

**IN THE MATTER** of the Resource Management Act 1991

**AND**

**IN THE MATTER** of a further submission on the proposed Waikato District Plan by the LIFE SCIENCES NETWORK INCORPORATED (further submission no. 1295)

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**STATEMENT OF EVIDENCE OF PROFESSOR ANDREW  
ALLAN  
FOR LIFE SCIENCES NETWORK**

**18 December 2019**

**TOPIC: GENETIC ENGINEERING AND GENETICALLY  
MODIFIED ORGANISMS**

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## **1. INTRODUCTION**

- 1.1 My name is Andrew Allan. I am a Professor at the University of Auckland in molecular plant physiology at the School of Biological Sciences. I have approximately 30 years' experience in researching plant biology and genomics. My qualifications are set out in Appendix A.
- 1.2 In summary, I have researched extensively the effect of gene changes on plant performance and nutrition. I have extensive research experience on crop species and an in depth knowledge of genes that control major traits in crops of importance to New Zealand. I have been involved in research projects for New Zealand's horticulture and agriculture sectors. My experience in plant genomics has allowed me to directly see and measure how often genes change naturally. This is why I find it so perplexing that small, researcher-directed gene changes must be considered more risky than the thousands of changes occurring naturally, in any one plant, at any time.
- 1.3 I have not been directly involved in any field-based research in the Waikato region.

## **2. CODE OF CONDUCT**

- 2.1 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

## **3. SCOPE OF EVIDENCE**

- 3.1 I have been asked by the Life Sciences Network (LSN) to prepare evidence in relation to the request by some submitters to include controls and prohibitions on genetically modified organisms (GMOs) in the proposed Waikato District Plan. Specifically the LSN has asked me to provide evidence in respect of an overview of the current science and activity relating to genetically modified organisms including gene editing in response to the Section 42A report. They have also asked me to provide information, context and perspective on the safety of GMOs which have been approved for use – in particular the response of science and regulatory bodies.
- 3.2 My statement addresses the following matters:
  - a. Executive summary.
  - b. Is there certainty of the safety of approved GMOs?
  - c. Gene editing. An emerging technology of economic significance.

#### 4. EXECUTIVE SUMMARY

4.1 GMOs are defined by the HSNO act (1998) as a new organism with altered DNA developed in vitro. Scientifically, however, DNA is modified by sunlight, by stress, and most commonly by reproduction. During plant domestication of any one species tens of thousands of DNA changes have occurred, over a long time period. With any new breeding step (eg. a pollen cross between one apple and another) many thousands of new DNA variants are introduced. New technology, termed gene editing, is now being used to introduce single letter (nucleotide base pair) changes to an organisms DNA. Logically these must be less risky than larger changes introduced randomly by natural processes.

4.2 It is my opinion that:

- a. The Inter Council Working Party (ICWP) information on which a number of submitters rely (eg. GE Free New Zealand submission, no. 651) is out of date and incomplete.
- b. The general scientific consensus of approved GM is that it is safe, as evidenced by the fact that internationally GM plants (or GMOs) are now 10% of planted arable land. These have improved the economies of regions, and have not caused any measured increase in detrimental outcomes. GM techniques have been used for over 30 years.
- c. Genetic technologies offer step changes in yield and consumer traits.
- d. There is likely to be a significant cost in delaying the use of these technologies.
- e. Gene editing offers even more precise improvements to plants and animals and does not add additional DNA. Gene edits, of a certain type, are unregulated in a number of countries, including Australia, so can compete with New Zealand's products in international markets.
- f. It is not possible to tell a gene edited organism from a non-GM organism produced through traditional breeding or mutagenesis.
- g. I have found the EPA to be robust and thorough in its assessments of GM applications under the HSNO Act.

## 5. IS THERE SCIENTIFIC CERTAINTY ON THE SAFETY OF APPROVED GMOS?

- 5.1 In this section of my evidence I comment on the questions of whether it is possible to say there is certainty about the safety of GMOs which have been approved or whether an unacceptable level of uncertainty remains, and what is the level of consensus amongst experts on issues of risk, safety and uncertainty.
- 5.2 A number of submissions requesting controls on GMOs in the District Plan rely on information provided by the Northland Inter Council Working Party on genetic modification. The 2004 -2010 ICWP reports are based on outdated information and in particular omit information which would otherwise contradict the conclusions it seeks to draw. For example the reports do not mention gene editing nor do they provide a comprehensive and science based view of the current safety record of approved GMOs. Approved GMOs currently cover 15% of the world's arable land with no evidence of harm or adverse effects.
- 5.3 Genetically modified organisms (GMOs) are generally regarded as plants, animals, insects and microbes which have had their genetic structure changed using laboratory techniques.
- 5.4 Since 1982 GMOs have been used to produce enzymes for industry (e.g. for use in washing powders) and food manufacture (e.g. cheese making including in New Zealand); and for medicine (such as insulin for the treatment of diabetes; Keytruda for the treatment of breast cancer; heart drugs and drugs to treat inherited genetic disorders). More recently a new therapy has been developed (CAR-T cell therapy) where blood cells from a cancer patient are removed, genetically modified to recognise and fight the cancer and returned to the patient leading to remission of the disease. In New Zealand these cells are considered to be GMOs and so have been approved for release by the Environmental Protection Authority under the Hazardous Substances and New Organisms Act.
- 5.5 Since 1996 genetic modification has been used in agriculture in countries/regions such as Australia, the USA, South America, parts of Europe, India and Asia. In its 2017 update<sup>1</sup> on the *Global Status of Commercialized Biotech/GM Crops* the International Service for the Acquisition of Agri-biotech Applications noted:
- In 2017 up to 17 million farmers in 24 countries planted 189.8 million hectares of genetically modified crops, an accumulated area since 1996 of 2.3 billion hectares
  - Uptake by farmers in the top five growing countries is as high as 90-100%
  - There has been large increases in the use of GM crops every year since 1996
  - The main biotech GM crops are cotton, soybeans, canola and corn
  - Other GM crops include alfalfa, sugar beets, papaya, squash, eggplant, potatoes, and apples
  - Crops under development include rice, banana, potato, wheat, chickpea, pigeon pea, rye grass, mustard, cassava, cowpea, and sweet potato
  - Economic gains from GM crops reached US\$186.1 billion from 1996 to 2016

