The path to 2050?

A summary of the research into the capacity of the New Zealand pastoral sector to achieve agricultural emissions reduction through system change.

A summary of the Future Farm Systems Research Programme White Paper

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Reference

This report is a summary of the full White Paper which covers the topics discussed in greater detail. The full paper can be found here.
www.ag-emissions.nz/publications/the-future-farm-systems-research-programme-white-paper-the-path-to-2050

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Introduction

The necessity for the New Zealand agricultural sector to contribute to global emissions reduction is increasingly apparent. Outside of New Zealand's international commitments, domestic legislation, or our customers' requirements, it is in our farmers' own interest that everyone can do what they can to slow, stop, and, ideally, reverse human impacts on the climate.

With methane emissions tightly linked to feed intake and nitrous oxide emissions largely derived from the nitrogen cycle, most currently applicable emissions mitigations relate to farm management practices. The implementation of most mitigations also has a cost, normally by way of lowered profitability, to the farm system.

Much of the recent research effort has focused on better understanding the drivers of the associated biological processes, finding ways to disrupt them to identify more cost-effective ways to mitigate them. There was therefore an opportunity to investigate the more disruptive impacts and transformational solutions associated with the New Zealand pastoral sector reducing its agricultural greenhouse gas (aGHG) emissions. As a result, the New Zealand Agricultural Emissions Centre initiated and funded a Future Farm Systems Research Programme in 2022.

The Future Farm Systems Research Programme

The Future Farm Systems Research Programme has two parts.

The first part, led by Erica van Reenen from AgFirst Whanganui-Manawatū, focused on the farm-level transition to a low emissions future. This essentially comprised work that concentrated on the farm level mitigation (both incremental and disruptive) needed to lower biogenic methane and nitrous oxide emissions and the drivers/barriers behind existing and further adoption.

The second part of the programme, led by Lee Matheson from Perrin Ag, applied a wider, more disruptive, and longer time-frame lens to emissions reduction. This research attempted to envision what a low emissions future for the primary sector might deliver in the absence of sufficient technological solutions that its customers might accept, or that have sufficient efficacy to allow our current land use systems to endure.

This body of research, completed over the past three years, supports the premise that change is indeed possible at farm level, but there are limitations and wider implications.

What's already happening behind the farm gate?

Five case studies were chosen to provide a cross section of land uses, location, focus (resilience or reducing biological greenhouse gases), whenua Māori, and mechanism (management change or land use change) from pastoral farming enterprises across New Zealand.

For these farm businesses, the gross biological emissions reductions achieved ranged from 2.2% to 16% over three to five years. In most of the case studies, emissions fluctuated between the base year and current year due to seasonal variation and the vagaries of implementing system change. Drivers of emissions reductions were rarely singularly focused with most having a combination of stocking rate reductions and management changes as well as land use changes within systems, to a greater or lesser extent, across the case studies.

In all the case studies, there was a strong focus on improving efficiency and management practices to improve overall farm performance, which then also reduced greenhouse gas emissions. Where more costly mitigation strategies were employed, such as indigenous tree planting and land retirement, external funding was often sourced, which helped promote these actions.

Given the global (and national) urgency to reduce emissions, it is important to recognise that across all case studies the observed changes were made over a protracted period, each time-step improving outcomes or adjusting to changing conditions. This was particularly important where there were multiple interests wanting confidence that it was the right approach, with each step proving the validity of the approach.

Four main themes in barriers to implementing emissions reductions on farm were identified through these case studies.

- **Uncertainty and mixed messaging undermine farmer confidence.** Confused communication, policy uncertainty (e.g. emissions pricing, ETS), and lack of integrated environmental policy discourage farmers from making changes. Fear of making the "wrong move" or not being recognised for early action also leads to inaction.
- **There are practical and people-related barriers to change.** Even well-intentioned or logical changes (e.g., land use) can have unintended practical consequences. Success depends on having the right people with the capacity and capability to implement changes well.
- **Volatility reduces appetite for risk.** Climate change, geopolitical instability, and falling financial returns create hesitation to act. Change feels riskier when external conditions are unstable.
- **Incremental, profit-backed change is key.** Big changes are only feasible when the fundamentals are strong (base production, profitability, capability). Without solid foundations, the appetite and ability of farmers to adopt new systems is limited.

