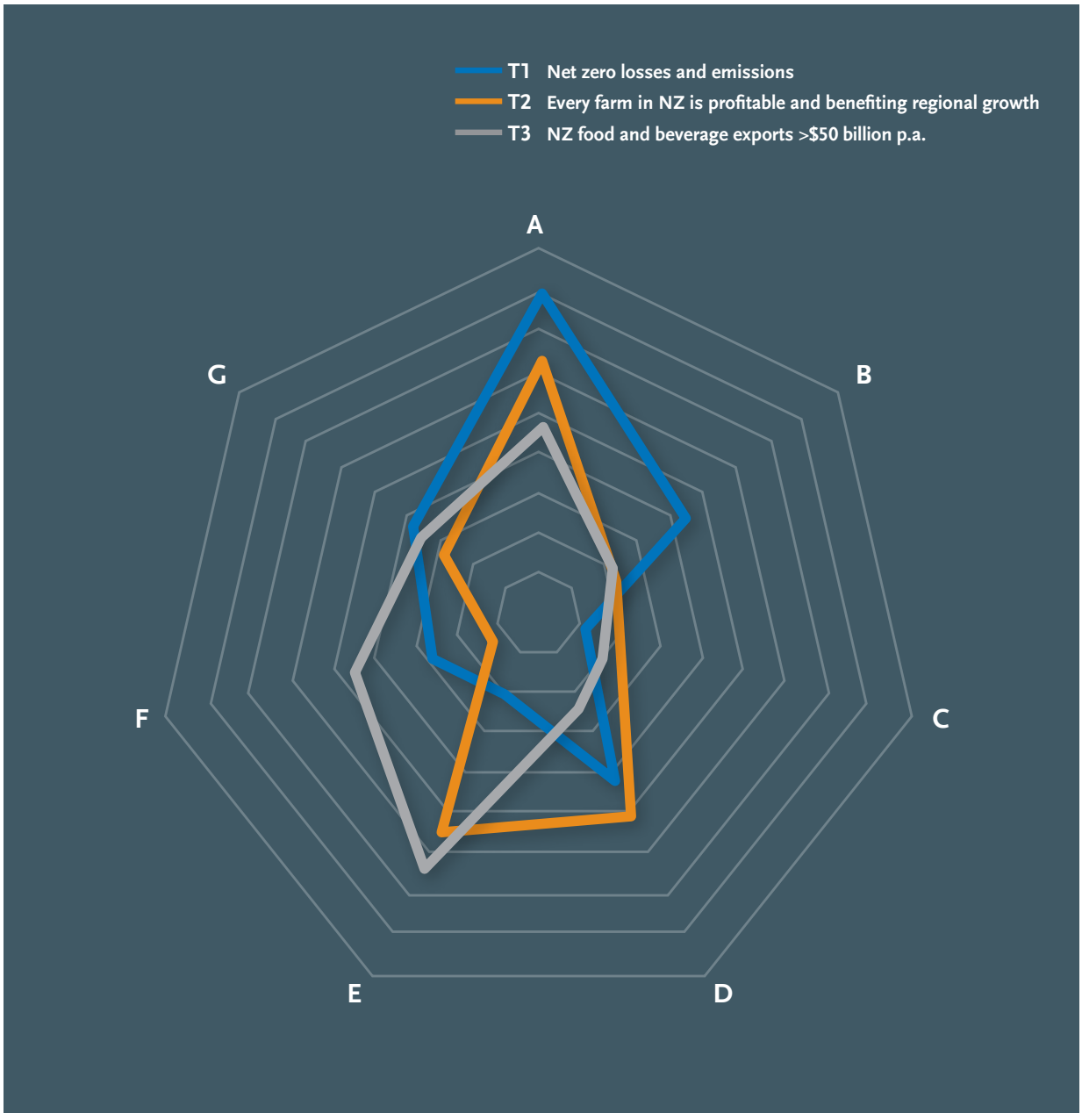
Strategic Investment Profile (below) – shows the relative trajectory and distribution of discretionary investment for our Challenge Target/Science Objective matrix.

- Strategic Science Investment Fund (SSIF) has been tactically realigned over the past two years as our investment priorities have changed or new funding streams replaced discretionary investment
- Investment strategy is seeking to provide a more balanced portfolio across our Science Objectives
- The contribution of each Science Objective to the Challenge Targets reflects their impact on the mega-trends
- We will continue to adjust investment trajectories as future foresighting and market drivers influence our science strategy



Relative contribution of Science Objectives to Challenge Targets.

The following radar diagram demonstrates that all Science Objectives play some role in the delivery of our Challenge Targets and emphasises the relative importance of each of the Objectives to the Challenge Targets.



Impact Measures and Key Performance Indicators

A) Sustainable agri-food production systems

We will improve the performance of our land (whenua) and our water (awa) quality in response to land use choices and our management decisions to deliver equitable and balanced economic, social, cultural and environmental outcomes by:

- Designing diversified landscapes and enterprises that support regional economies while operating within natural resource limits;
- Reducing environmental footprints at both farm and catchment scale;
- Maximising the biological and economic efficiency of farm systems; and
- Enhancing natural capital stocks and flows.

Impact measures

- Year-on-year improvements in monitored water quality and air emissions (2020 baseline) can be attributed to implementation of new land use/on-farm innovations at farm or catchment scales by 2030.
- 25% increase in inflation-adjusted value (2020 baseline) to the land-owner through on-farm gains in biological, environmental and economic resource efficiency and diversification by 2030.

