
**MAINS iMPACT 2025** **07-07-2025**

# GENETICALLY MODIFIED (GM) CROPS

**SYLLABUS:**

GS > Agriculture > Crops > Genetic engineering

**REFERENCE NEWS:**

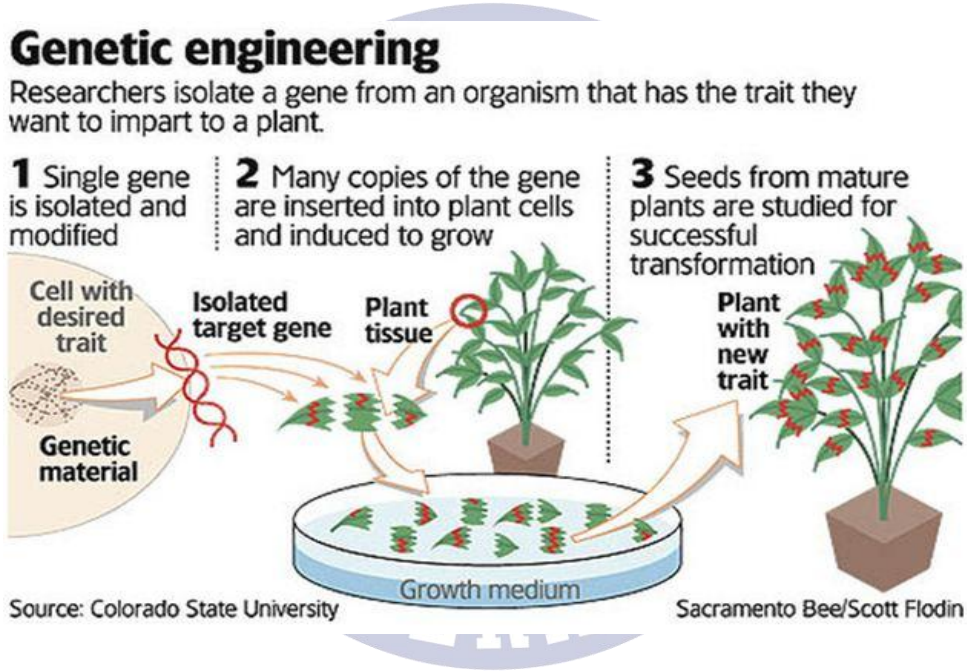
- The Trump administration is intensifying pressure on India to **open its market to American genetically modified (GM) crops**, particularly **soyabean and maize**. These crops are major exports for the United States, and India's response to this demand is fraught with both political and economic implications.

**MORE ON NEWS:**

- The U.S. has more than **3.5 times higher soyabean yields than India**, making U.S. producers **more cost competitive**. India imports 5 million tonnes of soyabean oil annually, and it would be **more efficient to import soyabeans for processing** into oil and protein-rich meal.
- While India's maize yields, especially in Bihar, are comparable to those in the U.S., **rising demand for maize in feed and ethanol biofuel** makes imports essential. Growing consumption of dairy and animal products increases the need for maize and soyabean meal as key feed ingredients.
- The **political aspect of India's agricultural policy** is a key issue, as **Indian farmers are denied GM technology, unlike U.S. farmers** who benefit from higher yields and better pest control.
- While **GM crops in the U.S. offer a competitive edge, India's resistance to GM crops has led to its shift from being a net exporter to a net importer of cotton.** The Trump administration's pressure to open the market to GM produce further stresses India's agricultural sector.

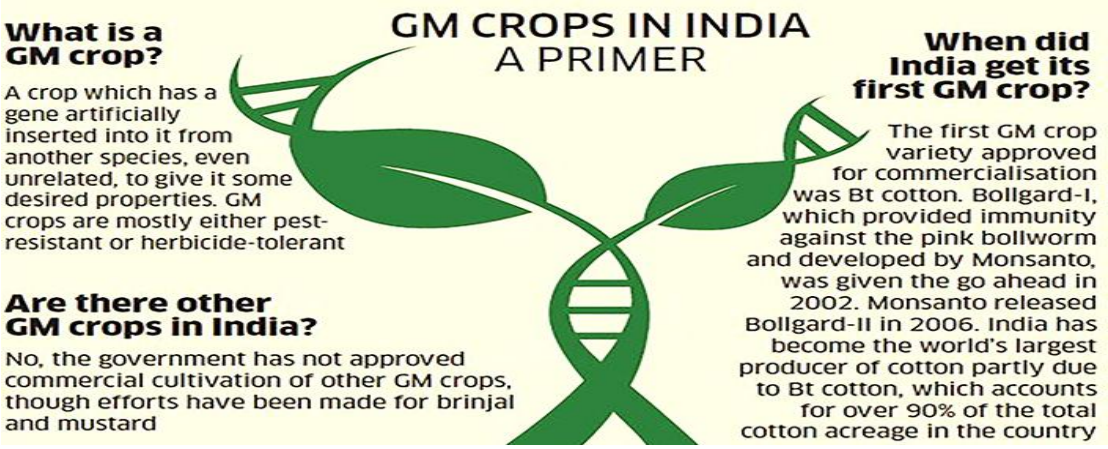
## GENETICALLY MODIFIED (GM) CROPS:

