The Pharma Innovation Journal 2023; SP-12(7): 1426-1429

www.ThePharmaJournal.com

The Pharma Innovation

**ISSN (E): 2277-7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2023; SP-12(7): 1426-1429

www.thepharmajournal.com
Received: 03-04-2023
Accepted: 08-05-2023

**Mayur Raj**
Department of Agricultural Statistics, B.A. College of Agriculture, AAU Anand, Gujarat, India

**Jigar Suthar**
Department of Agri. Sciences, College of Agricultural Information Technology, AAU, Anand, Gujarat, India

**Nilesh Vegad**
Department of Agri. Extension, College of Agriculture, AAU Jabugam, Gujarat, India

**Corresponding Author:**
**Mayur Raj**
Department of Agricultural Statistics, B.A. College of Agriculture, AAU Anand, Gujarat, India

# Artificial intelligence aided Indian agriculture: A review

**Mayur Raj, Jigar Suthar and Nilesh Vegad**

**Abstract**
Indian agricultural industry needs to become more flexible and effective to meet difficulties like climate change, supply chain disruptions, and growing population etc. Farmers face various hurdles during crop life cycle i.e., right from seed procurement stage to crop harvesting and selling. Also, with depleting resources like land, water, and human labour, it is difficult to match the growing demand of food grain. So, there is substantial need to conserve natural resources and at the same time help farmers. Emerging areas of information technology like Artificial Intelligence (AI) and AI based Internet of Things (IoT), can boost agricultural productivity, increase crop yield & quality, and lower the cost of food production. High computing power from cloud can be used to predict food grain demand and estimate yield by analyzing Big Data using Deep Learning algorithms. This paper reviews penetration of AI usage in Indian agriculture.

**Keywords:** Agriculture, artificial intelligence, internet of things, big data, deep learning

## Introduction
Currently, 37.7% of the earth's surface is dedicated to growing crops. Agriculture has a significant role in providing bread and butter and contributes to the national economy. The rural community's per-capita income has significantly increased as a result of agriculture. Therefore, it will be sensible and appropriate to give the agricultural sector more attention (Talaviya *et al*., 2020) [27].

Agricultural sector accounts for 17.8% of Gross Value Added in India and for 54.6% population it is primary source of earning (Anonymous, 2021) [4]. Mogili & Deepak (2018) [16] stated that growth in the agricultural sector is directly proportional to rural development and its transformation. By 2050, as per the Food and Agriculture Organization report, 60 per cent more food will be required to feed. Thus, it is mandatory to boost agriculture productivity using depleting natural resources (Silva, 2012) [24]. India faces unique difficulties such as inadequate infrastructure, ignorance, reliance on traditional values, ignorance, and a lack of farmer capital. Due to their ignorance or unawareness, farmers frequently have trouble selecting the ideal seeds, planting schedules, and crop-enhancing practices. As per Dhanaraju *et al*. (2022) [8] current research and trends in society states that emerging technologies like artificial intelligence, block chain, IoT, cloud computing, mobile technology, and bigdata analytics etc. can help in precise utilization of natural resources and assist in solving food grain demand problem by increasing agriculture productivity. Raj & Vegad (2017) [20] posited use of remote sensing for evaluating current situations or estimate future for advisory, can help extension workers to disseminate location specific and precise advisory to the farmers. This paper highlights few profits leading AI implementation in India.

## Artificial Intelligence
Artificial Intelligence has contributed to various domains and uplift working strategies for betterment of workforce. AI mimics the human brain. It can be used to preserve human expertise. AI has started changing human work environment, attitude, and way of thinking. AI basically is one of main research areas of computer science but has roots in mathematics, statistics, engineering, biology, linguistics, and psychology (Talaviya *et al*., 2020) [27]. Artificial Intelligence and its subsidiary branch Machine Learning (ML) and Deep Learning (DL) have a vast impact on data processing and analysing industry (Ammulu, 2021) [2]. It is used to map crops from remotely sensed images for yield mapping, optimizing irrigation, crop planning, and making planning decisions. To extenuate shortage of agriculture labour, Agribots and machinery based on AI and machine learning can become a viable option.

These robots can harvest more quickly and correctly detect and eradicate weeds, which lowers operational expenses and labor requirements. Due to ease in accessibility AI based agricultural chatbots are also gaining popularity. Agriculture is a source of big data, thus, data mining with AI and its subsidiary branch has started playing significant role in improving farmers life with timely and precise information.

**Internet of Things**

The Internet of Things (IoT) is a network of networked devices, ranging from basic sensors to smart phones and tablets. It is a relatively new concept that is gaining hold quickly in the world of contemporary wireless telecommunications. From US $ 4.98 billion in 2020, it is anticipated to increase to US $ 9.28 billion by 2025 in India (Editors, 2022) [10]. Due to the recent advent of this paradigm, writers utilize a variety of terminology to refer to the IoT's devices, including "mobile device," "smart device," "mobile technologies," and "mobile smart device." (Silverio-Fernández *et al*., 2018) [25]. Both the quality and quantity of the agriculture sector can be enhanced using IoT. Agriculture still confronts many obstacles, such as meeting the demands of a growing global population, cutting production costs, and responding to climate change. All these challenges can be mitigated using IoT (Singh *et al*., 2021) [26].

