

IITA Position Statement on Genome Editing Technologies for Crop Improvement

The International Institute of Tropical Agriculture (IITA), one of the CGIAR centers, is a leading research partner in Africa with the goals of reducing poverty, improving food and nutrition security, and preserving natural resources and ecosystem services.

IITA combines traditional plant breeding with modern technologies to accelerate the development of crops that are more productive, nutritious, and sustainable. This integrated approach helps tackle urgent challenges such as hunger, malnutrition, and poverty. Among the most promising new tools is genome editing, which has already been used in many plant species to better understand gene function and to improve key agricultural traits.

IITA's Position on Genome Editing and Regulation of its Products

Genome editing is a **safe and precise tool** that can improve crops much faster than traditional breeding methods. It does not replace other approaches but complements them, offering scientists more options to address agricultural challenges.

At IITA, genome editing is applied responsibly and only when it provides **benefits for African farmers, consumers, and the environment**. Current research at IITA is focused on **edits that do not involve adding foreign genes**, ensuring that the resulting crops are similar to those that could also arise naturally through conventional breeding. In several African countries, such genome-edited products that do not contain foreign genes are treated similarly as conventionally bred varieties. IITA also recognizes that the application and approval of such products must comply with each country's biosafety laws and regulatory frameworks governing agricultural biotechnology.

Genome-edited products are no riskier than those created by other crop improvement techniques, such as mutagenesis, which has a long history of safe human and animal consumption. Any risks depend on the specific plant variety, not the method used to create it. Every new genome-edited crop undergoes thorough testing to ensure it is safe for people, animals, and the environment.

IITA affirms, based on scientific evidence, that plant varieties developed through genome editing which do not contain foreign DNA should not be regulated under biosafety protocols designed for genetically modified organisms (GMOs). Instead, these products should be evaluated and released in the same manner as those developed through conventional or traditional breeding.

What is Genome Editing?

Genome editing (also called gene editing) is a group of technologies that allow scientists to make precise and heritable changes at specific sites in the genome of an organism. Depending on the approach, these changes may be made without

introducing foreign DNA, resulting in changes indistinguishable from those that could occur naturally or through conventional breeding. In other cases, small nucleic acid fragments may be used as templates to guide the repair process, but the outcome is still highly targeted and controlled compared to older genetic modification methods.

Genome editing works by adding, removing, or altering genetic material at targeted locations in the genome.

These targeted changes can, for example, help plants resist diseases, tolerate drought, improve nutrition, or increase yield. Because of its accuracy and efficiency, genome editing has become one of the most promising tools for crop improvement.

Why Genome Editing is Accurate and Efficient

Traditional breeding can take many years, often requiring multiple generations to combine desirable traits while still carrying unwanted ones. Genome editing accelerates this process by allowing scientists to directly target the exact genes responsible for those traits.

Accuracy: Genome editing tools like CRISPR/Cas act like molecular “scissors,” cutting DNA at specific sites guided by short RNA sequences. This precision greatly reduces unintended changes elsewhere in the genome, ensuring that only the desired trait is modified.

Efficiency: Once the target site is identified, edits can be made in a single generation. This makes the process far faster than conventional breeding, which is often time- and resource-intensive.

How does genome editing work?

Genome editing uses special tools called site-directed nucleases (SDNs), sometimes referred to as “molecular scissors,” to make precise cuts at specific locations in a plant’s DNA. When the DNA is cut, the plant’s natural repair systems step in to fix the break. This repair can happen in two main paths, and scientists can guide which way is used depending on the goal:

- **NHEJ (Non-Homologous End Joining)**, the quick patch: The cell repairs the cut ends directly. In the process small “mistakes” may occur, like deleting or adding a letter in a word. This can change how a gene works or turns it off completely.
- **HDR (Homology-Directed Repair)**, the guided repair: The cell is provided with a DNA “repair template” to copy from. Depending on the size of this template, the edit can be small and precise or involve inserting larger sections of DNA.

What is CRISPR-Cas-mediated genome editing?

