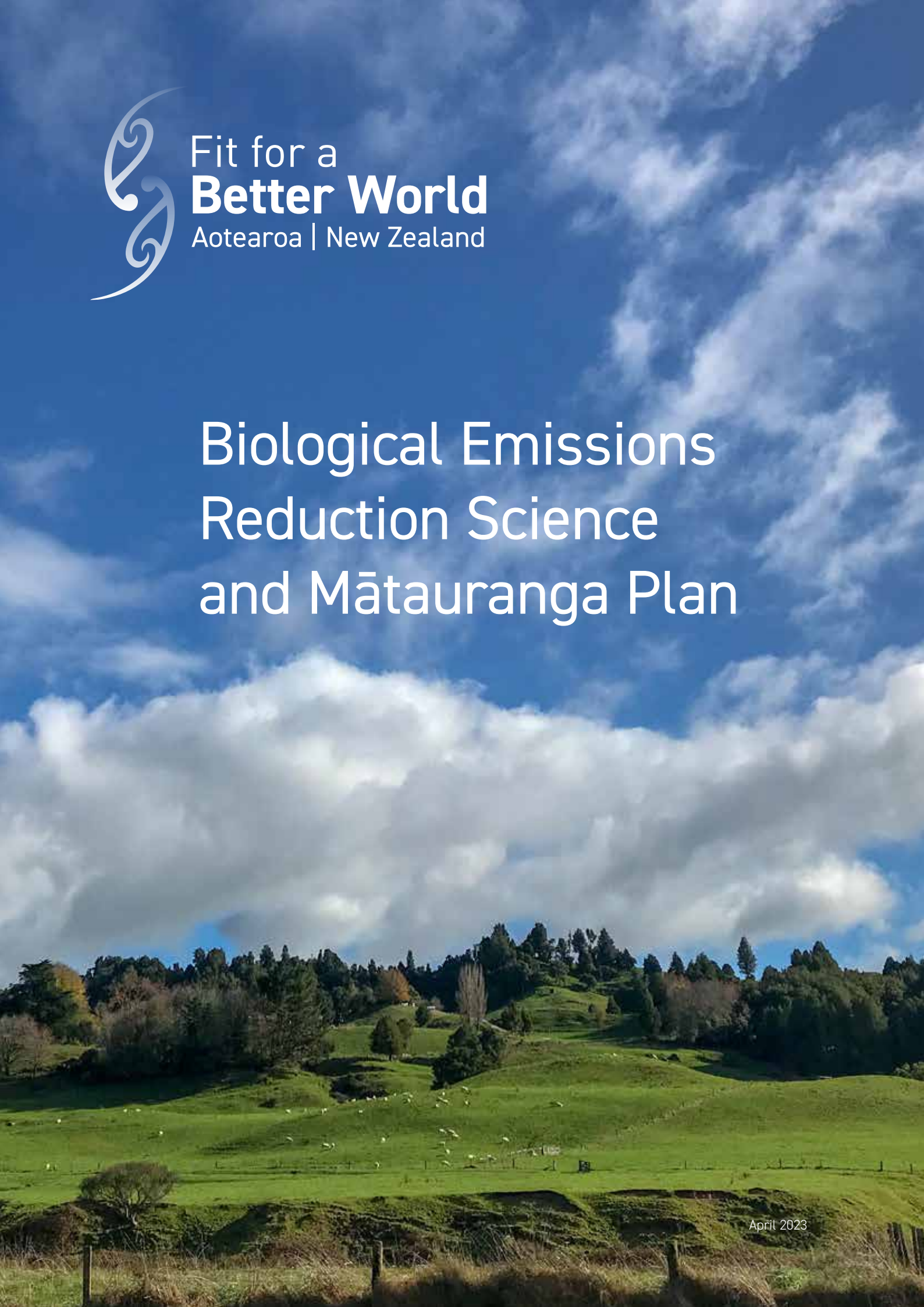
Fit for a
Better World
Aotearoa | New Zealand

Biological Emissions Reduction Science and Mātauranga Plan



April 2023



Ministry for Primary Industries
Manatū Ahu Matua

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Foreword

Aotearoa New Zealand needs to reduce its agricultural emissions to combat climate change and support the long-term health of our land and people.

Our predominantly pastoral farming systems provide an opportunity to lead and accelerate research and development (R&D) to ensure we have the right emissions mitigation options available to our farmers and support global efforts.

New technologies, approaches, built on robust science and mātauranga Māori-based R&D can help unlock significant emissions reductions both here and overseas.

The Biological Emissions Reduction Science and Mātauranga Plan (the Plan) is a R&D plan to help get new technologies and practices into farmers' hands sooner to reduce biological emissions from agriculture now and in the future.

This work has been developed from the perspectives and insights from industry, Māori, scientists, and government to meet both the Government's targets for reducing emissions and the increasing expectations from our customers and consumers for sustainable products.

The Plan complements the work of He Waka Eke Noa, the Primary Sector Climate Action Partnership, and a range of other climate change initiatives.

The development of the Plan was supported by a working group of industry, science, Māori, and government organisations. We acknowledge the Leadership Group from DairyNZ, Beef + Lamb New Zealand, Te Herenga Waka, AgResearch, Federation of Māori Authorities Me Uru Kahikatea, Māori advisors, and the Ministry for Primary Industries.

