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CIMMYT Position on gene editing:

An example to support the development of a common position on gene editing

Purpose

This document provides CIMMYT's 'Position Statement on Novel Genome Editing Technologies in Crops' as an example to support the discussion on a common position on gene editing.

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CIMMYT Position Statement on Novel Genome Editing Technologies in Crops

The International Maize and Wheat Improvement Center (CIMMYT) conducts research that brings sustainable increases in agricultural productivity and improves the quality of life of millions of farmers and consumers, especially in developing countries. We are committed to using traditional and novel technologies responsibly to ensure that smallholder and resource-poor farmers benefit from the best that science can offer.

- **Novel genome editing technologies defined**

Genome editing technologies make it possible to enhance, diminish or turn off the expression of genes in crops, rapidly converting these genes into more favorable variants via precise editing of a single "letter" (nucleotide) or a short sequence of "letters" in the DNA (deoxyribonucleic acid) code. The method uses DNA-site-specific guides to locate an exact nucleotide or nucleotide sequence to be edited. Enzymes and natural DNA repair mechanisms then create precise "edits" in the DNA sequence within or affecting the gene of interest. While this technology can be used to create transgenics by guiding the insertion of a complete gene from one species into another, the main use, and the only use that CIMMYT will apply, is to edit and make changes in the existing DNA sequence in ways that are comparable to changing, inserting or deleting letters to revise a text document. Such changes in DNA often happen spontaneously, but because spontaneous changes occur randomly, precise desirable changes may never occur or might not be recognized or selected. Genome editing technologies do this precisely, increasing the chance to generate and identify a favorable characteristic such as disease resistance. Genome editing technologies have been pursued actively for over 15 years, but the simplicity and high effectiveness of the recently identified CRISPR-Cas9 system (see Frequently Asked Questions, below, for a brief description) mean that genome editing can finally be a practical way for enhancing food production and food quality.

- **Novel genome editing technologies have a role**

Genome editing can accelerate plant breeding, thus helping to meet the challenges of sustainably increasing the productivity of global agriculture. Because genome editing makes a precise and small change in the DNA of a single gene, it can be used to improve specific traits in popular varieties more efficiently than conventional cross-breeding and selection. The first crop varieties produced using genome editing are beginning to emerge in the USA and Canada, and there is significant potential for these technologies to speed up breeding for crop varieties that contribute to the food security and nutrition of a growing global population, while better addressing climate change and the declining natural resource base for agriculture.

At CIMMYT, our first intended use of genome editing techniques is to improve resistance to maize lethal necrosis (MLN), a disease that has recently devastated maize crops in eastern Africa (Ethiopia, Kenya, Uganda, Rwanda, Tanzania, and DR Congo), while maintaining the productivity of elite varieties. We are also exploring how to improve resistance to other diseases that affect wheat and maize globally. Future work might include enhancing the nutritional value (for example, zinc or pro-vitamin A contents) of wheat or maize.

- **Novel genome editing technologies are not a "magic bullet"**

Genome editing technologies can improve traits that are under the control of single or a small number of genes. This will include improving resistance to certain diseases and enhancing quality or nutritional traits, but it is unlikely to be used for complex traits such as grain yield in the near future.

The increases in agricultural productivity and efficiency needed by humanity will not come from any one technology alone. Traditional plant breeding—far and away the most significant source of gains in food crop yields worldwide—as well as improved farming techniques, training, improved local markets, better storage facilities, effective supply chains, and favorable agricultural policies are crucial. However, to accomplish the goal of increasing agricultural production by almost 2% a year for the next 40 years, the responsible, safe use of all available technologies must be considered.

- **Sovereignty and safety first**

CIMMYT does not pursue or advocate increased farm productivity at the expense of human and animal health or environmental safety, nor does the Center support the work of institutions that fail to show proper regard for those concerns and national biosafety regulations and procedures. CIMMYT endorses and follows the safe use of biotechnologies, including to safeguard biodiversity. CIMMYT recognizes and respects the sovereignty of individual nations to determine if, when, and how biotechnologies, including genome editing, are used in their territory, and provides technical support as requested in this process.

