MODIFYING THE RULES

An overview of the divisions and inconsistencies in the global regulation of agricultural gene editing

A BIGGER CONVERSATION

Modifying the Rules – An Overview of the Divisions and Inconsistencies in the Global Regulation of Agricultural Gene Editing

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Introduction

In many countries across the world discussions are ongoing about how to regulate organisms created using newer forms of genetic engineering technologies. Proponents of these so-called gene editing technologies, such as CRISPR/Cas-9, claim that they are more precise than the genetic modification (GM) technologies which came onto the market in the 1990s, and therefore should not be regulated as genetically modified organisms (GMOs).

In May 2022 the UK government published its draft Genetic Technology (Precision Breeding) Bill[1] which, if passed, would effectively deregulate organisms created using gene editing technology. Accompanying this Bill has been a narrative from Defra that all across the world countries are doing the same, and this legislation is essential so that we don't fall behind and therefore miss out on potentially lucrative international trade.

This report shows what is actually happening across the world. The findings are that, in reality, only a small handful of countries have passed legislation for these new gene-edited crops at all. The vast majority still regulate them as GMOs.

Of the countries that have passed legislation, most have adapted existing GMO legislation, often by establishing exemptions for certain organisms or processes. These exemptions often hinge around the presence or absence of transgenes. Many countries use a tiered approach based on the SDN-1, SDN-2, SDN-3 categorisation. There are, however, a range of approaches as to which specific organisms are exempt and the process for formally exempting them.

This report considers both the scope of exemptions and the application process for developers to obtain authorisation of exemption of their organism, and in so doing reveals the complexity and lack of coherence. It is also clear that the Bill, from what we can tell of it at this stage, is likely to exempt more organisms than most other countries and will be almost unique in not requiring an official application process to establish exemption.

All 195 countries were studied for their legislative approaches to gene editing. Of these, 16 have clear regulatory policies and processes in place, of which 6 are Central/South American countries following a very similar approach. Two additional countries – China and India – have detailed legislation which may not be completely in force yet. All 18 of these countries have been included in this analysis.

A further 10 countries or country groups are in the process of considering their legislative approach to gene editing. Since none of these countries have detailed proposed legislation, they have been mostly excluded from this analysis, although what is known of their approaches is outlined in Appendix 1.

The EU is among these country groups which are currently considering their approach. The EU currently regulates gene-edited crops as GMOs following a court ruling in 2018, however a review is underway. Although the EU has not been included in the main body of the report, as the UK's main trading partner its decision is of fundamental importance to the UK and therefore has been explored in some detail on pages 13-16.

1 https://publications.parliament.uk/pa/bills/cbill/58-03/0011/FactsheetGenetic.pdf

SCOPE OF UK LEGISLATION

The Genetic Technology (Precision Breeding) Bill applies only to England.

When the UK was an EU member, free trade within the UK internal market (England, Wales, Scotland, Northern Ireland) was guaranteed by the common rules of the EU Single Market. Brexit creates the possibility of divergence in regulation between different parts of the UK where policymaking is devolved (such as on environmental and agricultural policy).

The UK Internal Market Act[2] sought to address this by guaranteeing 'businesses market access across the UK, provided they meet the regulatory standards in the part of the UK in which their goods are produced [or imported to], or service providers originate.' Yet an additional series of 'common frameworks' have been established to manage situations where regulations diverge (leaving open the possibility of some regulations, subject to agreement, being excluded from the free-market access principles); and the Northern Ireland Protocol also establishes a set of distinct rules for Northern Ireland.

In response to the draft Genetic Technology Bill, the Scottish[3] and Welsh[4] governments have stated they wish to remain aligned to EU standards. They have further indicated they may seek an exemption under the Internal Market Act to prohibit the trading of English gene-edited goods in their markets.

The position of devolved nations raises potential challenges for the UK internal market. While the Westminster government disputes that Scotland and Wales have the legal authority to ban the sale of English Gene-edited products, the recent decision by the Scottish government to ban single use plastics from England suggests Westminster's position may not be tenable[5].

The situation in Northern Ireland is equally complex. Although Northern Ireland is a part of the UK, under the terms of the Northern Ireland Protocol it remains aligned to the EU. Thus, currently, English genetically engineered organisms would not be allowed for import or sale without approval and labelling.

In the proposed UK legislation[6], the new sub-category of GMO, the so called "precision bred organism" is defined as one in which:

a) *any feature of its genome results from the application of modern biotechnology,*
b) *every feature of its genome that results from the application of modern biotechnology is stable, and*
c) *every feature of its genome could have resulted from*
    i. *traditional processes, whether or not in conjunction with selection techniques, or*
    ii. *natural transformation.*

2 https://www.legislation.gov.uk/ukpga/2020/27/contents/enacted
3 https://www.gov.scot/publications/genetic-technologies-precision-breeding-bill-letter-to-uk-government
4 https://www.bbc.co.uk/news/science-environment-58737669
5 https://www.gov.scot/publications/single-use-plastics-regulations-draft-guidance-document
6 https://publications.parliament.uk/pa/bills/cbill/58-03/0011/220011.pdf

This definition does not provide clarity on the key criteria – an organism that could have resulted from traditional processes or natural transformation – which will be used to decide which organisms will and will not fall under this definition. It is likely that this clarity will come either with secondary legislation and/or as guidance from ACRE.

Nevertheless, these criteria, which have been challenged by the scientific and policy community[7], put the UK in a minority, as nearly all other country's regulations make clear which processes and organisms are exempt from GMO legislation (e.g., presence of transgenes in the final product).

This report mainly covers gene-edited plants. The situation with gene-edited animals is even more controversial, and only six countries' legislation covers animals at all. This topic is examined in more detail on pages 26-7.

The inherent technicality and complexity of gene editing, the speed of change, translation challenges and the fact that it is sometimes difficult to access the full legislative text of each country, mean that it is difficult to provide a full global picture. This report has sought to give the most accurate account possible as of October 2022.

However, like the UK's Bill, many countries' regulations contain ambiguity, and as much of the legislation is very new it is not clear exactly how each country will interpret challenges as they come up. This ambiguity will likely have significant trade and transparency implications and it will be interesting to watch how the legislative landscape evolves over the coming years.

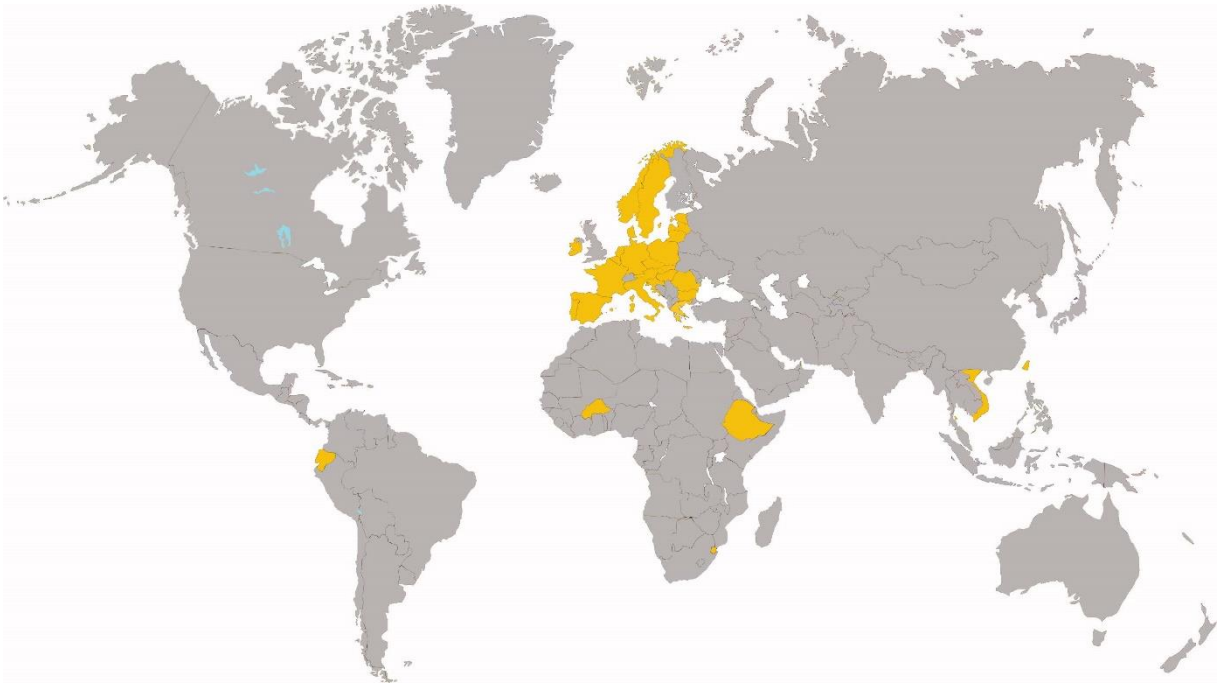
7 https://docs.google.com/document/d/1bTXTWZwwDHfReRaiA4Kt25Jfrqab4iNyAlLAsEGTPR4/edit?usp=sharing See also: https://docs.google.com/document/d/1NMye5n0Q5Db5_n99LutYb9jXXSigLiFF/edit?usp=sharing&ouid=109669580121482568414&rtpof=true&sd=true

Global Overview of Legislation

Countries with specific regulatory policies and processes for gene-edited organisms

North America: Canada, USA. **Central and South America:** Argentina, Brazil, Colombia, Chile, Honduras, Paraguay**. Africa:** Nigeria, Kenya, South Africa. **Middle East:** Israel. **Oceania:** Australia, New Zealand. **Asia:** China [legislation may not be fully approved yet]; India [legislation may not be fully approved yet], Japan, Philippines.

Countries with ongoing discussions (no proposed legislation yet)



Europe: EU, Norway, Sweden; **Central and South America:** Ecuador; **Africa:** Burkina Faso, Eswatini, Ethiopia; **Asia:** Taiwan, Thailand, Vietnam.

Process vs Product-based approaches

The literature has broadly divided legislative approaches into process-based (the regulations are based on the process used to create the organism), and product-based (the regulations consider only the final product, not the process used to create it). In reality, many are a combination of the two. The most common approach is a process trigger for regulation, with developers obliged to submit an application for the relevant bodies to determine whether or not their gene-edited product is exempt from existing GMO legislation.

