CRISPR-Cas9 ,Gene Editing and It's Application in *Agricultural Products*

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Abstract

CRISPR-Cas9 is a powerful gene-editing tool revolutionizing agriculture by enabling precise, DNA-free modifications in crops and livestock. It offers significant benefits, including enhanced nutritional value, increased disease resistance and reduced environmental impact. While challenges such as off-target effects, repair inefficiencies and regulatory concerns persist, ongoing advancements continue to improve its reliability. As the most advanced gene-editing technology available, CRISPR-Cas9 holds strong potential to drive sustainable agricultural innovation and global food security.

Problem Statement

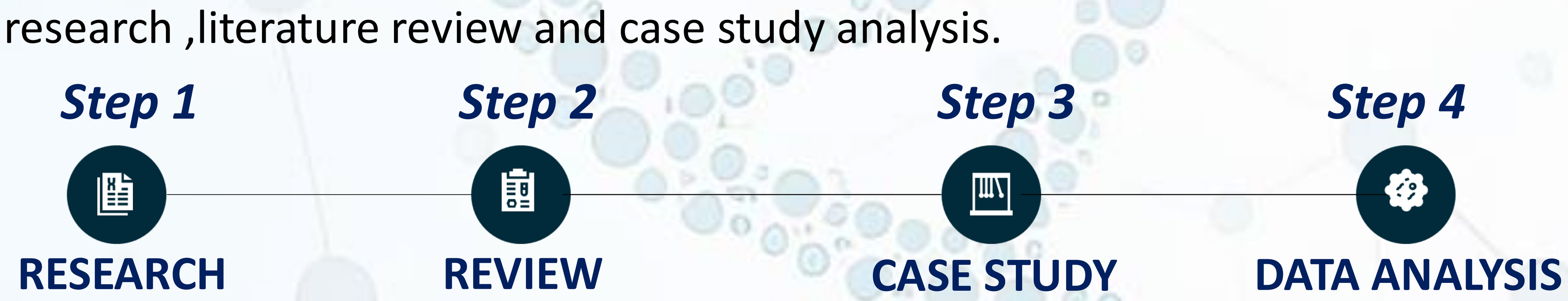
Traditional agricultural methods struggle to meet the rising demands of food production, climate resilience and crop sustainability. There is a need for precise, efficient and innovative solutions to enhance crop traits and ensure global food security.

Objectives

- To explain the role of CRISPR-Cas9 and gene editing in improving agricultural productivity.
- To highlight real-world applications of gene-edited crops.
- To raise awareness of the ethical and regulatory aspects of gene editing in agriculture.
- To increase the national as well as global food security through the CRISPR-Cas9 and gene editing.

Methodology

This poster presentation is developed through a combination of qualitative research ,literature review and case study analysis.



CRISPR Lexicon

CRISPR: "Clustered Regularly Interspaced Short Palindromic Repeats" of genetic information that some bacteria use as part of an antiviral system and that Dr. Charpentier and others discovered how to use as a gene-editing tool.

Cas9: A CRISPR-associated (Cas9) endonuclease, or enzyme, that acts as "molecular scissors" to cut DNA at a location specified by a guide RNA.

Guide RNA (gRNA): A type of ribonucleic acid (RNA) molecule that binds to Cas9 and specifies, based on the sequence of the gRNA, the location at which Cas9 will cut DNA.

Mechanism

CRISPR-Cas9 Gene Editing basically have three steps-
1.Disrupt
2.Delete
3.Correct or Insert

CRISPR-Cas9 can make a single cut using one guide RNA; the cut is then repaired through natural processes, which can result in the addition or deletion of base pairs, leading to gene inactivation.

A segment of DNA can be removed by using two guide RNAs that target separate sites; after cleavage the two separate ends are joined together while the intervening sequence is removed.

Adding a genetic template alongside the CRISPR-Cas9 machinery can enable the cell to correct a gene or insert a new gene. And a new custom sequence can be added when the DNA is repaired.

CRISPR in Agriculture

The many methods to grow plants with desired traits
1. Selective Breeding
2. Mutagenesis
3. Transgenic technologies
4. CRISPR genome editing

