Plant genetics

Natural transgenic plants

Bacteria may have modified the genomes of thousands of plants

Michael Le Page

IMAGINE CHINA/SHUTTERSTOCK

Some tea plants have been found to contain genes from a bacterium

ABOUT one in 20 flowering plants are naturally transgenic, carrying bacterial DNA within their genomes. The added genes can make them produce unusual chemicals, and the species they have been found in include tea, bananas and peanuts.

Other plants that carry bacterial genes include sweet potatoes, yams, American cranberries, Surinam cherries and the hops used to flavour beer. What effect the added genes have on the plants that contain them is still far from clear. "We are only at the start of this," says Léon Otten at the Institute of Molecular Biology of Plants in Strasbourg, France.

The culprit is a microbe called *Agrobacterium* that infects plants. When this bacterium gets inside a plant cell, it inserts a "cassette" of DNA containing hundreds of genes into the genome of the cell. These genes include ones that encode hormones that make plants grow tumour-like lumps called crown galls (pictured, below right) and enzymes that make chemicals the bacteria feed on.

Agrobacterium is the main tool used to create the genetically engineered crops grown globally. Biologists swap out the microbe's cassette of genes for whatever DNA they want the bacterium to splice in for them. "*Agrobacterium* is nature's own genetic engineer," Mary-Dell Chilton, once wrote. In 1980, she was the first to use it to modify plants.

In the wild, though, it was thought that the genes added by *Agrobacterium* hardly ever got passed on to the next generation. For this to happen, an infected cell has to grow into an entire new plant, says Otten. That plant then has to flower and produce offspring, and those offspring have to thrive despite harbouring alien genes meant to hijack them.

Until now, the only known examples of *Agrobacterium* DNA persisting in a plant genome were in tobacco and the sweet potato. Otten and Tatiana Matveeva of St Petersburg State University in Russia have now found dozens more by analysing the genomes of hundreds of plants (*Plant Molecular Biology*, doi.org/dcdn).

5%

of flowering plants may carry DNA inserted by bacteria

Their results suggest that about 5 per cent of the hundreds of thousands of species of flowering plants carry *Agrobacterium* DNA. "They did a good job," says Jan Kreuze at the International Potato Center in Lima, Peru, who found in 2015 that sweet potatoes are transgenic. "I think it's true."

This has only just been discovered because no one had looked before, says Otten. Of the *Agrobacterium* genes identified by Otten and Matveeva, most contained mutations that should disable them, but some are still likely to be active.

Plants that are transgenic in this way don't count as genetically modified under European Union regulations, which specifically exclude organisms modified by "natural" processes.

The discovery is good news for Henrik Lütken at the University of Copenhagen in Denmark, who plans to test the limits of this definition.

He is creating new plant varieties using natural strains of *Agrobacterium*. For instance, he has created a compact variety of a house plant called *Kalanchoe blossfeldiana*, which is now ready for commercial sale. He thinks these plants shouldn't count as GM and the latest findings will bolster his case.

Because the genes inserted into plants by *Agrobacterium* can produce big changes, Otten thinks this process could drive the evolution of new plant species. His research suggests that tobacco plants have been modified by *Agrobacterium* several times in the past few million years, and these events seem to have coincided with the emergence of new species.

LEONARD LESSIN/SPL

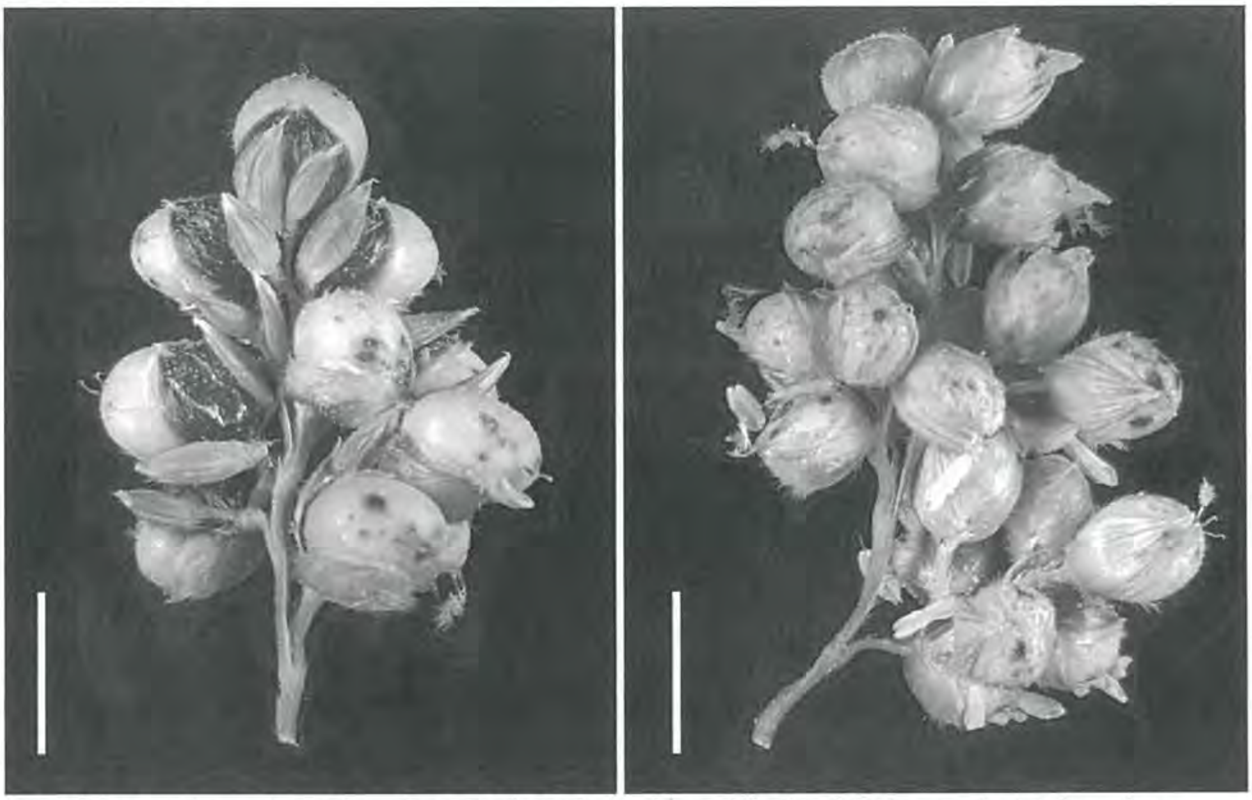
A tree with a crown gall caused by infection with *Agrobacterium*

Infection by *Agrobacterium* isn't the only way that transgenic organisms can be created naturally. Viruses often move genes between species. For instance, monarch butterflies have acquired genes from wasps in this way, and gonorrhoea bacteria have some human DNA inside them.

It has also been discovered that the horticultural process of grafting different plants together can lead to the exchange of genes, meaning humans have inadvertently been creating transgenic plants for millennia. From genome studies, we can see that gene swapping has been going on since the dawn of life. ■

Scientists Double Sorghum Grain Yields by 200%

November 6, 2019



The left image shows the grains of a normal sorghum plant, while the right image depicts how the amount of grains doubled in the genetic variant. Photo Source: Cold Spring Harbor Laboratory

Scientists at the Cold Spring Harbor Laboratory (CSHL) and U.S. Department of Agriculture Agricultural Research Service (USDA ARS) have doubled the amount of grains that a sorghum plant can yield. Led by Dr. Doreen Ware, CSHL Adjunct Professor and research scientist at USDA and colleague Dr. Zhanguo Xin, the research team identified novel genetic variations in sorghum's *MSD2* gene, increasing the grain yield by 200 percent.

MSD2 comes from the gene line that boosts flower fertility by lowering the amount of jasmonic acid, a hormone that controls seed and flower development. It is regulated by *MSD1*, a gene discovered by Dr. Ware's team in 2018. Their research shows that manipulating either gene increases seed and flower production.

Sorghum is one of the world's most important sources of food, animal feed, and biofuel. It is considered a model crop for research because it has a high tolerance to drought, heat, and high-salt conditions.

Leopoldina
Nationale Akademie
der Wissenschaften

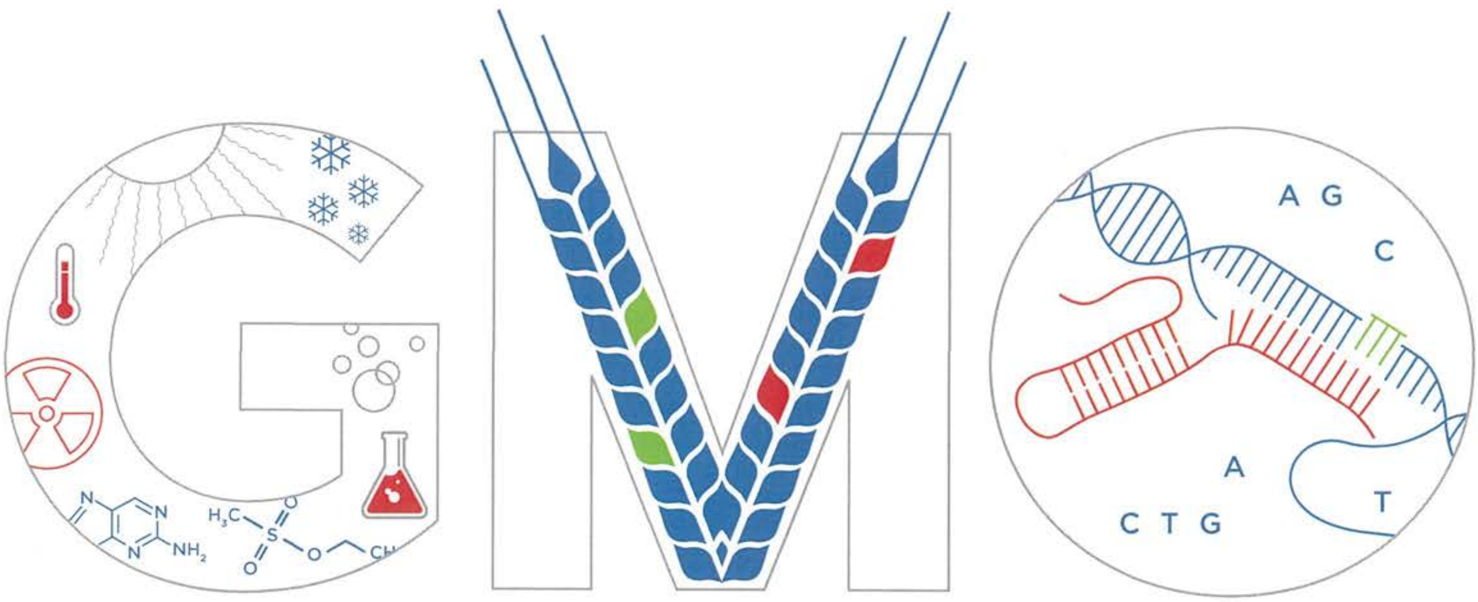
UNION
DER DEUTSCHEN AKADEMIEN
DER WISSENSCHAFTEN

DFG Deutsche Forschungsgemeinschaft

2019
Short Version of the Statement

Towards a scientifically justified, differentiated regulation of genome edited plants in the EU