Canada has a purely product-based approach, where the novelty of the trait is assessed on a case-by-case basis, irrespective of the technology used to develop it. By contrast, the EU and New Zealand both have a purely process-based approach, with courts in both jurisdictions ruling that gene-edited organisms are still considered genetic modification and therefore should be regulated as GMOs.

Current proposed legislation indicates a trajectory towards a product-based system, with the trigger for regulation (or deregulation) being made solely on the end product and not on the process used to create it. If enacted, this would put UK regulation in an extremely small minority.

Definitions of key terms vary from country to country

Cartagena Protocol and Living Modified Organisms

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity[8] is an international agreement which aims to ensure the safe handling, transport and use of GMOS (which the protocol calls living modified organisms, LMOs) resulting from modern biotechnology. It was adopted on 29 January 2000 and entered into force on 11 September 2003. It has been signed by 173 countries worldwide.

Of the 18 countries in this review, which have or are making moves to deregulate gene editing:

- 12 (Brazil, Colombia, Honduras, Paraguay, Kenya, Nigeria, South Africa, China, India, Japan, Philippines, New Zealand) have signed and ratified the protocol
- 3 (Argentina, Canada, Chile) have signed but not yet ratified it
- 3 (USA, Israel, Australia) are not signatories

The UK signed the protocol in 2000 and ratified it in 2004, so is also under an obligation to abide by definitions set out in the protocol. The protocol defines an LMO as follows:

> *"Living modified organism" means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology;*

8 https://bch.cbd.int/protocol

"Living organism" means any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses and viroids;

"Modern biotechnology" means the application of:

a) In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or
b) Fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection;

Many of the signatories to the protocol claim to have used these definitions in their discussions of how to regulate gene editing. Japan, for example, has determined that an organism with foreign DNA is regarded as an LMO and is subject to the regulations stipulated in the Cartagena Act unless the complete removal of the foreign DNA is confirmed[9]. This is controversial as the protocol focusses on process, not end product and it is likely that inserting foreign DNA then removing it means the organism is, in fact, an LMO. The protocol has not yet formally expressed a view on this.

DNA originating from outside of the organism

All countries which have some policies exempting gene-edited crops from GMO legislation have developed a concept of genetic material which originated outside of the organism – often called 'foreign DNA', 'transgenes' or 'exogenous DNA'. None of these terms appear in the Cartagena protocol, which focusses on the process and not the final product.

Moreover, the specific definitions of these terms vary slightly from country to country. The most common definition is provided by Canada[10], and also used by USA and Central/South American countries:

"The term 'foreign DNA' refers to DNA that is originally sourced from genetic sources outside the plant species and cannot be introduced into that plant species using conventional methods of plant breeding."

Also relevant here is the distinction between 'transgenesis': the insertion of DNA which was sourced from genetic sources from a non-sexually compatible species (the same as 'foreign DNA' above); and 'cisgenesis': the insertion of DNA from the same or a sexually compatible species. Cisgenes can normally be introduced into a plant species using conventional methods of breeding.

Other countries – such as China and India – use the term 'exogenous' DNA, which means DNA originating outside of the organism[11]. Notably, this definition differs from the definition of transgenes/foreign DNA as it includes genes from any different species, regardless of whether or not the species is sexually compatible (i.e., both transgenes and cisgenes). In other words, insertion of DNA from a sexually compatible species as part of the gene editing process may mean that the organism is exempt from GMO legislation in Argentina and Canada, but not in China and India.

9 https://www.frontiersin.org/articles/10.3389/fbioe.2019.00387/full
10 https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/guidance-documents/guidelines-safety-assessment-novel-foods-derived-plants-microorganisms/guidelines-safety-assessment-novel-foods-2006.html
11 https://groups.molbiosci.northwestern.edu/holmgren/Glossary/Definitions/Def-E/Exogenous_DNA.html

It is difficult to be clear on these linguistic differences at this early stage of much of the legislation, but it's important to be aware that such differences may have a significant impact as to which organisms are actually exempt from legislation.

Conventional/traditional breeding

Many definitions of genetically engineered crops include the terms 'traditional' or 'conventional' breeding, often to distinguish the different kinds of breeding techniques. In the gene editing context, some countries use the phrase "*organisms which could have been obtained by traditional breeding"* to establish which are exempt from GMO legislation. Often, though, the terms are not clearly defined. It is unclear, for example, whether there is a distinction between conventional and traditional breeding or whether they are used interchangeably.

The Cartagena protocol uses the term "traditional breeding" but does not define it. Some countries, for example Canada[12], do list the methods they consider to be conventional or traditional breeding. The UK's Genetic Technology Bill defines[13] "traditional processes" as:

> *In relation to plants:*
>
> i. *sexual fertilisation*
> ii. *spontaneous mutation*
> iii. *in vitro fertilisation*
> iv. *polyploidy induction*
> v. *embryo rescue*
> vi. *grafting*
> vii. *induced mutagenesis, or*
> viii. *somatic hybridisation or cell fusion of plant cells of organisms which are capable of exchanging genetic material by a process within sub-paragraphs (i) to (vii)*

This list includes cell fusion as a conventional technique. This has been an area of considerable debate. The International Federation of Organic Agriculture Movements (IFOAM) has concluded that cell fusion – which uses electric shock (electrofusion) or chemical treatment to fuse together of the cells from different organisms – is in fact, a form of genetic engineering and therefore prohibited in its standards[14].

Likewise, in the the UK's Genetically Modified Organisms (Deliberate Releases) 2002 regulation[15], "*cell fusion (including protoplast fusion) or hybridisation techniques where live cells with new combinations of heritable genetic material are formed through the fusion of two or more cells by means of methods that do not occur naturally*" is described as a GM technique. But in the draft Genetic Technology Bill it inexplicably falls under the heading of "traditional practices".

With no globally recognised standard definition of traditional or conventional breeding, nor agreement over whether such methods even exclude genetic engineering at all, it is imperative that all terms in any forthcoming legislation are clearly defined.

12 https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/guidance-documents/guidelines-safety-assessment-novel-foods-derived-plants-microorganisms/guidelines-safety-assessment-novel-foods-2006.html#a5.5
13 https://publications.parliament.uk/pa/bills/cbill/58-03/0011/220011.pdf
14 https://orgprints.org/id/eprint/33669/1/IFOAM-2017-cell_fusion_replacement_strategy.pdf
15 https://www.legislation.gov.uk/uksi/2002/2443/contents/made

Novel foods

Many countries, including the UK, have a concept of novel foods. Most regulate GMOs separately to novel foods but in the UK GMOs sit under the umbrella of novel foods. Some definitions of novel foods from around the world may be useful:

- Currently in the UK, novel foods are determined and defined by the Food Standards Agency (FSA) as "*foods which have not been widely consumed by people in the UK or European Union (EU) before May 1997*"[16]. This definition currently encompasses genetically modified organisms, however there is currently pressure on the FSA to remove so called "precision bred" (gene-edited) organisms from the novel foods register

- In the EU a "novel food" is any food or substance that has not been used for human consumption to a significant degree within the EU before 15 May 1997[17]

- In Australia and New Zealand, the definition has 2 parts. The first is a definition of "non-traditional food", and the second is a definition of "novel food", which is a subset of "non-traditional food"

    - "Non-traditional food" means one of the following: a food that does not have a history of human consumption in Australia or New Zealand; or a substance derived from a food, where that substance does not have a history of human consumption in Australia or New Zealand other than as a component of that food; or any other substance, where that substance, or the source from which it is derived, does not have a history of human consumption as a food in Australia or New Zealand

    - "Novel food" is further defined to mean a non-traditional food that requires an assessment of the public health and safety considerations having regard to: the potential for adverse effects in humans; the composition or structure of the food; the process by which the food has been prepared; the source from which it is derived; patterns and levels of consumption of the food[18]

- Canada defines "novel food" to mean:

    - a substance, including a microorganism, that does not have a history of safe use as a food

    - a food that has been manufactured, prepared, preserved or packaged by a process that (i) has not been previously applied to that food; and (ii) causes the food to undergo a major change

    - a food that is derived from a plant, animal or microorganism that has been genetically modified such that (i) the plant, animal or microorganism exhibits characteristics that were not previously observed in that plant, animal or microorganism; (ii) the plant, animal or microorganism no

16 https://www.food.gov.uk/business-guidance/regulated-products/novel-foods-guidance
17 https://food.ec.europa.eu/safety/novel-food_en
18 https://www.foodstandards.gov.au/industry/novel/documents/Guidance%20Tool%20-%20for%20website%20_2_.pdf

> longer exhibits characteristics that were previously observed in that plant, animal or microorganism; or (iii) one or more characteristics of the plant, animal or microorganism no longer fall within the anticipated range for that plant, animal or microorganism[19]

Of these three examples, only Canada orients its GMO legislation around the concept of novel foods. The EU and Australia also require approval for novel foods but regulate GMOs separately. In any legislative changes for gene-edited organisms, the relationship between the regulatory status of 'new' GMOs and the novel foods regulatory status must be made clear.

Countries where gene editing is regulated as GMO

Two countries have decided to regulate gene-edited crops as GMOs:

- South Africa – In October 2021 the government confirmed it will classify genome edited plants as GM crops: "The GMO Act defines a Genetically Modified Act (GMO) as an organism the genes or genetic material of which has been modified in a way that does not occur naturally through mating or natural recombination or both. Based on the definition of a GMO under the GMO Act, the Executive Council has concluded that the risk assessment framework that exists for GMOs, would apply to NBTs"[20]

- New Zealand – In 2014, the New Zealand Environmental Protection Authority ruled that plants produced via gene editing methods, where no foreign DNA remained in the edited plant, would not be regulated as GMOs. However, following a challenge in the High Court, this decision was overturned such that New Zealand regulates all products of gene editing as GMOs[21]

In the European Union, at time of writing, gene editing is also regulated as a GMO. The European situation with regard to regulation is arguably more complex than elsewhere in the world. Because of the structure of the EU, decisions to regulate or not regulate are not straightforward and given that the EU is the UK's largest trading partner and that what happens in one territory directly impacts on what happens in the other it is worth extra scrutiny of the EU process.

What happens in Europe?

In July 2018 the Court of Justice of the European Union (CJEU) ruled that organisms obtained by newer methods of directed mutagenesis such as genome editing are not excluded from the scope of the EU GMO directive. Therefore, at present all gene-edited organisms are regulated in the EU as GMOs.