- 5.6 This report suggests that where GM crops are approved they are popular amongst farmers.
- 5.7 A number of states in Australia have now approved the use of GM crops a report by Biden et al (2018)<sup>2</sup> estimates the early introduction of GM crops, rather than the delay that has occurred, would have:
- Reduced the use of on farm chemicals by 6.5 million kgs;
  - Saved 8.7 million litres of diesel fuel;
  - Reduced greenhouse gas (GHG) and compound emissions by 24.2 million kgs
  - Increased canola production by 1.1 million tonnes
  - Increased farm revenue by AU\$485.6 million
- 5.8 On this basis, it is my opinion that delayed introduction of genetically modified crops has resulted in significant lost opportunities and costs to both the environment and economy. I see no reason why the same analysis would not apply in New Zealand.
- 5.9 Internationally, approvals of genetic modification in the primary industry have moved beyond broad acre crops and into foods which are eaten unprocessed. In 2017 US regulators approved the production and consumption of GM salmon<sup>3</sup> and apples<sup>4</sup>. The 2019 harvest and sale of 6,800 bins of GM apples represents 3.5 times more than 2018.
- 5.10 New Zealand Crown Research Institute, AgResearch, has developed a genetically modified grass which is currently being trialled in the USA. Laboratory testing has shown<sup>5</sup> the GM ryegrass “to grow up to 50 per cent faster than conventional ryegrass, be able to store more energy for better animal growth, to be more resistant to drought, and to produce up to 23 per cent less methane (the largest single contributor to New Zealand’s greenhouse gas emissions) from livestock.”
- 5.11 Regulators and national scientific bodies around the world have concluded that the use of genetic modification poses no more risk than conventional agriculture. For example, the National Academy of Sciences in the USA released a report in 2016 titled “Genetically Engineered Crops – Experiences and Prospects”<sup>6</sup>. In it they say:
- The use of GM in agriculture has had an overall positive outcome for the environment.
  - Humans have been eating meals containing GM food for more than two decades resulting in the consumption of trillions of GM meals without any scientifically credible negative health effect.
- 5.12 The European Commission after a decade of study made this statement in 2011:
- “The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are not per se more risky than e.g. conventional plant breeding technologies”.

- 5.13 Similar conclusions have been reached by more than 270 regulatory and national scientific and inquiry bodies around the world including the U.S. National Academies; U.S. Institute of Medicine; American Medical Association; British Royal Society; Royal Society of Medicine; European Food Safety Authority; EU Economic Commission; World Health Organization; American Association for the Advancement of Science; American Dietetic Association and the International Seed Foundation. The list and links can be found in appendix B.
- 5.14 In referring to these reports, I am not saying that all GMOs in all contexts will be 'safe'. Nor am I saying that the science organisations mentioned simply endorse the 'safety' of all GMOs in all contexts. It is too simplistic to refer to GMOs in the abstract or in general terms when considering safety and risk. Rather, the critical elements for an assessment of the risks, uncertainty and safety of GMOs are both the specific GMO under consideration (which includes the controls on the development and use of that specific organism) and the social and environmental contexts in which it will be used. That is the basis of international quality assured risk assessment practice. For example, the United States National Research Council and National Academy of Sciences, states: "In this regard the committee's findings support those of other scientists who have examined this problem of predicting risk and concluded that risk assessment...must focus on the ecology of the specific introduced organism (or both the donor and recipient in the case of transgenic organisms) and the characteristics of the accessible environment into which the organism will be released"<sup>7</sup>.
- 5.15 The scientific bodies, societies and international regulatory bodies I have referred to above all recognise the importance of best practice risk assessment of GMOs. Ongoing safety of future GMOs depends on continued risk assessment, monitoring and testing, including continuing improvements with technologies for testing. For example, in 2016, the US National Academy of Sciences said: "There is an urgent need for publicly funded research on novel molecular approaches for testing future products of genetic engineering so that accurate testing methods will be available when the new products are ready for commercialization"<sup>8</sup>. However, there is nothing distinct about GMOs in this respect. Many other developing uses of science and technology, while considered 'safe' when in controlled and approved contexts, also require ongoing assessment, testing and monitoring.
- 5.16 In my view, the critical role of the Environmental Protection Authority under the HSNO Act is demonstration of exactly the sort of cautious and considered approach which the various expert bodies endorse. I am advised that the Hearing Panel are considering whether additional controls should be placed on GMOs **approved by the EPA**. In my opinion, that is quite a different consideration to whether GMOs generally or in the 'abstract' are 'safe' or otherwise. That is something which the EPA has to consider under the HSNO Act. This is an area which the ICWP reports have also failed to provide a complete and objective assessment. Those reports discuss GMOs in general terms but fail to acknowledge that the HSNO process is all about identifying risks and dealing with uncertainties (like any other scientific endeavour). The EPA's approach to risk and uncertainty is considered the most robust, detailed and conservative as anywhere in the world.

5.17 Reports and studies suggesting health risks from GM crops have not withstood scientific scrutiny and have been discounted by science based regulators. Most famously a 2012 study<sup>9</sup> published in *Food and Chemical Toxicology* by French biologist Gilles-Éric Séralini<sup>10</sup> claimed to show increased tumour development in rats through the consumption of GMO feed and/or the herbicide Roundup. This was retracted<sup>11</sup> after criticism from the science community. It was later republished in a non-peer reviewed/low impact journal. Experts in this area do not publish in non-peer reviewed journals.

5.18 It is important to appreciate that studies do not gain legitimacy simply by being published. Critical for their credibility is repetition of the study by other science groups and critical analysis by the science community. It is my view that this study had critical flaws which have not been adequately addressed and I am not aware that this study has been repeated with the same outcomes.