- Genetic modification of plants involves **adding a specific stretch of DNA into the plant's genome, giving it new or different characteristics**. This could include changing the way the plant grows, or making it resistant to a particular disease.
- Engineered genes are added or removed using genetic engineering techniques such as gene guns, electroporation, microinjection, agrobacterium, CRISPR and TALEN.
- The technology is also called "modern biotechnology" or "gene technology", "recombinant DNA technology" or "genetic engineering".
- The first genetically engineered crop plant was **tobacco**, reported in 1983. However, the first commercialized GM crop was **"Flavr Savr" tomato**, engineered to have long shelf-life.




## GM CROPS IN INDIA:

- The **only approved GM crop in India till date is BT Cotton**, introduced **in 2002**.
- The area under Bt. Cotton has increased from 0.29 lakh hectares in 2002-03 to 117.47 lakh hectares in 2019-20, which is **almost 94% total area under cotton** cultivation in India.
- In **2010, Bt brinjal was cleared for commercial cultivation**, but the environment ministry later **placed an indefinite moratorium on it.**




**NATIONAL REGULATORY EFFORTS:**

**I. ENVIRONMENT (PROTECTION) ACT, 1986**

- Genetically modified organisms (GMOs) and crops are regulated under the Environment (Protection) Act, 1986 and rules notified under it. Under the Act, planting unapproved GM seed varieties can attract a five-year jail term and a fine of up to Rs. 1 lakh.

**II. GENETIC ENGINEERING APPRAISAL COMMITTEE (GEAC):**

- The GEAC is India's **apex biotechnology regulatory body**. It functions under the Ministry of Environment, Forest and climate change.
- It is chaired by the Special Secretary/Additional Secretary of MoEF&CC and co-chaired by a representative from the Department of Biotechnology (DBT).
- It accords environmental approval of activities involving large scale use of hazardous microorganisms and recombinants in research and industrial production. It is also mandated with approving the release of genetically engineered organisms and products into the environment, including experimental field trials.

**III. REVIEW COMMITTEE ON GENETIC MANIPULATION (RCGM)**:

- It functions under the Department of Biotechnology (DBT), Ministry of Science and Technology.
- It is mandated with monitoring and regulating safety related aspects of ongoing research projects and activities, including small scale field trials.

**IV. BIOLOGICAL DIVERSITY ACT, 2002:**

- India enacted Biological Diversity Act in 2002 for giving effect to the provisions of the CBD. The Act envisages a three-tier structure to regulate the access to biological resources:

1. **National Biodiversity Authority (NBA)** at the central level:

2. **State Biodiversity Boards (SBB)** at the state level:
3. **Biodiversity Management Committees** at the local level:.

**V. Other Acts and rules concerned with GM Crops:**

- Rules for The Manufacture, Use/Import/Export and Storage of Hazardous Micro Organisms/ Genetically Engineered Organisms or Cells (Referred to as Rules 1989)
- Plant Quarantine (Regulation of Import into India) Order, 2003
- Food Safety and Standards Act, 2006

**SHOULD INDIA PURSUE GM CROPS?**

**YES:**

- **Promising results:**
  - Eight years after the deployment of **Bt cotton**, India became the top exporter of cotton globally and the second largest cotton producer in the world. Also, **Bangladesh** has been successfully cultivating the **Bt Brinjal** developed by an Indian firm for several years.
- **Address food security and hidden hunger:**
  - Genetic modification can increase both quantity as well as the **nutritional value** of foods. Such technological advances can save millions from starvation and poverty.
  - For example, **rice with high beta carotene**, also called **golden rice**, was developed to address **deficiency in vitamin A.**
- **Improve farmers' income:**
  - GM crops, such as Bt cotton, significantly boost production, enhance resistance to failures, and reduce input costs like pesticides. This improves farm income, positively impacting India's economy. A study by the **International Food Policy Research Institute** shows that Bt cotton adoption resulted in a **24% increase in yield per acre and a 50% increase in profit** for smallholder farmers in India.
- **Environmental benefits:**
  - Reduced use of chemical pesticides and insecticides can reduce environmental pollution and improve the quality of products. For instance, a normal brinjal crop requires up to 30 sprays of insecticides. But a Bt variety requires fewer sprays.
- **Economic benefits:**
  - Use of genetically modified corn, cottonseed, soybean and potato as livestock feed can increase the productivity from livestock. Also, the use of GM oilseeds can drastically reduce India's **import dependency on edible oil**.