German National Academy of Sciences Leopoldina
German Research Foundation
Union of the German Academies of Sciences and Humanities



On 25 July 2018, the European Court of Justice ruled on the interpretation of the definition of the term 'genetically modified organism' (GMO) in the GMO Directive 2001/18/EC. It follows from the ruling that all organisms produced by genome editing are subject to the legal framework applicable to release, placing on the market, labelling, and traceability of GMOs. In contrast to traditional breeding methods, genome editing methods enable directed, cost and time-saving modifications (mutations) of the genome of crops, which are often indistinguishable from naturally occurring mutations. The blanket legal classification as a GMO therefore fails to consider the type of genetic modification present in the genome edited organism and whether this modification could have occurred accidentally or through traditional breeding methods. It also disregards whether the origin of the genetic modification can be identified and attributed to a particular breeding method. The science academies and the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) therefore conclude that the primarily process-based European regulatory approach is no longer justifiable. After all, potential risks can only emanate from the modified traits of the organism as a product of the breeding process, and not from the process itself.

More than 100 (potentially) marketable genome edited crops are currently known worldwide; these plants have been created through directed point mutations or deletions of a small number of base pairs and are beneficial for nutrition as well as for productive, low-pesticide and resource-conserving agriculture. They include soybeans with healthier fatty acids, gluten-reduced wheat, potato tubers with a longer shelf life, bacteria-resistant rice, fungus-resistant varieties of grapes, wheat and cocoa, and drought-tolerant varieties of corn, wheat, and soybeans. Likewise, it is possible to produce genome edited plants that combine beneficial properties of wild plants with those of high-performance varieties. Some of the new breeding lines have yet to prove these benefits in field trials. Meanwhile, these trials are almost impossible in the European Union (EU) due to frequent vandalism and deliberate destruction of testing fields.

In many countries outside the EU, genome edited plants that could in principle have come about by chance or through traditional breeding are exempted from GMO-related regulations. European genetic engineering legislation, on the other hand, hinders the research, development and application of urgently needed improved crops to support productive, climate-adapted and sustainable agriculture.

The products of random mutagenesis breeding using high-energy radiation or mutagenic chemicals have been classified by the European legislator as 'safe' GMOs for decades and are therefore exempt from GMO regulation. This is in line with the consistent application of the precautionary principle, under due consideration of opportunities as well as risks. Likewise, even after almost 30 years of worldwide utilisation of transgenic crops produced using conventional genetic engineering in agriculture, no risks inherent to the technology could be detected for humans, nature or the environment. Accordingly, the science academies and the DFG see an urgent need to reassess the products of the much more precise and efficient methods of genome editing and to amend European genetic engineering law.

Recommendations

Recommendation 1. Amendment of European genetic engineering legislation: In a first step, the European genetic engineering legislation should be amended. This should include a revision of the GMO definition or the associated exemptions within the current legislative period of the European Parliament in order to exempt genome edited organisms from the scope of genetic engineering legislation if no foreign genetic information is inserted and/or if there is a combination of genetic material that could also result naturally or through traditional breeding methods. An official preliminary examination process should be used in individual cases to provide scientific clarification as to whether a GMO is present within the meaning of the amended regulations. These moderate changes to existing genetic engineering legislation, which can be implemented within a manageable timeframe, would better reflect the current state of scientific knowledge than the existing GMO regulatory framework. This would also align European legislation with the regulation of some of the EU's major trading partners in the agricultural sector.

Recommendation 2. A fundamentally new legal framework: A second step should comprise developing a fundamentally new legal framework that is detached from the previous, process-based regulatory approach to genetic modification. This longer-term action is the logical next step from a scientific point of view. The current process-centric approach cannot be scientifically justified. However, it is also unwarranted for regulation to distinguish between breeding methods with and without transgenic DNA. Risks to humans, nature, and the environment can only arise from the plant (or its new traits) and the way in which it is used, but not from the process on which the genetic modification is based. A new legal framework must therefore link the requirement of authorisation, registration, or declaration to resulting traits. The requirement, nature and scope of a science-based risk assessment should be determined on the basis of the innovative nature of the product or trait concerned. In case of doubt, an upstream assessment process involving the European Food Safety Authority should be established with a national authority. This process should clarify the regulatory status of the plant in question (where appropriate, already early in the development phase). The European Commission should review the new EU regulatory framework on a regular basis, at least every five years, with regard to its adequacy in light of the state of the art in science and technology and against the background of fair market competition. The framework should be revised accordingly where necessary.

Recommendation 3. Facilitating field trials: Genome editing methods are an essential methodological addition to plant and agricultural research, as they allow the genetic make-up of cultivated plants to be modified in a much more precise and time-efficient way than before in order to investigate unknown gene functions in detail. Particularly complex properties such as tolerance to salt, drought or heat are still insufficiently understood at the genetic level. The strict, primarily process-based regulation which covers all genome edited plants indiscriminately, substantially restricts the freedom of research in the EU without substantial justification. The associated bureaucratic effort delays plant research and makes it considerably more expensive. Moreover, it creates a recruitment disadvantage for top researchers and damages the career opportunities of young scientists. Field trials, which are necessary for the transfer of research results from the laboratory to actual cultivation conditions and for approval under current genetic engineering legislation, are virtually non-existent with genome edited crops in the EU. This is also due to the fact that field trials with GMOs have to be published in a location register and have therefore often been the target of deliberate field destruction. This has resulted in the 'export' of field experiments to non-EU countries, where genome edited plants are regulated in a more differentiated way. However, breeding successes can only be reliably studied in those growing regions in which the varieties are ultimately to be cultivated. Field trials are therefore an essential component of modern plant sciences and breeding research. For this reason, an amendment of genetic engineering legislation is particularly pressing so that field trials in the EU can be made practicable again as quickly as possible. Suitable communication strategies should also be developed in this context to strengthen the voice of science in the societal discourse on genetic engineering.

Recommendation 4. Differentiated discussion of breeding methods: The further development and use of genome edited crops depend not only on regulatory practice but also on consumer acceptance. The sciences should communicate realistic expectations. Critics of genetic engineering should also clearly distinguish between processes and their products as well as between application scenarios, for example in crops and in human medicine. European consumers are under the false impression that most of the food available in Europe, including organic products, is produced 'GMO-free'. However, even ubiquitous products of traditional random mutagenesis breeding are GMOs in the sense of the GMO Directive, but do not have to be labelled as such or in the product. The discussion on the application of new molecular breeding methods should be conducted as part of a constructive dialogue centred on common goals and options for action. New breeding methods and their products can contribute to greater sustainability in agriculture if they are meaningfully combined with other ecologically relevant innovations and practices.

Recommendation 5. Securing freedom of choice: Consumers ought to be informed about genome edited products by way of consistent labelling rules that also reflect the similarity with products of traditionally bred organisms. The challenge for product labelling is that genome editing applications are often not detectable, especially when there is no foreign genetic information in the final product. According to the current legal situation, these products must nevertheless be labelled as 'genetically modified'. This can lead to considerable problems of controllability, particularly in the international trade of goods. Implementation of the regulatory options identified in Recommendation 1 would eliminate the need to label the corresponding genome edited products as 'genetically modified'. In order to nevertheless create freedom of choice for consumers, the following regulation appears appropriate. For products which do not contain any foreign genetic information, the obligation to provide positive labelling specifically for genetic engineering should be waived, while the negative label 'GMO-free' may be used on a voluntary basis. Companies that use this label would have to disclose certificates from along the value chain to ensure that no genetic engineering processes were used.

Recommendation 6. Responsible exploitation of innovation potential: Solving urgent resource problems, which are exacerbated by climate change, requires multi-faceted innovative approaches that minimise losses of food and other biological resources, increase agricultural productivity and preserve valuable agricultural and natural landscapes. In addition to environmentally compatible and more sustainable agricultural practices (e.g. crop rotation), this requires innovative plant breeding methods that increase the diversity and performance of crops and other biological resources. Improved, particularly stress-resistant crops make it possible to increase the productivity and sustainability of value chains for food and biologically produced resources by reducing the use of pesticides, while limiting crop losses and the need to acquire new natural habitats for agricultural use.

Further development of sustainable agriculture in Europe is considerably obstructed by the particularly restrictive, undifferentiated and time and cost-intensive approval processes for molecular breeding products. The absence of certain innovations also poses costs and risks for humans, nature and the environment. Responsible management of technology-related developments means weighing the positive and negative effects against each other and monitoring them in order to intervene and take control if necessary. The application of the precautionary principle must not be linked to speculative risks. Instead, the precautionary principle should be applied on a scientific basis and, alongside the experience with conventional genetic engineering over the past 30 years, the benefits of new molecular breeding methods and their products must be considered appropriately and in a problem-oriented manner. To this end, research on the consequences for health, ecology, society and the economy of genome edited plants and their use, oriented towards the product and application scenario of new molecular breeding methods, should be publicly funded and strengthened. Research should also focus on the apprehensions and concerns about genetic engineering that are widespread in society.