Discussions are now underway about a new approach to gene-edited organisms, which has led to much speculation that the rules will soon be relaxed. However, there are many

19 https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/guidance-documents/guidelines-safety-assessment-novel-foods-derived-plants-microorganisms/guidelines-safety-assessment-novel-foods-2006.html
20 https://gain.fas.usda.gov/Download.aspx?p=1347&q=51ee2f85-c423-4b66-9bae-2813c7bc3f6c
21 https://www.frontiersin.org/articles/10.3389/fpls.2018.01323/full

complicating factors, such as a complex balance of power between the Commission and various member states, and widespread consumer opposition, which makes this outcome far from certain.

GMO legislation in the EU

In 2001, EU Directive 2001/18[22] came into force, requiring a risk assessment of GMOs that are intended to be released into the environment. The European Commission (EC) along with the European Food Safety Authority (EFSA) and national authorities of EU Member States are all involved in this authorisation process:

- If the application is for food and feed only, EFSA undertakes risk assessments
- If it also covers cultivation, EFSA delegates the environmental risk assessment to an EU country which sends EFSA its Environmental Risk Assessment (ERA) report
- EFSA then submits its opinion to the Commission and to the EU countries
- The Commission proposes to Member States to grant or refuse the authorisation
- If authorisation is granted, the legislation is written by the EC together with Member States Expert Committee

Under a 2015 Directive (2015/412)[23] EU countries are able to restrict or prohibit GMO cultivation on their territory. They can do this in one of two ways:

- During the authorisation procedure by asking to amend the geographical scope of the application to exclude part or all of its territory
- After a GMO has been authorised for cultivation, a country may adopt national opt out measures restricting or prohibiting the cultivation of a GM crop, by invoking grounds such as environmental or agricultural policy objectives, town and country-planning, land use, coexistence, socio-economic impacts, or public policy

The legislation also imposes a post-market monitoring of the environment for each authorised GMO allowing the Commission and Member States to take appropriate measures in case a non-anticipated adverse effect is identified. In order to provide consumers with information and freedom of choice, traceability and labelling obligations are required for any authorised GMO[24].

All EU food and environmental laws are based on some fundamental principles, such as the precautionary principle, the classic definition of which is:

> *"Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (UNEP 1992)[25].*

22 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02001L0018-20210327
23 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32015L0412
24 https://ec.europa.eu/commission/presscorner/detail/en/MEMO_15_4778
25 https://ec.europa.eu/environment/integration/research/newsalert/pdf/precautionary_principle_decision_making_under_uncertainty_FB18_en.pdf

In other words, regulation may be appropriate even if evidence of harm is incomplete, as environmental protection is paramount. The precautionary principle, which was adopted by the EU in 2000[26], has been used in many cases regarding GMOs, such as the 2018 case where the CJEU ruled that gene editing techniques should be regulated as GMOs.

While some believe the Precautionary Principle to be static and a hurdle to innovation it is, in reality, a dynamic guideline, written with a changing world in mind, which mandates that: "*Measures should be periodically reviewed in the light of scientific progress, and amended as necessary*"[27].

EU GMO APPROVALS

Up until 2018, 202 approvals were granted in the European Union (EU): for food (99), feed (100), and cultivation (3 maize events with insect resistance or glufosinate herbicide tolerance)[28].

The food and feed authorisations are essentially to oil the wheels of trade; the EU imports a large amount of GMO crops as animal feed.

However, only two EU countries cultivated 120,990 hectares in 2018, distributed among Spain (95%) and Portugal (5%). In the 21 years from 1998 to 2018, the EU countries cumulatively cultivated 1,736,725 hectares with GM crops - just 0.07% of the 2.5 billion hectares cultivated in total around the globe since 1996[29].

This suggests that despite regulatory approvals, there are many factors making cultivation of genetically engineered crops in Europe difficult including the complex balance of power within the EU and consumer pressure.

Balance of power

To date, not a single GM product has received a qualified majority decision for authorisation among EU states[30]. This is an expression of the differing attitudes among states. Spain and Portugal are the only countries which cultivate GMOs, while several other countries such as Poland, Greece, Latvia and Lithuania have banned them completely[31]. Many other countries, such as France, Germany and Italy have strong public opposition to GMOs, regional opt-outs and a long history of contentious legislation and court battles[32].

For the most part, the EU adopts a unified approach to legislation whereby all countries are bound by EU laws. For GMOs, a hybrid situation exists in which all countries are involved in the assessment of a GMO, but there is a certain amount of freedom for each

26 https://ec.europa.eu/commission/presscorner/detail/en/IP_00_96
27 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52000DC0001&from=EN
28 https://www.isaaa.org/resources/publications/briefs/54/download/isaaa-brief-54-2018.pdf
29 https://www.tandfonline.com/doi/full/10.1080/21645698.2020.1795525
30 https://www.embopress.org/doi/full/10.15252/embr.202154529
31 https://ec.europa.eu/environment/europeangreencapital/countriesruleoutgmos
32 https://www.liebertpub.com/doi/10.1089/blr.2019.29135.rbk

country to make their own decisions. This adds complexity to the already fraught legislative landscape around biotechnology in the EU.

Historically, consumers in the EU have strong opinions about where their food comes from, as indicated by the fact that organic food in European countries accounts for the highest percentage of their overall food markets[33]. Attitudes of the EU public towards GMOs have historically been hostile[34]. and according to ENGA (The European Non-GMO Industry Association)[35].

> *"Non-GMO production has developed into a well-established quality standard in many European countries: at present in Austria, France, Germany, Slovenia, Italy, Hungary, Poland, the Czech Republic, Switzerland and Bosnia-Herzegovina laws or industry agreements are in force that regulate non-GMO labelling on a voluntary basis. In other countries efforts are underway to introduce a non-GMO labelling system."*

What does this all mean for gene editing?

In April 2021 the EC published a report on gene editing and other new breeding techniques, concluding that current legislation may no longer be fit for purpose[36]. Following this, a public consultation was launched on possible legislative changes, which closed at the end of June 2022.

The EC is considering various scenarios, from full deregulation of gene-edited crops (as per the UK), to approvals for exemptions (as per most other countries); from labelling requirements staying as they are, to reducing or scrapping them for gene-edited crops; and including potentially adding sustainability incentives/criteria for approval[37, 38]. Proposals for new regulations are due to be published in Spring 2023.

However, there are multiple factors which will make agreeing on new legislation challenging. In 2021, the French Conseil d'État referred two new questions to the CJEU, the ruling for which is expected in November 2023[39]. The questions involve application of the precautionary principle, so the ruling could have widespread effects. Moreover, the complex balance of power in the EU and consumer pressure means that it is far from certain that gene editing will be deregulated at all.

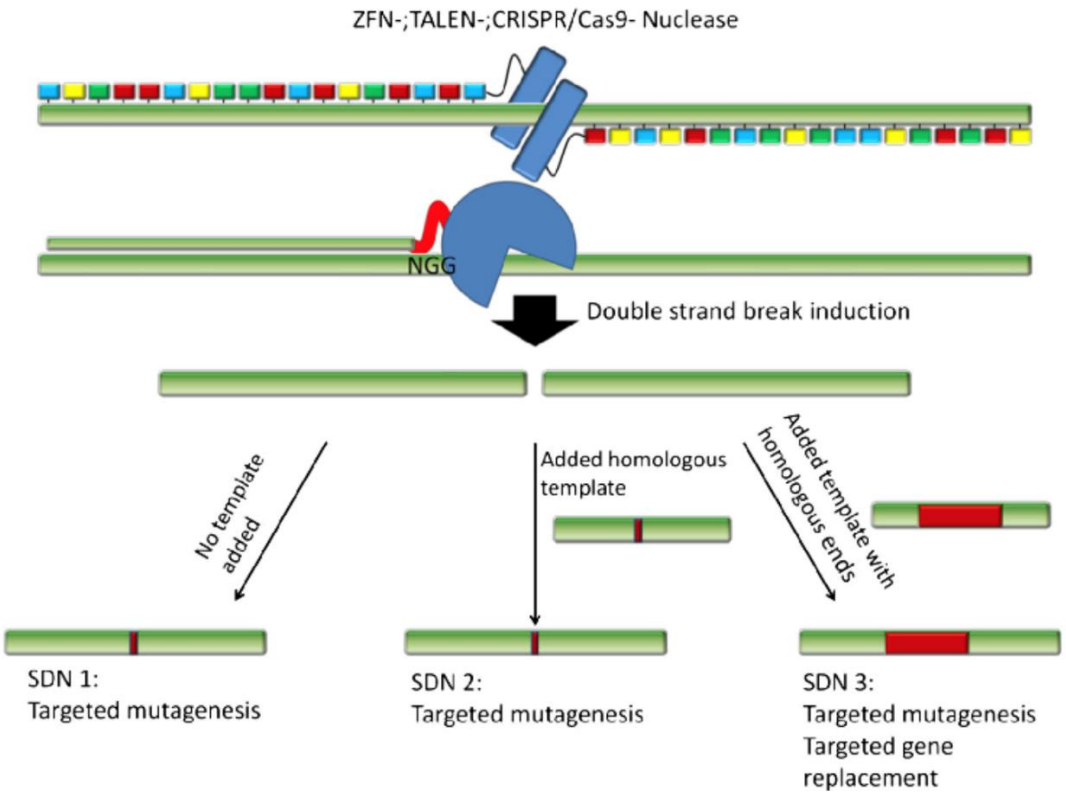
Tiered regulation

Of all the countries which have developed regulation for gene-edited crops, Canada is the only one which does not have some kind of tiered system. Instead, its approach is purely product-based: foods which are considered as novel foods must undergo a risk assessment, regardless of the method used to create them. Foods with transgenes present in the final

33 https://www.fibl.org/en/info-centre/news/exceptional-growth-of-the-european-organic-market-2020
34 https://scielo.conicyt.cl/fbpe/img/ejb/v6n1/a04/bip/
35 https://www.enga.org/non-gmo-production-in-europe
36 https://food.ec.europa.eu/plants/genetically-modified-organisms/new-techniques-biotechnology/ec-study-new-genomic-techniques_en
37 Note: the difficulty in agreeing criteria for what constitutes 'sustainability' is discussed on p28 of this report.
38 https://gmwatch.org/files/Legislation-survey-on-New-Genomic-Techniques.pdf
39 https://viacampesina.org/en/more-than-80-organisations-call-on-the-european-commission-to-wait-for-cjeu-clarifications-on-new-genomic-techniques

product are classed as novel foods. All 15 other countries assessed have some form of tiered legislative system for gene-edited plants.

