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## INDIAN SEED INDUSTRY – OPPORTUNITIES AND CHALLENGES

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**H**igh-quality seed is the cornerstone of sustainable agriculture. Breeders at public research institutes have worked diligently to develop new and improved crop varieties that enhance productivity, resource use efficiency, and tolerance to both biotic and abiotic stresses, while also meeting specific quality traits. Contributions from international organisations, the private seed industry, farmers, and the broader farming community have led to the creation of these crucial crop varieties, which have played a vital role in boosting global food production and ensuring food and nutritional security. In some developing economies, particularly India, contemporary plant breeding, the development of high-yielding varieties (HYVs), and improved production and protection technologies have dramatically increased food grain production and productivity. This transformation from food dependence to food security is known as the "Green Revolution." A significant factor in the success of the Green Revolution in India has been the integration of crop improvement with the seed production system. Since 1950, food grain production has surged by 6.19 times, pulse production by 3.30 times, oilseed production by 7.46 times, cotton production by 10.31 times, and sugarcane production by 7.55 times. The correlation between food grain production and the availability of high-quality seeds is evident. In 1980-1981, with 350,000 tonnes of high-quality seed available, India produced 129.29 million tonnes of food grains, 9.37 million tonnes of oilseeds, and 10.63 million tonnes of pulses. In stark contrast, when the availability of high-quality seeds increased to 4,836,600 quintals, food grain production reached a record 310.74 million tonnes, while oilseed output rose to 35.95 million tonnes and pulse production reached 25.46 million tonnes. (Agricultural Statistics at a Glance, DAC & FW, MA&FW, GOI, 2021, [www.agricoop.nic.in](http://eands.dacnet.nic.in), <http://eands.dacnet.nic.in>). Consequently, the global demand for high-quality seeds of improved varieties is rapidly increasing (Tony et al. 2002).

The production and distribution of seeds is a complex process involving various stakeholders, including breeders, seed technologists, farmers, government agencies, research institutions, the private seed industry, and farmers' cooperatives. Public organisations primarily dominate the production and distribution of high-volume, low-value seeds for food security crops such as cereals, pulses, and oilseeds. In contrast, the private seed industry tends to focus on high-value segments, including vegetables, hybrids of field crops, and other horticultural products (Hanchinal 2017). As a result, ensuring the production and supply of high-quality seeds of improved crop varieties to growers has become a top priority for agricultural growth and development.

### Indian Seed Industry – Current Outlook

India's agricultural output has increased alongside the growth of the seed sector. Currently, the Indian seed industry ranks fifth in the world, capturing 6% of the global seed market, following the United States (19%), China (14%), France (6%), and Brazil (6%). Indian seed exports amount to USD 150 million within a global export market valued at USD 15 billion.

**2004-2014:** The seed industry has experienced significant growth, increasing from USD 1.5 billion to USD 2.75 billion. Key factors driving this expansion include hybridization in maize, rice, vegetables, and millet, as well as the introduction of genetically modified (GM) traits in cotton.

**2014-23:** The Indian seed industry has expanded from USD 2.75 billion in 2014 to USD 4.25 billion in 2023-24. Key drivers of this growth include the Seed Replacement Rate (SRR) in crops like rice, wheat, and soybean, hybridization efforts in mustard, and the adoption of improved varieties in the vegetable seed sector.

**2024-2034:** With the Indian economy projected to grow to USD 10 trillion by 2034 and USD 7 trillion by 2030, according to NSAI estimates, the seed industry is expected to reach USD 6 billion domestically. There is potential for this sector to grow to USD 7 billion if efforts are made to achieve USD 1 billion in exports (Prabhakar Rao)

### Opportunities

- **Specific varieties:** There is a pressing need to explore new business models for seed production that focus on product quality in response to customer and industry

demands. By prioritizing quality, these models can enhance seed performance, meet specific market requirements, and improve overall agricultural productivity. Adapting to changing customer needs will not only strengthen market competitiveness but also ensure sustainability in the seed sector.