Recommendation 7. Increasing market competition: The low costs and high efficiency of genome editing methods also make them suitable for use by small and medium-sized enterprises (SMEs) and by public research institutions (including in developing countries). This facilitates molecular breeding of insufficiently cultivated or neglected crops such as legumes or fruit and vegetable varieties of only regional importance. The undifferentiated regulation of genome edited plants prevents SMEs in particular from taking advantage of the opportunities offered by genome editing. A high market share of SMEs can help to counter the process of monopolisation in the already highly concentrated international markets for new plant varieties and seeds. Only large multinational corporations can afford the current costs and delays caused by European approval processes.

Regulatory practice also contributes to a global reduction of applications to a small number of crop species and a handful of traits with high market potential. Targeted regulatory incentives should therefore be created for breeders and seed producers so that improved crops and associated cultivation methods become more productive and at the same time more resource-efficient and environmentally compatible. This could be achieved through the coordinated identification, for instance in the course of dialogue forums, of plant traits that are both agriculturally and socially desirable, and through government support for the development and approval of corresponding new varieties that allow, for example, reduced use of pesticides, water and fertilisers. A science-based GMO regulatory practice can facilitate SMEs' access to the market for new plant varieties and seeds, thereby increasing competition and diversity, e.g. of locally adapted crops. The frequent undetectability of the use of genome editing poses particular challenges for patent and plant variety protection. The legislator should therefore monitor developments in this field and consider legal changes of patent and plant variety protection law where necessary.

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South Australia A Step Closer to Lifting GM Ban

December 4, 2019

The State Government of South Australia (SA) has introduced a legislation to finally lift the GM crop ban in mainland SA. The ban was supposed to take effect on December 1 but was met with challenges last week causing the delay. Parliament will be working on the Bill this week to make sure that SA farmers can plan their 2020 cropping season.

The Genetically Modified Crops Management (Designated Area) Amendment Bill 2019 will allow farmers from mainland SA to benefit from GM crops. The lifting of the ban allows SA farmers to have equal choices as those from the neighboring states thereby increasing productivity and job opportunity. On the other hand, the Bill also designates Kangaroo Island as the only place in SA where the GM moratorium will be implemented until September 2025, as the island has an established non-GM canola market with Japan.

Minister Tim Whetstone of the Department of Primary Industries and Regional Development (DPIRD) continuous to push for the GM ban to be lifted as he believes that the moratorium denies the SA farmers their right to choose what crop they will plant while at the same time costing them more money to produce crops. He also believes that new and improved crop varieties are tools that can help farmers overcome drought and climate change challenges. These statements are consistent with an independent expert review completed by the economist professor Kym Anderson of the University of Adelaide in 2018. According to the review, the GM ban has cost SA farmers at least AUD 33 million since 2004 and will cost farmers at least an additional AUD 5 million if it is extended to 2025.

The Minister is pleading to fellow lawmakers to set aside their ideology and put their trust in the farmers to grow the state. His statement also mentions that if the Bill does not pass parliament this year, the Marshall Liberal Government will reconsider other regulatory options for farmers to have access to more choices.

Read the DPIRD Minister's statement for more details.

TIM MP

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LEGISLATION TO BE INTRODUCED TO LIFT GM BAN

DECEMBER 03, 2019

The Marshall Liberal Government will today introduce legislation to remove the moratorium on genetically modified crops on the South Australian mainland which will help our farmers grow the economy and create jobs.

New regulations to lift the GM crop moratorium in South Australia, except for Kangaroo Island, were meant to take effect on December 1 but Labor, SA Best and the Greens last week combined to play petty politics and deny our farmers a choice.

Minister for Primary Industries and Regional Development Tim Whetstone said it was time for South Australia to be brought in line with the rest of the country when it comes to GM crops.

"Last week we were challenged to bring forward legislation so we are doing exactly that and we will be asking the Parliament to deal with the Bill this week to provide our farmers with certainty for planning their 2020 crop," said Minister Whetstone.

"The Genetically Modified Crops Management (Designated Area) Amendment Bill 2019 will designate Kangaroo Island as the only place in South Australia where the GM moratorium will exist from 1 January 2020 until it expires on 1 September 2025 as per current arrangements.

"Lifting the GM crop moratorium will allow South Australian farmers to have the same choices as farmers in our neighbouring states which will increase productivity and create jobs.

"By continuing to leave a moratorium in place the Labor Party are costing farmers in South Australia real money and denying them a basic right – choice.

"New and improved crop varieties will also help farmers tackle drought and climate change as we look to provide our grain growerswith as many tools as possible.

"The decision to lift the GM crop moratorium followed extensive industry and community consultation, as well as the findings of the high-level independent expert review undertaken by Professor Kym Anderson and the recommendations of the GM Crop Advisory Committee.

"The independent review found the GM moratorium has cost South Australian grain growers at least $33 million since 2004 and will cost farmers at least a further $5 million if extended to 2025."

Minister Whetstone said the GM moratorium has failed the state over the past fifteen years.

"Not only have the promised premiums failed to eventuate, South Australian farmers have been penalised by being GM free," said Minister Whetstone.

"Instead of earning more than growers in other states, a comparison of canola prices across Australia on 28 November 2019 shows South Australian farmers are earning less, with our GM-free canola being discounted by the markets.

"The day after Labor, SA Best and the Greens combined to block lifting the GM moratorium, South Australian canola was trading $60 below the price of non-GM canola in Western Australia, $29 below the price of non-GM canola in New South Wales and $10 less than the price of non-GM canola in Victoria.

"Over the past fifteen years the GM moratorium has failed dismally and has achieved little more than to punish our farmers and discourage research and investment. It is time for politicians to put ideology aside and have trust in the ability of our farmers to grow the state."

If the Bill does not pass Parliament this year the Marshall Liberal Government will reconsider regulatory options to provide choice to farmers.

mediarelease feature

Latest News

(/news)

Inaugural AdvanceAg to encourage farmers to adopt AgTech (/inaugural_advanceag_to_encourage_farmers_to_adopt_agtech)

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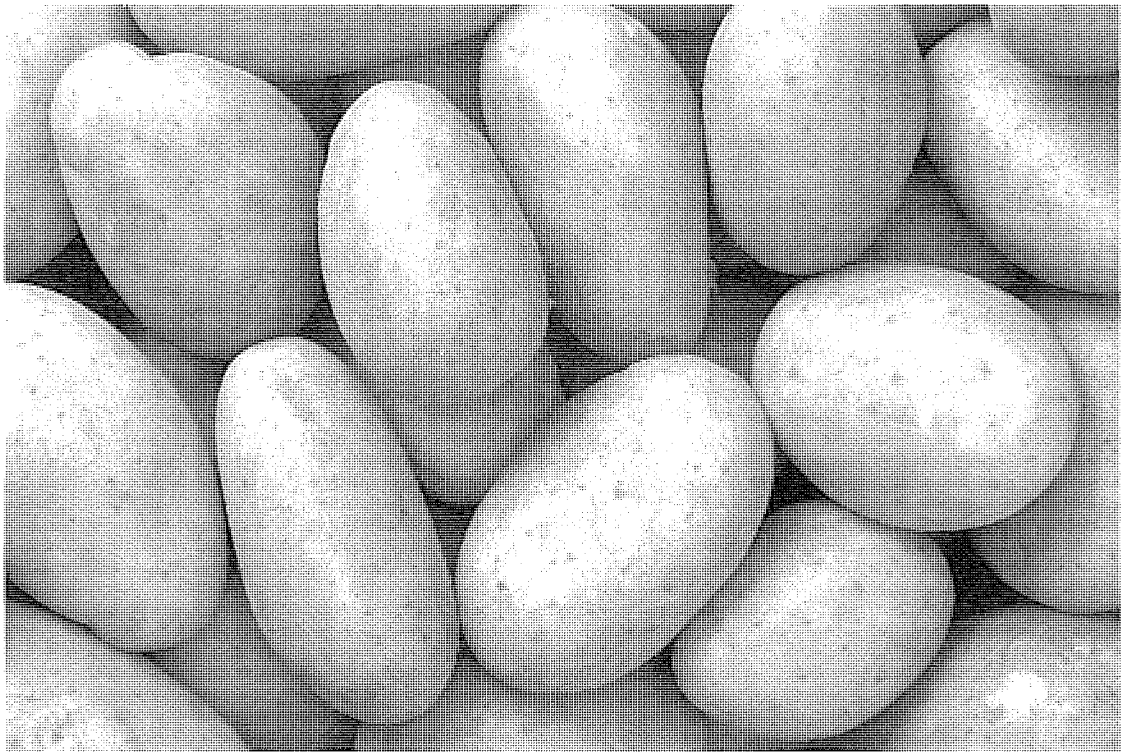
First Argentine GM Potato to be Released in 2020