- For instance, Dhara Mustard Hybrid-11 (DMH-11), a **genetically modified mustard** with genes that enable high-yielding, is under review in India to **boost oilseed and vegetable oil production**.

- **Meet a climate uncertain future:**
  - GM crops can be engineered to withstand weather fluctuations and extremes that India may face due to climate change.
  - For example, **salt tolerant transgenic rice variety**, which was developed by Bose Institute in Kolkata.
- **Indigenous development capacity:**
  - India is steadily moving towards self-sufficiency in developing indigenous GM crops and reducing dependency on multinational corporates. **Bt Brinjal and DMH-11** are examples.

**NO:**

- **Regulatory flaws**:
  - For approval in India, most of the tests are **conducted by the company itself**. This raises questions over the reliability of tests.
  - Also, standing committee on Agriculture in 2012 found that in both Bt cotton and Bt brinjal, the **requisite numbers of tests were not carried out** in the country.
- **Miscalculations**:
  - Critics argue that the rise in cotton yields can be explained **by improvements in irrigation** and a dramatic **growth in the use of fertilizers** and not solely due to the GM crop.
- **Unsustainable:**
  - In areas of Bt cotton cultivation, initial yields were high due to pest resistance. However, small and marginal farmers later faced losses from high input costs and yield declines as pests like the **pink bollworm developed resistance**.
  - For instance, in Maharashtra, **pink bollworm resurgence led to a 40% drop in cotton production** in 2018, underscoring the impact of pest resistance on productivity (Source: Biosafety Information Centre)
- **Corporate monopoly:**
  - Patent laws give developers of the GM crops, such as **Monsanto**, monopoly over the supply of seeds, resulting in fewer choices and higher cost for seeds.
  - For example, Monsanto's "**terminator seeds**" are modified seeds that are designed to only last one generation. This is to ensure that farmers have to annually purchase new seeds from the organization.

- **Eliminates local varieties:**
  - Excessive use of GM varieties have resulted in the near-complete destruction of indigenous crop varieties and diminished the genetic diversity.
  - For instance, the cultivation of Bt cotton has ca**used traditional non-GE cotton varieties to be wiped out**, thereby reducing farmer seed choices.
- **Indirectly leads to farmer suicides**:
  - The high input costs, combined with lack of traditional varieties, indebtedness and resurgence of pests were the root causes of farmer suicides in the country.
- **Impact on health**:
  - GM Crops such as Bt brinjal poses risks to human health, as it is resistance to antibiotics and can turn medicines ineffective in the future.
  - Also, Herbicide-tolerant GM crops have led to an increase in the use of **herbicides such as Glyphosate**. Its rampant use has increased the risk of cancers and other health issues.
- **Environmental cost:**
  - When the GM crops breed with non-GE and wild relatives, it can result in genetic contamination, resulting in far-reaching environmental impact.
  - For instance, in the US, **Monarch butterflies and their principal host plant**, the milkweed, have been pushed to **near extinction** after the introduction of GM corn.

**CHALLENGES/CONCERNS:**

- **Illegal Use and Unregulated Trials:** Despite a ban, GM seeds are available in the black market, and there are reports of illegal field trials. This puts both farmers and consumers at risk, as these untested crops are not subject to safety assessments.
- **Negative Public Perception:** Regulatory failures and concerns about monopolistic practices by multinational corporations have led to widespread skepticism among the public about the safety and ethical implications of GM crops.
- **State Government Opposition:** Many states, including Kerala and Bihar, have opposed GM crop trials. The lack of mandatory consultation with state governments before field trials is a major concern.

- **Lack of Awareness:** Both farmers and consumers have limited knowledge about GM crops, which hinders informed decision-making regarding the adoption of GM technology.
- **High Input Costs for Small Farmers:** With 86.21% of India's landholdings being small and marginal (under 2 hectares), the high costs associated with GM crops, including seeds, are unaffordable for most farmers.
- **Flaws within the GEAC:** The Genetic Engineering Appraisal Committee (GEAC), which approves GM crops, lacks statutory backing and representation from civil society. Additionally, it faces conflicts of interest as it both approves and evaluates the same crops, reducing transparency.

