# ARTIFICIAL INTELLIGENCE (AI) BASED SMART AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

**Abstract**

*Agriculture plays a significant role in the economic growth and development. Over the years, AI-based technological improvements have profoundly impacted farming and transformed the business. These technologies could help farmers to be proactive rather than reactive in their farming practices. These technologies allow farmers to boost agricultural yield, soil analysis, pest attack monitoring, water management, seed management, crop rotation, better control of harvesting conditions and timing, nutrition management, and reduced waste. However, in order to reap all these benefits, effective collaboration between Government, science, and business is also vital. This article attempts to outline the significant AI based smart agricultural technologies, their significance and the challenges confronting Indian agriculture with potential solutions.*

**Gurwinder Kaur**
Research Coordinator
Department of Food Science and Technology
I .K. Gujral Punjab Technical University, Kapurthala
*gurwinder04011994@gmail.com*

**Dr. Barinderjit Singh**
Assistant Professor
Department of Food Science and Technology
I .K. Gujral Punjab Technical University, Kapurthala
*barinderjitsaini@gmail.com*

**Dr. Anil Kumar Angrish**
Associate Professor (Finance and Accounting)
Department of Pharmaceutical Management
National Institute of Pharmaceutical Education and Research, Mohali
*anilkangrish@gmail.com*

**CMA (Dr.) Sanjeev K.Bansal**
Assistant Professor
Department of Management
I .K. Gujral Punjab Technical University, Kapurthala
*commerce.ptu@gmail.com*

*"AI and Big Data will play major roles in the agriculture sector in coming years since data is key to targeted development".*

-Sh.Sanjay Agarwal
Secretary, Ministry of Agriculture & Farmers' Welfare
Government of India

## INTRODUCTION

The agriculture sector in India is one of the most important in the country's economy, with a current worth of US$ 370 billion. According to the United Nations Food and Agriculture Organization, the population will increase from 7.5 billion to 9.7 billion by 2050, putting further strain on the land[1]. Agricultural producers and enterprises are under tremendous pressure to develop new strategies for increasing productivity while reducing expenses and waste. The technological advancement in agriculture relies on artificial intelligence (AI) based technologies, and these technologies could signal a significant paradigm shift in the agriculture sector. AI-based technologies work by interpreting patterns in huge volumes of data and turning those interpretations into human-like actions. According to McKinsey and the National Association of Software and Service Companies (NASSCOM), an Indian NGO, accessing 15 important agricultural databases might yield a $65 billion potential in India alone. The AI-based agricultural market was worth USD 766.41 million in 2020 and is expected to reach USD 2468.02 million by 2026, increasing at a CAGR of 21.52 per cent [2]. The biggest businesses involved in AI-based agricultural technologies include Microsoft Corporation, IBM Corporation, Granular Inc., aWhere Inc., and Prospera Technologies Ltd. Microsoft's AI-Sowing app and Infosys Precision Crop Management are both game-changers in this space[3]. It is depicted that the AI market has an enormous potential in the agriculture sector and hence these business houses planned to invest money in this sector.

## AI-BASED SMART AGRICULTURAL TECHNOLOGIES

There are many smart and sustainable technologies, such as precision agriculture, vertical farming, smart green housing, image processing, and agricultural drones/robotics, which can be used in agriculture.

**Precision agriculture, vertical farming, smart green housing, image processing, and agricultural drones/robotics, which can be used in agriculture**

**a. Precision agriculture**

Precision agriculture is the concept of employing information technologies such as global positioning systems, produce monitors, remote map-based devices, geographic information systems and targeting systems to gather precious, in-depth data from a wide range of sources, which help to take an accurate and timely decision for better yield. Precision agriculture helps to increase agricultural productivity, diminishing the use of chemicals in agricultural production, reducing labour period, efficient usage of water management, distribution of advanced farming methods to improve product quality, quantity, and cost-effectiveness, as well as developing positive perceptions and shifting farmers' socio-economic conditions[4].