October 23, 2019



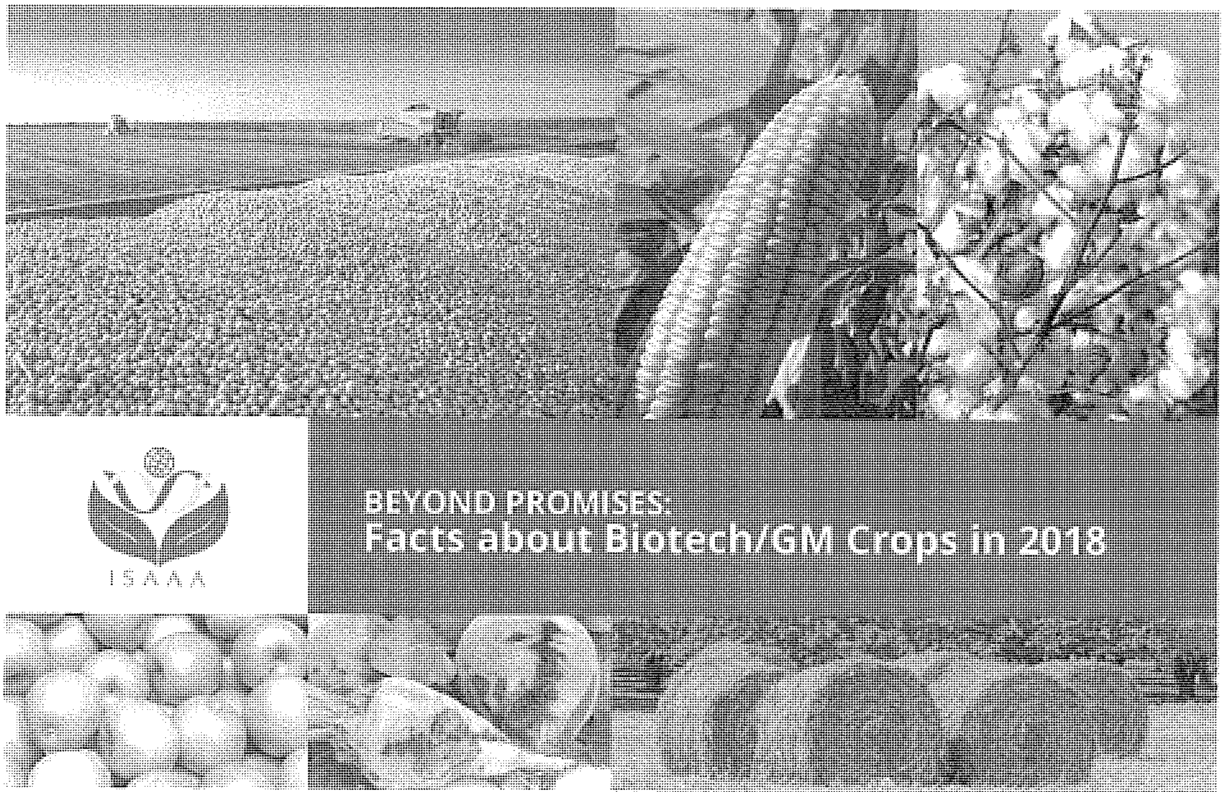
The National Council of Technical and Scientific Research (CONICET) commenced with the registration of the first biotech potato variety in Argentina to the National Seed Institute. CONICET, in partnership with Sidus, developed the biotech potato with resistance to virus Y called SPT TICAR. This new biotech potato variety is expected to provide potato farmers with 10% cost savings, reduction in the use of insecticides, and general improvement of competitiveness across the value chain.

Potato virus Y is a common obstacle of potato farmers in all production zones around the country. Development of TICAR biotech potato started 20 years ago. The developers are currently working on potato varieties with drought tolerance and other virus resistance traits. TICAR potato is expected to be commercially available in Argentina in 2020.

Read the original article from eFarm News Argentina.

Biotech Crop Area Reaches 2.5 Billion Hectares in 23 Years

October 23, 2019



High adoption of biotech crops continued in 2018, according to the ISAAA Report, *Global Status of Commercialized Biotech/GM Crops in 2018*. On the 23rd year of commercial cultivation of biotech crops, 26 countries grew 191.7 million hectares of biotech crops, bringing the accumulated biotech crop area to 2.5 billion hectares, a ~113-fold increase since 1996, the first year of commercial planting of biotech crops. This makes biotech crops the fastest crop technology adopted in recent times.

The total area of 191.7 million hectares in 2018 were grown by 26 countries, 21 developing and 5 industrial countries. Developing countries led by Brazil planted 54% of the total biotech crop area, while the industrial countries led by the USA planted the remaining 46%. An additional 44 countries imported biotech crops for food, feed, and processing, bringing the total number of countries that adopted biotech crops to 70.

Learn more about biotech crops adoption in 2018, download and read the booklet Beyond Promises: Facts about Biotech/GM Crops in 2018.

GM PETUNIAS

BACKGROUND

MPI has taken action after an overseas recall on unauthorised genetically modified (GM) petunias.

Several varieties of GM petunias have been reported in Europe, USA and Australia, and are being recalled by regulatory authorities there.

MPI has identified potentially affected seeds from one importer in New Zealand and has sent them for testing in an MPI-approved laboratory overseas.

Those test results came back positive for genetically modified material in the 'African Sunset' variety. We feel there are sufficient parallels with what's going on elsewhere in the world for us to take pre-emptive action on other varieties which have tested positive overseas and are known to be in New Zealand.

We have no evidence to suggest the GM material was deliberately brought into New Zealand. The importer concerned was unaware of the GM content of these seeds and, as soon as they became aware of the possibility, they contacted MPI. We applaud them for that.

This is a global situation, many other countries are dealing with the same issue and MPI is working closely with our overseas counterparts. It seems that no authorities anywhere in the world were aware that these varieties of petunia contained or were bred with GM plant material.

WHAT IS THE RISK?

There is negligible biosecurity risk from these seeds and no risk to people or the environment. However, New Zealand has strict controls around genetically modified organisms (new organism). It is illegal to import, develop, field test or release a genetically modified organism without approval. MPI is an enforcement agency for new organisms.

It is unlikely there are any plants currently in circulation and the risk of these plants becoming established is negligible. Petunias are often grown as annuals, so they complete their life cycle in one year. They also do not set seed efficiently, so their ability to grow in the wild, shed seeds and spread is negligible.

AFFECTED VARIETIES

The varieties identified as GE and currently known to have been imported into New Zealand are marketed under the names African Sunset (an orange flowered variety), Trilogy Red (also known as Diva Red) and Trilogy Deep Purple (also known as Diva Deep Purple).

Trilogy Deep Purple

African Sunset

Trilogy Red

June 2017

WHAT IS MPI DOING?

We will be instituting new actions at the border. MPI is amending the seed and nursery stock Import Health Standard. Before being allowed to enter New Zealand all Petunia species imported as plants for planting or seeds for sowing will require a GMO certificate stating they have been tested and are GM free.

MPI is working with industry to trace and destroy all seed stock and unsold plants existing in New Zealand.

We have made it clear to businesses holding the suspected GM petunia varieties that they must not be sold, and therefore will have to be taken off the market. While these plants and seeds do not present a risk, they do not have regulatory approval, this means it is an offence to knowingly plant or otherwise propagate them. Any existing stock will be destroyed.

WHAT YOU CAN DO TO HELP

Anyone who may have purchased petunias with these variety names are advised to remove the plants from their garden and dispose of them in their domestic/household rubbish. Any seeds or unplanted seedlings can be disposed of the same way. We ask that the public not dispose of plant material or seeds in compost or green waste.

A number of other varieties around the world are also known to be GM. For more detail visit **www.mpi.govt.nz/protection-and-response**

MORE INFORMATION IS AT:

Ministry for Primary Industries: **www.mpi.govt.nz**

MPI general enquiries: **0800 00 83 33**

For more information: **info@mpi.govt.nz**

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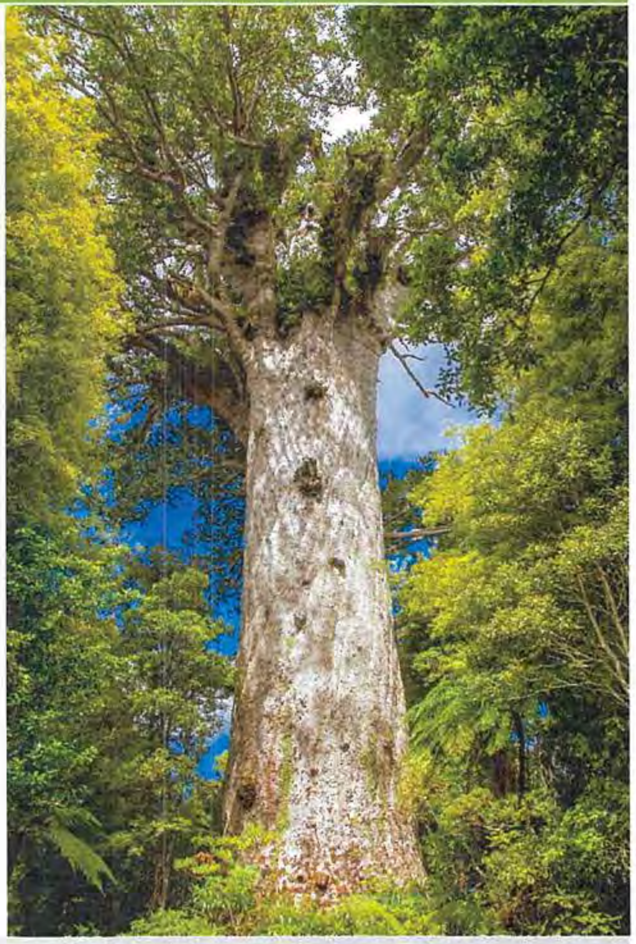
A look at New Zealanders' current opinions and understanding of genetic technologies



Key Research Questions

How **aware** are New Zealanders of genetic technologies?

How **informed** do New Zealanders feel they are about genetic technologies?

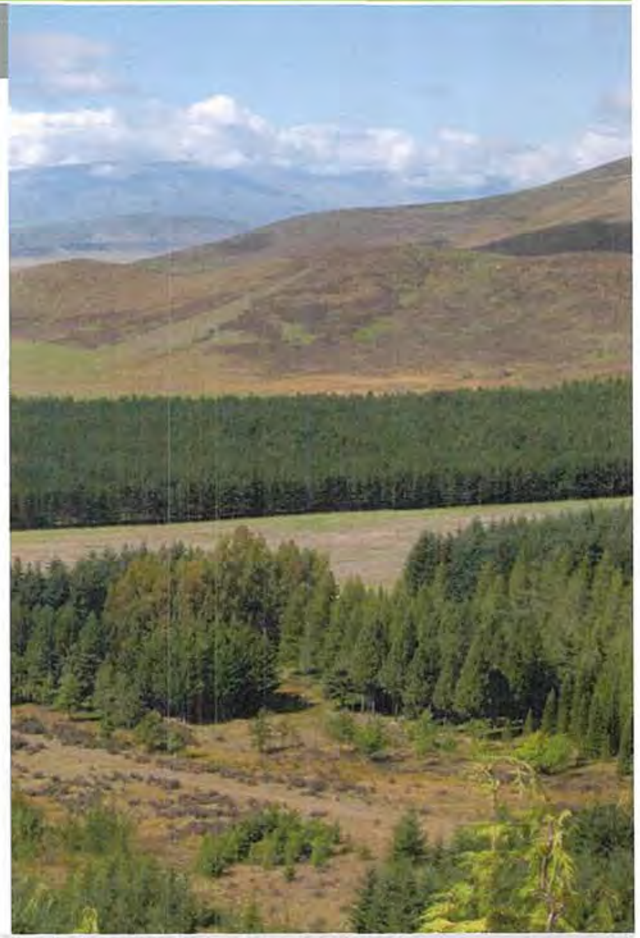
How **accepting** are New Zealanders of the use of genetic technologies?

