Food and Agriculture Organization of the United Nations

Information toolkit on food biotechnologies with a focus on food safety

9

Current innovations

This “Information toolkit on food biotechnologies with a focus on food safety” is a publication consisting of one handbook and ten booklets, referred to as tools. It is strongly recommended to read through the whole set before using the information it contains.

Contents of the information toolkit on food biotechnologies with a focus on food safety

Introduction

Tool 9 provides information on the latest developments, uses and applications in the area of food biotechnology focusing on genome editing. It also provides examples that could help users of this toolkit to explain genome editing, the difference between genetic modification and genome (or gene) editing and the potential benefits of these new technologies. In addition, it supports users to highlight possible research and development activities ongoing in their own country. According to the stock-taking report on food biotechnology communication materials (FAO, 2020), there have been a very few communication materials produced worldwide that discuss genome editing, which suggests that the public has not yet been well informed of these new developments. While genome editing is new compared with other biotechnologies such as genetic modification, there are already some foods on the market that are derived from genome editing. This means that questions may be raised about these new technologies and governments will need to talk about them. As described in the handbook, the terms “genome editing” and “gene editing” may be used interchangeably in some countries. The tool includes four examples that address the following questions. Some of the examples may require country specific information.

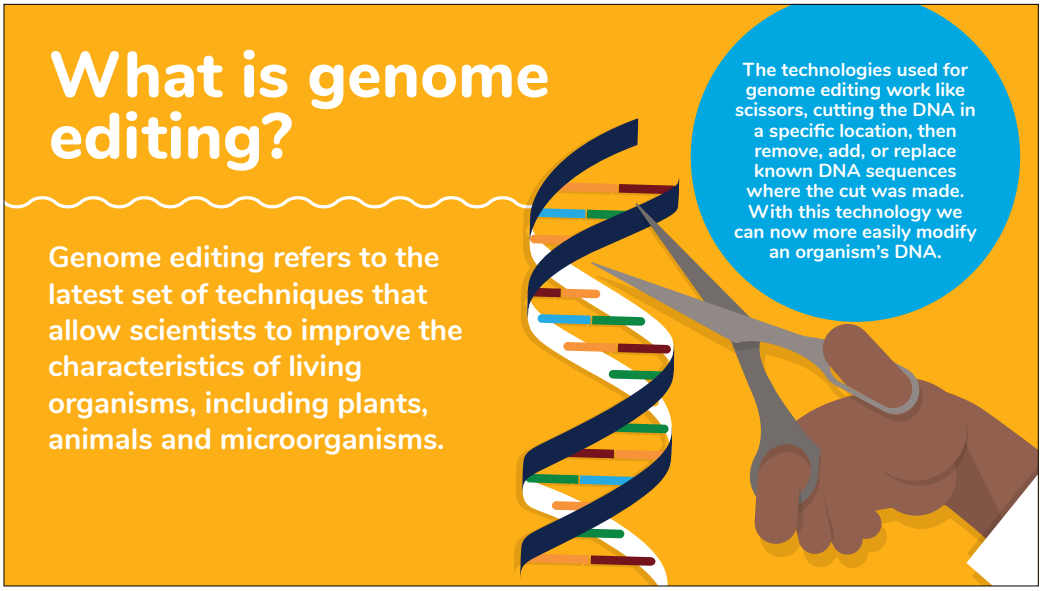
1. What is gene/genome editing?
2. What is the difference between the techniques of gene/genome editing and genetic modification?
3. Why do we have these new technologies?
4. What are the new developments in my country?

The four examples in this tool can be referred when developing materials about the scientific basics of food biotechnologies. These could then be showcased on web-based platforms and used as educational materials. They can be used to introduce the topic to graduate students and government officials who are new to the field. The square images alongside the text below can be referred to as quasi-illustrations of how one may present the materials.

Four examples

What is genome editing?

