Navigating Genetic Technology: Supporting Dairy Farmers Through Regulatory Reform and Adoption

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1. Executive Summary

Background

There have been significant advancements in genetic technology over the last ten years. Modern genetic technology is now more precise and capable of producing genetically modified organisms with changes similar to those that could have been achieved naturally. The world is responding to these advancements, prompting many countries to adopt more liberal and precise regulatory frameworks.

New Zealand is one of these countries and is now beginning its own regulatory reform process. New Zealand aims to use this reform to harness these technological advancements to improve agricultural productivity, sustainability, and competitiveness in global markets. However, these advancements also bring complexities and challenges that must be carefully managed through regulation and surrounding processes and mechanisms to ensure their safe and effective implementation.

Aims and Objectives

To navigate these complexities and ensure a smooth transition, this work aims to identify possible actions and strategies to support New Zealand dairy farmers as modern genetic technology becomes permissible on farms.

Methodology

This research involved a literature review and seven semi-structured interviews with dairy farmers. The literature review primarily focused on documented impacts from modern genetic technology use overseas and the actions and strategies taken to mitigate these impacts. The interviews were conducted with a range of participants, covering small- to large-scale dairy operations, and a variety of views on the use of genetic technology. The interview data was analysed using thematic analysis. These findings were compared and evaluated against the literature review to develop the key findings.

Key Findings

The data collected from the literature review and interviews were analysed and found:

- Regulatory reform is needed to keep pace with technological advancements and meet international standards. However, consideration should be given to ensuring that regulations are not more permissive than those of our key markets.
- Collaborative governance and inclusive decision-making are critical, particularly integrating farmers' practical knowledge to create effective and trusted policies.
- Farmers require effective coexistence measures and regulatory alignment with export market standards to mitigate economic impact.
- Farmers and industry will need certainty and clarity about genetic technology's impacts in a New Zealand-specific context.
- Clear communication and collaboration between government, industry, and research institutions, along with robust education and training programs, are essential for effective technology adoption.
- A gradual and controlled approach to adopting genetic technology, starting with low-risk modifications, can build knowledge, capabilities, and trust.

Recommendations for Decision-Makers:

1. Foster collaboration and inclusive decision-making: Create a regulatory environment incorporating diverse perspectives and building public trust. Consider establishing a semi-independent body or commission to ensure all stakeholders, including farmers, scientists, consumers, and Māori, have input in the regulatory reform process.
2. Develop coexistence measures: Work closely with stakeholder groups to develop and enforce mandatory coexistence measures such as buffer zones and isolation distances.
3. Enhance farmer education and support: Invest in demonstration farms, early adopter programs, and robust extension services to provide hands-on training and support.
4. Ensure clear and transparent communication: Build public and market confidence in using modern genetic technology through consistent and accurate information dissemination. This may require a unified communication strategy involving government, industry, and research institutions to clearly explain genetic technology's benefits, risks, and regulatory requirements.
5. Align market differentiation with export markets: Align New Zealand's labelling and standards for GM products with those of major export markets to facilitate trade and avoid market access issues.
6. Gradual and controlled adoption strategy: Start with low-risk applications of genetic technology, such as those with environmental or biosecurity benefits, and gradually expand to more complex modifications.

2. Acknowledgements

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I would also like to acknowledge the Kellogg 51 cohort. You have provided a great sense of community and the motivation and support to get through this report process. It's been a privilege to build these connections, and I hope to stay in touch in the future.

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3. Table of Contents

Cover image credit: NZ Story Toolkit

4. Key Terms and Definitions

The following table outlines the definitions of some of the key terms used throughout this report. These definitions have been sourced from Te Puna Whakaaronui's report on modern genetic technology (2023).

Table 1 Key terms and definitions

Term	Definition
Genetic technology	A form of biotechnology and the umbrella term for all techniques, methodologies and tools used to analyse and intervene in the genetic material of living organisms. The term genetic technology includes anything from traditional breeding techniques to genetic modification
Genetic modification (GM)	The act of utilising genetic technology to modify the genome of an organism. This can also referred to as genetic engineering. This does not include traditional breeding techniques.
Genetically modified organism (GMO)	Any organism that has been genetically modified through any genetic engineering technique, including transgenic organisms. This is a scientific definition. However, this term has several legal definitions in different jurisdictions. Note, organisms that result solely from traditional breeding techniques are not genetically modified organisms.
Modern genetic technology	The term covers new techniques, methodologies and tools used to analyse and intervene in the genetic material of living organisms. This can include gene editing and other precision breeding techniques.

1 Introduction

With the recent advancements in science, the world is beginning to reassess its regulatory stance on using genetic technology in food production (Genetic Literacy Project, 2020). Recent innovations have prompted a global reevaluation of existing policies as countries recognise the potential benefits of more precise genetic technologies. Consequently, nations are shifting towards more liberal and nuanced regulatory systems that enable the adoption of these precise technologies with less administrative and bureaucratic burden.

In many countries, this transition involves updating outdated regulations that were originally designed to address the broader and less targeted genetic modification methods of the past. The newer regulatory frameworks are more attuned to the capabilities of modern genetic technology, which can make highly specific modifications with greater accuracy and predictability.

New Zealand's current regulation of genetic technology , the Hazardous Substances and New Organisms Act 1996, is considered one of the strictest in the world. Driven by these global trends and recent advancements in genetic technology, New Zealand has begun its regulatory reform process. New Zealand aims to use this reform to harness these technological advancements to improve agricultural productivity, sustainability, and competitiveness in global markets. However, these advancements also bring complexities and challenges that must be carefully managed through regulation and surrounding processes and mechanisms to ensure their safe and effective implementation.

This report explores how New Zealand can best support its dairy farmers through this regulatory reform process and ultimately help the sector adopt genetic technology in a way that minimises risk. The successful adoption of genetic technology requires regulatory change and robust support systems for farmers, ensuring they are equipped with the knowledge and tools needed to navigate this new frontier. This report outlines the regulatory adjustments, market-based standards and measures, and educational initiatives that may be required to facilitate this transition.

The key findings from this research are designed to guide decision-makers and industry leaders in supporting our farmers as this new technology becomes available. These recommendations aim to ensure that New Zealand remains at the forefront of agricultural innovation while fostering a sustainable and prosperous future for our farming communities.

2 Aims and Objectives

This work aims to identify possible actions and strategies to support New Zealand dairy farmers as modern genetic technology becomes permissible on farms. The report was centred around the research question:

What support will dairy farmers need if the use of genetic technology in food and fibre production is permitted in New Zealand?

In response to this question, the report aims to outline what actions should be taken and by whom, but it does not outline the details of how each of these actions should be implemented.

3 Literature Review

This literature review provides the context for New Zealand's current regulatory reform. It also provides background on the possible impacts of the use of genetic technology and how other countries have supported the sector in mitigating these impacts.

The first section of the literature review covers why New Zealand is currently considering regulatory reform. The second section outlines some economic, social, and environmental impacts of using genetic technology in food production overseas. The final section explores some of the actions taken to mitigate these impacts.

3.1 Why is This Conversation Important Now? - A Changing Regulatory Environment

3.1.1 Current Regulatory Environment

The use of genetic technology in New Zealand is currently governed by the Hazardous Substances and New Organisms Act (HSNO Act). It sets out a comprehensive regulatory framework for assessing, managing, and controlling the risks associated with these substances and organisms. The Act defines all organisms created using genetic technology as high-risk and applies a stringent risk assessment and approval process.

When the framework came into effect, it was considered one of the strictest in the world. Since then, there have only been minor changes to the legislation. The Act is not an outright ban; it allows scientists to experiment with GM techniques and organisms in a lab and contained field trials. It also permits the release of GMOs, subject to an approval process. However, while there is a high use of genetic technology in lab settings, the prescriptive nature of the criteria around field trials and the subsequent intensive administrative obligations are such that scientists have found it almost impossible to meet them. As a result, the EPA has only approved 13 applications for genetically modified plants for contained outdoor field trials since 1996. No field trials of genetically modified organisms have been approved since 2010 (Genetically Modified Organisms Field Tests | EPA, n.d.)

3.1.2 Proposed Regulatory Change

The 2024 National Government has campaigned on a promise to review and reform New Zealand's regulation of genetic technology. At a March 2024 biotechnology conference, science and technology minister Judith Collins announced that the government will enact legislation to overhaul New Zealand's gene-editing legislation by the end of 2025. The regulatory reform is moving at pace, with Minister Collins indicating that the legislation would be ready to go before Parliament by the end of 2024 (Hurrell, 2024).

3.1.3 Drivers for Regulatory Change

There are several key drivers for regulatory reform in New Zealand. These are primarily related to the advances in genetic technology, changes to the global regulatory approach, and an increased need for tools in the climate change tool box.

New Advancements in Genetic Technology

One of the drivers for regulatory change is ensuring that regulation keeps up with technological advancements.

Genetic technology has advanced over time, and techniques have become progressively more precise. As the precision of genetic technology increases, the risk of unintended consequences or off-target effects decreases. With modern genetic technology, scientists can make modifications resulting in organisms with changes similar to those obtained via traditional methods (Te Puna Whakaaronui, 2023). In other words, scientists can make modifications that could occur in nature, but just on faster timelines.

The following figure from Te Puna Whakaaronui's report on modern genetic technology (2023) shows the continuum from low-precision to high-precision techniques over time.

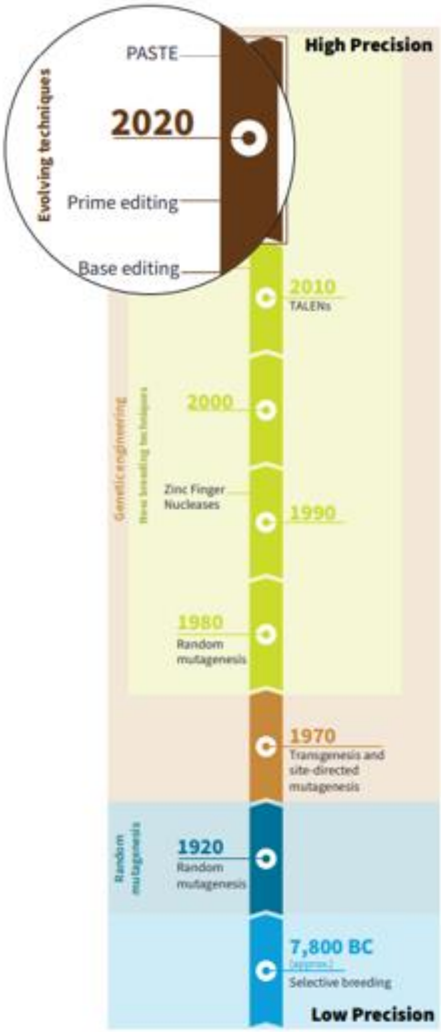


Figure 1 A continuum from low precision to high precision genetic techniques. Sourced from: WELL_NZ: Modern Genetic Technology - what it is and how it is Regulated: a Reference Document from Te Puna Whakaaronui: New Zealand's Independent Food and Fibre Sector Think Tank.

New Zealand's current regulation on genetic technology was developed before precision techniques became available. The regulation treats all types of genetic modification as high-risk. Regulatory reform could enable New Zealand to assign different risk processes to different types of genetic technology.

Misalignment with the Global Regulatory Approach

Another of the main drivers is misalignment with the global regulatory approach.

There are currently 29 countries growing GMO crops: Argentina, Australia, Bangladesh, Bolivia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Honduras, India (Bt cotton only), Malawi, Mexico, Myanmar, Nigeria, Pakistan, Paraguay, Philippines, Portugal, South Africa, Slovakia, Spain, Sudan, eSwatini (Swaziland), United States, Uruguay, Vietnam, and Zambia (Genetic Literacy Project, 2024).

At present, seven of New Zealand's top eighteen export markets grow and import genetically modified organisms (Trading Economics, 2023; Genetic Literacy Project, 2024). These seven markets include New Zealand's highest-value export markets, comprising 77% of our total export value. Table 2 below shows the breakdown of New Zealand's export markets and their stance on GMO cultivation and importation.

Table 2 New Zealand's key export markets and their current use of genetically modified organisms in food production and consumption.

Key Export Countries	Export Value (Trading Economics, 2023)	GMOs grown? (Genetic Literacy Project, 2024)	GMOs imported? (Genetic Literacy Project, 2024)
China	$11.32B	Yes	Yes
Australia	$5.43B	Yes	Yes
United States	$5.08B	Yes	Yes
Japan	$2.33B	No	Yes
South Korea	$1.46B	No	Yes
Singapore	$1.04B	No	Yes
Indonesia	$974.83M	Yes	Yes
United Kingdom	$883.93M	No	Yes
Malaysia	$785.89M	No	Yes
Thailand	$762.78M	No	Yes
Hong Kong	$665.99M	No	Yes
Saudi Arabia	$632.32M	No	Yes
Netherlands	$625.59M	No	Yes
UAE	$605.26M	No	Yes
Algeria	$599.14M	No	No
Canada	$579.68M	Yes	Yes
Vietnam	$576.30M	Yes	Yes
Philippines	$439.09M	Yes	Yes
New Zealand	-	No	Yes

Further, many countries are currently undergoing regulatory reform. The United Kingdom (Genetic Technology (Precision Breeding) Act 2023 - Parliamentary Bills - UK Parliament, 2023), the European Union (Actions to Boost Biotechnology and Biomanufacturing in EU, 2024), and China (Liang J et al., 2022) are in the process of moving to more liberal regulatory approaches to the use of modern genetic technology.