METHODOLOGY

WHAT: 10 minute online survey using the Colmar Brunton Fly Buys panel.

WHEN: 12th July to 7th August 2019
(Additional fieldwork completed 25th October to 4th November 2019)

WHO: 4042* New Zealanders aged 18-69 years old.



* Design effect = 1.17
The maximum margin of error for a sample size of 4042, inflated by a design effect of 1.17 is +/- 1.8% at the 95% confidence level.

Sample Profile

Ethnicity

New Zealanders	84%
New Zealander of European descent / Pakeha	70%
New Zealander of Maori descent	19%
New Zealander of Pacific Island descent	2%
New Zealander of other descent	2%
Pacific Islanders	1%
Asian	9%
Other ethnicity	10%

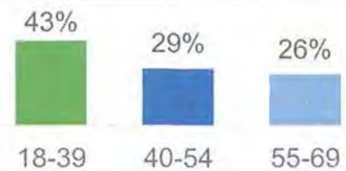
Region

Gender

NZ Residency

All NZ citizens / residents

Age



Income

Less than $50k	31%
$50-$100k	34%
$100k plus	30%

Type of area lived in

Urban	27%
Suburban	49%
Rural	24%

Education

High School level education	56%
University educated	25%
Other*	19%

Q1. Age Q2. Gender Q3. NZ Residency Q4. Region Q5. Type of area lived in Q6. Education Q7. Income Q8. Ethnicity
Base: Total sample (n=4042) Data is post weighted for age, gender, region, income and education to be nationally representative

*Other types of education mentioned include trade qualifications and other non-university higher education

Awareness of genetic technologies

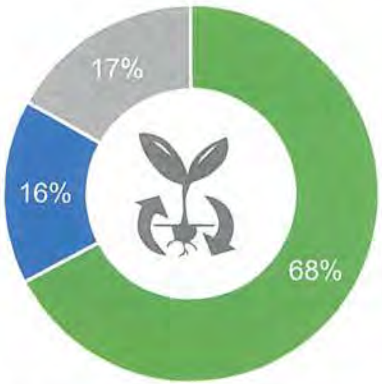
Three quarters of the population are aware of at least one type of genetic technology with genetic modification being the most heard of.

AWARENESS OF GENETIC TECHNOLOGIES

Overall aware	Aware of none
74%	26%

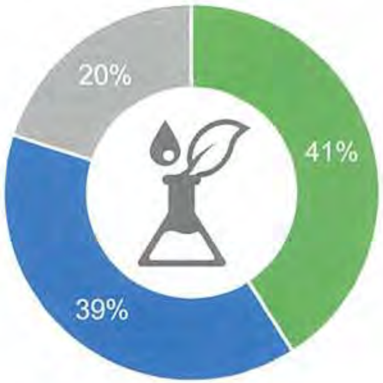
Yes / No / Don't know

Genetic modification / transgenic technology



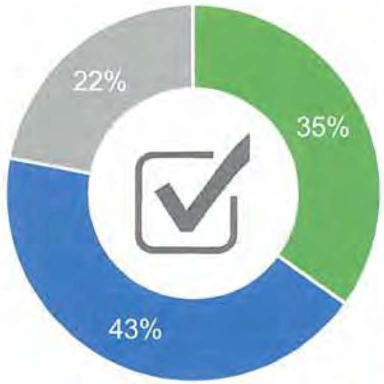
Awareness of Genetic modification significantly higher than all other genetic technologies

Gene editing (such as CRISPR-Cas9)



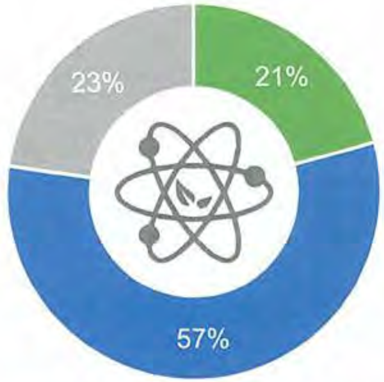
Awareness of Gene editing modification significantly higher Genomic selection and Marker-aided selection

Genomic selection



Awareness of Genomic selection significantly higher than Marker-aided selection

Marker-aided selection



Awareness of Marker-aided selection significantly lower than all other genetic technologies

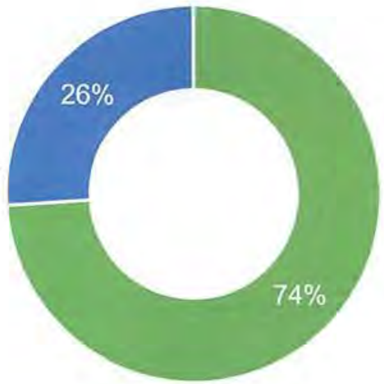
Q9. Which, if any, of these genetic technologies are you aware of?
Base: Total sample (n=4042)

Xx/Xx Significantly higher lower than total

Those who are most likely to be aware of genetic technologies are males, 55-69 year olds, identify as NZ European, living in rural areas, university educated and earning a higher income, whilst people unaware are more likely to be female, 18-39 years old, living in an urban area, on a lower income and identify as Maori or Pacific Islander.

PROFILES OF AWARE AND UNAWARE OF GENETIC TECHNOLOGIES

Overall unawareness significantly higher among:
Females (**29%**)
18-39 year olds (**30%**)
Live in North Island excl. Auckland, Waikato and Wellington (**29%**)
Urban dwellers (**32%**)
High School educated (**32%**)
Earning an income of less than $100k (**29%**)
Maori (**31%**)
Pacific Islanders (**47%**)

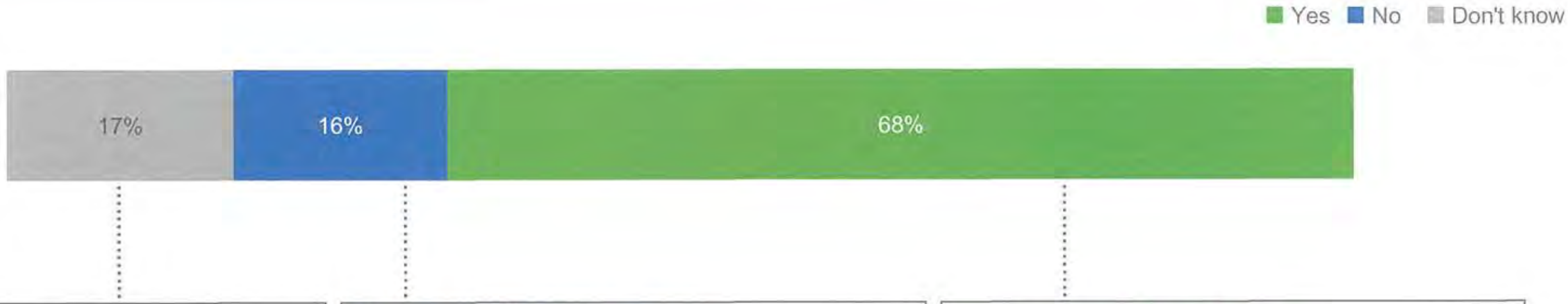


Overall awareness significantly higher among:
Males (**76%**)
55-69 year olds (**79%**)
Rural dwellers (**77%**)
NZ European (**76%**)
University educated (**83%**)
Earning an income of $100k or over (**81%**)

Base: Total sample (n=4042), Aware (n=3041), Not Aware (n=1001)

Significant differences in awareness of genetic modification / transgenic technology

AWARENESS OF GENETIC MODIFICATION / TRANSGENIC TECHNOLOGIES PROFILE



Don't know significantly higher among:
Other North Island (19%)
Living in an urban area (20%)
High School Educated (19%)
Earning an income of less than $50k (22%)
New Zealanders of Maori descent (20%)
New Zealanders of Pacific descent (30%)
Indian / Pakistani / Sri Lankan (26%)

No significantly higher among:
18-39 years old **(21%)**
Christchurch **(23%)**
Living in an urban area **(19%)**
High School Educated **(19%)**
Pacific Islanders **(40%)**

Yes significantly higher among:
55-69 years old (75%)
Living in a rural area (73%)
University Education – Undergrad (76%)
University Education – Postgrad (80%)
Earning an income of $100k or over **(75%)**
NZ European **(71%)**
Chinese **(77%)**
New Zealanders **(69%)**

Q9. Which, if any, of these genetic technologies are you aware of?
Base: Total sample (n=4042)

Significant differences in awareness of gene editing

AWARENESS OF GENE EDITING

Don't know significantly higher among:
Female (21%)
55-69 year olds (24%)
Other North Island (23%)
Living in an urban area (22%)
Earning an income of less than $50k (26%)
New Zealanders of Maori descent (25%)
New Zealanders of Pacific Island descent (34%)
Pacific Islander (34%)

No significantly higher among:
Female **(42%)**
18-39 year olds **(42%)**
High School Educated **(42%)**

Yes significantly higher among:
Males (**46%**)
University Education – Undergrad (**50%**)
University Education – Postgrad (**62%**)
Earning an income of $100k or over (**46%**)
New Zealanders of European descent / Pakeha (**43%**)

Q9. Which, if any, of these genetic technologies are you aware of?
Base: Total sample (n=4042)

