International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Applications of Artificial intelligence in Agriculture

Dr. Harsha R. Vyawahare, Sukhada Shripad Tare
Assistant Professor -Computer Science &Engineering,Sipna College of Engineering & Technology
Student, Computer Science and Engineering, Sipna College of Engineering & Technology

ABSTRACT
The application of AI in agriculture has been widely considered as one of the most viable solutions to address food inadequacy and to adapt to the need of growing population. The main concept of AI in agriculture is its flexibility, high performance, cost-effectiveness. This paper presents an accurate review of the applications of AI in soil management, crop management, weed management and disease management Internet of Things.

INTRODUCTION

The term "Artificial intelligence" was first introduced in the 1955. Dartmouth conference by John McCarthy. intelligence is a branch of computer science dealing with the simulation of intelligent behavior in computers. "Artificial intelligence is not a man versus Machine, it's infact Man with Machine energy."[1]

Agriculture, an essential consideration of any country, is still one of the major challenges currently. It is approximated that over 820 million people are in hunger today. Furthermore, with global expected to reach 9.1 billion in 2050, 70 percent more food needs to be produced. In addition, an expanding gap between a growing water demand and the availability of water supply is anticipated, and it is likely that over Three billion people would experience by 2025. [3]

The introduction of AI to agriculture will be enabled by other technological advances, including big data analytics, robotics, the internet of things, the availability of cheap sensors cameras, drone technology, and even wide-scale internet coverage on geographically dispersed fields. By analyzing soil management data sources such as temperature, weather, analysis, moisture, and historic crop performance. AI systems will be able to provide predictive insights into which crop to plant in a given year and when the optimal dates to sow and harvest are in a specific area, thus improving crop yields decrease the use of water, fertilizers, and pesticides. Via the application of AI technologies the impact on natural ecosystems can be reduced, and worker safety may increase, which in turn will keep food prices down and ensure that the food production will keep pace with the increasing population [2]

Status of AI application in agriculture

Agriculture today stands armed with drones and robots programmed to gather data from production fields to advance precision agriculture or 'smart farms'. Further, interconnected technologies and high performance analytics are helping farmers in understanding real time data. Farmers are drawing insights like how to increase crop yield, input use efficiency, improve farm management, and make environment friendly decisions on the level of resources needed and where to apply them. Farm productivity is set to

increase in times to come as cognitive computing in agriculture continues to grow. This is transforming ordinary farms into digitally controlled 'smart' farms. Smart farming refers to managing farms using modern information and communication technologies to increase the quantity and quality of products while optimizing the human labour required.
It is paramount to review the application of AI to agriculture in respect to soil, crop, diseases and pest management [1]
Soil is a critical part of successful agriculture and is the original source of the nutrients used to grow crops. Soil is the basis of all production systems in agriculture, forestry and fishery. Soil stores water, nutrients and proteins in order to make them available for proper crop growth and development. [2]

1. SOIL MANAGEMENT

Soil Management is an integral part of agricultural activities. A sound knowledge of an integral part various soil types and conditions will enhance Crop yield and Conserve soil resources. It is the use of operations, practices and treatments to improve soil performance.[4]
A summary in Al soil management techniques is shown in Table I Management-oriented modeling (MOM) minimizes nitrate leaching as it consists of a set of generated plausible management alternatives, a simulator that evaluates each alternative, and an evaluator that determines which alternative meets the user-weighted multiple enteria. MOM uses "hill- climbing" as a strategic search method that uses "best-first" as a tactical search method to find the shortest path from start nodes to goals. Knowledge of engineering for constructing the Soil Risk Characterization Decision Support System (SRC- DSS) involves three stages: knowledge acquisition, conceptual design and system implementation. An artificial neural network (ANN) model predicts soil texture (sand, clay and silt contents) based on attributes obtained from existing coarse resolution soil maps combined with hydrographic parameters derived from a digital elevation model (DEM). The dynamics of soil moisture are characterized and estimated by a remote sensing device embedded in a higher-order neural network (HONN) [2]

Technique	Strength	Limitations
MOM	Minimizes nitrate leaching; maximizes nitrogen production.	Takes time; limited to only a few conditions.
Fuzzy Logic / SRC-DSS	Can classify soil according to associated risks.	Needs big data; only a few cases were studied.
DSS	Reduces erosion and sediment yield.	Requires big data for training.