5.19 In a review of the environmental and human health effects of GM crops published in 2017<sup>12</sup> the authors said that the “amount of uncertainty and unpredictability of risks associated with GM crops developed through modern biotechnological techniques or conventional mutation breeding or hybridization is variable but sure”. From this statement I take it that both conventional and biotechnological methods have similar variable but sure risks. Both need sensible consideration when releasing the developed organism.

5.20 Nonetheless, a small group of vocal activists have continued to assert that the use of genetic modification is uncertain and presents significant safety risks. In in 2015 313 “scientists and experts” signed a declaration<sup>13</sup> that “there is no scientific consensus on GMO safety”. Consequently, it is quite correct to say that there is not a complete and full consensus amongst scientists and other experts about what is an acceptable level of residual uncertainty and on the risk/safety of GMOs. For example, the following statement is representative of that small minority who take a different approach:

“Recent claims of consensus over the safety of genetically modified organisms (GMOs) seems to be an artificial and misguided perpetuated construct (Hilbeck et al., 2015; Domingo, 2016) regardless of contradictory evidences published during last three decades which lead scientific community to reconsider that the debate on this topic isn't ‘over’ yet”<sup>14</sup>

5.21 There is nothing surprising in this. In most areas of science there is not a full consensus on all issues. But I am firmly of the view that there is indeed a general consensus amongst experts that GMOs approved by scientifically based independent agencies using best practice risk assessment and management methodologies have acceptable levels of certainty and safety.

5.22 In that regard, in 2017 131 Nobel Laureates (1/3 of all those living) signed a letter<sup>15</sup> to Greenpeace in support of biotechnology (GMOs), stating that:

*“Scientific and regulatory agencies around the world have repeatedly and consistently found crops and foods improved through biotechnology to be as safe as, if not safer than those derived from any other method of production.”*

5.23 The letter also says:

*“WE CALL UPON GOVERNMENTS OF THE WORLD to reject Greenpeace's campaign against .....crops and foods improved through biotechnology .....; and to do everything in their power to oppose Greenpeace's actions and accelerate the access of farmers to all the tools of modern biology, especially seeds improved through biotechnology. Opposition based on emotion and dogma contradicted by data must be stopped.”*

5.24 A survey<sup>16</sup> undertaken by the Pew Institute indicated that the scientific consensus on the safety of genetically modified foods (88%) was comparable to that on climate change (87%).

5.25 Appendix C to my evidence contains a table of views from seven of the most respected science organisations in the world comparing their statements on climate change and on the safety of GMOs.



## 6. GENE EDITING IS GENETIC MODIFICATION IN NEW ZEALAND

6.1 While the traditional methods of genetic modification involve the insertion of whole genes into an organism more recent techniques (labelled “gene editing”), not mentioned in the s42A report, allow changes to be made in a far more precise way. These techniques are explained in a series of information papers put out by the Royal Society of New Zealand. A simple analogy is that if the genetic code is a book, traditional GM is akin to inserting a sentence (possibly on an unrelated topic) randomly into the pages; gene editing is like using the find-and-replace function on your word processor. Some of these edits can be as small as a single letter (nucleotide base pair).

6.2 The genetic code in an organism runs into billions of letters. Gene editing, where it changes only one or two letters of that genetic code in a precise and targeted way compares favourably with traditional (non GM) methods such as mutagenesis where thousands of random mutations are created by exposing a plant or seed to radiation or chemicals in order to speed up the natural process of mutation. Gene editing does, in fact, introduce fewer changes than either mutagenesis or traditional breeding using pollen crosses.

6.3 Mutagenesis is unregulated whereas gene editing is regulated in New Zealand as genetic modification. It is not possible to tell a gene edited organism from a non GM organism produced through traditional breeding or mutagenesis making identification in breeding programmes or the market difficult. A number of countries (Australia, USA, Brazil, Japan, Sweden) have deregulated certain gene editing techniques where the outcome could have been achieved through traditional breeding.

6.4 Examples of gene editing being developed in agriculture include:

- Non browning mushrooms – already approved in the USA as the USDA have decided<sup>17</sup> not to regulate gene editing where the outcome could also be achieved through conventional breeding techniques.
- soybeans with healthier oil<sup>18</sup> now being grown in the USA without GM regulatory constraints
- Polled (hornless) cattle. Simulation<sup>19</sup> of gene edited and conventional mating schemes indicates that gene editing will have positive outcomes for genetic improvement compared with conventional breeding.
- virus-resistant pigs<sup>20</sup>
- disease-resistant cassava<sup>21</sup>
- low-gluten wheat<sup>22</sup> (that people with celiac disease could eat),
- low-fat pigs<sup>23</sup> that better regulate heat (which would better protect piglets from cold weather, a common cause of death)
- oilseed crops with high levels of omega-3 fatty acids<sup>24</sup> .
- disease-resistant rice<sup>25</sup>
- Wheat with a 27% increase in grain weight<sup>26</sup>
- New high-nutrient and flavoured tomatoes and their relatives<sup>27,28</sup>

6.5 The Royal Society has convened a panel of experts to explore the risks, opportunities and implications for New Zealand of gene editing. The Gene Editing Panel<sup>29</sup> is chaired by Professor Barry Scott, Professor of Molecular Genetics in the Institute of Fundamental Sciences at Massey University.

6.6 The panel have published a number of information papers on gene editing<sup>30</sup> including:

- Gene Editing Evidence Update
- Gene Editing in the Primary Industries
- The use of Gene Editing to Create Gene Drives for Pest Control in New Zealand
- Gene Editing: Legal and Regulatory Implications
- Gene Editing in a Healthcare Context

6.7 According to Professor Scott “gene editing techniques will allow more targeted and precise genetic changes than what has been possible before in crop and livestock breeding”.

