NZASE science research

Indigenous perspectives and gene editing

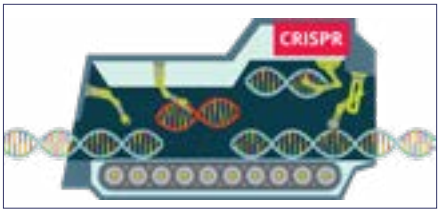
This article summarises for students a paper by scientists from the University of Waikato, and Plant and Food Research.

Abstract

Gene editing could be seen as the most significant recent addition to the modern biotechnology toolbox, with many possible uses. However, it has re-ignited the ethical debates generated by earlier forms of genetic modification (GM). In Aotearoa New Zealand, gene editing is considered GM and is subject to approval by the Environmental Protection Authority, a process requiring Māori perspectives to be taken into account. This article explores the ways Māori values might be used to analyse the risks and benefits of gene editing in our country. These perspectives were gathered from available research, interviews and a survey. This article shows that the cultural values underpinning Māori viewpoints on GM remain relevant to gene editing. While Māori participants were not categorically opposed to the idea of gene editing, they suggested regulatory approval case by case.

Background

DNA affects an organism's traits and is inherited down the generations. Spontaneous changes in DNA – mutations or variants – can affect phenotype; for example, naturally occurring mutations in genes that improve grain yield and milk production have been selected for, and therefore allowed domestication of plants and animals. In the last 70 years techniques have been developed to alter DNA artificially; gene editing is the most recent.



Other new techniques to alter DNA:

- Radiation-based mutation – gamma-ray irradiation generates many random mutations across the genome. This is used in plant breeding to generate new traits such as seedless table grapes.
- Genetic modification – inserts an entire gene into the host genome. This gene can come from a different organism, creating a Genetically Modified Organism (GMO). For example, insect-resistant Bt maize and cotton result from inserting a gene from the bacteria *Bacillus thuringiensis*.

Gene editing alters DNA very precisely using a system called CRISPR-Cas9 – Clustered, Regularly Interspaced, Short Palindromic Repeats – and its associated protein, Cas9. This system recognises a specific base sequence, cuts it in a specific place, deletes or inserts a section, and re-joins the ends, inducing a mutation. Importantly, for some, this technique can avoid insertion of new DNA but create changes that could have occurred naturally.

From the US National Human Genome Research Institute.

Potential uses

Gene editing is or could be used in:

- Medicine to make immune cells attack cancer cells or to stop the HIV virus replicating
- Agriculture to create more hardy, nutritious and productive plants and animals
- Conservation to make a pest sterile or spread a malaria resistance gene in mosquitoes.

The broad range of uses could re-ignite ethical debates that occurred when New Zealand scientists started to research GM. Public outrage led to the establishment of a Royal Commission of Inquiry into GM, which recommended a case-by-case approach to approvals of organisms generated using GM.

However, due to continued public concerns

no genetically-modified crops have been grown in New Zealand. Māori values were recognised within the RCGM report and the decision-making processes of regulations dealing with GMOs.

Potential uses of gene editing

Methods

A discussion paper reviewed 38 research publications between 2005 and 2017, and identified ideas for questions.

Separate interviews were held with eight Māori participants, six women and two men, chosen for their familiarity with both scientific research and Māori perspectives, and their role translating between the two. An electronic survey was also shared with two networks of Māori familiar with the science.

Results

The review of research showed that many Māori are opposed to GM, although they feel more positively towards GM projects that have a clear benefit or genuinely contribute to communities and the environment.

Interviews and survey

Potential opportunities for gene editing

Participants saw opportunities for gene editing to support their communities in potential applications such as preserving (and sequencing) endangered species, health, protecting biodiversity, environmental restoration, sustainability and pest control.

Concerns about gene editing

- The risks of unintended consequences – an innate risk from a Māori perspective.
- Benefits to society were clear in environment and health, but not so clear when commercial interests were involved.
- The need for public conversations about GM, as public understanding lags well behind knowledge and capability.
- Participants suggested level of regulation ranged from 'no GMOs', to 'only in the lab', to 'after strict decision-making'.

The status quo allows all gene technologies to be monitored appropriately, although they are technically different.

