Submission

Submission on Gene Technology Bill
17 February 2025 (Final)

MCGUINNESS INSTITUTE
TE HONONGA WAKA

1.0 Introduction

The Institute welcomes the opportunity to offer feedback on the *Gene Technology Bill* (the Bill). We would like to thank the Health Committee for inviting public feedback.

We would welcome the opportunity speak to our submission.

2.0 Executive summary

This Bill represents a significant attempt to change New Zealand's policy on the use of gene technology and regulated organisms in New Zealand. It is unclear why such a complex, controversial and important issue for the country has been rushed, and why relevant stakeholders (such as iwi and the farming community) have not been adequately consulted.

If we get this policy wrong, there are a number of risks and costs, many of which are irreversible. Impacts of gene technology will ripple across the community, the economy, and the environment. Conversely, if gene technology is managed well, it represents potential opportunities and benefits for New Zealand. We have the chance to develop and maintain a strong reputation as a leader in environmental stewardship and protection, whilst ensuring the country is a safe place for people, flora and fauna to thrive.

The Office of the Minister of Science, Innovation and Technology states the 'proposed new regulatory regime has been developed at pace.'[1] Development at pace is unfortunate for a Bill which has serious, complex consequences for our country. This is not a Bill that should be rushed. We need to take time to understand the context and history behind it and whether it will deliver the benefits it promises, particularly at a time when society is facing so much uncertainty.

The Institute has had a significant interest in genetic modification/engineering and gene technology in New Zealand. You can learn more about the Institute and view a list of the Institute's publications on genetic modification in Appendices 1 and 2 respectively.

Over the past few years, the world (including New Zealand) has experienced significant social, economic and political uncertainty. We need to understand what our trading partners are doing in the gene technology space, and need to carefully analyse what the impacts of any policy changes would be in the long as well as the short term.

The views of New Zealanders need to be understood when designing public policy. Recent research from Primary Purpose in 2024[2] found New Zealanders' opinions on using genetic technologies to grow food were approximately split into thirds:

- 34% supported
- 31% opposed
- 34% were unsure.

In order to consider the next steps forward for gene technology in New Zealand, it is vital to look at the history of the issue and assess the potential costs, benefits and risks. We need to build on learnings from the past so we design efficient public policy that is fit-for-purpose.

3.0 General observations and concerns

3.1 Need to consider the history of this issue in New Zealand, including a review of the Royal Commission recommendations

The issue of gene technology has been passionately debated in New Zealand for a long time, with New Zealand undertaking its first outdoor experiment in 1988.[3] As mentioned above, this Bill has been developed 'at pace.' One of the unfortunate consequences of this is that important history and context on New Zealand's gene technology has been brushed over without sufficient analysis.

In April 2008, the Institute published *Project 2058 Report – The Review of the Forty-nine Recommendations of the Royal Commission on Genetic Modification.*[4] The strategic purpose of this report was to '… evaluate the current governance and accountability framework for managing genetic modification in New Zealand."[5] Seven years on from the 2001 Royal Commission on Genetic Modification, the Institute's research highlighted that fewer than half of the 49 recommendations in the Commissioners' report were fully implemented.

The findings show the Government was not pursuing the strategic option of 'preserving opportunities', as proposed by the Commissioners. The report reveals that of the 49 recommendations proposed:

- Only 20 were put into practice
- 12 were partially implemented
- 17 recommendations were not implemented at all. [6]

At the time, the McGuinness report also noted that the absence of a national strategic direction from government on GMO release meant it was highly likely that New Zealand would drift towards a GM future. By developing a national strategy on gene technology, New Zealand will be better placed in the future.

Another significant piece of work the Institute has published, *An Overview of Genetic Modification in New Zealand 1973–2013: The first forty years,*[7] analyses the history of gene technology in New Zealand, which helps explain the public controversy and debate on the topic. This report describes New Zealand's approach to managing the risks of genetic modification 40 years on from when it was first developed. It documents how government, Crown Research Institutes (CRIs), industry and society responded to this policy issue and makes recommendations as to the way forward.