6.8 Because gene editing is a GMO, I understand that such uses would be subject to the proposed ban on releases. As example of the ‘safest’ type of GMOs, it is my opinion that a proposal to ban the use of EPA approved gene editing in the Waikato District is unreasonable because it fails to have proper regard to the risks associated with such an approved use.

## **7. CONCLUSION**

7.1 GMOs are defined by the HSNO Act (1996) as a new organism with altered DNA generated in vitro. This Act, and the associated regulations, includes some of the strictest controls of any country. One result of this Act has been that New Zealand primary industries have not released any GMO plants or animals. This may well have resulted in lost opportunity costs. Additional controls which duplicate the HSNO controls and which include bans on releases of GMOs may well result in further adverse economic and environmental effects.

7.2 Furthermore, reports showing GMO plants are dangerous have been discredited, internationally. New techniques, termed Gene Editing, can introduce DNA changes equivalent to those occurring naturally. However, these are still defined and regulated by the HSNO Act (1996) as GMO. As a scientist skilled in this area, I can state that these changes are so small compared with changes occurring naturally, that they are logically less risky (especially after testing) than other plants produced using traditional practices.

## References and Notes

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- <sup>1</sup> ISAAA. 2017. Global Status of Commercialized Biotech/GM Crops in 2017: Biotech Crop Adoption Surges as Economic Benefits Accumulate in 22 Years. ISAAA Brief No. 53. ISAAA: Ithaca, NY.
- <sup>2</sup> Biden, S, S J Smith, and D Hudson. 2018. The economic and environmental cost of delayed GM crop adoption: The case of Australia's GM canola moratorium. <https://www.tandfonline.com/doi/full/10.1080/21645698.2018.1429876>
- <sup>3</sup> FDA Consumer Notification: "FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon" <https://www.fda.gov/ForConsumers/ConsumerUpdates/ucm472487.htm>
- <sup>4</sup> USDA Stakeholder Announcement: "USDA Announces Deregulation of Non-Browning Apples" [https://www.aphis.usda.gov/stakeholders/downloads/2015/SA\\_arctic\\_apples.pdf](https://www.aphis.usda.gov/stakeholders/downloads/2015/SA_arctic_apples.pdf)
- <sup>5</sup> AgResearch Communication: "Key step forward for game-changing grass" <https://www.agresearch.co.nz/news/key-step-forward-for-game-changing-grass/>
- <sup>6</sup> National Academies of Sciences, Engineering, and Medicine. 2016. Genetically Engineered Crops: Experiences and Prospects. Washington, DC: The National Academies Press. <https://doi.org/10.17226/23395>.
- <sup>7</sup> NRC. 2002. Environmental Effects of Transgenic Plants: The Scope and Adequacy of Regulation (Washington (DC): National Academies Press (US) Copyright 2002 by the National Academy of Sciences
- <sup>8</sup> Ibid 6
- <sup>9</sup> Seralini et al., 2014 Republished study: long-term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize. Environmental Sciences Europe Bridging Science and Regulation at the Regional and European Level <https://doi.org/10.1186/s12302-014-0014-5>
- <sup>10</sup> Seralini Study <https://www.geneticliteracyproject.org/glp-facts/gilles-eric-seralini-activist-professor-face-anti-gmo-industry/>
- <sup>11</sup> Seralini RETRACTED: Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize Food and Chemical Toxicology, Volume 50, Issue 11, November 2012, <https://www.sciencedirect.com/science/article/pii/S0278691512005637>
- <sup>12</sup> Tsatsakis, A.M., Nawaz, M.A., Kouretas, D., Balias, G., Savolainen, K., Tutelyan, V.A., Golokhvast, K.S., Lee, J.D., Yang, S.H., and Chung, G. 2017. Environmental impacts of genetically modified plants: A review. Environ Res 156, 818-833
- <sup>13</sup> European Network of Scientists for Social and Environmental Responsibility, Published Statement: "No scientific consensus on GMO safety" [https://ensser.org/press\\_release/pr01-15/#more-179](https://ensser.org/press_release/pr01-15/#more-179)
- <sup>14</sup> Ibid 11.
- <sup>15</sup> Laureates Letter Supporting Precision Agriculture (GMOs), June 2016 [http://supportprecisionagriculture.org/nobel-laureate-gmo-letter\\_rjr.html](http://supportprecisionagriculture.org/nobel-laureate-gmo-letter_rjr.html)
- <sup>16</sup> Pew Research Centre Report, Public and Scientists' Views on Science and Society, Jan 2015 [http://www.pewinternet.org/wp-content/uploads/sites/9/2015/01/PI\\_ScienceandSociety\\_Report\\_012915.pdf](http://www.pewinternet.org/wp-content/uploads/sites/9/2015/01/PI_ScienceandSociety_Report_012915.pdf)