AgResearch contribution

- **KPI:** AgResearch Smart Sensor Networks and Augmented Reality Decision Support Tools are being actively trialled at 10 representative on-farm and/or catchment-scale locations across New Zealand by 2022.
- **KPI:** At least 3 full-scale AgResearch solutions are being used to deliver farm and catchment sustainability improvements at double the regional average by 2025.
- **KPI:** AgResearch has actively leveraged 3 trans-sectoral initiatives (OLW NSC, NZAGGRC, PGGRC) to ensure productivity imperatives are appropriately balanced against environmental and social license attributes by 2025.

B) Climate change adaptation and mitigation

We will adapt to and mitigate the effects of climate change while enhancing biosecurity by:

- Reducing methane and nitrous oxide emissions from pastoral systems;
- Designing low carbon-emitting and high-carbon sequestration systems;
- Developing adaptive animal breeds, forage cultivars and farm systems;
- Developing strategies and tools to prevent incursions and manage pests and diseases, including next-generation biocontrol agents; and
- Building farm system resilience to extreme weather events.

Impact measures

- NZ has adopted a science-based framework against which farm system methane/nitrous oxide mitigation options are assessed to ensure that they are effective in reducing emissions, protect New Zealand's competitive position, and have no unintended consequences by 2025.
- Automated and targeted pest and disease incursion alerts and response solutions are available to all participants across the NZ biosecurity system by 2030.

AgResearch contribution

- **KPI:** At least 1 high-throughput measurement technology developed to accurately measure cattle methane emissions in a pastoral system by 2022.
- **KPI:** At least 1 methane and 1 nitrous oxide mitigation platform developed by AgResearch have been taken to commercial scale and deployed in the NZ sector by 2025.
- **KPI:** Novel pest management strategies and technologies are developed that are effective in reducing management costs by >50% (2020 baseline) for at least one animal and one plant disease and are adaptable to future threats by 2025.

C) Vibrant Māori agribusiness

We will enable vibrant Māori agribusinesses, unlocking the unique characteristics, mātauranga and values of Te Ao Māori by:

- Designing holistic land use configurations centred on kaitiakitanga principles;
- Networking Māori properties and value webs built on aligned kaupapa; and
- Developing product attributes and business models that reflect Te Ao Māori.

Impact measures

- Māori primary production systems are enabled to express tino rangatiratanga and increase value toward social, environmental, cultural and economic (SECE) goals by 20% over 2020 baseline evaluation levels by 2025.
- Provenance mātauranga is embedded as added value in all products derived from Māori agribusinesses, where relevant to tangata whenua goals, by 2030.

AgResearch contribution

- **KPI:** AgResearch has co-created (with Māori stakeholders) and implemented an engagement framework for researchers to align science with Māori agribusiness by 2020.
- **KPI:** SECE scorecards and baseline measurements established for 10 existing Māori agribusiness partners by 2022.
- **KPI:** Two successful examples of Māori agribusiness partners using AgResearch-supported provenance measures that underpin Māori product value chains (one local and one global) by 2025.

D) Fit-for-purpose plants and animals

We will develop forages and animals with the attributes that meet the requirements of future diverse production systems and value webs by:

- Matching animals and forages for minimised environmental impact and maximised product value; and
- Developing world-leading animal health and welfare systems.

Impact measures

- Best practice in health and welfare for NZ farm animals is fully validated through evidence-based measurements and accredited protocols by 2030.
- Genomic tools and associated technologies double the rates of genetic gain in productivity and environmental performance for forages and livestock by 2030.
- New technologies and management practices reduce agricultural chemical use by 25% by 2030.

AgResearch contribution

- **KPI:** A set of measurable indicators to determine the well-being of the animal is developed in conjunction with industry and embedded across AgResearch's research programmes by 2022.
- **KPI:** Development and scale-up of 3 state-of-the-art technologies that have been designed to accelerate adoption of genomic selection by industry by 2025.
- **KPI:** Development and field validation within New Zealand of 3 multiple end-point technologies that concurrently decrease auditable environmental impact and target value-add productivity gains by 2025.

E) Added value foods and bio-based products

We will create safe food and bio-based products with optimised nutritional, sensory and performance attributes, capturing value through provenance and credible consumer health and wellbeing effects by:

- Ensuring full food safety, traceability and validated provenance;
- Taking a consumer-centric approach to differentiating New Zealand raw materials and whole foods;
- Scientific evaluation of the effect of functional foods and ingredients on consumer health and wellbeing;
- Developing non-invasive food and bio-product evaluation tools;
- Using systems biology approaches for predictive control of food and bio-based product properties from pasture to plate; and
- Understanding global consumer trends and markets.

Impact measures

- Health claim evidence dossiers generated in support of 2 new NZ functional foods are delivered with >25% reduction in assessment and approval times by 2030.
- New Zealand has moved up seven places from our 2018 position (16th place to 9th place) in consumer confidence studies for food safety and quality by 2030.
- Optimised food and bio-product production and logistic chains for zero rejection, downgrading or disposal of surplus food products by 2030.

AgResearch contribution

- **KPI:** A validated integrated meta-omics pipeline for ingredient screening has selected at least 5 NZ-based candidate ingredients for functional foods and processes by 2023.
- **KPI:** AgResearch has developed competencies in three aspects of consumer-centric research that drive differentiation of at least 3 NZ raw materials and whole/processed foods by 2025.
- **KPI:** Developed at least 5 enabling technologies for shelf-life extension, smart packaging, and new uses for downgraded surplus foods and bio-products by 2027.

