New Genomic Techniques: what are they and how can they improve our food systems?

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The EU Commission has released their draft proposal for a reformed regulation on New Genomic Techniques (NGTs).[1] This article explains what is meant by NGTs and how they are (or can be) used to make agricultural production more sustainable. Potential risks, areas of uncertainty and suggestions for the regulation of NGT-derived products are also discussed.

What are New Genomic Techniques and how are they different from traditional breeding methods?

New Genomic Techniques (NGTs), or gene editing techniques, are methods for creating targeted mutations (mutagenesis) in the genome of living organisms. An example is the "gene scissors" known as CRISPR/Cas9 introduced in 2012[2] which allows for precise editing of DNA on the level of single bases (individual units or "letters" of the genetic code). While the resulting plant or animal derived from NGTs is not always distinguishable from conventionally bred organisms, NGTs are much faster than traditional methods for breeding plants or animals with desirable traits (e.g., crossing). The precise editing by NGTs allows for rapid results within few generations. By contrast, conventional breeding techniques may lead to undesired, or unplanned side mutations (off-targets) which then have to be removed.

What is the difference between gene edited foods and genetically modified organisms (GMOs)?

A 'genetically modified organism' (GMO) may be a plant, an animal, or a microorganism whose genetic make-up has been modified using biotechnology, typically by transplanting genes that code for desirable traits from one species into another. This is different from NGTs, which are used to edit the

existing genes of an organism in a highly targeted way and without inserting any foreign genetic material.

Are there any actual examples of food produced by NGTs?

In the European Union, there is currently no production of plants or animals using NGTs because they are regulated under strict legislation for genetically modified organisms (GMOs) (see below). However, imported goods like processed foods and animal feed may contain some gene-edited components or ingredients. Outside the EU, the number of plants created with NGTs is increasing, ranging from salt-tolerant rice varieties[3] to virus-resistant cassava[4] and soybeans enriched with oleic acid[5], although only a few of these are already on the market. These include GABA tomatoes (Japan), high oleic acid soybean (US), leafy mustard greens (US) and non-browning bananas (Philippines).

What are the benefits of NGTs for agriculture? What are potential risks?

Using conventional breeding methods, it can take 10 to 15 years until a new (plant) variety is ready for the market. Due to their precision, NGTs are much faster and enable breeders to rapidly adapt to changing conditions. As climate change causes extreme weather events and spreading of plant diseases, NGTs are becoming valuable tools for adapting agricultural production and achieving food security, providing speed and flexibility to the breeding process. Moreover, NGT-derived crops can show increased yields and reduced need for pesticides[6] leading not only to better farmer incomes but also to more sustainable food production.

Potential risks of NGTs in agriculture include the unknown effects on wild relatives of crops, i.e., the unintended release of new genetic traits into nature. While this concern also widely applies to conventionally bred plants, the powerful new genomic technique called “gene drive“ has to be studied with caution, as it was designed to (intentionally) wipe out whole populations, e.g., mosquitos carrying the Malaria disease agent.[7] Further, if NGTs are used to create herbicide-resistant crops they can lead to an increased quantity of chemical herbicides. As this is not desirable, many research groups are already working on using NGTs to improve the plant’s own defence response instead of coupling breeding to pesticide use.

Are products derived from NGTs safe to eat?

Generally, there is no scientific evidence that NGTs pose higher risks than any other breeding technologies.[8,9] Changes in genetic make-up occur naturally between generations of plants and animals. Given that NGTs produce highly specific mutations to the genomes of plants that occur naturally during evolution, health effects of NGT-derived foods are unlikely. Nevertheless, all food products undergo safety testing independent of the technology used for their production.

Where are NGT-derived crops grown?

At the moment NGT-derived crops are not grown in Europe. Today more than 90% of crops produced with NGTs are grown in North and South America, but developing countries in Africa and South Asia are rapidly implementing these technologies as well.[10] Furthermore, just in the past months, the

governments of Canada and the United Kingdom confirmed new legislations that remove the products of “precision breeding“ (i.e., NGTs) from the restrictive GMO rules so we may be more likely to see production of NGT-derived crops in these countries in the future.

How can we regulate products made with NGTs to promote sustainable crops?

Several countries (including Japan, Australia, Argentina, Brazil, Canada, India, Kenya and more) now differentiate NGT-derived products that could occur from conventional or natural processes, from their biotechnology regulations.

In 2018, the EU Court of Justice ruled that products of NGTs are classified as genetically modified organisms (GMOs) and should be treated according to the strict European GMO legislation. As the regulatory framework is very time- and cost-intensive, only few big companies have the resources to work on NGTs and their approval. Further, NGT’s did not yet exist when the legislation was adopted. The new European Commission proposal sets out two pathways for placing NGT plants on the market. NGT’s that could also occur naturally or via conventional breeding, and which meet a specific set of criteria set out in the regulation, will be treated like conventional plants and exempted from the GMO legislation requirements. All other NGT plants, will still need to meet the requirements of the existing GMO legislation, meaning they are subject to a risk assessment and can only be put on the market once they have regulatory authorisation.

Crops bred with NGTs also have value for reaching sustainability goals like pesticide reduction or the mitigation of greenhouse gas emissions. This is why products of NGTs should be evaluated case-by-case instead of imposing a categorical ban on all the method itself. Safety testing for environmental threats and human consumption will need to be done on the basis of the final product’s attributes rather than its method of manufacture. Proper traceability and labelling along the product value chain and evidence-based communication of the environmental benefits that NGTs can raise are also important for empowering informed consumer choices.

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