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- <sup>17</sup> USDA statement <https://www.usda.gov/media/press-releases/2018/03/28/secretary-perdue-issues-usda-statement-plant-breeding-innovation>
- <sup>18</sup> Bloomberg: Gene-Edited Foods Are Coming to Your Plate But Aren't Being Regulated  
<https://www.bloomberg.com/news/articles/2018-10-05/frankenfood-or-a-better-bean-first-gene-edited-crop-harvested>
- <sup>19</sup> Mueller et al. (2018) Simulation of Introgression of the Polled Allele into the Holstein Breed via Conventional Breeding versus Gene Editing. Proceedings of the World Congress on Genetics Applied to Livestock Production, 11.755, 20705-2350, USA
- <sup>20</sup> Genetic Literacy Project: Super pigs: CRISPR gene-edited virus-resistant pigs could cut piglet deaths, pork prices, Feb 2017 <https://geneticliteracyproject.org/2017/02/24/super-pigs-crispr-gene-edited-virus-resistant-pigs-cut-piglet-deaths-pork-prices/>
- <sup>21</sup> News Report, St. Louis Public Radio: In a Race to Prevent Hunger, Danforth Researchers Use CRISPR to Gene-edit Cassava, Oct 2017  
<http://news.stlpublicradio.org/post/race-prevent-hunger-danforth-researchers-use-crispr-gene-edit-cassava#stream/0>
- <sup>22</sup> New Scientist, Genetically modified wheat used to make coeliac-friendly bread, Sept 2017  
<https://www.newscientist.com/article/2148596-genetically-modified-wheat-used-to-make-coeliac-friendly-bread/>
- <sup>23</sup> Burkard et al. (2017) Precision engineering for PRRSV resistance in pigs: Macrophages from genome edited pigs lacking CD163 SRCR5 domain are fully resistant to both PRRSV genotypes while maintaining biological function, PLoS Pathog 13(2): e1006206. <https://doi.org/10.1371/journal.ppat.1006206>
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<https://onlinelibrary.wiley.com/doi/pdf/10.1111/pbi.12663>
- <sup>25</sup> Borrelli et al., (2018) The Enhancement of Plant Disease Resistance Using CRISPR/Cas9 Technology *Front Plant Sci*. 2018; 9: 1245.
- <sup>26</sup> Wheat Wang et al., (2018) Transgenerational CRISPR-Cas9 Activity Facilitates Multiplex Gene Editing in Allopolyploid Wheat *The CRISPR Journal* Vol. 1, No. 1
- <sup>27</sup> Zsögön et al (2018) De novo domestication of wild tomato using genome editing. *Nature Biotechnology*  
<http://dx.doi.org/10.1038/nbt.4272>
- <sup>28</sup> Information Piece: Food Ingredients First: Genome Editing: Could the Ground Cherry Become the Next Big Fruit Crop?

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<https://www.foodingredientsfirst.com/news/genome-editing-could-the-groundcherry-become-the-next-big-fruit-crop.html>

<sup>29</sup> Royal Society Gene Editing Panel

<https://royalsociety.org.nz/major-issues-and-projects/gene-editing-in-aotearoa/gene-editing-panel/>

<sup>30</sup> See Royal Society Te Aparāngi website

<https://www.royalsociety.org.nz/major-issues-and-projects/gene-editing-in-aotearoa/>

## **Appendices**

- A. Qualifications
- B. Scientific and Technical Institutions which Support the Safety of GM Crops
- C. Scientific Organisation Views on Climate Change and GMOs

## **Appendix A: Qualifications & Experience**

1. My name is Andrew Allan. I am employed as a Professor by The University of Auckland.
2. I hold the degree of Bachelor of Science with First Class Honours in Plant and Microbial Sciences from the University of Canterbury, and a PhD in Biochemistry from Cambridge University, United Kingdom.
3. I am a Principal Scientist at Plant and Food Research.
4. I have worked as a plant biologist, researching, teaching and advising on MBIE panels.
5. I have published 121 peer-reviewed papers.
6. I have over twelve thousand citations.
7. In 2018 I was recognised as a Highly Cited Researcher, among the top 1 percent of science and social science researchers in the world.

## Appendix B

### Scientific and Technical Institutions which Support the Safety of Genetically Modified Crops

#### Africa (14)

|              |  |   |
|--------------|--|---|
| South Africa | Academy of Science of South Africa   | <a href="#">GMOs for African Agriculture: Challenges and Opportunities</a> (2010)                     |
| Continent    | Academies of Sciences from Cameroon, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Senegal, South Africa, Sudan, Tanzania, Uganda and Zimbabwe. | <a href="#">Declaration of the 9th Annual Meeting of African Science Academies</a> (2013)             |
| Continent    | International Society of African Scientists  | <a href="#">Potential Benefits of Biotechnology to Agriculture in Africa and the Caribbean</a> (2001) |
| South Africa | AfricaBio  | <a href="#">Food and Feed Safety Assessment</a> (2017)  |

#### Asia (5)

|             |   |   |
|-------------|---|---|
| China       | Chinese Academy of Sciences                       | <a href="#">Transgenic Plants and World Agriculture</a> (2000)  |
| India       | Indian National Academy of Sciences               | <a href="#">Transgenic Plants and World Agriculture</a> (2000)  |
| India       | Indian National Academy of Agricultural Sciences  | <a href="#">GM Crops for Nutritional Security</a> (2014)  |
| Japan       | Agricultural Academy of Japan                     | <a href="#">Agricultural Academy of Japan proposes conduct of confined field trial of GM crops</a> (2017) |
| Philippines | National Academy of Science and Technology (NAST) | <a href="#">Filipino Scientists in Support of Biotechnology</a> (2001)                                    |



## Europe (89)

|                |  |   |
|----------------|--|---|
| Czech Republic | Biology Centre of the Academy of Sciences of the Czech Republic  | <a href="#">White Book: Genetically Modified Crops</a> (2009)   |
| France         | French Academy of Agriculture  | <a href="#">Conclusions du groupe de réflexion et de proposition de l'Académie d'Agriculture de France sur les Plantes Génétiquement Modifiées</a> (2012) |
| France         | French Academy of Agriculture, French Academy of Science, National Academy of technologies of Frances  | <a href="#">French Academies call for freedom of research on Genetically Modified Plants (GMPs) to be restored</a> (2014)                                 |
| France         | French Academy of Sciences   | <a href="#">Genetically Modified Plants</a> (2002)  |
| Germany        | National Academy of Sciences (Leopoldina)   German Academy of Science and Engineering (acatech)   Berlin-Brandenburg Academy of Sciences and Humanities                  | <a href="#">In support of a new policy on Green Genetic Engineering</a> (2009)  |
| Germany        | Union of the German Academies of Science and Humanities (8 academies)  | <a href="#">Are There Health Hazards for the Consumer from Eating Genetically Modified Food?</a> (2006)   |
| Germany        | Federal Ministry of Education and Research   | <a href="#">BMBF Research Programme: Biological safety research on genetically modified organisms</a> (2014)  |
| Italy          | National Academy of Science   Lincean Academy  | <a href="#">Plant biotechnology and GMO variety</a> (2007)  |
| Italy          | Joint statement of 14 scientific intitutions of Italy  | <a href="#">Food safety and GMOs. Consensus Document</a> (2004)   |
| Italy          | Joint statement of 21 scientific intitutions of Italy  | <a href="#">Coexistence of Traditional, Organic and Genetically Modified Crops</a> (2006)   |
| Netherlands    | Plant Research International – Wageningen UR   | <a href="#">Sustainability of current GM crop cultivaton</a> (2011)   |
| Spain          | Declaration promoted by the Spanish Bioindustry Association (ASEBIO) and signed by more than 150 Spanish scientists from different universities and research institutes. | <a href="#">Science, progress and environment</a> (2007)  |
| Spain          | Declaration promoted by the National Association of Plant Breeders (ANOVE) and signed by 14 Spanish institutions   | <a href="#">Press release</a> (2010)  |