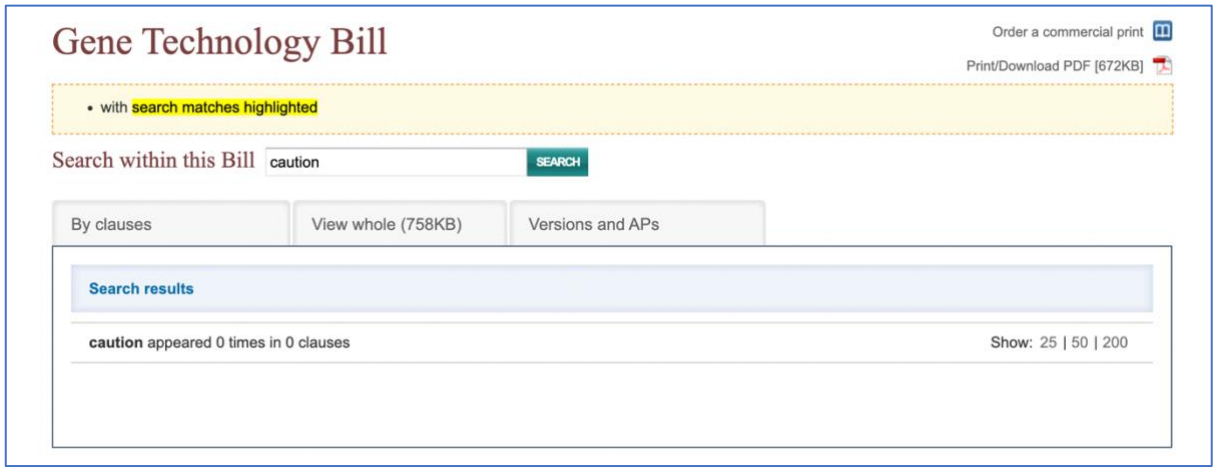
Finding a policy solution that balances the need for caution and the need for progress cannot be rushed. This is a matter of national significance with potentially irreversible consequences. The Institute believes a detailed review of the Royal Commission recommendations is necessary, both to learn from our history and to prevent replicating any past mistakes.

3.2 Shifting from a precautionary approach to a permissive one

The proposed Bill is planned to replace parts of the Hazardous Substances and New Organisms Act 1996 (the HSNO Act) that regulate GMOs with a standalone regime that aims to future-proof the law. One of the Bill's most significant changes is it will shift New Zealand's approach from its current precautionary stance to a much more permissive one.

As illustrated in the first box below, the Gene Technology Bill does not refer to 'caution' as an important consideration. The Regulatory Impact Statement accompanying the Bill states that the precautionary approach is one of the provisions to be changed in the new Bill and is out-of-date:

> Out-of-date provisions include:
>
> - A purpose statement and related provisions which emphasise decision-makers should take a precautionary approach…[8]



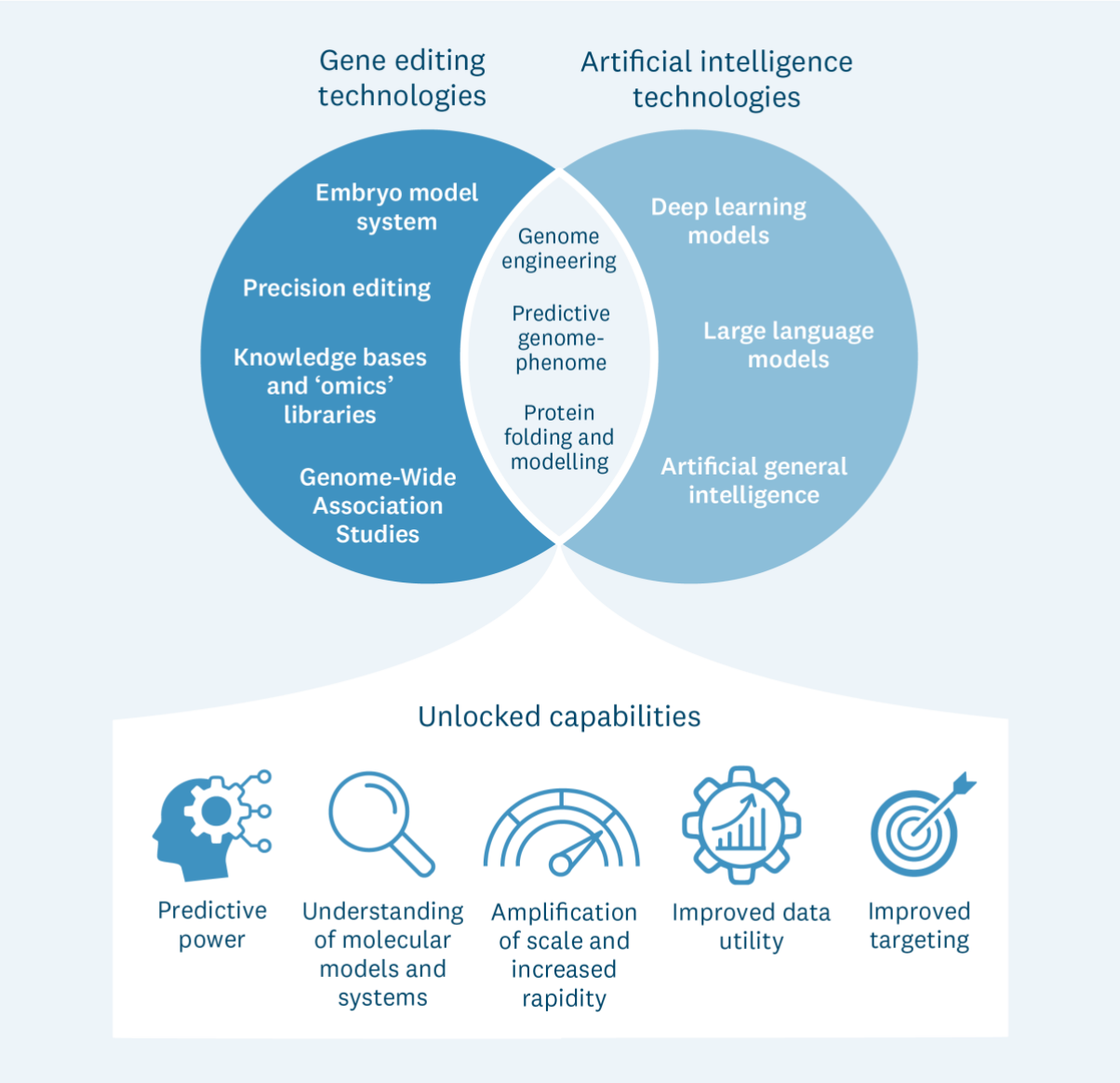
This needs to be read in context of the existing legislation (see box below), which embedded a precautionary approach as front and centre to decisions made under the current law.

