AN ANALYSIS OF THE LITERATURE ON ARTIFICIAL INTELLIGENCE IN AGRICULTURAL SETTINGS

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Abstract - *This study offers a thorough literature review on the topic of artificial intelligence methods and their use in farming. Disease and insect infestation, poor soil treatment, insufficient drainage and irrigation, and several other issues plague the agricultural sector. Excessive use of pesticides causes these problems, which in turn cause agricultural loss and environmental dangers. To tackle these challenges, several studies have been carried out. Thanks to its powerful learning capabilities, artificial intelligence has emerged as a crucial tool for addressing a wide range of issues in the agricultural sector. Experts in agriculture are working on systems to help them find better answers globally. This literature review encompasses one hundred significant contributions that tackled agricultural difficulties with the use of artificial intelligence approaches. This study delves into the use of AI methods in the primary area of agriculture, allowing readers to follow the multi-faceted evolution of agro-intelligent systems over the last four decades, from 1983 to 2023.*

Key Words: Artificial Intelligence; Agriculture; Literature Survey; Fuzzy logic; Artificial Neural Networks

1.INTRODUCTION

A major focus of computer science research is artificial intelligence (AI). Artificial intelligence (AI) is quickly becoming ubiquitous due to its large field of application and fast technical improvement. It is especially useful for issues that people and conventional computer systems struggle to address. An extremely important sector is agriculture, which employs over 30.7% of the global population on 27,81 million hectares of land. From planting seeds to reaping the rewards, such an enterprise encounters several obstacles. The most pressing concerns are infestations of pests and diseases, insufficient chemical treatment, poor drainage and irrigation, weed management, production projection, and so forth

In 1983, the first report on the use of computers in farming was made. Databases and decision support systems [4] are only two of the many proposed solutions to the current issues plaguing the agricultural sector. Regarding accuracy and robustness, systems that use AI have shown to be the best performers among these options. Because agriculture is a constantly evolving field, there is no silver bullet answer. Through the use of AI, we are now able to fully understand each scenario and deliver a tailored response. With the development of new AI systems, more difficult issues are being resolved.

This literature review encompasses two hundred significant papers that tackled the difficulties in agriculture by using AI approaches. The areas of concentration are three main AI techniques: expert systems, artificial neural networks, and fuzzy systems. This study tracks the use of AI methods in agriculture, a key subdomain, from 1983 to 2023, to help readers understand the slow but steady evolution of agro-intelligent systems.

OVERALL MANAGEMENT OF CROPS

Typically, crop management systems provide a platform for comprehensive crop management, including all facets of farming. When McKinion and Lemmon published their 1985 article "Expert Systems for Agriculture", they were the first to suggest using AI techniques in crop management. In his PhD thesis, Boulanger put out an alternative expert system for protecting maize crops. The POMME expert system was first suggested by Roach et al. in 1987 for use in apple orchard management. The COTFLEX expert system was developed by Stone and Toman for the management of cotton crops. For the purpose of managing cotton crops, Lemmon developed an additional rule-based expert system called COMAX.

To prevent frost damage to citrus trees on the Italian island of Sicily, Robinson and Mort developed a system based on a multi-layered feed-forward artificial neural network. When training and testing the network, the parameters used for input and output were encoded in binary form. In order to get the most accurate model, the authors experimented with various input setups. The top-performing model that was discovered has a 94% accuracy rate, two output classes, and six inputs. In order to improve the image information, Li, S. K. et al. suggested an image-based AI method for wheat crops that uses a pixel-labeling algorithm and subsequently a Laplace transformation. With five hidden layers trained to 300,000 iterations, the top network achieved an average accuracy of 85.9%. In order to help farmers with decisions like crop choice, fertiliser applications, and pest control, Prakash, C. et al. created a soybean crop management system based on fuzzy logic.

CONTROL OF ANTIGENS

One of the most concerning issues in agriculture that causes significant economic losses is insect pest infestation. Computerized systems that might detect active pests and propose management actions have been developed by researchers over decades in an effort to lessen this threat. There have been several proposals for rule-based expert systems, such as SMARTSOY by Batchelor et al. CORAC by Mozny et al. Knight and Cammell Mahaman et al.