Large economies will likely continue progressing their regulation of modern genetic technology to more liberal systems. These large trading partners will likely want reciprocal agreements on market access and trade of their own genetically modified products. Non-alignment may impact New Zealand through impacts on preferential trading agreements (Lazo & Sauvé, 2017).

Climate Change Mitigation and Adaptation

New applications of genetic technology can help food producers tackle some of the challenges associated with climate change. New Zealand will likely see more unpredictable weather, droughts, floods, and increased pest and disease incursions (Climate Change and Possible Impacts for New Zealand | NIWA, n.d.).

These challenging conditions will directly impact our ability to produce food. Gloablly, climate change is predicted to cause a 23% decline in major crop production from maize, wheat, rice, and soybean by 2050 (James, 2017).

Some of the possible applications of genetic technology to support adapting or mitigating climate change in the dairy sector include cows with short and sleek hair coats that have increased thermoregulation (Bio.News - Biotechnology Innovation Organization (BIO), 2023), modified forages that are more resilient to changing weather (Caradus et al., 2021), or forages that have the potential to reduce the environmental impact of pastoral farming (Roldan, Marissa B., et al. 2019)

3.1.4 Likely New Regulatory Environment

At the time of this report's publication, New Zealand is in the process of regulatory reform. The new regulatory framework will likely be modelled after jurisdictions such as Australia, the EU, and the UK.

These jurisdictions have a tiered risk-based framework. This regulatory framework assigns different risk levels to different types of genetic technology. The underpinning principle of this framework is that, from a scientific perspective, genetically modified organisms, where no new DNA has been introduced into the genetic material of an organism, are unlikely to pose a greater risk than similar organisms produced with traditional breeding techniques (Royal Society Te Apārangi, 2019)

3.2 What are Some of the Impacts of Using Modern Genetic Technology in Food Production?

This section reviews the impacts of modern genetic technology on food production, focusing on economic, social, and environmental elements.

3.2.1 Economic Impacts

Economic impacts are some of the most well-documented effects of using modern genetic technology in food production. The literature covers key impacts to farm profitability, national and product brand, and coexistence measures that enable economic benefit from market differentiation.

Farm Profitability

In general, the literature shows that the use of modern genetic technology in food production increases a farm's profitability. A 2014 meta-analysis of the impacts of genetically modified crops showed that while GM seeds are more expensive than non-GM seeds, the additional seed costs are compensated through chemical and mechanical pest control savings. The average profit gain for GM-adopting farmers is 69% (Klümper & Qaim, 2014**).**

Brand

Little research has been done on using GMOs on New Zealand's brand. John Knight completed the most recent comprehensive study in 2011. This study concluded that there is no premium for NZ being GM-free. Knight (2011) completed a survey of New Zealand tourists. Using the example of GM drought-tolerant grass, they found that it was likely that NZ's clean green image would not be damaged. What (some) people valued was whether the product itself was GM-free.

A more recent study by Caradus et al. (2022) found that the long-term use of GM plants in New Zealand for food production will likely have minimal negative effects on international markets and the New Zealand brand.

However, Knight (2014) found that products that must be labelled as genetically modified are likely to have lower demand and willingness to pay from some consumers.

Coexistence

Many countries differentiate their non-GM products from GM products in the market. Because of producer and consumer preferences, GM crops have been separated into different supply chains from non-GM crops. In the literature, managing and maintaining the separation between GM, non-GM, and organic processes is known as coexistence.

In countries where genetic technology is permitted in food production, there are risks to non-GM and organic growers of cross-contamination. Cross-contamination among crops has economic costs. In 2016, USDA–ERS released a survey that showed that the percentage of organic farmers reporting economic losses due to the unintended presence of GE materials in their crops varied by region and by the presence of GE crop varieties in their area (Greene et al., 2016).

However, it has also been shown to be feasible to grow GM crops alongside non-GM or organic crops if the right systems and processes are in place. A 2019 independent review of the South Australian GM food crop moratorium found that the successful coexistence of GM and non-GM occurred in the Australian states that allowed GM. Further, the premium for GM-free canola from GM-free states was the same as the GM-free premium from states where GM was allowed. In other words, there was no premium for growing in a GM-free region (Anderson, 2019).

3.2.2 Social Impacts

Adopting modern genetic technology can affect community and rural dynamics, impacting labour markets, economic viability, and cultural values (National Academies of Sciences, Engineering, and Medicine, 2016). This section outlines these impacts, addressing the complexities and concerns related to community dynamics, the availability and cost of GM seeds, and the influence of cultural and community values.

Community and Rural Impacts

The United States National Research Council report (2010) concluded that adopting GM crops can affect community dynamics, labour dynamics, and the viability of rural communities. The adoption of GM crops can affect community dynamics by altering traditional farming practices and social relationships, often increasing dependence on technology providers and changing the roles within local agricultural communities. Labour dynamics are influenced as GM crops may reduce the need for manual labour due to their pest-resistant and herbicide-tolerant traits, potentially leading to job losses or a shift in the type of labour required. Finally, the viability of rural communities can be impacted as small-scale farmers may struggle to afford the higher costs of GM seeds and related inputs.

Very few studies have explicitly focused on the impact of GMOs on communities, so it is difficult to draw any overarching conclusions related to specific applications of genetic technology. Lobao and Stofferahn (2008) drew inferences from other studies on the intersection of agricultural technologies and communities. They stated that there is a risk that GMOs could contribute to the industrialisation of farming, potentially leading to increased farm consolidation and a decline in family farms.

Availability and Cost

In general, GM seeds are more expensive than non-GM seeds. This cost can limit adoption, especially for smaller farms (Finger et al., 2011). There is also evidence that a rise in land planted with GM crops is correlated with a decline in the availability of non-GM seeds (Pechlaner, 2012).

While farmers may benefit from reduced inputs or labour associated with the adoption of genetic technology, the availability and cost of seeds may result in poor accessibility for smaller farms and further industrialisation of farming enterprises.

Cultural and Community Values

Recent research (Clark et al., 2024) has explored the different New Zealand Indigenous perspectives on the use of gene editing (a precise form of genetic modification). Interviews, literature reviews, and surveys were conducted to inform this analysis, which found that perspectives on genetic technology vary widely based on its application, with opinions ranging from positive to negative, influenced by values and relationship dynamics. Clark et al., (2024) found that there is scepticism about the claimed benefits and risks despite recognition of the potential advantages. Key concerns include the cultural and environmental impacts and the potential for misuse by unscrupulous interests. Strong feedback highlights control issues, such as questioning who owns and manages the technology and the associated genomic data.

3.2.3 Environmental Impacts

A significant amount of the literature is focused on the environmental impact of genetically modified crop use in the United States from the 1990s – 2000s. While these environmental risks and impacts still apply today, it should be noted that environmental impacts are more significant when genetic modification results in a change in the organism that couldn't occur naturally. More recent, precise genetic technologies result in changes that are similar to what could occur with traditional breeding, minimising this risk (Koller et al., 2023).

Possible Environmental Impacts

- Gene flow: The transfer of genes from GM organisms to wild relatives or non-GM organisms can lead to unintended ecological consequences, such as creating hybrid species that may become invasive or alter the genetic makeup of wild populations (Tsatsakis et al., 2017).
- Toxicity: Some GM crops require specific chemicals, such as herbicides and pesticides, which can be toxic to non-target species, including beneficial insects like beetles, bees, and butterflies (Ammann, 2005). The use of chemicals with GM crops can have harmful side effects on soil and water quality (Cerdeira & Duke, 2010)
- Weediness: There is a risk that GM crops could become weedy or invasive, spreading beyond their intended agricultural environment and disrupting local ecosystems (Ammann et al., 2000)
- Biodiversity: The widespread adoption of GM crops can reduce biodiversity. This includes a decline in the variety of crops planted and adverse effects on non-target species that play critical roles in ecosystems (Bigler & Albajes, 2011).
- Reduced efficiency of pest, disease, and weed Control: Over time, pests, diseases, and weeds can develop resistance to the GM traits designed to control them, leading to reduced effectiveness of these controls and potentially necessitating increased use of chemicals (Bonny, 2016).

3.3 What Actions Could Support Farmers and Industry with the Use of Genetic Technology in Food Production?

3.3.1 Farmer Knowledge and Education

The literature suggested that farmers need to be more involved in regulatory processes, embedding their tacit knowledge into policy and risk management to deliver better outcomes for the use of genetic technology in food production.

Henderickson (2015) found that the knowledge of actual farming practices and the farming systems in which they are embedded helps in assessing both the positive and negative impacts of technology. The National Academies Of Sciences Engineering And Medicine et al. (2016) suggested that regulators often ignore practical knowledge from farmers, which could otherwise inform policies more effectively. Goven and Morris (2012) argued that regulatory regimes of the United States, the European Union (EU), Canada, and New Zealand tend to exclude, even if unintentionally, farmer knowledge related to establishing regulatory policies. These factors leave a deficit of farmer and practical knowledge in decision-making, leading to difficulties in creating impactful and fit-for-purpose policies.

The National Academies Of Sciences Engineering And Medicine et al. (2016) concluded that farmer knowledge is crucial for understanding the impacts of any agricultural technology, including genetically modified organisms, and improving regulatory structures.

The following table (Table 3) outlines how this intervention may support the mitigation of the impacts outlined in Section 5.3.

Table 3: Overview of how farmer education and knowledge intervention may support the mitigation of impacts from the use of genetic technology in dairy production.

	Economic	Social	Environmental
Will this mitigate impacts?	Yes	Yes	Yes
How will this mitigate impacts?	More fit-for-purpose policies and regulation may lead to lower compliance costs, better optimisation of genetic technology, and greater ease in meeting market standards.	A community and farmer-centred approach may lead to community empowerment, more equitable outcomes, and increased trust with regulators.	Education and fit-for-purpose regulations may lead to more sustainable practices, reducing environmental degradation and conserving biodiversity.

3.3.2 Cost and Intellectual Property

Genetically modified farm system inputs are likely to be more expensive than non-GM inputs. Although the GM varieties often produce greater yields and sometimes reduce other input costs, the literature presented some case studies in which it was not always economically feasible for smaller-scale farmers to adopt GM crops or to continue planting in seasons after initial adoption (The National Academies Of Sciences Engineering And Medicine et al., 2016).

The literature identified two possible mitigations: humanitarian-use licenses or subsidies. This sort of government intervention in the market may support disadvantaged groups in society by enabling them to access innovation or ensuring that a technology that provides a public good (e.g., emissions reduction) is adopted widely across the sector.

Humanitarian-use Licenses

The use of humanitarian use licenses enables people in need to access innovations on a royalty-free basis or at lower costs. Some initiatives have attempted to address cost through humanitarian-use licenses that allow researchers to develop GM crops without concern about having to pay royalty fees to agricultural biotechnology firms (Takeshima, 2010).

Microfinance and Credit Programmes

Without access to affordable credit, many farmers cannot invest in GM crops despite the potential long-term benefits such as higher yields and reduced input costs. Credit support can enable smallholder or disadvantaged farmers to adopt GM technology, improving productivity and income (Azadi et al., 2016).

Some governments and non-governmental organizations (NGOs) offer subsidies or low-interest loans to encourage the adoption of GM crops. Studies have highlighted that access to credit institutions helps facilitate farmers' technology uptake (Glover 2010a; Dowd-Uribe and Schnurr 2016).

The following table (Table 4) outlines how cost and intellectual property intervention may support the mitigation of the impacts outlined in Section 5.3.

Table 4: Overview of how cost and intellectual property intervention may support the mitigation of impacts from the use of genetic technology in dairy production.

	Economic	Social	Environmental
Will this mitigate impacts?	Yes	Yes	Maybe
How will this mitigate impacts?	Genetic technology adoption may be more economically feasible for small-scale farmers, potentially increasing their productivity and income.	Humanitarian-use licenses and microfinance programmes may enable disadvantaged farmers to access GM technologies, fostering social equity and community development.	This could promote positive environmental outcomes if the applications of genetic technology that are incentivised for adoption have environmental benefits.

3.3.3 Coexistence Measures

Different countries have varying approaches to managing coexistence, ranging from prescriptive regulation to market-based interventions. For example, the European Union has a regulatory framework for coexistence, requiring Member States to develop national strategies and measures (EC, 2009). Meanwhile, in the US, coexistence is largely managed through voluntary guidelines rather than mandatory regulation (Kalaitzandonakes & Magnier, 2016).

In the New Zealand context, Rolleston (2016) published a paper exploring how coexistence could play out in New Zealand pastoral systems. The paper concluded that voluntary or mandatory coexistence measures could be successful. However, successful coexistence requires balancing the rights and responsibilities of GM and non-GM farmers.

Mandatory Government Regulations and Guidelines

Countries that have actively regulated coexistence through specific rules and allocation of property rights include the member states of the European Union, Australia, Japan, and Brazil (The National Academies of Sciences Engineering and Medicine et al., 2016). These countries have different policy mechanisms to regulate coexistence, but commonly, they include mandatory isolation distances, buffer zones, and specific crop management practices to prevent cross-contamination.

Voluntary Guidelines

Countries that let the market and firms manage coexistence through voluntary guidelines and standards include the United States of America, Canada, and South Africa (The National Academies of Sciences Engineering and Medicine et al., 2016). In these countries, governments have let markets determine the rigour required for market differentiation of non-GM to GM products. For example, in the US, seed companies of crops with GE traits and farmer trade associations have developed programs, guidelines, and best management practices to reduce the incidence of unwanted low-level presence of GM traits. In the US, seed companies have sponsored the Excellence Through Stewardship Program, which develops best management practices to prevent gene flow during testing and field trials of GM crops and to minimise inadvertent introduction of unwanted GM traits (Excellence Through Stewardship, 2008, updated 2014).