F) Minimised resource loss

We will maximise value and minimise waste from whole of resource across production to consumption by:

- Using "circular bio-economy concepts" to reduce waste and optimise energy and water usage efficiency from agri-food production; and
- Developing new technologies to unlock the inherent biological value in secondary food and bio-based product processing streams.

Impact measures

- 50% increase in value (2020 baseline) extracted from biological material in NZ agri-food secondary processing streams by 2030.
- NZ agri-product production energy, carbon and water footprints reduced 50% from 2020 levels by 2030.
- NZ agri-foods sector has adopted an accredited circular bioeconomy framework that adheres to global best practice by 2025.

AgResearch contribution

- **KPI:** At least 2 products taken to pilot scale that increase value from target secondary processing streams five-fold by 2025.
- **KPI:** Two agri-industry value chains adopted decision support tools that benchmark current energy, carbon and water footprints and are being used to inform development of solutions generating 25% use reductions (2020 baseline) by 2025.
- **KPI:** At least three transition pathways to a circular bio-economy designed and documented with identified international co-development partners by 2022.

G) Transformed sectors

We will provide the underpinning science evidence to support the transformational agenda of the agri-food sector and aid transition to new agri-food systems that enhance to societal and environmental conditions by:

- Developing knowledge and technical capabilities that either disrupt existing competencies and technologies or complement them, to produce in new combinations;
- Developing new tools, processes and systems to enable implementation of effective practice and behaviour change;
- Designing interventions with policy and practice to support society-accepted transition pathways and transformation; and
- Developing improved practice for monitoring and evaluation of impact within complex systems.

Impact measures

- At least six examples of actions to address critical barriers to transforming the agri-products sector implemented by participants from government, industry and/or civil society by 2025.
- Repeat analyses (every 4 years) of the current state of the agri-products sector shows increased prevalence of production systems and supply chains that involve diversified land use, new ways of doing business, and new ways of adding value to products by 2030.
- Biannual surveys demonstrate an increased awareness in the NZ public of what NZ farming transformation means to them by 2025.

AgResearch contribution

- **KPI:** AgResearch is working with 5 new stakeholder groups in non-traditional focus areas to develop and implement new ways of progressing sector transformation by 2022.
- **KPI:** AgResearch is leading a globally-recognised integrative initiative that has increased by 50% (2020 baseline) the proportion of NZ research informing and supporting the agri-sector's social licence to operate by 2022.
- **KPI:** An agri-sector education outreach program has directly engaged with 15% of NZ schools by 2025.

Leveraging capacity through Platforms

AgResearch is seeking smart ways to accelerate the pace of its research.

New and emerging research tools, such as visualisation, non-invasive sensing, deep phenotyping, machine learning/artificial intelligence, and convergent design, must be harnessed to underpin genuine systems-based research and the drive towards hyper-transparency and full predictive control. To this end, the organisation will continue to strengthen use of our transformational Enabling Platforms to drive delivery across all Science Objectives.

KPI: Infrastructural investment and recruitment strategies will allow 3 cross-organisational Enabling Platforms to be operationalised by 2020.

Definition of an Enabling Platform

Enabling Platforms incorporate the following critical attributes:

- A way of thinking, involving an appropriately resourced network of people, with multiple, cross-cutting capabilities that enable internal and external collaboration and integration.
- Capabilities beyond simply science, including thought leadership, methodologies/technologies development, integrative behaviour and oversight.
- Active coordination of infrastructure and systems procurement both within the organisation and with external partners/stakeholders to support a synergistic Community of Practice in strategically-critical areas.
- Readily scalable to be mission-led and will be deployed to solve current and future problems outside of the traditional project-level structures of the organisation.

Application of Platforms across AgResearch is expected to lead to the faster generation of knowledge, with greater insights and impact than could be generated by the individual components/nodes.

Examples of potential platforms

1. Digital Agriculture Platform

Research communities have developed databases, analysis tools, email, wikis and ontologies, along with faster computing, to advance research capability and collaboration. However, typically, these tools are distinct and disconnected, fragmenting research content across multiple separate applications.

AgResearch's eResearch-based Digital Agriculture platform will interface cyber-technologies with biological systems across supply chains to enable hyper-transparency. Such a platform will enable the integration of the research process in systems-based science, making it significantly more effective.

The platform will encompass capabilities that interface biological systems with physical and cyber-physical systems such as: distributed sensory networks; Internet of Things (IoT); sensing technologies; automation; robotics; electronics; embedded systems; Blockchain and emerging technologies.

This interfacing will involve skills internal and external to AgResearch on signal processing, computer vision, artificial intelligence, engineering (software, mechanical, process), product design and prototyping.

A set of criteria have been identified to ensure investment in eResearch infrastructure – via a High-Performance Computing (HPC) facility – will meet the requirements and strategies for integrated digital platforms at AgResearch.

2. Systems Biology Platform

Traditionally, biological research has been based around component analysis, constraining as many variables as possible to explore the relationship of limited factors. It is now increasingly understood that biological systems are highly complex and interconnected, and unable to be simplified down to limited variables as per traditional approaches (e.g. food-microbiome-host interactions).

To fully understand both the mechanisms and inter-relationships that will underpin future transformative science breakthroughs and create global impacts, systems biology-based research is critical.