Technologies like CRISPR do not, in themselves, create new organisms. In most instances, these genome editing tools, which are sometimes described as 'genetic scissors', are used to cut both strands of the DNA helix at a pre-determined location. This cut then activates the cell's DNA repair mechanism. This combination of events allows genetic engineers to introduce a genetic modification at a specific location on the genome.



Overview of SDN techniques and resulting gene editing.

SDNs (site directed nucleases) are the enzymes used in gene editing technology to cut into the genome. The SDN-1, SDN-2, SDN-3 distinction is the most common one used to differentiate between the different kinds of gene editing processes. The graphic above is a visual overview of the difference between the three[40]. In the simplest possible terms:

- **SDN-1** The cut is made and the organism's normal cellular repair mechanisms are left to make the repair;
- **SDN-2** The cut is made and a template is provided to instruct the organism how to repair itself;
- **SDN-3** The cut – and sometimes multiple cuts – are made and both a template for repair and the simultaneous insertion of genes which originated from outside the organism are applied.

40 From https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4903111

Many countries have exempted plants made using one or more of these techniques from their existing GMO legislation. Although not all countries have framed their legislation in this way, for ease of comparison the following table outlines each country's legislative approach:

Country Group	Country	SDN-1	SDN-2	SDN-3
North America	USA	Exempt from GMO legislation	Exempt from GMO legislation	Regulated as GMOs if transgenes are present
Central & South America	Argentina	Exempt	Exempt	Regulated as GMOs if transgenes are present
	Brazil	Exempt	Exempt	Regulated as GMOs if transgenes are present
	Colombia	Exempt	Exempt	Regulated as GMOs if transgenes are present
	Chile	Exempt	Exempt	Regulated as GMOs if transgenes are present
	Honduras	Exempt	Exempt	Regulated as GMOs if transgenes are present
	Paraguay	Exempt	Exempt	Regulated as GMOs if transgenes are present
Africa	Kenya	Exempt	Exempt	Regulated as GMOs if transgenes are present
	Nigeria	Exempt	Exempt	Regulated as GMOs if transgenes are present
	South Africa	Regulated as GMOs	Regulated as GMOs	Regulated as GMOs
M. East	Israel	Exempt	Exempt	Regulated as GMOs if transgenes are present
Oceania	Australia	Exempt	Regulated as GMOs	Regulated as GMOs
	New Zealand	Regulated as GMOs	Regulated as GMOs	Regulated as GMOs
Asia	China	Exempt	Unclear	Regulated as GMOs
	India	Exempt	Exempt	Regulated as GMOs
	Japan	Exempt	Exempt	Regulated as GMOs if transgenes are present
	Philippines	Exempt	Exempt	Regulated as GMOs if transgenes are present

Of the 17 countries in the table above:

- 15 have exempted or are likely to exempt SDN-1 techniques
- 13 have exempted or are likely to exempt SDN-2 techniques (with 1 – China – being unclear)

All 17 countries regulate or are likely to regulate SDN-3 techniques as GMOs when the final product contains transgenes. Of these, 6 regulate all SDN-3 techniques as GMOs, regardless of whether cisgenes or transgenes are used.

For perspective, it is worth noting that of the 13 countries which have the same approach of exempting all transgene-free organisms from GMO legislation, six (46%) are in the Central and South America block which have largely followed Argentina's lead. This only leaves 7 additional countries with that approach out of 195 countries in total. This represents a fraction of the world's countries.

SDN-1 and SDN-2 techniques are often used simultaneously in a single organism[41]. Some countries have clarified their approach to multiple edits, others have not. The USA, for example, has clarified that a gene-edited plant with multiple edits qualifies as exempt if each edit arises from individually exempt events that are combined through conventional breeding. Gene-edited plants with multiple edits that were achieved at the same time or carried out serially in the same organism do not qualify for an exemption[42].

Gene-edited organisms exempt from GMO regulation

An *exemption* can be defined as "*explicitly carving out certain classes of products that are within the scope of the regulation, but have characteristics, or meet certain criteria that do not warrant concern or require regulatory review*"[43]. The approach the majority of countries have taken to new gene editing techniques has been to create exemptions for certain types of organisms from existing GMO regulation.

Here follows an overview of each country's approach to exempting some organisms from GMO legislation.

North America

The **USA** exempts from its GMO legislation:

- Single deletion, substitution or addition (if the addition is from the plant's gene pool) created using CRISPR, TALENS, ZFNs or other genome editing techniques. In effect, this means that most organisms free of transgenes are exempt from GMO legislation

- Also exempt are gene-edited plants which contain a plant-trait-mechanism of action (MOA) combination that is the same as a gene-edited plant already evaluated under USDA regulations and determined not to be regulated. For example, a glyphosate-tolerant corn developed using the same gene as a previous gene-edited corn approved by USDA or with a new gene that carries out the same biochemical process (e.g., a gene producing a different enzyme but that catalyse the same biochemical reaction) would be exempt[44]

41 https://www.testbiotech.org/en/content/overview-genome-editing-applications-using-sdn-1-and-sdn-2-regard-eu-regulatory-issues
42 https://allianceforscience.cornell.edu/blog/2020/10/analysis-problematic-provisions-in-new-usda-rule-for-ge-plants
43 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8376113
44 https://allianceforscience.cornell.edu/blog/2020/10/analysis-problematic-provisions-in-new-usda-rule-for-ge-plants

USDA has since clarified that a gene-edited plant with multiple edits qualifies as exempt if each edit arises from individually exempt events that are combined through conventional breeding. Gene-edited plants with multiple edits that were achieved at the same time or carried out serially in the same organism do not qualify for an exemption[45].

The USA's standard for "could be achieved through conventional breeding" is that:

> *"the genetic modification could practically be expected to be pursued and achieved in a conventional breeding program. For example, evidence that multiple desired traits or genetic modifications can be introduced in a plant in a single step on a practical basis is needed to meet this standard. [They] are unlikely to adopt an exemption for plants containing statistically improbable modifications."*

In **Canada**, products which qualify as "novel foods" must go through a health and environmental risk assessment. It has been confirmed that the following categories will not be classed as novel foods:

- Foods derived from plants with genetic modifications that do not introduce or increase a known allergen or toxin
- Foods derived from plants with genetic modifications that do not have an impact on key nutritional composition and/or metabolism
- Foods derived from plants with genetic modifications that do not intentionally change the food use of the plant
- Foods derived from plants with genetic modifications that do not result in the presence of foreign DNA in the final plant product[46]

Central and South America

Many countries in this region have specific gene editing legislation which excludes certain organisms from GMO legislation. For these countries, the defining criteria for this exclusion is the absence of foreign DNA in the final product. **Chile** defines 'foreign DNA' as a stable insertion of one or more genes or DNA sequences coding proteins, interference RNA, double stranded RNA, signal peptides, or regulatory sequences[47]. **Brazil** further clarifies that as well as the absence of foreign DNA, exempted products can include the presence of genetic elements that could be obtained by crossing, the presence of induced mutations that could also be obtained by established techniques, such as exposure to radiation or chemicals; and the presence of mutations that could occur naturally[48].

In **Argentina**, the process prioritises risk analysis by stating that even if a crop is exempt from GMO regulations, if it possesses characteristics that may present the probability of a noteworthy risk it can be susceptible to further monitoring by the authorities.

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45 *ibid.*
46 https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/guidance-documents/guidelines-safety-assessment-novel-foods-derived-plants-microorganisms/guidelines-safety-assessment-novel-foods-2006.html#a5
47 https://www.alice.cnptia.embrapa.br/bitstream/doc/1132164/1/Regulatory-framework-of-genome-CAP-5.pdf
48 *Ibid*

Africa

Of the three African countries which have a firm legislative position on gene editing, one – **South Africa** – does not exempt any gene-edited organisms from GMO legislation. The other two – **Kenya**[49] and **Nigeria**[50] - have similar approaches to South American countries, focussing on the presence of transgenes in the final product. In other words, where the gene editing or the product thereof does not lead to or does not have a new combination of genetic material (e.g., does not use a recombinant DNA or uses a recombinant DNA that is removed in the final product), a non-GM regulatory classification is applied.

Middle East

In **Israel** following a 2017 decision by the National Committee for Transgenic Plants, genome edited plants resulting from only a deletion of nucleotides, and with no insertion of foreign DNA, are exempt from GMO legislation[51].

Oceania

Following a 2014 court ruling, **New Zealand** regulates all gene-edited organisms as GMOs. In **Australia**, the 2019 amendments expressly excluded from GMO regulations "*organisms modified by repair of single-strand or double-strand breaks of genomic DNA induced by site-directed nuclease, if a nucleic acid template was not added to guide repair*"[52]. In other words, all SDN-2 and SDN-3 techniques are regulated as GMOs in Australia.

Asia

China released its draft legislation in January 2022, containing proposals to regulate gene-edited products as a sub-category of GMOs, with biosafety certificates still required. The guidelines state that they apply only to "*gene-edited plants that do not introduce exogenous genes*"[53].

India's draft legislation (released May 2022) exempts plants created using SDN-1 and SDN-2 techniques, saying that they "*are either indistinguishable from naturally occurring variants or comparable to mutants derivable through conventional mutagenesis*"[54]. The application of all SDN-3 gene editing technology is subject to 1989 GMO regulation.