**WAY FORWARD:**

- **Biotechnology Regulatory Authority of India (BRAI):** There is an urgent need to establish an independent authority, such as the Biotechnology Regulatory Authority of India, to oversee GM crop approval and ensure environmental, human health, and biodiversity safety.
- **Strengthen the Regulatory Framework:** The current regulatory framework should be given statutory backing, with a composition that includes stakeholders like scientific communities, civil society, and state governments to ensure effective oversight.
- **Increase Transparency:** GM crop trials should include public consultation, and the findings of safety tests should be made available to the public. This would foster trust and improve public acceptance.
- **Improve Accountability:** The patent regime needs to be proactive, with strict liability laws to prevent monopolies and ensure the responsible introduction of GM crops. This would also enhance accountability and public trust.
- **Separation of Functions:** The evaluation of GM crops should be entrusted to an independent body, such as the Council of Scientific and Industrial Research (CSIR), to avoid conflicts of interest within the GEAC.
- **Support for Local Varieties:** A focus on supporting indigenous crop varieties, alongside GM crops, will ensure that traditional farming systems remain intact, reducing the risk of loss of biodiversity.

- **Increase Awareness:** A stronger labelling system for GM products is essential, enabling consumers to make informed choices. Farmer education programs should also be enhanced to clarify the benefits and risks of GM crops.

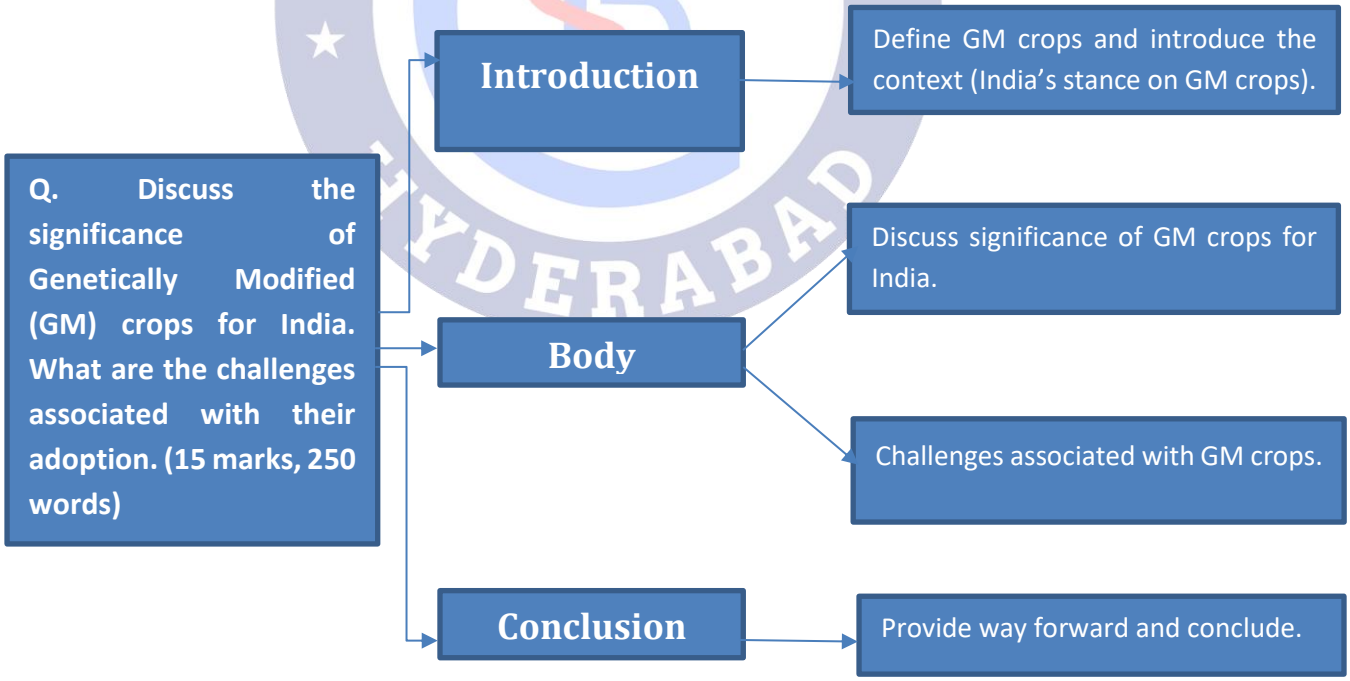
**CONCLUSION:**

- The debate over GM crops in India involves concerns about food security, health, and sustainability. While GM crops can boost yields, reduce pesticide use, and improve farmer incomes, challenges like regulation, public perception, and affordability remain. A balanced approach is needed to integrate GM technology while protecting biodiversity, ensuring food safety, and supporting small farmers. Strengthening regulations, transparency, and inclusive decision-making will be crucial for the future of GM crops in India.

