Asian Journal of Applied Science and Technology (AJAST)
Volume 7, Issue 1, Pages 167-176, January-March 2023

Agriculture in Indian Economy and Contribution of Science and Technology

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DOI: https://doi.org/10.38177/ajast.2023.7116

Article Received: 15 February 2023 *Article Accepted: 26 March 2023* *Article Published: 30 March 2023*

ABSTRACT

One of the oldest occupations in history, agriculture has benefited much from innovation throughout the years. Since then, science has played a significant role in agricultural innovation and quality assurance. We have listed a few of the factors that were mentioned in the introduction section if you'd want to understand more about the significance of science and technology in agriculture. Encouraging the use of science and technology is the cornerstone for improving agriculture's productivity, quality, efficiency, and competitiveness, which also contributes to the modernization of agriculture and rural areas, ensures food security, social security, and increases the income of agricultural producers and traders.

Keywords: Agriculture; Innovation; History; Science; Technology and social security.

1. Introduction

Due to the aim to boost the efficiency of agricultural production, some farmers have chosen to focus on agricultural practices, such as the raising of poultry, cattle, and certain crops. Hence, agricultural production mechanization, crop and animal protection, and soil fertility improvement for increased crop output, and the development of disease-resistant crop varieties and animal species have all benefited greatly from science and technology.

Even though the agriculture sector in India is responsible for over 65 percent of all employment, it only makes for about 18 percent of the GDP of the nation. Despite significant advancements in food grain production, there are still a number of challenges to be overcome if the government is to increase agricultural production as a share of GDP.

Agriculture in India is strongly dependent on the environment, but worries about the weather and global warming make farming risky. There is an urgent need to educate farmers on how to use cutting-edge technology and innovative approaches to increase production and profitability. In the parts that follow, we'll talk about the importance of agriculture to the Indian economy, its function in that sector, and the significant contributions that science and technology have made to agriculture.

2. Some Technological Advancements that have Innovated Agriculture Sector

It has been more clear over time that agricultural development practises deplete natural resources faster than they can be regenerated. The need for food and shelter caused by the exponential growth in the human population is placing pressure on the "natural" carrying capacity of the land.

Signs of a natural imbalance include pollution, deteriorating soil, diminishing wildlife populations, and human-caused changes to flora and fauna. It is logical to assume that as the human population continues to increase, the agri-ecosystem will experience more pressures. As a result, technology has been and will continue to be essential to agricultural and sustainable development.

The application of technology in farming and agricultural operations has expanded with the emergence of digital technology. Innovation, which lowers costs and boosts output, is changing how agriculture is conducted. Farmers

gain as a result of this. Digital and analytical technologies are driving continuous advancement in agriculture, and this trend is here to stay. This has increased agricultural yields and contributed to an increase in the farming community's income.

Fertilizers, herbicides, even seed technologies are only a few of the aspects of agriculture that have been impacted by technology. Pest resistance and higher agricultural yields have been achieved using biotechnology and genetic engineering. The effectiveness of physical labour, including such tilling, harvesting, as well as other manual chores, has increased thanks to mechanisation. It goes without saying that other factors also contribute, such as better irrigation systems, improved transportation systems, and less processing-related waste.

The application of contemporary technologies is highlighted, including robotic, targeted farming, artificial intelligence, technology for block chains, and others [1-7].

Figure 1. Science, Technology and Management [8]

Improved productivity from mechanization of agriculture – Mechanization of agriculture has increased production because manual labour and hand tools have energy and output restrictions, especially in tropical regions. Smallholder farmers' opposition to agricultural mechanisation is typically ineffective due to issues with accessibility, cost, and upkeep. Most often, combine harvesters are utilised to speed up processes and eliminate manual labour. Due to the small landholdings in Indian agriculture, cooperation is required to use modern machinery.

Future acceptability of mechanised services will rise as a result of supporting farmers in expanding their capacity, making new equipment accessible, particularly to small farms, and resolving affordability issues through legislation. Mechanization in agriculture has the potential to increase harvest gains and decrease post-harvest losses, which may have a direct and indirect effect on yields.