In **Japan** the Ministry of Environment worked with the definition of Living Modified Organisms (LMOs) given in the Cartagena Protocol. Based on this, they established that products from SDN-1 methods do not satisfy the definition of LMOs. On the other hand, the end products obtained by the SDN-2 and SDN-3 methods contain inserted nucleic

49 https://www.biosafetykenya.go.ke/images/GENOME-EDITING-GUIDELINES-FINAL-VERSION-25th-Feb-2022-03.pdf
50 https://nbma.gov.ng/wp-content/uploads/2022/03/NATIONAL-GENE-EDITING-GUIDELINE.pdf
51 https://www.saaseed.org/sitio/en/getfile/documentos/352
52 https://www.ashurst.com/en/news-and-insights/legal-updates/no-new-genetic-material-no-regulation-no-problems
53 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=MARA%20Issues%20First%20Ever%20Gene-Editing%20Guidelines_Beijing_China%20-%20People%27s%20Republic%20of_01-26-2022.pdf
54 https://dbtindia.gov.in/sites/default/files/Final_%2011052022_Annexure-I%2C%20Genome_Edited_Plants_2022_Hyperlink.pdf

acids processed extracellularly and are categorised as LMOs. Any organism with inserted extracellularly processed nucleic acid (including RNA guide templates) is regarded as an LMO and is subject to the GMO regulations unless the complete removal of the inserted genetic material is confirmed. Therefore, the regulations allow for any exogenous DNA to be removed, for example by backcrossing, which would make it exempt from GMO legislation.

In the **Philippines**, exemptions from GMO legislation are granted to gene-edited organisms which do not contain a "*novel combination of genetic material in the final product*", which is defined as "*a resultant genetic combination in a living organism that is not possible through conventional breeding*"[55].

Self-declaration by product developers

Only three countries: **USA**, **Canada and Australia** have a system where the developer is able to make their own assessment of whether or not their product qualifies for an exemption from the GMO/novel foods legislation.

Canada has launched a Voluntary Transparency Initiative for developers to register gene-edited products which aren't novel foods. The Canadian government website states that "*Developers using biotechnology are strongly encouraged to request an opinion from the CFIA or to contact Health Canada to confirm whether their product is novel*"[56]. This pre-submission consultation includes information on plant traits and genetic modification information and takes around 3 months from first contact by developers to completion[57].

In the **USA** developers can request a confirmation from APHIS that a modified plant qualifies for an. APHIS will provide a written response within 120 days of receiving a detailed confirmation request. APHIS will post both the confirmation requests and the issued confirmation letters on its website[58]. It is recommended that developers begin dialogue with APHIS prior to the formal request.

Australia also does not require notification or consultation for organisms exempt from GMO legislation to be released into the environment and it is the responsibility of developers to ensure that the exclusion applies[59]. However, unlike the USA and Canada, Australia only considers SDN-1 organisms to be exempt from GMO legislation.

Approval processes

Every country aside from the USA, Canada and Australia requires developers to go through an application process to determine whether or not their product is exempt from or covered by GMO legislation on a case-by-case basis. A breakdown of each country's approach follows:

55 https://gain.fas.usda.gov/Download.aspx?p=1718&q=3d01bdfa-a362-4652-bbd2-e4778cf72ed5
56 https://inspection.canada.ca/plant-varieties/plants-with-novel-traits/gene-editing-techniques/eng/1541800629219/1541800629556#a2
57 https://inspection.canada.ca/plant-varieties/plants-with-novel-traits/applicants/pre-submission-consultation/eng/1368394145255/1368394206548
58 https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/permits-notifications-petitions/confirmations/confirmation-process
59 https://www.nature.com/articles/d41586-019-01282-8

Central and South America

Most countries are following the model set by **Argentina** in 2015, meaning all products are assessed on a case-by-case basis to determine whether or not they are exempt from GMO legislation.

The assessments are broadly similar from country to country and generally include:

- Technical information on the breeding methodology used to develop the crop
- The targeted DNA sequences and their functions in the organism prior to and after genome editing
- The sequence of the DNA constructs employed in the gene-edited method
- An analysis of off-target effects
- Analyses of any potential unintended effects on phenotypes or changes in proposed uses of the organism
- Robust evidence of the absence of transgenes in the final product, for example evidence that integration into the plant genome has not occurred or has been removed through backcrossing[60]

Response times vary from 20 days (Chile) to 120 days (Brazil).

Africa

Kenya[61] and Nigeria's[62] application forms include evidence of the purpose for gene editing, details of molecular techniques used, names of vectors used, whether any recombinant DNA was used and, if so, whether it is used temporarily and expression of new or altered trait. Both countries also include a question about whether the product has been authorised for use in another country.

Middle East

In **Israel** the applicant must submit data showing that they meet the determined criteria to ensure that foreign DNA sequences were not incorporated into a plant genome[63].

60 https://publications.iadb.org/publications/english/document/Genome-Editing-in-Latin-America-Regional-Regulatory-Overview.pdf
61 https://www.biosafetykenya.go.ke/images/GENOME-EDITING-GUIDELINES-FINAL-VERSION-25th-Feb-2022-03.pdf
62 https://nbma.gov.ng/wp-content/uploads/2022/03/NATIONAL-GENE-EDITING-GUIDELINE.pdf
63 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Agricultural%20Biotechnology%20Annual_Tel%20Aviv_Israel_10-20-2021.pdf

Asia

In **China**[64], applications fall under four requirement categories based on the risk profile of the target trait: 1) target traits that do not increase risk of environmental and food safety; 2) target traits that may increase environmental safety risk; 3) target traits that may increase food safety risk; 4) target traits that may increase environmental and food safety risk. Within each requirement category separate requirements are provided for product applications for production (cultivation) and applications for import (as materials for processing).

For plants deemed to have no additional environmental or food risk, applicants must provide:

- Information on target genes and gene editing methods
- Data on inbred or hybrid generation of each gene-edited material, and changes of target genes
- Data on vector sequence PCR detection
- Analysis data on off-target effects
- A comprehensive safety evaluation report
- Genetic stability data on gene-edited plants for at least 3 generations, including the stability of target gene editing and the performance of target traits
- Evaluation data on target traits and functional efficiency
- Data or materials that target traits increase neither environmental safety risk nor food safety risk[65]

For those deemed to be a greater risk, additional processes of getting environmental and/or food safety certificates will apply.

For foods imported as raw materials, many of the above criteria will also be needed, along with data from the exporting country or region that these foods have been proved by scientific experiments to be harmless to humans, animals, plants, microorganisms and the ecological environment.

In **India**[66], applicants will have to provide information on:

- The biology of host plants
- Details on programmable nuclease/nickase and template nucleotide sequence

64 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=MARA%20Issues%20First%20Ever%20Gene-Editing%20Guidelines_Beijing_China%20-%20People%27s%20Republic%20of_01-26-2022.pdf
65 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=MARA%20Issues%20First%20Ever%20Gene-Editing%20Guidelines_Beijing_China%20-%20People%27s%20Republic%20of_01-26-2022.pdf
66 https://dbtindia.gov.in/sites/default/files/Final_%2011052022_Annexure-I%2C%20Genome_Edited_Plants_2022_Hyperlink.pdf

- Methods followed for gene editing, molecular characterisation of gene-edited plants (including evidence that the genome edited plant is SDN-1 or SDN-2 only)
- Characterisation of off-target mutations
- Stability of edits over the generations

There will also be an additional step when the intended change is the introduction of novel food/feed traits by altering the composition beyond the existing normal range present in the crop where there is no history of safe use. For such cases, applications will have to be made to the Food Safety and Standards Authority of India (FSSAI) if meant for human consumption or Department of Animal Husbandry, Dairying and Fisheries (DoAHDF) if meant for animal consumption for their approval. No information is yet available about what these additional applications will include.

In **Japan**[67] applications must be made to all three regulatory agencies involved: Ministry of the Environment (MOE), the Ministry of Agriculture, Forestry, and Fisheries (MAFF), and the Ministry of Health, Labor and Welfare (MHLW).

Developers are requested to initially submit information for a "pre-consultation" for MAFF and MHLW to determine if a product is a GMO. MHLW applications include:

- Crop, variety, use of product and purpose of use
- Method of genome editing and description of the modification
- Absence of foreign DNA
- Confirmation that the change does not produce new allergens or increase known toxins
- Change of nutrients relating to the target metabolic pathway
- Year and month of launch

The applications to MOE and MAFF are similar but also include information on potential impact on biodiversity.

In the **Philippines**[68] developers must submit a Prior Evaluation Form (PEF) to the Bureau of Plant Industry (BPI) for them to decide whether or not the organism is exempt from GMO legislation. The form includes information such as:

- Type of organism and species used
- Breeding technique used
- Novel characteristic(s) introduced and evidence of the desired genetic changes
- Proof of total absence of foreign DNA in the final product

67 https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Japanese%20Health%20Ministry%20Finalizes%20Genome%20Edited%20Food%20Policy_Tokyo_Japan_4-12-2019.pdf
68 https://gain.fas.usda.gov/Download.aspx?p=1718&q=3d01bdfa-a362-4652-bbd2-e4778cf72ed5

The submission is then posted on the BPI website for the public to submit technical information on the product, before an official meeting to review evidence and decide whether or not the product should be exempt from GMO legislation. If it is decided that the product is exempt, the developer receives a 'Certificate of Non-Coverage from the JDCI, s2021', which is also made public.

Animals

Regulations on genetically engineered animals are more controversial than those for plants, and there is even less harmony amongst the 15 countries globally which are loosening regulations on gene-edited plants.

Just six countries' exemptions for some gene-edited organisms from GMO legislation covers animals. In three of these – Argentina, Brazil and Japan – at least one breed of gene-edited animal has been approved for commercialisation, but only in Japan have they entered the market.

In Argentina and Brazil, these exemptions have been granted to breeds of cattle which have been developed largely by US-based company Recombinetics, which likely sought approval in South America to overcome the stricter legislation in the USA. In Japan, two types of fish have been approved for sale. In the other three countries whose gene editing exemption policies cover animals, no animals have been approved for commercial production.

In three countries – USA, Canada and China – the gene-edited policies explicitly exclude animals, which are still regulated as GMOs.

In the other seven countries in this review – Colombia, Chile, Honduras, Paraguay, Israel, India and Philippines – no regulation is in place to approve either GMO or gene-edited animals, reflecting the unwillingness of these countries to pursue this activity.

It is notable that only one country in the world allows developers to decide that gene-edited animals are exempt from GMO legislation without state input: Australia (which only exempts SDN-1 techniques from GMO legislation and regulates all SDN-2 and SDN-3 techniques as GMOs). The other two countries which don't require a formal application process to exempt gene-edited crops from GM legislation – USA and Canada – still regulate most animals as GMOs.