The first example provided here explains the genome editing technique. Genome editing technologies are used to make precise changes in the genetic makeup of living organisms with the resulting expression of new traits. While there is no international consensus or agreement on the name of the technique, this example and guiding document call it “genome editing” for the sake of clear understanding. Users of this toolkit may want to choose gene editing instead, based on their country’s commonly used terminology. It is recommended that users look at the materials on genome editing produced in other countries, and that they think about producing materials about these new developments in their country. The stock-taking report (FAO, 2020) that compiles communication materials addressing a wide range of biotechnologies may be of help in this regard.



What is the difference between the techniques of genome editing and genetic modification?

The second example material talks about the difference between the techniques of genome editing and genetic modification, focusing on the technical aspects.

Genetic modification is a method to directly manipulate an organism's genome using modern biotechnology and it typically employs a means of transferring genes from one species to another. Genome editing is another method of manipulating DNA. There are several techniques available for genome editing including those called zinc-finger nucleases (ZFN), transcription activator-like effector nucleases (TALEN), and the clustered regularly interspersed short palindromic repeats (CRISPR)/Cas systems (Gaj et *al*., 2016). Genome editing may involve deletion, insertion, silencing or repression of specific DNA sequences. In addition to its high precision, genome editing allows a gene's functions to be fine-tuned because very small and exact changes can be made to the DNA.

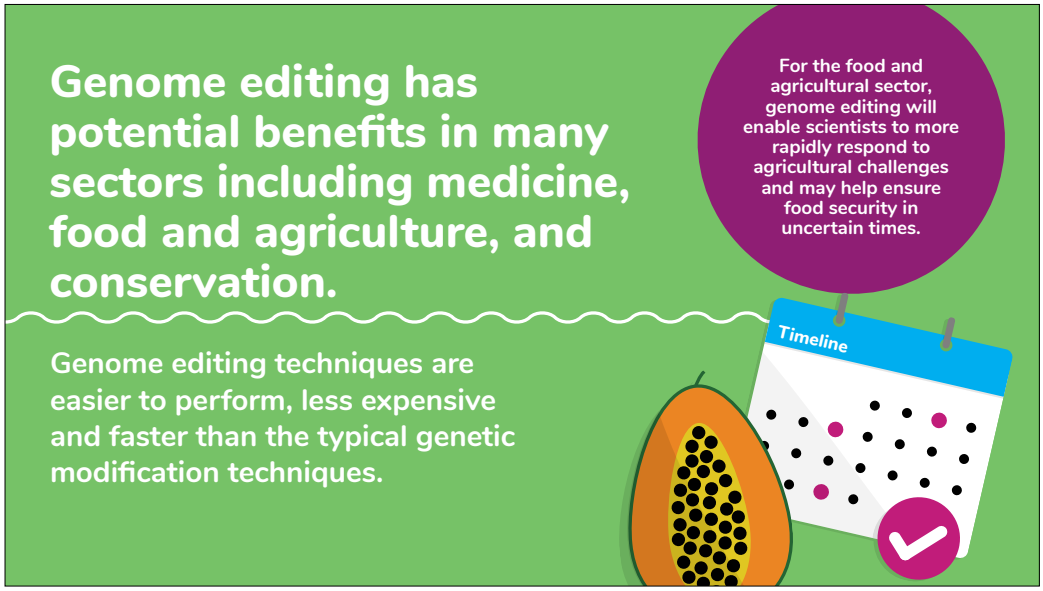
While the differences between the two techniques may be difficult for non-experts to understand, it could be useful to develop materials about them if/when people want to know more about genome editing. It may be useful to combine this item with Tool 2 to demonstrate the difference between conventional breeding and genetic modification to emphasize the fact that the goal of improving the production and quality of the food we eat is the same even though the methods are different.

What is the difference between the techniques of genome editing and genetic modification?

Genome editing enables scientists to make changes to the DNA with much higher precision than with the genetic modification techniques used previously.

Why do we have these new technologies?

The example below shows some of the potential benefits of using genome editing. It begins with an introduction to some sectors that can benefit from these new technologies: users can focus on the potential benefits for their food and agricultural sector and they could also introduce benefits that have been attained through other techniques such as conventional breeding and genetic modification. These benefits include pest and herbicide tolerance, production of higher yields with less fertilizer, reduced food loss and waste and increased nutritional value. In countries where genome editing products are already on the market, users may like to introduce those products when developing their own materials.