↓ 2.2% -16%

Gross biological emissions reductions achieved over three to five years in the five case studies.

An opportunity for collective solutions?

While the actions taken to reduce emissions by the case study farmers had been voluntary, even if under a spectre of likely regulation and market signals, these had also been largely undertaken in isolation from other farming businesses.

The emergence of catchment groups in the wider sector and formal collectives within Māori agribusiness suggest there is an appetite and capacity for farmers to work collectively to achieve emissions reduction. Collective or collaborative action provides several potential benefits, such as increased confidence to act, the sharing of knowledge, mutual accountability and perhaps the benefits of scale for more costly mitigations and an opportunity for behaviour change to rely less heavily on regulation.

The potential of collective farmer response and action to contribute to the agricultural sector's emissions reduction was a next logical focus for the research.

Five farmer groups from across the country were identified and subsequently initiated a process to voluntarily explore mitigating greenhouse gas emissions.

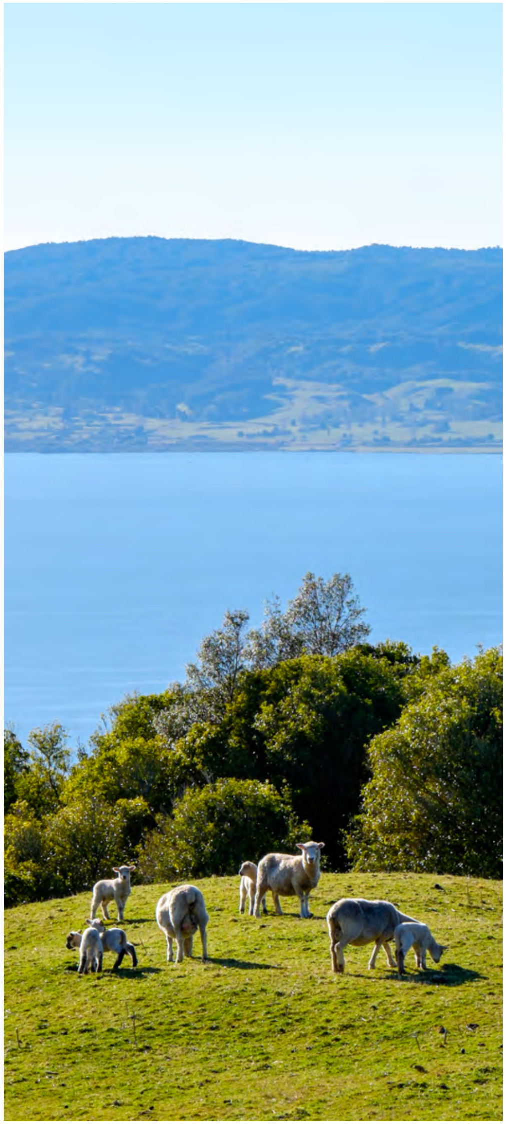
All the farmer groups (three in the North Island and two from the South) were provided with the same opportunity statement as the basis of their collective engagement.

"To identify how the collective can give meaningful effect to the aspirations of the Zero Carbon Act while retaining their financial viability and directly contributing to the reduction of gross methane emissions from the primary sector."

Each group had budget at their disposal, albeit within the control of the programme, to contract appropriate subject matter experts to assist them in this process, but with a defined timeframe and support to work through roadblocks as and when they occurred. The groups' progress was observed by an expert researcher, who also conducted interviews with participants outside of formal engagements, to capture and document the process and develop understanding about participants' attitude to make change to reduce agricultural emissions.

We found that reducing emissions is complex and "messy", not linear. It would appear it is easier for farmers to undertake this journey with others than doing so individually. Doing so collectively provides (a) mutual support/reassurance about the difficulty of this issue (which is critical for ongoing engagement) and (b) an exposure to different risk appetites, solutions, and approaches that can empower farmers to step outside of their own paradigms and risk parameters. The work also identified some important findings about farmer engagement with emissions reduction.