Our Systems Biology platform will connect to all areas of our Science Plan, and involve the simultaneous measurement of multiple biological system components, bringing genomic, transcriptomic, proteomic, metabolomic, metagenomic etc. data together. A strong underpinning bioinformatics capability is required for integration and interpretation. The high levels of data generated will require efficient data infrastructure and the use of computational tools, such as machine learning and related analysis techniques, to pull as much meaning from the data as possible. This makes a Systems Biology platform highly complementary to the Digital Agriculture platform.

1. Responsible Innovation Platform

There is increasing societal and consumer concern regarding negative and unintended socio-ethical, environmental and cultural consequences from science and technology, particularly applied to food and its production. In response, societal groups have been calling for increased participation in what science is done, how new technologies develop, and creation of future food systems.

This platform will draw on existing Māori frameworks for "responsible innovation" as well as Responsible Research and Innovation to enable consideration of cultural and socio-ethical implications of research areas, and the inclusion of these implications in the design of future food systems. This will ensure AgResearch research incorporates:

1. Anticipation – by providing thought leadership on scenarios for future food systems that our science enables
2. Inclusion – by identifying societal concerns that our science needs to be cognisant of, e.g. by taking a consumer-centric focus and seeking to deliver to United Nations Sustainable Development Goals
3. Reflexivity – by assessing cultural/socio-ethical assumptions underpinning our science
4. Responsiveness – by changing the direction of our science considering emerging knowledge of potential implications and societal expectations now and in the future.

Applying this Responsible Research and Innovation framework of anticipation-inclusion-reflexivity-responsiveness to our research will ensure AgResearch develops technologies and food production systems that are not only technically feasible, but culturally and socially acceptable, and therefore deliver benefits to all New Zealanders.

Accelerating impact via integration

At the heart of our revitalised Science Plan is a strongly systems-based approach to science.

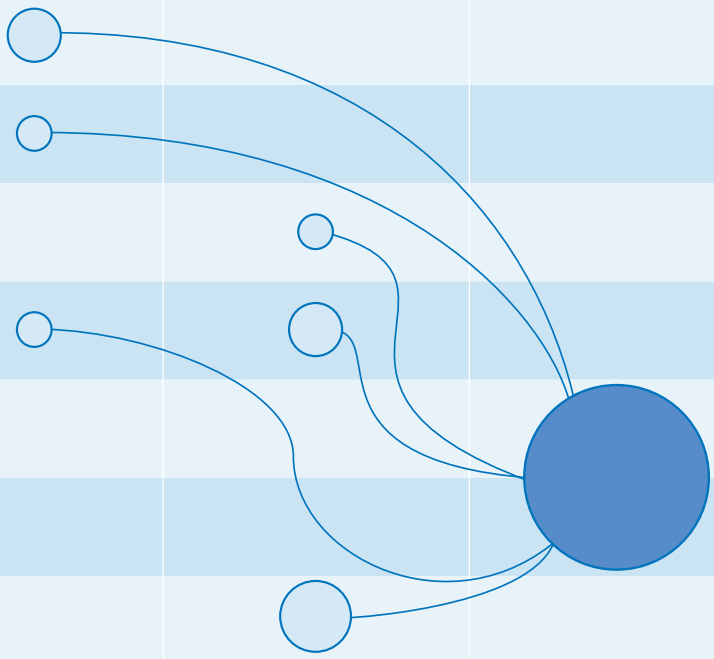
Achieving this vision requires creating genuine and significant integrative programmes of work. These will bring together multiple disciplines and approaches whilst working across Science Objectives to contribute within and between Challenge Targets.

Conceptualised below, these "jellyfish" initiatives will be designed dynamically, able to transition nimbly into new areas of endeavour, and bring together critical, symbiotic elements of our Innovation Pipeline. As such, a broad range of projects will be delivered under a singular and co-ordinated strategic framework and will attract significant integrated investment from both Government and commercial sources (typically $5-10m per year in magnitude).

These programmes will derive from, and be supported directly by, our Enabling Platforms.

Primary focus Secondary contributors Relative investment

Challenge Targets	Net zero losses and emissions	Every farm in NZ is profitable and benefiting national growth	NZ food and beverage exports >$50billion p.a.
Objectives	Relative contribution	Relative contribution	Relative contribution
A. Sustainable agri-food production systems			
B. Climate change adaptation and mitigation			
C. Vibrant Māori agribusiness			
D. Fit-for-purpose plants and animals			
E. Added value foods and bio-based products			
F. Minimised resource loss			
G. Transformed sectors			



Integrated initiative exemplars

1. NZ Bioeconomy in the Digital Age

This programme seeks to harness the emerging power of digital technologies to enable the transformation of New Zealand food systems. It focuses on establishing proof-of-concept to help transition our existing pastoral sector to an agile, adaptive and sustainable "bioeconomy" future, involving emerging aligned and new sectors.

We here test the hypothesis that digital technologies are vastly more effective in addressing difficult problems than reductionist approaches. This initiative will contribute to delivery of transformed landscapes, food and rural enterprises, and value webs, and therefore will contribute to addressing multiple goals across our Science Plan. To truly test this hypothesis, this programme harnesses capability from across the organisation and beyond and has as a key and critical feature the integration of traditional biological sciences (pre- and post-farmgate) with emerging digital and computational technologies.