What are the new developments in my country?

This last example may help users of this toolkit to display the research developments in their country. When developing their own materials, users may focus on genome editing or other biotechnology techniques. In the example below, the term “small-scale farming” is used to mean food production that is both small in physical size and economic scale. Physical size is expressed by the amount of land used and the number of livestock heads in

production, whereas the economic size of the food producer is expressed by its revenues. This definition of small-scale farming was proposed for monitoring the Sustainable Development Goal indicators 2.3.1 and 2.3.2 (FAO, 2018).

Ongoing research into genome editing technique is happening in many countries around the world.

Research includes topics such as: resistance to emerging pests and diseases, improved stress tolerance, crops developed specifically for small-scale farming and local food preferences, enhanced nutritional content and increased yields.

References

FAO. 2018. *Proposed International Definition of Small-scale Food Producers for Monitoring the Sustainable Development Goal Indicators 2.3.1 and 2.3.2.* Rome, FAO (also available at https://unstats.un.org/unsd/statcom/49th-session/documents/BG-Item3j-small-scale-food-producers-definition-FAO-E.pdf).

FAO. 2020. *Stock-taking report: food biotechnology communication materials in the world – Background paper for the 2020 technical consultation meetings on developing a communication toolkit about food biotechnologies*. Rome, FAO (also available at http://www.fao.org/3/cb1394en/cb1394en.pdf).

Thomas, G., Shannon, J. S., Sai-Ian, S., Jia, L. Genome editing technologies: Principles and applications. *Cold Spring Harbor Perspect. Biol*. 2016;8:a023754. doi: 10.1101/cshperspect.a023754 (also available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5131771/).

Terminology

Biosafety	Set of measures or actions addressing the safely aspects related to the application of biotechnologies and to the release into the environment of transgenic plants and other organisms, particularly microorganisms, that could negatively affect plant genetic resources, plant, animal or human health, or the environment (FAO, 2001).
Biotechnology	Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for a specific use. In this document, the words "food biotechnology" are used when biotechnology is applied to make or modify foods for human consumption (FAO, 2001).
Conventional counterpart	A related organism/variety, its components and/or products for which there is experience of establishing safety based on common use as food (FAO and WHO, 2009).
Deoxyribonucleic acid	Deoxyribonucleic acid (DNA) is a long chain polymer of deoxyribonucleotides. DNA constitutes the genetic material of most known organisms and organelles, and is usually in the form of a double helix, although some viral genomes consist of a single strand of DNA, and others of a single- or a double-stranded ribonucleic acid (RNA) (FAO, 2001).
Gene	The unit of heredity transmitted from generation to generation during sexual or asexual reproduction. More generally, the term is used in relation to the transmission and inheritance of particular identifiable traits. The simplest gene consists of a segment of nucleic acid that encodes an individual protein or RNA (FAO, 2001).
Genome editing	Techniques utilized by scientists to correct or to introduce specific mutations at a particular site (locus) within the DNA of an organism. The techniques used to accomplish these site-specific corrections or directed mutations (base substitution, addition or deletion) include living modified organism (LMO) genome editing and transcription activator-like effector nucleases (TALEN). The term gene editing may be used interchangeably (FAO, 2019).
Genetic modification	Altering the genetic material of cells or organisms with the intention of making them capable of producing new substances or performing new functions (FAO, 2020a). The term genetic engineering may be used interchangeably.
Genetically modified food	Food produced for human consumption and derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through introducing a gene from a different organism (FAO, 2020a).
Genetically modified organism	An organism that has been transformed by inserting one or more transgenes (FAO, 2001).
Living modified organism	A living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology. It is a synonym of GMO, but is restricted to organisms that can endanger biological diversity (FAO, 2001).
Modern biotechnology	Application of: i) *In vitro* nucleic acid techniques, including r-DNA and direct injection of nucleic acid into cells or organelles, or ii) fusion of cells beyond the taxonomic family that overcome natural physiological reproductive or recombinant barriers and that are not techniques used in traditional breeding and selection (FAO, 2001).

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