|                |  |  |
|----------------|--|--|
| United Kingdom | Royal Society of London                                      | <a href="#">Transgenic Plants and World Agriculture</a> (2000)   <a href="#">Genetically modified plants for food use and human health—an update</a> (2002)   <a href="#">Reaping the benefits: Science and the sustainable intensification of global agriculture</a> (2009)   <a href="#">GM Plants: Questions and Answers</a> (2016) |
| United Kingdom | Royal Society of Medicine                                    | <a href="#">Genetically modified plants and human health</a> (2008)  |
| United Kingdom | Royal Society of Edinburgh                                   | <a href="#">RSE Calls for a Rational GM Debate</a> (2015)  |
| United Kingdom | Biochemical Society UK                                       | <a href="#">Genetically Modified Crops, Feed and Food: A Biochemical Society position statement</a> (2011)   |
| United Kingdom | British Medical Association                                  | <a href="#">Genetically modified foods and health: a second interim statement</a> (2004)   |
| United Kingdom | Letter signed by 32 scientific and agricultural institutions | <a href="#">Letter to Scottish Government from research organisations</a> (2015)   |
| United Kingdom | Science and Technology Committee – House of Commons (UK)     | <a href="#">EU regulation on GM Organisms not ‘fit for purpose’</a> (2015)   |
| Vatican        | Pontifical Academy of Sciences                               | <a href="#">Transgenic Plants for Food Security in the Context of Development</a> (2010)   |
| European Union | European Commission  | <a href="#">A Decade of EU Funded GMO Research</a> (2010)  |
| European Union | European Academies Science Advisory Council (EASAC)          | <a href="#">Planting the future: opportunities and challenges for using crop genetic improvement technologies for sustainable agriculture</a> (2013)   |
| European Union | European Food Safety Authority (EFSA)                        | <a href="#">FAQ on genetically modified organisms</a> (2012)   <a href="#">Safety and nutritional assessment of GM plants and derived food and feed: The role of animal feeding trials</a> (2008)  |

*\* In this table the academies of Germany are 10, in the case of United Kingdom there are 33 institutions; 22 institutions from Italy, 14 from Spain, and 3 from France.*

*\* The European Academies Science Advisory Council (EASAC) currently has **29 members**: one representative each from the 25 national science academies of EU member states, the Academia Europaea, ALLEA, and also representatives of the Norwegian and Swiss national academies of sciences.*

## **Latin America (9)**

|           |  |   |
|-----------|--|---|
| Argentina | Nutrition Society of Argentina (SAN)                                   | <a href="#">Transgenic Food: SAN Position</a> (2012)   <a href="#">Biotechnology and genetically modified food: Answers to frequently asked questions</a> (Undated)   |
| Argentina | International Life Sciences Institute (ILSI)                           | <a href="#">Safety of Genetically Modified Organisms: The case of GM soy in Argentina</a> (2004) Pages 22-27   <a href="#">Biotechnology and genetically modified food: Answers to frequently asked questions</a> (Undated) |
| Brazil    | Brazilian Academy of Sciences  | <a href="#">Transgenic Plants and World Agriculture</a> (2000)  |
| Brazil    | Brazilian Association of Nutrition*                                    | <a href="#">ABRAN supports the development of GMOs with better nutritional properties*</a> (2005)   |
| Chile     | Chilean Academy of Sciences  | <a href="#">Declaration of the Chilean Academy of Sciences on GM crops</a> (2004)   |
| Chile     | Chilean Academy of Agricultural Sciences                               | <a href="#">Position of the Chilean Academy of Agricultural Sciences on GMOs</a> (2013)   |
| Mexico    | Mexican Academy of Sciences  | <a href="#">Transgenic Plants and World Agriculture</a> (2000)   <a href="#">For the responsible use of GMOs</a> (2011)   <a href="#">Transgenic: Great Benefits, Absence of damage and Myths</a> (2017)                    |
| Peru      | Peruvian Association for the Development of Biotechnology (PeruBiotec) | <a href="#">PeruBiotec takes up the challenge</a> (2009)  |
| Continent | REDBIO (600 scientists from 21 countries)                              | <a href="#">Viña del Mar Declaration: RedBio participants express support for agrobiotechnology</a> (2007)  |

\* *The source is an interview where is mentioned the support of “Brazilian Association of Nutrition” to biofortified GM crops. A public statement should be corroborated.*