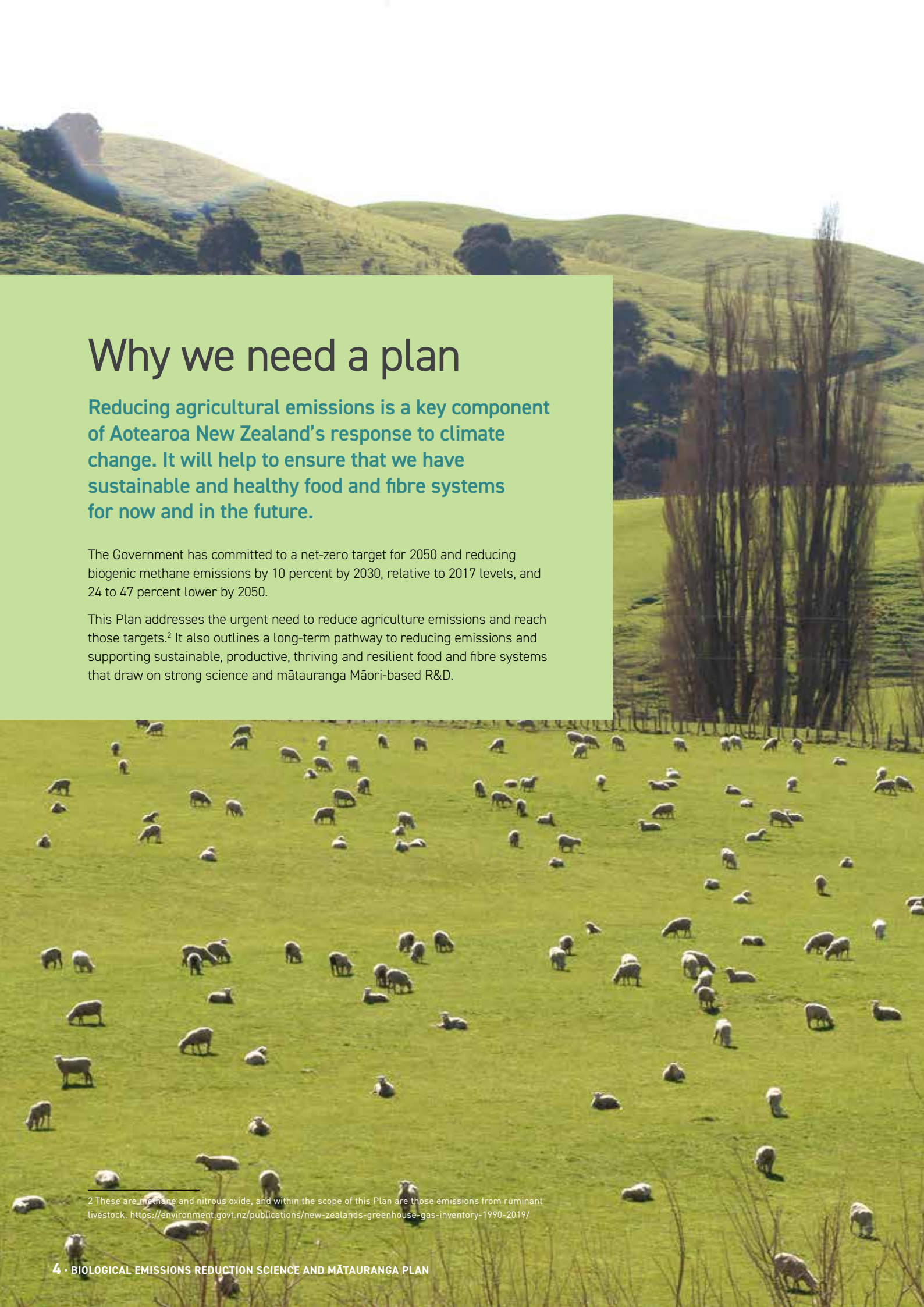
This work is both ambitious and exciting, and our expectation is that the Plan opens the way for ground-breaking solutions to reduce agricultural emissions.

Because we have much to learn in this space, the Plan will be a living document that will be updated as new knowledge, developments, and ground is broken over time.[1]

Leadership Group of the Biological Emission Reduction Science and Mātauranga Plan

- Tim Mackle (DairyNZ) – Chair
- Sam McIvor (Beef+Lamb New Zealand)
- Margaret Hyland (Te Herenga Waka – Victoria University of Wellington)
- Sue Bidrose (AgResearch)
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- Tanira Kingi (Kokiri Research Ltd)
- Te Horipo Karaitiana (FOMA)
- Steve Thompson (Observer)

1 The plan content has been approved by the Leadership Group by consensus, the publication of the plan was approved by majority.



Why we need a plan

Reducing agricultural emissions is a key component of Aotearoa New Zealand's response to climate change. It will help to ensure that we have sustainable and healthy food and fibre systems for now and in the future.

The Government has committed to a net-zero target for 2050 and reducing biogenic methane emissions by 10 percent by 2030, relative to 2017 levels, and 24 to 47 percent lower by 2050.

This Plan addresses the urgent need to reduce agriculture emissions and reach those targets.[2] It also outlines a long-term pathway to reducing emissions and supporting sustainable, productive, thriving and resilient food and fibre systems that draw on strong science and mātauranga Māori-based R&D.

2 These are methane and nitrous oxide, and within the scope of this Plan are those emissions from ruminant livestock. https://environment.govt.nz/publications/new-zealands-greenhouse-gas-inventory-1990-2019/

How this plan fits with other climate change work

The Plan has links to, and complements, a number of other pieces of work, including:

- Climate Change Response (Zero Carbon) Amendment Act 2019;
- *Fit for a Better World* (FFBW) – Accelerating our Economic Potential;
- He Waka Eke Noa, the Primary Sector Climate Action Partnership;
- Climate Change Commission Recommendations, Inaia Tonu Nei;
- Ngā Pouwhiro Taimatua (the Māori Primary Sector Forum);
- a cross-cutting Te Ao Māori accelerator programme;
- MBIE Te Ara Paerangi Future Pathways - Research, Science and Innovation System Reform; and
- current New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC), Pastoral Greenhouse Gas Research Consortium (PGGRC) & industry led greenhouse gas mitigation research programmes and strategies.

