



## Technology in Indian Agriculture

This editorial is based on [Seeds for growth](#) which was published in The Indian Express on 10/08/2023. It talks about the use of technology to boost Indian agriculture.

**For Prelims:** [G20](#), [Minimum Support Price](#), [e-NAM](#), [Farmer Producer Organizations](#), [National Seeds Corporation](#), [Bt cotton](#), [Protection of Plant Varieties & Farmers Rights Act](#), [intellectual property rights](#)

**For Mains:** [Sustainable Agriculture](#), [Monsoon](#), Challenges of Indian Agriculture

Agriculture and allied sectors are central to the Indian economy. Keeping this and a sustainable future in mind, the Indian government, quite rightly, is **promoting technology-enabled sustainable farming**, including natural, regenerative and organic systems, **during its G20 presidency**.

However, India still faces many challenges and opportunities in its agricultural sector, such as meeting the **demand and affordability of some crops, improving the productivity**, quality and nutrition of its agricultural produce, reducing the cost of production and the environmental impact of farming, and coping with climate change and its effects on agriculture. This can be done by adopting seed technology.

India has a rich history and tradition of seed technology, dating back to the 1960s when the [National Seeds Corporation](#) was established. Since then, India has made **significant progress in developing and adopting various seed technologies**, such as hybridization, tissue culture, molecular markers, transgenics, etc.

Seed technology **refers to the science and art of improving the genetic and physiological quality of seeds to enhance their performance** under different cultivation conditions. Seed technology can offer significant advantages for sustainable agriculture at little additional cost. The size of the **Indian seed market has reached an estimated in between \$ 4.0 to 6.0 billion** with untapped potential to be the seed hub for **G20 countries**.

### Why is Seed Technology Important for Indian Agriculture?

- **Higher Productivity:**
  - Seed technology can **increase the yield potential of crops by developing improved varieties that have desirable traits**, such as high grain or fruit quality, resistance to pests and diseases, tolerance to drought or salinity, etc.
  - Seed technology can also **improve the germination rate, seedling vigour, and plant establishment of seeds** by using priming or physiological advancement protocols.
- **Higher Input Use Efficiency:**

- Seed technology can **reduce the amount and cost of inputs such as fertilizers, pesticides, and water** by using film coating, pelleting, or seed treatments that can deliver these inputs directly to the seeds or plants in optimal doses.
- Seed technology can also **enhance the nutrient uptake and utilization of plants by using bio-stimulants** and nutrients that can stimulate plant growth and metabolism.
- **Higher Resilience:**
  - Seed technology can **improve the adaptability and stability of crops under changing and unpredictable climatic conditions** by using genetic manipulation, speed breeding, gene-editing tools, or AI-responsive sensors or substances that can modulate plant responses to external stimuli.
  - Seed technology can also **improve the diversity and health of crops** by using biologicals or microbial inoculum that can enhance **plant immunity and soil fertility**.

## What are Some Examples of Seed Technologies in Use or Development in India?

- **Millet Seeds:**
  - Millets are **nutrient-rich, hardy and short-cycle crops** that are well-suited for **sustainable agriculture**.
    - India is the global leader in millet production and has the potential to capture the global seed market by producing quality-assured seeds of improved varieties of millets, especially minor millets.
  - India has developed several **high-yielding and climate-resilient varieties** of millets using conventional breeding and molecular techniques.
    - India has also **introduced priming and film coating technologies** for millet seeds to improve their germination, emergence, uniformity, and protection.
- **Cotton Seeds:**
  - Cotton is one of the most important cash crops in India and a major source of income for millions of farmers.
    - India has achieved remarkable success in cotton production by **introducing Bt cotton hybrids in 2002**.
    - Bt cotton is a transgenic crop that expresses a gene from a soil bacterium called *Bacillus thuringiensis* (Bt) that produces a protein that kills certain insect pests.
    - Bt cotton has increased cotton yield by reducing pest damage and pesticide use.
  - India has also developed several new varieties of cotton using molecular breeding and gene-editing tools that have improved traits **such as fibre quality, drought tolerance, herbicide resistance, etc.**
- **Vegetable Seeds:**
  - India has a **diverse range of vegetable crops** that require different types of seeds.
  - India has developed many improved varieties and hybrids of vegetables using conventional breeding and biotechnology methods.
  - India has also introduced various seed enhancement technologies for vegetable seeds such as **film coating, pelleting, priming, bio-stimulants, nutrients, biologicals, etc.**, to improve their quality and performance.