Several approaches to genome editing have been developed, one of which is CRISPR-Cas, short for “Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) and CRISPR- associated protein (Cas)”. This system was first discovered in bacteria, where it works like an immune system—helping them recognize and cut up the DNA of invading viruses. Scientists have adapted and customized it to work in plants and animals, allowing them to precisely change DNA at specific locations. The most common version used in crop improvement is CRISPR/Cas9.

CRISPR/Cas9 edits genes by precisely cutting DNA and then letting natural DNA repair processes take over. CRISPR has rapidly become the most popular genome engineering approach for crop improvement due to its simplicity, efficiency, specificity, multiplexing, and ease of adaptation. CRISPR/Cas9 works using two key components:

- **Cas9 nuclease enzyme** – a pair of molecular “scissors” that cuts the DNA at the desired spot
- **Guide RNA (gRNA)** – a short piece of RNA that tells Cas9 exactly where to cut.

Together, the **gRNA** directs **Cas9** to the exact spot in the DNA, where Cas9 makes the cut. After the cut, the plant’s natural DNA repair system fixes the break, incorporating the intended change. Depending on how scientists guide this process, CRISPR-Cas9 can be used for any type of genome editing. This flexibility makes it one of the most powerful and versatile tools for crop improvement. Although Cas9 was the earliest and is the most commonly used, many other Cas enzymes have been adapted to perform similar genome editing functions.

Why CRISPR-Cas?

CRISPR-Cas-based editing tool is popular because it is simple, fast, accurate, versatile, and affordable. It can also edit multiple genes at once and works in many types of crops. Compared to other genome editing systems, it is faster, cheaper, and more efficient.

At IITA, CRISPR-Cas is used to improve important African crops such as banana, yam, maize, Bambara groundnut, and tomato, helping to develop traits like disease resistance, better nutrition, and higher yields.

How is IITA using genome editing?

IITA continuously explores new scientific breakthroughs that can strengthen its mission of improving food security and livelihoods in Africa. One of the promising tools is genome editing, which allows researchers to directly fine-tune a plant’s genes for crop improvement. With this technology, crops can be made more resilient to pests, diseases, and harsh environmental conditions such as drought. Genome editing can also be used to improve yields, enhance nutritional value, reduce harmful compounds or allergens, and increase the levels of beneficial nutrients. In many cases, it also helps remove genes responsible for undesirable traits. In short, genome editing enables the development of crops that are healthier, more productive, and better suited to farmers’ needs.

At IITA, genome editing is already being applied to several key crops (<https://genomeengineering.iita.org>). For example:

- **Plantain/banana:** Inactivating the integrated banana streak virus (eBSV) that complicates breeding and germplasm exchange.
- **Banana:** Developing resistance to bacterial wilt and Fusarium wilt diseases.

- **Yam:** Creating semi-dwarf, bushy varieties that reduce labor needs, support mechanization, and lower environmental impact.
- **Maize:** Building resistance to Striga, a parasitic weed that drastically lowers yields in smallholder systems.
- **Tomato:** Improving disease resistance and extending shelf life.
- **Bambara groundnut:** Reducing cooking time to save energy, make preparation easier, and boost adoption of this nutritious crop.
- **Cowpea:** Developing resistance to aphids and enhancing yields with farmers' preferred seed coat color.

When and why would IITA use genome editing?

Multiple criteria guide the decision to use genome editing technologies. IITA applies genome editing when it offers clear advantages over traditional breeding. Decisions are guided by factors such as regulatory requirements, market acceptance, farmer and consumer demand, available resources, and the potential benefits to agriculture and food systems.

One of the biggest advantages of genome editing is that it allows improvements to be made directly in **locally important crop varieties**, without the long process of repeated crossing that often reduces yield and delays progress. This makes breeding much more efficient and timelier. In the context of climate change and increasing pressure on food systems, genome editing gives IITA and its partners a powerful tool to deliver solutions faster and more effectively.

Decision Tree for Applying Genome Editing at IITA

Before applying genome editing to crop improvement, IITA follows a structured step-by-step decision process to ensure that the technology is used responsibly and delivers real value.