It was commissioned by the Food and Fibre Partnership Group and forms part of *Fit for a Better World*, a government and industry roadmap to 2030 seeking to build a more sustainable, productive and inclusive food and fibre sector. It has informed a number of actions in the Government's first Emissions Reduction Plan to accelerate new mitigations to address greenhouse gas emissions from agriculture. These include:

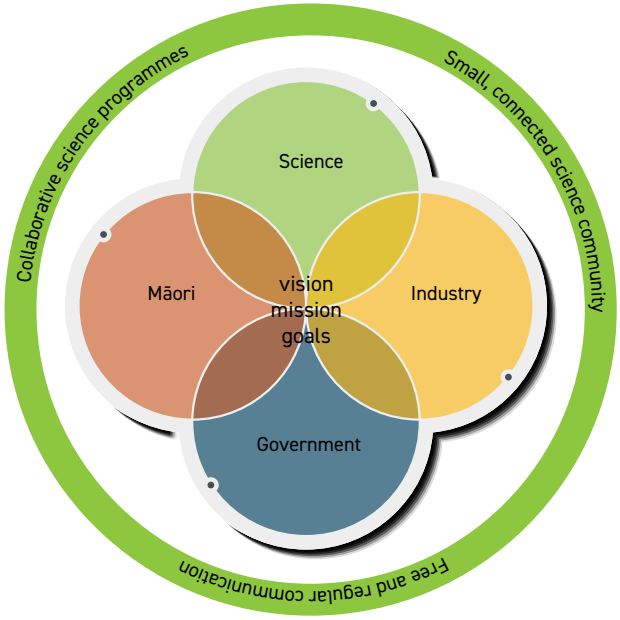
- strengthening the role of research and development to get mitigations to producers sooner;
- establishing a new Centre for Climate Action on Agricultural Emissions to drive a step change in research, development, and commercialisation of emissions reduction technologies;
- establishing and sustaining mātauranga Māori-based R&D approaches to emissions reductions from agriculture;
- supporting clear and effective regulatory pathways for agricultural mitigation tools; and
- leading and contributing to global agricultural climate change mitigation research.

Guided by the priorities of the Fit for a Better World programme, the Plan focuses on accelerating R&D for new emissions reductions technologies with a focus on reduction of methane and nitrous oxide emissions.

Other factors such as soil carbon, economic analysis of the mitigations and impacts on farm systems viability or social science systems analysis to understand barriers and motivations/incentives for adoption were out of scope for this specific Plan but are being explored and advanced through relation initiatives and programmes of work.

A partnership between government, industry, Māori, and science was established and a working and leadership group developed the Plan (Figure 1). Participants included representatives from the Ministry for Primary Industries, the Ministry of Business, Innovation and Employment, AgResearch, the New Zealand Agriculture Greenhouse Gas Research Centre, the Pastoral Greenhouse Gas Research Consortium, DairyNZ, Beef + Lamb NZ, Fonterra, Māori organisations and Universities.

Figure 1. Partnership between Government, industry, Māori, and Science



Vision

Healthy, resilient, and abundant land, air, and water, that nourishes and supports the wellbeing and prosperity of our land and people, sustained by a relationship of respect and reciprocity with the natural world and the growth of ideas and knowledge for the benefit of generations to come.

Values

Whakapono – We seek and honour the diverse perspectives, knowledge, and experience of science and mātauranga.

Whakapapa – We value and build on the mahi of those before us and contribute our knowledge and understanding to support the needs and aspirations of future generations.

Mana motuhake – We work together to achieve our shared aspirations, while respecting the autonomy, authority, independence and identity of our partners.

Objectives

In the near term, the objectives of the Plan are to:

- meet the urgent need to reduce biological emissions by accelerating adoptable mitigation solutions for all farmers;
- develop integrated or 'whole of whenua' system-level approaches to lowering biological emissions that improve the sustainability of land-based food production;
- understand and respond directly to the needs and aspirations of Māori agribusiness and landowners, iwi and hapū and ensure they are resourced and supported;
- strengthen the system required to support the acceleration of adoptable mitigation solutions.

The key strategic objectives of the Plan are to:

- establish an integrated approach for biological emissions reduction that recognises the connection between the health of our land and the health and resilience of our communities, waterways, biodiversity, and climate;
- support a combination of science and mātauranga knowledge so that the wisdom and understanding of both systems helps establish a specifically unique New Zealand response to emissions reductions;
- build inter-connected R&D approach that leads towards inter-related, holistic, and comprehensive research strategies;
- contribute to intergenerational prosperity and wellbeing in Aotearoa New Zealand and position us at the forefront of sustainable land-based food production systems.

Approach

Dual knowledge systems

The Plan is built on a common vision and values while acknowledging the independence and integrity of both science and mātauranga Māori in providing farmers and landowners with solutions that meet their relevant needs. The whakataukī **Te Kawau Mārō** provides guidance:

Kia mau tonu ki tēnā; kia mau ki te kawau mārō.

Whanake ake! Whanake ake!

Let us hold fast to the thrust of the Kawau (Cormorant). Thrust forth together …

Te Kawau Mārō shows us how the duality of science and mātauranga can be brought to bear to bring balance and impel action. It expresses the leadership necessary to progress ideas and accelerate our collective efforts to make progress in achieving biological emissions reduction in Aotearoa New Zealand.

The R&D elements of the Plan focus on new science and technology options for reducing biological emissions. These are founded on a comprehensive stocktake undertaken that identified potential mitigation solutions already in the pipeline.

The mātauranga Māori elements of the Plan provide a path for discussion and engagement with Māori agribusinesses and landowners that will be further developed and mature over time. In applying Te Kawau Mārō in the Plan these efforts come together and both science and mātauranga Māori expertise can drive action.

Partnering with Māori

Māori agribusinesses and landowners are major contributors to dairy and livestock production. They need appropriate tools, options, and support to reduce greenhouse gas emissions.

The Plan supports engagement and partnerships to create solutions from science and in mātauranga Māori, and has a focus on ensuring that mitigation solutions fit the needs and aspirations of Māori agribusinesses and landowners.