- **Farmer willingness to engage in a farmer-led project varies significantly.** They seem to be more willing to engage when there is an external pressure-point to do so (such as the proposed emissions pricing that still existed at the start of this research) and commitment wanes if this drops off.
- **There appears to be limited farmer confidence in mitigation technologies, a**part from genetics, being able to contribute significantly to reductions. This is mostly around market acceptance and cost/practicality to utilise. Most participants see farm system change, land use change, and alternative revenue sources as critical factors in how they respond.
- The research has also identified that **there are still significant gaps in farmer understanding** about the drivers of emissions and, subsequently, what that means in terms of the extent of and impact from system changes needed to achieve variable levels of emissions reduction.
- Participants **referenced a lot of information that seems to contradict New Zealand's international position and our markets' growing expectations.** This clearly highlights the lack of supporting information out there from [trusted] agricultural sources around what the sector needs to do and why, and where the evidence sits for this. Rural media, both analogue and digital channels, appear to be dominated by "anti-mitigation" narratives, with limited to no alternatives presented.
- There was also an underlying perspective by participating farmers that **they need to be rewarded [now], somehow, for environmental performance** and/or being early adopters.



If less cows, then what?

While technological solutions are increasingly likely to play a collective [and possibly dominant] role in deliberate emissions reduction, land use change seems to be a widely expected outcome for the sector in the medium-term, whether directly driven by mitigation, adaptation, or both. In saying this, the research by no means suggests this will be a fait accompli.

To evaluate the capacity of alternative [lower emissions] land uses to provide a suitable mechanism for emissions reduction, five land uses, considered to be broadly representative of available options in New Zealand, both existing and emergent, were analysed in this project. They were milling wheat, chestnuts, blueberries, industrial hemp and tōtara.

While all these crops have the potential to be produced at greater scale than they currently are, the analysis identified several key parameters that have not only limited their commercial scale today but would likely prevent their significant expansion tomorrow.

- **A lack of financial competitiveness.** Many alternative land uses (e.g. milling wheat, hemp, tōtara) struggle to currently compete financially with existing pastoral systems, especially dairy. Global price benchmarks and consumer unwillingness to pay premiums for local products can also limit financial viability. Perishable crops may have domestic price advantages but limited industry-wide scalability, while forestry alternatives face long-term horizons and high establishment costs.
- **Barriers to capital investment.** High upfront costs are a barrier for emerging sectors. Small-scale operations face disproportionate costs due to lack of economies of scale. Infrastructure, some of it needing to be imported, is often needed before industry scale justifies it, requiring risk-taking entrepreneurs or co-investment models.
- **Low returns on post-harvest and processing infrastructure.** Seasonal peaks and short harvest windows lead to underutilised processing infrastructure and poor returns, deterring investment. Small grower scale makes self-sufficiency in value-added processing financially unrealistic. Capital pooling and equipment sharing (like our predominant cooperative models) are possible solutions, but coordination challenges remain.
- **A lack of coordinated industry knowledge and activity.** Knowledge-sharing is strong in established export sectors but weak in emerging/niche industries due to competitive sensitivities. A lack of shared infrastructure, technical support, and market access planning reduces sector confidence and limits growth. We suggest that entrepreneurial risk-aversion to sharing slows industry maturity and capital attraction.
- **The shallow depth of our domestic markets.** New Zealand's small population limits domestic market capacity to early-stage development and proof-of-concept only. New sectors must export early, increasing exposure to global pricing and risk. Lack of secondary/off-specification markets (e.g. for hemp seed cake or failed crops) raises commercial risk and deters diversification. Small market size also makes it difficult to support by-product utilisation or ensure minimum viable pricing

Incorporating alternative land uses to the extent that is practical and financially feasible to landowners at current prices may, therefore, be insufficient for a meaningful contribution to the achievement of emissions reduction targets. Collective approaches may aid in reducing the financial burden on individual landowners, but the lack of capital and infrastructure throughout the whole supply chain will likely have limiting effects. To enable sufficient adoption of alternate land uses to an extent sufficient to make a significant reduction in agricultural emissions, the requirements for, and role of government support need to be further addressed.

The potential role of government and wider impacts of emissions reduction were subsequently considered in the last phase of this research.

