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AI AND AGRICULTURE

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Abstract— According to the Food and Agriculture Organization of the United Nations, by 2050, there will be an additional 2 billion people living on the planet, yet there will only be an additional 4% of land under cultivation. In this situation, more effective agricultural techniques be achieved using the most recent technical developments and fixes for the farming industry's present obstacles. Direct use of AI (Artificial Intelligence) or machine intelligence in the agricultural industry could represent a paradigm shift in the way farming is now carried out.
One of the most practical ways to manage food insufficiency and adjust to the needs of a growing population is the application of AI in agriculture. A farmer may accomplish more with fewer resources thanks to AI-powered farming solutions, which also improve quality and ensure speedy GTM (go-to-market) strategies for crops. The analysis begins by highlighting two industries—soil management and weed management—where AI may have a significant impact. Next, the Internet of Things (IoT), a technology with enormous potential for the future.The current article offers a perspective of how AI might fuel the various agricultural sectors. Additionally, it looks into future AI- powered concepts and potential difficulties.
The spread of automation and the accuracy with which algorithms can handle huge amounts of data and efficiently, as well as the devices' security and privacy of data. Despite highlighting the challenge of using machines and algorithms that have been developed over the last years. The analysis shows an already fruitful comparison of experimental environments to real surroundings a promising future for application and development.

Keywords: Agriculture, Artificial Intelligence, Farming

1. INTRODUCTION

John McCarthy first proposed a study based on the premise that "every aspect of learning or any other feature of intelligence can, in principle, be so precisely described that a machine can be made to simulate it" at the 1955 Dartmouth Conference, which is where the term "Artificial Intelligence" was first used. During the Industrial Revolution in the 19th century, machines were used to supplement or reduce human labour. This eventually gave rise to the idea of artificial intelligence (AI)-powered devices as information technology advanced in the 20th century with the invention of computers. It is a fact that artificial intelligence is gradually replacing human labour in the future.

By emphasising three significant factors and accomplishments—soil management, weed control, and the utilisation of the Internet of Things—this review attempts to describe the current state of artificial intelligence in agriculture. It also assesses the urgent issues that must be resolved in this field, such as the predictable uneven distribution of mechanisation in various regions, security and privacy concerns, and the adaptability of algorithms in real-world applications when plants are physically heterogeneous and large data sets and other factors must be processed. It does so by outlining the history of this particular sector, providing specific examples, and outlining significant

problems, determines the potential applications in the future while also taking distinct national conditions into account.
AI's different farming strategies have quickly adapted in the agricultural sector. Cognitive computing is the idea that uses a computer model of human thought processes. This leads to tumultuous AI- powered agriculture technology that provides its assistance in interpreting, learning about, and responding to various situations (depending on the learning collected) to increase efficiency.

Farmers can be provided with solutions via platforms like chatterbot in order to reap benefits in the field by keeping up with new innovations in the farming business.

2. THE DEFINITION OF ARTIFICIAL INTELLIGENCE (AI)

Because of the technology's rapid evolution, the definition of artificial intelligence has evolved throughout time, and there is still no one definition in use today. However, there are commonly four categories into which definitions can be divided: A system with artificial intelligence (AI) thinks and behaves rationally or like a human would.
The Turing Test is a game that Alan Turing proposed in a paper he authored in the 1950s to address the topic "Can a machine think?" A computer needs to be capable of four things in order to pass the Turing test: machine learning, automated reasoning, knowledge representation, and natural language processing [9]. Turing provided the most popular definition of AI in this instance, although it had the flaw of not discriminating between knowledge and intelligence, much to how software and hardware are distinguished when defining a computer. AI was also described as "such a programme that will cope not worse than a human in an arbitrary world,"

indicating that it is a collection of programmes with inputs and outputs as well as an existence. Intelligent database retrieval, expert consulting systems, theorem proving, robotics, automatic programming and scheduling issues, perception issues, etc. are some uses of AI.

3. CURRENT STATUS OF AI APPLICATION IN AGRICULTURE

SOIL MANAGEMENT
In addition to being the primary source of nourishment, soil is one of the most crucial elements of successful agriculture. Proteins, phosphorus, potassium, nitrogen, and water that are necessary for healthy crop growth are stored in soil as well as growth. Compost and manure can be used to improve the soil's condition. porosity, aggregation, and with a different tillage technique to prevent the physical deterioration of the soil With Taking soil management as an example, harmful elements like soil-borne diseases and pollutants cut down. Another example is the creation of soil maps using AI, which helps to illustrate the relationships between the soil landscape and the different soil layers and proportions.