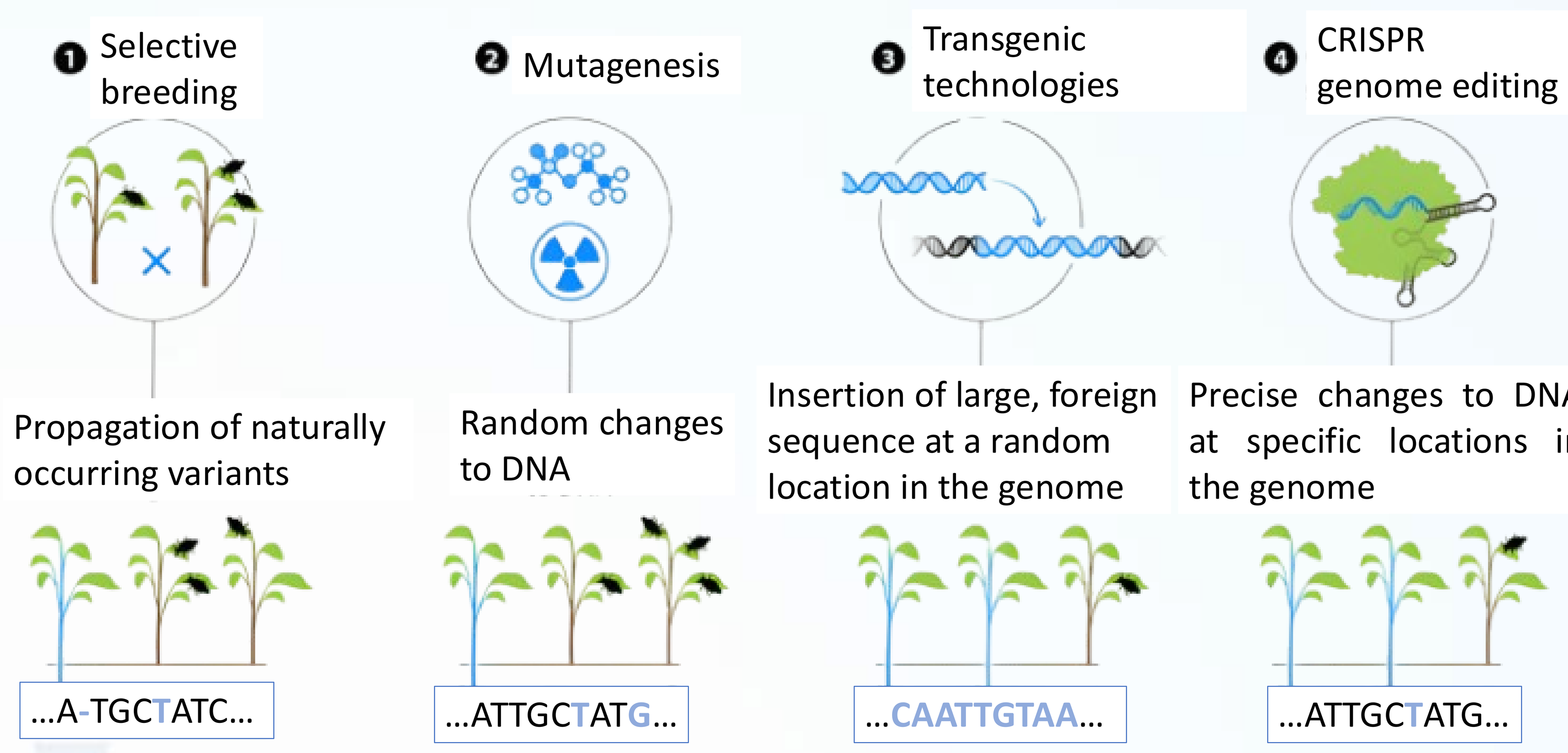


Figure 01: Methods of growing plants by CRISPR and gene editing

Key Applications

1. Maize

From: Incorporating desired characteristics in multiple cycles of common breeding practices

To: Incorporating desired characteristics in as little as 1 to 2 cycles via CRISPR-Cas advanced breeding