This programme directly derives from and is supported by our Digital Technologies Enabling Platform, requiring strong capability links to both the "soft" data evaluation/integration and machine learning areas, as well as in the "hard" sensors, robotics and automation areas.

2. Biome to Biome

Advances in knowledge over the last decade or so have highlighted the critical importance of microbiomes that work alongside and in conjunction with other biological systems right across the food production system from soil to plant to animal to consumer. Understanding how these microbiomes influence and affect each other, as well as how changes in their composition can be used to influence and control production and product attributes, represent key knowledge frontiers in agri-food science.

We here look to link and integrate our considerable application-specific microbiome capability across the organisation – soil microbiology, plant microbiology, rumen microbiology, food safety/assurance microbiology, and human gut microbiology – to create for the first time systems understanding of interconnections and key potential points of intervention. This is an ambitious goal, with initial work focused on collection and integration of shared data.

This programme will be directly supported by our Systems Biology Enabling Platform, requiring integration of meta-genomic, proteomic and metabolomic data streams from across the food production system, together with robust bioinformatic interrogation.

3. Pastoral biorefinery

Drivers towards more effective utilisation of our on-farm feedstocks – coupled with sustainability demands and value-add imperatives – will create opportunities to build integrated biological ecosystems that link to industrial symbiosis-based value chains targeting optimal recovery and processing of all material and energy outputs from pastoral systems.

Diversification of our pastoral landscapes (including through NZBIDA outcomes) will see mosaic farming systems producing a range of targeted biomass outputs. Systems biology will be used to design forage materials with readily differentiated and extracted protein, carbohydrate and structural constituents that can be directed to low-GHG animal production systems, industrial biotechnology platforms (sourced from our unique microbiomes) for bio-based chemical production, bioenergy platforms, or advanced engineering of functional biomaterials based on biomimetic concepts.

We will leverage our capabilities in our Digital Agriculture, Systems Biology and Responsible Innovation Enabling Platforms to attract national (e.g. BPA, BPN) and international partnerships in the feedstock production, biorefinery and industrial biotechnology space. Adherence to the globally-emergent principles of the circular bioeconomy and identifying unique NZ differentiators (including those emerging from our Maori agri-business KPIs) will be critical elements in the success of this initiative.

Partnership Framework

Partnerships will play a pivotal role in achieving impact from our Science Plan.

In choosing our partners – both collaborators and stakeholders – we will actively consider the need to:

- identify **shared values and a common vision** that builds engagement, trust, clarity of expectations and understanding of each partner's key strengths;
- **create shared value** through adopting principles of co-design and co-innovation, shared risks and responsibilities, and building interdependence;
- **move from a transactional relationship to a transformational relationship** defining success beyond financial to embrace sustained economic, environmental, social and cultural outcomes.

This framing works alongside the associated principles that will guide development of our research-to-research collaborations:

- Access to capability to deliver to the Science Plan
- Increased science vitality through post-doctorates and post-graduates
- Increased generation and recognition of science excellence
- Access to data and infrastructure
- Global science citizenship
- Access to networks and stakeholders
- Opportunity for extended learning
- Exploit the benefits of Open Innovation methodologies
- Opportunity to source non-traditional investment

We will use this information to evaluate our current partnerships as fit-for-purpose to deliver to the Science Plan.

KPI: AgResearch reviews its portfolio of current international collaborations and identifies and consolidates partnerships with up to 6 current and new priority organisations aligned with Challenge Targets by 2020.

KPI: Co-authored publications with collaborators will increase by 20% over 2019 levels.

1. International Science Collaborations

We currently have international organisation-to-organisation formal collaborations with:

CSIRO (Australia), Teagasc (Ireland), Scottish Rural College, U C Davis, CAAS/CAS (China), INIA (Uruguay), and IRTA (Spain). We have a vibrant cohort of 11 PhD students who are jointly funded by AgResearch and Teagasc or SRUC.

We have over 250 scientist-to-scientist international collaborations logged within a data base.

Currently we are exploring opportunities to collaborate with Wageningen University (Netherlands; digital agriculture, circular bio-economy, protein transition). We will also take advantage of Science New Zealand's cross-CRI collaborations e.g. INRA (France; meat quality, whole of value chain, multi-functional landscapes and digital agriculture). Other initiatives that we will explore include the Internet of Food and Farming (IoF2020) funded by the EU Commission.