Li et al. Chakraborty et al. Pratibha and Mansfield and many more. Using a rule-based expert system might introduce uncertainty due to the incomplete, unclear, and imprecise nature of the knowledge involved in agricultural management. Various expert systems based on fuzzy logic have been suggested to account for this ambiguity; they include IPEST by Hayo et al. Saini et al. Siraj and Arbaiy, Peixoto et al. Roussel et al. Shi et al. and Jesus et al.

Ghosh et al. developed TEAPEST, an expert system for pest control in tea, using an object-oriented approach to define a rule basis. A consultative and identification procedure that is phased out has also been implemented here. Samanta and Ghosh subsequently used a multi-layer back propagation neural network to redesign this system.

And then revised by Banerjee et al. to obtain better classification rates with the use of a radial basis function model.

Controlling Illnesses

A farmer's number one worry is crop diseases. Finding a sick plant and getting it back on its feet requires a great deal of knowledge and experience. The illnesses are being diagnosed and control methods are being suggested using computer-aided systems on a global scale. Byod and Sun Sarma et al. were among the first rule-based systems to be created. Researchers Balleda et al. A model for disease prediction using leaf wetness duration was suggested by Tilva et al., and it is based on fuzzy logic.

Francl and Panigrahi Babu and Rao, Ismail et al., and others have developed models based on artificial neural networks to manage diseases in various crops. The groups mentioned are Karmokar et al., Sladojevic, Hanson, and Hahn. There were also recommendations for hybrid systems. Huang suggested a methodology for disease classification in phalanopsis seedlings using an image processing algorithm combined with an artificial neural network model. In their study, Sannakki et al. used a fuzzy logic method in conjunction with image processing to determine the infection proportion in leaves. In order to create their system, Al-Hiary et al. and Bashish et al. used the k-means segmentation technique. Khan et al. created Dr. Wheat, an expert system for diagnosing wheat illnesses, which is accessible online.

The Control and Monitoring of Agricultural Products

Crop storage, drying, and grading are as crucial parts of farming as is keeping an eye out for pests and illnesses. Several AI-based systems for food quality management and monitoring are discussed in this section. Kavdir et al. Gottschalk et al. and Escobar et al. are among the systems that were developed using fuzzy logic. Taki et al. Capizzi et al., Yang, Nakano, and artificial neural network (ANN) systems are to be discussed. Some of the works cited are Melis et al., Miranda and Castano, Perez et al., Martynenko and Yang, Movagharnejad and Nikzad Khazaei et al., Higgins et al., Chen and Yang, and Boniecki et al.

Irrigation and Soil Management

Soil and irrigation management concerns are of paramount importance in farming. Damage to crops and an overall decline in quality may result from careless irrigation and soil management. Here we take a look at a few studies that used AI to help with soil and irrigation management. To assess the efficacy and efficiency of microirrigation systems, Brats et al. developed an expert system based on rules.

In order to construct a fuzzy based system that might suggest crops based on maps of land suitability, Sicat et al. drew on farmers' expertise. Si et al. are among the other fuzzy-based systems. According to Tremblay and colleagues? In order to determine a plant's stem water potential using weather and soil moisture data, Valdes-Vela et al. used a Takagi Sugeno Kang fuzzy inference system.

Arif et al. developed a method that estimates soil moisture in paddy using an artificial neural network. Soil and irrigation systems developed by Broner and Comstock that use artificial neural networks are also very popular. He and Song Zhai et al. "Patil et al." It was the work of Hinnell and colleagues. Alexanders et al. and Junior et al. In order to forecast rainfall based on four different atmospheric inputs, Manek and Singh examined several neural network designs. According to the results, radial basis function neural networks outperform the other models tested.

Table 2: Irrigation and Soil Management in Agriculture

Aspect	Details
Types of Irrigation	Surface Irrigation Drip Irrigation Sprinkler Irrigation Subsurface Irrigation
Irrigation Methods	Flood Irrigation Furrow Irrigation Center Pivot Irrigation Lateral Move Irrigation
Benefits of Efficient Irrigation	Water Conservation Improved Crop Yields Reduced Water Logging Enhanced Nutrient Uptake
Challenges in Irrigation	Water Scarcity High Initial Costs Maintenance Requirements Risk of Salinization
Soil Management Practices	Crop Rotation Cover Cropping Conservation Tillage Organic Amendments (e.g., Compost, Manure)
Soil Fertility Management	Soil Testing and Analysis Balanced Fertilizer Application Use of Green Manures Micronutrient Management
Soil Conservation Techniques	Contour Plowing Terracing Strip Cropping Agroforestry
Benefits of Soil Management	Improved Soil Structure Enhanced Water Retention Reduced Erosion Increased Soil Organic Matter
Challenges in Soil Management	Soil Degradation Compaction Erosion Nutrient Depletion
Innovative Technologies in Irrigation and Soil Management	Precision Agriculture Soil Moisture Sensors Remote Sensing Automated Irrigation Systems

This table provides a comprehensive overview of irrigation and soil management in agriculture, detailing the types and methods of irrigation, benefits and challenges, soil management practices, and innovative technologies.