Liabilities and Dispute Resolution

As with the approach to coexistence measures, there are different approaches to liabilities and dispute resolution.

In some countries, for example, the US, it is argued that farmers and growers who seek to market such high-value speciality crops (e.g., non-GM or organic) should bear the costs of protecting their unique qualities by carefully segregating them throughout the growing and distribution chain. These farmers and growers voluntarily take a risk by agreeing to private contracts with low thresholds of the presence of GM content and therefore should bear the burden of the costs of meeting those requirements (Smyth et al., 2002).

In other countries, such as the EU and Australia, GM crop growers are held responsible for economic damages caused by contamination of non-GM or organic crops (Rehbinder & Loperena, 2006; Paull, 2019).

The following table (Table 5) outlines how coexistence measures may support mitigating the impacts outlined in Section 5.3.

Table 5: Overview of how coexistence measures may support the mitigation of impacts from the use of genetic technology in dairy production.

	Economic	Social	Environmental
Will this mitigate impacts?	Yes	Maybe	Maybe
How will this mitigate impacts?	Mandatory coexistence measures in regulated countries can ensure market stability and prevent economic losses for non-GM and organic producers. In contrast, voluntary guidelines can reduce regulatory costs, and ensure alignment with market demand.	Mandatory coexistence measures enhance social equity by protecting non-GM and organic farmers' rights and economic interests. Voluntary guidelines may lead to social inequities, as these farmers may lack the resources to manage coexistence effectively.	Government regulations that mandate specific management practices help minimise cross-contamination and preserve biodiversity. However, voluntary guidelines that rely on industry best practices may vary in effectiveness.

3.3.4 Labelling

Labelling of genetically modified organisms is closely linked to coexistence measures. The stringency of coexistence measures required is often determined by the labelling threshold (Desquilbet et al., 2012).

Different countries have adopted different approaches to GM labelling. Some require mandatory labelling of GM foods, while others follow a voluntary system. GM food producers and governments that consider GM foods generally as safe as or near equivalent to 'natural ones' maintain that the mandatory labelling of such foods is unnecessary. In addition, they believe that labelling would add complexity and cost to segregation through the supply chain (Huffman et al., 2002).

On the other side, more cautious governments and consumer interest groups call for mandatory labelling of GM foods. They believe that consumers have the right to know what they are taking as food, given some concerns about the human and environmental health implications of GM food (Raab & Grobe, 2003), and possible religious or ethical objections from consumers (Latifah et al. 2011)

Labelling thresholds also differ across different countries' regulations and standards. In the EU, where there is mandatory labelling, a product must be labelled if it contains more than 0.9 per cent content derived from GM crops. In the USA, where mandatory labelling was only introduced on December 29, 2023 (BE Disclosure | Agricultural Marketing Service, n.d.), the "Non-GMO Project" was created to provide consumers with a choice to eat non-GM food. This standard provides non-GMO accreditation to products with up to 5% GMO presence in feed and supplements for livestock, poultry, bee and seafood and 0.9% tolerance for wholesale goods approved for human ingestion ((The Non-GMO Project, 2023). Both standards and regulations build a reasonable threshold (e.g., 1% GM presence) for coexistence, which can allow both GM and non-GM farming practices to coexist without stringent regulations.

Finally, what is legally defined as a genetically modified organism can differ across countries. With the recent advancements in genetic technology, some jurisdictions are introducing regulations that exclude small, precise gene edits from the legal definition of 'GMO'. For example, the EU has proposed that plants be exempt from current regulation if no more than 20 nucleotides[1] are added or replaced during gene editing (Stokstad, 2023). This likely means that, as long as this approach is not at odds with key trading partners, these applications of genetic technology will not need to be labelled as GM.

The following table (Table 6) outlines how labelling may support mitigating the impacts outlined in Section 5.3.

Table 6: Overview of how labelling may support the mitigation of impacts from the use of genetic technology in dairy production.

	Economic	Social	Environmental
Will this mitigate impacts?	Maybe	Maybe	Maybe
How will this mitigate impacts?	Mandatory labelling can increase production and segregation costs for GM food producers. However, voluntary labelling systems can reduce these costs but may lead to inconsistent consumer information and potential market disadvantages for non-GM products.	Mandatory labelling supports consumer rights by providing transparency about GM content, allowing consumers to make informed choices based on health, ethical, or religious concerns. However, it may also lead to increased costs and complexity in the supply chain, potentially limiting the availability of affordable GM foods.	Stringent labelling thresholds can encourage better coexistence practices and reduce the risk of cross-contamination, thereby reducing environmental risk.

4 Methodology

4.1 Interviews and Thematic Analysis

4.1.1 Interview Procedure

Seven semi-structured interviews, each lasting approximately 60 minutes, were conducted via Microsoft Teams to gather in-depth insights into participants' experiences and perspectives.

Interview participants were selected to cover small—to large-scale dairy operations and a variety of views on the use of genetic technology in food production. Six of the seven interview participants are current farm operators, with one having retired from farming. Two interview participants are considered large-scale operators; the remaining four are family or small-scale operators. One organic farmer was interviewed.

[1] A molecule that is the basic building block of the nucleic acids DNA and RNA.

The semi-structured format allowed for flexibility in probing deeper into specific areas of interest while maintaining a consistent framework across all interviews. Interview questions can be found in Appendix One. These questions were structured first to understand general views and perceptions on the use of genetic technology in dairy production. Then, questions sought to understand what support farmers may need on the farm for adoption and access to technology. Finally, the questions sought to understand how this may impact the dairy value chain and the ability of the sector to differentiate in the market.

4.1.2 Thematic Analysis

The interview data were analysed using the thematic analysis method outlined by Braun and Clarke (2006). Initially, the transcripts were read and re-read to become thoroughly familiar with the data, allowing for the noting of preliminary ideas. Subsequently, the data were systematically coded to identify interesting features throughout the dataset. These codes were then grouped into potential themes. The themes were reviewed and refined to ensure they accurately represented the data, followed by clearly defining and naming each theme. Following the thematic analysis process, mind maps were developed to show the high-level themes arising from the interviews (refer to Figures 3, 4, 5, 6, 7, & 8).

4.1.3 Terminology for Participant Responses

In this report, the terms "some," "many," "most," and "few" indicate the proportion of interview participants who shared a particular experience, perspective, or theme. These terms provide a qualitative sense of the prevalence of certain insights.

- *Some:* This term indicates that a minority of participants (less than four) mentioned a particular point or theme. It suggests that while the finding is notable, it was not widely shared across the participant pool.
- *Many:* This term is used when a substantial portion of the participants (more than four) expressed a particular experience or viewpoint. It implies that the finding is fairly common but not dominant.
- *Most:* This term indicates that a majority of participants (more than five) shared the same experience or perspective. It conveys that the finding is widely prevalent among the participants.
- *Few:* This term signifies that only a small number of participants (less than three) mentioned a specific point or theme. It suggests that the finding is relatively rare within the participant group.

4.2 Limitations of Research

Due to time constraints for this project, this report does not provide an in-depth analysis of farmer impacts from using genetic technology and the associated possible strategies to support farmer use. The report aims to surface all the elements at a high level but does not explore the details of these elements.

A significant amount of references sourced for this work were published before 2016. This is a limitation, as significant advancements in genetic technology only occurred after the mid-2010s. The views and perceptions referenced may now be outdated, as they are based on older technology. This is a notable gap in the literature, where further research is required.

This report is limited by the number of qualitative interviews and their individual perspectives. Interviewees were selected to try to cover a range of small to large-scale operators with varying positions on using genetic technology. The views expressed in qualitative interviews may not represent the broader population. Because these interviews rely on a limited number of participants, the perspectives shared are shaped by their unique experiences and knowledge. As a result, the findings might not fully capture the diversity of opinions and experiences in the larger farming community. Therefore, the results are inherently constrained by the interviewees' experiences and knowledge. Some comments from participants in the report have been refined to improve readability and, therefore, are not quoted verbatim.

This report is also limited as it solely considers the use of genetic technology in dairy production systems. This information would likely have applications in most New Zealand food and fibre production.

5 Analysis and Results

Farmer participants were asked questions about their general views on the use of genetic technology in the dairy sector, what (if any) concerns they had, what impacts the technology may have on markets and the value chain, and what support they may need from industry and government. Figure 3 on the following page outlines the key themes identified throughout the discussions about the support required for the use of genetic technology in the dairy sector.

This report discusses these themes in order of least to most proximal to the farm gate. This is shown below in Figure 2, with more strategic themes such as positions and regulation being discussed first before moving to themes that address actionable support on-farm.

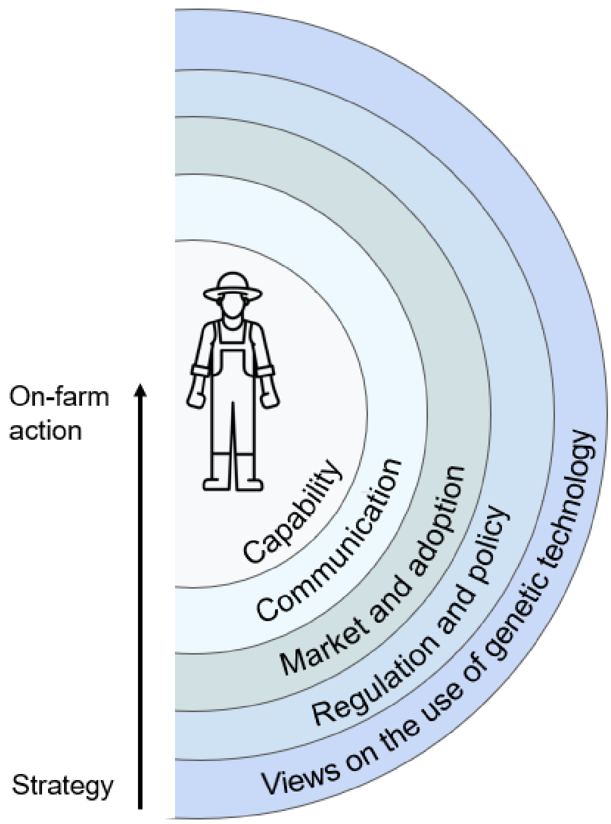
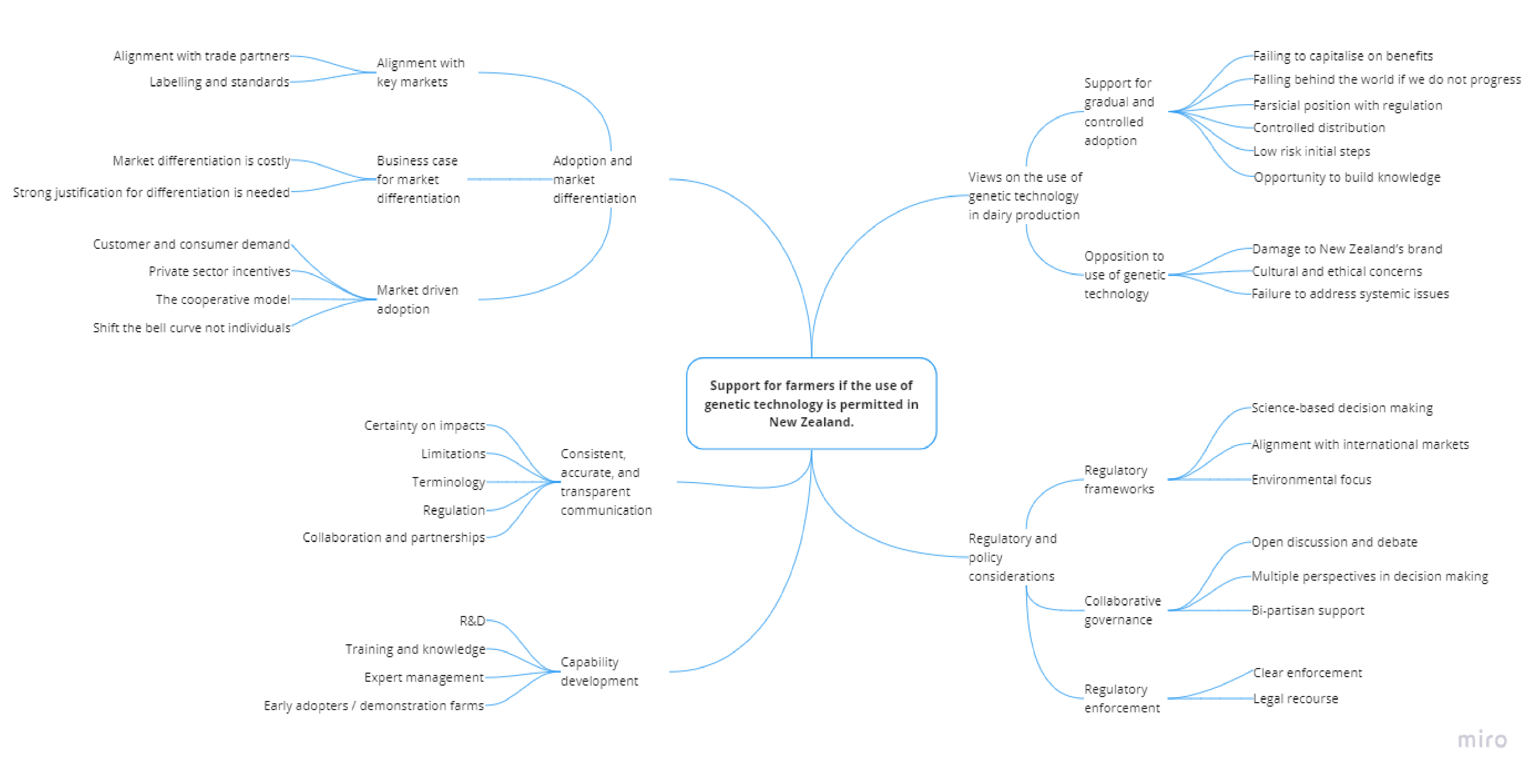


