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Review Article

Use of Artificial Intelligence in Agriculture: A Review

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ABSTRACT

We are at an interesting juncture in the evolution of the digital age, where there is an enormous amount of computing power and data in the hands of everyone. There has been an exponential growth in the amount of data we now have in digital form. Information management systems control the data collected and allow AI software to make decisions based on deep-learning techniques and machine learning through predictive analytics. These mathematical artificially intelligent formulas can assist with crop yield boosting by deciding on the best course of action for a crop from seed planting to harvest.

Keywords: *Artificial intelligence, Agriculture and Technology.*

INTRODUCTION

Background of study

Artificial Intelligence (AI) refers to the titivation of human intelligence in machines that are organized to think like humans and imitate their actions. AI makes it feasible for machines to learn from experience, adapt to new inputs and carry out human-like tasks. Using technologies; computers can be trained to attain specific tasks by processing large amounts of data and acknowledge patterns in the data. The spell Artificial Intelligence was coined in 1956 (Bhar et al., 2018). NITI Aayog has decided to focus on five sectors that are picturised to benefit the most from AI in solving societal needs:

a) **Healthcare:** greater access and affordability of quality healthcare.
b) **Agriculture:** magnified farmers' income, increased farm productivity and trimming of wastage.
c) **Education:** better access and quality of education.
d) **Smart Cities and Infrastructure:** efficient connectivity for urban population.
e) **Smart Mobility and Transportation:** smarter, guarded and safer modes of transportation and better traffic and crowding problems.

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Artificial intelligence importance in agriculture

Agriculture is one of the earliest, most important and salient professions in the world. Because the world population is continuing to grow and land is becoming scarcer, people need to get creative and become more efficient and innovative about how we farm, using less land to produce more crops and elevating the production and yield of the cultivated lands (Banu, 2015).

Nowadays the worldwide agricultural industry is turning towards AI technologies to help yield more , healthier crops, control pests, monitor soil and growing conditions, organize data for farmers, help with their workload, and improve a broader spectrum of agriculture-related tasks in the entire food supply chain, Sonam and Raghupathi (2018).

There are so many challenge areas where research and development using AI in Agriculture can give outstanding results. They are -

1. Insufficient demand prediction
2. Absence of guaranteed irrigation
3. Ill use of pesticides and misuse of fertilizers
4. Crop yield upgradation and improvement using real time advisory systems
5. Prior detection of pest attacks
6. Crop damage detection and analysis
7. Prediction of market for premier crop practices
8. Weed control and weed -crop distinction

Scope of AI in Agriculture

India is a country where over 58% of the rural population is dependent on agriculture in direct or indirect manner. Introducing AI tools and technologies to this sector can be ground breaking and transformative (Jain et al., 2012). The farming sector is still unorganized and scattered therefore **agriculture suppliers** are sourcing AI-powered tools to help the farmers accelerate and streamline their activities. A variety of agritech startups in India are already tapping on the potential of Machine Learning, Big Data, and Artificial Intelligence in agriculture. It is not just helping the farmers in assessing the soil, conditions, and crops for better yield but also offering predictive analysis and image reporting for effective farming advice (Bhar et al., 2018). Agriculture is seeing rapid adoption of Artificial Intelligence both in terms of agricultural products and in-field farming techniques. Currently, Microsoft is working with 175 farmers in Andhra Pradesh, India to provide advisory services for sowing, land, fertilizer and so on. This initiative has already resulted in 30% higher yield per hectare on an average compared to last year. The scope of AI in agriculture is endless and tapping on this technology can help alleviate the farmers' grief and eliminate agricultural crisis (Jat et al., 2017).

Applications of AI in Agriculture

1. Harvesting with robots.
2. Irrigation and water management
3. Quick-witted seed selection using seedgerm technology
4. Soil nutrition management
5. Nutrient and fertilizer usage.
6. Prediction of weather condition.
7. Weed management and pest control.
8. Increasing the share of price realisation to producers

How to Works Artificial Intelligence

AI works by combining large amounts of data with fast, iterative processing and intelligent algorithms, allowing the software to learn automatically from patterns or features in the data. AI is a broad field of study that includes many theories, methods and technologies, as well as the following major subfields:

Machine learning automates analytical model building. It uses methods from neural networks, statistics, operations research and physics to find hidden insights in data without explicitly being programmed for where to look or what to conclude.