## What is a GM crop?

A crop which has a gene artificially inserted into it from another species, even unrelated, to give it some desired properties. GM crops are mostly either pest-resistant or herbicide-tolerant

## Are there other GM crops in India?

No, the government has not approved commercial cultivation of other GM crops, though efforts have been made for brinjal and mustard

# GM CROPS IN INDIA A PRIMER

## When did India get its first GM crop?

The first GM crop variety approved for commercialisation was Bt cotton. Bollgard-I, which provided immunity against the pink bollworm and developed by Monsanto, was given the go ahead in 2002. Monsanto released Bollgard-II in 2006. India has become the world's largest producer of cotton partly due to Bt cotton, which accounts for over 90% of the total cotton acreage in the country

## What are Some of the Policies and Regulations that Support Seed Technology in India?

- **Protection of Plant Varieties & Farmers Rights Act (PPV&FR Act), 2001:**
  - This act provides **intellectual property rights** protection to plant breeders and farmers for their varieties and innovations.
  - It also encourages the conservation and sustainable use of plant genetic resources.
- **Seeds Act, 1966 and Seeds Rules, 1968:**
  - These acts and rules **regulate the quality control and certification of seeds** in India. They also prescribe the standards and procedures for seed testing, labeling, and marketing.
- **Fertiliser (Inorganic, Organic or Mixed) (Control) Amendment Order, 2021:**
  - This order amends the Fertiliser (Inorganic, Organic or Mixed) (Control Order, 1985 to include **bio-stimulants as a category of fertilizers**.
    - Bio-stimulants are substances or microorganisms that enhance plant growth and development.
    - This order will facilitate the **registration and use of bio-stimulants in India**.

## What are the Challenges of Indian Agriculture?

- **Uncertainty in Water Supply:**
  - Agriculture in India is **largely dependent on monsoon rains, which are often erratic, unreliable, and insufficient**.
    - As a result, production of food grains and other crops fluctuates year after year.
    - A year of abundant output is often followed by a year of acute shortage.
  - Moreover, **only one-third of the cropped area in India is under irrigation**, and the irrigation **infrastructure is often inadequate, inefficient**, and poorly maintained.
  - Water **scarcity and drought are major threats to Indian agriculture**, especially in the semi-arid and arid regions.
- **Lack of Remunerative Income:**