Figure 2 Key themes for support requirements for farmers using genetic technology, shown relative to the farm gate


Support for farmers if the use of genetic technology is permitted in New Zealand.
Adoption and market differentiation
Alignment with key markets
Alignment with trade partners
Labelling and standards
Business case for market differentiation
Market differentiation is costly
Strong justification for differentiation is needed
Market driven adoption
Customer and consumer demand
Private sector incentives
The cooperative model
Shift the bell curve not individuals
Consistent, accurate, and transparent communication
Certainty on impacts
Limitations
Terminology
Regulation
Collaboration and partnerships
Capability development
R&D
Training and knowledge
Expert management
Early adopters / demonstration farms
Views on the use of genetic technology in dairy production
Support for gradual and controlled adoption
Failing to capitalise on benefits
Falling behind the world if we do not progress
Farsicial position with regulation
Controlled distribution
Low risk initial steps
Opportunity to build knowledge
Opposition to use of genetic technology
Damage to New Zealand's brand
Cultural and ethical concerns
Failure to address systemic issues
Regulatory and policy considerations
Regulatory frameworks
Science-based decision making
Alignment with international markets
Environmental focus
Collaborative governance
Open discussion and debate
Multiple perspectives in decision making
Bi-partisan support
Regulatory enforcement
Clear enforcement
Legal recourse
miro

5.1 Views on the Use of Modern Genetic Technology in Dairy Production

5.1.1 Key Themes

Farmers were asked a series of questions about their views on the use of genetic technology in dairy production, and what, if any, concerns they may have if it were adopted in their farm system or catchment. Views both for and against the use of genetic technology were represented, but the predominant view could be described as 'cautious optimism'. Figure 4 outlines the key themes identified under views on the use of genetic technology in dairy production.

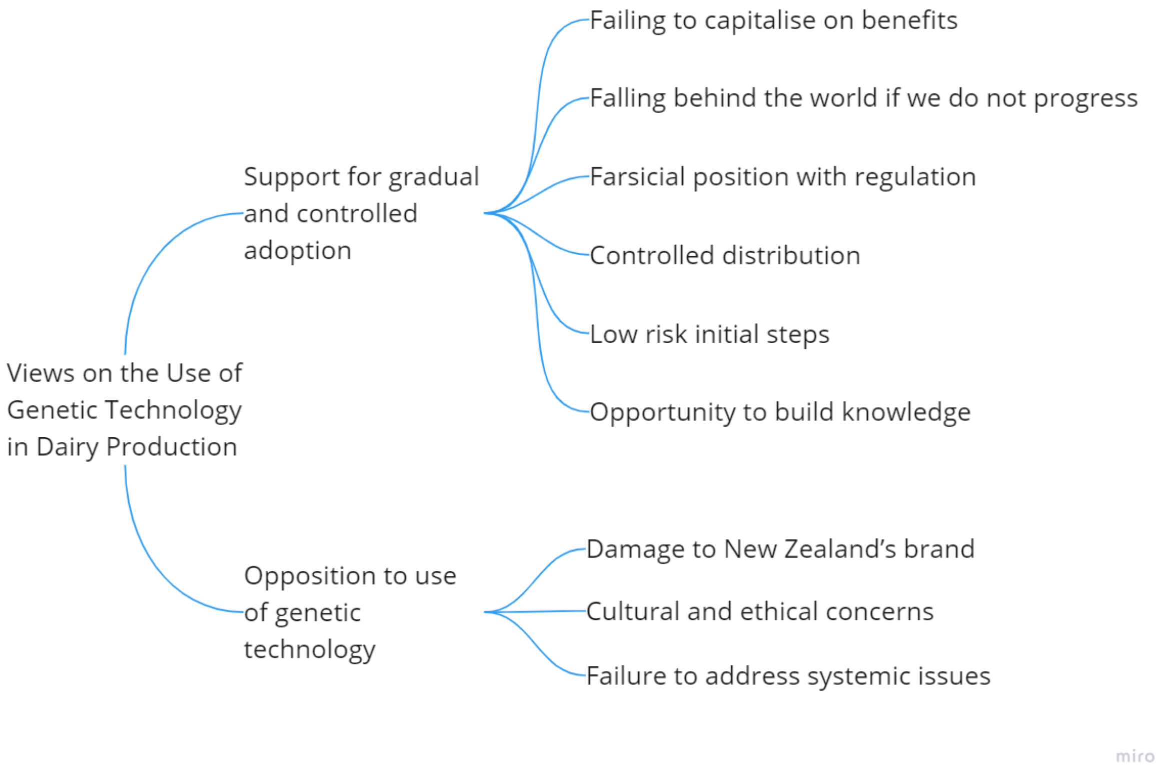


Figure 4: Key themes arising in relation to views on the use of genetic technology in dairy production.

5.1.2 Support for Gradual and Controlled Adoption of Genetic Technology

Most interviewed farmers were supportive of the adoption and use of genetic technology in dairy production. They saw significant benefits from the technology's adoption but were also concerned about the possible risks to the environment, society, and economy. Many suggested a gradual approach to adoption to build knowledge and provide clarity and certainty around impacts.

Potential Benefits of Adopting Genetic Technology

Many interview participants saw the possible benefits of using genetic technology in New Zealand dairy production. Farmers outlined the following as possible benefits from the use of genetic technology in the dairy sector:

- Production benefits.

- Decreased inputs such as less agri-chemical usage.
- Using genetic technology to increase pest and disease resistance, or improve environmental tolerance.
- Reducing the environmental footprint of dairy production and adapting to environmental stressors.

  "There is a role for modern genetic technology in adaptation to and mitigation of climate change. For example, modifications that enable plant species to grow in a wider range of environments or more unpredictable environments, heat tolerance in livestock, or perhaps genetically modifying a cow or her rumen to get rid of methanogens."

- Using genetic technology to rapidly advance genetics and increase the speed at which we acquire highly valuable phenotypes.
- Creating consumer traits, and targeting new niche markets with optimised diets or nutriceuticals.

  "The future human diet will be plant-based but animal optimised, we need to make sure animal products meet those key nutritional needs"

- Meeting customer requirements for production, such as scope 3 intensity targets.

Potential Risks of Not Adopting Genetic Technology

All of the interviewed farmers recognised that the global genetic technology regulatory landscape is changing, and beginning to take a more liberal approach. Many interviewees believed that New Zealand may be at a competitive disadvantage if we do not act with urgency.

"Other jurisdictions are easing regulations around the use of modern genetic technology – if we don't move with them, we will be left behind."

As outlined above, many of the interviewed farmers saw significant opportunities for environmental, consumer, and producer benefits with the use of genetic technology. However, this translates into a risk of competitive disadvantage if other key markets adopt the technology, while we continue with the status quo.

This was particularly front of mind with participants for scope 3 and other customer environmental targets.

"How do we meet our scope 3 emissions targets if some of our competitors have access to these technologies?"

Many of the interviewed farmers noted the increasing requirements from international standards, as our customers and consumers expect responsible agricultural practices concerning water usage, biodiversity conservation, and climate management. New Zealand is currently relatively well-positioned to fulfil these expectations. However, if a technology that reduces the environmental impact of production becomes available, and we cannot adopt that technology due to our regulatory settings, we may become environmental laggards.

A Farcical Position?

Some of the participants stated that our current regulatory position is farcical. They believed imposing stringent regulations domestically while facing divergent standards abroad was ironic. This highlighted the need for a more coherent approach to regulatory alignment and trade negotiations.

"New Zealand has gotten out of touch with what is happening in the rest of the world. Look at what is happening overseas. Lots of people are adopting NGTs [New Genomic Techniques], which result in pretty minimal changes in the organism."

Perceived Risks of Adopting Genetic Technology

All interviewed farmers acknowledged that liberalising the regulation of genetic technology was not without risk. These perceived risks were mostly driven by uncertainty around the impact of the use of genetic technology on the environment, society, and the economy.

"However, we need to understand the risks to our environment, brand, and market access/premiums from changing our approach to the use of GM/GE. These could be significant and long-lasting and may not be directly foreseeable. For example, the residues in milk from DCD"

Participants consistently asked the following questions across the seven interviews:

- What is the perception of risk from our customers and consumers?
- What is the potential impact on current and future markets?
- What are the risks and potential impacts to human and environmental health?

A Gradual and Controlled Approach to Adoption

Some participants proposed a gradual and controlled adoption approach to mitigate the risks associated with the technology. Many of the interviewed farmers believed that a gradual approach would allow knowledge and trust to be built around the use of technology and ensure that we could mitigate any environmental, social, and economic risks.

Many interviewees stated that if regulations were eased, we should roll out the technology on a case-by-case basis, starting with 'low-risk' technology. Across the interviews, participants proposed three key considerations for defining 'low-risk' applications of genetic technology.

1. Type of modification. Organisms with changes like those which could be obtained via traditional methods are seen to be at lower risk than organisms with permanently introduced DNA from other species or synthetic DNA.
2. Purpose of the modification. Genetically modified organisms that benefit the environment, biosecurity, animal welfare, or biodiversity are seen as lower risk as they will likely have more social buy-in and support.
3. Distance of the modification from products. In the case of dairy, modifications to organisms that are distant or unrelated to milk production would be lower risk and preferable.

"We do not need to jump in with both feet, we can dip our toes, test the water, and roll out the lower-risk options first. The value of GM/GE could be negated if we open up too quickly, something goes wrong, and we ruin our brand. We need to build a positive track record around GM/GE to build trust with the public and markets."

"Should start with some options that reduce the environmental footprint of production. This will achieve buy-in from the young and those thinking about this space."

"The time has come for this to happen, but we need to look at the low-hanging fruit first so that it is less of a populist issue. We may be interested in more high-value traits but need to get some wins on the board before moving towards other modifications that may be perceived as higher risk. We should begin with lower-risk options, that are beneficial to New Zealand"

"There will be a small noisy minority that will have issues with the changing regulation. There are a whole lot of steps along this spectrum. We don't need to do all of them at once. Low-risk options first to build trust. Assure some options are off the table."

One participant emphasised that if regulation is changed, even if we *didn't* take a gradual approach, the genetically modified organism would not appear on farms or in supermarkets overnight. There will be a robust testing process over a long timeline. This highlights that we need regulatory settings to enable scientists to do this work and enable us to build our knowledge around impacts, risks, and benefits.

A further suggestion for mitigating the risks associated with the use of genetic technology was to begin with controlled distribution of the technology. Some interviewed farmers gave the example of LIC and artificial insemination (AI).

"We should also look at something that can be distributed through LIC and the AI system to mitigate the risk of misuse of genetic technology. For example, using GM/GE for dehorning cows. Great outcomes for animal welfare can be distributed through LIC/AI so the technology is in the hands of scientists and those suitably qualified to manage any associated risks."

5.1.3 Opposition to the Adoption of Genetic Technology

Few of the interviewed farmers were completely opposed to the adoption of genetic technology in dairy production in any form. Reasons for opposition varied from cultural and ethical concerns, failure to address deeper systemic issues, to damage to New Zealand's brand.

Damage to New Zealand's Brand

Interview participants on both sides of the for and against genetic technology argument raised concerns about the impact of genetic technology on New Zealand's brand.

Those 'against' the use of genetic technology thought that it would damage New Zealand's 'clean green' brand.

"New Zealand has a unique position and point of difference. Why would we give away our value proposition by becoming GM producers? Instead of being GM producers, we need to better capitalise off our GM-free status"

"New Zealand is known for the high-quality nutritional content of its food. Is there a risk that introducing GM would reduce this quality?"

Those 'for' the use of genetic technology also commented on New Zealand's brand advantage. However, they argued that the strength of our brand is not 'anti-GM', but our simplicity and uniformity. Our brand should not be complicated by partially adopting genetic technology, and fragmenting how we market ourselves.

"*One of New Zealand Inc's advantages is our uniformity and consistency. Marketing New Zealand against the world is easy, we have a strong consistent brand. Any use of genetic technology should not complicate this. The use of genetic technology should be simple and scalable at a national level."*

Cultural and Ethical Concerns

Some participants had strong opposition to permanent genetic modifications on a cultural and ethical basis and highlighted the importance of passing on a better legacy to future generations.

"I do not support anything that is permanent and has consequences beyond our lifetime. The Indigenous perspective is that we pass on something in a better way than we found it. These are generational decisions. We will not know the outcome of these decisions because we will not be here."

These participants also indicated that there would be a range of views on the potential cultural and ethical impacts of the use of genetic technology in food production, and wider community engagement would be required to understand the breadth of these concerns.

Failure to Address Systemic Issues

Some participants believed that genetically modifying organisms was a plaster for wider systemic issues. For example, questions were raised about whether we should modify the cow's genome to reduce its environmental impact or if it were more appropriate to address the systemic issues of intensive farming.