## North America (28)

|        |  |   |
|--------|--|---|
| Canada | Canadian Cancer Society  | <a href="#">Food Issues: Genetically modified foods</a> (2016)  |
| Canada | Royal Society of Canada  | <a href="#">Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada</a> (2001)   |
| Canada | Health Canada  | <a href="#">Safety Assessment of Genetically Modified Foods</a> (2016)  |
| USA    | National Academy of Sciences (NAS)   | <a href="#">Transgenic Plants and World Agriculture</a> (2000)   <a href="#">Impact of Genetically Engineered Crops on Farm Sustainability in the United States</a> (2010)        |
| USA    | Institute of Medicine (IOM) & National Research Council (NRC) of the National Academies. | <a href="#">Safety of Genetically Engineered Foods: Approaches to Assessing Unintended Health Effects</a> (2004)  |
| USA    | National Academies (NRC, NAS, NAM)   | <a href="#">Genetically Engineered Crops: Experiences and Prospects</a><br><br>(2016)   |
| USA    | American Medical Association (AMA)   | <a href="#">Council on Science and Public Health Report</a> (2012)  |
| USA    | American Association for the Advancement of Science (AAAS)                               | <a href="#">Statement by the AAAS Board of Directors On Labeling of Genetically Modified Foods</a> (2012)   |
| USA    | American Council of Science and Health (ACSH)  | <a href="#">Biotechnology and Food (Second Edition)</a> (2000)  |
| USA    | Society of Toxicology (SOT)  | <a href="#">The Safety of Genetically Modified Foods Produced through Biotechnology</a> (2003)   <a href="#">Food and Feed Safety of Genetically Engineered Food Crops</a> (2017) |
| USA    | American Dietetic Association  | <a href="#">Position of the American Dietetic Association: Agricultural and food biotechnology</a> (2006)   |
| USA    | Genetics Society of America  | <a href="#">Assessing Benefits and Risks of Genetically Modified Organisms</a> (2001)   |
| USA    | American Society for Cell Biology (ASCB)   | <a href="#">ASCB Statement in Support of Research on Genetically Modified Organisms</a> (2009)  |
| USA    | American Society of Plant Biology (ASPB)   | <a href="#">Statement on Plant Genetic Engineering</a> (2006)<br><br><a href="#">Plant scientists: GM technology is safe</a> (2016)   |
| USA    | American Society for Microbiology (ASM)  | <a href="#">Statement of the American Society for Microbiology on Genetically Modified Organisms</a> (2000)   |
| USA    | American Phytopathological Society (APS)   | <a href="#">APS Statement on Biotechnology and its Application to Plant Pathology</a> (2001)  |
| USA    | Society for In Vitro Biology (SIVB)  | <a href="#">Position Statement on Crop Engineering</a> (Undated)  |
| USA    | Crop Science Society of America  | <a href="#">CSSA Perspective on Biotechnology</a> (2001)  |

|     |  |   |
|-----|--|---|
| USA | Council for Agricultural Science and Technology (CAST)   | <a href="#">Crop Biotechnology and the Future of Food: A Scientific Assessment</a> (2005)   |
| USA | Federation of Animal Sciences Societies (FASS) – <i>representing the American Dairy Science Association (ADSA), American Society of Animal Science (ASAS) and the Poultry Science Association (PSA).</i> | <a href="#">FASS Facts On Biotech Crops – Impact on Meat, Milk and Eggs</a> (2001)   <a href="#">Biotechnology as a Tool to Enhance Sustainability for Animal Production</a> (2011) |
| USA | Food and Drug Administration (FDA)   | <a href="#">Questions &amp; Answers on Food from Genetically Engineered Plants</a> (2015)   |
| USA | Entomological Society of America   | <a href="#">ESA Position Statement on Transgenic Insect-Resistant Crops</a> (2001)  |
| USA | American Cancer Society  | <a href="#">Common questions about diet and cancer: Genetically modified foods</a> (2016)   |
| USA | American Veterinary Medical Association  | <a href="#">AVMA supports safety of GMO and GE foods</a> (2017)   |

*\* The American Dietetic Association (ADA) has become The Academy of Nutrition and Dietetics (AND). While the above statement reflected the ADA's position the president of AND has stated that AND is currently neutral and has no position on GMOs.*

## Oceania (7)

|                         |  |   |
|-------------------------|--|---|
| Australia               | Australian Academy of Science  | <a href="#">Submission to the Inquiry into Primary Producer Access to Gene Technology</a> (1999)<br><br><a href="#">Statement gene technology and plants</a> (2007) |
| Australia               | Biotechnology Ministerial Council                                    | <a href="#">Australian Biotechnology: A National Strategy</a> (2000)  |
| Australia               | Commonwealth Scientific and Industrial Research Organization (CSIRO) | <a href="#">Biotechnology Strategy</a> (2002)   |
| Australia               | National Farmers' Federation (NFF)                                   | <a href="#">Biotechnology Position Statement</a> (Undated)  |
| Australia               | Australia's Biotechnology Organization (AusBiotech)                  | <a href="#">Backing innovation: The way forward for Australian agriculture</a> (2004)   |
| Australia & New Zealand | Food Standards Australia – New Zealand                               | <a href="#">Review of genetically modified food safety assessments</a> (2009)   |
| New Zealand             | New Zealand Royal Commission   | <a href="#">Report of the Royal Commission on Genetic Modification</a> (2000)   |

