Submission on Proposal P1055 - –Definitions for gene technology and new breeding techniques

Introduction

Many thanks for the opportunity to comment on Proposal P1055. Whilst we appreciate the chance for input, we remain deeply concerned that this process is just a retrospective attempt to validate an unaccountable and highly conflicted decision that Food Standards Australia New Zealand (FSANZ) has already made. Documents revealed under Freedom of Information laws show that FSANZ has been consulting with the biotechnology industry on this issue for years. The same cannot be said of public health experts or public interest advocacy groups.

In 2012 and 2013 FSANZ convened an expert panel – comprised almost entirely of genetic engineers who own gene technology patents and are engaged in the professional or commercial practice of genetic engineering. They looked at whether these new genetic modification (GM) techniques, and others that may be invented later, should be considered novel genetic engineering methods, to be regulated accordingly. FSANZ appears to have deliberately misled the Senate, in response to Senate Estimate questions, when it stated "FSANZ is not aware that any members of the expert panel have potential conflicts of interest."[1] FSANZ would have been aware of some members holding patents and other potential conflicts of interest at the time, as this information is well documented and has since been publicised. For instance, the chair of the expert panel Peter Langridge even alerted FSANZ to his potential conflicts of interest in an email[2] Despite this, he remains an advisor to FSANZ on these issues to this day..

Not surprisingly, the panel concluded that the majority of the new techniques do not pose significant food safety concerns and recommended that they either be deregulated or undergo a simplified form of food safety assessment[3] - conclusions that overseas regulators have strongly disputed.[4]

Disturbingly, FSANZ appears to have adopted the advice it received from this expert panel in full. Correspondence between FSANZ and the Minister obtained by FoE under Freedom of Information laws stated that:

> *"We have considered the key findings of the expert panel and concur with their conclusions regarding which foods should be regarded as GM food, and which should not."*
>
> "*Foods derived using oligo-directed mutagenesis, zinc-finger nuclease technology used to introduce small, site-specific mutations involving one or a few nucleotides, and seed production technology are not captured by the standard and therefore do*

not require pre-market approval." [5]

In other words, FSANZ made a *de facto* decision not to regulate these techniques in food that is completely unaccountable, unchallengeable and hasn't been subject to any Parliamentary or public scrutiny. Now FSANZ appears to be attempting to validate a decision that was already taken in-house, through this more formal consultation process.

A flawed process

FSANZ's pro-industry bias is again reflected in the composition of the Expert Advisory Group on New Breeding Techniques (EAG NBT) it has convened to provide "expert advice on issues relevant to the review, such as the current science relating to NBTs and potential food safety issues associated with the use of NBTs." This includes a number of scientists with personal patents and commercial interests in these new GM techniques.[6]

It is also reflected in the language used in the consultation document. For example, it uses the industry PR term 'new breeding techniques' rather than the more accurate term 'new genetic engineering techniques'.

FSANZ is very aware that good governance requires disclosure and management of actual and potential conflicts of interest.[7] The Board of FSANZ, for example, is required to register pecuniary and other potential or actual conflicts of interest. The Register makes clear the broad scope of actual and potential conflicts of interest to which FSANZ works.[8]

Similarly, the FSANZ tendering process, which involves the engagement of external interests, includes a requirement that any potential conflict of interest by a tenderer must be reported to FSANZ. FSANZ defines a conflict of interest as a personal, professional or commercial relationship with FSANZ or with an organisation that would affect the performance of the contract or would bring disrepute to or embarrass FSANZ.[9]

We are deeply concerned that FSANZ has relied on advice from scientists with serious conflicts of interest and a narrow range of relevant expertise, to conclude that new GM foods derived from novel processes which have scant history of safe use pose no greater risks to public health than conventional foods. Those seeking to commercialise GM plants, animals and microbes should play no role in deciding how - or even whether – FSANZ should regulate foods derived from them.

Definitional issues

We support expanding FSANZ's definition for 'gene technology' so FSANZ continues to assess and regulate food products derived from all techniques and methods of genetic modification, other than conventional breeding.

Importantly, the definition of genetically modified organism (GMO) in the Food Standards Australia New Zealand Act 1991 - prior to the 2016 Food Standards Australia New Zealand Amendment (Forum on Food Regulation and Other Measures) Act - was the same as that in the Gene Technology Act 2000. It referred to an organism (or progeny of an organism) that has been modified by gene technology. The Act defined gene technology as "any technique for the modification of genes or other genetic material". [10] This definition would clearly include these new and emerging GM techniques.