- The majority of farmers in India **practice subsistence farming**, which means they grow crops mainly for their own consumption and **have little or no surplus to sell in the market.**
  - The prices of agricultural produce are **often low and volatile**, and do not cover the cost of production.
  - The farmers also **face exploitation by middlemen, traders, and moneylenders**, who charge high interest rates and commissions.
- The farmers have **limited access to formal credit and insurance**, which makes them vulnerable to debt traps and crop failures.
  - The farmers also **lack bargaining power and collective action** to demand fair prices and policies.
- **Fragmentation of Land Holdings:**
  - Due to the **growth of population and breakdown of the joint family system**, there has been a continuous **subdivision of agricultural land into smaller and smaller plots.**
    - The **average size** of land holdings in India is **less than 2 hectares, and about 86% of the farmers are small and marginal farmers** who own less than 2 hectares of land.
  - Fragmentation of land holdings reduces the efficiency and productivity of farming, as well as the scope for mechanization and diversification.
  - It also **increases the cost of cultivation and management.**
- **Lack of Access to Quality Seeds and Inputs:**
  - Seeds are the most **critical input in agriculture**, as they determine the yield potential and quality of crops.
  - However, many farmers in **India do not have access to quality seeds of improved varieties that have desirable traits such as high yield**, resistance to pests and diseases, tolerance to drought or salinity, etc.
    - The **seed replacement rate (SRR)**, which is the percentage of area sown with certified seeds out of the total area sown with that crop, **is low for many crops in India.**
    - **For example**, the SRR for **rice is only 39.8%, while for wheat it is 40.3%.**
  - The farmers also lack access to other inputs such as fertilizers, pesticides, bio-stimulants, nutrients, etc., which can enhance the performance of seeds under different cultivation conditions.
- **Lack of Mechanization and Modernization:**
  - Little or no use of machines is made in **ploughing, sowing, irrigating, weeding, harvesting, threshing and transporting the crops.**
    - Lack of mechanization reduces the efficiency and productivity of farming, as well as increases drudgery and labour cost.
  - Moreover, many farmers are not aware or trained in using **modern technologies such as precision agriculture, biotechnology, digital agriculture**, etc., which can improve the quality and quantity of agricultural produce.
- **Lack of Allied Infrastructure:**
  - The farmers in India also face challenges due to the lack of allied infrastructure **such as market access, storage facilities, processing units, transport networks**, etc., which can add value to their produce and increase their income.
  - The farmers **often have to sell their produce at low prices** due to lack of market information, competition, regulation, etc.
    - The farmers also **suffer from post-harvest losses** due to lack of proper storage facilities that can preserve their produce from spoilage and damage.
  - The farmers also have **limited opportunities to process their produce** into value-added products that can fetch higher prices in the market.
  - The farmers also face **difficulties in transporting their produce from farm to market due to poor road connectivity** and high transportation cost.

## What Should be the Way Forward?

- **Maximizing Income, Minimizing Risk:**
  - Farmers need to be **empowered to make informed choices about their crops, markets, inputs, technologies, and organizational forms.**

- They also need to be protected from **price volatility, climate shocks, pests and diseases, and other uncertainties.**
- This can be achieved by strengthening the existing institutions and mechanisms such as **Minimum Support Price (MSP), crop insurance, extension services, cooperatives,** etc., as well as creating new ones such as **contract farming, e-NAM, farmer producer organizations,** etc.
- **Liberalized Farming:**
  - Farmers must be made free to determine the **best mix of resources, land, inputs, technology, and organizational forms for their farms.**
    - They must also have access to **diverse and competitive markets** for their produce, both within and outside the country.
  - This can be facilitated by **removing the barriers and distortions that hinder the free flow of agricultural goods and services,** such as restrictive trade policies, excessive regulations, inefficient intermediaries, etc.
    - This can also be **supported by creating an enabling environment for private sector investment and innovation** in agriculture.
- **Sustainable Farming:**
  - Farmers must be **encouraged and incentivised to adopt sustainable farming practices that conserve natural resources,** enhance soil health, reduce greenhouse gas emissions, and improve biodiversity.
    - This can be done by promoting **agro-ecological approaches such as organic farming, integrated pest management, agroforestry, etc.,** as well as adopting new technologies such as precision agriculture, biotechnology, digital agriculture, etc.
  - This can also be aided by creating awareness and demand for sustainable agricultural products among consumers and retailers.

***Drishti Mains Question:***

Technology can play a vital role in boosting Indian agriculture by enhancing the productivity, profitability, and resilience of its farming sector. Critically analyze.

**UPSC Civil Services Examination Previous Year's Question (PYQs)**

***Prelims:***

**Q. Consider the following statements: (2019)**

1. According to the Indian Patents Act, a biological process to create a seed can be patented in India.
2. In India, there is no Intellectual Property Appellate Board.
3. Plant varieties are not eligible to be patented in India.

**Which of the statements given above is/are correct?**

- (a) 1 and 3 only
- (b) 2 and 3 only
- (c) 3 only
- (d) 1, 2 and 3

**Ans: (c)**

***Mains:***

**Q. What are the present challenges before crop diversification? How do emerging technologies provide an opportunity for crop diversification. (2021)**

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