2. National Science Collaborations

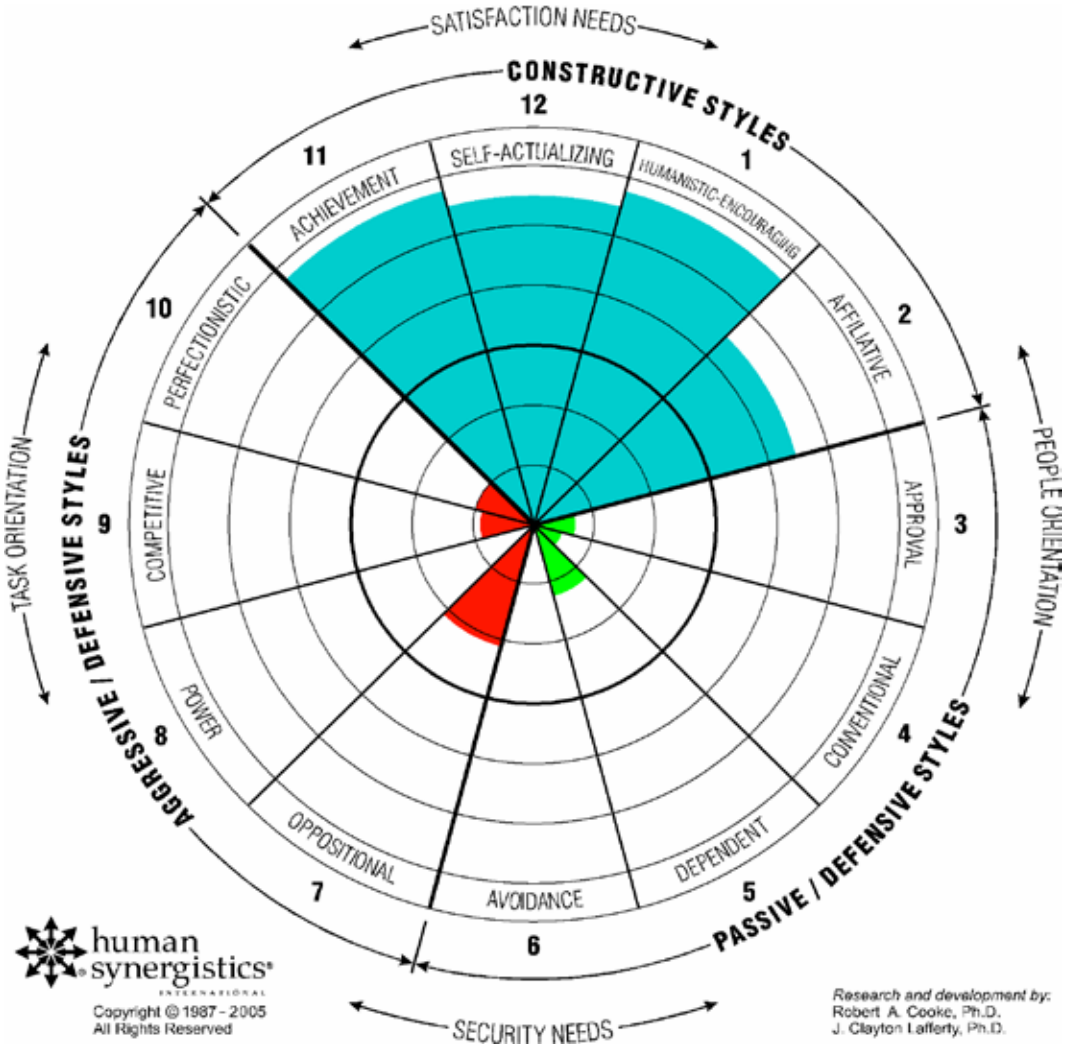
In alignment with our three Challenge Targets, we have strong enduring relationships with National Science Challenges and will be a significant contributor to their goals:

- We host Our Land and Water and there is strong alignment between AgResearch's Science Plan and OLW's strategy with associated aligned SSIF-funded research programmes where we will share case studies when appropriate.
- There is strong alignment between Better Border Biosecurity (B3) – a long-standing cross CRI/MPI initiative – and the Biological Heritage NSC.
- Our food science capability is a major contributor to the High Value Nutrition NSC.
- AgResearch also hosts the New Zealand Agriculture Greenhouse Gas Centre and our rumen, soil science and farm system capabilities contribute to mitigation of methane and nitrous oxide from livestock systems.
- We are a partner in the New Zealand Food Safety Science & Research Centre and Food HQ.

AgResearch collaborates with other CRIs and Universities to access and build capability in Mātauranga Māori. We are currently involved in projects with Otago University and Manaaki Whenua as well as building capability in the relevance of science to Māori entities through six projects partially funded by SSIF.

Culture of Innovation Excellence

Successful implementation of the Science Plan requires us to develop new collaborations and transdisciplinary teams and partnerships outside of traditional internal and external networks. Diversifying in this way also requires a fresh look at our culture and ensuring that the behaviours that underpin Our Values are demonstrated.



Using our 2017 Organisational Cultural Inventory (OCI) results, we have identified that AgResearch's desired culture is highly constructive and collaborative. These cultural characteristics are reinforced in the Science Plan. In this type of culture, leaders encourage and motivate others to approach their work in ways that help them to individually meet their needs for growth and satisfaction; employees are empowered to make decisions and are willing to take on challenging tasks. High levels of trust exist within this type of organisation.

1. Culture Levers

Seven "culture levers" will underpin the drivers towards a Culture of Innovation Excellence:

Effective Leadership
- Frequent discussion about our Vision and the Science Plan to ensure clarity and accountability
- Greater openness and transparency: share the challenges and celebrate the successes
- Champion integrative approaches and transdisciplinary teams
- Develop our people to enable them to thrive as leaders at multiple levels

Attitudes & Behaviours
- Allow and support more time for thinking, creativity and innovation
- Address 'below the line' behaviours without delay
- Empower our people to make decisions, take risks, and learn from mistakes
- Acknowledge and provide feedback on what is done well

Removing Silos
- Take the time to ensure understanding of integrative approaches
- Involve the right people from the start - no matter what team they are in
- Openly share information and knowledge across all parts of the organisation
- Adopt and build new enabling platforms

Resources
- Empower and enable our people to develop in different areas
- Identify and grow the right technical and soft skills
- Adopt an agile approach to the use of technology
- Continue to develop a 'growth mindset' in our people which fosters curiosity

Structure & Roles
- Encourage integrative ways of thinking in all roles
- Build or recruit for integrative coaching skills
- Be clear about what positions have an integrative component
- Trust people to make the right decisions

Project Design
- Recognise project management as requiring a specialised skill set
- Introduce greater diversity of thinking across teams
- Understand that everyone does not have to be a project manager
- Build on best practice and continuous improvement

Funding
- Ensure greater transparency around funding decisions
- Develop key people to be effective influencers and negotiators
- Explore how to stop the 'end-of-year rush'
- Simplify funding application processes

2. Facilitating Whole Person Leadership

To achieve our vision for the future, an aligned One AgResearch culture will provide the environment to deliver high levels of sustained performance. Whole Person Leadership (WPL) has been identified as a key enabler to embed this culture and a framework and strategy has been developed and will be actively implemented to achieve this.

