IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

# Artificial Intelligence, Machine Learning, and Internet of Things in Indian Agriculture: Opportunities and Challenges

**Pramod Mahale**
Assistant Professor
Faculty of Engineering and Technology,
Datta Meghe Institute of Higher Education and Research (DU),
Sawangi (M) Wardha (MS) India
E-mail: pramodm.feat@dmimsu.edu.in

***Abstract*- Day by day the use of advanced technology in the field of agriculture is inevitable for increasing crop production for food security. The use of new technologies such as artificial intelligence and the internet of things (IoT) can be possible to reduce the cost of cultivation, reduction in time for various operations, quality of work, uniformity of applications, and reduction in drudgery. This can be done through with exact diagnosis of diseases and pests, efficient application of water, efficient application of inputs, and identifying the crop maturity at right time. The different uses of artificial intelligence (AI) and the Internet of Things (IoT) in agriculture are discussed in this study, Artificial Intelligence in Agriculture. Crop selection is another area where artificial intelligence is useful in agriculture. AI-based solutions are of great importance for choosing crops depending upon factors including soil type, monsoon dates, availability, and affordability. Monitoring of crops is possible, involving data collection from the fields via IoT, drones, and satellite imaging, followed by monitoring and analysis by AI-based applications to find the best solutions. For improved results from this technology, AI training also has to take into account the expertise and experience of farmers in their industry.**

Keywords: agriculture, mechanization, artificial intelligence, Internet of Things, machine learning

## I. INTRODUCTION

The agriculture sector has immense importance for food security looking into the increasing population and day-by-day reduction in cultivable land. Technology has been used in agriculture throughout human history to boost production and decrease the demand for labor-intensive human labour. Modern technology which uses high-yielding varieties, manures and chemical fertilizers, herbicides, use of improved implements, and machines brought remarkable progress in agriculture by increasing production in which researchers and farmers played an important role [1]. But still, the aspects of nutrient management, water management, disease, and insect/pest management, weed management, and crop maturity identification at a minute level cannot be done and requires a major labor force as well as time. Nowadays other than the agriculture sector like healthcare application of AI and ML plays an important role [1]. The use of this modern technology in the agriculture sector through various applications can be done and the same is elaborated on upcoming sections of the paper.

## II. APPLICATION OF AI, ML AND IoT

The Internet of Things is the connection of various devices through an electronic device, and the Internet provides accurate data that is useful to make the right decisions. In contrast to artificial intelligence, which is a technology that can learn, make decisions, and solve problems, a technology called the "Internet of Things" links many gadgets together. Below are some examples of how artificial intelligence is being used in agriculture as presented in Figure 1.

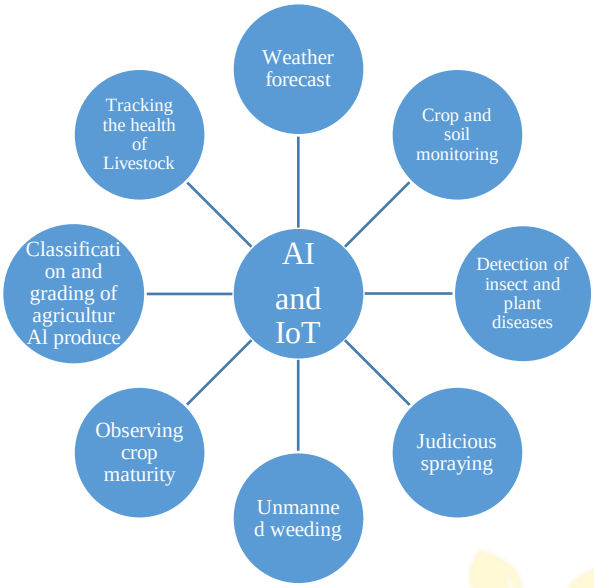


**Figure 1: Applications of AI and IoT in agriculture**

*Weather forecast*

The most obvious application of AI is in weather forecasting because climate affects agriculture globally. There are numerous similar programmes in various nations that forecast the weather.

*Crop and soil surveillance*

Identifying the precise nutritional content of soil is a challenging process. The quantity and quality of the yield, as well as the health of the crop, are directly influenced by the micro- and macronutrients in the soil. Monitoring the various growth stages while the crops are still in the ground is crucial for maximizing production effectiveness. In order to make changes for better crop health, it is crucial to comprehend how crop growth and the environment interact. In the past, human observation and judgment were used to assess the health of the soil and the crops. Alternatively, we can utilize unmanned aerial vehicles (UAVs) to collect aerial image data, train computer vision models to use it for precise monitoring of crop and soil conditions, and then analyze the data. This approach, however, is neither precise nor timely. Visual sensing data may be evaluated and interpreted by artificial intelligence to check crop health, predict yields with accuracy, and spot crop malnutrition far faster than humans can. Additionally, farmers can be alerted to specific problem areas by artificial intelligence models so that they can act right away.