"People are coming up with simple solutions to problems because they don't understand the problem"'

"Governments and councils need to listen to communities to better understand the problems and challenges before offering solutions. Challenges may be driven by lack of funding, lack of policies and procedures, or lack of extension or support. Decision-makers need to work with communities and identify and facilitate expertise where you have the gap, rather than offering genetic technology as a solution."

5.2 Regulatory and Policy Considerations to Support Farmers

5.2.1 Key Themes

Interview participants were not asked specific questions about the regulatory framework, but it became a clear focus of many conversations. Many participants saw fit-for-purpose regulatory settings and decision-making processes as critical for supporting the sector in adopting genetic technology. Figure 5 outlines the key themes identified regarding regulatory and policy settings.

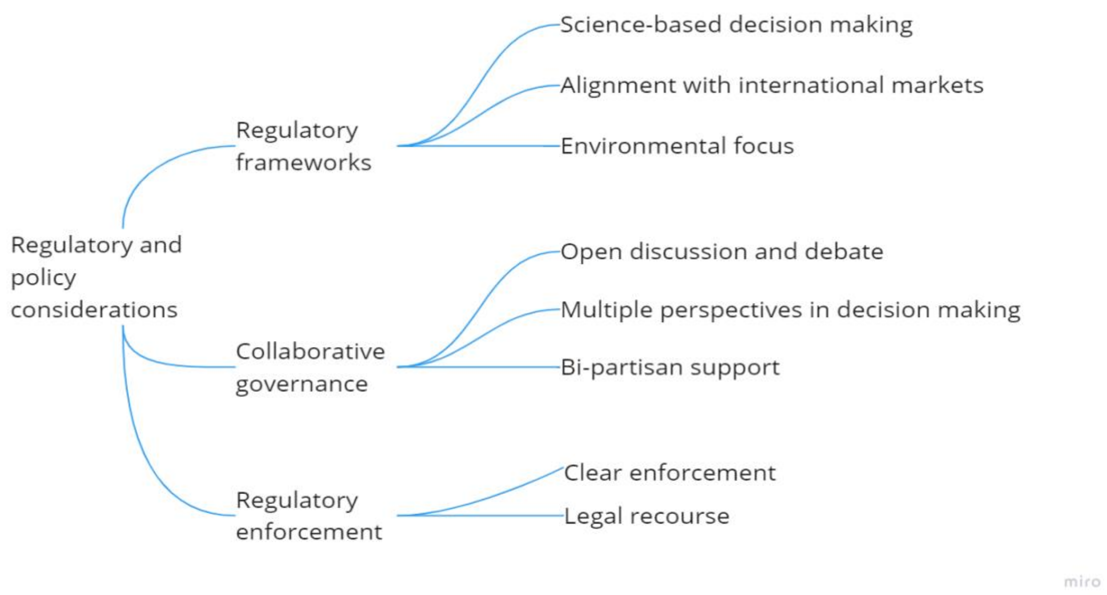


Figure 5: Key themes arising in relation to views on regulatory and policy considerations

5.2.2 Regulatory Frameworks

Interview participants sought a regulatory framework that followed science-based decision-making principles, looked holistically across the environment and society, and was in alignment (without becoming more liberal) with key international markets.

Science-Based Decision Making

Many participants were concerned that this regulatory change programme may become politically rather than scientifically driven. Many felt that science needed to be at the core of the decision-making process and should be the foundation for answering questions on managing environmental, human health, economic, and social risk.

"The decision needs to be a science-based decision rather than a political decision. We need a regulatory system which leans on scientific expertise and ensures we can use the technology effectively."

Alignment with International Markets

In addition to a science-based approach to regulating the use of genetic technology, most participants thought it was important for us to align our regulation with our key international markets. Most participants also felt we should ensure that our regulatory framework is not more liberal than our key markets.

"We need to follow international regulations, standards, and accreditations for GM or GE products. New Zealand exports a vast majority (90%) of its agricultural products, making adherence to international standards crucial."

There are a lot of countries that have a more liberal approach to regulating the use of genetic technology. Many participants felt that we should learn from the international community on how best to regulate, and to understand risks and how to mitigate them.

This space is fast-moving, with a lot of regulatory reform happening internationally. Some participants felt that New Zealand should definitely not be the first movers, but does need to position itself to be able to fast followers.

Environmental Focus

Some participants wanted the regulatory framework to take a holistic approach and not just focus on economic impacts.

"While economic benefits are important, decisions should also consider nutritional and environmental factors. The focus should be on holistic outcomes, not solely on economic gains. There is interconnectedness of agricultural practices with nutrition, environmental sustainability, and overall well-being."

5.2.3 Collaborative Governance

Many participants indicated they do not want this regulatory reform process to be rushed. They saw it as crucial to have open discussion and debate and include multiple perspectives in the decision-making process.

Open Discussion and Debate

Many participants saw a need for an environment that allows for balanced and open debates on the use of genetic technology. This is a controversial topic, where there is a diversity of views that should have the opportunity to be voiced.

"It is important to create the space for a conversation that genuinely considers different views."

"We need the ability to put both sides of the argument out there with equal footing. The current approach to regulatory change is losing this element."

Some participants thought that there should be a semi-independent body or commission established to provide the opportunity for all groups across New Zealand to provide perspectives and input.

Some participants also drew specific attention to the importance of this environment to discuss its impact on cultural and community values.

"There needs to be a thorough discussion on where you 'draw the line' from a cultural and ethical perspective. With regards to tikanga, Māori believe we should not play god. But you cannot be black and white with these decisions. For example, IVF allows families to have children, which could be interpreted as interfering in natural processes"

Participants commented that it takes time to have these conversations and give them the consideration that they require. Some participants commented that, while we must act with some urgency to ensure we are not left behind, we must not rush the process for the sake of political agendas.

"It worries me that the political space appears to only be concerned with short-term agendas. Farming is not a short-term agenda. GMO release into the environment is not a short-term agenda. It is a long-term agenda item and needs to be treated as such"

Multiple Perspectives in Decision-Making

In addition to open discussion and debate, many participants felt that there needed to be broad representation in the decision-making process.

"Having all the right people and voices at the table is important. All decisions about the use of this technology need to be a collective New Zealand decision, with opportunities for involvement. A space needs to be created for open dialogue and genuine conversation."

A specific focus of this theme was how important it would be to involve communities in the decision-making process.

"A bottom-up approach to decision-making is important. Decision-making always starts in the community, and the ask for change needs to start at that level. There needs to be significant engagement and relationship-building with communities to ensure that solutions are fit for purpose."

Bi-Partisan Agreement

Some participants raised that it would be important to achieve bi-partisan support for this regulatory change programme. This is a significant change for New Zealand's future direction, and some participants felt it would be prudent to ensure that both sides of the political spectrum were aligned on this direction.

"We need a bi-partisan New Zealand scale discussion on the use of genetic technology before any decisions are made about the adoption of technology. While there are some definite opportunities

and gains that could be made from the use of genetic technology, we need to have a mature, high-level, discussion before we would state whether we would use this on-farm."

5.2.4 Regulatory Enforcement

Some participants highlighted the importance of clear enforcement of the regulation. These participants believed that the onus for compliance with regulatory standards should sit with the farmer adopting genetic technology in their farm system.

Clear Enforcement

Some participants thought that clear and fit-for-purpose enforcement mechanisms were critical for supporting the sector in adopting genetic technology. Without clear enforcement, there may be an increased risk of unintended environmental, social, and economic impacts.

Legal Recourse

Some participants believed that the enforcement mechanisms needed to include legal recourse for contamination from genetically modified organisms.

"If there are issues arising from the use of these seeds, such as contamination of neighbouring fields or environmental damage, there's a question of responsibility: who pays for the cleanup or containment efforts? This is particularly relevant in genetic contamination of non-GMO crops or environmental harm caused by GMO cultivation."

Some participants stated that the responsibility for any unintended spread of genetically modified organisms should sit with the farmer who introduced them to their farm system. The participants suggested strong auditing and certification processes, with requirements for boundaries or other spread mitigating strategies.

"There should be good auditing and certification processes. Organics farmers currently must pay $3k per year in audit fees. There should be an obligation and good process, standards, and certifications to show how GM products have been used, and how they have moved throughout the value chain."

"The onus should be placed on GM producers to contain the organisms within their farm system. If organic farmers must have a boundary to protect their farm systems, GM producers should also have the responsibility to maintain a boundary."

5.3 Adoption and Market Differentiation

5.3.1 Key Themes

Interview participants were asked a series of questions on what support they may need to support the adoption of genetic technology in their value chain. Questions ranged from adoption strategies and impacts on the value chain to market differentiation. Figure 6 outlines the key themes that emerged from discussions around technology adoption.

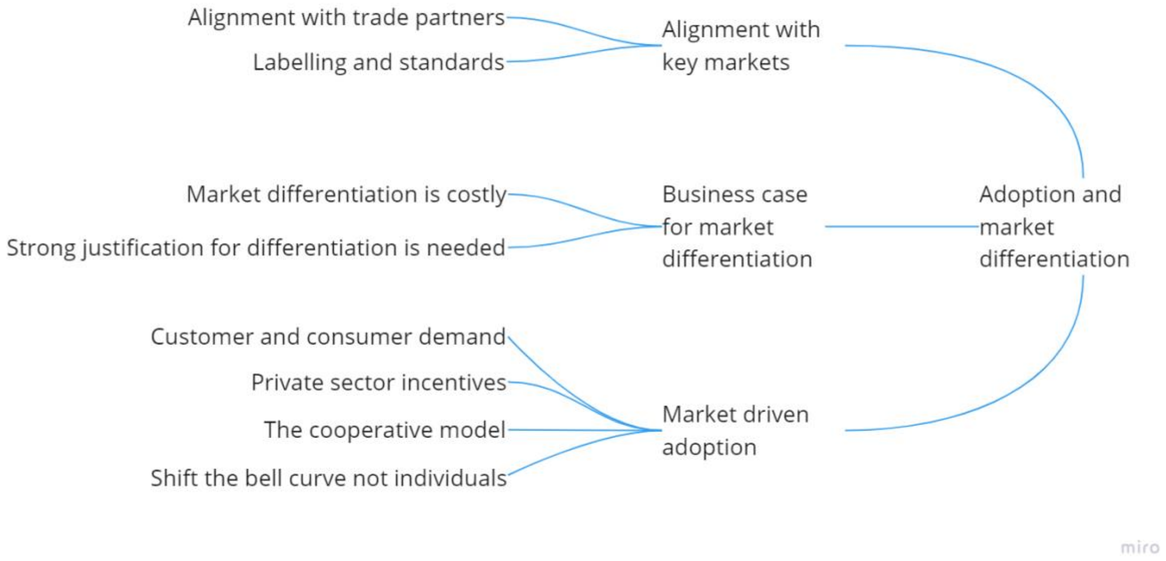


Figure 6: Key themes arising in relation to views on adoption and market differentiation

5.3.2 Alignment with Key Markets

Interview participants stated that aligning our regulatory settings and our labelling standards with our key export markets is crucial for enabling the adoption of genetic technology on farms.

Alignment with Trade Partners

The discussion of this theme has some overlap with the 'alignment with international markets' in the regulatory and policy considerations section (5.2.2). In the regulatory discussion, many participants felt that aligning with international markets is critical to ensure that our trade and market access are not impacted. In addition, some participants felt that if we aligned our approach and regulations, we would not have to worry about market differentiation.

"If we align with trade partners, we won't have to market differentiate. The person who pays the bills (our key export markets) are the ones that play the tune."

"Aligning with international trade standards can reduce the need for separate market differentiation."

Other participants felt we should learn from other countries that have successful market differentiation with both GM and GM-free production

"There are lots of examples of GM market differentiation overseas. We should learn from international experience and expertise to inform our approach in NZ."

Labelling and Standards

Some participants stated that market differentiation would be dictated by our key export market's labelling and standards requirements. The participants emphasised that we need to develop our labelling requirements and standards to achieve equivalence with the requirements of target markets. If a key market does not require the labelling of a specific genomic technique or application of genetic technology, then no market differentiation would be required for the use of that genetic technology.

5.3.3 Business Case for Market Differentiation

Participants felt that market differentiation would be significant in cost and complexity. Significant premiums for non-GM produce would be needed for genetic technology to be adopted and differentiated in the market.

Market Differentiation is Costly

Many participants outlined that milk that required labelling as genetically modified would require an entirely separate supply chain. Participants felt that this would introduce significant complexities for milk processors and would likely make the production of GM milk unprofitable.

"Maintaining separate supply chains for different products can dilute overall efficiency, as resources are divided among multiple channels. The economic viability of establishing a separate supply chain specifically for GMO milk is unlikely, with uncertainty about whether potential price premiums for GMO milk would justify the costs of maintaining a dedicated supply chain."

Some participants suggested that whole supply companies may take a specific strategy regarding the use of genetic technology. However, they felt that differentiation within a brand or company would not make good business sense.

Other participants suggested New Zealand could take a regional approach to market differentiation, with only some regions adopting genetic technology.

"Fonterra has a number of smaller plants nationwide that could provide GM milk processing. This would have to be regionally specific, with farms in the surrounding area adopting genetic technology. We would need to be able to market one region ahead of another."

Strong Justification for Differentiation is Needed

Due to the inefficiencies and costs associated, many participants stated that there would need to be strong justification to support any market differentiation.