Countries where gene-edited exemptions apply to animals as well as plants

1) Argentina – Argentina has procedures in place for requesting the commercial approval of GM animals, as well as for excluding gene-edited animals from the regulation. In 2020, Argentine regulators ruled that three breeds of gene-edited cattle would not be considered GMO

2) Brazil – On October 4, 2018, CTNBio determined that the genome-edited hornless cow would be a conventional animal

3) Kenya – research projects for gene-edited pigs and cattle are underway but none have been approved yet

4) Nigeria – no evidence of gene editing research projects underway

5) Australia – Covered by gene editing regulation. No GM or gene-edited animals currently approved for field or commercial production

6) Japan – Animals covered by gene editing legislation. So far, two gene-edited fish – a red sea bream and a tiger puffer – have made it to market. All of Japan's interest in gene-edited animals so far has focussed on fish – there are no trials of meat animals underway

Countries where gene-editing exemptions do not apply to animals

7) Canada – Novel foods guidance which exempts some gene-edited plants from novel food regulation does not apply to animals. To date, Canada has approved only one animal product of biotechnology, a GM Salmon

8) USA – In a 2017 draft guidance, the FDA proposed that all intentional genome alterations in animals will be regulated as a veterinary drug. This means the presence of any "*intentionally altered DNA*" in an animal's genome triggers regulation. From 2018-2020 the FDA reviewed its position, and in 2020, the FDA released a statement to defend its 2017 decision to require that every animal created by gene editing should be subject to mandatory premarket review and substantial safety testing

9) China – No GMO animal has ever made it to market

No regulation in place to approve GMO or gene-edited animals

10) Colombia
11) Chile
12) Honduras
13) Paraguay
14) Israel
15) India
16) Philippines

Sustainability, ethical and social considerations

Some countries have taken a wider view of important factors to consider in their GMO legislation, beyond human and environmental health.

In Norway, the Gene Technology Act[69] emphasises the importance of sustainability, benefit to society and ethics. It states that the deliberate release of GMOs should represent a "*benefit to the community*" and enable "*sustainable development*". The Norwegian Biotechnology Advisory Board carries out the assessments, which include questions such as:

69 https://www.regjeringen.no/en/dokumenter/gene-technology-act/id173031/

Sustainability

- Is biodiversity affected on a global scale?
- Is the fulfilment of basic human needs like food, shelter and health affected?
- Are emissions of greenhouse gases affected?
- Is the distribution of benefits or burdens between generations affected?
- Is the distribution of benefits or burdens between rich and poor countries affected?

Benefit to Society

- Is there a need for the product in terms of demand or otherwise?
- Will the product solve or possibly contribute to solving a societal problem?
- Is the product significantly better than equivalent products already on the market?
- Does the product create problems for existing production which should be preserved?[70]

These considerations carry equal weight to those of 'scientific' risk assessment and products which are otherwise 'safe' can and have been rejected on the basis that they do not meet sustainability of social utility criteria[71].

As more countries turn their focus to final products, rather than processes, it could be argued that developing clear criteria for social utility becomes even more important as guidance and an assessment tool for newly created plants and animals.

The EU is also considering a sustainability criterion, according to its gene editing consultation. Likely criteria[72] for whether a genetically engineered organism could be considered sustainable are if it results in:

1) Reduction in use of plant protection products
2) Reduction in use of fertilisers
3) Reduction in use of natural resources
4) Tolerance/resistance to environmental conditions (abiotic stresses), including climate change effects
5) Tolerance/resistance to plant diseases (biotic stresses), e.g., due to nematodes, fungi, bacteria, viruses or pests

70 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7550366/
71 https://bch.cbd.int/database/attachment/?id=19306
72 Policy scenarios included in the Targeted Survey for the Impact Assessment of New Legislation on New Genomic Techniques, conducted by Technopolis on behalf of the European Commission, p32, https://gmwatch.org/files/Legislation-survey-on-New-Genomic-Techniques.pdf

6) Better composition or healthier nutrient profile, e.g., on fats, proteins, vitamins, fibres, sugar content, lower content of toxic substances or allergens

7) Better agronomic characteristics, e.g., increased or more stable yields, more or larger seeds or fruits, improved flowering time, improved breeding characteristics

8) Reduced food waste through better harvest, post-harvest, transport or storage performance

9) (Re-)Introduction of niche/orphan plants that are important from a local ecological or agri-food perspective

CULTURAL CONSIDERATIONS

In Honduras GM plant cultivation is restricted in three of the 18 departments, Intibucá, Lempira and Gracias a Dios, as well as in the municipality of Pespire, Choluteca. GM planting is also restricted in areas near native corn stocks and in regions higher than 1,000 metres above sea level, as requested by those communities[73].

Indigenous groups are also affecting the regulatory status of GMOs in Guatemala. One year after regulation came into force that allowed the submission of applications to plant biotech crops in 2019, indigenous groups won a provisional appeal against the law on the grounds that they were not consulted. Article 12.2 of the regulations spells out that a prior consultation process with indigenous groups and consent is required before submitting a petition for planting GM crops in officially recognized indigenous territories and recognizes centres of origin and genetic diversity of wild relatives, where GM crops will not be authorised for planting. No ruling has yet been made[74].

In Mexico, which is still considering its stance on gene editing, the planting of transgenic corn is suspended due to concerns about the risk to the country's culturally significant native corn varieties. A presidential decree published December 31, 2020, bans the use of glyphosate, the official name of a Bayer-produced herbicide, along with imports of GMO corn from January 2024. This is potentially significant as Mexico is the largest importer of GMO corn from the USA. There is some ambiguity in the ruling as to exactly what will be covered (e.g., animal feed) and court challenges may mean the ruling changes before the scheduled implementation date[75].

It is worth noting here that there is no agreed definition on what constitutes 'sustainable'. For example, the negative impact on biodiversity of high-yielding monocultures is well

73 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Agricultural%20Biotechnology%20Annual_Tegucigalpa_Honduras_10-20-2020
74 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Agricultural%20Biotechnology%20Annual_Guatemala%20City_Guatemala_10-20-2020
75 https://www.iatp.org/blog/202102/mexico-ban-glyphosate-gm-corn

documented, including by the European Commission[76]. However, the proposed EU sustainability criteria makes no reference to biodiversity, and instead appears to focus on higher yields as a good measure of sustainability.

It appears that no country apart from Norway and the EU have attempted to bring a sustainability criterion into their GMO/gene editing legislation, although the media rhetoric that such technologies can help build a more resilient farming system by introducing certain traits (e.g., drought resistance) is widespread. This can be seen as indicative of the complexity and lack of agreement on what constitutes 'sustainability', which would make the development of a global sustainability criteria extremely challenging.

Traceability and labelling

Traceability allows tracking of genetically engineered organisms through the supply chain. Labelling allows consumers to be able to understand what they are buying. The issues surrounding traceability and labelling of genetically engineered crops has always been contentious, with no global agreement on the best approach.

Of the 16 countries with legislation regulating gene-edited crops separately from other GMOs, it seems that only one – Nigeria – is mandating the labelling of the gene-edited foods which are exempt from GMO legislation.

With regards to traceability, many countries have not addressed the issue in their legislation. The EU consultation which in the second quarter of 2022 included a question on traceability, acknowledging that analytical methods may not always be available or reliable.

Respondents were, therefore, asked whether effective traceability of plants obtained by targeted mutagenesis or cisgenesis, and of their food and feed products, could be ensured via: documentation transmitted through the chain of operators, public databases/registries, digital solutions, e.g., block chain, or other means.

The UK's draft legislation includes a proposal for a public register of all notifications of gene-edited organisms received by the Secretary of State.

It is unclear how many other countries are planning to make their data about approved gene-edited products available to the public, but it appears that the UK is in a minority. Public access to information is crucial for the process of traceability of gene-edited products and accountability of developers and regulatory bodies so the register is an opportunity to demonstrate good practice.

However, it is important that information about all gene-edited events (i.e., SDN-1, 2 and 3) are recorded on the register to ensure full traceability of genetically engineered organisms throughout the supply chain.

76 https://ec.europa.eu/research-and-innovation/en/horizon-magazine/rise-and-fall-monoculture-farming

Analysis

The narrative surrounding the current push for deregulation of gene-edited crops in the UK and EU is that many other countries around the world are doing the same. This analysis has shown that in fact only a small handful of countries have drawn up legislation regulating gene-edited crops separately from GMOs. Specifically, only 16 of the world's 195 countries (8%) have relaxed their rules for organisms produced using these newer genetic engineering technologies and leading these are the countries with the biggest biotech sectors.

There is no universal approach or agreement on the regulation of agricultural gene editing and there are significant divisions and inconsistencies.

According to data from ISAAA, five countries – USA, Brazil, Argentina, Canada and India – produce 91% of the world's biotech crops[77]. These countries are also some of the biggest commodity exporters in the world:

- The USA, Brazil and Argentina are the top 3 exporting countries for maize[78], almost all of which is genetically engineered[79]
- Canada is the biggest exporter of rapeseed oil[80]; approximately 95% of that crop area is genetically engineered[81]
- India, Brazil and the USA are the top three cotton exporting countries. It is estimated that around 90% of cotton grown in all 3 countries is genetically engineered[82]

It is unsurprising, therefore, that these countries are leading the push to relax regulation.

Six of the 16 countries with more relaxed regulation are based in Central and South America, and they have all followed Argentina's approach. They are effectively operating as one block (with notable exceptions in Ecuador, Peru and Mexico who have more restrictive GMO legislation and are unlikely to approve gene-edited crops any time soon). Outside of the Americas only eight countries have relaxed their rules for gene-edited crops, with a ninth – England – likely to follow soon. This would put England in a small minority of countries globally regulating gene-edited crops differently to GMOs.

Two countries – New Zealand and South Africa – have had their courts decide that gene editing is genetic modification and therefore should be regulated as such. The EU has also taken this approach, although consultation is underway which may lead to a change.

The dominant approach to gene-edited crops among the 16 that have relaxed regulations is to create exemptions for certain organisms from existing GMO legislation.