The Food Standards Australia New Zealand Amendment (Forum on Food Regulation and Other Measures) deleted the definition of GMO and GM product from the Food Standards Act. Friends of the Earth and GeneEthics warned at the time that by deleting this definition from the Act, FSANZ was attempting to deregulate these techniques by stealth, since the definition now in the Food Standards Code is much weaker. This defines gene technology as "recombinant DNA techniques that alter the heritable genetic material of living cells or organisms". Predictably, FSANZ is now claiming that "A degree of uncertainty exists about whether foods produced using NBTs are '*food produced using gene technology*' because some of the new techniques can be used to make defined changes to the genome of an organism without permanently introducing any new DNA, although it may be present in the genome initially."[11]

This inconsistency in the national scheme regulating GM plants and foods derived from them and other organisms should not now be used as a loophole and baseless rationale by which these techniques are deregulated.

All GM foods should be regulated

Polling shows most Australians, and global citizens don't want to eat genetically modified (GM) foods. All GM foods should be independently assessed by government regulators for their health and environmental hazards and risks, be labelled as GM, and be traceable. This includes gene editing, GM rootstock grafting, cisgenesis, intragenesis RNA interference and null segregants. This will allow farmers, food producers, retailers, and shoppers to avoid them, if they choose to do so for a variety of legitimate reasons such as trade, markets, organic standards and values.

The Cartagena Protocol on Biosafey, an international agreement to which 166 governments worldwide are party, and the UN's food standards body Codex Alimentarius, both agree that all GM techniques differ from conventional breeding. They also concur that pre-market safety assessments are essential before GM organisms are used in food. Furthermore, the Third Review of the Gene Technology Scheme in 2018 found that "stakeholders generally agreed that maintaining the current [process-based] regulatory trigger would be the most sensible outcome at this point."[12]

We therefore strongly oppose changes to the Food Code that would allow a wide range of GM foods, made using novel methods that have scant history of safe use, to be sold without safety assessment or labelling. These would include meat and milk from some genetically modified animals and substances like vanilla and stevia produced by genetically modified microbes in factory vats. The proposed changes would undermine FSANZ's key responsibilities to ensure food safety and our right to know what is in our food.

Industry self-assessment puts us all at risk

Agrochemical companies cannot be trusted to self-assess the safety of GM foods as they have an appalling record of manipulating data to promote dangerous products.

Gene editing techniques have been found to make genetic changes that could never occur in nature and to result in widespread genetic damage and genetic inserts that often go undetected by GM developers.

The potential risks that FSANZ's deregulatory approach poses are all too clearly illustrated by the recent scandal where a Victoria based company - Total Livestock Genetics – was found to have bred dairy cows from 'gene edited' bulls whose genomes have since been found to unintentionally contain bacterial DNA.

Importantly, US Food and Drug Administration (FDA) scientists accidentally found the bacterial DNA in the bulls.[13] The developers of the cattle did not detect these potentially dangerous genetic inserts.[14] The study demonstrates how risky FSANZ's proposed deregulation of a number of these new genetic modification techniques in animals, plants and microbes is.[15]

FSANZ asserts that "when NBT food is equivalent in product characteristics to conventional food with a history of safe use, the NBT food can also be considered equivalent in risk."[16] The discovery that bacterial DNA was accidentally incorporated into cattle clearly demonstrates that FSANZ's position is wrong. As the experts from the FDA pointed out, the errors that the genetic engineering technique caused are unlikely to be individual cases. Unexpected integrations of foreign DNA through the gene editing process have been observed in many other species.[17]

The US FDA has argued this example illustrates the risks that these techniques pose and why they need to be regulated in animals.[18] This is in stark contrast to what FSANZ is proposing. Since the developers of these cattle did not detect these potentially dangerous genetic inserts, under FSANZ's proposed changes, milk and other products from these cows could enter our supermarkets with no safety assessment or labelling. [1920]

Potential Trade Impacts

The proposed changes would make Australia one of very few countries in the world to allow genetically modified animal products into our food chain with no regulation or labelling. This would put us at odds with our international trading partners, which FSANZ admits "may have a significant impact on trade".

