Article Id
AL04207

ARTIFICIAL INTELLIGENCE AND ITS APPLICATIONS IN AGRICULTURE

[1]Vishal Yadav*, [2]Ashutosh Kumar and [3]Preeti Yadav

Email

vishalyadav9220@gmail.com

[1]Department of Extension Education, ANDUA &T, Kumarganj, Ayodhya, India

[2]Shree Durga Ji PG College, Chandeshwar, Azamgarh, India

[3]Kulbhaskar Ashram PG College, Prayagraj, India

Artificial intelligence (AI) is a technology that demonstrates behavior that can be described as human intelligence. Artificial intelligence is a branch of computer science that deals with the simulation of intelligent behavior in computers. AI refers to the ability of machines to perform cognitive tasks such as thinking, perceiving, learning and problem-solving and decision making. AI technologies can predict the most accurate crop for a specific area and time. Today, how to ensure food security for the world's growing population is one of the major global challenges, while at the same time ensuring long-term sustainable development. According to the FAO, food production must grow by 70% to feed the world's population, which will reach 9 billion by 2050. Policy makers need to make AI a key element in flagship programs such as Make in India, Skill India and Digital India. Farmers need to look for cognitive technologies (e.g. AI) to increase crop yields. It largely solves the problem of shortage of resources and manpower. Artificial intelligence can prove to be a technological revolution and boom agriculture to feed the growing human population of the world.

Agriculture is extremely important to India's economy. Agriculture is the primary source of income for more than 58 per cent of rural households. Agriculture and allied sectors (including agriculture, livestock, forestry, and fishing) are anticipated to account for 15.87 per cent of Gross Value Added (GVA) in 2018-19 at 2011-12 prices, according to the Central Statistics Office (CSO). Agriculture accounts for around 17.3% of GDP.

While the demand for agricultural products is tremendously increasing year by year, the resources are constrained. Therefore, to produce more with minimal inputs, the main machine interaction method will lead to quality outputs with sustenance by removing several

barriers in agriculture sector. In consideration of man machine method, artificial intelligence plays an influential role in establishing the best production and management practices. Most of the developed countries have customized Artificial Intelligence based technologies implemented at farm level for site specific farming viz. appropriate distribution of fertilizers and chemicals in farms, smart irrigation, intelligent processing, crop health monitoring, disease analysis, positioning of farm machineries, pest surveillance, secure storage and distribution analysis, consumption analytics of agriculture products and monitoring of animal health. The implementation of artificial intelligence in agriculture has been used more effective precision farming tool for post- harvest productions, minimizing the wastage and simplifying the transportation of output products etc. (Anonymous 2018)

Artificial Intelligence

Artificial intelligence (AI) is a technology that displays behaviour that resembles human intellect. Artificial intelligence (AI) is an area of computer science concerned with simulating intelligent behaviour in computers. The ability of machines to execute cognitive functions such as thinking, perceiving, learning, problem solving, and decision making is referred to as artificial intelligence (AI). Artificial Intelligence is not a battle between man and machine; rather, it is a collaboration between man and machine. But the question is whether artificial intelligence can be used in agriculture. Is it possible for a machine to outperform a human in making judgments involving other living organisms in a complicated environment? Is it possible for an algorithm to outsmart a farmer's instincts and experience?

Need of Artificial Intelligence in Agriculture

One of the most pressing global issues today is providing food security for a growing global population while also assuring long-term sustainable development. In this regard, one of the most pressing needs is the application of cutting-edge technical solutions to make farming more precise and efficient. Scarcity of labour and rising labour expenses, as well as crop failures owing to illnesses, lack of rainfall, climatic changes, and loss of soil fertility, as well as shifting market prices in agriculture commodities, have all had a substantial detrimental impact on farmers' socio-economic position.

On the other hand, rising population has increased demand for food grains, resulting in agricultural commodity price inflation. We can design smart and exact farming procedures using artificial intelligence to reduce farmer losses and offer them with high yields with

accuracy, allowing farmers to manage all the unknown difficulties they encounter in the agriculture business.