77 https://www.isaaa.org/blog/entry/default.asp?BlogDate=5/19/2021
78 https://www.fao.org/3/cb9928en/cb9928en.pdf
79 https://www.centerforfoodsafety.org/issues/311/ge-foods/about-ge-foods#:~:text=Currently%2C%20up%20to%2092%25%20of,often%20used%20in%20food%20products).
80 https://www.tridge.com/intelligences/canola-seed-rapeseed/export
81 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Agricultural%20Biotechnology%20Annual_Ottawa_Canada_10-20-2020
82 See https://source.wustl.edu/2020/03/long-term-analysis-shows-gm-cotton-no-match-for-insects-in-india, and https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption, and https://news.agropages.com/News/NewsDetail---21832.htm

Within this framework, countries have taken a variety of approaches:

- All 16 have exempted organisms created using SDN-1 techniques, which involves cutting the genome and allowing the cell's own mechanism to repair the break, unaided. Only the simplest modifications are able to be made using these approaches

- 14 of the 16 have exempted organisms created using SDN-2 techniques, which involves cutting the genome, inserting a template from another organism to guide the repair in the way developers want, and then breeding the foreign DNA out of the final product. Australia, however, has determined that organisms created using this technique should be classed as GMOs, and China's approach is unclear at this stage

- No country is exempting all organisms created using SDN-3 techniques from GMO legislation. In SDN-3, the cut is made and both a template for repair and the simultaneous insertion of genes which originated from outside the organism are applied. However, 12 of the 16 countries focus on the presence of transgenes in the final product, meaning it is, in theory, possible that some organisms created using this technique could be exempt from GMO legislation if the inserted gene is from the same or a sexually compatible species (cisgenes). The remaining four countries are regulating all organisms created using SDN-3 techniques as GMOs

This underscores there is no agreement about the scope of exemptions of gene-edited crops from GMO legislations. Of the countries outside of the Americas, only 5 (Nigeria, Kenya, Israel, Japan and Philippines) focus on the presence of transgenes in the final product as the basis on which GMO regulation would be triggered. Australia, China and India have concluded that all organisms created using SDN-3 techniques, which involves the insertion of genes from outside of the organism, should be regulated as GMOs regardless of where the genes originated.

This nuance could be extremely important for export countries – for example, China is one of the biggest importers of produce from Central and South America, but their stricter regulation on SDN-3 crops may be a barrier to their commercialisation in export countries too.

This question of the scope of gene editing legislation across the world is complex but important. As much of this legislation is new and translations of crucial terms such as transgenes, exogenous DNA etc may not be completely accurate, it will be interesting to watch how different countries respond to requests from developers to exempt specific products from GMO legislation over the coming years. Only then will we come close to a full understanding of the extent of exemptions for organisms created using new gene editing technologies and the variation from country to country.

There is also no agreement about the process by which exemptions are granted for gene-edited organisms in the various countries with gene editing legislation. There is, however, a general trend towards an application process to the relevant regulatory body. Only 3 countries – USA, Canada and Australia – allow the developers to decide for themselves whether their product is exempt from regulation.

All 13 of the other countries require them to submit detailed information on, for example, the nature of the product, the methods used and proof that there are no transgenes present in the final product. This report has detailed the types of information required by each country, which for the most part is set out in their primary legislation.

Once again, the case of China is important here as a major trading partner of many other countries. China's legislation sets out requirements for a biosafety certificate for gene-edited crops exempt from GMO legislation. Information required from developers for this certificate is extensive, both for organisms intended to be bred in China and for imported organisms. As well as having impacts for trade, this will likely mean that developers would have to keep such information to have access to this (and other similar) market(s), so the benefits to the industry of more relaxed regulation in the UK are much reduced.

In the proposed UK legislation, the new sub-category of GMO, the so called "precision bred organism" is defined[83] as one in which:

a) *any feature of its genome results from the application of modern biotechnology,*
b) *every feature of its genome that results from the application of modern biotechnology is stable, and*
c) *every feature of its genome could have resulted from*
    i. *traditional processes, whether or not in conjunction with selection techniques, or*
    ii. *natural transformation.*

This definition does not provide clarity on the criteria which will be used to decide which organisms will and will not fall under this definition. It is likely that secondary legislation and/or guidance from ACRE will provide this clarity. This, in itself, puts the UK in a minority, as nearly all other country's regulations make clear which processes and organisms are exempt from GMO legislation (e.g., presence of transgenes in the final product).

Moreover, nearly every other country (except Canada, which focusses on end product/ novel foods) has created categories of exemption for gene-edited products from GMO legislation. The UK's proposal to create a whole new category of organism is highly unusual. Research conducted for this report has not found the term 'precision bred organism' in regulations anywhere else.

Nor does it exist as a discrete category in the 2022 International Organization for Standardization (ISO) Genome Editing Vocabulary[84], which provides an internationally agreed-upon list of terms to "*improve confidence in and clarity of scientific communication, data reporting and data interpretation in the genome editing field*".

The UK's proposed approach of allowing developers to decide for themselves whether their product should be regulated as GMOs, but requiring notification, also appears unique. However, it will put the country closer to the USA/Canada model of deregulation than the majority of countries' approaches to application processes for exemptions.

An application process allows regulators to retain some control, which will help ensure that the risks for these new organisms are monitored and, in the long term, understood.

83 https://publications.parliament.uk/pa/bills/cbill/58-03/0011/220011.pdf
84 https://www.iso.org/obp/ui/#iso:std:iso:5058:-1:ed-1:v1:en

Argentina, which is often held up as an example of a very permissive regulatory system, prioritises risk analysis in this way by stating that if a gene-edited crop presents the possibility of a noteworthy risk, it can be further monitored by the authorities. There are risks inherent in allowing the release of new organisms into the environment and/or food system. Unlike other countries, the proposed UK legislation neither acknowledges nor safeguards against this.

When it comes to animals, there is an even more cautious approach worldwide. Just six countries' exemptions for some gene-edited organisms from GMO legislation covers animals. In three of these – Argentina, Brazil and Japan – at least one breed of gene-edited animal has been approved for commercialisation, but only in Japan has the animal (two varieties of fish) entered the market. In the other 9 countries with legislation relaxing rules about gene-edited crops, animals are still regulated as GMOs. This demonstrates the substantial ethical concerns reflected in public attitudes to genetically modifying animals all over the world.

No country with gene editing legislation currently in place has a social, ethical or cultural component to their approval process. Norway and the EU are considering a sustainability criterion, but since there is no global agreement as to what constitutes a sustainable food and farming system this is complicated. The consideration of some Central and South American countries of their indigenous populations' objections to genetically engineered food may provide a template for other countries to consider the cultural significance of native food in their legislation.

It appears that no country except Nigeria is mandating labelling of gene-edited food. Since most countries have an approval process for obtaining exemption from GMO legislation, they will have the information about gene-edited products on the market, which will help traceability. It is unclear, however, how many of these registers will be public. Public registers are crucial to ensuring traceability and accountability of genetically engineered products in the environment and on the market.

It is currently unclear how international agreements or organisations such as the Cartagena protocol will consider gene-edited products. It is unlikely that organisms created using SDN-2 techniques – i.e., inserting foreign DNA as a guide template for repair then breeding it out so the final product is free of transgenes – are compatible with the Cartagena protocol's definition of a Living Modified Organism. The protocol has not yet taken a stance, so it seems that currently every country is making their own interpretation of the definition.

There are currently at least 10 more countries or country groups considering their approach to gene editing, including the EU and the large rice-exporting countries of Thailand and Vietnam. It is far from certain that these countries will follow the lead of the large biotech export countries of the Americas. It is at least as likely that the more cautious approaches of India, China or Australia will be preferred, especially by countries that are geographically and/or culturally closer to these nations.

As the conversation develops, interventions by international bodies/agreements such as the Cartagena protocol could have a significant impact on the direction of travel.

APPENDIX 1

Country-by-country comparison

Country	Date Cartagena protocol came into force	GE regulation	Outline of approach to GE	Product or process-based	Authorisation process?
EU [under discussion]	2003	Currently regulated as GMOs following a court decision in 2018.	Currently consulting on whether certain organisms should be exempt from GMO regulations.	Likely to be process-based	Not yet decided
Norway [under discussion]	2003	Currently regulated as GMOs.	Currently considering proposals for a more relaxed, tiered system. White paper expected in 2022.	Not yet clear	Not yet decided
Switzerland [under discussion]	2003	Currently covered by the moratorium on GMOs.	Government to propose details for relaxation of rules to permit some types of GE by 2024.	Not yet clear	Not yet decided
Canada	Signed in 2001, not yet ratified	On May 18, 2022, Health Canada published the new guidance indicating that gene-edited crops that meet the categories set for food that is not considered novel food can be treated like conventional crops	Assess products on a case-by-case basis. If food produced by GE doesn't meet the criteria for novel foods, they do not have to be registered or undergo safety checks. Any final product with the presence of foreign DNA automatically has to go through the novel foods authorisation process.	Product-based	If they meet the criteria for novel foods, they undergo a health and environmental risk assessment. If not, no notification or authorisation needed. Voluntary Transparency Initiative launched for developers to register GE products which aren't novel foods.
USA	Did not sign	Statement from United States Agriculture Minister March 2018 and new SECURE Rules (2020)	The new guidelines exempt a single deletion, substitution or addition (if the addition is from the plant's gene pool) created using CRISPR, TALENS, ZFNs or	Process-based trigger, product-based assessment	If a product is exempt, no authorisation process is required, but developers may request confirmation that their products are exempted (answer within

			other genome editing techniques. Also exempted are new GM plants which are the same plant (e.g., soybean) with the same trait (e.g., herbicide tolerance) achieved with the same mechanism of action as a GM plant already reviewed by USDA and found not to be a plant pest.		120 days). If the product is not exempt, there is a simpler case-by-case process to determine that the product does not post a pest risk.
Argentina	Signed in 2000, not yet ratified	Resolution No. 173/15 (2015)	CONABIA considers gene-edited crops on a case-by-case basis to determine whether they are considered GMOs. The analysis considers a) the techniques used in the process; b) if there was a permanent genetic change; and c) the absence of a transgene in the end product. Moreover, the process prioritises risk analysis by stating that even if a crop is exempt from GMO regulations, if it possesses characteristics that may present the probability of a noteworthy risk it can be susceptible to further monitoring by the authorities.	Process-based trigger, product-based assessment	All products are assessed. Applicants must provide information on the breeding methodology used to develop the crop, information about the new trait, and the genetic changes in the final product at this stage. If a transgenic gene construct is used transiently, scientific information must be provided to ensure that integration in the plant genome has not occurred or has been removed through backcrossing or outbreeding. They will receive a response within 60 days.
Brazil	2004	Normative Resolution No. 16 (2018)	The government assesses the risk level of each newly developed plant or food, whether new genetic material was introduced and whether the product has already been approved for commercialization in other countries.	Process-based trigger, product-based assessment	Applicants must provide information on include the molecular map of the constructs used, the genes manipulated and their function, the purpose or use of the end product, molecular data of parental and progeny showing the absence of rDNA in the progeny, product approvals in other countries, and evidence of