This is a concern because the use of the precautionary approach reflects the seriousness and risks of potential consequences when experimenting with new kinds of technology in New Zealand's unique environment.

It does not make sense to shift to a more permissive approach in 2025, at a time when all kinds of emerging technologies are developing at an increasing pace.[9] There are unknown consequences of integrating gene technology with other technologies and biological systems (such as artificial intelligence (AI) and biotechnology).[10] Some of these complex technological

and scientific interactions have never happened before, and could have serious impacts across national security, agriculture, medicine and the economy.[11] For instance, we do not yet understand the consequences of using AI to design genetic modifications and as such we need proactive policy is needed to manage these emerging risks.[12]

Figure 1: Intersection of technology and unlocked capabilities
Source: Zakaria, S. et al. (2023).[13]



The combination of different technological advancements all magnify the risk, pace, scale and complexity around using gene technology, as seen in **Figure 1** above. This Bill needs to be developed with consideration for how gene technology will be managed as it integrates with other emerging technologies. The precautionary principle makes sense when it comes to regulating such a new and unknown area.

As well as the risks occurring with developing technology, New Zealand's geography also means it makes sense to follow a precautionary approach. As an island nation, New Zealand has a protected ecosystem and is in a unique position of maintaining GE-free pastures and crops,

without the high risk of cross-contamination. This not only protects the environment, but benefits New Zealand financially and allows New Zealand farmers to claim and label their produce as GE-free. The financial benefits of our GE-free status are explained in point **3.4** below.

3.3 An irreversible decision

There are very few decisions that a Government can make that it cannot undo, however, releasing gene technologies into the environment is one of them. By passing this Bill as it is proposed, we take away the rights of future generations to be GM-free food producers by releasing these experimental technologies into the environment.

Implementing this Bill is not a decision that should be made lightly or (as is the case here) without significant public support. For more detail on lack of public support, see point **3.1** above.

Further information on the lack of public support for introducing gene technology into New Zealand is outlined below in points **3.5** and **3.8**.

3.4 Lack of evidence of international success

The MBIE website states:

> Recent improvements mean we can use it more precisely and safely than ever before and places like Australia, Japan, the EU and England have safely embraced gene technologies.[14]

However, as outlined in the New Zealand Institute of Economic Research (NZIER) 2024 report, despite the hype and promised economic benefits of gene technology, there is a real lack of international success stories in commercialising gene technology. In their report, NZIER outline a number of discontinued, unsuccessful and non-commercial products, such as non-browning mushrooms, the FLAVR SAVR tomato, and AquAdvantage salmon.[15]

It is also relevant, as noted above, that due to New Zealand's isolated island location, we have an opportunity that many other countries do not. We have unique flora and fauna that have been able to thrive with careful conservation initiatives, as well as a developing tourism industry built on our 'clean and green' reputation.

We also are unique in that our agricultural sector has a premium place in international markets, with our farmers benefitting from consumer attitudes towards New Zealand meat and dairy products as clean, ethical and sustainable. Beef + Lamb New Zealand believe we need to understand and consider all perspectives as this complex issue unfolds. They note that New Zealand is different to Australia (and other countries) due to our reliance on exports:

> Australia approaches GMO regulation from a purely scientific perspective with no consideration of consumer perspectives/reaction. This difference is important, as New Zealand exports more agricultural products than Australia.[16]

As evidenced in economic analysis by NZIER,[17] with our current 'GE/GM-free' status, New Zealand products achieve a premium price internationally. If the Bill were passed, this may have a negative economic impact on New Zealand's exports (see below **3.5**).