1. **Is there a trait that would be beneficial (e.g., disease resistance, improved yield, nutrition)?**
 - **Yes:** Proceed with genome editing
 - **No:** Explore other breeding objectives or techniques
2. **Can the desired outcome be achieved such that the product will not be treated as GMO in the target regulatory environment?**
 - **Yes:** Proceed with genome editing
 - **No:** Re-evaluate the method or explore alternative approaches
3. **Is the regulatory environment favorable or neutral regarding genome-edited crops?**
 - **Yes:** Continue research and development
 - **No:** Pause or adjust according to national regulations
4. **Can the product be developed with minimal environmental or health risk?**
 - **Yes:** Proceed to development and potential commercialization
 - **No:** Rethink the application, enhance safety measures, or consider alternative breeding approaches

IITA's Governance of Genome-Edited Products

Internal Management at IITA

IITA has developed institutional policies and procedures to ensure responsible use of genome editing. These policies guide:

- **Decision-making** on research priorities
- **Stewardship** to ensure responsible management of new technologies
- **Quality control** to maintain product integrity

Product integrity includes the overall quality, safety, and stability of traits in new plant varieties. IITA applies internationally certified stewardship procedures, such as those developed by the Global Stewardship Group (GSG) (www.gsg.ag) in its own work and in collaboration with partners.

The Leader of Biotechnology Program approves and oversees all research using genome editing technologies at IITA, with expert advice and guidance from IITA senior management. The Institutional Biosafety Committee monitors the technical implementation of research using genome editing. All decisions are guided by science-based risk assessment principles to ensure safety and transparency.

Regulatory Approach and Compliance

IITA is committed to **full compliance with national laws and regulations** in every country where it operates. This includes biosafety, environmental, and food-related regulations.

- IITA recognizes and respects the **sovereignty of each country** to decide whether and how genome editing technologies may be used.
- IITA provides **technical support** to governments and regulators who are developing national guidelines for genome-edited products.
- IITA does **not** undertake genome editing research in countries that lack biosafety policies, regulations, or official agencies to oversee such work.

Product stewardship

IITA follows internationally recognized best practices for the responsible stewardship of agricultural biotechnology. These include principles established by the Excellence Through Stewardship (ETS) Plant Breeding Innovation (PBI) program under the Global Stewardship Group (GSG), of which IITA is a certified member.

For deployment and commercialization:

- IITA follows each country's national procedures for the release and use of genome-edited products.
- IITA ensures that partners responsible for multiplying seeds and distributing them to farmers receive the necessary information, materials, and training to do so in line with national regulatory requirements.

Annex Frequently Asked Questions

1. What is genome editing?

Genome editing is a precise technology used to make specific changes to a plant genomic DNA. It can be used to add, remove, or alter specific genes to improve traits like disease resistance, nutritional value, or crop yield.

2. How is genome editing different from conventional/traditional breeding?

Traditional breeding relies on cross-breeding plants and selecting offspring with desirable traits, and the genetic changes happen randomly. Genome editing, however, allows for precise and targeted changes to a plant's genetic composition, facilitating more efficient, precise and timely inclusion of desirable traits while limiting the uncertainty of random changes associated with traditional breeding techniques.

3. How do genome-edited plants differ from GMO?

GMO are created by adding foreign genes from other species. Genome-edited plants, however, are different. Instead of inserting foreign genes, CRISPR technology makes tiny changes directly to the plant's existing DNA, similar to natural genetic variations that happen in nature. These changes are much smaller than the large DNA insertions used in the development of GMO. Most importantly, many genome-edited plants can be produced that do not contain foreign DNA.

4. Are genome-edited plants physically different from other traditional plants?

No, there is no general physical difference between genome-edited and other plants, unless a specific trait, like disease resistance or improved yield, has been intentionally changed. They generally look the same as traditional plants, but with improved qualities.

