Indian Farmer
Volume 13, Issue 01, 2026, Pp. 11-13
Available online at: www.indianfarmer.net
ISSN: 2394-1227 (Online)

Original Article

Role of Genetically Modified Crops in Enhancing Productivity and Resilience in Modern Agriculture

Nikita Kumari Meel

Department of Agronomy, College of Agriculture, Jodhpur, Agriculture University, Jodhpur, Rajasthan, India 342304

**Corresponding author: nkmeel2003@gmail.com*

Received: 06/01/2026 *Published:09/01/2026*

Advanced farming systems integrate modern technologies to enhance productivity, sustainability and resilience against biotic and abiotic stresses. Among these technologies, genetically modified (GM) crops play a pivotal role. GM crops are developed by introducing specific genes into plants using biotechnology to express desirable traits such as insect resistance, herbicide tolerance, nutritional enhancement and stress tolerance. These crops are increasingly important for addressing challenges related to food security, climate change and environmental sustainability.

Genetically modified crops are plants whose genomes are altered through recombinant DNA technology, allowing precise insertion, deletion or modification of genes. This approach is faster and more targeted than conventional breeding and enables the transfer of genes across unrelated species.

Importance of GM Crops in Advanced Farming

1. **Enhanced Crop Productivity**

GM crops protect plants from major yield-limiting factors such as insects and weeds. Insect-resistant crops reduce crop losses and ensure yield stability, a key requirement in advanced farming systems.

2. **Reduced Dependence on Agrochemicals**

The use of insect-resistant and herbicide-tolerant GM crops significantly reduces pesticide and herbicide application, leading to lower production costs, reduced environmental pollution and improved farmer safety.

3. **Climate Resilience**

GM technology enables the development of crops tolerant to drought, salinity, heat and flooding. Such traits are critical for maintaining productivity under climate variability and extreme weather events.

4. **Nutritional Enhancement (Biofortification)**

GM crops can be engineered to improve nutritional content, addressing hidden hunger and micronutrient deficiencies, especially in developing countries.

5. **Resource-Use Efficiency**

Herbicide-tolerant GM crops support conservation agriculture practices such as zero tillage, improving water-use efficiency, soil health and carbon sequestration.

6. **Economic Sustainability**

Higher yields and reduced input costs improve net farm income, making GM crops economically beneficial in advanced farming systems.

Examples of GM Crops:

GM Crop	Introduced / Modified Gene(s)	Source Organism	Trait Expressed
Bt Cotton	cry1Ac, cry2Ab	Bacillus thuringiensis	Resistance to bollworms
Drought-tolerant Maize	cspB	Bacillus subtilis	Improved drought tolerance
Bt Maize	cry1Ab	Bacillus thuringiensis	Resistance to stem borers
Herbicide-tolerant Soybean	cp4 epsps	Agrobacterium tumefaciens	Glyphosate tolerance
Golden Rice	psy, crtI	Maize & Erwinia uredovora	β-carotene (Vitamin A) synthesis
Bt Brinjal	cry1Ac	Bacillus thuringiensis	Resistance to fruit and shoot borer
Virus-resistant Papaya	PRSV coat protein gene (CP)	Papaya ringspot virus	Resistance to PRSV
Flavr Savr Tomato	Antisense polygalacturonase gene	Tomato	Delayed fruit softening

GM Crops and Sustainable Agriculture

GM crops contribute to sustainable agriculture by reducing greenhouse gas emissions, conserving biodiversity through lower chemical use and enhancing crop resilience. When integrated with precision agriculture, climate-smart practices, and digital farming, GM crops significantly strengthen advanced farming systems.

Challenges and Biosafety Considerations

Despite their advantages, GM crops raise concerns related to gene flow, resistance development, biosafety and public acceptance. These challenges can be addressed through robust regulatory frameworks, resistance management strategies, and transparent risk assessment.

Future Prospects

Emerging technologies such as CRISPR-Cas9 genome editing and synthetic biology are expanding the scope of GM crops. Future research is expected to focus on multi-trait crops with enhanced photosynthetic efficiency, nitrogen-use efficiency and climate resilience.

CONCLUSION

GM crops are a cornerstone of advanced farming, offering solutions to productivity constraints, environmental challenges and nutritional deficiencies. With science-based regulation and responsible deployment, GM technology can play a transformative role in achieving sustainable and climate-resilient agriculture.

REFERENCES:

Brookes, G. (2021). Environmental impacts of genetically modified (GM) crop use: Impacts on pesticide use and carbon emissions. In *Plant Biotechnology: Experience and Future Prospects* (pp. 87-101). Cham: Springer International Publishing.

FAO (2021). Biotechnology and Climate Change in Agriculture. Food and Agriculture Organization of the United Nations, Rome.

ISAAA (2023). Global Status of Commercialized Biotech/GM Crops. ISAAA Brief No. 58.

Klümper, W., & Qaim, M. (2014). A meta-analysis of the impacts of genetically modified crops. *PloS one*, *9*(11), e111629.

Qaim, M. (2016). *Genetically modified crops and agricultural development*. Springer.

Zhang, Y., Massel, K., Godwin, I. D., & Gao, C. (2018). Applications and potential of genome editing in crop improvement. *Genome biology*, *19*(1), 210.