*Using Computer Vision to Reach the Ground*

To describe soil texture and soil organic matter, soil computer vision is crucial. In order to characterize the soil present-day technique is to dig up soil samples from different parts of a field at various depths and then bring them to a lab which is a time-consuming examination. Instead, of that, it can be decided to test if the same thing can be accomplished by training an algorithm using the picture data from a low-cost portable microscope. Undoubtedly, the machine vision model was able to produce estimations of sand concentration and SOM that were as accurate as pricey lab processing. Therefore, a computer vision system is not just significantly more effective than humans at crop and soil monitoring than it is at arduous, physical labour.

*Detection of insect and plant diseases*

While crop maturity and soil quality may be detected and analyzed using artificial intelligence computer vision, deep learning-based Image Recognition Technology (IRT) can now automatically identify plant diseases and pests in environments with less predictable agricultural settings. This works by developing models that use classification, detection, and picture segmentation methods to monitor plant health.

*Judicious spraying*

Computer vision can spot disorders in crop and also helps to prevent them. Unmanned aerial vehicles (UAVs) with computer vision artificial intelligence can be sued to spray insecticides or fertilizer consistently across a field automatically. UAV sprayers can be functioned with high precision both in terms of the area and volume to be sprayed thanks to real-time detection of target spraying areas. As a result, there is a considerably lower chance of poisoning water supplies, crops, people, and animals. Although there is a lot of potential in this sector, there are still some difficulties. For instance, using numerous UAVs to spray a broad area is far more effective, but determining the precise task sequences and fly paths for each craft can be challenging. To apply accurate amounts of herbicide with precision targeting, a camera fitted on the sprayer detects the geo-location of weeds and evaluates the size, shape, and colour of each challenging plant.

*Unmanned weeding*

Intelligent sprayers can become useful by using artificial intelligence for weed control. In addition, there are computer-vision robots that remove undesirable plants in even more direct ways. Similar to how computer vision can detect an insect, weed detection. The ability to manually remove weeds not only saves a farmer but also reduces the use of chemicals, making farming considerably more environmentally friendly and sustainable.

Robots can also be used for weed management. It can identify weeds and distinguish them from crops. In order to create robots that carry out autonomous weeding, machine learning and computer vision algorithms are coupled. The weeds are found and eliminated by the agricultural robot using a camera and image recognition software. Through picture training on leaf size, shape, and colour, it is easy to distinguish between weeds and crops.

*Observing crop maturity*

Detection of crop maturity for every crop is important for harvesting the crop, but it is very difficult as well as labour intensive also. Crop maturity is not the same throughout the field and in such a situation use of artificial intelligence can help the farmers to make an accurate judgment on crop maturity and the subsequent action. There can be different techniques for different crops to identify crop maturity such as the images of crops can be collected, an algorithm can be created that will analyze the color of the fruit, and based on that the crop maturity can be assessed.

*Classification and grading of agricultural products*

The use of artificial intelligence through computer vision can help the farmers for grading and sorting of their agricultural produce after harvesting. Similar to how artificial intelligence is used to identify flaws, diseases, and pests on plants, imaging algorithms can be used to sort and grade products according to shape and size as well as to differentiate good produce from faulty ones. To analyze fruit and vegetables for size, shape, colour, and volume, computer vision automate the sorting and grading process with accuracy rates and speed significantly higher than even a skilled professional.

*Tracking the health of livestock*

Our agricultural system also includes a significant amount of animals like cows, chickens, and pigs, who require more monitoring and tracking than plants. Algorithms for computer vision are used to monitor the health and activity of cattle using overhead cameras. This means that finding a problem does not require a cattle farmer to be present immediately next to the cow. Instead, the cattle can be monitored remotely and in real time, allowing farmers to be alerted as soon as a problem is identified. Animal counting, disease detection, seeing aberrant behaviour, and keeping tabs on important events like delivery are all possible using computer vision. It can also collect data from cameras and drones (UAVs), and it can be combined with other technologies to inform farmers about the health of their livestock and their access to food and water.

By doing aerial surveys and imaging and use of computer vision applications for surveying land and can monitor crops and livestock. In order to assist farmers in monitoring their crops, artificial intelligence can evaluate photographs obtained from satellites and drones. It won't need to constantly monitor the fields because it will be alerted right away if something seems off. The accuracy and effectiveness of pesticide application can both be improved by using aerial imagery.

*Opportunities for AI and IoT in Indian agriculture*

The right use of technological innovations like the use of AI, the IoT, and drones (UAV) in the field of agriculture can bring a major change in increase in production, reducing physical work and drudgery, identification and assessment of diseases, and insect pest control.

Traditional farming practices based on outdated techniques frequently produce worse results. Technology development should be used to improve land productivity and comprehend all facets of the agriculture industry. IoT affects the lives of the average person by making practically every field sophisticated and smart. A very promising role for the IoT and ML in improving the agricultural sector. This chapter discusses recent cutting-edge work with IoT and ML in the realm of agriculture as well as the difficulties associated with using the appropriate technologies in this industry. Automation in agriculture can increase productivity and possibly lessen interference from people. IoT is being employed in a variety of industries. Machine learning an application of artificial intelligence, gives the system the ability to automatically learn and get better with time. In the agriculture sector, ML and IoT can play a very promising role in studying many farming-related aspects. The variables could be weather and irrigation conditions as well as soil variables including pH, moisture, temperature, and humidity.