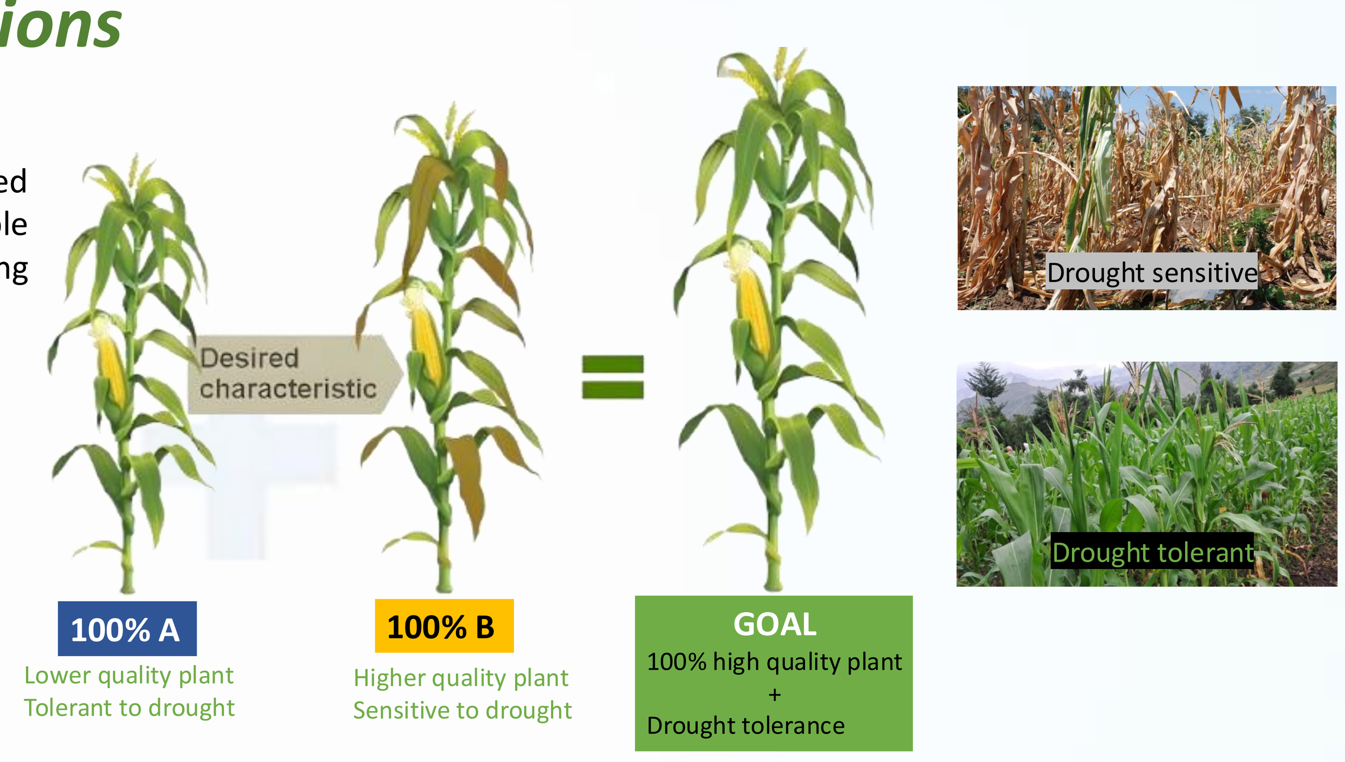


Figure 02: Drought tolerance of Maize crops

2. Rice and Wheat

Editing genes to make crops resistant pathogens

Figure 03&04: Powdery mildew affected maize and healthy maize

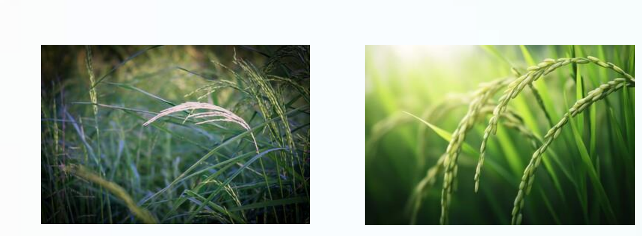


Figure 05&06: Bacterial blight affected rice and healthy rice plant

Charts

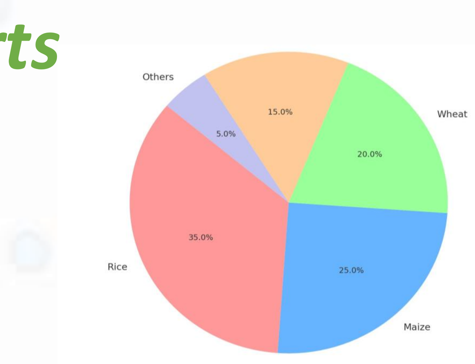


Figure 07:CRISPR-Cas9 application in Agricultural Products

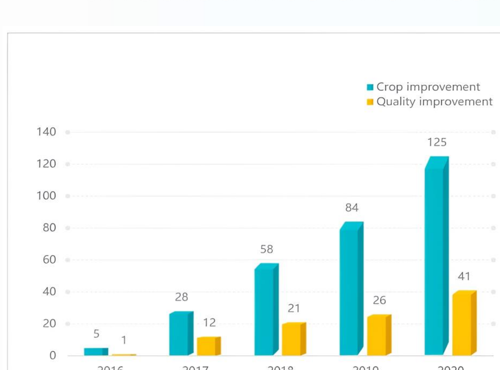


Figure 08:CRISPR-Cas9 from 2016 to 2020

Results

The use of CRISPR-Cas9 technology in agriculture has steadily increased from 2013 to 2024, marking a major shift in crop improvement for better yield, resilience and efficiency. This gene-editing tool has been widely applied to enhance key traits in major crops like rice, maize, wheat, and soybean, resulting in improved productivity, pest and disease resistance, and tolerance to environmental stresses.

Rice accounts for the largest share at 35%, reflecting its global importance and focus on yield and nutrition. Maize follows with 25%, benefiting from edits that boost both agricultural and industrial value. Wheat, at 20%, has been enhanced mainly for disease resistance and grain quality, while soybean, at 15%, is targeted for oil content and pest resistance. Overall, CRISPR-Cas9 is proving to be a vital tool in building a more sustainable and productive agricultural future.

References

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