**Big Data**

Bigdata refers to vast amounts of information in each field or relevant to it, whose growth is exponential. Thus, standard databases are unable to accommodate it. Also, its complexity is high since it can be unstructured, semi-structured or structured (Raj *et al*., 2018) [21]. This type of data is generated via sensor, remote sensing data. Sensors are used in farms to collect crop phenological changes, moisture status or to collect weather data. Since decades sensor are used to collect minute weather data in meteorology observatories. IoT based local weather stations are best for precision agriculture in Indian region (Math & Dharwadkar, 2018) [14].

**Objective**

To review status of usage of Artificial Intelligence in Indian Agriculture.

**Artificial Intelligence in Agriculture**

Artificial Intelligence can assist in detailed field analysis, crop monitoring, and field surveys etc. Balasubramanian (2017); Sharma *et al*. (2016); Dutta *et al*. (1998) [6, 22, 9].

Agrawal & Agrawal (2021) [21] proved that data pertaining to Meteorology, soil, rainfall, and infestation is needed from sources like remote sensing, IoT, precision farming, drone imagery, and proximity sensing for providing intelligent information.

Chithambarathanu & Jeyakumar (2023); Liu & Wang (2021) [7, 13] showed that artificial intelligence-based plant identification, pest infestation and diseases identification are also gaining popularity.

Javaid *et al*. (2022) [11] asserted that surveillance alert systems based on AI are becoming prevalent to prevent crop damage caused by animal or human breaches.

Raj *et al*. (2015) [17] in their review paper showed that pattern matching a branch of AI is used to identify good quality agricultural products; grading of seeds or cultivars (Raj & Swaminarayan, 2015) [19].

Cognitive computing has emerged as the most disruptive technology in the agricultural services sector because it can learn from, interpret, and interact with many situations to boost production. The yield per hectare rose on average by 30% for 175 farmers for whom Microsoft was providing advisory. Throughout the trial project, agricultural AI applications were utilized to provide information about dates, soil preparation, fertilizer based on soil tests, seed treatment, appropriate spreading depth, and more. Additionally, for facilities and locations with radiation that cannot be analyzed, digital agricultural robots backed by mobile robots and field sensors, transdisciplinary cameras, and laser scanners are used. (Anonymous, 2016) [3].

Raj *et al*. (2016) [18] classified major 5 wheat varieties grown in Gujarat using 11 features comprising of shape, color and morphological characteristics with more than 90% accuracy. According to them, the main concern is the grading of new varieties announced by breeders, as new varieties are created by crossing existing varieties. For this new varieties well-established and optimized machine learning algorithms can lead to poor results in these variants.

Roy *et al*. (2019) [28] derived inventory and assessment method from sentinel imagery for coriander crop in the Rajasthan region. Using multiple date data classification accuracy increased to 91.14% as different phenological stages helped in crop discrimination using Maximum Livelihood Classifier.

Mishra *et al*. (2023) [15] showed that IoT based system utilizes water adequately for plant watering based on moisture value and its current requirements which encourages the proper plant growth.

Koshy *et al*. (2018) [12] provided personalized advisory services to the Groundnut growing farmers of Andhra Pradesh and to develop cohesion between Agriculture, Revenue and Irrigation department for information sharing and better decision-making, HARITA-PRIYA (Harmonized Information of Agriculture, Revenue and Irrigation for a Transformation Agenda-Precision Technology for Agriculture) a pilot project was implemented. Location specific and personalized advisory was provided based on micro-climate information collected via Wireless Sensor Networks (WSN) installed in farmers' field. In collaboration with Indian Institute of Oil Seeds Research, WSN based system was developed for forewarning of castor diseases in Hyderabad and Palem farms. Crop growth stage and other parameters were used to determine the Percentage Diseases Incidence (PDI). Based on PDI forewarning advisory is sent to the farmers. The author has proposed coupling of IoT data and Unmanned Aerial Vehicle (UAV) system for better advisory.

The usage of drone or UAV applications optimized water usage to 10 liter/acre from 50 liter, increase production from 1.00-2.00 tones/acre to 2.73-3.00 tones/acre, and precise application of fertilizers by spraying for the paddy farmers of Pazhayannur in Thrissur who were facing problems like labour shortage, low production, high cost of inputs (Anonymous, 2022) [5].

Shukla *et al*. (2022) [23] helped the potato and peppermint farmers of Barabanki, Uttar Pradesh, who were facing the issue of late blight identification. Impact of drone usage was seen on yield from 50 kg/acre to 70 kg, on time preventive measure was taken by early detection of late blight disease, and judicious use of inputs significantly increased profit margin.

## Conclusion

Use of AI for agriculture sector has just sprouted in India, so only few case studies are available and majorly it is used in remote sensing. IoT and Bigdata for agriculture domain are also boon and should be explored more. Even though it appears promising, using AI, IoT and Bigdata in agriculture is not without its difficulties. It has a long way to go because a lot of data is needed, and high computing power is required for machine learning algorithms to expediate training process and generate high accuracy. This is one of the reasons artificial intelligences isn't used in field solutions, but rather in quality and quantity assessment of agricultural products like seeds, crops or fruits etc.

Automated grading of agricultural products varies product wise and even by its variety. This even varies from region to region. So new models or algorithms are required.

In the case of remote sensing, multispectral spatial data is easily and freely available nowadays, but it is difficult to find temporal data for big agricultural areas. At the farm level, solutions must be more accessible, affordable to small and marginal farmers, and open source. The use of this emerging technology can transform Indian agriculture and improve the sustainability of farmers and meet food demand. With persistent efforts and scalable inventions in AI, IoT and Bigdata from the public and commercial sectors, more farmers can benefit.

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