Evolution of Artificial Intelligence

1950: Alan Turning, He published a landmark paper in which he speculated about the possibility of creating machines that think.

1951: In the field of artificial intelligence, Christopher Strachey created a checkers programme while Dietrich Prinz created a chess software.

1956: The phrase "Artificial Intelligence" was coined by John McCarthy in a Dartmouth conference.

1959: The first AI laboratory, the MIT AI Lab, was established.

1960: General Motors' Robot debuts in 1960. On the GM assembly line, the first robot was introduced.

1961: First Chatbot-In 1961, ELIZA, the first AI chatbot, was introduced.

1997: In the game of chess, IBM's Deep Blue defeats champion Garry Kasparov.

2005: The autonomous robotic car Stanley, built by the Stanforf Racing Team, wins the 2005 DARPA Grand Challenge.

2011: IBM in 2011.

Types of Artificial Intelligence

1) **ANI (Artificial Narrow Intelligence):** it's all over the place, like Google maps, and it's great for discovering efficient routes to places when driving, or it can be compared to a chess programme. It's also characterized as "weak AI," because it only applies AI to select activities. Examples: Alexa, Siri, Sofia, and self-driving cars are just a few examples.
2) **AGI (Artificial General Intelligence):** imagine a computer that is as intelligent as a person in every way. So, anything we can do with our brain, including learning, is possible.
3) **ASI (Artificial Super Intelligence):** AI is becoming more powerful every day, with applications leading to machines and systems leading to more advanced AI, such as ASI (Artificial Super Intelligence).

Applications of Artificial Intelligence in Agriculture

1. Internet of Things (IoT)

The Internet of Things, or IoT, is a network of interconnected computing devices that can send and receive data without the need for human-to-human or human-to-computer contact. IoT technology enable for the linkage of structured and unstructured data to deliver food production insights. Every day, massive amounts of organized and unstructured data are generated. These include information such as historical weather patterns, soil reports, fresh research, rainfall, pest infestation, and photographs from drones and cameras, among other things. All of this data may be sensed by cognitive IoT devices, which can deliver powerful insights to boost yield. The IoT enabled sensors must be installed in the field at the prescribed locations to collect data on climatic conditions, soil moisture & fertility, root & shoot growth, profuse leaves growth, photo-period monitoring, floral & seed setting, grain/fruit bearing, pest & disease as critical growth factors symptoms and harvest readiness.

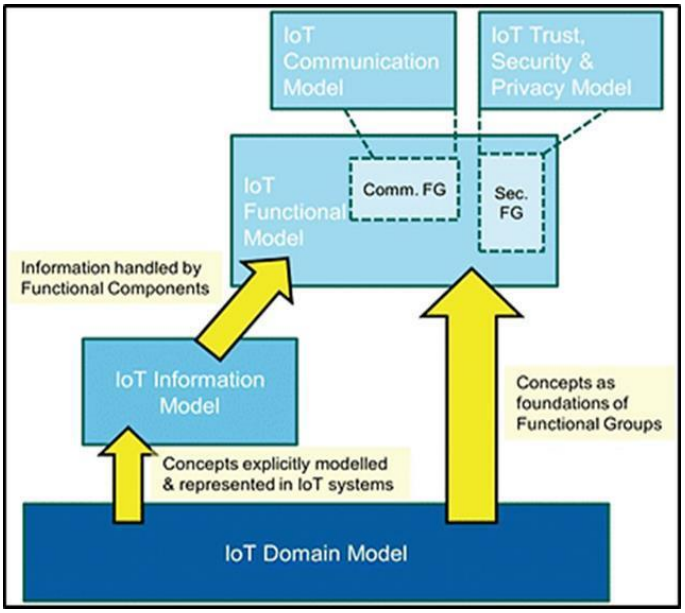


Fig 1: Internet of things (IoT) Domain Model

2. Precision/Site-Specific farming

Precision farming is defined by the four R's: right place, right time, right method, and right product. This is a more precise and controlled process that takes the place of the labor-intensive and repetitive aspects of farming. It also includes information on crop rotation.