Envisioning a low emissions future

While the expected trajectory for climate in the medium-term is reasonably settled, the socio-economic environment within which our food systems and rural communities will operate is largely unknown.

To this end, four possible alternate future scenarios in which we would need to lower emissions from our primary sector were developed through a co-design process with stakeholders in Te Tai Tokerau Northland and Murihiku Southland. These regions were chosen to represent the extremes of agricultural systems here in New Zealand. The scenarios were then interrogated with a wider group of community stakeholders to explore how these communities might respond to emissions reduction and what might be required to support their transition.

Despite differences in their respective economies and communities, across both regions and the range of different futures, the needs, concerns and expectations associated with the transition to lower agricultural emissions were similar.

- **Labour.** Ensuring the success of the expected increase in horticultural crop production and marketing requires ongoing access to migrant labour due to domestic shortages, alongside regional capability building through technical expertise and dedicated centres of excellence.
- **Energy.** There is a need to develop sustainable energy sources like solar, geothermal, and biofuels to support the energy demands of post-harvest supply chains without overloading existing infrastructure or increasing emissions.
- **Transportation.** Improved transport networks and electrification of freight vehicles, trains, ships, and planes are essential to efficiently move larger volumes of perishable products while reducing emissions from increased freight activity.
- **Water availability.** Horticultural crops are sensitive to moisture stress at critical times and hence the availability of irrigation water at these times is likely to be a major enabler for this land use change. The post-harvest management of these crops including packing and processing of these crops also requires water.
- **Biosecurity.** The introduction of new crops such as tropical fruits exposes New Zealand to new biosecurity risks and amplifies the importance of protection against risks of insects and plant borne diseases incursions.
- **GE.** The opportunity to manage biosecurity risks with genetically modified plants should be explored and debated. Remaining competitive with other international producers of horticultural crops is unlikely without GE.
- **Research and development into new technology.** Increased investment in R&D is needed to explore alternative crops, pests, sprays, fertilisers, and to advance greenhouse gas reduction in livestock systems, supporting innovation and biosecurity.
- **Urban contribution.** Workshop results indicated that participants believed it was crucial for individual households to be aware of their greenhouse gas emissions. Participants emphasized the importance of introducing comprehensive food waste reduction initiatives to promote environmental sustainability and reduce the overall carbon footprint.
- **The Māori economy.** Greater recognition of mātauranga Māori and Te Tiriti principles in the primary sector is needed to enhance productivity, protect whenua rangatiratanga, certify and brand heritage cultivars, and support urbanizing rangatahi through urban marae development
- **Role of government.** Government incentives for emerging technologies and potential changes to foreign ownership rules could drive investment, innovation, and infrastructure development, supporting economic diversification and resilience to market fluctuations.

Even given the size of the recently scaled back methane reduction target of 14-24%, this research suggests that the primary sector's transition to lower emissions will involve fewer ruminants, new or expanded supply chains, and a need for significant capital investment, both within specific sectors and in public infrastructure.

Understanding the main drivers of success in reducing agricultural greenhouse gas emissions will therefore be crucial for decision-making by central and regional authorities. These drivers include community aspirations, infrastructure costs, and social/economic impacts. Any community is most likely to succeed in our uncertain future when the targeted outcome aligns with community support and adequate resources.

So, what does this all mean?

The research ultimately highlights the importance of collaboration, the need for integrated policy across all environmental challenges, and the role of government and community support in achieving the emissions reduction goals for the pastoral sector.

While there are specific take-home messages for industry, government and for the science sector, given the complex challenges that the research identifies face the pastoral sector in reducing agricultural emissions, it is critically important that we continue to research the options for methane and nitrous oxide reduction that would enable the continuation of a pastoral sector of similar economic value to today.

In making this recommendation we are fully cognisant of the fact that, due to a broader range of environmental and social impacts, not least the need to reduce emissions, farming as we know it today must continue to evolve and improve - quickly. Given, however, the reality that Aotearoa New Zealand's standard of living continues to rely on the production of food and fibre from our natural resources, it is not tenable in our view to advance narratives that such activity needs to substantively cease.

We need to find ways, if we can, working together, to have both our environmental cake and to eat the economic one.