A neural network is a type of machine learning that is made up of interconnected units (like neurons) that processes information by responding to external inputs, relaying information between each unit. The process requires multiple passes at the data to find connections and derive meaning from undefined data.

Deep learning uses huge neural networks with many layers of processing units, taking advantage of advances in computing power and improved training techniques to learn complex patterns in large amounts of data. Common applications include image and speech recognition.

Additionally support AI:

Graphical processing units are key to AI because they provide the heavy compute power that's required for iterative processing. Training neural networks requires big data plus compute power.

The Internet of Things generates massive amounts of data from connected devices, most of it unanalyzed. Automating models with AI will allow us to use more of it.

Advanced algorithms are being developed and combined in new ways to analyze more data faster and at multiple levels. This intelligent processing is key to identifying and predicting rare events, understanding complex systems and optimizing unique scenarios.

Application processing interfaces, are portable packages of code that make it possible to add AI functionality to existing products and software packages. They can add image recognition capabilities to home security systems and Q&A capabilities that describe data, create captions and headlines, or call out interesting patterns and insights in data.

In summary, the goal of AI is to provide software that can reason on input and explain on output. AI will provide human-like interactions with software and offer decision support for specific tasks, but it's not a replacement for humans – and won't be anytime soon.

Harvesting with robots

There is a reduction in the number of farm workers who don't want to do the often repetitive, seasonal work of picking fruit and vegetables day after day. This displays the fact that ripe fruit is often left unpicked due to worker shortages which means lost profits. Around 40% of a farm's profits, depending on the nature of the agribusiness, are spent on manual labor and salaries.AI can reduce that amount dramatically, as once machines are purchased; they pay for themselves over time. Just two examples of machine harvesting comes from Harvest CROO Robotics which has created hardware which picks ripe strawberries, and Abundant Technologies who have machinery which can harvest orchards of apple trees. This type of AI couples perception and action, so the autonomous machines can see what needs to be harvested, then proceeds to carry out the action of harvesting.

Irrigation and water management

Plants need a regular water supply to grow properly, and in areas of the world where rain and fresh water is scarce, growing crops is especially difficult. Modern AI methods of irrigation can keep track of the moisture levels in the soil through machine learning in agricultural settings in real-time to know exactly when to provide water to crops, and how much too to save water consumption (Jat et al., 2017). This means that farmers have more time to do important tasks and not have to worry about manually watering their crops (Jain et al., 2012). It is estimated that about 70 % of the freshwater supply on earth is used on agricultural practices, so managing this more effectively will have a knock-on effect on how this precious resource is used. Machines which are trained on historical weather pattern, soil quality and kind of crops to be grown, automate irrigation and increase overall yield. With close to 70% of the world's fresh water being used in irrigation, automation can help farmers manage their water problems in a better way (Bhar et al., 2018).

Automatic irrigation system

This works quite efficiently with a positive impact on the place where it is installed. When it is installed in the agricultural field, the water distribution to crops and nurseries becomes trouble free and doesn't require any human help to perform the operations. Occasionally automatic irrigation can also be performed by using mechanical appliances such as **clay pots** or **bottle irrigation system**. It's very challenging to implement irrigation systems because they are very expensive and

complicated in their design. Here are some technologies –

A. Automatic Irrigation System on Sensing Soil Moisture Content

The automatic irrigation system on sensing soil moisture project is made for the development of an irrigation system that switches submersible pumps on or off by using relays to perform this action on sensing the moisture (water) content of the soil. The main advantage of using this irrigation system is to reduce human interference in fields and ensure proper irrigation. The Microcontroller acts as a serious block of the whole project, and an influence supply block is employed for supplying power of 5V to the entire circuit with the help of a transformer, a bridge rectifier circuit and a transformer. The 8051 microcontroller recieves the input from the sensing material which consists of a comparator to understand the varying conditions of the moisture in the soil. Once the microcontroller gets the info from the sensing material – it compares the info as programmed during a way, which generates output signals and activates the relays for operating the submersible pump. The sensing arrangement is completed with the assistance of two stiff metallic rods that are inserted into the agricultural field at a long way.