5. Will genome editing solve all agricultural challenges?

While genome editing is a powerful tool it is not intended to address and solve all agricultural challenges. It works best for improving traits controlled by one or a few genes, such as making crops more resistant to certain diseases or boosting nutritional qualities like pro-vitamin A. However, feeding the world's growing population requires much more. We also need to increase productivity, use natural resources wisely, adapt to climate change, and support farmers with better practices and policies. That's why it is important to use **a combination of tools and approaches** to strengthen agriculture, improve food security, and protect the environment.

It is crucial that we use all tools at our disposal.

6. Does genome editing introduce new risks?

No, genome editing does not introduce new risks that are different from traditional breeding methods. The changes made by genome editing are similar to those found in natural mutations or those common to older breeding methods, which are already established as safe for people and the environment. When scientists edit a plant's DNA, they carefully verify the changes to ensure they are safe.

7. Is genome editing safe?

Current evidence shows that genome editing is comparable in safety to conventional

breeding methods. When properly applied, it produces changes similar to those that could occur naturally or through traditional breeding.

8. Is the use of genome editing in plant breeding risky?

Genome editing itself is not considered risky. It is a very precise tool. The possible concern relates to unintended changes, which IITA scientists manage carefully. Prior to editing, advanced computer models and laboratory methods are used to guide accurate and precise modifications. After editing, plants go through detailed molecular analysis and performance testing. Only plants that meet all quality, safety, and performance criteria are advanced for further use, ensuring safety and reliability.

9. Does making changes to the genetic information of plants automatically pose a health risk?

No, making changes to plant DNA does not automatically create a health risk. In fact, small genetic changes (mutations), happen naturally all the time. In the past, breeders used chemical or radiation-induced mutations safely to improve crops. Genome editing is simply a **more precise and controlled way** to make specific changes. All edits are carefully tested to make sure they do not create harmful or unsafe traits.

10. Do the products of genome editing pose a risk to human or animal health or the environment?

No, genome-edited products are no riskier than those created by other crop improvement techniques, like mutagenesis that have a long history of safe human and animal consumption. Any risks depend on the specific plant variety, not the method used to create it. Every new genome-edited crop undergoes thorough testing to ensure it is safe for people, animals, and the environment.

11. In what areas is IITA currently applying genome editing?

At IITA, genome editing is used as one of several tools to improve crops. It works similar to traditional breeding but is faster, more precise, and more efficient. The technology is mainly applied to genetically simple traits, such as disease resistance and enhanced yield, which remain a central focus of our breeding programs alongside conventional breeding methods.

The decision to focus on specific traits follows a careful, demand-driven process. For all our breeding work, including genome editing, IITA consults with partners, farmers, and stakeholders to identify traits that address important and viable challenges for smallholder farmers and consumers. This ensures that our research is practical, relevant, and aligned with the needs of those who rely on the crops.

Currently, IITA is using genome editing to enhance resistance to bacterial, fungal, and viral diseases in banana, pest resistance in cowpea, and striga tolerance in maize. In addition, genome editing is being applied to develop semi-dwarf, bushy yam varieties that reduce labor requirements and support mechanization.

This approach allows IITA to use genome editing in a targeted, responsible, and demand-driven way, ensuring that improved crop varieties provide tangible benefits to farmers and consumers.

12. Are current IITA varieties genome-edited?

No. Currently, there is no IITA crop variety grown by farmers that is a product of genome editing

13. Will all future IITA varieties be genome-edited?

No, not all future IITA varieties will be genome edited. IITA will use genome editing on a case-by-case basis when traditional methods cannot achieve certain desired traits, like disease resistance in banana and semi-dwarf yam.

14. When will genome-edited banana varieties from IITA be available?

IITA expects its genome-edited disease-resistant banana varieties to be ready for release by 2028.

15. Does IITA have freedom-to-operate for CRISPR-based genome editing technology?

Yes, IITA has a commercial license to use CRISPR-based genome editing tools like FULCRUM™ from Pairwise.

The genome-edited varieties developed by IITA will be royalty-free and its seed/planting material will be freely available to African governments and institutions to promote and distribute. Each country will manage its own seed production and distribution using local seed companies.

For more information about genome editing technologies at IITA, please contact L.Tripathi@cgiar.org.

Last updated: 12 February 2026