The Plan also recognises that dedicated investment is needed to grow Māori-based R&D capability and capacity and to ensure access to both science and mātauranga Māori-based tools and knowledge. It supports Māori to to innovate and develop Māori led-solutions capable of delivering reduced agricultural emissions that are built on both knowledge systems.



Developing the Plan

Science Stocktake – where are we today

A comprehensive stocktake of research and funding streams relating to agricultural greenhouse gas emissions was undertaken during the first half of 2021: **A Stocktake of Agricultural Greenhouse Gas Research in New Zealand.** This work was co-ordinated by the New Zealand Agricultural Greenhouse Gas Research Centre and includes:

- an overview of the funds and funders of agricultural greenhouse gas research in Aotearoa New Zealand;
- mitigation options under development, their current investment and assessment of their progress in the Aotearoa New Zealand context; and
- case studies of how the funds have worked together to accelerate research progress.

Science Prioritisation – where do we focus our efforts

Prioritisation is critical for focusing effort and getting solutions into the hands of farmers. Adoptable mitigation solutions are those that:

- have evidence of benefit to the level required by the New Zealand Greenhouse Gas Inventory and/or the He Waka Eke Noa Greenhouse Gas reporting and accounting framework;
- have relevant regulatory approval for use of the technology;
- have acceptance or approval of the technology by processors and other participants in the downstream supply chain, including customers and end-consumers, and by New Zealand society; and
- are developed with farmers (preferably from an early stage) to ensure that the adoptability of the technology is demonstrated in real farming situations, to increase uptake and ultimate success of the technologies in reducing emissions.

A prioritisation process was undertaken to identify priority actions for acceleration. This built on work initially coordinated by the Pastoral Greenhouse Gas Research Consortium.

For assessment of mitigation approaches, a comprehensive, Reach-Impact-Confidence-Effort (RICE)-based **prioritisation framework** was applied in three phases:

- **Phase 1:** Outlining mitigation approaches with potential application in Aotearoa New Zealand.
- **Phase 2:** Evaluation of mitigation approaches based on criteria relating to national impact potential; confidence of efficacy, fit with farm systems, and economic viability/effort and time required to make an approach adoptable.
- **Phase 3:** Assessing whether approaches are 'fit for purpose' for use in Aotearoa New Zealand.

In addition, a portfolio of priority mitigations was identified that ensured options were being developed that targeted methane and nitrous oxide, ensured options were available for each sector, and that supported a range of classes of mitigations to balance the inherent risk and uncertainty in each individual technology. Applying this framework, the following priority mitigation solutions for acceleration have been identified:

- **Methane inhibitors** – specifically the application and use of 3NOP in New Zealand grazing systems and development of NZ focused (including synthetic bromoform-based) inhibitors that can work effectively in grazing systems.
- **Nitrification inhibitors** – developing new fit-for-purpose inhibitors.
- **Methane vaccine** – to achieve proof of concept in the first instance.
- **Low emissions animal genetics**.

It is expected these priorities will change over time to reflect progress, knowledge, and opportunities. Specific mitigation solutions identified in this Plan reflect the current situation for the most promising immediate options to accelerate.

Issues and actions – identifying what needs to be done

Based on the findings of the stocktake, a series of four 'deep dive' workshops were convened with key stakeholders, scientists, developers, and subject matter experts to understand the issues and barriers to the development of new mitigations and use the analysis for the further refinement of the Plan. These focused on:

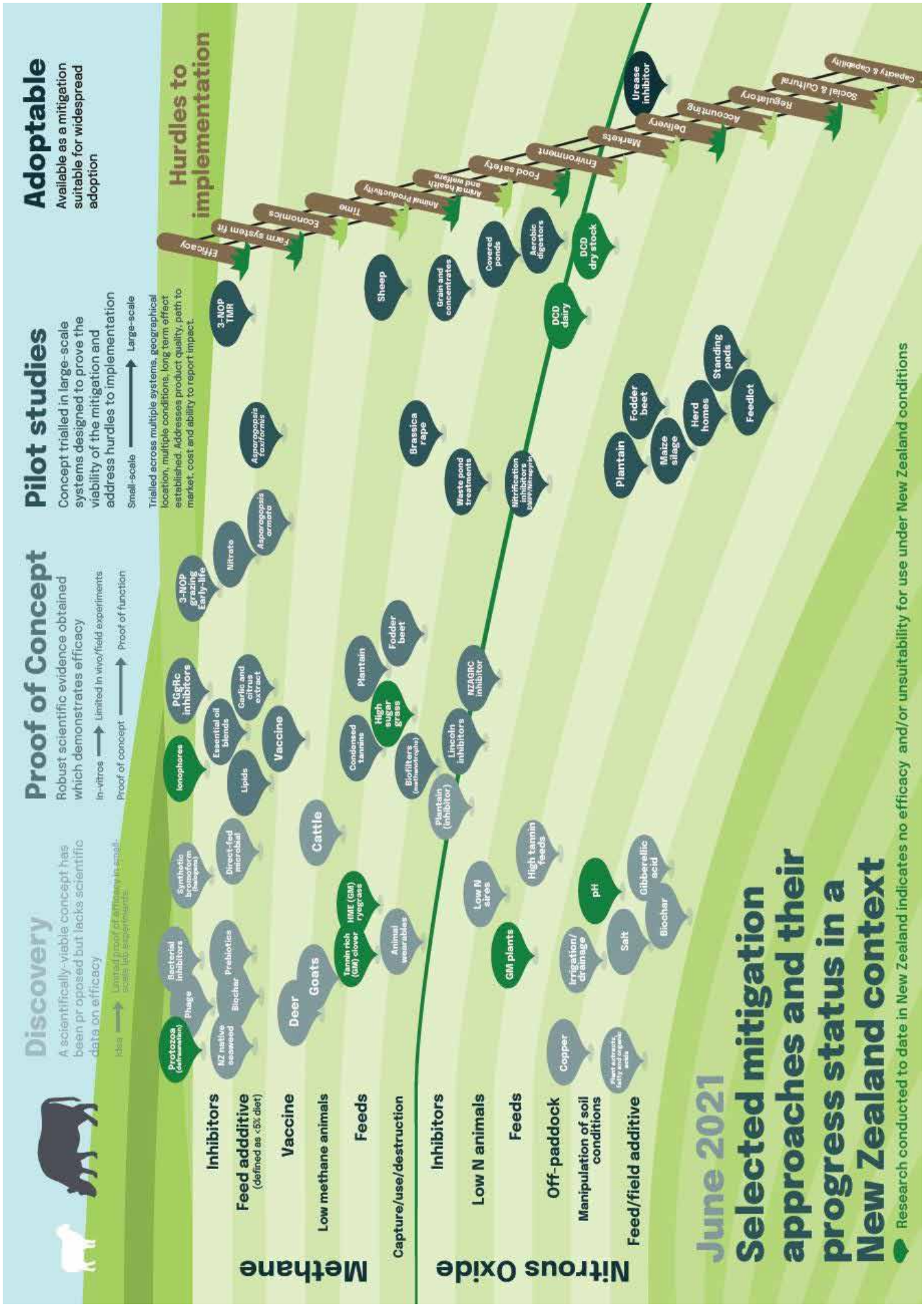
- developing a clear and shared understanding of regulatory requirements and processes relevant to the mitigations being developed to support agricultural biological emissions reduction and being available in a timely manner;
- providing insight into the productivity and economics of on-farm use of mitigations, including considerations for long-term use or exposure, co-benefits, and economics of different mitigations on farm;
- understanding the pathway to market and commercialisation of methane and nitrous oxide mitigation technologies; and
- understanding how mitigations fit with, or deliver on, consumer expectations and related demand for the use of mitigation technologies.