- **Policies and protocols in place**

CIMMYT's CIMMYT Policy and Procedures on Novel Genome Editing Technologies supports the application of internationally certified stewardship procedures (see www.excellencethroughstewardship.org) for the use of genome editing technologies at CIMMYT and in CIMMYT's research collaborations with partners. The CIMMYT Biotechnology Research Oversight Committee, comprising senior management including the Director General, approves and oversees all research using genome editing technologies at CIMMYT. The CIMMYT Biosafety Committee monitors the technical implementation of research using genome editing.

- **Complementary roles of the public and private sectors**

CIMMYT recognizes the leadership of private companies and advanced research institutes in developing and sometimes restricting the use of novel technologies through various forms of intellectual property control. In line with its role to develop, use, and share global public goods, CIMMYT works with partners to secure access to and freedom to operate with these technologies, as well as to ensure equity in the benefits for small-scale and resource-poor farmers in the developing world.

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FAQs - Frequently Asked Questions about Novel Genome Editing Technologies

Q: How do genome-edited plants differ from transgenic plants?

"Transgenic" plants have been modified by insertion of a gene or genes from other plant species or bacteria, or engineered genes from the same species. Genome editing applications targeted by CIMMYT result in small, precise changes in "native" genes, that is, the genes that already exist within the plant.

Q: What is CRISPR-Cas9?

Clustered regularly interspaced palindromic repeats (CRISPR) are one of several genome-editing systems available for use in plant gene editing. The CRISPR-Cas9 system occurs naturally in Streptococcus pyogenes bacteria, where it functions as an immune system, recognizing and destroying DNA of invading viruses. Applied in plant breeding, the CRISPR-Cas9 system recognizes specific, breeder-defined DNA sequences in the plant, and edits them to alter the expression of the gene of interest.

Q: Who owns genome editing technologies?

Currently no one clearly owns these technologies, and many organizations and companies are using them. CIMMYT will implement genome-editing projects in collaboration with reputable public and private sector laboratories that have credible claims for ownership and allow us to develop and share products from the research among our partners and beneficiaries, as we do with all our products and knowledge.

Q: How are the products of genome editing regulated?

The decisions of whether and how genome-edited plants will be regulated have not yet been made in most countries where CIMMYT operates. CIMMYT will follow its current policy of fully respecting and observing the sovereignty and regulations of partner countries.

Q: Is genome editing in plant breeding dangerous?

Genome editing methods are not inherently dangerous. They are precise and specific, but "edits" can occur in genome regions other than the targeted sequence. Non-specific edits, if they occur, can be removed by crossing and selection before a variety is ready to be released. As with all products of plant breeding, equivalency testing as well as multi-location and multi-year evaluation trials must be used to verify the superior performance of new varieties.

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

They are no more or less risky than products developed by other crop improvement techniques. Any risk can only be in a specific product, and not inherent to the method by which it was developed. CIMMYT will focus its use of genome editing technologies on genetically simple traits, such as enhanced disease resistance, which has been and remains an objective of our breeding programs, which also rely on other crop improvement techniques.

Q: Are current CIMMYT varieties genome-edited?

No. No current CIMMYT-derived maize or wheat variety sown by farmers is a product of genome editing.

Q: Will all future CIMMYT varieties be genome-edited?

No. CIMMYT's first genome editing activity will be focused on maize with improved resistance to maize lethal necrosis (MLN). CIMMYT is also exploring how to improve resistance to other diseases that affect wheat and maize globally. Genome editing, like every tool, is selectively useful; it will be used for developing new varieties with specific traits or characteristics for which the tool is suited.

Q: When will genome-edited maize or wheat varieties from CIMMYT be available?

Genome editing research for the nearest-term product envisioned by CIMMYT — maize varieties that resist maize lethal necrosis, a deadly disease that appeared in eastern Africa in 2011 and has critically damaged maize production in the region — is still two or more years away.

Q: Will CIMMYT stop transgenic research in favor of genome editing technology?

Because genome editing and transgenic technologies achieve different objectives (see first question, above), they cannot be used interchangeably and decisions to adopt or abandon either of these tools for developing new varieties are independent decisions. CIMMYT currently plans to maintain the capacity to use both transgenic and genome editing techniques to help ensure that these options remain available to benefit smallholder, resource-poor farmers.

For more information about novel genome editing technologies or other work at CIMMYT, please contact M.Listman@cgiar.org or K.Pixley@cgiar.org