

ARTIFICIAL INTELLIGENCE IN AGRICULTURE

**T. Sri Chandana* and
K. Madhuri**

S.V. Agricultural College,
Tirupati-517502, Andhra
Pradesh, India



*Corresponding Author

T. Sri Chandana*

E-mail:

talarisrichandana39@gmail.com

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INTRODUCTION

Agriculture is the backbone of India's economy. It is the principal livelihood for over 58% of the rural households. But it faces difficult challenges from sowing to harvest. Hence modernization of agriculture is most needed to address these challenges. In agriculture there is a quick adaptation to AI in its various farming techniques where Artificial Intelligence (AI) is one of the key areas of research in computer science with its rapid technological advancement and vast area of application, AI is becoming relevant very rapidly because of its robust applicability in the problems particularly that cannot be solved well by humans.

Artificial intelligence (AI) is a branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. The “AI” term was coined by John McCarthy, an American computer scientist, back in 1956 at The Dartmouth Conference. The term artificial intelligence composed of word “artificial” (made or produced by human being rather than occurring naturally) and “intelligence” (the ability to acquire and apply knowledge and skills). Artificial intelligence (AI) makes it possible for machines to learn from past experience, adjust to new inputs and have the ability to execute tasks naturally associated with human intelligence, like speech recognition, decision-making, visual perception and translating languages.

Applications of artificial intelligence (AI) in Indian agriculture

1. Crop health monitoring: Assessment of the health of a crop, as well as early detection of crop infestations is critical in ensuring good agricultural productivity. Stress associated with such as climate change, nutrient deficiencies, weed, insect and fungal infestations must be detected early enough to provide an opportunity for the farmers to mitigate.

AI can be used to predict advisories for sowing, pest control, input control can help in ensuring increased income and providing stability for the agricultural community. Using high resolution weather data, remote sensing data, AI technologies and AI platform, it is possible to monitor crops holistically and provide additional insights to the farmers for their farms as and when required.

2. Microsoft, ICRISAT develop sowing application for farmers using AI: A sowing application for farmers combined with a personalized village advisory dashboard for Andhra Pradesh has been developed by Microsoft India in collaboration with International Crops Research Institute for Semi- Arid Tropics (ICRISAT). The sowing app advises farmers on the best time to sow crops depending on weather conditions, soil and other indicators. The sowing app is developed to provide powerful cloud-based predictive analytics to empower farmers with crucial information and insights to help reduce crop failure and increase yield, in turn, reducing stress and generating better income.

3. Soil health monitoring: Soil is for the farmer what the pulse is for the doctor. It helps them take decisions about when to irrigate, when and what to sow, nutrient application and so on. Image recognition and deep learning models have enabled distributed soil health monitoring without the need of laboratory testing infrastructure. AI solutions integrated with data signals from remote satellites, as well as local image capture in the farm and help farmers to take immediate possible action to restore the soil health.

4. Soilsens: A technology called soilsens is a low cost smart soil monitoring system has come as a potential help to farmers facing farming decisions predicament. The system is embedded with soil moisture sensor, soil temperature sensor, ambient humidity sensor and ambient temperature sensor. Based on these parameters, farmers are advised about optimum irrigation through a mobile app. This data is also available on cloud. It can help with guidance about ways to optimize water usage

as per the requirement of the crop and soil. The system can also help to avoid over irrigation, thus protecting crops from disease, prevent leaching of nutrients from the soil, saving water, electricity, predict early onset of diseases and offer advisories.

5. Agricultural robotics and drones: Agriculture robotics also known as an agribot, now becoming popular due to labor shortages and increased need to feed the global population. Agribots automate tasks for farmers, increasing the efficiency of production and reducing the industry's dependency on manual labor. This includes applications such as harvesting; picking, seeding, spraying, pruning, sorting and packing etc. Drones are equipped with multi-spectral and photo cameras that can monitor crop stress, plant growth and predict yield. It is time and labour saving technology in not having to go out to visual checking on a crop. The more advanced drones can carry and deliver payloads like herbicide, fertilizer and water.

6. Plantix app: Berlin-based agricultural tech startup PEAT has developed a deep learning application called Plantix that identifies potential defects and nutrient deficiencies in soil. The analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pest and disease. The app uses images to detect plant diseases and other possible defects through images captured by the user's smart phone camera.

7. Robot drone tractor: Robot will decide where to plant, when to harvest and how to choose the best route for crisscrossing the farmland. These robots are to reduce the usage of pesticides, herbicides, fertilizers and water.

8. Predictive analytics: With climate change, forecasts are now important for crop yields as farmers cannot end just on traditional knowledge. More accurate forecasts could enable farmers to pick the optimal days for planting or harvesting. AI techniques apply reinforcement learning on past predictions and actual outcomes. To aid in weather

forecasting, data is fed into an algorithm that uses deep learning techniques to learn and make predictions based on past data.