Further targeted subject-matter expert workshops with scientists and technology developers were held to identify:

- what and how scientific research on potential mitigation solutions in the pipeline could be accelerated;
- priorities for advancing relevant fundamental or platform science to support mitigation solutions, and how could this be supported and/or accelerated;
- how could progress of new mitigation solutions through the path to market be accelerated.

Outcomes and findings of these workshops were analysed and fed into the further refinement of the recommendations of actions.

Figure 3. Mitigation approaches and their progress status in Aotearoa New Zealand context



Path to Implementation

The Plan is intended to guide coordinated action and investment towards its outcomes, and implementation will involve Government, Māori, industry and science. The Plan has already been influential. Key actions have been included in the Government's first Emissions Reduction Plan and Budget 2022 invested $338.7 million over four years to accelerate development of high-impact technologies and practices to reduce agricultural greenhouse gas emissions, including the establishment of a new Centre for Climate Action on Agricultural Emissions (the Centre). The work on the Plan was a critical input to these initiatives.

The Centre was launched in November 2022 and represents a significant change in reducing agricultural emissions. It includes a new public-private joint venture to drive product development and commercialisation, and an enhanced New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) to underpin these efforts and support the wider system. Initial indicative commitments in the joint venture would see around $172 million invested over the next four years by industry and government), on a 50:50 basis, to develop and commercialise practical tools and technologies for farmers.

Alongside investments through the Centre, the new funding will support additional efforts in Māori-led innovation, regulatory capacity and capability, and international engagement and investment.

Together, these investments will:

- unite efforts to accelerate research and development;
- get new tools, technology, and practices to lower on-farm emissions to farmers faster;
- complement the work being done through the He Waka Eke Noa partnership; and
- generate Māori-led solutions and ensure that mitigation solutions fit the needs and aspirations of Māori agribusinesses and landowners.

While the Centre and Joint Venture will deliver many actions outlined in the Plan, those in the regulatory space or with a strong public good element will be overseen by MPI. An Oversight Group will be established to help ensure progress towards biological emissions reduction efforts and the outcomes in the Plan. This will be chaired by MPI, and include Centre leaders, and the Chairs of Ngā Pouwhiro Taimatua (NPT) and the Food and Fibres Partnership Group (FFPG), MPI's advisory groups on the Māori primary sector and primary sector strategy respectively.

The development of the work to produce Māori-led solutions in biological emissions mitigations and reductions will rely on partnership with the Māori sector. The Oversight Group that includes the Chair of NPT will provide an oversight voice on that process. However, the complexity of the iwi Māori and mātauranga elements may require additional resource to support the Chair of NPT and MPI (being led by its Māori Agribusiness Directorate) with the process and design of those components of the work.

Photo: NZAGRC

Areas of recommendation for action and acceleration

The actions to achieve the objectives of the Plan build on the broad range of existing R&D programmes and activities relating to different aspects of biological emissions reduction and climate change. The intent is to address key barriers and increase momentum and scale in critical areas that need to be accelerated.

This is a live Plan, and therefore these actions reflect our current understanding at the time of writing. They will continue to be updated through regular review as well as by new developments, knowledge and experience gained over time. The Plan will also specifically incorporate outcomes from Māori engagement to develop Māori-led solutions at national/central and regional/local levels.

1. Increase investment

Where are we now?

Government and industry have invested about $200 million over the last 10 years into agricultural emissions mitigation research, capability building and international leadership. This investment has contributed to building an evidence base, developing new technologies, increasing animal productivity while reducing emissions, and improving emissions measurement.

While significant R&D activity is already underway, there was a need for a step change of investment by government, industry, and Māori to build the infrastructure, capacity, and people capability required to grow and accelerate the development of mitigations and practices to achieve the objectives of the Plan

The necessary scale and ambition signalled as needed for investment has been achieved through the $338.7 million over four years appropriated in Budget 2022, building on the $24 million over four years appropriated in Budget 2021 and with a significant increase in the commitment from industry to invest alongside government (at least $86 million over the next four years). This will support equitable outcomes and include dedicated investment in Māori-led solutions.