Significant differences in awareness of genomic selection

AWARENESS OF GENOMIC SELECTION

Don't know significantly higher among:
55-69 year olds (26%)
Other North Island (26%)
High School Educated (24%)
Earning an income of less than $50k (28%)
New Zealanders of Maori descent (26%)

No significantly higher among:
High School Educated **(48%)**

Yes significantly higher among:
Males (**37%**)
University Education – Undergrad (**45%**)
University Education – Postgrad (**62%**)
Earning an income of $100k or over (**41%**)
New Zealanders of European descent / Pakeha (**37%**)
Other ethnicity (**46%**)

Q9. Which, if any, of these genetic technologies are you aware of?
Base: Total sample (n=4042)

Significant differences in awareness of marker-aided selection

AWARENESS OF MARKER-AIDED SELECTION

Don't know significantly higher among:
55-69 year olds (28%)
Other North Island (26%)
High School Educated (25%)
Earning an income of less than $50k (28%)
New Zealanders of Maori descent (28%)

No significantly higher among:
Female (**58%**)
18-39 years old (**59%**)
University Education – Undergrad (**59%**)
Earning an income of $100k or over (**61%**)
New Zealanders of European descent / Pakeha (**58%**)

Yes significantly higher among:
Males (**24%**)
University Education – Undergrad (**25%**)
University Education – Postgrad (**36%**)
Earning an income of $100k or over (**23%**)
Chinese (**30%**)

Q9. Which, if any, of these genetic technologies are you aware of?
Base: Total sample (n=4042)

Understanding of genetic technologies

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Although the majority of the population is aware, this does not translate to knowledge, with less than a third of the population overall saying they feel informed about some type of genetic technology and only a third of those who are actually aware of each technology feeling informed.

HOW INFORMED ARE NEW ZEALANDERS ABOUT GENETIC TECHNOLOGIES?

Overall Informed 28%

Not informed about any 72%

Informed

Uninformed

% who feel informed amongst those aware	Genetic modification/ transgenic technology	Gene editing (such as CRISPR-Cas9)	Genomic selection	Marker-aided selection
	32% (n=2803) Significantly lower than Marker-aided selection	34% (n=1741)	34% (n=1505)	36% (n=838) Significantly higher than Genetic modification

Q10. How informed do you believe you are at present about these genetic technologies?
Base: Total sample (n=4042)

Significant differences in feeling informed about genetic modification / transgenic technology

FEELING INFORMED ABOUT GENETIC MODIFICATION / TRANSGENIC TECHNOLOGIES PROFILE – AMONGST THOSE AWARE

No significantly higher among:
Females **(74%)**
40-54 years old **(71%)**
Other South Island **(78%)**
High School Educated **(72%)**
New Zealanders of European descent / Pakeha **(71%)**
New Zealanders of Maori descent **(74%)**

Yes significantly higher among:
Males (**39%**)
18-39 years old (**36%**)
Otago (**42%**)
Living in an urban area (**38%**)
University Education – Undergrad (**37%**)
University Education – Postgrad (**54%**)
Chinese (**45%**)
Indian / Pakistani / Sri Lankan (**62%**)

Q10. How informed do you believe you are at present about these genetic technologies?
Base: Those who are aware of the technology (n=2803)

Significant differences in feeling informed about gene editing

FEELING INFORMED ABOUT GENE EDITING PROFILE – AMONGST THOSE AWARE

No significantly higher among:
Females **(72%)**
Other South Island **(75%)**
New Zealanders of European descent / Pakeha **(68%)**
New Zealanders of Maori descent **(74%)**

Yes significantly higher among:
Males (**39%**)
18-39 years old (**37%**)
University Education – Postgrad (**46%**)
Indian / Pakistani / Sri Lankan (**61%**)

Q10. How informed do you believe you are at present about these genetic technologies?
Base: Those who are aware of the technology (n=1741)

Significant differences in feeling informed about genomic selection

FEELING INFORMED ABOUT GENOMIC SELECTION PROFILE – AMONGST THOSE AWARE

No significantly higher among:
Females **(73%)**
Other South Island **(75%)**
Living in a suburban area **(69%)**
High School education **(70%)**
New Zealanders of European descent / Pakeha **(68%)**

Yes significantly higher among:
Males (**41%**)
Otago (**47%**)
University Education – Postgrad (**48%**)
Indian / Pakistani / Sri Lankan (**61%**)

Q10. How informed do you believe you are at present about these genetic technologies?
Base: Those who are aware of the technology (n=1505)

Significant differences in feeling informed about marker-aided selection

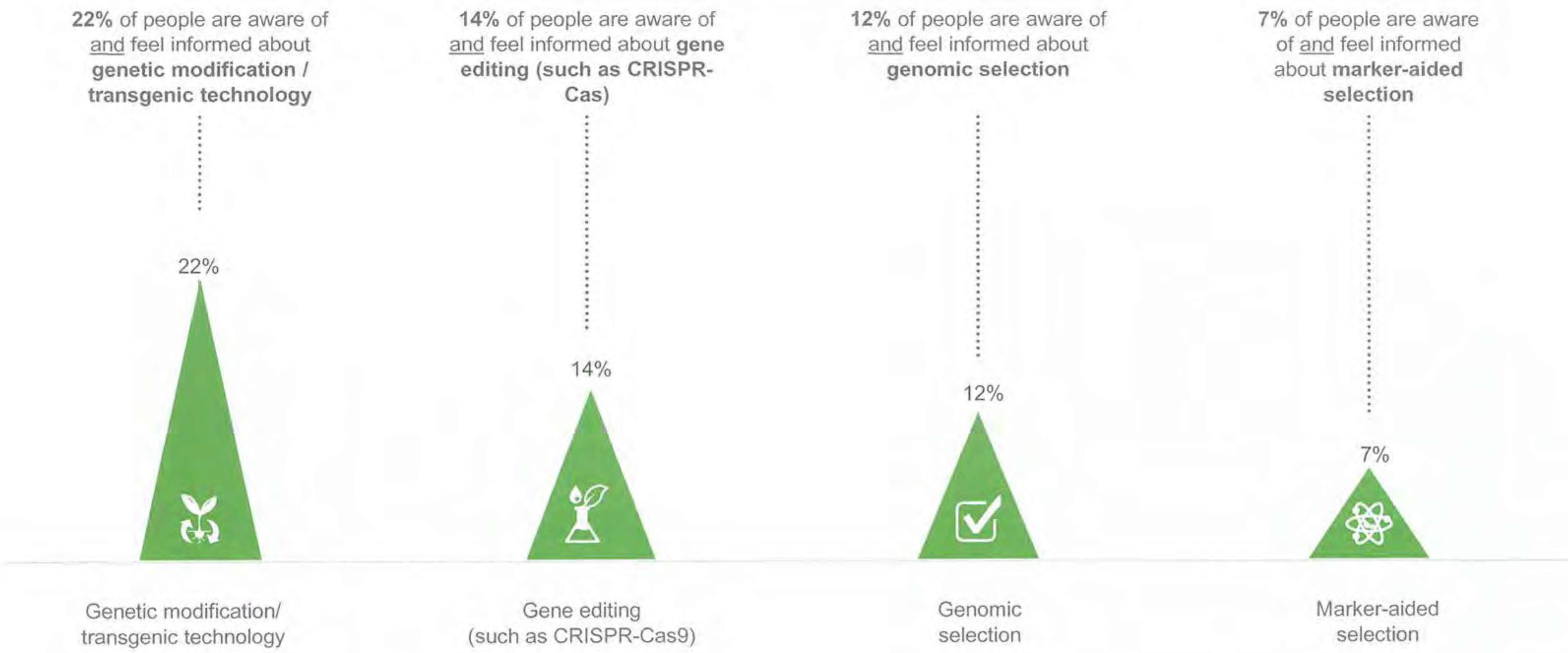
FEELING INFORMED ABOUT MARKER-AIDED SELECTION PROFILE – AMONGST THOSE AWARE

No significantly higher among:
Females **(69%)**
40-54 years old **(70%)**
Living in a suburban area **(68%)**
High School education **(68%)**
New Zealanders overall **(68%)**

Yes significantly higher among:
Males (**40%**)
18-39 years old (**40%**)
Living in an urban area (**43%**)
University Education – Postgrad (**48%**)
Indian / Pakistani / Sri Lankan (**59%**)

Q10. How informed do you believe you are at present about these genetic technologies?
Base: Those who are aware of the technology (n=888)

22% of the population are aware of and feel informed about genetic modification, 14% of gene editing, 12% of genomic selection and only 7% of people are aware of and feel informed about marker-aided selection.



Importance of genetic technologies

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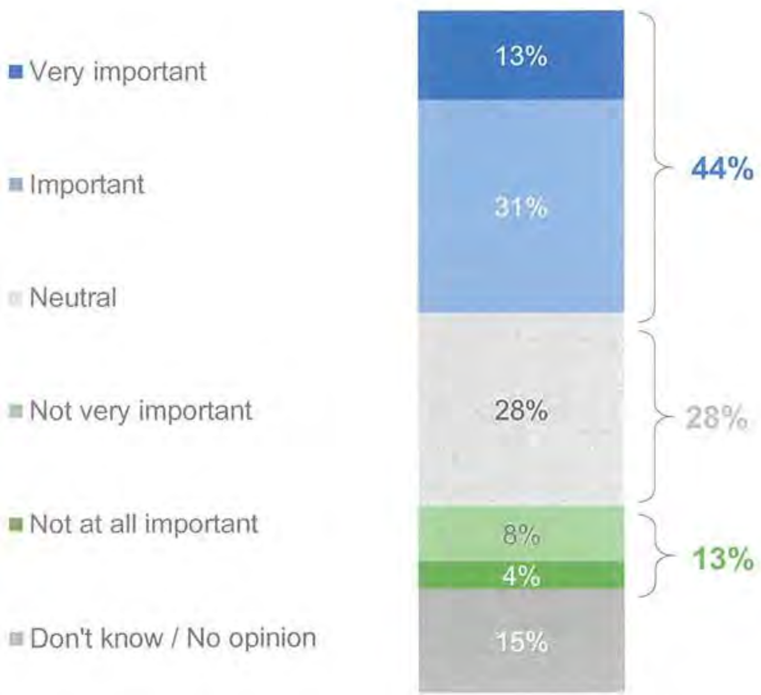
44% of people believe genetic technologies are important for New Zealand's future, significantly more so for those who are aware and feel informed whilst 13% do not think it is important. 55-69 year olds significantly more likely to feel strongly either way.