Climate/ weather prediction through artificial intelligence – An important advancement is the use of artificial intelligence in agriculture (AI). Modern technology and AI-based solutions, which also promote precision farming and well-informed decision-making, enable data collection. The weather in and around fields is regularly monitored by drones, remote sensors, and satellites, providing farmers with vital information on temperature, rainfall, soil, humidity, and other elements. However, adoption of AI is slow in countries like India where poor farming practises,

widespread landholdings, and other issues provide challenges. Nonetheless, there is no doubting that technology based on AI has the potential to bring precision to large-scale farming while massively increasing production.

Figure 2. Use of weather forecasting [9]

Resilient crops developed via use of biotechnology – Agriculture encompasses a wide range of technological advancements, including traditional breeding methods, genetic engineering, and the development of microorganisms expressly for agricultural purpose. In general, genetic engineering enhances plants and animals by locating and modifying genes to increase agricultural pest resistance. Genetic engineering can also be used to develop high-yielding cultivars.

The use of biotechnology in agriculture has had several beneficial effects for farmers and end users. Even though some controversial practises have created reluctance to the use of biotechnology, there is little doubting that Sustainable biotechnology will play an important part in the future of agriculture given the changing climate and growing population.

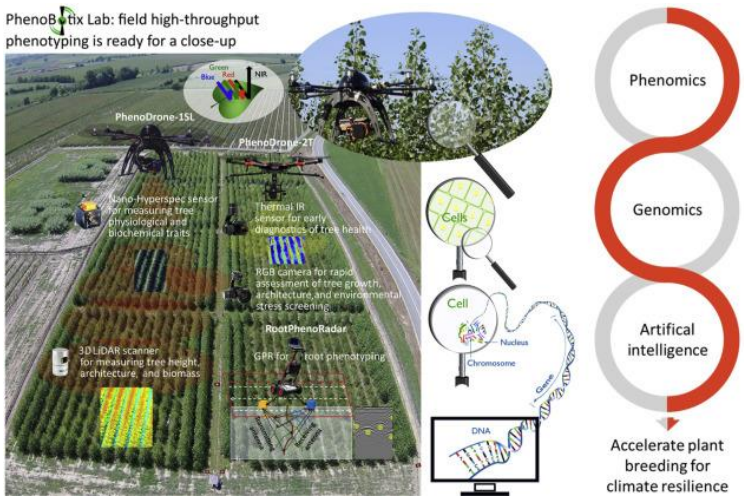

Figure 3. Climate Resilient Plant Breeding [10]

Use of Sensors in Agriculture – The development of communications technology in India has paved the way for smart farming. Sensors are currently used in agriculture to assist farmers in monitoring and optimising crops

regardless of environmental factors and limitations. These wirelessly interconnected sensors are employed for a number of purposes, including exact location determination, airflow measurement, nutrient identification, and analysis of soil composition and humidity levels. With fewer chemicals and less work, farmers may apply fertiliser more efficiently by employing sensors. They allow farmers to use less natural resources while yet producing more.

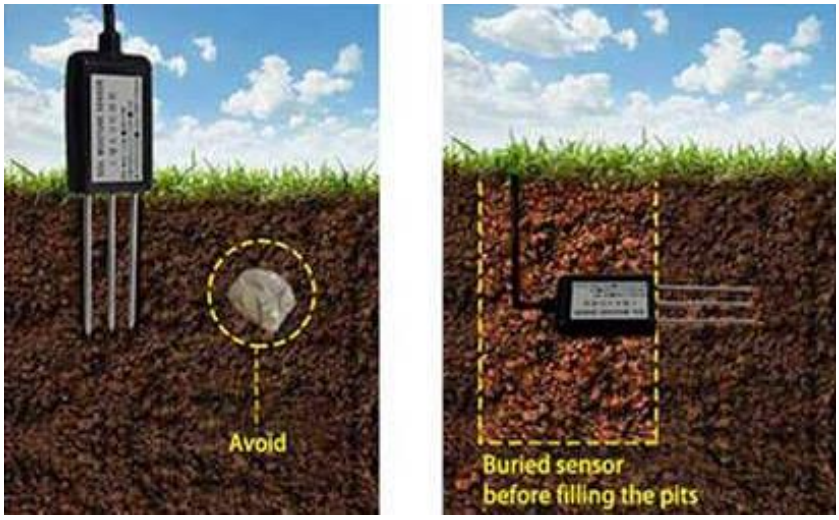

Figure 4. Illumination sensor [11]

Increasing farm outputs and using supply chain management Big Data – By its gathering, compilation, and subsequent processing, data is increasingly being used for decision-making and problem-solving. Big data in smart agriculture is anticipated to have positive effects on markets and the entire supply chain. A wide variety of elements are having an impact on agriculture as it grows.