Many participants were unclear about the value of the GM-free brand as a dairy producer. Participants felt that there would need to be a strong demand for non-GMO products to justify market differentiation.

"There needs to be a customer/consumer pull for niche or differentiated products. You must get money out of the marketplace to make the most of differentiation. However, premiums drop away when times are hard. We are currently experiencing an economic downturn, and the extra value out of non-GMO may not compensate for the lost opportunities from GM/GE."

Further, many participants commented that niche markets were unlikely to succeed in the current economic environment.

"*Niche markets are not succeeding in economic downturn*. *We are currently experiencing the collapse of goat and sheep milk, and synlait. In previous years, consumers have paid a premium for organics, but this is only if they have discretionary income. People's values are constrained by their economic reality."*

"*The business case from small milk runs is not there at the moment*. *The only different supply chain that Fonterra currently operates is for organic milk. However, the value is not currently there for organics, especially with the economic downturn. Small milk plants are being rationalised in the North Island."*

Participants who were supportive of the use of genetic technology stated that if the technology is truly valuable, then what may start as a niche 'GM' market will become a commodity market.

"Over time, niche markets either fail or become commodity markets. Today's niche is tomorrow's commodity. If you find something that is truly beneficial and profitable, people will get on the bandwagon."

This raised the question of whether market differentiation was a worthwhile investment with some participants.

"If you have a GMO production system next to a non-GMO production system, market selection pressure will change over time and select the production system with the best inputs and best produce. Customer trends turn niche markets into commodities. If the trend for GM is strong enough, is GM market differentiation a worthwhile investment for big milk companies?"

Ultimately, many participants felt that strong premiums from non-GMO branding or equally strong discounts from GMO branding would be needed to justify the investment in market differentiation.

5.3.4 Market Driven Adoption

Participants saw a strong role for the market in driving adoption. They believed that customer and consumer demand would be key determinants of what is adopted. Participants thought that the Government's role is risk and trade access, while the market should drive the adoption of commercially viable technologies.

Customer and Consumer Demand

Many participants felt that strong evidence of the value of genetic technology would need to come from processors, customers, and consumers. Participants felt that if there were no certainty about our customers' acceptance of technology, then there would be no adoption, even if our regulatory settings permitted it.

"Customers will be the big determinants of whether we can use GMOs in our supply chain. If the likes of Nestle do not want GMOs in the supply chain, it is almost certain that we will not adopt GMOs. We don't want to lock ourselves out of premium markets through the use or (non-use) of GMOS. We can only feed 40 million people. Let's feed the expensive ones"

Private Sector Incentives

Participants stated that the private sector should drive the adoption of new technology. They believed that the Government should be responsible for managing trade and market access, as well as the environmental and social risks associated with the use of genetic technology, and they trust that the private sector will only incentivise the uptake of technology that will have a positive economic outcome.

"Government should focus on environmental risk and setting equivalent standards for trade and market access. The private sector will ensure that adopted technologies will provide a commercial benefit."

Participants stated that the private sector often has the data and incentive to demonstrate the benefit on a business-by-business basis. The private sector will be able to direct farmers towards the adoption of commercially beneficial technologies and provide the relevant information for individual farm business cases.

The Cooperative Model

The majority of New Zealand dairy farmers are part of a cooperative. Participants noted that as co-operatives are vertically integrated throughout the value chain, they will have control over processes and will be able to mitigate concerns related to the adoption of genetic technology.

Shift the Bell Curve not Individuals

Similarly to the discussion around differentiation within a brand or company not being a good business decision, some participants felt that farmer adoption should not be piecemeal. The private sector, processors, and customers should try to 'shift the bell curve', as there is limited value to driving the uptake of new technology on farms if the value must be captured at an individual level.

"If the technology adoption is determined to be a good business decision, processors and customers will need to shift the bell curve, not just individuals."

5.4 Consistent, Accurate, and Transparent Communication

5.4.1 Key Themes

Throughout interviews, participants consistently mentioned the need for clear communication. They emphasised the vital importance of having certainty and accuracy on potential impacts and having those impacts communicated to them clearly and consistently.

Participants believed that farmers, consumers, and markets need to be well-informed about the benefits and risks to build confidence and trust in the technology. They believe that transparent communication would support informed decision-making and foster a positive perception of genetic technology advancements in dairy production.

Figure 7 outlines the key themes that emerged.

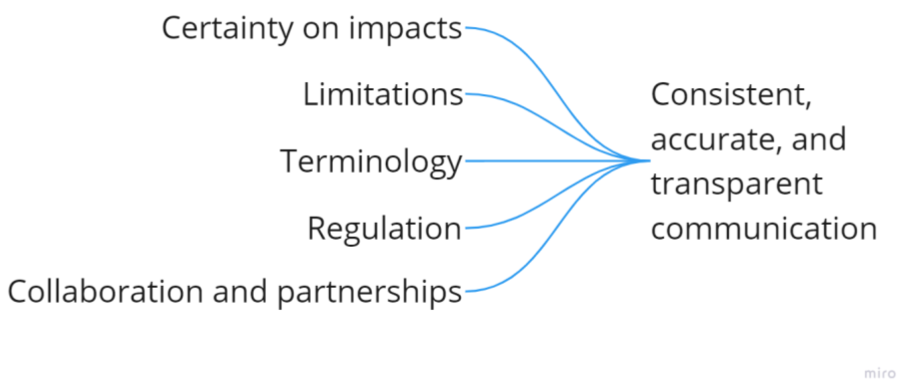


Figure 7: Key themes arising in relation to views on consistent, accurate, and transparent communication

Certainty on Impacts

Most participants stated that business decisions will require certainty and clarity about genetic technology's potential impacts on the environment, economy, and society.

At a farm level, participants felt that there would need to be strong confidence that the use of genetic technology is not going to create issues with processors, markets, communities, or neighbours in order to feel comfortable with adoption.

"There needs to be strong confidence that the use of genetic technology will not lead to unintended consequences. Once an organism is introduced into a farm system, if there are unintended consequences, it may be costly to remove from the production system or may lead to reputational and market access issues."

Further, participants felt that if the economic benefit was clearly communicated, farmers would quickly begin to adopt the technology.

"Clear evidence of economic benefit will incentivise adoption. Farmers won't take long to adopt genetic technology if there is evidence that it would result in a real step-change in profitability."

Terminology

Some participants identified the terminology surrounding genetic technology and genetically modified organisms as a big challenge. They saw a need for clear communication around the different types of genetic technology and genomic techniques, as some are inherently 'lower risk' than others.

"Terminology has gotten confused in the public mind. People believe that all genetic technology is crossing species and transgenics. Various methods can be used that are nowhere near as invasive or unnatural."

Limitations

Some participants were concerned that this might be seen as a solution for all farming problems. Participants stated that the limitations of any given technology would need to be clearly communicated alongside its benefits.

"This can't be sold as a panacea for all other farming problems. Sales reps (etc.) need to be pragmatic and realistic about who should use GM/GE and what benefits/risks it may have."

Regulation

Clear and accurate communication also extended to the regulatory settings. Participants stated that farmers would need to be able to easily understand the rules and expectations around the use of genetic technology. They believed that without clear guidelines, farmers would struggle to adopt.

"We need to be provided with clarity on what good looks like and what is expected from a regulatory perspective. In the case of modern genetic technology, how do we get clarity around the regulatory framework? What are farmers allowed to do and not able to do? What are the impacts and trade-offs?"

Collaboration and Partnerships

Collaboration and partnership underpinned these conversations on clear, accurate, and consistent communication. Many participants felt that the successful adoption of genetic technology in dairy production hinges on strong partnerships and collaboration between government, industry organisations, and farmers.

"There is a role to play for all government, industry, and research institutes in providing clarity and supporting the capability of farmers to adopt new technology."

However, participants stated that industry and government needed clear roles and responsibilities.

Some participants felt that the government should be solely responsible and accountable for communicating with farmers.

"The government has a role in clearly communicating the differences in technology, what technologies we are permitting, and how that aligns with our trade partners as an accepted technology to speed up the regulatory process."

"I do not think that industry bodies should get involved in that battle [communication]. Leave it to the government and the government scientists. The industry needs to be clear on its role. They are not responsible for taking government legislation out and supporting it."

While most participants acknowledged the government's leading role in this regulatory change process, many participants felt that the industry still needed to be involved.

"These stakeholders must work together to develop strategies, create guidelines, and inform policies to ensure the responsible use of GM/GE technology. A unified approach will help manage risks and leverage the benefits of genetic advancements."

"There needs to be some level of regulation, rules, and guidelines around the use of GM/GE in food and fibre production. Processes need to be established and governed to determine what and how this technology is used. Industry organisations and industry bodies have a responsibility to develop and inform these policies. Industry organisations need to work together and collaborate with the government/regulator. These policies and regulations will, at least to begin with, need to be restrictive until more trust and evidence are built."

Participants felt that without industry involvement, there was a risk of inconsistent communication between different industry parties and the Government.

"The industry is currently very disjointed with lots of organisations trying to do the same thing. With new technology, there is a possibility for lots of different organisations coming down driveways and creating confusion around practice change and the use of technology. To effectively communicate with farmers, there needs to be collaboration and partnership between industry organisations, good connections with the community and alignment with rural professionals in a region"

5.5 Capability Development

5.5.1 Key Themes

Participants were asked several questions about what knowledge and support farmers may need to navigate the use of genetic technology in the dairy sector. They outlined several key roles and capabilities that they believed would be essential to support the use of genetic technology. Figure 8 outlines the key themes that emerged.

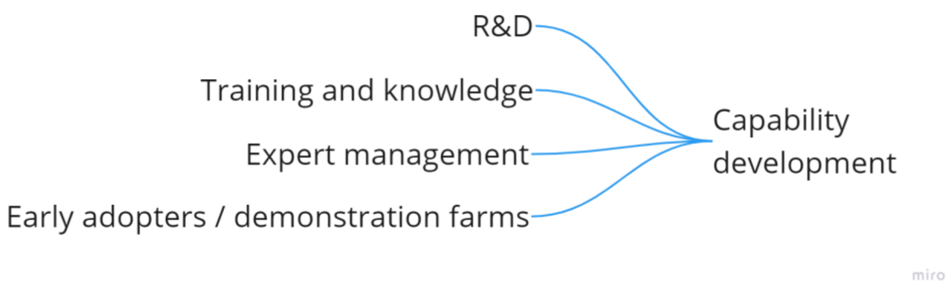


Figure 8 Key themes arising in relation to views on capability development

R&D

Some participants thought that our current R&D system was not fit for purpose to support this regulatory reform process.

"Our current R&D model in NZ is a failure. Funding incentives drive short-term research and thinking. This prevents meaningful long-term research."

Technological advancements are rapidly increasing. Participants felt that we need to ensure that our R&D system is well-positioned to keep up with them. Genetic technology is an example of one of these advancements. Participants stated that we need our R&D system to deliver thorough and extensive testing to understand the potential impacts of genetic technology.

Some participants felt that our R&D needs to work closely with markets and focus its efforts towards applications of genetic technology that will meet customer or consumer needs and public goods.

Training and Knowledge

Participants stated that farmers would need proper training and knowledge before adopting new technologies. They felt there would be risks to farm businesses adopting new technology without the skill sets or knowledge to use it effectively and benefit from it.

"We need to ensure that farmers have the capability and knowledge before they make a significant change or adopt new technology on-farm. People often buy on emotion and justify with logic. For example, halter is a great tool, but it can be terrible for some farmers who are not equipped to use it. You need to communicate to farmers that you need the right skills to use a tool."

Extension Services

To support farmer training and knowledge, participants indicated that strong extension services would be required. Participants stated that these services could come from salespeople, processors, or industry bodies. The critical factor for extension services is ensuring that the support is tailored to the individual's needs and capabilities. Without a tailored approach, participants felt there was a risk of people adopting technology without the ability to properly implement it.

Early Adopters / Demonstration Farms

Many participants believed that initially, genetic technology should be managed by experts to prevent misuse. Some participants thought that this should come in the form of support and focus on early adopters who can showcase the use of genetic technology.

"We need to identify early adopters that can support the rollout of genetic technology. The best source of information is other farmers. The skill of good extension is to find the most respected farmer in a catchment."

"Early adopters and demonstration farms are critical for rolling out new technology. These farms can show the reality of the technology and demonstrate, in practical terms, what works well and what doesn't. Lincoln University farm plays a particularly important role. They have the means and capability to trial new technology and fail."

"There will need to be extensive testing of proposed applications of GM/GE before widespread introduction to dairy production. There should be control trials and a lot of trial work with certain farmers. This should be an iterative approach, editing our policy approach in response to trial results."

6 Findings and Discussion

6.1 Regulatory Reform

The literature review and interviews outlined key drivers for regulatory reform in this space. Both sources recognised the need for regulation to keep up with technological advancements and the global shift towards more liberal regulation of genetic technology. Interview participants were particularly strong on the importance of aligning New Zealand's regulations with international regulations and standards. If we are too far behind the international approach, we risk losing our competitive advantage and facing potential trade barriers from regulatory misalignment. If we are too far ahead of the international approach, we risk losing trade and market access.

While interview participants acknowledged the importance of 'not being left behind', they were also concerned about New Zealand's current pace of regulatory change, believing it will not enable genuine engagement and informed decision-making. The literature outlined the importance of collaborative governance in informing fit-for-purpose policy. The literature suggests that inclusive decision-making processes can help address diverse perspectives and build trust in the regulatory system. This was also emphasised by interview participants. They stressed the importance of open discussion and debate involving multiple perspectives in decision-making to ensure societal buy-in and bipartisan support.