## International Organizations (14)

|  |  |
|--|--|
| World Health Organization (WHO)  | <a href="#">Modern food biotechnology, human health and development: an evidence-based study</a> (2005)<br><br><a href="#">Frequently asked questions on genetically modified foods</a> (2014) |
| Food and Agriculture Organization of the United Nations (FAO)  | <a href="#">FAO Statement on Biotechnology</a> (2001)   <a href="#">Frequently Asked Questions about FAO and Agricultural Biotechnology</a> (2011)   |
| Third World Academy of Sciences (TWAS)   | <a href="#">Transgenic Plants and World Agriculture</a> (2000)   |
| International Council for Science (ICSU)*  | <a href="#">New Genetics, Food and Agriculture: Scientific Discoveries – Societal Dilemmas</a> (2003)  |
| International Union of Food Science and Technology (IUFoST)  | <a href="#">IUFoST Scientific Bulletin on Biotechnology and Food</a> (2005)  |
| International Seed Federation (ISF)  | <a href="#">Position Paper on Genetically Modified Crops and Plant Breeding</a> (2005)   |
| International Union of Nutritional Sciences (IUNS)   | <a href="#">Statement on Benefits and Risks of Genetically Modified Foods for Human Health and Nutrition</a> (Undated)   |
| Consultative Group for International Agricultural Research (CGIAR)   | <a href="#">Agricultural Biotechnology and the Poor: Promethean Science</a> (2000)   |
| United Nations Development Programme (UNDP)  | <a href="#">UNDP Report Supports Biotechnology</a> (2001)  |
| AgBioWorld Foundation [ <i>Declaration signed by 25 Nobel Prize winners and more than 3,400 scientists</i> ] | <a href="#">Scientists In Support Of Agricultural Biotechnology</a> (2011)   |
| Organisation for Economic Co-operation and Development (OECD)  | <a href="#">The OECD Edinburgh Conference on the Scientific and Health Aspects of Genetically Modified Foods</a> (2000)  |
| International Society for Plant Pathology.   | <a href="#">Genetic modification for disease resistance: a position paper</a> (2016)   |
| International Congress on Poverty, hunger and emerging food (Catholic University of Valencia, Spain)         | <a href="#">Press: The World Congress against hunger concludes that GM doesn't affect health</a> (2016)  |
| 123 Nobel Prize Laureates Supporting Precision Agriculture (GMOs)**  | <a href="#">Laureates Letter Supporting Precision Agriculture (GMOs)</a> (2017)  |
| Asian Development Bank   | <a href="#">Agricultural Biotechnology, Poverty Reduction, and Food Security</a> (2001)  |

\* The document from the [International Council for Science](#) (ICSU) was signed in 2003 by **101 science academies and 27 scientific unions**. ICSU currently has **31** Scientific Union Members and **121** National Scientific Members.

\*\* The statement from Nobel prizes is included by the importance of the document, but it is not counted as an institution.

Source : <http://www.siquierotransgenicos.cl/2015/06/13/more-than-240-organizations-and-scientific-institutions-support-the-safety-of-gm-crops/>

# GMO: What is the independent scientific consensus?

**The organizations you trust on climate science state that GMOs are safe and beneficial:**

| Organization  | Statement on Climate Change   | Statement on GMOs  |
|---|---|--|
| American Association for the Advancement of Science | "The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society." (AAAS Board Statement on Climate Change, 2006)  | "The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe." (AAAS Board Statement on Labeling of Genetically Modified Foods, 2012)   |
| American Medical Association                        | "Our AMA ... supports the findings of the Intergovernmental Panel on Climate Change's fourth assessment report and concurs with the scientific consensus that the Earth is undergoing adverse global climate change and that anthropogenic contributions are significant." (Global Climate Change and Human Health, 2013)   | "Our AMA recognizes that there is no evidence that unique hazards exist either in the use of rDNA (GE) techniques or in the movement of genes between unrelated organisms." "Bioengineered foods have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature." (Report of the Council on Science and Public Health, 2012)  |
| National Academies of Science (USA)                 | "The scientific understanding of climate change is now sufficiently clear to justify taking steps to reduce the amount of greenhouse gases in the atmosphere." (Understanding and Responding to Climate Change, 2005)   | "Genetic engineering is one of the newer technologies available to produce desired traits in plants and animals used for food, but it poses no health risks that cannot also arise from conventional breeding and other methods used to create new foods." (Expert Consensus Report: Safety of Genetically Modified Foods, 2004)<br>"An analysis of the U.S. experience with genetically engineered crops shows that they offer substantial net environmental and economic benefits compared to conventional crops." "Generally, GE crops have had fewer adverse effects on the environment than non-GE crops produced conventionally." (Impact of Genetically Engineered Crops on Farm Sustainability in the United States, 2010) |
| World Health Organization                           | "There is now widespread agreement that the Earth is warming, due to emissions of greenhouse gases caused by human activity. It is also clear that current trends in energy use, development, and population growth will lead to continuing - and more severe - climate change." (Protecting Health from Climate Change, 2008)  | "GM foods currently available on the international market have passed risk assessments and are not likely to present risks for human health. In addition, no effects on human health have been shown as a result of the consumption of such foods by the general population in the countries where they have been approved." (20 questions on genetically modified foods, 2013)  |
| European Commission                                 | "There is unequivocal evidence that the Earth's climate is warming.... The consensus among climate experts is that it is extremely likely that the main cause of recent warming is the 'greenhouse' gases (GHGs) emitted by human activities, in particular the burning of fossil fuels – coal, oil and gas – and the destruction of forests." (Climate Change Fact Sheet, 2012)  | "The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are no more risky than conventional plant breeding technologies." (A decade of EU-funded GMO research, 2010)  |
| The Royal Society (UK)                              | "There is strong evidence that the warming of the Earth over the last half-century has been caused largely by human activity, such as the burning of fossil fuels and changes in land use, including agriculture and deforestation." (Climate Change: A summary of the science, 2010)   | "A previous Royal Society report (2002) and the Government's GM Science Review (2003/2004) assessed the possibilities of health impacts from GM crops and found no evidence of harm. Since then no significant new evidence has appeared. There is therefore no reason to suspect that the process of genetic modification of crops should per se present new allergic or toxic reactions." (Reaping the benefits: Science and the sustainable intensification of global agriculture, 2009)  |
| International Science Academies: Joint Statement    | "Climate change is real... there is now strong evidence that significant global warming is occurring. The evidence comes from direct measurements of rising surface air temperatures and subsurface ocean temperatures and from phenomena such as increases in average global sea levels, retreating glaciers, and changes to many physical and biological systems. It is likely that most of the warming in recent decades can be attributed to human activities." (The Science of Climate Change, 2001) | "GM technology has shown its potential to address micro-nutrient deficiencies [in developing nations]." "GM technology, coupled with important developments in other areas, should be used to increase the production of main food staples, improve the efficiency of production, reduce the environmental impact of agriculture, and provide access to food for small-scale farmers." "Decisions regarding safety should be based on the nature of the product, rather than on the method by which it was modified. It is important to bear in mind that many of the crop plants we use contain natural toxins and allergens." (Transgenic Plants and World Agriculture, 2000)  |