



Agriculture 4.0: Future of Indian Agriculture

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Agriculture plays a significant role in India's growing economy. With around 54.6% of the total workforce involved in agriculture and allied sector activities, the sector contributes to 17.8% of the country's gross value added (GVA). During 2021-22, the country recorded US\$ 50.2 billion in total agriculture exports with a 20% increase from US\$ 41.3 billion in 2020-21. It is projected that the Indian agriculture sector will grow by 3.5% in FY23. With the use of conventional farming methods, there's comparatively less improvement in efficiency and agricultural yields which resulted in lower productivity. Due to this concern, the government initiated the fourth wave of revolution in the agricultural sector to introduce technological advancement in these activities to improve yields and promote the involvement of the population in this sector. Agriculture 4.0 is a considerably advanced version of precision farming methods. It has the potential to transform the existing methods of farming. Precision farming focuses on a comprehensive approach towards maintaining the field and soil well-being with a focus on improving the quality and quantity of yield with minimum environmental harm. The idea of revolution in agriculture involves the use of the Internet of Things (IoT), big data, artificial intelligence, and robotics to accelerate and improve the efficiency of activities throughout the entire production chain. It has the potential to transform the conventional farming industry. Conventional farming practices control crop watering and spraying pesticides or fertilisers uniformly across the field. Instead, the farmers will need to be more targeted and data-driven in the context of farming. Future farms will be more productive owing to the employment of robotics, temperature and moisture sensors, aerial photos, and GPS technology. These cutting-edge methods will improve farm profitability, efficiency, safety, and environmental friendliness. They are together referred to as advanced or high-tech precision farming. Around one-third of food produced for consumption which is worth over US\$ 1 trillion is lost or wasted in transit. This leads to millions of people sleeping hungry every night. The UN World Food Programme reports state that the primary cause of rising hunger around the globe is food wastage or loss due to uneven handling of food. The concern about food wastage gave rise to the involvement of technology in agriculture to improve productivity and reduce wastage by proper handling of food. The data analytics and AI will help farmers to monitor the activities of seeds to the final crop. This will result in better yield and as a result, people will be involved in agriculture and eventually, the nation will target the least hunger issues. These challenges led to the introduction of Agriculture 4.0 wherein farmers won't be dependent on water facilities, fertilizers, and pesticides uniformly across entire fields. Instead, farmers will

be suggested to use minimum quantities and target specific areas for different crops to get better productivity (De Clercq *et al.*, 2018).

Prospects of Indian Agriculture: The continuous technological innovation in the Indian agriculture sector plays a critical role in the growth and development of the Indian agriculture system. It will be crucial for ensuring agricultural production, generating employment, and reducing poverty to promoting equitable and sustainable growth. Constraints include diminishing and degraded land and water resources, drought, flooding, and global warming generating unpredictable weather patterns that present a significant barrier for India's agriculture to grow sustainably and profitably. The future of agriculture seems to involve much-developed technologies like robotics, temperature and moisture sensors, aerial images, and GPS technology. Farms will be able to be more productive, efficient, safe, and environmentally sustainable owing to this cutting-edge equipment, robotic systems, and precision agriculture. Various factors such as data analysis matrix and technological advancement in the existing agricultural machinery contribute to the production of food grains for consumption and commercial needs. The production of commercial food grain support the economy and improves the GDP. Hence, the future growth of Indian agriculture appears to be growing with an upward graph which is backed by technological advancements and government initiatives.

Recent Trends in Agriculture: India's agriculture mainly depends on nature, however changing climate and global warming are making farming unpredictable. The need to use modern technologies to increase productivity and profitability led to the emergence of Agriculture 4.0 in India. There have been significant changes in India in the context of agriculture over the decades and many new technologies have been developed. Several new-age farmers are using soil mapping software as well to determine the optimum level of fertilizers used in the farms. These emerging technologies in farming and agriculture pave the way for more opportunities. The aggrotech start-ups and traditional farmers are also using the latest solutions and trends to improve production in the food value chain. It includes the adoption of new technologies such as cloud-based solutions and other relevant advanced agricultural management techniques to increase farmer efficiency and produce more crops (Da Silveira *et al.*, 2021).

Examples

- Grape farmers in India who have begun spotting and geo-locating crop diseases or pestilence, allowing them to control infestations earlier and in a more precise manner. This also leads to lower use of harmful pesticides on the crop. Soil mapping software is used by several new farmers to determine the optimum level of fertiliser use in their farms. They are also using drones which allow spraying pesticides in a more targeted manner.
- Sugarcane farmers in India have started using technology to gauge the most appropriate time to harvest their crops, which allows them to better plan their harvest and maximise output. Several Indian farmers have also begun to use AI/ML-powered technologies to forecast crop yield, weather conditions and price trends in mandis. A few farmers have also begun testing self-driving tractors and seed-planting robots to free their farms from the vagaries of labour shortages. Emerging trends in the agricultural sector that are quite prominent in the post-liberalization era include increased production, increased investment, diversification of the sector, use of modern techniques, development of horticulture and floriculture, increasing volume of exports and development of the food processing industry. Some of the recent trends in agricultural technology:

Agricultural Drone Technology: Drones are used widely for medical delivery to protection assistance and are used in agriculture to improve the growth of crops, maintenance, and cultivation methods. For example, these ariel carriers are used to access crop conditions and execute better fertilization strategies for more yields. Even the accessibility of hovering robots help farmers through a survey of large areas and data collection to generate better insights about their farms. Using drones in agriculture has provided more frequent, cost-effective remote monitoring of crops and livestock. It also helps analyse field conditions and determine appropriate interventions such as fertilizers, nutrients, and pesticides.