*Challenges for AI and IoT application in Indian agriculture*

The majority of the farmers are marginal farmers having landholding less than < 2 hectares also the size of the land is very small many times they are not able to sustain the cost of buying the seeds and other essentials [1]. This situation is really a tricky one to accept and invest in such technology.

The affordability and know-how of these technologies is a major challenge to the Indian farmers for the application. The framers in India are completely dependent on others for the inputs they applied on farms as well as to sell their produce on the other side the entire agriculture is weather dependent, which directly influences their income. Skill for using the latest technology and equipment is a must for efficient use of technology. Farmer cannot ensure a guaranteed income from their produce and as the produce is perishable he has to sell his produce for whatever amount they received.

AI can become a life-changing solution in the field of agriculture which depends on the quality of data that is available. It is a huge challenge in India to get relevant data at a farmer's level. Data collection is not so easy also farmers are reluctant to share their data and thus it can be a challenge. The technological answer could be a solution for data collection. The data can be collected in an automated way with the use of technology without any force.

Agriculture mechanization is a need of the hour looking into the increase in urbanization which results in labor scarcity in the rural area at the same time due to drudgeries in agriculture work most of the persons are reluctant to work. So agriculture mechanization is not done crop-wise as well as area-wise in India. Focus can be made on some crops and areas specifically to improve mechanization. In some operations of agriculture use of equipment and machines is needed to apply the concept of AI and ML.

Due to the lack of online services and experience managing AI operations, the majority of AI systems may not be able to be used in remote or rural locations. [6]

Due to variables in the illumination, the complexity of the background, the angle at which the image was taken, and other factors, the photographs produced in practice differ from the images utilized in control situations. Furthermore, even at the same site, grains grown in the field are physically heterogeneous due to the influence of other factors including insects, soil, and inert materials. Consequently, a larger and more varied collection of control data was needed to increase the existing classification accuracy because the physiological characteristics of an individual increase the complexity of variables to be taken into account while processing photographs.

Nevertheless, despite the limited number of case studies, algorithms like DBN (Deep Belief Networks) and CNN (Convolution Neural Network) suggest intriguing future applications for processing enormous volumes of complex data. [1]. Additionally, the most pertinent data should be processed in order to reduce a system's reaction time. The ability of a system to complete activities accurately and quickly determines its economic value and has a significant impact on user choice. Customers prioritize accuracy and reduce the amount of work required on their part. [2].

Security and privacy of many physical devices, such as the Internet of Things (IoT), are first vulnerable to assaults on the hardware since they may be left unattended in an open location for extended periods of time. Common security countermeasures include data encryption, tag frequency modification, tag destruction rules, the use of blocker tags, etc. Location-based services are also susceptible to device capture attacks, meaning that once the device has been captured, the attacker will be able to extract any cryptographic implementations and will therefore have full access to all of the data on it. Similar vulnerabilities apply to data transfers from the device to the gateway, where they are then uploaded to other infrastructures like the cloud.

## III. CONCLUSION

This paper presents an overview of various aspects of agriculture where AI, IoT and ML can be used and automation of agriculture can be done. By using these applications drudgery of agriculture workers can be reduced to a large scale by increasing the quality of work and cost of cultivation. To apply this technology technical know-how is a pre-requisite so that the desired results can be achieved. Although there are challenges for small and marginal farmers some of the technology can be availed on the basis of a custom hiring process such as the use of drones for judicious spraying.

## REFERENCES

[1] A Saxena, T Suna and D Saha. Application of Artificial Intelligence in Indian Agriculture, In book: Souvenir: 19 National Convention – Artificial Intelligence in Agriculture: Indian Perspective. RCA Alumni Association, Udaipur, India. 2020, pp 14-22

[2] Jiali Zha. Artificial Intelligence in Agriculture" Journal of Physics: Conference Series, Volume 1693, The 2020 3rd International Conference on Computer Information Science and Artificial Intelligence (CISAI) 2020 25-27 September 2020, Inner Mongolia, China

[3] T Talaviya, D Shah, N Patel, H Yagnik, M Shah "Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides, 2020 pp 58-73.

[4] A. Subeesh, C.R. Mehta, Automation and digitization of agriculture using artificial intelligence and internet of things, 2021, pp 278-291.

[5] A. Bagchi. Artificial Intelligence in Agriculture. Accessed on 02.09.2022 https://www.mindtree.com/sites/default/files/2018-04/Artificial%20Intelligence%20in%20Agriculture.pdf

[6] L M Bhar, Ramasubramanian V., Alka Arora, Sudeep Marwaha and Rajender Parsad. Era of Artificial Intelligence: Prospects for Indian Agriculture.

[7] A. Baruah, Artificial Intelligence in Indian Agriculture – An Industry and Startup Overview. Business intelligence and analytics. 2019

[8] G S Dhaliwal, S B Jindal. Mohindru, Crop Losses due to insect pests: Global and Indian Scenario. Indian Journal of Entomology, 2015, pp. 77:165-168.