B. Solar Powered Auto Irrigation System

In agricultural field, the right usage of automatic irrigation method is extremely vital thanks to some shortcomings of the important world like scarcity of land reservoir water and scarcity of rainfall. The water level is getting reduced because of the continuous extraction of water from the bottom and thus gradually leading to water scarcity within the agricultural zones slowly turning them into barren lands. In the above irrigation system, solar power generated from the solar panels is employed for operating the irrigation pump. The circuit comprises moisture sensors built by using OPAMP IC. The OP-AMP is used as comparators. Two stiff copper wires are inserted into the soil to understand whether soil is wet or dry. A charge controller circuit is employed to charge the photovoltaic cells for supplying the solar power to the entire circuit. A moisture sensor is employed for sensing the soil condition – to understand whether the soil is wet or dry, and therefore the input signals are then sent to the 8051 microcontroller, which controls the whole circuit. The microcontroller is programmed by using KEIL software. Whenever the soil condition is 'dry', the microcontroller sends commands to the relay driver and therefore the motor gets switched on and supplies water to the sector. And, if the soil gets wet, the motor gets transitioned (Jain et al., 2012).

Soil nutrition management

AI techniques help to monitor the health of the soil before planting and also during the growing process. This technique is used to analyze soil deficiencies and can make visual perception with the help of drones and detect certain areas of crop which are growing in defected soil, or suffering from disease and pests. This is done by imaging foliage which afterwards is run through software which can differentiate between normal and diseased growth patterns.

Soil sensors

These sensors measure a variety of essential soil properties. These can be used in association with a Global Positioning System (GPS) to generate field maps of particular soil properties.

Measurement of soil properties

In an ideal precision agriculture system we must measure and know all the properties of soil in order to sow the correct crop's seeds in correct place. Most sensors and applicator controllers developed take certain time for measurement, integration, and/or adjustment, which decreases the allowable operation speed or measurement density. Variable rate fertilizer and pesticide applicators need some additional information to develop prescription algorithms. A map-based approach may be more desirable because it can collect and analyze data, make the prescription, and conduct the variable rate application in two or more steps. In this case, multiple layers of information including yield maps, a digital elevation model (DEM), and various types of

imagery could be combined together using a geographic information system (GIS) software package designed to manage and process spatial data, Sonam and Raghupathi (2018).

Various Sensors used for Automated Measurements

Nowadays following types of sensors are being used -

- Airflow
- Electrochemical
- Electromagnetic
- Mechanical
- Optical

Airflow sensors

These are used to measure soil air permeability. These show potential for distinguishing between various soil types, moisture levels, and soil compaction.

Electrochemical sensors

These provide information about soil nutrient levels and pH. The values obtained may not be as precise as a laboratory test, but the high sampling density increases the overall accuracy of the results of soil nutrient or pH maps.

Electromagnetic sensors

These use electric circuits to measure the capability of soil particles to conduct electrical charges. Several such sensors are commercially available. Other soil properties such as residual nitrates or soil pH can also be predicted using these sensors.

Mechanical sensors

These can be used to estimate soil mechanical resistance. These sensors use a mechanism that penetrates and enters deep into the soil and records the force measured by strain gauges or load cells.

Optical sensors

These use light reflectance to characterize soil. These sensors simulate the human eye when looking at soil and also measure near-infrared, mid-infrared, or polarized light reflectance. Various remote sensing services allow measurement of virgin soil reflectance using a satellite. Several optical sensors are also available to predict clay, organic matter, and moisture content.

Trace Genomics

This gives us data to know what to plant, how to improve soil health, which treatments to employ and much more. First thing we need to do is digitalize the living soil by applying soil DNA extraction and sequencing process to quantify millions of microbes in the soil. Then afterwards we decode that data, by high speed, cost efficient data analysis to compare against a large set of soil data. At last, we do good decision-making by enabling data-driven, evidence-based recommendations for the best actions to take.

Nutrient & fertilizer usage

Soil does not always provide all the nutrition for crops so farmers have to rotate fields regularly. Farmers provide crops with essential nutrition in the form of nitrogen fertilizer. Modern AI can detect how much fertilizer will be needed to cut down on wastage. **Rowbot** is an image-based machine which collects plant data during growth. It then delivers fertilizer to the crops that need it the most (Bhar et al., 2018).