- **Seed Production Research:** A key factor in the future of agricultural productivity is the development of improved crop varieties and hybrids, supported by effective and affordable seed production methods. To enhance the nation's seed production system, it is essential to focus on creating suitable seed production technologies and diversifying the locations for seed cultivation. Mapping disease-free seed production zones and pinpointing specific areas for high-quality seed production could significantly facilitate the adoption of seed production technologies in non-traditional regions.
- **Export-oriented production:** Emphasizing the development of vegetable seed breeding and promoting an export-oriented vegetable seed chain can position India as a leading hub for vegetable seed production, catering to similar agro-climatic zones in Asia and Africa. Collaborating with the food processing sector will further enhance this initiative, creating synergies that drive growth and increase competitiveness in the global market.
- **Climate Resilient Seed Production:** The reproductive success of plants is heavily influenced by environmental conditions during the growing season, particularly moisture and temperature. Early reproductive processes—such as pollen viability, stigma receptivity, anthesis, pollination, fertilization, and early embryo development—are especially susceptible to these stresses. Failures in any of these processes can lead to early embryo abortion, resulting in poor seed set and reduced seed yield (Vision 2050).
- **Proprietary Seed Production Technology (SPT):** The technology involves utilizing a genetically modified (GM) line to propagate a male sterile line, which is then used as one of the parents to produce hybrid seeds. Importantly, genetic modification does not pass on to the hybrid. The principle of this seed production technology (SPT) could be applied to other crops, especially cereals like wheat and rice, as well as certain pulses and oilseeds, where there is a demand for improved hybrid systems and alternative male sterility methods that have yet to be developed.

- Developing crop and location-specific organic seed production technologies, along with harmonizing organic seed standards, is essential for enhancing the efficiency and quality of organic farming. This approach ensures that organic seeds meet the diverse needs of different regions while promoting consistency and reliability in organic seed supply.

### Challenges of the Indian Seed Sector

- **Seed production of major crops:** Meeting the seed requirements for such a diverse range of crops presents a significant challenge for the seed sector. To address this, it is essential to identify seed hubs that can produce and supply seeds to farmers in specific areas. This approach not only minimizes transportation costs but also helps reduce the overall cost of seed supply for farmers (Planning Commission, 2011a).
- **Distorted seed chain:** The production of certified seed through an efficient chain of Breeder Seed (BS), Foundation Seed (FS), and Certified Seed (CS) remains a significant concern. States must prioritize the production, multiplication, and timely replacement of seeds to progressively increase the Seed Replacement Rate (SRR), particularly for regionally important varieties (Paroda, 2013).
- **Erosion of plant genetic resources:** In many countries in the region, plant genetic erosion poses a significant challenge. This issue arises from the replacement of local varieties with genetically uniform high-yielding varieties, alongside environmental degradation and insufficient funding to maintain existing field collections. While governments recognize the importance of implementing programs for the conservation of plant genetic resources (PGR), a persistent lack of financial support hinders progress. (FAO, <https://www.fao.org/4/y2722e/y2722e0e.htm>)
- **In-efficient post-harvest management of seed:** Seed production is a value-added farming system, making it essential to prioritize the production of high-quality seeds. The primary goal of effective seed storage is to create conditions that protect the seeds and maintain their quality and quantity, thereby minimizing product loss and financial impact. Establishing safe storage facilities for seeds and reserves of food and agricultural inputs serves as a key indicator of adaptive capacity in the agricultural sector (CARE, 2010).
- **Seed Availability:** Farmers primarily meet their seed requirements through farm-saved seeds, with approximately 65% relying on their own saved seeds or those

distributed among them (Vision 2050, Directorate of Seed Research). Ensuring the timely availability of quality seeds presents a greater challenge than production itself.

- Other than those, the perishability of seed, high price, strict regulation of production, quality assurance, vulnerability to environmental stresses and inefficient extension services (Koundinya & Kumar, 2014) are the major issues faced in the Indian seed industry.
- An artificial shortage of desired seed varieties can lead to soaring prices and exploitation. In India, the scarcity of quality seeds results not only from climatic challenges but also from mismanagement (Mahadevappa, 2015)

### Conclusion

The Indian seed industry is vibrant and has largely met its targets, but more must be done to address future requirements driven by a growing population. Ensuring the availability of good quality seeds at affordable prices is essential, as seeds are critical for agricultural success. To achieve the goal of doubling farmers' incomes, science-based decisions must be implemented, and social scientists should be involved to provide realistic statistics and assess the impact of varietal technologies. Public-private collaboration is crucial for sharing information and resources, enhancing investment in the seed sector, and ensuring quality through governance and accountability. While agriculture is a state subject, there is a need for harmonizing regulations related to seed sales and technology licensing. Targeting underdeveloped areas, especially in the northeastern states, can boost production and productivity by improving access to quality seeds.

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