Managing Weeds

The use of herbicides also has direct consequences for the environment and human health. Proper and accurate weed control is being done using modern AI approaches to minimise the administration of herbicides. Oats, barley, triticale, and wheat are among the crops that may benefit from the rule-based expert system that Pasqual developed. Five different species of weeds were identified by Burks et al. using machine vision and a neural network trained using back propagation. Using the same data set as the last publication, Burks et al. [80] examined three distinct neural network models—back propagation, counter propagation, and a radial basis function based model—and determined that the back propagation network performed the best.

has the highest level of accuracy at 97%. The use of neural networks and image analysis led to the development of an alternative method by Shi et al. Notable further works were reported by Nebot et al. Barrero et al., and Eddy et al.

Table 1: Managing Weeds in Agriculture

Aspect	Details
Types of Weeds	Broadleaf Weeds Grasses Sedges Aquatic Weeds
Methods of Control	Chemical Control: Herbicides (Selective and Non-selective), Pre-emergent Herbicides, Post-emergent Herbicides Mechanical Control: Tillage, Mowing, Mulching, Hand Weeding Biological Control: Natural Predators, Pathogens, Grazing Animals Cultural Control: Crop Rotation, Cover Crops, Proper Irrigation, Mulching Integrated Weed Management (IWM): Combination of Chemical, Mechanical, Biological, and Cultural Methods
Benefits of Weed Management	Improved Crop Yields Reduced Competition for Nutrients Enhanced Crop Quality
Challenges	Herbicide Resistance Environmental Impact High Costs Labor Intensity

Aspect	Details
Innovative Technologies	AI and Machine Learning for Weed Detection Precision Agriculture Automated Weeding Robots
Monitoring and Evaluation	Regular Field Inspections Use of Drones and Sensors Data Analysis for Effective Management

This table condenses all information into a format providing a comprehensive overview of managing weeds in agriculture.

PREDICTION OF YIELD

Marketing tactics and agricultural cost assessment both benefit greatly from the ability to forecast crop production. In addition, in this era of precision agriculture, it is also possible to use prediction models to analyse important elements that directly impact the yield. Soil parameter yield prediction was carried out by Liu et al. using an artificial neural network model that used a back propagation learning approach. Kaul et al. is among the other notable works. (Uno et al. 2007). The authors of the publication are Ji, Zhang, and others. Singh Alvarez, Russ et al., Rahaman, and Bala. A neural model was developed by Ehret et al. to forecast greenhouse tomato output, growth, and water use. Using neural networks, Thongboonnak and Sarapirome tested logan yield in several Thai areas. As an alternative metric, Pahlavan et al. measured the yield of basil plants grown in a greenhouse by measuring their energy production. Khoshnevisan et al., Nabavi-Pelesaraei et al., and Soheili-Fard et al. are some notable research efforts that have concentrated on yield prediction. A neural model for predicting seven distinct crop yields from air inputs and fertiliser usage was suggested by Dahikar and Rode in 2014.

3. CONCLUSIONS

From 1983 until 2023, a total of 200 research publications covering the topic of artificial intelligence methods used to agriculture were published. This little area cannot do justice to all of the masterpieces that have before it. To cover all the bases, we've picked and selected which representatives to target in our multifaceted methods. The purpose of this document is to provide as much useful information as possible on artificial intelligence (AI) methods used in farming. While rule-based expert systems saw heavy usage in the '80s and '90s, models based on artificial neural networks and fuzzy inference systems have since surpassed them in popularity. These days, hybrid systems that combine elements of several types of processing, such neuro-fuzzy or image processing with artificial neural networks, are all the rage. More precise and automatic systems that respond in real time are the direction it's heading. So that conventional farming can affordably transition to precision agriculture, new studies are being carried out using cutting-edge instruments.

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