ANN	Can predict soil enzyme activity; accurately classifies soil structure.	Measures only a few soil enzymes; classification focus rather than soil performance improvement.
ANN	Can predict monthly mean soil temperature.	Considers only temperature as a factor.
ANN	Predicts soil texture accurately.	Requires big data; restrictions in areas of implementation.
ANN	Predicts soil moisture effectively.	Fails over time due to unpredictable weather conditions.
ANN	Successfully reports soil texture.	Does not improve soil texture or provide solutions to poor soil texture.
ANN	Cost-effective, saves time, shows ~92% accuracy.	Requires large datasets.
ANN	Estimates soil nutrients after erosion.	Estimate limited to specific nutrients only.

Table 1. AI IN SOIL MANAGEMENT SUMMARY

CROP MANAGEMENT

The crop management techniques are summarized in Table II. Crop management starts with sowing, and continues with monitoring growth, harvesting, and crop storage and distribution. It is summarized as the activities that improve the growth and yield of agricultural products. In-depth understanding of class of crops according to their timing and thriving soil type will certainly increase crop yield. Precision crop management (PCM) is an agricultural management system designed to target crop and soil inputs according to field requirements to optimize profitability and protect the
environment. PCM has been hampered by lack of timely. distributed information on crop and soil conditions. Farmers must combine various crop management strategies to cope with water deficit resulting from soil, weather or limited irrigation. Flexible crop management systems based on decision rules should be preferred. Timing, intensity, and predictability of drought are important features for choosing among cropping alternatives [1]
Proper understanding of weather patterns helps in the decision-making process that will result in high and quality crop yield. PROLOG utilizes weather data, machinery capacities, labor availability, and information on permissible and prioritized operators, tractors, and implements for evaluating the operational behavior of a farm system. It also estimates crop production, gross revenue, and net profit for individual fields and for the whole farm. Crop prediction methodology is used to predict the suitable crop by sensing various soil parameters and parameter related to the atmosphere. Parameters like soil type, PH, nitrogen, phosphate, potassium, organic carbon, calcium, magnesium sulfur, manganese, copper, iron,

depth, temperature, rainfall, humidity Demeter is a computer-controlled speed-rowing machine, equipped with a pair of video cameras and a global positioning sensor for navigation. It is capable of planning harvesting operations for an entire field, and then executing its plan by cutting crop rows, turning to cut successive rows, repositioning itself in the field, and detecting unexpected obstacles. The use of AI in harvesting cucumber comprises of the individual hardware and software components of the robot including the autonomous vehicle, the manipulator, the end-effector, the two computer vision systems for detection and 3D imaging of the fruit and the environment and, finally, a control scheme that generates collision-free motions for the manipulator during harvesting. Field-specific rainfall data and weather variables can be used for each location. Adjusting ANN parameters affects the accuracy of rice yield predictions. Smaller data sets required fewer hidden nodes and lower learning rates in model optimization. [5]

Technique	Strength	Limitations
CALEX	Can formulate scheduling guidelines for crop management activities.	Time-consuming.
PROLOG	Removes rarely used farm tools from the farm.	Location-specific; not generalizable.
ANN	Predicts cotton yield accurately.	Considers only weather as the factor affecting yield.
Robotics – Demeter	Can harvest up to 40 hectares of crops.	Expensive; consumes a lot of fuel.
Robotics (General)	Has ~80% success rate in harvesting crops.	Slow picking speed and accuracy.
ANN	Above 90% accuracy in detecting crop nutrition disorders.	Only a limited number of symptoms were considered.
Fuzzy Cognitive Map	Predicts cotton yield; improves decision-making for crop management.	Relatively slow performance.
ANN	Predicts crop response to soil moisture and salinity.	Considers only soil temperature and texture as factors.