Precision Farming Objectives

Profitability: Profitability is determined through carefully identifying crops and markets, as well as projecting return on investment based on cost and margin.

Efficiency: Investing in precise algorithms allows for better, faster, and less expensive farming options. This ensures overall accuracy and resource efficiency.

Sustainability: Improved social, environmental, and economic performance ensures that all performance measures improve incrementally each season.

3. Drone Based Technology

Agriculture is one of the most promising fields, where drones have the ability to solve huge problems. Agriculture is getting a high-tech facelift thanks to drone technology. Drones will be employed in six different ways throughout the crop cycle:

Soil and field analysis: Drones can help with seed planting and data collection for irrigation and nitrogen management.

Planting: Drone-planting technologies developed by start-ups have reduced planting expenses by 85 per cent. These systems fire pods containing seeds and nutrients into the soil, supplying all of the nutrients required for crop growth.

Crop spraying: Drones can scan the ground and spray crops in real time for even coverage. As a result, aerial spraying with drones is five times faster than traditional gear.

Crop monitoring: Drones can use time-series animations to depict the progress of a crop and uncover inefficiencies in production, allowing for improved management.

Irrigation: Sensor drones can detect areas of a field that are dry or in need of improvement.

Health assessment: Drone-carried gadgets can assist track changes in plants, indicate their health, and alert farmers to illness by scanning a crop using both visible and near-infrared light. Unmanned aerial vehicles (UAVs) could one day be made up of autonomous swarms of drones that collect data and perform tasks.

4. Artificial Intelligence in Image-Based Insight Generation

Precision farming is one of the most hotly debated topics in agriculture today. Drone-based photos can assist with in-depth field analysis, crop monitoring, field scanning, and other tasks. Farmers can use a combination of computer vision technologies, IoT, and drone data to take quick actions. Drone image data feeds can create real-time alerts to speed up

precision farming. The following are some examples of applications using computer vision technology:

Disease detection: Pre-processing of the image ensures that the leaf images are split into areas such as background, non-diseased part, and diseased part. After that, the infected area is clipped and sent to distant labs for further analysis. It also aids in pest detection, nutrient deficit detection, and other tasks.

Crop readiness identification: Under white/UV-A light, images of various crops are collected to determine how ripe the green fruits are. Before shipping their crops to market, farmers can develop several levels of readiness based on the crop/fruit category and stack them separately.

Field management: By developing a field map and identifying places where crops require water, fertilizer, or pesticides, real-time estimates can be created during the cultivation period using high-definition photographs from airborne systems (drones or copters). This significantly aids resource optimization.

5. Artificial Intelligence in Optimal Mix for Agronomic Products

Cognitive solutions give suggestions to farmers on the best crops and hybrid seeds based on many characteristics such as soil condition, weather forecast, type of seeds, and infestation in a specific location, among others. The advice can be further customized based on the farm's needs, local conditions, and historical data on successful farming.

Farmers may also consider external elements like as market trends, prices or consumer wants in order to make an informed decision.

6. Artificial Intelligence in Remote Sensing

In contrast to on-site observation, such as of the Earth, remote sensing is the collecting of information about an object or phenomenon without establishing direct contact with the object. The phrase "remote sensing" is now commonly used to describe the use of satellite-or aircraft-based sensor technology to detect weather, crop infestation, irrigation management, and soil profile, among other things. This technology will also be used to track crops during their whole existence, as well as generate reports in the event of anomalies.

7. Artificial Intelligence in Automatic Irrigation System

An automatic irrigation system automates the operation of a system without the need for human intervention. Electronic appliances and detectors like as computers, timers, sensors, and other mechanical equipment automate every irrigation system, including drip, sprinkler, and surface watering. The use of an automatic irrigation system reduces crop production costs, making the industry more competitive and sustainable. Average crop yields must be maintained (or increased). Excessive applied water and subsequent agrichemical leaching have a negative influence on the ecosystem. Maintaining an adequate soil water range for plant growth in the root zone Low labour input for irrigation process maintenance and significant water savings when compared to irrigation management based on historical weather patterns.