3.5 Lack of evidence of promised benefits

The MBIE website promises the Bill will deliver a number of benefits:

> The updated rules intend to support our scientists in using gene technologies to make advancements in healthcare and climate change, protect our unique environment, lift our agricultural productivity, and boost exports.[18]

Unfortunately, there is no evidence provided in support of these claims. In fact, independent economic research by NZIER[19] suggests the opposite is true:

> The quantitative analysis we have been able to conduct with limited time and resources suggests that the environmental release of GMOs in New Zealand could reduce exports from the primary sector by up to $10billion to $20billion annually.

A Bill of this importance needs to be grounded on both scientific evidence and economic evidence. A change this significant needs to be based on detailed cost/benefit analysis, including a detailed economic analysis.

3.6 Lack of Consultation

As well as the lack of public support (with only a third of New Zealand's population in support of gene technology used for food in the most recent survey),[20] this Bill lacks support from key stakeholders.

It is critical to note that the Bill may have severe consequences for our farming communities, Māori, tourism operators, environmentalists, the organics sector, and others, however, they have not been consulted on this Bill. In particular:

- The Crown has not engaged with Māori adequately or sufficiently, and no consultation has taken place prior to the introduction of this Bill.[21]
- The farming community have expressed concern at a lack of consultation.[22] Gene technology has significant environmental and economic impacts on farmers.
- The organics sector has also expressed concern at a lack of consultation. If gene technologies are freely tested in the environment, they could compromise the integrity of New Zealand's organic farming by leading to genetic contamination. New Zealand's organic sector is worth around $1 billion, and it continues to grow steadily.[23]

3.7 Different applications of gene technology should be treated differently

Issues and complexities arise from the way this Bill assumes all gene technology developments should be treated the same. For instance, MBIE's website considers three examples of how gene technology could be used:

> With the changes in regulation, gene technologies could:
> - Make it easier for doctors and scientists to research, develop and manufacture innovative therapies in New Zealand like using the patient's own cells to help fight against cancer.
> - Support scientists in developing a new type of pine tree that meets our forestry needs but doesn't spread. This would help to protect and preserve our natural environments.

- Support the development of fruit and vegetables that are more resilient to pests and diseases. This would mean more food ends up on the table, and less in the bin.[24]

The costs, risks, benefits and opportunities of each of these examples are significantly different. The narrative that New Zealand could, through the passing of this Bill, create therapies to fight cancer is particularly irresponsible given New Zealand has very little medical expertise in this area. It is in our view unethical to promote this example, giving false hope to cancer patients and their families, without clear evidence to support it.

To position a cure for cancer (alongside commercial interests in forestry and agriculture), is reminiscent of the 2001 incident where AgResearch genetically modified cows with human genes, promoting this research that may help cure MS.[25] However, the High Court called for a 'rapid rethink' of this project, and Waikato University biological sciences professor Dick Wilkins said the medical claims promised were 'largely a nonsense.'[26] Green Party co-leader Jeanette Fitzsimmons also expressed concerns about the false promises made by AgResearch '…the real purpose of these experiments is to perfect the techniques of putting human genes into cows in order to produce genetically engineered dairy food and have nothing to do with MS…MS sufferers all over New Zealand have been cruelly deceived.'[27]

AgResearch's work in this area is still ongoing. Ten years later there is still no clear evidence of benefits experienced by MS patients, or indeed, to our knowledge, any financial benefits from the project.[28] However, as evidenced in the Institute's research, the costs to the public from this project have been significant. Approximately $100 million of public funds has been used to progress this research. This means the sunk cost of each existing asset (GM livestock) is approximately $1.3 million per animal.[29] It is unethical to overpromise medical cures will be developed with gene technology when there is no evidence to support these claims.

For such complex, irreversible and important research and development, it is not 'one size fits all.' Different applications of gene technology should be treated carefully, depending on their costs, benefits, risks and opportunities. Exceptions should be made for medical use, which already has precise policies around clinical trials, etc., before being allowed in the field. This should be done after careful consultation with medical, scientific and ethical experts.

3.8 The shared values of New Zealanders

Seven shared values of New Zealanders were identified by the Royal Commission in 2001 when it was analysing the use of gene technology in our country. These were:

1. the uniqueness of New Zealand
2. our cultural heritage
3. sustainability
4. being part of a global family
5. the well-being of all
6. freedom of choice, and
7. participation.[30]

These values were then used as a platform on which to develop the Royal Commission's recommendations in 2001 and we believe these values remain robust and relevant to New Zealand in 2025.