From a Science Plan perspective, this will entail looking for ways to broaden options for all staff – both Science and non-Science - at all levels of the organisation to have the ability, capacity and opportunity to take leadership roles in the creation, development and delivery of science outcomes for AgResearch.

3. Capability and Capacity Mapping

During FY2020, a capability and capacity mapping methodology (including status, risk analysis and trajectory) will be defined across the Science Teams and infrastructure. This mapping process will:
- Cover science disciplines, technical specialties/ proficiencies and soft skill sets
- Identify existing gaps and priorities for future recruitment/procurement
- Identify succession challenges in priority spaces
- Identify key in-house differentiators to foster and sustain strategic partnerships
- Define attraction and retention strategies for talent who possess these capabilities

We have determined our baseline capability (i.e. where we are currently world class, nationally leading, or have new capability requirements):

Capabilities – Current View

World-class
- Forage genetics and genomics for economic and environmental performance
- Forage germplasm resources
- Endophytes
- Animal genomics for GHG emissions and productivity efficiency
- Rumen microbiology for mitigation of methane
- Environmental (water quality, GHG emissions) mitigation for grazed farm systems
- Fibre science
- Gut health/gut microbiomes
- Meat quality science
- Redox proteomics and protein chemistry

Nationally-important AgResearch lead

- Biological weed and pest controls in pasture-based systems
- Grazed Farm systems for economic, environmental, cultural and social outcomes
- Reducing GHG emissions from ruminants
- Plant and animal biosecurity management
- Animal health and welfare
- Sustainable nutrition from ruminant-based food systems
- Food safety, traceability and validated provenance
- Combination foods
- Proteomics and metabolomics
- Specialty dairy
- Maximising value-add products throughout the value web
- Agriculture Innovation Systems
- Bio-based products from agriculture
- On-farm decision making
- Genetic modification of plants
- Social science in innovation systems

New capability required by AgResearch

- Data science
- Mātauranga Māori science
- Digitalisation of complex systems
- Spatial and visual landscape science
- Value chain/web economics
- Augmented systems biology
- Sustainability transitions research
- Predictive modelling across and through agri-food systems and value chains

4. Measuring the Vitality of our Science Culture

We will measure progress towards our desired culture through use of a set of Science Vitality Measures that have been defined around AgResearch's Core Values:

Core Value	Science Vitality Measure	FY20 Indicators
Professionalism – Whakarangatira	Leadership	• Improvement of 'I have confidence in the senior leadership of AgResearch' to 50% (from 45%) • Improvement of 'There is a sense of common purpose in AgResearch' to 50% (from 46%)

	Thought leadership	• 15 Development Modules delivered for:
		  • Science Leadership Team
		  • Science Team Leaders/Impact Leaders

	Emerging talent	• An identified emerging talent pool is targeted for development sessions designed and delivered in collaboration with other CRIs
	Employee turnover	• Voluntary employee turnover for science staff remains below 1.5% (currently 0.5 for scientists and 1.1 for technicians)
	Gender balance	• Approximate 50:50 gender balance in science roles

Core Value	Science Vitality Measure	FY20 Indicators
Collaboration – Mahitahi	Publications with collaborators (% total publications)	• Only AgResearch author: 14% • With other NZ authors: 39% • With international authors: 26% • With combination of NZ/international authors: 21%
	Commercial reports per FTE scientist	1
	External stakeholder engagement	• Stakeholder relationship measure "very good" or "better"satisfaction rating >60% • Dealing with us "preference to work" >60% • Contribution to stakeholder strategy "good or better" >90%
	Staff engagement	• Increase Engagement Index by 5 points to 70% (from 65%)
	Our Values	• Improvement on question: "I believe in AgResearch's values": Target 68%
	Collaboration with Māori	• Cultivate collaboration to support Māori agribusiness by co-developing funding proposals with stakeholders: Target 6
	Employee engagement with Health and Safety	• Employee engagement index of Health and Safety with AgResearch increases to >75% score
	Post-doctorate appointments	• At least 20 postdocs domiciled in AgResearch
	PhD students working in AgResearch	• At least 80 PhD students domiciled in AgResearch
Innovation – Ata Matai	External awards & Industry recognition	• At least 5 domestic or international awards or recognition
	Succession plans	• Succession plans in place for 50% of key people or critical roles
	Publications	• At least 1.8 peer reviewed publications per R5S scientist and above • At least 30% peer reviewed publications with Impact Factors >3.0
Quality – Matai Whetu	Emeritus status	• Emeritus status is granted to at least 1 retiring Principal Scientist
	High-potential talent pool	• At least 15 high-potential employees have development plans
	Health & Safety	• No notifiable injuries and less than 2 notifiable events
	Communications	• Maintain 90% (or greater) positive/neutral media coverage about AgResearch • Improvement of "Communication in AgResearch is open and honest" to 53% (from 49%)
	Taking action (Engagement Survey)	• 50% positive response to the "Taking Action" Engagement Survey items
	Customers	• 70% of customers rate their current relationship with AgResearch as good or better • At least 85% of surveyed stakeholders rate AgResearch's understanding/contribution to their strategy as good or better
Customer Focus – Matai	Vision Matauranga (VM)	• Recruit 3 Māori PhD students • At least 100 employees undertake VM/Cultural Competency/Noho Marae development • At least 20 Senior Science Staff undertake advanced Kaitiakitanga training