IMPORTANCE OF GENETIC TECHNOLOGIES FOR NEW ZEALAND'S FUTURE



Importance significantly higher among:
Males (49%)
55-69 years old (48%)
NZ European (48%)
University educated (55%)
Earning an income of $100k or over (53%)
Aware of genetic technologies (51%)
Informed about genetic technologies (60%)

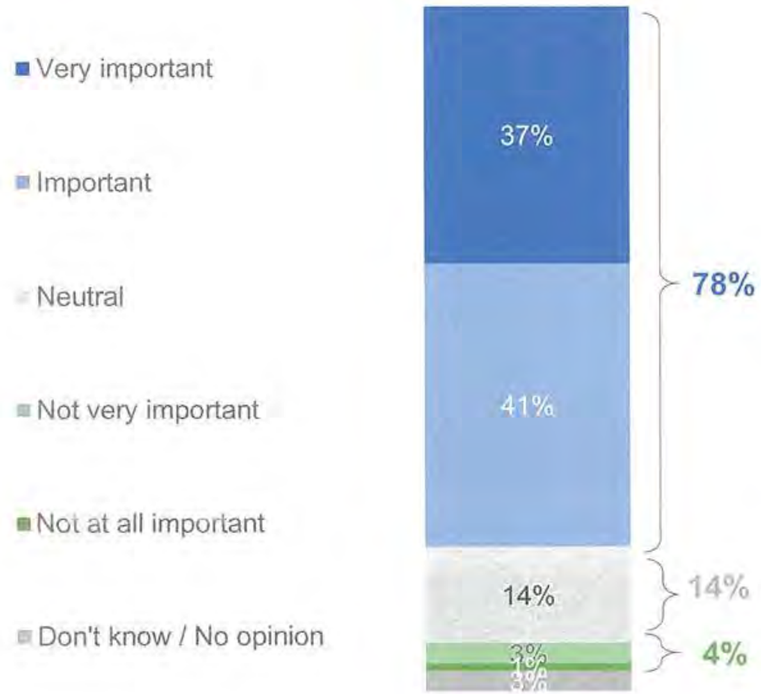
Neutral significantly higher among:
18-39 years old (31%)
Other South Island (32%)
High School Educated (31%)
Earning an income of less than $50k (31%)
New Zealanders of Maori descent (33%)

Unimportance significantly higher among:
55-69 years old (15%)
Living in a rural area (15%)
Earning an income of less than $100k (14%)

Q11. How important do you believe it is to New Zealand's future to use genetic technologies?
Base: Total sample (n=4042)

A large proportion of New Zealanders feel conservation is important to them personally. This resonates most strongly with older people, those who identify as a New Zealander or are NZ European, females and higher income earners as well as people who have prior awareness of genetic technologies.

IMPORTANCE OF CONSERVATION TO NEW ZEALANDER'S PERSONALLY



Importance significantly higher among:
- Females (**82%**) 41% saying *very important*
- 40-69 year olds (**85%**)
- Living in South Island excl. Christchurch and Otago (**84%**)
- Living in a rural area (**83%**)
- University educated (**82%**)
- New Zealanders (**79%**)
- NZ European (**81%**)
- Earning an income of $100k or over (**86%**)
- Aware of genetic technologies (**82%**)

Neutral significantly higher among:
- Males (17%)
- 18-39 year olds (19%)
- Waikato (18%)
- Living in an urban area (17%)
- Earning an income of $50k or less (18%)
- New Zealanders of Pacific Island descent (29%)
- Chinese (27%)
- Indian / Pakistani / Sri Lankan (23%)

Unimportance significantly higher among:
- 18-39 year olds (**6%**)
- Living in Otago (**8%**)
- Living in an urban area (**5%**)
- High school highest level of education (**5%**)
- Earning an income of $50k or less (**5%**)

Q12. How important is conservation to you personally?
Base: Total sample (n=4042)

How accepting are New Zealanders of the use of genetic technologies?

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Scenarios shown to respondents

Scenario A

In the USA, the American Chestnut tree was brought to the edge of extinction by a disease called chestnut blight. Using genetic modification a gene from wheat has been introduced into the DNA of American Chestnut. This has made the tree resistant to the disease and offers a way to save the tree.

Scenario B:

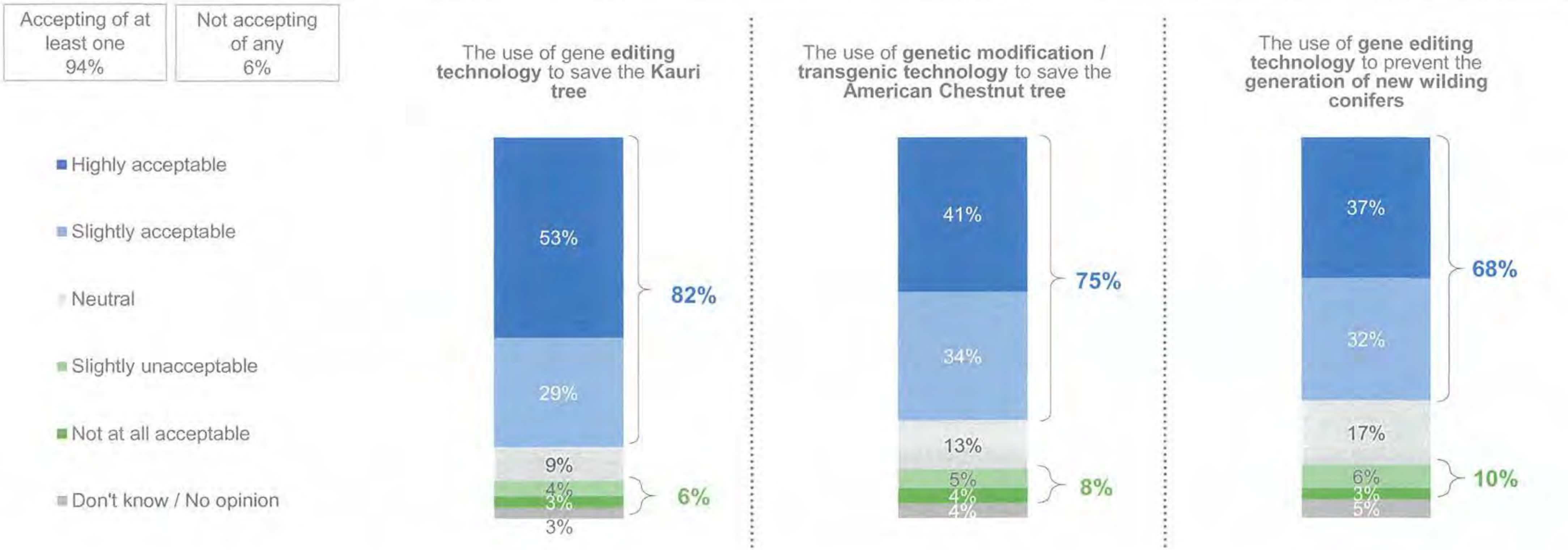
As you may be aware, in New Zealand's, Kauri trees are dying and could face extinction due to a disease called Kauri Dieback. We now have the technology to save NZ's Kauri trees. This involves editing the Kauri tree's DNA (genetic material) to turn off a particular gene by removing a small part of the DNA. This makes the tree resistant to the Kauri Dieback disease. This process is called gene editing.

Scenario C:

Some conifers produce wildings and can be a big problem in some parts of New Zealand. They occupy large tracts of conservation land where they endanger native ecosystems and alter iconic landscapes. They develop via the spread of seed from non-native species such as Douglas fir, that are planted for timber, shelter belts or erosion control. They are difficult and costly to control and the area they occupy is increasing by approximately 5% each year. Scientists have identified several genes that are essential for cone development. Cones are the source of seeds which create wildings. Gene editing can be used to turn off (inactivate) genes (by removing a small part of the DNA) to prevent cone (and thus seed) formation. This will allow these commercially important trees to be planted without risking the spread of new wildings.

Most New Zealanders would be accepting of the use of genetic technologies to conserve native trees and plants, with the use of gene editing to save the Kauri tree being seen as the most acceptable.

ACCEPTANCE OF THE USE OF GENETIC TECHNOLOGIES



Q13. How accepting would you be of using genetic modification / transgenic technology to save the American Chestnut tree? Q14. How accepting would you be of using gene editing technology to save the Kauri tree? Q15. How accepting would you be of using gene editing technology to prevent the generation of new wilding conifers? Base: Total sample (n=4042)

Significant differences in acceptance of the use of gene editing technology to prevent the generation of new wilding conifers

ACCEPTING OF THE USE OF GENE EDITING TECHNOLOGY TO PREVENT THE GENERATION OF NEW WILDING CONIFERS - PROFILE

Not accepting significantly higher among:
40-54 years old **(12%)**
Living in a rural area **(12%)**
Earning an income of $50k or less **(12%)**
Other ethnicity **(18%)**

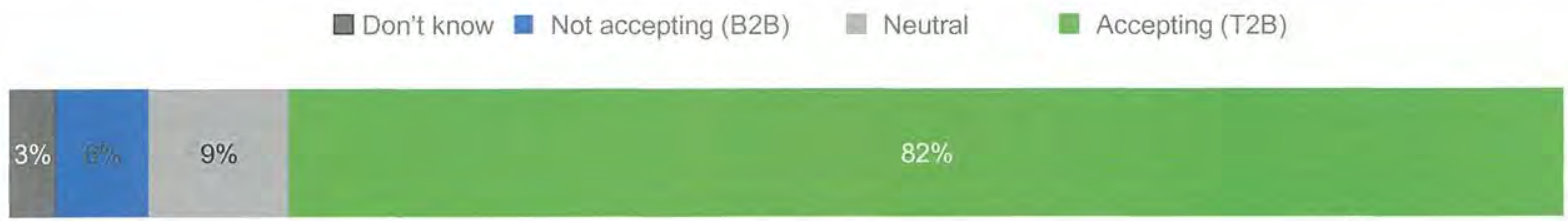
Neutral significantly higher among:
Males (18%)
18-39 year olds (22%)
Living in an urban area (20%)
High School Educated (19%)
Earning an income of $50k or less (18%)
Indian / Pakistani / Sri Lankan (24%)
Conservation not important personally (26%)