As a result, complex data is now being gathered and utilized more frequently, necessitating efficient management and interpretation. Markets, supplier networks, online networks, or field-collected sensor/machine data are all potential sources of data. Agriculture is changing as a result of big data, that is having an impact on crop yield, management of supply chains, yield projection, and other factors.

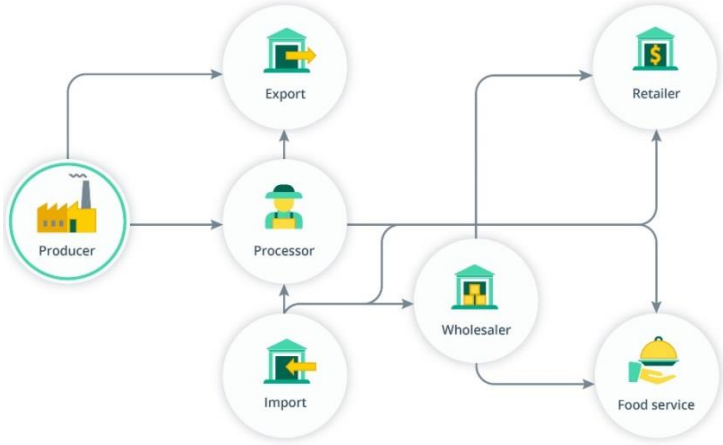

Figure 5. Configuration of stakeholders and functions in the agricultural supply chain [12]

Monitoring of Livestock – In order to manage livestock on a big scale and prevent disease outbreaks, chip and sensors are essential. Body sensor and chips monitor vital information and symptoms that could detect disease

early and halt the spread of infection among herds. Similar to this, ultrasounds are a useful technique for assessing the quality of meat. This helps to preserve and improve the meat's quality.

Improvement of soil fertility – The utilisation of inorganic chemical compounds in replenishing soil minerals has been identified by soil scientists. Inorganic fertilizers and organic manures can be used to replenish the minerals that over-cropping has removed from the soil. Crop rotation is one of the scientific agriculture strategies that have been developed by researchers to enhance farmer productivity.

Improve the sustainable farming systems – Modern, sustainable manufacturing methods (such Viet GAP, Global GAP, etc.) are becoming more well-liked and replicable. Moreover, efforts to adapt farming and production practises to climate change have been made [14-19].

3. Current Initiatives Under Digital Agriculture in India

Efforts have also been undertaken to digitalize the current value chain. It is clearly accepted and acknowledged that Indian agriculture has to become more digital.

The commencement of the Digital Agricultural Mission 2021–2025 was announced by Mr. Narendra Singh Tomar, Union Minister of Agriculture & Farmers Welfare, for September 2021. He also signed five Memorandums of Understanding (MoUs) to expand digital agriculture though the pilot programs of CISCO, Ninjacart, Jio Platforms Limited, ITC Limited, and NCDEX e-Markets Limited (NeML).The goal of the Digital Agricultural Mission 2021–2025 is to encourage and speed up ventures based on cutting-edge technologies including artificial intelligence (AI), blockchain, remote sensing and GIS, and usage of robots and drones.

In August 2019, Cisco created an Agriculture Digital Infrastructure (ADI) solution to improve farming and knowledge exchange. This ADI is probably going to be quite important in the data pool that the Department of Agriculture will develop for the National Agri Stack. At Kaithal (Haryana) and Morena (Mexico), this initiative's pilot project will be conducted (Madhya Pradesh).

In order to empower farmers, the Jio Agri (JioKrishi) platform, which was introduced in February 2020, digitizes the agricultural ecosystem along the full value chain. The platform's core purpose uses data from small applications to provide guidance; recent versions use data from numerous sources, feed it into AI/ML algorithms, and then employ the results to provide exact, individualized advice. The towns of Jalna and Nashik in Maharashtra will host the initiative's pilot experiment.