Kaitiaki responsibilities

- Need to consider the intent of the use, how kaitiaki understand the science, and whether its use disrupts or enhances the relationships they have with taonga species.
- Participants generally felt that gene editing could support kaitiaki to exercise their responsibilities.
- Extreme options like gene-editing may be needed to deal with intractable problems where all the choices are ethically challenging, such as pest control.
- Hapū or iwi should decide whether this technology is appropriate for their concerns.

Whakapapa between and within species

All participants thought that introducing DNA from one species into another through GM affected whakapapa. But not all felt it was the same if DNA within one species was edited. Some kaumatua were more concerned than others.

Taonga and introduced or commercially-produced species

Participants had mixed views on whether there was a difference when applying gene editing to a taonga species, or an introduced or commercially-produced species. Participants wanted Māori to have a say in relation to both. All participants said that te Tiriti o Waitangi acknowledges Māori rights to taonga species, and some participants viewed all species as taonga.

Mauri

The effect on mauri is a key dilemma in genetic modification. Most participants believed that mauri is changed by gene editing, but views varied with nature, size and

heritability of the change in characteristics. Participants thought that all gene editing should be subject to standardised processes, with protocols specific to each hapū or iwi. Māori stressed that their input is necessary especially for taonga species.

Discussion

Research shows that indigenous peoples are strongly against GM developments and their commercialisation. Biotechnology projects are seen as inconsistent with Māori values, impinging on Māori rights and sovereignty, and continuing a process where indigenous cultures, values and knowledge systems are marginalised and undervalued.

Despite inclusion in existing regulatory processes and more positive interactions over the past decade, Māori are unlikely to agree to widespread use of gene-based technologies in the short term. Māori tend to be concerned about how the technologies are used and the rationale, and the consequences of use. All participants wanted appropriate regulation, and recognised that there will always be cases of justifiable and unpalatable use. They thought that regulation may need to include the ability to approve each case on its merits.

The Māori worldview underpins their perspectives on both GM and gene editing. Important concepts include whakapapa, mauri, mana, and kaitiakitanga. Participants in this study suggested that gene editing may enhance or diminish Māori values. The precautionary principle is important here; when an innovation has the potential for harm, but the science is not clear, it is best to be cautious, pause and review before implementing changes that may prove disastrous.

The outcomes of GM and gene editing are different. Gene editing does not necessarily insert foreign DNA into the genome of the host organism, and the small DNA sequence changes from gene editing cannot be differentiated from natural ones.

The participants in this study wanted a constructive discussion to create a robust regulatory framework that deals with gene editing case by case, and uses Māori values in making decisions.

Ngā Kupu

Hapu – Subtribe
Irakē – Genetic mutation
Iranga tuko iho – Genetic inheritance
Iwi – Tribe, nation
Kaitiaki – Guardian, steward
Kaitiakitanga – Guardianship
Mana – Inherent authority, power
Mauri – Life essence
Pītau ira – DNA
Raweke ira – Genetic modification
Taonga – Treasure, precious
Whakapapa - Genealogy, lineage

From Paekupu and Te Aka Maori Dictionary

Summary

If the New Zealand government considers whether to change regulations for gene editing technologies, it should include a new round of public consultation.

Māori participants drew on values of whakapapa, mauri, mana, and kaitiakitanga to consider the ethics of gene editing. They expressed a range of views and were prepared to consider gene editing case by case, especially where it aligns with Māori worldviews. Incorporating Māori values into decision-making processes could ensure that broader community interests are considered in the future use of gene editing technologies. Using gene editing technologies tends to put commercial interests ahead of community benefit, increasing public sensitivities about inequities.

The authors recommended additional research to clarify the strength of the various positions identified in this study, and to explore their relevance to other indigenous communities.

Links

- Hudson, M., Mead, A. T. P., Chagné, D., Roskruge, N., Morrison, S., Wilcox, P. L., & Allan, A. C. (2019). Indigenous perspectives and gene editing in Aotearoa New Zealand. *Frontiers in bioengineering & biotechnology, 7*, 70.
- Table of the impact of gene editing on Maori values
- Royal Society Te Apārangi resources
- Explainer: How CRISPR works, 2017 *ScienceNews for students*
- Life hackers, 2017, *NZ Geographic*