What can we achieve?

Increased public and private funding for biological emissions reduction R&D and infrastructure will ensure sufficient long-term resource to implement this Plan, including development of long-term capability, capacity, and infrastructure required to meet national and international emissions reduction targets. It will help to ensure all farmers have access to appropriate mitigation solutions, including through Māori-led R&D programmes. This also provides long-term confidence for organisations to invest in capability and infrastructure, and for new personnel to be attracted to the research areas.

Key:

Actions initiated

Actions to be initiated

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Increase investment in R&D infrastructure to grow the capacity needed to deliver acceleration of the portfolio of mitigations.	**ACHIEVED**		
Government and industry commit to increase annual science and mātauranga R&D investment to at least $100 million per annum by 2025.	**ACHIEVED**		

This is a live Plan, and therefore these actions reflect our current understanding at the time of writing (January 2023).

2. Build capability and infrastructure

Where are we now?

There are critical gaps in capacity, capability and infrastructure to support and accelerate the development of mitigation solutions and approaches, delaying their availability to farmers and our ability to meet our emission reduction targets. What is needed is a pipeline of people with the knowledge, training and capabilities required and the removal of bottlenecks and capacity constraints for effective responses to methane and nitrous oxide.

Facilities, specialised equipment, and skilled staff are required to test mitigation options from discovery to proof of concept, and from pilot studies to implementation, as well as supporting a "fail fast" approach to evaluating promising new solutions. Ensuring Māori are able to access appropriate mitigation solutions will also require investment in capability and capacity in Māori-led processes and programmes.

What can we achieve?

Building Aotearoa New Zealand's capability and infrastructure to support development and delivery of biological emissions reduction solutions and approaches will:

- address the key bottleneck around access to greenhouse gas measurement infrastructure (e.g. open circuit calorimetry using respiration chambers);
- help identify alternative technologies and proxies for greenhouse gas measurement and predictive capabilities to alleviate pressure on available infrastructure; and
- ensure we have a robust system of people and capacity that can meet our ambition and facilitate the accelerated development of mitigations.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Develop and implement a people capability plan to meet short and long-term needs for science and mātauranga in areas of critical importance for reducing biological emissions (including within science institutions and Māori organisations at national, regional or local levels).			
Develop and implement an infrastructure investment plan to meet immediate and long-term measurement needs for research and validation of biological emissions reduction approaches, including 'whole of whenua' approaches, and options to optimise currently available measurement facilities (such as coordination, standardisation of methods).			



3. Develop partnerships with Māori landowners and Māori agribusiness sector that leads to adoption and adaptation of emission reduction mitigations

Where are we now?

Māori landowners and the Māori agribusiness sector are major contributors to dairy and livestock production and partnering with whenua Māori owners, iwi, local collectives, and Post Settlement Entities is a critical component of the R&D plan. Independent Māori design and implementation alongside co-design and co-implementation approaches are core partnership principles that will ensure that mitigation solutions fit the needs and aspirations of Māori agribusinesses and landowners. The partnership approach, which will be further designed and implemented at national, regional, and local levels with networks of Māori organisations and collectives.

What can we achieve?

By applying Te Kawau Mārō we can ensure"the system supports approaches based in both science and mātauranga Māori, expanding the range of options available to farmers, and that the needs of Māori agribusinesses.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Engage with relevant Māori agribusiness entities through Māor-led engagement.			
Develop an engagement plan for the "Māori led innovation and mātauranga Māori-based approaches to emissions reductions from agriculture" as part of the the Centre for Climate Action on Agricultural Emissions, building on the partnership approach with Māori Agribusiness, landowners, iwi, and local collectives.			
The partnership approach ensures equitable participation of Māori in leadership and decision-making in implementing this Plan and developing it further.			
Ensure data collection, assessment and analyses contribute to an approach to biological emissions reductions that considers and measures success from multiple viewpoints and interests.			



Photo: NZAGRC

4. Accelerate development of priority mitigation technology solutions

Where are we now?

Through the work of the Plan, a portfolio of priority mitigations was identified that are expected to have the biggest impact in our farming systems. While these, and all mitigations, will benefit from the wider actions in this plan, this priority area has an explicit focus addressing the needs of these priority mitigations, reflecting their specific nature and stage of development.

What can we achieve?

A thriving R&D pipeline of potential solutions is needed to ensure that sufficient solutions are successfully developed through to adoption, providing options that will work for differing farmer needs and farming sectors and systems. By directing effort toward priority solutions, we can:

- increase the likelihood and timelines of effective solutions being available to farmers in Aotearoa New Zealand by 2030.
- support a combination of science and mātauranga knowledge so that the wisdom and understanding of both systems helps establish a specifically unique New Zealand response to emissions reductions; and
- advance development of Aotearoa New Zealand-relevant options, including delivery mechanisms and efficacy in pasture-based systems.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Methane inhibitors: Prioritise research and other support required for target methane inhibitors (3NOP (Bovaer™10) and synthetic-bromoform based methane inhibitors) to be adoptable and available for use in New Zealand grazing systems.			
Low emissions animals: Develop a workable methodology to incorporate the gains from genetic improvement for methane in the National Greenhouse Gas Inventory.			
Methane inhibitors: Develop effective delivery methods and forms for methane inhibitors, including rumen delivered for use in grazing systems, in-field systems and early-in-life intervention.			
Methane vaccine: Establish proof of concept for a vaccine to reduce methane.			
Low emissions animals: Improve uptake and ensure gains from existing sheep genetics through targeted genotyping in the New Zealand sheep flock and incorporation of rapid breeding technologies by commercial ram breeders.			
Nitrification inhibitors: Identify N_2O inhibitory compounds and confirm potency and appropriate chemistry; develop a robust and consistent assessment and measurement framework, and effective tools and technologies, for testing their efficacy and adoptability (including food residues and environmental impacts).			
Low emissions animals: Identify and validate phenotype direct measures, or proxy methods for rapid selection (e.g. rumen microbiome, saliva, milk), for remaining ruminant species and increase the availability of low-cost methods or proxies for identifying low methane animals in the field; conduct research in a variety of production systems to understand the relationship of low emissions genetics to other breeding and productivity traits.			