Weather predictions

aWhere

aWhere uses AI technology to predict weather patterns which enables farmers to take the right steps ahead of time. It measures everything from solar radiation, to precipitation, temperature speculations and wind speed to provide accurate data.

Weed management and pest management

AI sensors use image sensing to detect features of diseases in plant leaves. AI machines are able to distinguish between healthy and diseased leaves, and subsequently remove them through integration with robotics. See & Spray is a robot which uses AI machine learning along with computer vision to seek out weeds in the field which affect crop growth and subsequently remove them. Precision spraying helps to prevent herbicide resistance, Sonam and Raghupathi (2018).

Drones in agriculture

- Collect aerial data with drone.
- Upload data to cloud account and generate high resolution maps and elevations.

- Analyze and summarize data with on demand analyse tool.
- Manage and share the data.

Sensors used in drones

- Visual sensor
- Video sensor
- Thermal sensor
- Multispectral
- Hyperspectral
- Lidar

Application of drones in agriculture

- Plant counting and yield prediction.
- Plant health indices.
- Plant height measurement.
- Canopy cover mapping.
- Assess field performance.
- Stockpile measuring.
- Drought stress identification.
- Disease pressure mapping.

Importance of Drone

Drones in agriculture have a lot of significance in terms of –

- Managing adverse weather conditions, productivity gains and yield management.
- Produce a 3-D field map of detailed terrain, drainage, soil viability and irrigation.
- Nitrogen-level management
- Aerial spraying with seeds and plant nutrients into the soil
- Spray liquids by modulating distance from the ground
- Collect precision field images

Startup companies on AI in Agriculture

1. Aerobotics
2. Abundant robotics
3. Agvoice
4. Indigo Agriculture
5. Farmshots
6. Motorleaf
7. Satsure
8. Agricx
9. Gobasco
10. Intello labs
11. Crop In
12. Aibono

Some more examples-

Kisan Suvidha mobile application facilitates dissemination of information to farmers on parameters viz., Weather; Market Prices; Plant Protection; input Dealers (Seed, Pesticide, Fertilizer) Farm Machinery; extreme weather alerts; Soil Health Card; Cold Storages & Godowns; Veterinary Centers and Diagnostic Labs.

CONCLUSION

Artificial intelligence including remote sensing techniques and 3d laser scanning are helpful to monitor crops throughout their lifecycle. Image recognition has enabled soil health monitoring without the need of laboratory testing infrastructure. AI solutions have made it possible for farmers to take immediate actions to restore soil health. AI is used now-a-days to predict advisories for sowing, pest control, input control can help in ensuring increased income and providing stability for the agricultural community. Using remote sensed data, high resolution weather data, AI technologies, and AI platform, it is now possible to monitor crops in a better way and provide additional insights to the extension workers/farmers for their farms as and when required.

REFERENCES

Banu, S. (2015). Precision Agriculture: Tomorrow's Technology for Today's Farmer. *J Food Process Technol*, *6*, 1-6.

Bhar, M. L., Ramasubramanian, V., Arora, A., Parsad, R., & Marwaha S. (2018). Artificial Intelligence in Agriculture: Status and prospects in India. National workshop on Artificial Intelligence in Agriculture: 8-18.

DoA & C. (2000). Policy framework for agricultural extension (draft), Extension division, Department ofAgriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi p 1-112.

Jain, D. P., Krishna, V., & Saritha, V. (2012). A Study on Internet of Things based Applications. Agriculture news p 36.

Jat, S., Kumhar B. L., & Sharma K. C. (2017). The role of ICT in India's agriculture and rural development. International Conference on Advances in Agricultural and Biodiversity Conservation For Sustainable development (ABCD – 2017) on 27 – 28 Oct., 2017 at C.C.S. University, Meerut (U.P.) pp 241.

Mathur, Dhrupad, Gupta, P., & Sridevi, A. (2009). e-Governance approach in India- The National e-Governance Plan (NeGP), In: R K Bagga and Piyush Gupta (Eds.) Transforming Government: e-Government initiatives in India, The ICFAI University Press, Hyderabad.

NPFF, (2007). National policy for farmers 2007, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi.

Sonam, S. K., & Raghupathi, B. (2018). Artificial Intelligence in Agriculture: Global Statu National workshop on Artificial Intelligence in Agriculture: 1-7.