Diversification of Agriculture: The agricultural sector produces generic consumption needs as well as crops like fruits, vegetables, spices, cashews, areca nuts, coconuts, and floral products such as flowers, orchids, etc. With the increasing demand for these products, there's a huge potential in terms of production and trade of these products. This shows how the agricultural sector is being transformed into a dynamic and commercial sector by shifting the mix of traditional agricultural products towards higher quality products, with a high potential to accelerate production rates. The diversification in agriculture is being supported by changes in technology or consumer demand, trade or government policy, transportation, irrigation, and other infrastructure developments.

Increasing Trend in Horticulture Production: The availability of diverse physiographic, climatic, and soil characteristics enables India to grow various horticulture crops. It includes fruits, vegetables, spices, cashew, coconut, cocoa, areca etc. The total horticulture production in FY22 is estimated at 342.333 million tonnes which is an increase of about 7.03 million tonnes (2.10% increase) from 2020-21.

Development of Agriculture in Backward Areas: In the post-green revolution era, the introduction of new agricultural strategies, research, and technology was mostly limited to producing specific food grains, i.e., wheat and rice. However, under the wave of liberalization, with the growing demand for agricultural exports, many new sectors of agricultural activities have become favourable and profitable. In some agriculturally backward areas with no irrigation system and access to fewer resources, dryland farming has been introduced. Other activities were also encouraged such as horticulture, floriculture, animal husbandry, fisheries, etc. To support the development in those areas, various modern techniques have been installed in the backward areas.

Ariel Imaging: Ariel imaging involves the use of geographic information system (GIS) technology to analyse the potential of irrigation projects and their impact on land degradation, erosion, and drainage. The visuals of this technology allow assessment of an individual plant's foliage. These visuals are actively used to detect pests and diseases to protect crops from environmental threats. It mostly helps farmers to monitor the soil conditions of farms and is useful in the summer season when there is the least availability of water.

Hydroponics and Vertical Farming: The concept of hydroponics farming focus towards better yields, texture, and taste of the final product with less water consumption. Plants which are grown hydroponically do not need extensive root systems and it allows them to contribute more energy towards the production of leaves and fruits. Because of indoor cultivation, these plants mature quickly and possess better immunity against pests and other diseases. In the context of sustainability, vertical farming allows farms to be located near or within areas of high population density which reduces the need for transportation and any harmful emissions. Vertical farming provides the ability to grow crops in urban environments and contributes to the availability of fresh foods conveniently. This farming significantly reduces the amount of land space required to grow crops compared to conventional farming methods.

IoT in Agriculture: IoT supports agriculture through the installation of various sensors in agricultural farms. These sensors are used to monitor light, humidity, soil moisture, temperature, crop health, etc. Some of the major uses of IoT in agriculture are as follows:

Various farm sensors such as autonomous vehicles, wearables, button cameras, robotics, control systems, etc help in the collection of data to analyse the performance of the farm. Use of aerial and ground-based drones for crop health assessment, irrigation, monitoring and field analysis. Use of tools to predict rainfall, temperature, soil, humidity, and other forecasted natural calamities.

Government Initiatives: The government has taken various initiatives to enable the potential digitalization of the agricultural sector in India. It focuses on promoting Agri-tech businesses which are working towards boosting productivity.

The government has finalised an India Digital Ecosystem of Agriculture (IDEA) framework that will establish the architecture for the federated database of farmers. This database is being built by taking the publicly available data as existing in various schemes and linking them with the digitalized land records. The IDEA would serve as a foundation to build innovative Agri-focused solutions leveraging emerging technologies to contribute effectively to creating a better Ecosystem for Agriculture in India. This Ecosystem shall help the Government in effective planning towards increasing the income of farmers and improving the efficiency of the agriculture sector.

To facilitate agricultural engineering research, operations, and technology diffusion, the Central Institute of Agricultural Engineering, Bhopal (ICAR-CIAE) of the Indian Council of Agricultural Research (ICAR) has created the Krishi Yantra App. A web portal has been made available by ICAR-CIAE on their website to guarantee that businesses choose the proper mechanisation technology. This aids current and potential business owners in choosing machines and purchasing options. The portal also offers the option of user and specialist engagement.

Farm Safety app was developed by ICAR-CIAE which provides information about safety guidelines and Safety Gadgets to avoid accidents while using different types of agricultural machinery.

A smartphone app called Water Balance Simulation Model for Roof Water Harvesting assists decision-makers in recommending design criteria. It provides that where the implementation of a roof water harvesting system may result in water savings and water security.

Conclusion

A significant industry in the nation is agriculture. It is one of the market-driven sectors that employs a sizable portion of the workforce in the nation. The recent adjustments have made it more easier for people to contribute more to economic progress. Drones and data-driven facilities are recent innovations that help to monitor the farming operation. It has helped farmers become more productive and make greater contributions to the agricultural sector. With the introduction of new technologies, Indian agriculture appears to have a bright and promising future. The government has intensified its attention on the industry, putting in place a number of regulations and programs to improve production and growth. With the help of technological breakthroughs and India's vast and diversified agricultural environment, farmers have numerous chances to maximize their potential and raise yields. Startups in the agriculture industry are also aiming to empower farmers with creative solutions for increased production, measuring tools, and other data-driven initiatives.

References

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