					unintentional effects (off-target mutations) in the end product. CNTBio has 90 to 120 days to make a non-GMO determination.
Colombia	2003	Resolution No. 00029299 (2019)	The government does a case-by-case assessment of gene-edited products to determine whether they meet the definition of Living Modified Organisms. The assessment focuses on whether the final product contains foreign DNA sequences.	Process-based trigger, product-based assessment	Applicants must provide the taxonomic classification of the species, breeding methodology, genetic maps of the genetic constructs used in the breeding process, including the protein and RNA sequences used, a description of the phenotype and its uses, the molecular characterization of the genetic changes in the end product compared to the original, and finally, prove the absence of foreign genetic material. Application response within 60 days.
Chile	Signed in 2000, not yet ratified	Introduction of methodological procedure (2017)	2017 regulation stating that crops developed using genome editing techniques that do not contain a new combination of genetic material are not subject to GMO regulations. For these purposes, a new combination of genetic material means a stable insertion of one or more genes or DNA sequences coding proteins, interference RNA, double stranded RNA, signal peptides, or regulatory sequences.	Process-based trigger, product-based assessment	The SAG department assesses applications on a product-by-product basis within 20 days of receiving them. Applicants must provide technical information including the name of the species, the variety/lineage, the description of the phenotype obtained, the company or institution that developed the material, the methodology, and the characteristics of the biotechnological technique used with the indication of the modified DNA sequences. Also, the applicant must inform whether the material has precedent for authorization in another country and if

					so, the official documentation must be presented.
Honduras	2009	Agreement SENASA 008-2019 (2019)	Gene-edited crops are exempt from GMO legislation. The definition of gene-edited crops hinges on the organism being " equivalent or indistinguishable to that which can be developed using traditional techniques of genetic improvement.”	Process-based trigger, product-based assessment	The review process requires SENASA to make a determination of the GMO status of gene-edited crops within 45 days of the application being submitted.
Paraguay	2004	Resolution No. 565 (2019)	Proposals are to exclude gene-edited crops from legislation so long as they no longer contain transgenes.	Process-based trigger, product-based assessment	Applications must include detailed documentation on potential off-target effects, and proper validation of the absence of foreign DNA. For GED crops and determination of their non-GMO regulatory status, applicants must provide information on the biology of the modified organism, the breeding methodology used, the targeted DNA sequences and their functions in the organism prior to and after genome editing, the sequence of the DNA constructs employed in NPBTs, an analysis of off-target effects, evidence of no rDNA in the final product, analyses of any potential unintended effects on phenotypes or changes in proposed uses of the organism, and any recommended changes in managing the organism.
Kenya	2003	Guidelines for determining the regulatory process of genome	Genome editing and derived products that will not be regulated under the	Process-based trigger,	The National Biosafety Agency will assess applications on a case-by-case

		edited organisms and products in Kenya (2022)	Biosafety Act include; modifications made by inserting genes from sexually compatible species, deletions/knockouts without foreign genetic material in the end-product, and processed products whose inserted foreign genetic material cannot be detected.	product-based assessment	basis and should reply within 30 days. Application form includes purpose for gene editing, details of molecular techniques used, names of vectors used, proof of removal of foreign DNA and whether the product has been exempted from GMO legislation anywhere else in the world.
Nigeria	2003	National Gene Editing Guidelines (2020)	Where the gene editing or the product thereof does not lead to or does not have a new combination of genetic material (e.g., does not use a recombinant DNA or uses a recombinant DNA that is removed in the final product), a non-GM regulatory classification is applied.	Process-based trigger, product-based assessment	Application form includes information on gene editing activities, whether any recombinant DNA was used and, if so, whether it is used temporarily, expression of new or altered trait, product intended uses, history of safe use of source DNA, and whether any other country has authorised it.
South Africa	2003	Genetically Modified Organism Act 15 (1997), clarified in a 2021 court case	In October 2021 the government confirmed it will classify genome edited plants as GM crops. "The GMO Act defines a Genetically Modified Act as an organism the genes or genetic material of which has been modified in a way that does not occur naturally through mating or natural recombination or both. Based on the definition of a GMO under the GMO Act, the Executive Council has concluded that the risk assessment framework that exists for GMOs, would apply to NBTs."	Process-based	Process for GMO clearance includes public participation and an advisory committee and takes between 30 days (for import/export of GMOs with pre-existing general release clearance) and 270 days (for general release of GMOs).
Israel	Not a signatory	Decision of the National Committee for Transgenic plants	Genome-edited plants resulting from only a deletion of nucleotides, and with	Process-based trigger,	In order to be exempt from the GM Seed Regulation, applicants must show

		(2017) & further clarifications (2021)	no insertion of foreign DNA are not considered to be transgenic and will not be subjected to the GM Seed Regulation.	product-based assessment	that there is no presence of any transgenes that may have been used in the genome editing process.
Australia	Not a signatory	Gene Technology Amendment (Measures No. 1) to regulations (2019)	The amendments expressly excluded from GMO regulations "organisms modified by repair of single-strand or double-strand breaks of genomic DNA induced by site-directed nuclease, if a nucleic acid template was not added to guide repair"	Process-based	The Office of the Gene Technology Regulator (OGTR) does not require notification or consultation for such organisms to be released into the environment and it is the responsibility of proponents to ensure that the exclusion applies.
China	2005	Guidelines for Safety Evaluation of Gene-Edited Plants for Agricultural Use (Trial) (2022)	Guidelines say that crops in which GE technology is used to remove genes or make single-nucleotide changes would fall under GE rather than GM approval processes. Presence of exogenous genes will still be regulated as GM. For crops regulated as GE, the process depends on their food or environmental risk factor – for low risk, the applicant can apply for a biosafety certificate. If the risk is higher, environmental testing will be needed.	Mainly process-based, though presence of exogenous DNA in the final product is a factor	The application process will likely include target gene-related data, data relating to gene editing methods, off-target effects, genetic stability and a "comprehensive" environmental and food safety evaluation report. It is expected to take at least 1-2 years. Some aspects of the process (e.g., how to assess the risk factor of the crop) remain unclear.
India	2003	Guidelines for the Safety Assessment of Genome Edited Plants (2022)	Exempts the genome-edited plants falling under the categories of SDN1 and SDN2, which are free of exogenous introduced DNA, from GMO legislation. These products are subject to case-by-case risk assessment and oversight by IBSCs, RCGM, and GEAC.	Mainly process-based, though presence of exogenous DNA in the final product is a factor	Assessed on a case-by-case basis. Applications include biology of host plants, details on programmable nuclease/nickase and template nucleotide sequence, methods followed for gene editing, molecular characterisation of gene-edited plants, characterisation of off-target mutations, stability of edits over the generations. No information on how

					long the application process is expected to take.
Indonesia [under discussion]	2005	In January 2020, biotech stakeholders produced a draft regulation for innovative biotechnologies.	According to the draft regulation, products created from innovative biotechnologies will follow the regulatory framework of GE products if there is a new genetic material combination or the final product contains a transgene.	Process-based trigger, product-based assessment	Unclear as yet
Japan	2004	Handling Procedures MHLW: Food Hygiene Handling Procedures for Food and Additives Derived from Genome Editing (2019); Notification by MOE: Handling of organisms obtained through the use of genome editing technology that do not fall under "genetically modified organisms" as defined in the Cartagena Act (2019)	Using the definitions in the Cartagena Act, the Ministry of Environment has determined that Living Modified Organisms (LMOs) are not subject to regulation if 1) they do not contain DNA or RNA that was processed outside the cell or if 2) the introduced DNA or RNA is no longer present in the final organisms—such organisms are known as null segregants. In contrast, LMOs harbouring introduced extracellularly processed nucleic acids are regulated.	Process-based trigger, product-based assessment	Three regulatory agencies involved: Ministry of the Environment (MOE), the Ministry of Agriculture, Forestry, and Fisheries (MAFF), and the Ministry of Health, Labor and Welfare (MHLW). Developers are requested to initially submit information for a "Pre-consultation" for MAFF and MHLW to determine if a product is an LMO. MHLW applications include: 1) crop, variety, use of product and purpose of use; 2) method of genome editing and description of the modification; 3) absence of foreign DNA; 4) confirmation that the change does not produce new allergens or increase known toxins; 5) change of nutrients relating to the target metabolic pathway; 5) year and month of launch. Information required for MOE, but also includes information on potential impact on biodiversity.

New Zealand	2005	Hazardous Substances and New Organisms (HSNO) Act (1998) after court decision NZHC 1067 (2014)	In 2014, the NZ Environmental Protection Authority ruled that plants produced via gene editing methods, where no foreign DNA remained in the edited plant, would not be regulated as GMOs. However, following a challenge in the High Court, this decision was overturned such that NZ regulates all products of gene editing as GMOs.	Process-based	N/A
Philippines	2007	Memorandum Circular No. 8, Series of 2022 (MC8)	Gene-edited products without the presence of a novel combination of genetic material will be considered a conventional product.	Process and product-based	The developer must submit a request to the Director of the Bureau of Plant Industry for Technical Consultation for Evaluation and Determination for the product to be evaluated as genetically engineered or conventional. If the product is declared as non-GE, a Certificate of Non-Coverage from the JDC1, s2021 will be released to the developer and to the public
South Korea [under discussion]	2008	Proposal announced in May 2021	In the proposal announced in May 2021 Korea classifies products of innovative biotechnologies as LMOs. Exemptions may be granted under the following conditions: 1) there is no introduction of a foreign DNA, 2) there is no foreign DNA present in the finished product, or 3) the finished product may be developed through conventional breeding technologies or natural mutation.	Process and product-based	There will be a pre-review system that will consider risk assessment exemptions, but the details are not yet clear.

Thailand [under discussion]	2006	Draft Biodiversity Act (2020)	The draft legislation is unclear as to whether some gene-edited products will be exempt from GMO legislation but does lay out tiered risk assessment processes for SDN-1, 2 and 3 products, including off-target analysis for all tiers, and a food safety assessment for all products developed using SDN2&3 methods.	Process-based	Unclear/undecided