Using a digital crop monitoring platform hosted on ITC's e-Choupal 4.0 digital platform, ITC has proposed to develop a personalised "Site Specific Crop Advice" service to transform conventional crop-level generic counsel into a personalised site-specific crop advise for farmers. At Sehore and Vidisha, this initiative's pilot project will be implemented (Madhya Pradesh).

- Several digital tools have been created by the Ministry of Agriculture & Farmers Welfare to encourage farmers to utilise technology, including: -

Market for National Agriculture (eNAM): The APMC-Agricultural Product Market Committee mandis are connected via the National Agriculture Market (eNAM), which was launched in April 2016, to create a single

national market for agricultural commodities. eNAM enables farmers to sell commodities to customers directly without the help of brokers or mediators by providing farmers with appropriate returns on their investment.

Central Agri Portal for Direct Benefit Transfer (DBT): The DBT Agri Portal, which was introduced in January 2013, serves as a centralised hub for all agricultural schemes in the nation. The portal provides government subsidies to assist farmers in acquiring modern farm equipment.

The Ministry of Agriculture and Farmers Welfare and Microsoft signed a Memorandum of Understanding in June 2021 to operate a pilot programme in 100 communities across six states. In accordance with the Agreement, Microsoft will use its cloud computing services to develop a "Unified Farmer Services Interface." This is a crucial part of a ministry's long-term plan to create "AgriStack," a solitary platform that would provide farmers with end-to-end service along the value chain for agriculture and food. To do this, the government intends to issue special farmer IDs to each farmer in the nation in order to integrate them with other government programmes and develop digital agricultural ecosystems [20-23].

4. Digital Agriculture and its Future in India

Submission of Digital Agriculture: Farmers may obtain information about, visualize, and assess crop and soil health problems at different stages of production in an efficient and practical way thanks to remote sensing, soil sensors, unmanned aircraft surveys, market insights, and other technology interventions. They can act as an early warning system to identify potential issues and provide speedy fixes.

In-the-moment actionable insights can be produced by artificial intelligence-machine learning (AI-ML) algorithms to help with soil screening, boost crop productivity, reduce pests, and lighten farmer workload.

You can track your food and track accurate, tamper-proof information about farming, inventories, and transactions with the aid of blockchain technology. As an outcome, farmers no longer have to depend on file or documentation to record and store essential information.

Digital Agriculture Benefits: By putting these technology solutions into practice, farms may be managed and monitored effectively. Farmers can act appropriately and avoid using excessive amounts of pesticides, fertilizers, and water since they have access to a complete computerized study of their crops in real-time. Other advantages include: Increasing agricultural productivity and lowering production costs, Avoiding soil deterioration, Lowering chemical use in agricultural production, Encouraging efficient and effective usage water resources, Enhancing farmers' socioeconomic positions, Reduced ecological and environmental impacts, and Boosting worker safety are all goals.

Digital Agriculture Implementation in India: India's high percentage of segregated small-holder farms, which makes data collection more challenging, is a major factor in the country's delayed adoption of digital farming. The sector's limited adoption of mechanization technology and frequent calamities like drought, flooding, and heavy monsoon rains have also had a significant impact on the utilisation of digital solutions. A custom strategy is therefore needed to implement digitized agricultural on such a typical Indian smallholding; this can then be taken up and made accessible to more Indian farmers. To ensure the success of digital agriculture in India, the following actions could be taken.

Technological Cost-effective: Indian farmers frequently earn more than $1,000 annually. Their low income explains the perilous financial problems that a typical Indian farmer encounters. Hence, lower technology expenses will be advantageous.

Plug-and-play hardware does have a higher probability in the Indian market considering typical Indian farms seem to be small. Also, under various farming arrangements, farmland leasing is fairly prevalent, so a farmer may switch to some other farming plots the following season. In such circumstances, buying portable equipment is advantageous for farmers.

Podiums for leasing and distribution agricultural gear and equipment include: Small agricultural plots and limited financial resources present an opportunity offers online platforms that offer leasing and sharing services for equipment as opposed to outright sales. Some agritech startups already offer equipment rental services, including Farmkart (rent4farm), EM3 AgriServices, and Trringo.

Academic backing: Farmers frequently interact with the traditional farm association and academic institutions through a variety of locally managed programmes and government initiatives. Farmer's adoption of digital technology will expand as a result of the availability of training materials from numerous universities and agricultural organisations [14].