ANN + Fuzzy Logic	Reduces insects that attack crops.	Cannot differentiate between crops and weeds.
ANN	Accurately predicts rice yield.	Time-consuming; works only for specific climates.

Autonomous vehicals such as autonomous tractors are given

Fig. 1. DRIVERLESS TRACTOR

DISEASE MANAGEMENT

To have an optimal yield in agricultural harvest, disease control is necessary. Plant and animal diseases are a major limiting factor regarding the increase of yield. Several factors play role in the incubation of these diseases which attack plants and animals, which include genetic, soil type, rain, dry weather. wind, temperature, etc. Due to these factors and the unsteady nature of some diseases causative influence, managing the effects is a big challenge, especially in large scale farming. Table III lists the AI applications in disease management available in the literature. To effectively control diseases and minimize losses, a farmer should adopt an integrated disease control and management model that includes physical chemical and biological measure. To achieve these is time consuming and not at all that cost effective, hence the need for application of AI approach for disease control and management. Explanation block (EB) gives a clear view of the logic followed by the kernel of the expert system. A novel approach of rule promotion based on fuzzy logic is used in the system for drawing intelligent inferences for crop disease management. A text-to-speech (TTS) converter is used for providing capability of text-to-talking user interface. It provides highly-effective interactive user interface on web for live interactions [45] A rule based and forward chaining inference engine has been used for the development of the system that helps in detecting the diseases and provide treatment suggestion in [2]

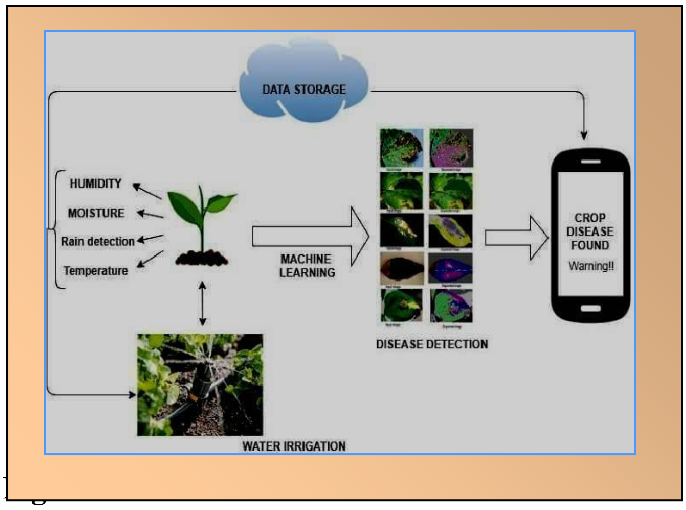
Technique	Strength	Limitations

Computer Vision System (CVS), Genetic Algorithm (GA), ANN	Works at high speed; can multitask.	Dimension-based processing may affect good species.
Rule-Based Expert System, Database (DB)	Accurate results in tested environments.	Inefficient when implemented on a large scale.
Fuzzy Logic (FL), Web GIS	Cost-effective, eco-friendly.	Scattered data distribution; slow to locate and disperse data; depends on mobile browser for data access.
FL Web-Based Intelligent Disease Diagnosis System (WIDDS)	Good accuracy; responds quickly to disease patterns.	Limited usage; requires internet; tested on only four seed crops.
FL & TTS Converter System	Resolves plant pathological problems quickly.	Requires high-speed internet; relies on voice-based multimedia interface.
Expert System (Rule-Based) in Disease Detection	Faster diagnosis and treatment; cost-effective; supports preventive measures.	Time-consuming to maintain; requires constant monitoring to see if pests develop immunity.
ANN, GIS	~95% accuracy.	Internet-based; rural farmers may lack access.
Fuzzy Logic + Xpest System	High precision in pest forecasting; provides useful pest information.	Internet dependent.
Web-Based Expert System	High performance.	Requires stable internet and web support.
ANN	Above 90% prediction accuracy; reduces disease impact.	Cannot kill infections; only reduces severity.