It is important that FSANZ considers the potential international trade impacts if it deregulates food produced using new GM techniques such as CRISPR and others that may be invented in future. Key export markets such as the European Union have yet to make a decision on whether they will regulate these processes as GM techniques and have zero tolerance policies for unapproved GMOs. As Markos Kyprianou, the former EU Commissioner for Health and Consumer Protection put it:

> *"There is no flexibility for unauthorised GMOs - these cannot enter the EU food and feed chain under any circumstances."*[21]

A survey of countries that the Food and Agriculture Organisation (FAO) conducted found that 73% of them have a zero tolerance for unapproved GM varieties.[22] The FAO found that between 2002 and 2012 there had been 200 cases of trade disruptions due to the presence of unapproved GMOs. The majority of the cases happened between 2009-2012, indicating increasing trade problems. Many of these cases cost GM countries hundreds of millions or even billions of dollars in lost exports.

The OGTR has stated that some of these techniques are currently untraceable. If zero tolerance countries cannot test for these GM techniques, the result is likely to be much broader restrictions on food imports from Australia.

We find it frankly inconceivable that FSANZ would deregulate foods produced using genetic modification techniques without a very thorough public assessment of the potential trade impacts of doing so. Other countries have taken a more cautious approach than Australia's, with our key agricultural competitor New Zealand recently announcing that it will regulate organisms derived from novel GM techniques as GMOs.[23]

Since FSANZ regulates food in both Australia and New Zealand it should seek consistency with New Zealand and regulate foods produced using new GM techniques as GM.

Risks associated with specific techniques

The proposal to deregulate new and emerging GM techniques and their food products, which pose new and unassessed risks, is completely unacceptable.

GM rootstock grafting

A review commissioned by the Austrian Government concluded that the risks associated with GM rootstock grafting are the same as transgenesis and include:

- Novel gene products (such as RNA and proteins moving from the GM rootstock into the rest of the plant and potentially also into food products such as fruit.[24]
- Stably inherited alterations to affect gene expression;
- horizontal gene transfer between the rootstock and the rest of the plant. [25]
- Suckers developing on the GM rootstock, producing leaves and fruits that are GM.
- Impacts on soil organisms such as nematodes, which are capable of directly taking up RNA from the environment.[26]

FSANZ's 2012 report on 'New Plant Breeding Techniques' also concluded that plants with GM rootstock "may contain novel RNA and/or protein as a result of the genetic modification to the rootstock. Depending on the genetic modification, the food may also have altered composition or other characteristics."[27] The report further states that it was the view of the panel that foods produced using this technique "should be regarded as GM food and undergo premarket safety assessment".

Null segregants

We strongly oppose the deregulation of 'null segregants' – the offspring of GMOs which ostensibly no longer contain any GM DNA. This is an assumption that needs to be tested via regulation that requires full molecular characterisation. The definition of a GMO in Australia should include organisms derived from GMOs, or those that include temporal GMOs, as is the case in the EU.

A review commissioned by the Austrian Government concluded that the risks associated with using GM techniques in the plant breeding process to produce null segregants are the same as transgenesis and include:

- Undetected secondary insertions of GM materials that may be retained during segregation;

- Changes to the expression of the target genes which may be preserved in subsequent generations;
- Unintentional changes to the regulation of other genes. [28]

The assumption that there have been no unintended genetic changes therefore must be tested before products derived from organisms created using these techniques are allowed in our food. Full safety assessments are therefore essential.

Gene editing

There are numerous reports of unintended impacts such as off-target effects, unintended on-target effects and other unintended consequences arising from gene editing. Despite this, searching for genomic irregularities is far from routine in these studies. Protocols vary widely and differ greatly in the efficacy of their detection. For a recent review see Kawall *et al.* 2020.[29]

While chemical and radiation mutagenesis can increase the rate of random DNA point mutations, gene editing techniques cause DNA double strand breaks and can be used sequentially to make dramatic differences to DNA. They are also prone to additional unexpected mutations. They therefore carry both novel and greater risks, and warrant pre-market safety assessment and approval.

We oppose the proposed deregulation of GM techniques such CRISPR (SDN-1) when used to make naturally repaired DNA breaks.