Example: The Enorasis wireless sensor network is one example. (To produce a detailed daily irrigation plan that best matches the demands of each crop, this model integrates weather forecast and sensor data about the farm's crops.)

8. Artificial Intelligence in Quality Grading (Potato Sorting System)

The Robotics Lab at the University of Lincoln developed an artificial intelligence robotic system that sorts and detects potato illnesses like silver scurf and common scab. TADD, or the Trainable Anomaly Detection and Diagnosis system, can detect, classify, and quantify a variety of typical potato defects. In comparison to manual selection on an industrial scale, a potato sorting machine can display superior precision in detecting impacted or sick potatoes. It also has the potential to reduce labour costs and increase food safety assurance.

9. AI in Self-Driving Cars and Autonomous Navigation (Driverless Tractors)

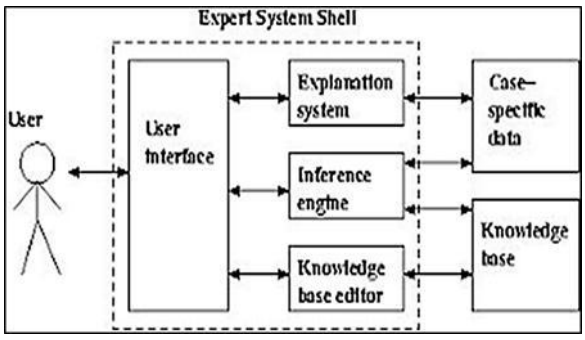
The system allows a combine operator to set the course of a driverless tractor pulling a grain cart, position the cart to receive grain from the combine, and then send the fully loaded cart to be unloaded using increasingly sophisticated software combined with off-the-shelf technology such as sensors, radar and GPS.

10. Artificial Intelligence in Expert Systems

An expert system is software that seeks to replicate the performance of one or more human experts, usually in a particular issue domain. The expert

system could be used for decision-making and technology distribution in specific locations. Expert systems aid in the selection of a crop or variety, the diagnosis or identification of pests, diseases, and problems, and the making of critical management decisions. The user, user interface, knowledge base, and inference engine are all critical components of an expert system.

Examples: Rice Crop Doctor, COMAX, COT FLEX, CUE, CROP LOT, SMART SOY etc.



The public installation where computers are deployed to make services available to the farming community is known as an information kiosk. The information kiosk serves as a hub for information tailored to the requirements of the community. Agri-kiosk is a one-stop shop for all agricultural needs, including soil testing, seed selection, appropriate pesticides, herbicides and fungicides, nutritional deficits and their management and video clips on various agricultural technology.

11. Artificial Intelligence in Decision Support System (DSS)

Decision support systems (DSS) are now widely utilized in a variety of industries to assist professionals in making decisions. A decision support system (DSS) can help with both organized and unstructured decisions. However, it cannot completely replace the decision maker because DSS lacks some human decision-making characteristics such as intuition, creativity, and imagination. It is, nonetheless, useful for enhancing a decision maker's ability to digest information or solve complex situations. It can also save a lot of time that a decision maker would need to grasp and process many parts of the problem. It can assist the decision maker in thinking out of the box and introducing new techniques, but DSSs are not ubiquitous; they are usually tightly focused on a single topic, such as yield prediction or fertilizers. A DSS's capabilities are also restricted by the computer system on which it runs, as well as the models and knowledge on which it is built.

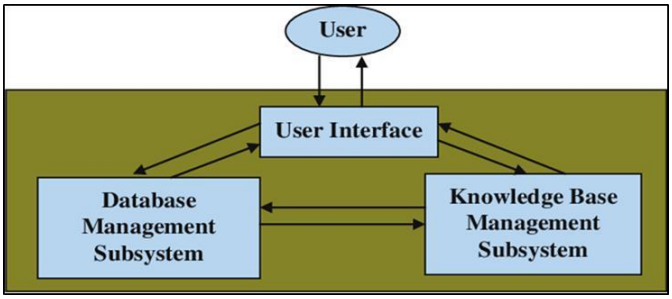


Fig 2: Decision Support System Model

12. Artificial Intelligence in Computer Vision Technology

Face recognition system for domestic cattle: Facial identification of cows in dairy units can track all elements of their behaviour in a group, including body condition and eating. When it comes to lameness, measuring the cow's back arch may provide an early indication of the problem. As a result of using this approach, you will be able to feed cows for a lot less money if you know what they will and will not eat. It's also possible to treat a lame cow before she displays signs of being lame, potentially saving months of diminished milk supply.