Both the literature and interview participants specifically highlighted the role of farmers in this decision-making process. The literature emphasised the importance of integrating farmers' practical knowledge and experiences into regulatory frameworks. This was echoed by interview participants, suggesting that farmers' tacit knowledge could help inform better policy and risk management.

6.2 Markets and Branding

The literature indicated that there was unlikely a premium for New Zealand being GM-free. Knight (2011) and Caradus et al. (2022) found that adopting GM forages would likely have a minimal impact on international markets and New Zealand's brand. The interview participants had different views on the impact on New Zealand's brand. Those 'against' the use of genetic technology thought that it would damage New Zealand's 'clean green' brand. Those 'for' the use of genetic technology argued that the strength of our brand is not 'anti-GM' but our simplicity and uniformity. They believed that partial adoption and trying to fragment our image as a nation would be damaging. Both 'for' and 'against' participants believed New Zealand's brand should not be complicated by partially adopting genetic technology and fragmenting how we market 'NZ Inc.'.

At a product level, there was a discussion of market differentiation and potential premiums for non-GM versus GM products. Both the literature and interviews underscored the costs and complexities associated with coexistence and market differentiation. The literature and interview participants emphasised that coexistence measures are crucial for managing cross-contamination risks between GM and non-GM crops, highlighting the importance of establishing buffer zones, isolation distances, and specific crop management practices to prevent gene flow.

The literature highlighted that labelling thresholds often determine the stringency of coexistence measures to enable market differentiation. Different countries have different approaches to labelling and different tolerance levels. Participants agreed with this sentiment and stated that market differentiation would be dictated by our key export market's labelling and standards requirements. The participants emphasised that we need to develop our labelling requirements and standards to achieve equivalence with the requirements of target markets. If a key market does not require the labelling of a specific genomic technique or application of genetic technology, then they believe that no market differentiation would be required for using that genetic technology.

Interview participants also felt that regulatory provisions should be established for liabilities or dispute resolutions regarding the unintended spread of genetically modified organisms. They felt that the responsibility should rest with the farmer who introduced them to their farm system. The literature review showed that only some countries that permit the use of genetic technology in food production adopt this approach. Other countries, such as the USA, argued that farmers and growers who seek to market such high-value speciality crops (e.g., non-GM or organic) should bear the costs of protecting their unique qualities.

The literature outlined various approaches to coexistence, including mandatory regulations and voluntary guidelines, to ensure that these crops can be grown alongside each other and that market differentiation can be achieved. The literature suggested that mandatory measures yield better social and environmental outcomes for all and better economic outcomes for non-GM and organic farmers. However, they may be more costly and impose a greater regulatory burden.

Interview participants did not comment on voluntary or mandatory coexistence measures. Their comments focused primarily on the high costs and complexities associated with market differentiation. Participants outlined that milk that required labelling as genetically modified would require an entirely separate supply chain. Participants felt that this would introduce significant complexities for milk processors and would likely make the production of GM milk unprofitable. For investment in coexistence measures and supply chain segregation to be profitable, strong premiums from non-GM branding or equally strong discounts from GM branding would be needed. Participants felt this was unlikely, and if the global GM adoption trend is strong enough, market differentiation will not be a worthwhile investment within individual milk companies.

6.3 Knowledge and Communication

Participants stated that businesses, processors, and markets wills will require certainty and clarity about genetic technology's potential impacts on the environment, economy, and society to make good decisions. There is some research into the environmental, economic, and social impacts of the use of genetic technology in food and fibre systems overseas. However, there is a notable gap in any research that applies to the New Zealand context or to applications of genetic technology that New Zealand would likely adopt. This is likely a byproduct of our current regulatory settings prohibiting this research. The interview participants identified this as a priority focus area to support technology adoption.

Interview participants also felt that this information must be communicated consistently, accurately, and clearly. Participants stressed the importance of collaboration between government, industry, and research institutions. They called for clear roles and responsibilities and highlighted the need for a unified approach to communication and education.

The literature indicated that education and training programmes are needed to equip farmers with the knowledge and skills required to support the use of genetic technology. Participants wanted to see investment in demonstration farms, early adopters, and extension services to effectively build the dairy community's capability to use genetic technology. Both sources recognised the necessity of robust education and training programs to build farmers’ capability to adopt and manage genetic technology effectively and minimise socioeconomic and environmental risk.

6.4 Approach and Adoption Strategy

Participants thought that a gradual and controlled adoption approach to the adoption of genetic technology would allow us to build knowledge, capabilities, and trust with markets and the New Zealand public. Participants believed that a gradual approach, starting with low-risk technology, could mitigate the risks associated with the technology.

Low-risk technology was defined using the criteria shown below:

1. Type of modification. Organisms with changes like those that could be obtained via traditional methods are seen to be at lower risk than organisms that have permanently introduced DNA from other species or synthetic DNA. As per the literature review, these types of organisms are less likely to be regulated by other markets or to have as onerous labelling requirements.
2. Purpose of the modification. Genetically modified organisms that benefit the environment, biosecurity, animal welfare, or biodiversity are seen as lower risk as they will likely have more social buy-in and support and are more likely to be seen as favourable by our trading partners.
3. Distance of the modification from products. In the case of dairy, modifications to organisms that are distant or unrelated to milk production would be lower risk and preferable. Modifications distant from the product are more likely to have social buy-in and less likely to have labelling requirements.

Figure 9 on the following page provides a logical flow on what actions could be taken to support the adoption of specific applications of modern genetic technology. This framework considers a specific export market and a specific application of modern genetic technology. It assumes that this application of genetic technology is permitted by New Zealand regulators and that there is a clear value proposition for use. The framework was developed using insights from both the literature and the interview process. The numbers in the figure correspond to the 'low-risk' criteria. Selecting applications of modern genetic technology that meet these criteria will result in a green 'adopt' response and will allow New Zealand to build knowledge and trust without significant risk to the environment or society.

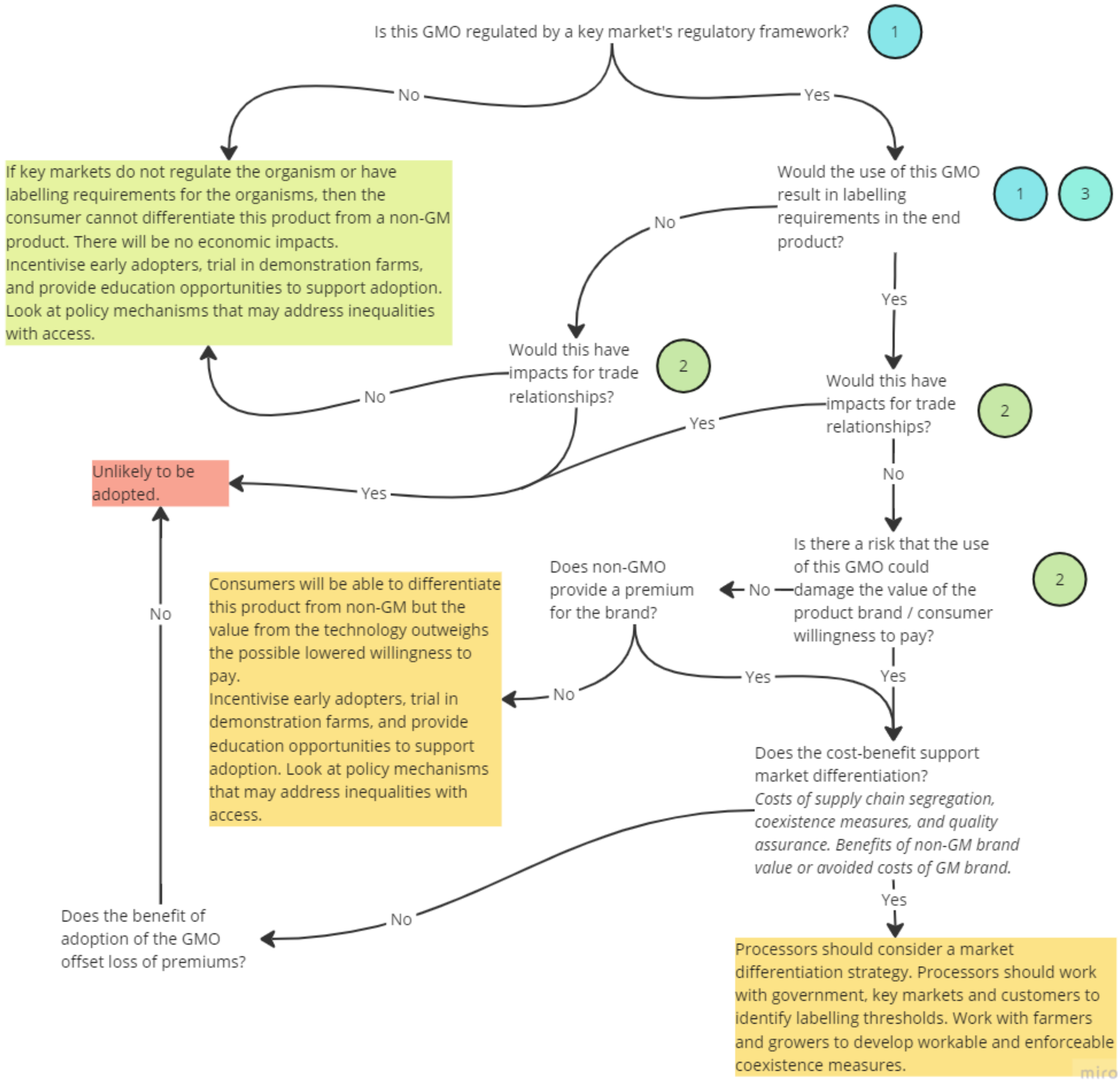


Figure 9 Logic flow on what actions could be taken to support the adoption of specific applications of modern genetic technology

7 Conclusions

Supporting farmers through the integration of genetic technology in New Zealand's agricultural sector is crucial for ensuring both the advancement and sustainability of dairy farming. This report underscores the importance of designing fit-for-purpose policies and providing farmers with support mechanisms to navigate the complexities associated with genetic technology.

As New Zealand moves through regulatory reform, it will be critical for the government, industry, scientists, and farmers to work together to understand how to grasp opportunities associated with genetic technology while minimising the risks.

The findings from this report highlight several critical areas where support and strategic action are required to successfully integrate modern genetic technology into New Zealand's dairy industry. The overarching message is the need for a balanced, well-communicated, and inclusive approach to regulatory reform and technology adoption. This can be further detailed by six core conclusions:

1. **Regulatory Reform**: Effective regulatory reform is paramount. The concept of a “Goldilocks” regulatory approach, neither too lenient nor too stringent, is crucial to maintaining New Zealand's competitive edge without jeopardising trade and market access. Collaborative governance, inclusive of diverse perspectives, is necessary to build trust and ensure that regulations are practical and widely accepted.
2. **Market and Branding**: The need for a cohesive national brand is emphasised by all stakeholders. Avoiding a fragmented national image while implementing coexistence measures for market differentiation between GMO and non-GMO products will be important. Determining the level of investment in coexistence measures requires understanding of market labelling requirements and the value of possible market benefits.
3. **Knowledge Generation and Communication**: Solid, place-based research within New Zealand is needed to provide reliable, science-based evidence on the impacts of genetic technology. This research must be communicated clearly and consistently, involving collaboration between government, industry, and research institutes to ensure accuracy and build confidence among farmers and the public.
4. **Extension and Education**: Investing in demonstration farms and early adopters is important for building community-focused capabilities. These farms can serve as practical examples, helping farmers understand and confidently apply new technologies. Extension services must be robust and tailored to support farmers throughout this transition.
5. **Gradual Adoption Strategy**: A gradual and controlled approach to adopting genetic technology is recommended to mitigate risks while building knowledge and capabilities. Starting with low-risk modifications (those similar to traditional breeding, environmentally beneficial, or distant from the final product) can help ease the transition and build trust with the public and markets.
6. **Building Public Trust**: Addressing the public's and sector's nervousness about genetic technology is critical. Transparent communication about the benefits and risks, coupled with a strong commitment to environmental and safety standards, is necessary to build trust and ensure preparedness for technology adoption.
7. **Collaboration and Inclusive Governance**: Establishing platforms for ongoing dialogue between farmers, scientists, industry stakeholders, and the public fosters collaboration and

ensures that diverse voices contribute to policy-making. This inclusive approach helps address concerns, share knowledge, and create a shared vision for the future of genetic technology in agriculture.

By prioritising supporting the sector through this transition, New Zealand can better enable its farmers to benefit from genetic technology effectively. This change is not without its risks. However, a strong and considered approach will not only drive innovation in the agricultural sector but also give us the potential to maintain New Zealand's reputation for high-quality, sustainable farming practices.

8 Recommendations

Recommendations for Decision-Makers:

1. Foster collaboration and inclusive decision-making: Create a regulatory environment incorporating diverse perspectives and building public trust. Consider establishing a semi-independent body or commission to ensure all stakeholders, including farmers, scientists, consumers, and Māori, have input in the regulatory reform process.
2. Develop coexistence measures: Work closely with stakeholder groups to develop and enforce mandatory coexistence measures such as buffer zones and isolation distances.
3. Enhance farmer education and support: Invest in demonstration farms, early adopter programs, and robust extension services to provide hands-on training and support.
4. Ensure clear and transparent communication: Build public and market confidence in using modern genetic technology through consistent and accurate information dissemination. This may require a unified communication strategy involving government, industry, and research institutions to clearly explain genetic technology's benefits, risks, and regulatory requirements.
5. Align market differentiation with export markets: Align New Zealand's labelling and standards for GM products with those of major export markets to facilitate trade and avoid market access issues.
6. Gradual and controlled adoption strategy: Start with low-risk applications of genetic technology, such as those with environmental or biosecurity benefits, and gradually expand to more complex modifications.

