GM Crops Adaption and Innovation

Mains: GS3 – Technology | Economic Development

Why in the news?

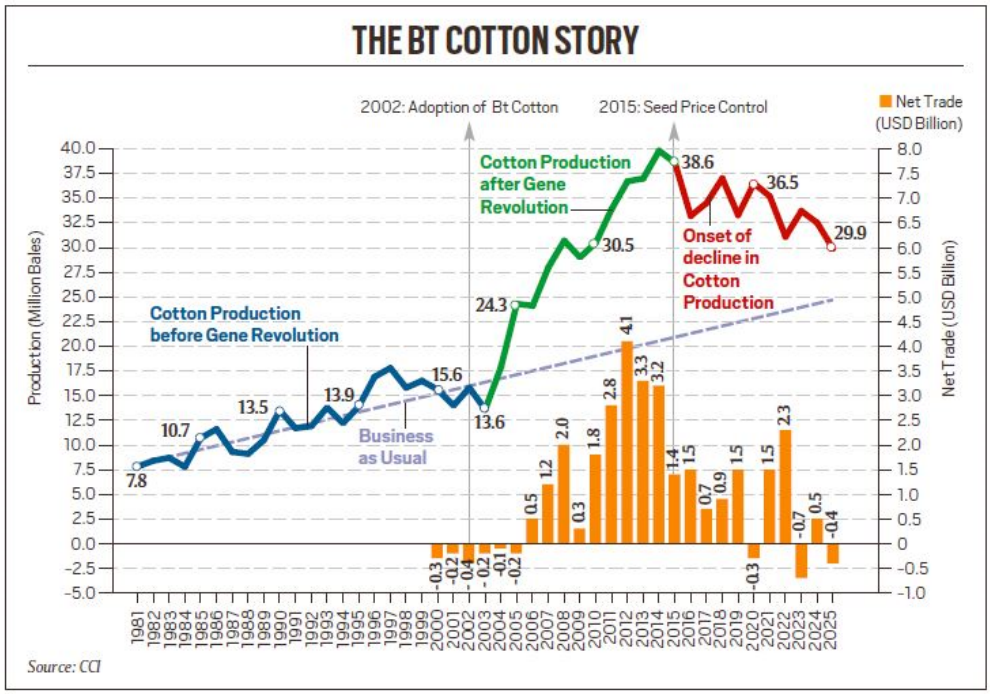
Recently US negotiators are turning up the heat, urging India to open its agriculture market to genetically modified (GM) crops.

What are GM crops?

- **GM crops** – It means Genetically Modified (GM) crops are plants whose DNA has been altered using genetic engineering techniques for desired traits such as pest resistance or higher yield.
- GM crops very different from traditional crops showcasing significant traits tolerating environment stress.
- **Traits** – GM crops are engineered to withstand harsh environmental conditions such as drought, salinity, and extreme temperatures, enabling them to thrive where traditional crops may fail.
    - **Water Efficiency** – Traits like drought tolerance allow GM crops to use less water, making them ideal for cultivation in water– scarce regions and promoting sustainable agriculture.
    - **Pest Resistance** – GM crops possess built– in resistance to pests, reducing the need for chemical pesticides and minimizing crop losses due to pest attacks.
    - **Herbicide Tolerance** – These crops are designed for herbicide tolerance, enabling farmers to control weeds more effectively and improve overall crop productivity.
- **Need** – Food security is the major concern to be addressed for the sustainability of the growing population in coming future.
- According to the United Nations, the world population is expected to reach the 9th billion mark by 2050.
- **Global usage** – Introduction of GM crops in 1995 also known as the "Gene Revolution" for the improvement of agricultural productivity to effectively address food security issues.
- Globally, GM crops are widely cultivated, with the area planted increasing to a record 209.8 million hectares in 2024.
- The most widely planted GM crops are soybean, maize, and cotton, with herbicide tolerance and insect resistance being the primary traits.
- The USA, Brazil, Argentina, Canada, and India account for the majority of global soybean, maize, and cotton GM crop cultivation.

What is the status of GM crops in India?