Symbiotic model for future transformation

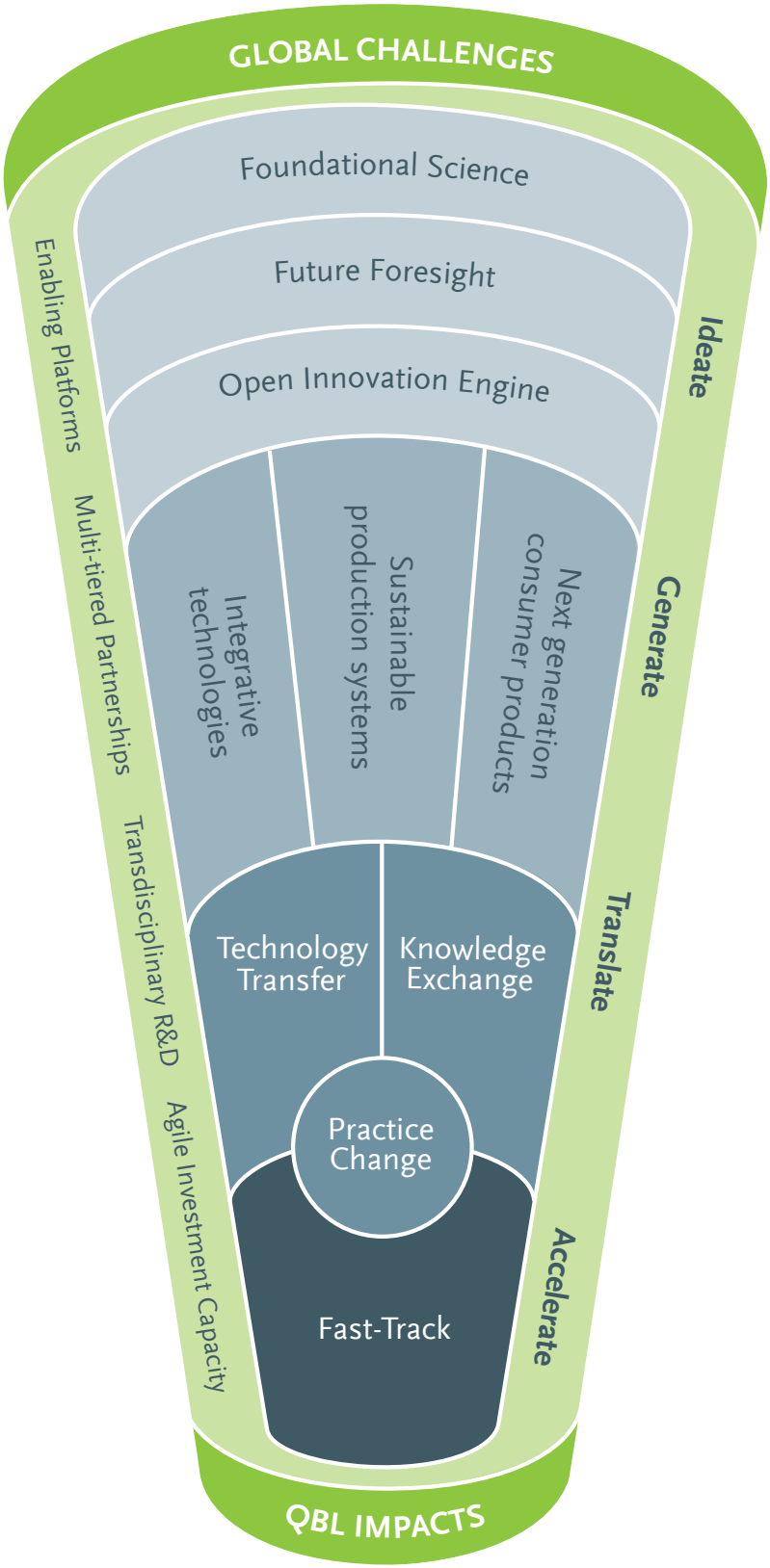
Our Science Plan articulates a highly integrated approach to translating key global challenges into transformational sector quadruple bottom line (QBL) impacts:

Ideate: Using our deep understanding of global, market and sector trends, design principles and analytics will leverage our strong science foundations into a high-potential innovation pipeline

Generate: The most impactful opportunities will be identified, prioritised and de-risked through effective use of our world-class science capability, partnerships and supporting platforms

Translate: Iterative engagement with our end-users and broader trans-sector players will ensure fit-for-purpose high-value solutions are co-developed and implemented across both traditional and non-traditional value chains

Accelerate: Co-investment of capacity, capability and capital will fast-track deployment of those pipeline outcomes that can cause the greatest positive disruption to our innovation ecosystem



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