It is significant to note that these values have not been reflected in the proposed Bill, which is a real lost opportunity to retain the values but design a different package based on the latest scientific and technical knowledge.

Any further discussion and decision-making on the use and application of genetic modification technology in New Zealand should start with consideration of these seven shared values. Public policy should reflect the values of the country it is trying to protect.

4.0 Recommendations

The Bill lacks the necessary financial analysis and of the costs, benefits, risks and opportunities that may occur. This makes it very difficult to provide detailed recommendations and analysis.

Below are some initial recommendations on how the current system could be strengthened, stressing the need for transparency, accountability, and the consideration of the interests of current and future New Zealanders:

1. Review all the 49 recommendations of the Royal Commission. Identify the recommendations that have not been fully implemented and consider whether they should be implemented in order to deliver a more robust, durable and considered legislative package.
2. Take into consideration the unique values, characteristics and environment of New Zealand and design a strategy that protects what New Zealanders consider important over the long term.
3. Ensure that all institutions and projects arising from this legislation have sufficient checks and balances, and must report annual on the approvals, ensuring in particular that near failures and failures are reported upon.
4. Undertake detailed research and economic analysis to understand the impacts of gene modification on the New Zealand economy, reputation and brand.
5. Make exceptions for medical use after consultation with medical, scientific and ethical experts. Different types of technology should be treated differently using a precautionary approach, and undertaking careful cost/benefit and risk/opportunity analysis.
6. Consult adequately with stakeholders and the public (especially Māori, the farming community and the organics sector, all of whom will be impacted significantly by gene technology). This Bill should reflect the comments from these communities.
7. Ensure reviews of the system, research institutions and scientists granted approvals are tactical and regular. Technology is changing at an increasing pace and this Bill will need to be regularly reviewed to ensure it is fit-for-purpose.
8. Incorporate a 'checking' mechanism into any new policy on gene technology. This should include removing permission to use this technology if there are any breaches of conditions. Compliance costs should be fully recovered from applicants.
9. Infringement fees for non-compliance with conditions to use gene technology should be significant. Any infringements should be required to be made public in the annual report of the regulator.
10. More clarity is required in cases were international applicants apply to undertake research in New Zealand, either on their own or in collaboration with a New Zealand company, that they cannot undertake in their own country.
11. Areas of particular concern that require to be taken into include:
    - GM livestock (e.g. ensuring epidemic and pandemic risk is assessed and risks minimized).

- Not overpromising cures or treatments in applications (e.g. in such cases, an independent review of the costs, risks and benefits should be mandatory).
- GM crops, grasses and pines (e.g. initial testing should be in a sealed laboratory and controls should be put in place to prevent escape).
- Use of antibiotics (e.g. should be minimised to help reduce antibiotic resistance).

5.0 Conclusion

Gene technology is a powerful tool which requires appropriate safeguards to ensure the well-being of the community and the environment. This Bill (and the documents surrounding it) promise a number of benefits for New Zealand, however, they fail to evidence how these benefits will be achieved. Further, there is no analysis of the potential economic costs of moving away from a precautionary approach to a more permissive regulatory regime. Lastly, there is little analysis on how the risks of gene technology might be mitigated.

There is a significant amount of policy work, consultation, scientific research, economic analysis, and community and environmental investigation required before this Bill should become law.

New Zealand has a number characteristics that differentiate us from other countries, including our geographic isolation, our unique environment, our Te Tiriti/Treaty obligations, and our reliance upon our farming communities and their international exports. As a country, we are economically reliant on selling high-quality exports that benefit from our clean, premium sustainable brand and our high-volume products (such as milk). The proposed Bill does not consider the complexities of introducing gene technology into a country with our unique values and characteristics.

This Bill misses the opportunity to develop a solid, precautionary gene technology policy for New Zealand.

Appendix 1: About the McGuinness Institute

The Institute was founded in 2004 as a non-partisan think tank working towards a sustainable future for Aotearoa New Zealand. Project 2058 is the Institute's flagship project focusing on Aotearoa New Zealand's long-term future. Because of our observation that foresight drives strategy, strategy requires reporting, and reporting shapes foresight, the Institute developed three interlinking policy projects: *ForesightNZ, StrategyNZ* and *ReportingNZ*. Each of these tools must align if we want Aotearoa New Zealand to develop durable, robust and forward-looking public policies. The policy projects frame and feed into our research projects, which address a range of significant issues facing Aotearoa New Zealand. The 11 research projects are: *CivicsNZ, ClimateChangeNZ, EcologicalCorridorsNZ, GlobalConflictNZ, OneOceanNZ, PandemicNZ, PublicScienceNZ, ScenariosNZ, TacklingPovertyNZ, TalentNZ* and *WaterFuturesNZ*.