**PRACTICE QUESTION:**

**Q. Discuss the significance of Genetically Modified (GM) crops for India. What are the challenges associated with their adoption. (15 marks, 250 words)**

**APPROACH:**




**MODEL ANSWER:**

Genetically Modified (GM) crops are created by **altering the plant's genetic material using biotechnology** to **introduce desired traits** such as pest resistance or drought tolerance. India, which has approved Bt cotton, faces significant challenges in adopting more GM crops, particularly due **to**

**political, regulatory, and environmental concerns**. The Trump administration's pressure to open India's market to GM crops such as soybeans and maize highlights both the potential benefits and challenges India faces in this regard.

**Significance of GM Crops for India:**

1. **Enhanced Agricultural Productivity**: GM crops like Bt cotton have helped India become the second-largest cotton producer globally, boosting yield and export capacity significantly.
2. **Improved Food Security**: GM crops, such as golden rice enriched with beta-carotene, can help alleviate malnutrition, particularly Vitamin A deficiency, addressing food security concerns.
3. **Boosting Farmer Income**: GM crops increase yield and reduce pesticide use, which boosts farmers' income. Bt cotton adoption, for example, resulted in a 24% increase in yield and a 50% increase in farmer profits.
4. **Environmental Benefits**: GM crops reduce the need for chemical pesticides and insecticides, minimizing environmental pollution and benefiting ecosystems. Bt brinjal requires fewer insecticide sprays compared to traditional varieties.
5. **Economic Efficiency**: GM crops like GM corn and oilseeds reduce India's dependency on imported edible oil and animal feed, contributing to national economic savings.
6. **Climate Resilience**: GM crops engineered for tolerance to harsh weather conditions (e.g., salt-tolerant rice) provide resilience against climate change, ensuring stable food production despite fluctuating weather patterns.

**Challenges Associated with GM Crops:**

1. **Regulatory Concerns**: India's regulatory framework for GM crops is weak, with concerns about the lack of adequate safety tests and the conflicts of interest within the Genetic Engineering Appraisal Committee (GEAC), which both approves and evaluates GM crops.
2. **Health and Environmental Risks**: GM crops, such as Bt brinjal, have raised concerns about long-term health impacts, including antibiotic resistance. Genetic contamination with wild species poses risks to biodiversity.
3. **Corporate Control**: Multinational corporations like Monsanto control the patent rights for GM seeds, resulting in monopoly pricing and limiting farmer choice, increasing costs and dependency on seed suppliers.

4. **Economic Sustainability**: While initial benefits are seen, small farmers, particularly those with limited landholdings, often face high input costs associated with GM crops, making long-term adoption economically unsustainable.
5. **Public Perception and Opposition**: There is significant public skepticism about the safety of GM crops, exacerbated by lack of awareness, misinformation, and fears about corporate exploitation, leading to resistance from states and civil society groups.
6. **Impact on Traditional Farming**: The adoption of GM crops threatens indigenous varieties, leading to loss of genetic diversity in crops. It also diminishes farmers' ability to rely on traditional farming practices and their control over seeds.

**Way Forward:**

- **Strengthening the Regulatory Framework**: An independent body like the Biotechnology Regulatory Authority of India (BRAI) should be established to ensure comprehensive, transparent evaluations of GM crops.
- **Promotion of Local Varieties** Efforts should be made to conserve indigenous crop varieties, ensuring the coexistence of GM and traditional crops to preserve biodiversity.
- **Public Awareness and Education** Increasing awareness about GM crops' benefits and risks through public consultations and information campaigns will foster trust and informed decision-making.
- **Regulating Corporate Practices** There is a need for stronger patent laws and mechanisms to prevent monopolization by multinational corporations, ensuring fair pricing and access to GM technology for farmers.

While GM crops present promising solutions to India's agricultural challenges **by increasing productivity, improving food security, and supporting climate resilience**, their adoption must be carefully regulated**. A balanced approach**, considering both the benefits and risks, along with robust regulatory mechanisms, transparency, and farmer support, is key to the successful integration of GM technology in India's agricultural landscape.