5. Establish and sustain Māori-led innovation and Mātauranga-based approaches to reducing biological emissions

Where are we now?

Supporting and enabling Māori to develop and access appropriate mitigation solutions is critical to providing Māori landowners, farmers and agribusinesses with options and approaches to reducing their emissions in ways that meet their needs and aspirations.

What can we achieve?

Dedicated support for Māori-led innovation and mātauranga Māori based approaches to reducing biological emissions will help to ensure that:

- Māori have equitable access to all available mitigation technologies;
- Māori are able to define their own priorities for biological emissions reduction; and
- Māori and, where appropriate, non-Māori have access to mātauranga Māori tools and resources to reduce biological emissions within the context of a whole-of-whenua approach to land use and sustainability.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Develop R&D projects that contribute directly towards reducing biological emissions on Māori farms and agribusinesses, including targeted solutions that respond to unique issues and challenges Māori landowners and agribusinesses may face.			
Invest in exemplar projects for biological emissions reductions that demonstrate integrated, holistic and mātauranga Māori-based approaches to reducing biological emissions.			
Establish Māori-led programmes and explore mātauranga Māori-based approaches to reducing biological emissions in the context of a whole-of-whenua approach towards land development and environmental sustainability— including specific Te Hau Ora o te Ao outcomes.			



6. Strengthening Systems research

Where are we now?

Making advances in breakthrough foundational science is key to the development of emerging and developing mitigation technologies, and providing the foundation to develop new mitigations. This requires a system able to develop a platform of R&D (e.g. mechanisms to support long term research programmes, certainty of funding and required people capability) as well as providing feedback loops to learn from advancing the current generation of mitigation solutions.

What can we achieve?

Developing deeper foundational knowledge of farm and whole-of-whenua systems, and the biological elements of those systems that lead to methane and nitrous oxide emissions or reductions. It is essential to underpin the development of the current generation of mitigation solutions with this foundational knowledge and provide confidence in their use. It also has an essential role to play in building the future pipeline of knowledge and solutions for the continued development of sustainable land-based food systems.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Support the development of sensing and data technology for enteric methane and nitrous oxide measurement and prediction in the lab and in the field, and develop or validate alternative greenhouse gas measurement technologies and proxies to support more efficient and cost-effective trial options.			
Explore, develop, farm-trial and assess appropriate farm planning and management frameworks that reflect a 'legacy-farming' and whole-of-whenua approach to reducing biological emissions.			
Develop rapid screening methods for identifying biological nitrification inhibition potency in agronomically viable temperate grass species.			
Identify and develop mechanisms for estimating the impacts of the whole of whenua system-level approaches to biological emissions.			
Expand/build on existing international research and initiatives to coordinate a global research programme for accelerating biological nitrification inhibition for temperate systems (New Zealand as global leader in pasture-based systems).			
Advance science to better understand processes leading to the formation of methane in the rumen, encompassing a wide range of possible approaches (e.g. inhibition of methanogens, alternative hydrogen sinks, host animal effects, and feeds) and further build the development of a knowledge platform based on the understanding of rumen biology and animal physiology.			
Investigate science or engineering solutions for minimising methane once it has been formed i.e., capture or oxidation.			
Identify opportunities to reduce waste nitrogen output whilst maintaining animal nutrition and productivity.			
Develop or test novel persistent pasture species that are high yielding with low N content.			
Develop a fundamental understanding of N_2O production, associated plant- and soil microbial interactions, and the drivers of N_2O inhibitor efficacy under varying farm conditions and systems.			

7. Strengthen International R&D co-operation and partnerships

Where are we now?

There are many potential benefits of international co-operation and collaboration. These include connecting Aotearoa New Zealand to leading global expertise, capability and resources for R&D on biological emissions reduction, accessing global-scale data sets, standardising methodologies, protocols and databases, monitoring global developments, drawing on indigenous knowledge globally, facilitating commercial partnerships and strengthening international relationships to support the development and use of new technologies in the global food supply chain. The experience of the Global Research Alliance (GRA) is indicative of the benefits and continued potential of international R&D collaboration for Aotearoa New Zealand. Every $1 invested through the GRA has accessed co-funding of more than $2 in international mitigation research.

What can we achieve?

This supports addressing domestic capacity restrictions and leveraging international resources and capacity, and supports ensuring that mitigations developed abroad are fit for purpose in our pastoral farming systems. This is a key lever in contributing to global emissions reduction, and demonstration of international leadership.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Strengthen R&D co-operation and establishment of international 'best teams' with key pastoral-based livestock farming countries, including specific co-operation with indigenous peoples, to develop knowledge relevant to mitigation of emissions from pastoral livestock farming and build global support for the development and adoption of mitigation technologies.			
Foster and strengthen international networks & partnerships (governmental, research, commercial and indigenous peoples) to create more options for cost-effective access to resources, infrastructure, capability or capacity for R&D and data-sharing.			
Ensure information about international projects and relevant global developments and their implications for New Zealand are communicated to key stakeholders.			



8. Streamline regulatory processes and improve Emissions accounting

Where are we now?

Aotearoa New Zealand's domestic regulatory regime is critically important for supporting the safe and effective development and use of new technologies. Regulatory requirements can be complex and must be well understood. To avoid unnecessary costs or delays, approval processes must operate efficiently at both the trial and commercialisation phases. Co-operation among international regulators also provides opportunities to share information and understanding, and harmonise global standards and approaches, particularly through CODEX. Emission reductions achieved using new technologies must be able to be captured in our national Greenhouse Gas Inventory as well as in farm-level emissions calculators and accounting systems.