13. Artificial Intelligence in Gas Fermentation System

The gas fermentation system is an artificial intelligence-based system that predicts the outcome of the fermentation process in cattle. It can provide a degree of nutritional analysis of a feed in four hours that traditional methods take 48 hours to achieve. It provides a diagnostic technique to delivering qualitative and quantitative data on the rate and extent of carbohydrate digestion by cattle, allowing for the prediction of fermentation outcomes and the isolation of additive effects during the fermentation process.

14. Artificial Intelligence in Predictive Agriculture Analytics

Various AI and machine learning methods are being utilized to estimate the best time to sow seeds, get insect attack notifications, and other tasks.

15. Artificial Intelligence in Supply Chain Efficiencies

To establish an efficient and smart supply chain, companies use real- time data analytics on data streams from different sources. ICT Tools: Bhoomi, aAqua, e-choupal, Ikisan, mKisan, Agris Net, IFFCO, Agri watch, and other ICT tools. Applications for mobile devices: PAU Kisan App, Myhco Farmer's App, Plantix App, and so on.

AI Models for Farmers Services

The following service models can be offered to the recipients of this service.

a) Agri-e-Calculator for crop selection and resource estimation
b) Chatbot
c) Crop maintenance.
d) Market forecasting and guidance
e) Crop financing and insurance.
16. Artificial intelligence start-ups in agriculture

Blue river technology: Blue River Technology has developed a robot named See & Spray that uses computer vision to monitor and accurately spray weeds on cotton plants, according to the company. Herbicide resistance can be avoided by precision spraying.

Farm Bot: Everything is taken care of by this physical bot using an open source software system, from seed planting to weed detection and soil testing to plant watering.

Plant diseases diagnosis app-plantix: Plantix is plant disease diagnosis software that detects probable flaws and nutrient deficits in soil. The programme uses photos to detect plant problems; a smart phone collects images, which are then matched with a server image, and a plant health diagnosis is delivered.

Crop in-increasing per-acre value with artificial intelligence: Crop ins smart farm solution assisted with remote sensing and weather advisory, scheduling and monitoring farm activities for complete traceability, educating farmers on the adoption of the right package of practises and inputs, Microsoft India-AI-based Sowing App: Microsoft India has developed an AI-based sowing app in partnership with ICRISAT, which sends out sowing tips to farmers on the best time to seed. crop health and harvest estimation and pest, disease and other alerts.

Challenges of Artificial Intelligence in Agriculture

Despite the fact that Artificial Intelligence has a wide range of applications in agriculture, there is still a lack of familiarity with high-tech machine learning solutions at most farms throughout the world. Farming is highly exposed to environmental elements such as weather, soil conditions, and the existence of pests. Though spatial data can be easily acquired in the case of huge agricultural area, temporal data is difficult to come by. Most

crop-specific data, for example, can only be gathered once a year, when the crops are growing. Because data infrastructure takes time to grow, it takes a long time to develop a reliable machine learning model. This is one of the reasons AI is more commonly used in agronomic items like seeds, fertilizer, insecticides, and other agronomic products mostly by in in-field precision solutions.

Limitations

- Before large-scale agricultural AI implementation can be successful, the farm's data infrastructure will need to become more robust and IT-equipped.
- While AI is ideally suited for precision agriculture, it may be used more quickly for the creation of new seeds, fertilizers, or crop protection products. The issue isn't with AI deployment and development; it's with the lack of compatibility between the two environments when it comes to validation and testing.
- Machine learning and AI are still a long way from being able to forecast crucial agricultural outcomes solely based on machines' cognitive capacities.
- The issue with AI's success isn't that it doesn't function; it's that industry hasn't spent enough time recognizing that agriculture operates in a highly volatile environment.