TABLE-III AI IN DISEASE MANAGEMENT SUMMARY

CROP HEALTH MONITORING

The use of drones equipped with AI As powered cameras has made crop monitoring easier and more efficient. These crops can capture high resolution images of crops and use machine during algorithms to identify potential issues such as nutrient deficiencies discuses and posts [3]



AI in Weed Management

Weed consistently reduces the farmer's expected profit and yield. A report confirms a 50% Reduction in yield for dried beans and corn crops if weed infestations not controlled. There is about 48% loss in wheat yield due to weed competition. There is about 4.8 % loss in wheat yield due to These losses may at times rise up to 60%. A study on the impact of weed on soyabeen showed about 8% -55 % Deduction in yield. The fluctuation in yield losses may be attributed to the length of exposure of the CROPS to the weeds and spatial heterogeneity of weeds [1]

A system can utilize an unmanned aerial vehicle (UAV)- imagery to divide image, vegetation indexes, detect crop rows, optimize parameters and learn a classification model Since crops are usually organized in rows, the use of a crop row now detection algorithm helps to separate properly weed and crop pixels, a common handicap given the spectral similitude of both. Weed control in sugar beet, maize, winter wheat and winter barley, can. be done by applying only online weed detection using digital image analysis taken by an UAV drone computer based decision making and global -positioning system (GPS)-Controlled patch spraying. The drone travelled at a speed of 1.2 km/h,with 68.10ms and 37.44 mms execution time to find the tomato and weed to the spray controller respectively. Table IV lists a summary of the AI in weed in weed management uses (2)

Technique	Strength	Limitations
ANN, GA	High performance; reduces trial-and-error processes.	Requires large datasets (big data).
Invasive Optimization (IVO), ANN	Cost-effective; enhanced performance.	Adaptation challenges when new data is introduced.
Mechanical Weed Control, Robotics, Sensor-Based Machine Learning	Saves time; removes resistant weeds.	Expensive; heavy machines reduce soil productivity.
UAV + GA	Quickly and efficiently monitors weed growth.	Little to no direct control on weed spread; expensive.
Saloma Expert System (Evaluation, Prediction & Weed Management)	High adaptation rate and strong prediction ability.	Requires big data and technical expertise to use.
Support Vector Machine (SVM), ANN	Quickly detects crop stress; facilitates timely, site-specific remedies.	Detects only low levels of nitrogen stress.
Digital Image Analysis (DIA)	More than 60% accuracy after refinement; good success rate.	Required 4 years of GPS-based work; highly time-consuming.
UAV	High weed-detection rate in a short period.	Very expensive; requires significant human expertise.
Learning Vector Quantization (LVQ),	High weed-	Data

ANN	recognition rate; short processing time.	input/quantization method reduced AI performance.

TABLE IV. AI IN WEED MANAGEMENT SUMMARY

Internet of Things

The Internet of Things (IOT)is a system consisted of computing devices, mechanical machines and various objects that are interrelated, and each is provided with unique identifier and possesses the of date transfer.co capability of data transfer [1]

IOT in agriculture uses robots, drones, remote sensors and computer imagings combined with continuously progressing machine learning and analytical tools for monitoring crops, surveying and mapping the fields and provide data to farmers for national farm management plans to save both time and money. [4]

Conclusion

This review presents an overview of the application of AI technology in agriculture to the current AI can be appropriate and efficacious in agriculture sector as it optimizes the resources use and efficiency. It s solves scarity of resources and labour to a large extent. Adoption of AI quite useful in Agriculture. Artificial intelligence can be technological Revolution and boom in agriculture to feed the increasing population.

References

[1] Jiali Zha. (2020). Applications of Artificial intelligence in Agriculture.
[2] N.C.C(2013) Applications of Artificial Intelligence in Agriculture A Review.
[3] S.Vijaykuman (2022) Artificial Intelligence (AI) and its application in Agriculture.
[4] Pavank. I and Prakash KK (2020) "Implementation of artificial intelligence (AI) for sustain agriculture"
[5] SHIVANI P "Artificial intelligence in agriculture”.