Table 7, on the following page, sets out a RACI (Responsible, Accountable, Consulted, Informed) framework for the provided recommendations.

Table 7: RACI framework for the provided recommendations.

Recommendation	Responsible (R)	Accountable (A)	Consulted (C)	Informed (I)
1. **Foster collaboration and inclusive decision-making**	Semi-independent body/commission	Minister for Agriculture	Farmers, Māori, Scientists, Consumer Groups	General Public
2. Develop coexistence measures	Ministry for Primary Industries (MPI), Processors	Minister for Agriculture	Farmers, Agricultural Organisations, Environmental Groups	General Public, Trade Partners
3. Enhance farmer education and support	Industry Bodies, Agricultural Training Institutions	Minister for Agriculture	Farmers, Extension Services, Agricultural Consultants	General Public
4. Ensure clear and transparent communication	Ministry for Primary Industries (MPI), Industry Bodies	Minister for Agriculture	Communication Experts, Scientists, Industry Representatives	General Public, Farmers, Trade Partners
5. **Align market differentiation with export markets**	Ministry of Foreign Affairs and Trade (MFAT), Ministry for Primary Industries (MPI)	Minister of Trade	Exporters, Trade Organisations, Key Export Markets	General Public, Farmers
6. **Gradual and Controlled Adoption Strategy**	Ministry for Primary Industries (MPI)	Minister for Agriculture	Farmers, Scientists, Industry Experts, Environmental Groups	General Public, Trade Partners

9 References

Actions to boost biotechnology and biomanufacturing in EU. (2024, March 20). European Commission - European Commission. https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1570

Ammann, K. (2005). Effects of biotechnology on biodiversity: Herbicide-tolerant and insect-resistant GM crops. Trends in Biotechnology, 23(8), 388-394.

Ammann, K., Jacot, Y., Rufener, P., & Al-Mazyad. (2000). Weediness in the light of new transgenic crops and their potential hybrids. Journal of Plant Diseases and Protection, 17, 19-29.

Anderson, K. (2019). Independent review of the South Australian GM food crop moratorium. Report to the SA Minister for Primary Industries and Regional Development, 76.

BE Disclosure | Agricultural Marketing Service. (n.d.). Retrieved June 3, 2024, from https://www.ams.usda.gov/rules-regulations/be

Bigler, F., & Albajes, R. (2011). Indirect effects of genetically modified herbicide-tolerant crops on biodiversity and ecosystem services: The biological control example. Journal für Verbraucherschutz und Lebensmittelsicherheit, 6, 79-84.

Bio.News - Biotechnology Innovation Organization (BIO). (2023, December 9). FDA greenlights marketing gene-edited cattle for food. Bio.News. https://bio.news/agriculture/fda-greenlights-marketing-gene-edited-cattle-for-food/

Bonny, S. (2016). Genetically modified herbicide-tolerant crops, weeds, and herbicides: Overview and impact. Environmental Management, 57(1), 31-48.

Caradus, J. (2022). A New Zealand perspective on growing and utilising genetically modified crops and forages. https://agscience.org.nz/a-new-zealand-perspective-on-growing-and-utilising-genetically-modified-crops-and-forages/

Caradus, J., Bouton, J., Brummer, C., Faville, M., George, R., Hume, D., Inch, C., Kerr, G., Montel, S., Stewart, A., & Woodfield, D. (2021). Plant breeding for resilient pastures. Grassland Research and Practice Series, 17. https://doi.org/10.33584/rps.17.2021.3441

Catacora-Vargas, G., Binimelis, R., Myhr, A. I., & Wynne, B. (2017). Socio-economic research on genetically modified crops: A study of the literature. Agriculture and Human Values, 35(2), 489-513. https://doi.org/10.1007/s10460-017-9842-4

Cerdeira, A. L., & Duke, S. O. (2010). Effects of glyphosate-resistant crop cultivation on soil and water quality. GM Crops, 1(1), 16-24.

Clark, A., Wilcox, P., Morrison, S., Munshi, D., Kurian, P., Mika, J., & Hudson, M. (2024). Identifying Māori perspectives on gene editing in Aotearoa New Zealand. Communications Biology, 7(1), 221.

Climate change and possible impacts for New Zealand | NIWA. (n.d.). https://niwa.co.nz/climate-change-information-climate-solvers/climate-change-and-possible-impacts-new-zealand#economy

Desquilbet, Marion & Poret, Sylvaine. (2012). Labelling and Co-Existence Regulation of GMOs and Non-GMOs: An Economic Perspective. Genetically Modified and Non-Genetically Modified Food Supply Chains: Co-Existence and Traceability. 193-214. 10.1002/9781118373781.ch13.

Dowd-Uribe, B., & Schnurr, M. A. (2016). Briefing: Burkina Faso's reversal on genetically modified cotton and its implications for Africa. African Affairs, 1-12.

EC (European Commission). (2009). Report from the Commission to the Council and the European Parliament on the coexistence of genetically modified crops with conventional and organic farming. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0153:FIN:en:PDF

Excellence Through Stewardship. (2008, updated 2014). Guide for maintaining plant product integrity of biotechnology-derived plant products. http://excellencethroughstewardship.org/wp-content/uploads/MPPI-Final-Board-Approved-6.12.14.pdf

Finger, R., Benni, N. E., Kaphengst, T., Evans, C., Herbert, S., Lehmann, B., Morse, S., & Stupak, N. (2011). A meta-analysis on farm-level costs and benefits of GM crops. Sustainability, 3(5), 743-762. https://doi.org/10.3390/su3050743

Glover, D. (2010). Is Bt cotton a pro-poor technology? A review and critique of the empirical record. Journal of Agrarian Change, 10(4), 482-509.

Genetic Literacy Project. (2020). CRISPR gene-editing regulation tracker. Retrieved July 18, 2024, from https://crispr-gene-editing-regs-tracker.geneticliteracyproject.org/

Genetic Literacy Project. (2024, January 21). Where are GMO crops and animals approved and banned? - Genetic Literacy Project. https://geneticliteracyproject.org/gmo-faq/where-are-gmo-crops-and-animals-approved-and-banned/

Genetically modified organisms field tests | EPA. (n.d.). https://www.epa.govt.nz/industry-areas/new-organisms/genetically-modified-organisms/gm-field-tests/

Hurrell, G. (2024, March 22). New genetic engineering law expected by end of next year: Judith Collins. BusinessDesk. https://businessdesk.co.nz/article/technology/new-genetic-engineering-law-expected-by-end-of-next-year-judith-collins

Huffman, W. E., Rousu, M., Shogren, J. F., & Tegene, A. (2002). Should the United States initiate a mandatory labelling policy for genetically modified foods? Selected Papers at the 2002 American Agricultural Economics Association Annual Meeting. Long Beach, California, USA.

James, C. (2012). Global status of commercialized biotech/GM crops: 2017.

Kalaitzandonakes, N., & Magnier, A. (2016). What can we learn about coexistence from commercial non-GM programs in the US? The Coexistence of Genetically Modified, Organic and Conventional Foods: Government Policies and Market Practices, 95-102.

Knight, J. G., & Marketing, U. O. O. D. O. (2011). New Zealand's "Clean Green" image: Will GM plants damage it?

Knight, J. G. (2014, August). GM crops and damage to country image: Much ado about nothing? In XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): III 1124 (pp. 23-32).

Klümper, W., & Qaim, M. (2014). A meta-analysis of the impacts of genetically modified crops. PloS One, 9(11), e111629. https://doi.org/10.1371/journal.pone.0111629

Koller, F., Schulz, M., Juhas, M., Bauer-Panskus, A., & Then, C. (2023). The need for assessment of risks arising from interactions between NGT organisms from an EU perspective. Environmental Sciences Europe, 35(1), 27.

Lazo, R. P., & Sauvé, P. (2017). The treatment of regulatory convergence in preferential trade agreements. World Trade Review, 17(4), 575-607. https://doi.org/10.1017/s1474745617000519

Latifah, A., Hashim, H., Sidik, N. M., Zainol, Z. A., & Anuar, N. (2011). Public attitude towards modern biotechnology. African Journal of Biotechnology, 10(58), 12409-12417.

Liang, J., Yang, X., Jiao, Y., Wang, D., Zhao, Q., Sun, Y., Li, Y., & Wu, K. (2022). The evolution of China's regulation of agricultural biotechnology. aBIOTECH, 3(4), 237-249. https://doi.org/10.1007/s42994-022-00086-1

Lobao, L., & Stofferahn, C. W. (2008). The community effects of industrialized farming: Social science research and challenges to corporate farming laws. Agriculture and Human Values, 25(2), 219-240. https://doi.org/10.1007/s10460-007-9107-8

National Academies of Sciences, Engineering, and Medicine. (2016). Genetically engineered crops: Experiences and prospects. Washington, DC: The National Academies Press. https://doi.org/10.17226/23395

NRC (National Research Council). (2010). The impact of genetically engineered crops on farm sustainability in the United States. Washington, DC: National Academies Press.

OpenAI. (2024). ChatGPT (June version) [Large language model]. Retrieved from https://www.openai.com/. *Used to summarise research in literature review.*

Paull, J. (2019). Contamination of farms by genetically modified organisms (GMOs): Options for compensation. Journal of Organics, 6(1), 31-46.

Pechlaner, G. (2012). Corporate crops: Biotechnology, agriculture, and the struggle for control. Austin, TX: University of Texas Press.

Raab, C., & Grobe, D. (2003). Labelling genetically modified food: The consumer's right to know? AgBioForum, 6(4), 151-161.

Rehbinder, E., & Loperena, D. (2006). Liability for genetic contamination of non-GM crops. Environmental Policy & Law, 36, 265.

Rolleston, W. (2016). Conditions for co-existence of genetic modification in a pasture-based system – a farmer perspective. Journal of New Zealand Grasslands, 78, 83-88.

Royal Society Te Apārangi. (2019). Gene editing legal and regulatory implications.

Smyth, S., Khachatourians, G. G., & Phillips, P. W. (2002). Liabilities and economics of transgenic crops. Nature Biotechnology, 20(6), 537-541.

Stokstad, E. (2023, July 7). European Commission proposes loosening rules for gene-edited plants. Science | AAAS. Retrieved June 14, 2024, from https://www.science.org/content/article/european-commission-proposes-loosening-rules-gene-edited-plants

Te Puna Whakaaronui. (2023a). WELL_NZ: Modern Genetic Technology - what it is and how it is Regulated: a Reference Document from Te Puna Whakaaronui: New Zealand's Independent Food and Fibre Sector Think Tank.

The Non-GMO Project. (2023, December 11). Non-GMO Project Home - The Non-GMO Project. The Non-GMO Project - Everyone Deserves an Informed Choice. Retrieved June 2, 2024, from https://www.nongmoproject.org/

Trading Economics. (2023). New Zealand exports by country. https://tradingeconomics.com/new-zealand/exports-by-country

Tsatsakis, A. M., Nawaz, M. A., Kouretas, D., Balias, G., Savolainen, K., Tutelyan, V. A., Golokhvast, K. S., Lee, J. D., Yang, S. H., & Chung, G. (2017). Environmental impacts of genetically modified plants: A review. Environmental Research, 156, 818-833. https://doi.org/10.1016/j.envres.2017.03.011

10 Appendix One – Interview Questions

General introductory questions

- What are your initial thoughts or perceptions on the use of genetic technology in dairy production?
- How do you see the use of genetic technology impacting your farming business?
- How do you see the use of genetic technology impacting your value chain?
- What concerns do you have around introducing genetic technology into the value chain / your farming business?

Access and adoption

- If you were to consider using genetic technology in your farming business, what do you see as key barriers to adoption?
- What potential risks or challenges do you foresee in implementing genetic technology in your farming practices?
- What support or resources would you need to address these barriers?
- What role do you think scientific research and evidence should play in shaping the adoption and regulation of genetic technology in agriculture?

Value chain

- How do you collaborate with others in the value chain, such as [seed suppliers, processors, distributors, and retailers]?
- How do you think the adoption of genetic technology may impact relationships throughout the value chain?
- If you were to adopt genetic technology in your farming business, what do you see as the key impact to the value chain?
- If others in the value chain were to adopt genetic technology in their farming business, what do you see as the key impact to your business?
- How do you think the use of genetic technology throughout the value chain could affect the overall competitiveness of farm businesses?
- What support or resources do you need to manage these impacts to your business, and other stakeholders throughout the value chain?

Market differentiation

- How important is the current GM free brand in your market?
- Do you think that there are sufficient systems in place to enable the market to differentiate to accommodate non-GM and GM producers?
    - How do you ensure transparency and traceability throughout your value chain?
- What support, and from who, would you need to enable market differentiation?

General / summary questions

- In your opinion, what kind of government and industry support would be necessary to facilitate the adoption of genetic technology in the agricultural sector?
- How do you envision the communication and public perception challenges associated with the use of genetic technology, and what support would be needed to address them?
- What kind of industry collaborations or partnerships do you think would be beneficial in maximising the benefits and minimising the risks of genetic technology in farming?