Appendix 2: List of McGuinness Institute Publications on Genetic Engineering, Genetic Modification and Gene Technology

Note table is in order of date published, with the most recent first.

Date	Title	Type of Publication	Project
July 2020	*Working Paper 2020/06 – Letter to the Minister on AgResearch's approval for GM animals in light of pandemic risk*	Working Paper	Pandemic NZ, PublicScienceNZ
Sep 2013	*Project 2058 – Report 16 – An Overview of Genetic Modification in New Zealand 1973-2013: The first forty years*	Project 2058 Report	Project2058
Aug 2013	*Press Release – Time for New Zealand to revisit the genetic modification debate (Attachments: The First Forty years of GM: By the Numbers, The Three Stage Process)*	Press Releases	PublicScienceNZ
Apr 2008	*Project 2058 Report – The History of Genetic Modification in New Zealand*	Project 2058 Report	Project2058
Apr 2008	*Project 2058 Report – The Review of the Forty-nine Recommendations of the Royal Commission on Genetic Modification*	Project 2058 Report	Project2058
Apr 2008	*Press Release – New Zealand likely to drift into a GM future*	Press Releases	Project2058
Apr 2008	*Press Release – A backwards glance: New Zealand's GM history revisited*	Press Releases	Project2058
Jul 2002	*Article – Accounting for hazardous substances and genetically modified organisms*	Articles	PublicScienceNZ

Appendix 3: Glossary of key terms

Note the below information has been copied from the **Gene technology media pack** provided by MBIE to accompany the Bill, with text in blue added.[31]

What is gene technology?

- Gene technology is any modern technique used for modifying genes. Products of gene technologies can be used in areas such as human and animal health, medicines, and food production.

What is biotechnology?

- Biotechnology is the use of biology to develop new products, methods and organisms intended to improve human health, the environment and society.

What's the difference between GMO and gene editing?

- Gene editing is generally regarded as a type of genetic modification that involves targeted changes to an organism's genome.
- More traditional genetic modification involves untargeted insertion of genetic material into an organism's genome (because of the untargeted nature of these older techniques, whole genes have to be inserted in order to produce intended changes).

Glossary of terms

Bioeconomy	Bioeconomy describes the parts of the economy that use renewable biological resources to produce food, products and energy.
Biotechnology	Biotechnology is the use of biology to develop new products, methods and organisms intended to improve human health, the environment and society.
Conventional breeding or traditional breeding	Choosing parent organisms with desirable traits and breeding these to produce offspring with the same desirable traits. Results can be variable, and the trait is not always passed from parent to offspring. Also sometimes called Traditional Breeding. Tools and techniques in this category do not fall under genetic modification regulations.
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats, which are the hallmark of a bacterial defence system that forms the basis for CRISPR-Cas9 gene editing technology.
DNA	Deoxyribonucleic acid, the hereditary material in humans and almost all other organisms.
Gene	A gene is the basic physical and functional unit of heredity. Genes are made up of DNA.
Gene editing	A technique to induce specific targeted changes in an organism's existing genome to achieve a specific desired outcome. Transgenic modification, often crossing species boundaries, is typically excluded from this definition (see definition below for transgenic). What technology and resultant organisms are encompassed under this definition varies by country. Gene edited organisms can be indistinguishable from conventionally bred counterparts and this is dependent on a number of factors including the change made, the size of the change and how much is already known about the genome and genetic variation of the organism and species.
Genetic engineering (GE)	Synonymous with genetic modification
Genetic modification (GM)	A technique to change the characteristics of an organism by modifying its genome. What technology and resultant organisms are encompassed under this definition varies by country.
Genetic technology	Gene technology is any modern technique used for modifying genes. Products of gene technologies can be used in areas such as human and animal health, medicines, and food production.
Genome	All the genetic information of an organism or species.

In vitro	(meaning in glass, or in the glass) studies or treatments that are performed with microorganisms, cells, or biological molecules outside their normal biological context.
In vivo	Studies or treatments that are performed within the body of a living organism.
Mutagenesis	Process by which DNA of an organism is changed due to a mutation. Can occur spontaneously in nature or via exposure to mutagens such as chemicals or radiation.
RNA	Ribonucleic acid. Can have multiple functions within an organism, including being the intermediate product between a gene (encoded by DNA) and a protein.
Selective breeding	The controlled breeding of organisms by human intervention to selectively produce traits.
Synthetic biology	A subset of biotechnology which includes the design and construction of biological systems and devices, as well as the redesign of existing biological systems for useful purposes.
Synthetic nucleic acid	Nucleic acid molecules (DNA or RNA) that are chemically synthesized or amplified but can base pair with naturally occurring nucleic acid molecules.
Trait	A genetically determined characteristic, sometimes called a phenotype.
Transgenic	Introducing specific genetic material from one donor organism to another host organism to produce a desired trait, where the two organisms are not sexually compatible species.