Accepting significantly higher among:
55-69 years old (**76%**)
University Education – Undergrad (**76%**)
University Education – Postgrad (**74%**)
Earning an income of $100k or over (**77%**)
New Zealanders of European descent / Pakeha (**71%**)
Conservation important personally (**73%**)

Q15. How accepting would you be of using gene editing technology to prevent the generation of new wilding conifers?
Base: Total sample (n=4042)

Significant differences in acceptance of the use of gene editing technology to save the Kauri tree

ACCEPTING OF THE USE OF GENE EDITING TECHNOLOGY TO SAVE THE KAURI TREE - PROFILE



Not accepting significantly higher among:
40-54 years old **(8%)**
Living in a rural area **(9%)**
Earning an income of $50k or less **(8%)**
New Zealanders of Maori descent (**11%**)
Conservation not important personally (**12%**)

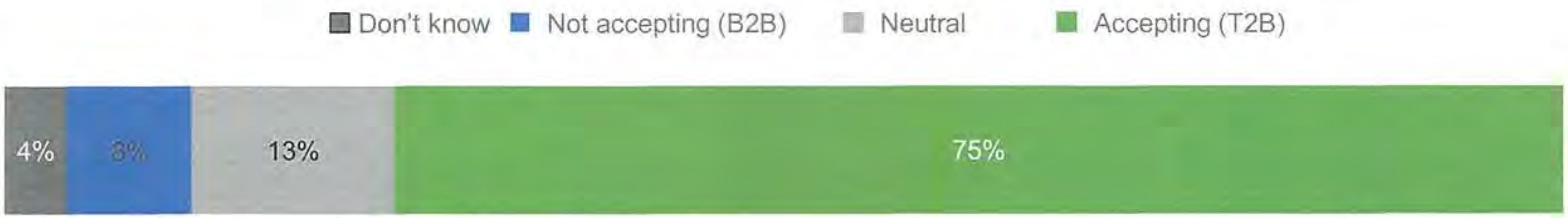
Neutral significantly higher among:
Males (10%)
18-39 year olds (12%)
Living in an urban area (12%)
Earning an income of $50k or less (15%)
New Zealanders of Maori descent (11%)
Asian overall (13%)
Feel neutral about conservation (21%)

Accepting significantly higher among:
Females (**84%**)
55-69 years old (**87%**)
University Education – Undergrad (**86%**)
Living in a suburban area (**84%**)
Earning an income of $100k or over (**88%**)
New Zealanders of European descent / Pākehā (**84%**)
Conservation important personally (**86%**)

Q14. How accepting would you be of using gene editing technology to save the Kauri tree?
Base: Total sample (n=4042)

Significant differences in acceptance of the use of genetic modification / transgenic technology to save the American Chestnut tree

ACCEPTING OF THE USE OF GENETIC MODIFICATION / TRANSGENIC TECHNOLOGY TO SAVE THE AMERICAN CHESTNUT TREE - PROFILE



Not accepting significantly higher among:
40-54 years old (**11%**)
Earning an income of $50k or less (**11%**)
New Zealanders of Maori descent (**12%**)
New Zealanders of Pacific Island descent (**12%**)
Pacific Islanders (**20%**)
Conservation not important personally (**14%**)

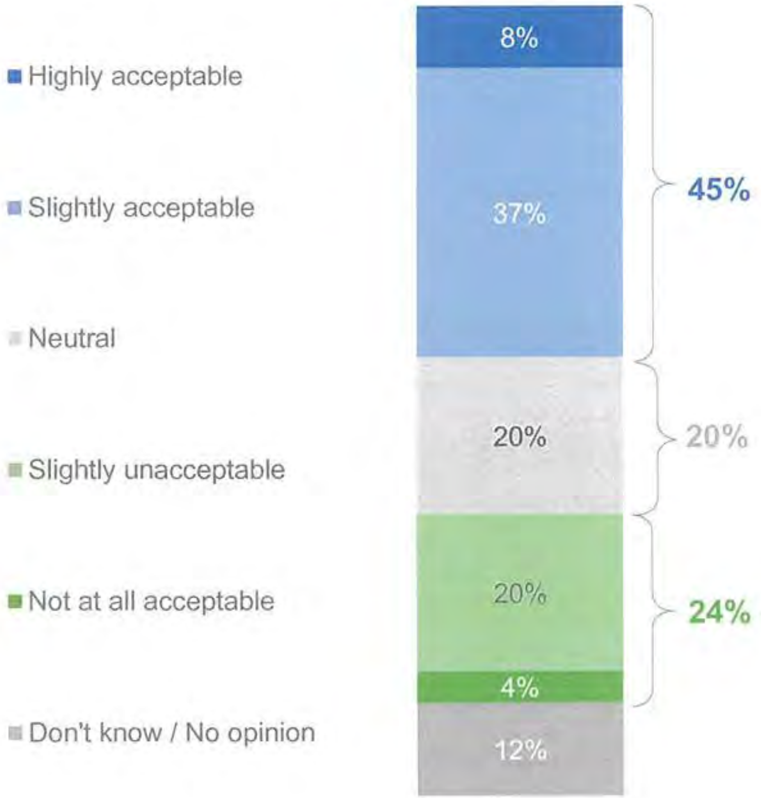
Neutral significantly higher among:
Males (15%)
18-39 year olds (16%)
Living in an urban area (16%)
Earning an income of less than $50k (19%)
Asian overall (20%)
Feel neutral about conservation (29%)

Accepting significantly higher among:
Females (**77%**)
University Education – Undergrad (**80%**)
Living in a suburban area (**77%**)
Earning an income of $50-$99,999k (**77%**)
Earning an income of $100k or over (**84%**)
New Zealanders of European descent / Pākehā (**78%**)
Conservation important personally (**80%**)

Q13. How accepting would you be of using genetic modification / transgenic technology to save the American Chestnut tree?
Base: Total sample (n=4042)

Just under half of New Zealanders think others would be accepting of the use of gene editing technology, despite the majority accepting the use of the technology in specific scenarios for the purpose of conservation.

HOW ACCEPTING DO YOU THINK OTHER NEW ZEALANDERS WILL BE OF GENE EDITING TECHNOLOGY?



Acceptance significantly higher among:
55-69 year olds (**51%**)
Living in a rural area (**48%**)
University Education – Undergrad (**48%**)
Indian / Pakistani /Sri Lankan (**54%**)
Conservation is important personally (**53%**)
Accept the use of genetic technology (**47%**)

Neutral significantly higher among:
Males (21%)
18-39 year olds (25%)
Living in an urban area (22%)
High School educated (23%)
Feel neutral about conservation (28%)

Unacceptance significantly higher among:
Males (**25%**)
40-54 year olds (**26%**)
University Education – Undergrad (**27%**)
Earning an income of $100k or more (**27%**)
Other European (**31%**)
Conservation not important personally (**36%**)
Do not accept the use of genetic technology (**46%**)

Q16. How accepting do you think other New Zealanders will be of gene editing technology?
Base: Total sample (n=4042)

Xx/Xx Significantly higher lower than total

Summary

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In summary…

Awareness of genetic technologies

Most New Zealanders have heard of genetic technologies on some level. Genetic modification is the most known, followed by gene editing, genomic selection and the least known is marker-aided selection with only a fifth having heard of the technology before.

When we look at the profiles of those who are aware of genetic technologies versus those who are not there are some differences. Males are more likely to have heard of a genetic technology, as have people aged 55-69 years old. People with a university education and in the higher income bracket are also more likely to have heard of genetic technologies while younger people and those living in urban areas are less likely to have heard of these technologies. There are also some differences in ethnicity, while NZ Europeans are more likely to be aware, those who identify as Maori or Pacific are less likely to have heard of genetic technologies.

Knowledge and importance of genetic technologies

Although awareness at an overall level is relatively high, this does not mean that people feel informed about genetic technologies, with less than 3-in-10 saying they feel informed about at least one type. Genetic modification is the technology people feel most informed about with fewer feeling informed about gene editing, genomic selection and marker-aided selection. Even among people who are aware of each technology most do not feel informed.

When asked about the importance of genetic technologies for New Zealand's future 44% of people believe it is important. This view significantly increases among people who are already aware of or feel informed about genetic technologies. Males, older people aged 55-69 years, NZ Europeans, university educated and higher earners are also significantly more likely to believe in the importance of genetic technologies. More people feel conservation is important to them personally (78%) and this is felt most strongly by females, people who identify as New Zealanders, higher income earners, and people aged 40 years and over.

Acceptance of the use of genetic technologies

When given context for the use of genetic technology with specific scenarios, most people would be accepting of it's use. This is particularly true for the use of gene editing to save the Kauri tree. Those who are more likely to be accepting of these scenarios overall are 18-29 year olds or higher income earners. People who identify as Pacific Islanders, on lower incomes or have no prior awareness of genetic technologies are more likely to say they would not be accepting of their use.

Interestingly, although most people would be accepting of the use of genetic technologies for the purpose of conservation, less than half thought other New Zealanders would be accepting of gene editing technology. However, people who themselves accept the use of genetic technologies are more likely to believe others would also be accepting.

With the importance of conservation at a personal level being high for many, an opportunity exists to increase people's perception of the importance of genetic technologies to the future of New Zealand by increasing awareness of the technologies used in New Zealand and then bridging the gap between being aware and feeling informed through education about the use of genetic technologies for conservation.

FOR FURTHER INFORMATION PLEASE CONTACT

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