Agriculture in Indian Economy

Even though the agriculture sector in India is responsible for over 65 percent of all employment, it only makes for about 18 percent of the GDP of the nation. Despite significant advancements in food grain production, there are still a number of challenges to be overcome if the government is to increase farm productivity as a share of GDP. Agriculture in India is strongly dependent on the environment but worries about the weather and global warming makes farming risky. There is an urgent need to educate farmers on how to use cutting-edge technology and innovative approaches to increase production and profitability. The majority of people in India worked in agriculture. The agricultural industry plays a significant role in the economy. The following are a few crucial points:

- Both rural agricultural and non-agricultural labourers can find work in agriculture.
- It is important for import and export operations as well as global trade.

The role of the agricultural sector in the Indian Economy is shown below by some points given below:

GDP contribution

Since the country's independence was declared, the agriculture sector has contributed the most to GDP. As during fiscal year 1950–1951, 59% of the country's total GDP came from agriculture and other related businesses. Despite a prolonged downturn, agriculture is still one of the key sectors of the Indian economy. On the contrary hand, wealthy countries just like USA and the UK only account for about 3% of their GDP from the agriculture sector.

Largest Employee Division

The sector that has the greatest workers in the country is agriculture, in which more than fifty percent of the total population in India is working. India has around 54.6% of the total population working in agriculture, which is higher than wealthy nations like the UK, USA, France, and Australia, where the percentage is between 2% and 6%.

Food Source

India is the second-most populous country in the world. Also, there is a constant need for food to feed such a big population. Agriculture is therefore vital, as is a decrease in the country's economic reliance on the sector.

Industrial and Agricultural Relation

To meet the continual demand for raw goods for production process, the bulk of the country's industries directly gather this material from the agricultural fields.

In India, the agriculturally oriented sectors generate around half of the nation's industrial sector's income. As a result, India's industrial sector is heavily dependent on agriculture.

Commercial Significance

The industrial sector, as well as internal and foreign trade, rely heavily on Indian agriculture. 20% of the nation's total exports are textile products like jute and cotton, and 50% are edible agricultural products like tea, sugar, cashew nuts, coffee spices, and others. They make up more than 70% of the country's overall exports and help it to make money abroad.

Contribution to the Government's Revenue

Agriculture is the main source of income for the state and federal governments. Growing land revenue is a substantial source of funding for the national government. Also, the movement of agricultural goods contributes to the financial success of the Indian Railways, in turn helping the government.

Economic Planning and Agriculture

So, the agricultural sector will have a significant influence on Indian planning in the future. A successful harvest invariably boosts the business climate for said transportation system, manufacturing industries, domestic trade, and other areas, which in turn fuels the country's anticipated economic growth.

5. Conclusion

Human labour and hand tools have energy and output limitations, especially in tropical areas, mechanization of agriculture has increased production. Smallholder farmers' opposition to agricultural mechanization is typically ineffective due to issues with accessibility, cost, and upkeep. More often, combine harvesters are utilised to speed up processes and eliminate manual labour. Due to the small landholdings in Indian agriculture, cooperation is required to use modern machinery. Future acceptability of mechanized services will rise as a result of supporting farmers in expanding their capacity, making new equipment accessible, particularly to small farms, and resolving affordability issues through legislation. Mechanization in agriculture has the potential to increase harvest gains and decrease post-harvest losses, which may have a direct and indirect effect on yields. So, the agricultural sector will have a significant influence on Indian planning in the future. A successful harvest invariably boosts the business climate for the transport network, manufacturing industries, domestic trade, and other areas, which in turn fuels the country's anticipated economic growth. If the crop is successful, the Govt will have sufficient money to cover its anticipated costs. Poor business situations across the country ultimately result in the collapse of economic planning,

much like a poor crop. As a result, in a country like India, the agricultural sector is essential and continues to be substantially responsible for the country's economic success. The study described above makes it abundantly clear that agricultural growth is a necessity for sectoral diversification and economic development.

Declarations

Source of Funding

This study did not receive any grant from funding agencies in the public or not-for-profit sectors.

Competing Interests Statement

Authors have declared no competing interests.

Consent for Publication

The authors declare that they consented to the publication of this study.

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