What can we achieve?

Streamlining regulatory processes and improving Aotearoa New Zealand's emissions accounting will be enabled through building strategic global partnerships to advance relevant standards (e.g. CODEX) to reflect the need to tackle climate change and support and inform rules that support the use of mitigation technologies. It will:

- help ensure researchers, developers and others are able to navigate the complexity of regulatory processes;
- support the ongoing development of our Greenhouse Gas Inventory and ensure it is sufficiently agile to respond to new technologies;
- ensure domestic and international market regulatory acceptability and science-based approaches to the use of new mitigation technologies; and
- provide alignment of domestic and international regulatory processes and outcomes.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Address process requirements and key capability or capacity constraints that might impact the timely approval of new mitigation solutions.			
Support the continued development of the New Zealand Greenhouse Gas Inventory and inclusion of new technologies.			
Identify potential areas for harmonization or increased co-operation on regulatory issues (domestic and international), including opportunities to reduce the cost and complexity of trials in Aotearoa New Zealand and enable the implementation of new technologies while maintaining our reputation for safety, integrity, and quality.			
Support the development of accounting, reporting, and verification systems to enable inclusion of new biological emissions reduction approaches in farm-level greenhouse gas calculators aligned with the Inventory requirements.			
Develop and implement a multi-year National Strategy to progress relevant international guidelines and approaches for advancing CODEX requirements that would support the use of new mitigation technologies.			

9. Support programmes, tools and resources for navigating the path to market and people

Where are we now?

Successfully developing and commercialising new technologies is complex. Aotearoa New Zealand's pasture-based farm systems create unique challenges for mitigation solutions and their impacts within the farm system, including on the environment, animal health and welfare, and product quality and safety. This complexity can create uncertainty for researchers and investors around funding needed, likely timelines and requirements their solutions may need to meet. Making new technologies an on-farm a reality requires close connectivity between the R&D pipeline and the needs of end-users, and with extension programmes and providers.

What can we achieve?

This action area will support identification of pathways for mitigations – from idea to market/success – including relevant requirements at each stage of development, go/no-go factors, evidence requirements and regulatory processes. It will:

- ensure entities providing advice to farmers (including industry good bodies, rural professionals, and government agencies) are well connected and understand and promote the adoptability of mitigation technologies;
- provide knowledge to enable decision making on-farm;
- encourage investment and entrepreneurship by providing more certainty and knowledge of path to market and success;
- link related processes and resources that are connected to mitigation technologies; and
- increase transparency and knowledge about mitigations and how they are developed/regulated for a range of communities, such as developers, farmers, Māori landowners, and processors, and enable them to tell a values-based and/or sustainability story.

	Indicative Timeframes		
Recommended Actions	**1-2 years**	**3-5 years**	**5+ years**
Engage with organisations providing extension services and advice to farmers (including farm service organisations, industry bodies, rural professionals, Ministry for Primary Industries) and support activities that promote the adoptability of mitigation technologies and their use, such as: co-development with end-users; demonstration or piloting of mitigation technologies for farmers, and including specific activities targeting Māori agribusiness and land owners, iwi and hapū; testing or building public, consumer or market acceptance.			
Support the building of a network of professionals and advisors who understand Māori cultural prerogatives and Māori land development who can assist with establishing a mana whenua (land development) and kaitiakitanga (environmental sustainability) response to reducing biological emissions through farm practice, planning, and decision-making.			
Support the development of programmes that support the uptake of new tools and knowledge, and leverage opportunities to assist farmers and landowners' transition to reduce biological emissions, including through new technologies and the whole of whenua farm planning, management and agribusiness innovation.			
Develop resources and tools to help developers bring approaches to market in Aotearoa New Zealand (such as guides to research programme design, understanding regulatory and inventory requirements, evaluation criteria, and economic cost-benefit models for farmers).			
Develop resources and tools to help participants in the food/people system tell effective stories to the food and fibre market in a way that under-pins and furthers their development and innovation.			

Monitoring and review of the Plan

The recommendations in the Plan will be incorporated in the ongoing activities, strategic direction, and reporting and monitoring of the Emissions Reduction Plan and in particular through the work of the Centre for Climate Action on Agricultural Emissions and the Ministry for Primary Industries. This will include:

- regular reporting on how the R&D is progressing and the estimated impact, including public reporting on those actions specifically adopted in the Emissions Reduction Plan This will help us to track progress, identify where more action is needed, and align and leverage effort more broadly. The oversight structure being developed for the Centre for Climate Action will have a key role in supporting this;
- establishing a review mechanism that enables the Plan to adapt and change over time to reflect growing knowledge and experience;
- ensuring appropriate processes and approaches are established to engage with Māori in any further development of the Plan;
- developing key success measures, and high-level monitoring and oversight of the implementation actions. Ensuring co-ordination and alignment of effort, including with other relevant initiatives and programmes.



Glossary

Mātauranga: In the context of this Plan mātauranga Māori is broadly defined as a body of distinct knowledge, experience, values and philosophy of Māori (Mead 2016, Winiata 2001). It includes the unique knowledge and understanding Māori have of the taiao, the environment, which is held and maintained by relevant Māori entities (whānau, hapū, iwi).

Te Taiao: In the context of this Plan Te Taiao is drawn from *Fit for a Better World* and refers to a deep relationship of respect and reciprocity with the natural world. The health of the climate, land, water and living systems comes first. And when nature thrives so do our families, communities, and businesses.

Whole of whenua: In the context of this Plan, "whole of whenua" approach is one that looks holistically at the farm system and considers the inter-relatedness of all aspects that include whenua, whanau, and whairawa (Planet, People, Profit).



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