- **GM Cotton** – The only GM crop officially approved for commercial cultivation since 2002; widely adopted across India.
  - **Trade** – India's cotton exports increased fivefold, reaching 15.3 lakh tons by 2007 and peaking at 23.7 lakh tons in 2013, making India the world's largest cotton exporter at the time.
  - For the 2024–25 season, exports are estimated at 15–17 lakh bales, a significant decline from 28.36 lakh bales the previous year.



  - **Cotton production** – It surged from 13.6 million bales in 2002–03 to 39.8 million bales in 2013–14 — a phenomenal 193 per cent growth.
  - **Productivity improvement** – Bt cotton in India have reduced chemical insecticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%.
  - More than 90 per cent of India's cotton area is under Bt cotton, and its seed is fed to cattle.

***GEAC** is a statutory body under the Environment (Protection) Act, 1986, constituted by the Ministry of Environment, Forest, and Climate Change.*

*It is the **apex regulator for** approving the use, release, import, and export of **genetically modified organisms (GMOs)** and products, including GM crops, in India.*

- **GM Mustard** – Approved for "environmental release" by GEAC in 2022 but awaits final clearance for commercial cultivation; faces legal and public resistance.

- **GM Brinjal** – Cleared by GEAC in 2009 but commercial rollout was blocked due to public and scientific concerns; cultivation is on hold.
- **Key challenges** – this include Regulatory delays, India faces lengthy and complex approval processes for GM crops with no new GM cotton hybrids commercialized since 2006.
- **Reliance on outdated technology** – Multi– stage trials, state– level permissions, and frequent court interventions have created a regulatory deadlock, stalled scientific progress and kept farmers reliant on outdated technology.
- **Biosafety concerns** – Persistent environmental and health risk worries often amplified by activist groups have led to moratoriums (e.g., on Bt brinjal) and stricter scrutiny of field trials.
    - These concerns, sometimes lacking scientific consensus, slow the adoption of new GM varieties.
- **Awareness gap** – There is a lack of public understanding and trust in GM technology.
    - Misinformation and insufficient outreach have fueled skepticism among consumers and policymakers, undermining science-based decision making and stalling innovation.
- **Farmer opposition** – Some farmers' groups and affiliated organizations oppose GM crops due to fears of seed dependency, market control by multinationals, and uncertain economic returns.
    - Their lobbying has influenced policy, contributing to delays and resistance at both state and national levels.

How GM Cotton fared in India?

- **Initial success** – Bt cotton was introduced in 2002 to combat bollworm infestations and quickly gained popularity among Indian farmers due to its pest– resistant properties.
- **Positive impact** – The adoption led to higher yields, reduced pesticide use, and increased farmer incomes.
    - Cotton production rose from 13.6 million bales in 2002–03 to 39 million bales in 2013–14, and yields nearly doubled during this period.
- **Negative effects** – Over time, pest resistance developed, with secondary pests emerging and some target pests adapting.
    - Farmers also faced rising seed costs, ecological concerns, and fluctuating profitability.
- **Regulatory hurdles** – Recent years have seen disputes over seed licensing, price controls, and the spread of unapproved HT Bt cotton varieties.
    - These regulatory and legal challenges have slowed innovation and complicated the cotton sector's progress.

How India can reap benefits of GM crops?

- **Robust regulation** – Strengthen biosafety evaluation and monitoring to ensure only safe GM crops are approved.
- **Awareness campaigns** – Promote scientific awareness and education to counter misinformation among farmers and the public.

- **R&D investment** – Increase funding for public– sector research to develop GM crops suited to Indian needs.
- **Transparency measures** – Ensure open data access and involve stakeholders in decisions to build public trust.
- **Controlled rollout** – Implement phased introduction and monitoring with contingency plans to minimize potential risks.

What lies ahead?

- The need of the hour is a strong, science– led political leadership and the future of agriculture belongs to technology adopters and innovators.
- Real progress needs commercial deployment of advanced biotech i.e. Ht Bt cotton, Bt brinjal, GM mustard, and even GM soy and corn.

Reference

[The Indian Express| Innovation and Adoption in Genetic Tech]

SHANKAR IAS PARLIAMENT
Information is Empowering