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# CHALLENGES IN GM CROP REGULATION IN INDIA

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## ABSTRACT

*Genetically modified (GM) crops offer significant potential to enhance agricultural productivity, improve resistance to pests and diseases, and strengthen food security under changing climatic conditions. Although India has strong expertise in plant biotechnology, genomics, and biosafety assessment, commercial adoption of GM crops has progressed gradually. Major challenges include regulatory complexity, public perception, limited commercialization, coordination of field trials, monitoring of unauthorized cultivation, and regulation of imported GM products. Strengthening a transparent, science-based, and efficient regulatory framework will promote responsible innovation while ensuring biosafety and sustainable agricultural development.*

**KEYWORDS:** Agricultural biotechnology, biosafety regulation, food security, regulatory framework

## INTRODUCTION

Modern biotechnology has become an integral component of agricultural research worldwide. Genetically modified (GM) crops have been developed to enhance crop productivity, improve resistance to insect pests and diseases, increase tolerance to abiotic stresses, and reduce dependence on chemical pesticides. Since the commercial introduction of GM crops in the mid-1990s, several countries have adopted biotechnology-based crops after comprehensive biosafety evaluations.

India has made significant investments in agricultural biotechnology and has developed substantial expertise in genetic engineering, molecular biology, and crop improvement. The country has established regulatory mechanisms for evaluating the environmental and food safety of GM crops under the Environment (Protection) Act, 1986. While Bt cotton has been successfully cultivated in India since

2002, the commercialization of other GM crops has remained limited. The regulatory framework continues to evolve in response to advances in biotechnology, biosafety requirements, environmental considerations, and public expectations. Understanding the existing regulatory challenges is important for strengthening evidence-based decision-making and promoting responsible use of agricultural biotechnology.

## SLOW APPROVAL PROCESS

The regulatory approval process for GM crops in India involves multiple stages of scientific evaluation, including laboratory studies, confined field trials, biosafety assessment, and regulatory review. Such a comprehensive process is essential to ensure environmental and human health safety. However, the duration of regulatory evaluation can sometimes extend over several years, creating uncertainty for research institutions, technology developers, and investors. A more predictable and time-bound regulatory process, while maintaining rigorous scientific standards, could facilitate innovation without compromising biosafety.

## PUBLIC PERCEPTION AND AWARENESS

Public perception plays an important role in the acceptance of GM crops. Concerns related to food safety, environmental impacts, biodiversity conservation, and socioeconomic issues have influenced public opinion in India. In many cases, these concerns arise from limited awareness or differing interpretations of scientific evidence. Effective science communication, public engagement, transparent risk assessment, and dissemination of evidence-based information can help improve public understanding and strengthen confidence in regulatory decisions.

## LIMITED COMMERCIAL ADOPTION

Although India has demonstrated scientific capability in developing GM technologies for several crops, commercial cultivation has largely been limited to Bt cotton. Consequently, the practical experience with GM technology remains confined to a limited number of traits and crops. Expanding regulatory evaluation of diverse crop traits, wherever supported by scientific evidence and biosafety assessment, would contribute to a broader understanding of biotechnology applications in Indian agriculture while maintaining appropriate regulatory oversight.

## COORDINATION IN FIELD TRIALS

Confined field trials are a critical component of the biosafety assessment process because they generate data on agronomic performance, environmental interactions, and potential ecological effects under local

conditions. Conducting field trials requires coordination among regulatory authorities, research institutions, state governments, and monitoring agencies. Strengthening institutional coordination and establishing streamlined procedures can facilitate timely generation of high-quality scientific data required for regulatory evaluation.

## MONITORING OF UNAUTHORIZED CULTIVATION

Effective monitoring of unauthorized cultivation is important for maintaining the integrity of the regulatory system. Unauthorized use of GM seeds may affect biosafety monitoring, seed quality assurance, and resistance management strategies. Strengthening surveillance systems, improving molecular detection capacity, enhancing seed quality monitoring, and promoting awareness among stakeholders can support effective implementation of existing regulatory provisions and improve traceability of GM planting materials.

## IMPORT REGULATION AND GM DETECTION

International trade has increased the movement of agricultural commodities containing genetically modified material. Therefore, robust systems for testing, certification, traceability, and labelling are important for managing imports of food, feed, seed, and research materials. Continued strengthening of laboratory infrastructure, standardized detection protocols, and coordination among regulatory agencies can facilitate effective implementation of import regulations while supporting safe international trade in agricultural products.

## FUTURE PERSPECTIVES

Rapid advances in biotechnology, including genome editing and precision breeding, are creating new opportunities for sustainable agricultural development. Regulatory frameworks should continue to evolve alongside scientific progress to ensure that new technologies are assessed using proportionate, science-based, and risk-based approaches. Enhancing transparency, improving stakeholder engagement, strengthening institutional capacity, and promoting international harmonization of biosafety standards can further improve regulatory efficiency while maintaining high standards of safety.

## CONCLUSION

India has established a comprehensive regulatory framework for evaluating GM crops with an emphasis on biosafety, environmental protection, and public health. Continued refinement of regulatory processes through greater transparency, scientific rigor, efficient coordination, and evidence-based decision-making

will help support responsible innovation in agricultural biotechnology. A predictable, risk-based, and trait-specific regulatory system can facilitate the safe development and evaluation of GM and genome-edited crops while contributing to sustainable agricultural growth, food security, and environmental conservation.

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