SDNs - also referred to as site-specific nucleases (SSN)[30] - use enzymes to cut DNA at specific sites so that genes can be deleted or new genes inserted. The cut DNA is repaired by the natural DNA repair systems of the plant itself. There are currently four major classes of SDNs: meganucleases, zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and clustered regularly interspersed short palindromic repeats (CRISPR)/Cas9 reagents.[31]

- **Zinc-finger nucleases (ZFN)**
    - This technique involves the use of an engineered enzyme to introduce site-specific mutations into the plant genome. Depending on the type of ZFN technology deployed, mutations can either be restricted to one or a few nucleotides or involve the insertion of new pieces of DNA;
- **Transcription activator-like nucleases (TALEN)**
    - These enzymes are similar in structure in ZFNs but have longer DNA binding sites;[32]
- **Meganucleases/homing endonucleases**
    - These are naturally occurring DNA cutting enzymes that have been isolated from a range of organisms including yeast and green algae;[33]
- **CRISPR/Cas9-Nucleases**
    - These are synthetic enzymes developed from a bacterial enzyme that is part of the bacteria's immune system, used to recognise and destroy foreign DNA;[34]
    - This technique has only been developed in the last couple of years. Scientists have been excited by its versatility leading many to inaccurately characterise it as a 'precise gene editing tool'.[35]

SDN-1 cuts the DNA without the presence of a donor DNA repair template. This can result in site-specific random mutations or deletions but can also result in the deletion of whole genes and even parts of chromosomes. It can also cause genomic inversions or translocations.[36]

The ways in which DNA double stand breaks are repaired and the potential consequences of misrepair are still not fully understood.[37] A review commissioned by the Norwegian Government observed that our understanding of these mechanisms is still in its infancy and that the majority of the studies have been done on mammalian cells, not plant, microbial or other animal cells.[38]

The Austrian Environment Agency's recent review found that SDNs can result in a number of possible unexpected effects. However, because of the current lack of knowledge regarding the mechanisms involved in these techniques, significant uncertainties are associated with an assessment of unintended effects.[39]

And the review commissioned by the Norwegian Government found that:

> *"There are several factors that influence both DNA binding and DNA repair, unfortunately they are to a large extent not fully understood. The lack of mechanistic understanding is a severe limitation for identifying potential hazards from SDNs and more research in this field is greatly recommended. Identifying unintentional effects in a system which is not fully understood becomes very difficult."*[40]

According to the Austrian Environmental Agency[41] unexpected effects caused by SDNs can result from:

- Unexpected mutations in genes sharing similar DNA sequences to the target gene;
- Knock-out mutations that result in fusion genes which could create potentially toxic fusion proteins;
- Unintended mutations as a result of the methods used to introduce SDNs into the target cells. This usually involves older GM techniques such as *Agrobacterium*-mediated transformation or bombardment using a gene gun;
- Changes in gene expression;
- Genes introduced using SDN-3 techniques behaving differently when inserted into different parts of the genome.

Off-target effects

One of the main concerns with these techniques is unexpected mutations due to the SDNs cutting DNA outside the target site. This has been observed for the ZFN, TALEN and CRISPR techniques.[42] Agapito-Tenfen and Wikmark (2015) observe that small deletions can cause gene knockout and some mutations. While these may not lead to easily detectable changes they can still trigger safety concerns. Furthermore, it is unsafe to assume that these changes will not be heritable.[43]

The Austrian Environment Agency's review also found that ZFNs result in significant unexpected mutations.[44] This is also an important problem for the TALEN technique and, according to another recent review, can result in severe side effects.[45] Fine *et al.* (2014) highlighted that identifying off-target mutations for ZFN and TALEN is a daunting task

because of the size of genomes and the large number of potential mutation sites to examine.[46]

Studies suggest that CRISPR results in even more off-target mutations than ZFN and TALENs.[47] For example, a recent study found that CRISPR/Cas9 can result in hundreds of unexpected mutations.[48]

Agapito-Tenfen and Wikmark (2015) conclude that off-target mutations occur with all SDN techniques and it is impossible to predict what these might be,[49] therefore:

> *"comprehensive untargeted profiling methods (such as omics) should be applied in order to detect and identify unintentional mutations in the entire host genome."*[50]

CRISPR has been used for genetic engineering for less than a decade. Reviews commissioned by the Austrian and Norwegian governments concluded that not enough is known about the risks posed by new GM techniques such as CRISPR. They recommended that products derived from these techniques require comprehensive case-by-case risk assessments.

Deregulating techniques such as CRISPR, given the knowledge gaps that exist around the risks they pose is completely at odds with the Precautionary Principle.