Endnotes

[1] Office of the Minister of Science, Innovation and Technology (2024). *Regulation of gene technologies - Policy decisions.* [online] *MBIE*, p.4. Available at: https://www.mbie.govt.nz/dmsdocument/29938-regulation-of-gene-technologies-policy-decisions-proactiverelease-pdf [Accessed 17 Feb. 2025].

[2] RNZ News (2024). *Research on genetic technologies in food production finds opinions split*. [online] RNZ. Available at: https://www.rnz.co.nz/news/country/521652/research-on-genetic-technologies-in-food-production-finds-opinions-split [Accessed 17 Feb. 2025].

[3] McGuinness Institute (2013). *Project 2058 – Report 16 – An Overview of Genetic Modification in New Zealand 1973-2013: The first forty years.* [online], p.6. McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/project-2058-reports [Accessed 17 Feb. 2025].

[4] McGuinness Institute (2008). *The Review of the Forty-nine Recommendations of the Royal Commission on Genetic Modification.* [online] McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/project-2058-reports [Accessed 17 Feb. 2025].

[5] McGuinness Institute (2008). *The Review of the Forty-nine Recommendations of the Royal Commission on Genetic Modification.* [online], p.5. McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/project-2058-reports [Accessed 17 Feb. 2025].

[6] McGuinness Institute (2008). *The Review of the Forty-nine Recommendations of the Royal Commission on Genetic Modification.* [online], p.3. McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/project-2058-reports [Accessed 17 Feb. 2025].

[7] McGuinness Institute (2013). *Project 2058 – Report 16 – An Overview of Genetic Modification in New Zealand 1973-2013: The first forty years.* [online] McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/project-2058-reports [Accessed 17 Feb. 2025].

[8] Ministry of Business, Innovation and Employment (2024). *Regulatory Impact Statement Reform of Gene Technology Regulation.* [online] *MBIE*, p.3. Available at: https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/gene-technology-regulation [Accessed 17 Feb. 2025].

[9] Zakaria, S., Marler, T., Cabling, M., Genc, S., Honich, A., Virdee, M. and Stockwell, S. (2023). *Machine Learning and Gene Editing at the Helm of a Societal Evolution.* [online], p.1. RAND Corporation. Available at: https://www.rand.org/randeurope/research/projects/2023/ai-at-the-helm-of-a-species-evolution.html [Accessed 17 Feb. 2025].

[10] Zakaria, S., Marler, T., Cabling, M., Genc, S., Honich, A., Virdee, M. and Stockwell, S. (2023). *Machine Learning and Gene Editing at the Helm of a Societal Evolution.* [online] RAND Corporation. Available at: https://www.rand.org/randeurope/research/projects/2023/ai-at-the-helm-of-a-species-evolution.html [Accessed 17 Feb. 2025].

[11] Zakaria, S., Marler, T., Cabling, M., Genc, S., Honich, A., Virdee, M. and Stockwell, S. (2023). *Machine Learning and Gene Editing at the Helm of a Societal Evolution.* [online], p.2. RAND Corporation. Available at: https://www.rand.org/randeurope/research/projects/2023/ai-at-the-helm-of-a-species-evolution.html [Accessed 17 Feb. 2025].

[12] Zakaria, S., Marler, T., Cabling, M., Genc, S., Honich, A., Virdee, M. and Stockwell, S. (2023). *Machine Learning and Gene Editing at the Helm of a Societal Evolution.* [online], p.iii,2. RAND Corporation. Available at: https://www.rand.org/randeurope/research/projects/2023/ai-at-the-helm-of-a-species-evolution.html [Accessed 17 Feb. 2025].

[13] Zakaria, S., Marler, T., Cabling, M., Genc, S., Honich, A., Virdee, M. and Stockwell, S. (2023). *Machine Learning and Gene Editing at the Helm of a Societal Evolution.* [online], p.v. RAND Corporation. Available at: https://www.rand.org/randeurope/research/projects/2023/ai-at-the-helm-of-a-species-evolution.html [Accessed 17 Feb. 2025].

[14] Ministry of Business, Innovation and Employment (2024). *Gene technology regulation | Ministry of Business, Innovation & Employment*. [online] MBIE. Available at: https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/gene-technology-regulation [Accessed 17 Feb. 2025].