**b. Vertical farming**

Vertical farming is the urban cultivation of crops within a metropolis or urban area building, with the floors constructed to accommodate specific crops. Vertical farming involves four key components: producing more food per square meter by stacking crops, proper balance of natural and artificial light, using hydroponics or aeroponics instead of soil, and incorporating sustainability characteristics to offset energy costs. Vertical farming has many advantages, including improved crop yields, less water consumption (95 per cent less than conventional farming), less weather impact, increased organic agricultural yields, human and environmental safety, and no exposure to heavy farming equipment or illness[5].

**c. Smart greenhouse**

Greenhouse agriculture is a potential and alternative approach for future food security and socio-ecological sustainability. In this, a house-like enclosure made of glass or plastic to protect the plants from pests, illnesses, and other harmful environmental conditions is used. Cold frame greenhouse farms can be set up to retain heat from the sun and keep the plants warm in cold weather. However, shaded greenhouses are used in dry and hot weather, which helps to maintain the plants' moisture. These techniques allow farmers to extend the planting season for growing various crops by modifying the local environmental factors like temperature, light, moisture and nutrients that ultimately produce high-quality crops[6].

**d. Image processing**

Image processing is a technique that displays the detected disease in the respective plant, as well as the reason for the cause and what method should

be used to control the disease. It also displays moisture, humidity, temperature, and so on. The source of radiation is essential in image processing. The sources are Gamma-ray imaging, X-ray imaging, imaging in the UV band, imaging in the visible band and IR band, imaging in the microwave band, and imaging in the radio band. Image processing can improve decision-making in areas such as vegetation measurement, irrigation, fruit sorting, etc. As with weed detection, segmentation and classification in fruit grading systems can be accomplished with high accuracy[7].

e. **Agricultural drones/robotics**

Agricultural robots and drones integrate routine and uninteresting tasks for agricultural producers, freeing them up to focus on increasing high crop production yield. In agriculture, drones are used for aerial photography, tracking, land auditing, supervising, sprinkling compost, and inspecting infected or decaying crops. However, some of the most common agricultural robot applications are weed control, harvesting and picking, automated mowing, pruning, sowing seeds, spray coating, sorting, and packing[8].

## SIGNIFICANCE OF AI-BASED SMART AGRICULTURAL TECHNOLOGIES

The agricultural sector faces various issues like climate impact, plant disease, improper soil analysis, pest infestation, irrigation, inadequate drainage, and many more. But AI-enabled smart agriculture technologies can fulfil the dreams of farmers. Massive structured and unstructured data are generated daily due to the Internet of Things (IoT), such as historical weather patterns, soil composition reports, rainfall, pest infestation, crop moisture, temperature in growing areas, and prediction of the ideal time for harvesting. All such real-time data collected from different farmers/locations may be sensed by cognitive IoT devices, which can provide valuable insights as to how to increase the yield while lowering the cost. AI aids in spraying herbicides on only targeted weed-grown areas, which helps to save money and reduce pollution of the surrounding ecosystem. Therefore, AI-enabled smart technologies in agriculture have produced apps and tools to provide farmers with accurate recommendations on best irrigation and fertilizer treatment times, water management, crop rotation, timely harvesting, crop type, optimum planting, pest attacks, precise pesticides/herbicides spraying and nutrition management, etc.

## CHALLENGES OF AI-BASED SMART AGRICULTURAL TECHNOLOGIES

Undoubtedly, AI has redefined traditional methods to boost efficiency and crop production rate with advanced approaches, and its use may ensure higher productivity. But still, many challenges such as availability of IT infrastructure and experts, rural broadband structure, higher power cuts, and higher costs are more considerable hurdles to effectively implementing AI-based smart agricultural technologies in India. Further cost-benefit analysis for adopting digital farming technology also poses a big challenge because of the higher cost of these smart equipment. For instance, an Indian-made drone that may be used for spraying purposes costs around Rs-4 -5 Lakhs[10]. However, while judging it from the financial perspective, we should also keep in mind the aspects of sustainability.