9. Supply chain efficiencies: Using AI, farmers would be able to understand market demand for their produce and also customer's choices and seasonality. This will help the farmers to get better return from their produce. AI-powered supply chains, on the other hand, can help improve their bottom line by reducing the cost incurred in managing distributed logistics and a multitude of middlemen. Through this smart routing, smaller farmers too will be able to organize their route to market more efficiently and gain benefits. They would also be able to get their perishable goods to market quicker without intervention of middlemen thus reducing wastage and losses.

10. Jivabhumii: Jivabhumii is an agri- tech platform for connecting farmers directly with Institutional buyers and consumers. Jivabhumii partners with farmers, farmers group, aggregates farm produce and makes it traceable leveraging BLOCKCHAIN enabled platform called FOOTPRINT. Jivabhumii enables consumers (B2C) and institutional buyers (B2B) to buy chemical, pesticide free and traceable farm produce directly from the producers. FOOTPRINT is a produce aggregation and produce traceability solution which aggregates the farm produce and implements produce traceability using technology such as BLOCKCHAIN to capture the information of the produce at various levels in the supply chain. Its aim is to digitalizing agriculture to solve supply chain inefficiencies using technology.

11. Gobasco: Gobasco is an artificial intelligence-based platform that offers procurement, optimization and yield prediction solution for the agriculture sector. The aim is to use artificial intelligence and big data to optimize the agri-supply-chain across India. This approach provides farmers and agricultural SMEs (Small and Medium enterprises) with a data-rich technology platform and network to grow their profits,

thereby creating new opportunities in rural commerce.

12. Smart Irrigation: Soil and irrigation management issues are pertaining very crucial in agriculture. Improper irrigation and soil management lead to crop loss and degraded quality. Hence a smart management system is needed to improve the productivity. The smart Irrigation system is an Internet of things (IoT) based device which is can automate the irrigation process by analysing the moisture of soil and the climate condition. Automated irrigation systems are designed to utilize real time machine which can constantly maintain desired soil conditions in order to increase average yields. Not only reduces the drudgery of farmers significantly but also provide the potential to drive down productions costs.

13. Decrease Pesticide Usage: Weed management can be effectively done by implementing computer vision, robotics and machine learning. With the help of the AI, data are collected to check the weed infestation area which helps the farmers to spray chemicals only where the weeds are. By this there is a reduction in over pesticide losses as well as herbicide losses. To address the issues AI-enabled agriculture bots help farmers to find more efficient ways to protect their crops from weeds. This also helps farmers to overcome the labour challenge.

14. Chat Bots for Farmers: Chat bots includes automates interactions with end users like conversational virtual assistant. In agriculture these are used for communication between farmers, government stakeholders, manufacturers and markets. Agriculture could also grasp this emerging technology by assisting farmers with answers to their questions, giving advice and recommendations on specific farm problems. Timely and interactive monitoring of the crops remotely will be provided by this innovative mode.

15. Automation of Green House: There are many factors that influence plant growth and the ripening of produce in green house. It is impossible for humans to analyse all these factors and know exactly how plants will

grow. AI makes analysis of all these growth factors possible and provides highly accurate assessments of plant growth.

AI startups in Agriculture:

1. Prospera, founded in 2014. It has developed a cloud-based solution that aggregates all existing data that farmers have like soil/water sensors, aerial images and so on. It then combines it with an in-field device that makes sense of it all. The Prospera device which can be used in green houses or in the field is powered by a variety of sensors and technologies like computer vision. The inputs from these sensors are used to find a correlation between different data labels and make predictions.

2. Blue River technology, founded in 2011. This California-based startup combines artificial intelligence, computer vision and robotics to build next-generation agriculture equipment that reduces chemicals and saves costs. Computer vision identifies each individual plant, machine learning decides how to treat each individual plant and robotics enables the smart machines to take action.

3. Farm Bot, founded in 2011. This company has taken precision farming to a different level by enabling environment conscious people with precision farming technology to grow crops at their own place. The product, Farm Bot comes at a price of \$4000 and helps the owner to do end-to-end farming all by himself. Ranging from seed plantation to weed detection and soil testing to watering of plants, everything is taken care of by this physical bot using an open source software system.

Challenges in AI Adoption in Agriculture

Though Artificial Intelligence offers vast opportunities for application in agriculture,

there still exists a lack of familiarity with high tech machine learning solutions in farms across most parts of the world. Exposure of farming to external factors like weather conditions, soil conditions and presence of pests is quite a lot. AI systems also need a lot of data to train machines and to make precise predictions. In case of vast agricultural land, though spatial data can be gathered easily, temporal data is hard to get. For example, most of the crop-specific data can be obtained only once in a year when the crops are growing. Since the data infrastructure takes time to mature, it requires a significant amount of time to build a robust machine learning model. This is one reason why AI sees a lot of use in agronomic products such as seeds, fertilizer, pesticides and so on rather than in-field precision solutions. Also in India adopting the AI in agriculture becomes more cost expensive and simultaneously it promotes unemployment.

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