[15] New Zealand Institute of Economic Research (2024). *Potential costs of regulatory changes for gene technology Economic assessments of an MBIE proposal.* [online], p.11. Available at: https://business.scoop.co.nz/2024/11/26/nz-exports-risk-multi-billion-dollar-hit-if-gmo-rules-deregulated [Accessed 17 Feb. 2025].

[16] Beef + Lamb New Zealand (2024). *Gene technology rules update for farmers*. [online] Beef + Lamb New Zealand. Available at: https://beeflambnz.com/news/gene-technology-rules-update-farmers [Accessed 17 Feb. 2025].

[17] New Zealand Institute of Economic Research (2024). *Potential costs of regulatory changes for gene technology Economic assessments of an MBIE proposal.* [online], p.18. Available at: https://business.scoop.co.nz/2024/11/26/nz-exports-risk-multi-billion-dollar-hit-if-gmo-rules-deregulated [Accessed 17 Feb. 2025].

[18] Ministry of Business, Innovation and Employment (2024). *Gene technology regulation | Ministry of Business, Innovation & Employment*. [online] MBIE. Available at: https://www.mbie.govt.nz/science-and-

technology/science-and-innovation/agencies-policies-and-budget-initiatives/gene-technology-regulation [Accessed 17 Feb. 2025].

[19] New Zealand Institute of Economic Research (2024). *Potential costs of regulatory changes for gene technology Economic assessments of an MBIE proposal*. [online], p.18. Available at: https://business.scoop.co.nz/2024/11/26/nz-exports-risk-multi-billion-dollar-hit-if-gmo-rules-deregulated [Accessed 17 Feb. 2025].

[20] RNZ News (2024). *Research on genetic technologies in food production finds opinions split*. [online] RNZ. Available at: https://www.rnz.co.nz/news/country/521652/research-on-genetic-technologies-in-food-production-finds-opinions-split [Accessed 17 Feb. 2025].

[21] Organics Aotearoa New Zealand (OANZ) (2025). *Gene Technology Bill Submission Guide*. [online] Organics Aotearoa New Zealand. Available at: https://www.oanz.org/gefree-future-make-a-submission [Accessed 17 Feb. 2025].

[22] Uys, G. (2024). *Farmers want consultation on GE changes*. [online] Farmers Weekly. Available at: https://www.farmersweekly.co.nz/politics/farmers-want-consultation-on-ge-changes [Accessed 17 Feb. 2025].

[23] Vicente, L. (2024). *Organics Aotearoa New Zealand*. [online] Organics Aotearoa New Zealand. Available at: https://www.oanz.org/new-blog/new-gene-technology-rules-discussion-welcomed [Accessed 17 Feb. 2025].

[24] Ministry of Business, Innovation and Employment (2024). *Gene technology regulation | Ministry of Business, Innovation & Employment*. [online] MBIE. Available at: https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/gene-technology-regulation [Accessed 17 Feb. 2025].

[25] NZ Herald (2001). *Editorial: Reprieve for cows bearing MS hope*. Available at: https://www.nzherald.co.nz/nz/ieditoriali-reprieve-for-cows-bearing-ms-hope/VLBY4QWVFH46UP7CG37U4MPD3M/#google_vignette [Accessed 17 Feb. 2025]. See also McGuinness Institute (2013). *Project 2058 – Report 16 – An Overview of Genetic Modification in New Zealand 1973-2013: The first forty years*. [online] McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/project-2058-reports [Accessed 17 Feb. 2025].

[26] The Dominion (2001). Court calls for rapid rethink on GM cow research. *The Dominion*, 8 May, p.7.

[27] The Dominion (2001). Court calls for rapid rethink on GM cow research. *The Dominion*, 8 May, p.7.

[28] EPA (2020). *File note – Summary and analysis of AgResearch ERMA200223 10-year repor*t. Available at: https://www.epa.govt.nz/assets/FileAPI/hsno-ar/ERMA200223/ERMA200223-2020-AgResearch-cattle-sheep-and-goats-10-year-report-Summary-and-Decision.pdf [Accessed 17 Feb. 2025].

[29] McGuinness Institute (2020). *Working Paper 2020/06 – Letter to the Minister on AgResearch's approval for GM animals in light of pandemic risk*. [online], p.5. McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/working-papers [Accessed 17 Feb. 2025].

[30] McGuinness Institute (2008). *The Review of the Forty-nine Recommendations of the Royal Commission on Genetic Modification*. [online], p.9. McGuinness Institute. Available at: https://www.mcguinnessinstitute.org/publications/project-2058-reports [Accessed 17 Feb. 2025].

[31] Ministry of Business, Innovation and Employment (2024). *Gene technology media pack*. [online] MBIE. Available at: https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/gene-technology-regulation [Accessed 17 Feb. 2025].