Another big challenge is developing a bridge between the farmers and the data-captured engineers, which will help to define the accountability and responsibility of each person. For example, the responsibility of precisely spraying pesticide/ herbicide on the crops needs to be defined. If higher number of traces are found after harvest of the crop, then it has a significant adverse impact on the consumer health after consumption and results in higher rejection of export consignment by the importers, which ultimately leads to many economic losses. Now, another question arises as to who will have the copyright and control over the big data and convert it into valuable information. AI systems require continuous feeding of new information in the data bases used for effective performance.

Moreover, machine learning, artificial intelligence, and advanced algorithm design have advanced at breakneck speed, but collecting well-tagged, meaningful agricultural data is still a big challenge. Therefore, there is a need to define all the stakeholders' responsibility and accountability to effectively implement these smart technologies into the agriculture sector. Apart from this, the misuse of big data is creating additional legal and ethical challenges for regulation and monitoring. Therefore, the Government needs to take the initiative to establish a regulatory architecture in this area.

## GOVT. INITIATIVES IN THIS DIRECTION

The Government has taken a few praiseworthy initiatives such as the following:

1. It encourages farmers to employ drones by offering financial incentives through the "Sub-Mission on Agriculture Mechanization."
2. For agricultural initiatives, the Indian Government has launched the Digital

Agriculture Mission 2021-25. Its goal is to assist and expedite projects that use emerging technologies such as artificial intelligence, blockchain, remote sensing, GIS and the usage of drones and robots.

3. The Union Ministry of Agriculture and Farmers' Welfare signed five MOUs (Memorandums of Understanding) with CISCO, Ninjacart, Jio Platforms Limited, ITC Limited, and NCDEX e-markets Limited in September 2021. These memoranda of understanding will include five pilot projects to advance digital agriculture to assist farmers in deciding what crops to produce, what seeds to use, and what best practices to apply to maximize production. In the third quarter of last year, Cisco released an Agricultural Digital Infrastructure (ADI) solution that improves farming and knowledge exchange.

## CONCLUSION

AI will considerably improve the farming industry's efficiency. However, we must ensure collaboration between Governments, agricultural scientists, IT firms, and businesses regarding adequate investment and research. It requires mature reforms considering the expanding population, farmer requirements, operational policies, and dwindling farmland. Furthermore, research on a comprehensive framework for evaluating digital agricultural solutions is necessary, including criteria for determining sustainability, social, economic, ecological, technological, quality, and interoperability. To put it another way, artificial intelligence (AI) can assist in the development of a robust agricultural economy. The Government could potentially foster it through public-private partnerships (PPPs). MA

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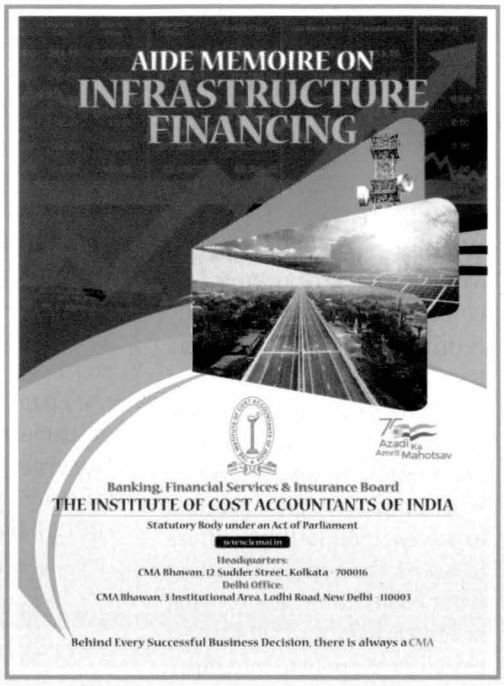


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