RNA interference

RNA intereference which can result in DNA methylation and gene silencing is quite clearly a genetic modification technique and can result in heritable genetic changes. It therefore needs to be assessed for safety before being used in our food.

Mutations created using these techniques are fundamentally different to natural mutations

Industry claims that new GM techniques such as CRISPR do not give rise to any different risks than natural mutations are scientifically indefensible. Likewise, the argument that these mutations could occur naturally and therefore don't need to be regulated is disingenuous, since the natural mutation rate is extremely low. One plant breeding study found that the probability of any letter of the genome changing in a single generation is about one in 140 million. In contrast, a single application of these new GM techniques can cause hundreds of unwanted mutations in some organisms.[51]

Not all natural mutations are "safe" and most of them - if they would occur at all - are not used for straightforward and rapid commercial development and use.

Furthermore, no good criteria are available to distinguish risky mutations from less risky ones. As FSANZ's discussion paper notes, the size or specificity of the genetic change has relatively little relevance to the extent of change in the organism and consequently to the risk that it poses to the environment or food safety. [52]

Mutagenesis techniques do not have a 'history of safe use'

Industry arguments that new GM techniques such as CRISPR create similar results to chemical and radiation mutagenesis, which have a history of safe use, do not stand up to critical scrutiny. Neither of these techniques has been safely used in animals or microbes. Chemical and radiation mutagenesis also typically results in small point mutations – whereas SDN-1 results in DNA double strand breaks.

Unlike chemical and radiation mutagenesis, which increase the rate of random mutation, all of these techniques can be used sequentially to make dramatic changes to the genome.

Chemical and radiation mutagenesis could also result in the production of allergens and toxins and should be regulated. A dangerous precedent would be set if we accepted the argument that new techniques such as CRISPR should be deregulated because of the Government's failure to regulate other potentially risky techniques and their products.

All of these techniques rely on older GM methods with the same associated risks

All of these new GM techniques rely on older GM methods such as protoplast creation, biolistics, electroporation, tissue culture, and *Agrobacterium*-mediated gene transfer. These can all cause unexpected mutations that would be extremely unlikely to occur in nature. This is why organisms produced using them need to be assessed for safety.[53]

All of the new GM techniques can also result in the accidental incorporation of bacterial or synthetic DNA into the chromosome. With no regulation, these unexpected effects won't be looked for or found.[54]

Detectability

Industry claims that organisms modified using the new techniques would be indistinguishable from natural organisms and so regulation would be unenforceable are nonsensical and self-serving. Existing SDN-1 products such non-browning mushrooms are patented – requiring full molecular characterisation and enabling traceability.

Claims that GMOs produced using SDN-1 are not detectable only consider the current unequivocal signatures of GMOs obtained through transgenesis. These signatures of course help when using "cheap" and "rapid" detection methods but there are a number of techniques that can be used to identify organisms produced using SDN-1.[55]

The development of further protocols (including advances in the robustness of whole genome sequencing) and techniques may allow for better, cheaper and more reliable detection of small changes (e.g. one base pair changes) in genome edited organisms. These include 'BATCH-GE', a bioinformatics tool for batch analysis of DNA sequence data and spectroscopy methods for differentiating between genome-edited and conventionally bred plant varieties.[56]

It is evident that advances in detection technologies are needed, not only for genome-edited organisms but for other techniques such as RNAi. Already networks of laboratories exist that coordinate and develop techniques to detect GMOs. In Europe, there is the European Network of GMO Laboratories (ENGL). ENGL could play a role in the discussion on detectability of new organisms generated with new techniques, if it were commissioned to do so. There just needs to be the political will to develop suitable detection technologies.

Even if claims that such changes could not be detected were true, not having an analytical control / enforcement method for tracing any product is not an acceptable legal argument, since numerous products in supply chains are only traced by documentary traceability tools. These include free range, organic, fair trade and products from specific countries of origin.

As the regulator of these techniques FSANZ should mandate that developers supply a detection test. Releasing untested GMOs into our food chain without a detection test is a recipe for disaster and we find it astonishing that FSANZ is even considering this.

Conclusion

FSANZ should define GMOs in such a way as to ensure that all foods produced using new GM techniques continue to be regulated and assessed for safety. Such food from novel biotech processes should also continue to be labelled so farmers and shoppers can make informed decisions about whether to purchase or use them.

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