Conclusion

AI technology assist farmers in analyzing land, soil, crop health, and other factors, saving time and allowing farmers to grow the optimum harvest for each season. AI-based forecasts allow for the recommendation of appropriate pesticides/crops/locations at the proper moment, prior to disease outbreaks on a big scale. There is a huge opportunity for the agriculture industry to leverage emerging technology of catboats for assisting farmers with all their queries and giving relevant advice and recommendations to their specific farm related problems, with a huge space still untouched in agriculture for the intrusion of automatic response systems. As a result, the AI market in agriculture is growing at a rapid pace.

References

Anmol MD. Artificial Intelligence in Indian Agriculture. -Millennium Development Goal, UN Summit, 2000.

Anonymous. National strategy for artificial intelligence for all, Discussion Paper, NITI Aayog, 2018.

Anonymous. National work shop on artificial intelligence: proceedings and recommendations. ICAR, New Delhi, 2018 July.

Anonymous Artificial intelligence for smart agriculture: proceedings: Punjab Agricultural University, Ludhiana, 2019 Feb.

Anonymous. National Sample Survey reports, 2019. Retrieved from http://www.mospi.gov.in/cso. On 28/08/2019.

Arka B. Artificial Intelligence in Agriculture To eradicate extreme poverty and hunger, 2001.

Arun G. How Internet of Things (IoT) is transforming the agriculture sector, 2019. Retrieved from https://www.businessofapps.com/insights/internet-of-things-iot-agriculture-sectoron.

Ayushman. Artificial Intelligence in Indian Agriculture-An Industry and Startup Overview, 2019. Retrieved from https://emerj.com/ai-sector- overviews/artificial-intelligence-in-indian-agriculture-an-industry-and- startup-overview.

Bannerjee G, Sarkar U, Das S, Ghosh I. (2018) Artificial Intelligence in Agriculture: A Literature Survey. *Inter J Sci Res in Comp Sci App and Man Stud*.;7(3):1-6.

Baruah, Ayushman. Artificial Intelligence in Indian Agriculture-An Indian Industry and Startup Review', 2018. Retrieved from www.emerj.com https://emerj.com/ai-sector-overviews/artificial- intelligence-in-indian-agriculture-an-industry-and-startup-overview.

Bauer M. IoT Reference Model. Enabling Things to Talk. Springer, Berlin, Heidelber, 2013.

Bhagawati K, Bhagawati R, Jini D. Intelligence and its Application in Agriculture: Techniques to Deal with Variations and Uncertainties. Int J Inte Sys & Appli. 2016;8(9):56.

Bhar LM, Ramasubramanian V, Arora A, Marwaha S, Parsad R. Era of Artificial Intelligence: Prospects for Indian Agriculture, 2019.

Dengel A. Special issue on artificial intelligence in agriculture. Springer, 2013.

Kumba S. AI in Agriculture-Present Applications and Impact, 2019. retrieved from https://emerj.com/ai-sector-overviews/ai-agriculture- present- applications impact/#targetText=Based%20on%20our%20research%2C%20the,faste r%20pace.

Kumbhar, Singh TP. A comprehensive study of application of decision support system in agriculture in Indian context. Inter J Comp App, 2013, 63(14).

Patrício DI, Rieder R. Computer vision and artificial intelligence in precision agriculture for grain crops: A systematic review. Comp and Ele in Agri. 2018;153:69-81.

Petr H, František K, Josef P. Design of intelligent decision support systems in agriculture Int J Math & Comp Simu. 2015;9:113-118.

Saira Gori. Artificial Intelligence And The Changing Dimensions Of Agriculture Sector In India. Int Res J Hum Res and Soc. Sci., 2018, 5(12).

Sriram N, Philip H. Expert System for Decision Support in Agriculture. TNAU Agritech, 2016.

Tooba M. A complete overview of Artificial Intelligence in Agriculture Market, 2018. Retrieved from https://krishijagra.com/news/a-complete- overview-of-artificial-intelligence-in-agriculture-market/.