WEED MANAGEMENT
One of the factors that most significantly lowers a farmer's predicted profit is weeds: for instance, if weed invasion is not controlled, dried bean and maize harvests may experience a 50% yield loss, and weed competition may result in a 48% fall in wheat output. Despite the fact that some weeds are toxic and may even pose a hazard to public health, they nonetheless compete with crops for resources like water, nutrients, and sunshine [13]. Even though spray is frequently used to prevent weed growth, too much of it can harm the environment and the public's health. In order to precisely determine the amount of spray to use and spray on the target spot, artificial intelligence weed detecting systems have been tested in laboratories which also lower costs and the risk of damaging crops.

The Use of Internet of Things Technology
The Internet of Things (IoT) is a network of interconnected computing devices, mechanical devices, and miscellaneous items, each of which is given a unique identifier and has the ability to send data. As a result, interactions between people or computers can be avoided. IoT is a development based on multiple current technologies, including RF identification, cloud computing, and wireless sensor networks (WSNs). IoT can be used in a variety of industries, including agriculture machinery, precision farming, tracking and tracing, greenhouse production, and monitoring. For instance, information input (such as the entire product life cycle, the transportation process, etc.), the capacity to store the information for a certain amount of time, and the ability to transfer, process, and output data are all included in the tracking and tracing of agricultural product chains.

The Internet of things (IoT) driven development
Each day, enormous amounts of data, both organised and unstructured, are produced. These facts include information on the weather, soil reports, fresh research, rainfall, insect attack susceptibility, and drone and camera images. Cognitive IoT technologies would sense, recognise, and produce smart solutions to increase crop yields.

Proximity and remote sensing are the two main technologies used for intelligent data fusion. Testing the soil is a significant application of this high resolution data.Contrary to distant sensing, proximity sensing just requires sensors that are in close contact with the soil. It does not require sensors to be integrated into aerial or satellite systems. This makes it easier to characterise the soil in a specific area based on the dirt below the surface.

In order to create the optimal fertiliser for corn cultivation and maximise crop production, hardware solutions like Rowbot (concerning crops like corn) have already started combining data-collection software with robotics.

Identify the readiness of the crop
Images of various crops captured under white light and UVA light are to check how ripe the green fruits are. From this analysis the farmers could create different levels on the readiness of the fruit or crop category. Then add them into assorted stacks before sending them to the market.
Field management
Employing images of high definition from drone and copters systems, real time estimations can be attained during the time span of cultivation by building a field map and discovering areas where the crops require water, fertilizer and pesticides. The optimization of resource is assisted to a huge extent by this.

Disease detection
The image sensing and analysis ensure that the plant leaf images are sectioned into surface areas like background, diseased area and non-diseased area of the leaf. The infected or diseased area is then cropped and sent to the laboratory for further diagnosis. This further renders assistance in the identification of pest and sensing nutrient deficiency

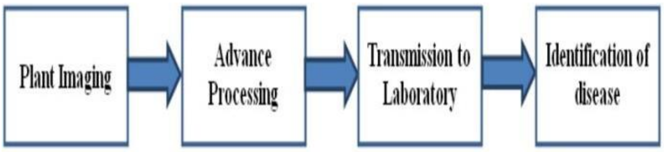


Image-based insight generation
Precision farming is one of the most debated aspects of agriculture in the modern world. Drone imaging can help with in-depth field analysis, crop monitoring, and field scanning. In order to ensure that the farmers act quickly, a mix of computer vision technologies, drone data, and IoT will be used.
Precision farming would be accelerated if data from drone images were used to generate real-time alerts. Commercial drone manufacturers like Aerialtronics have made it mandatory to use the Visual Recognition APIs and IBM Watson IoT Platform for real-time image processing

PRECISION FARMING

Precision farming is a more precise and controlled kind of farming that, in addition to offering advice on crop rotation, replaces the tedious and labor-intensive aspects of farming. High precision positioning systems, geological mapping, remote sensing, integrated electronic communication, variable rate technology, optimal planting and harvesting time estimators, water resource management, plant and soil nutrient management, and rodent and pest attacks are among the notable key technologies that enable precision farming.
Goals for precision farming

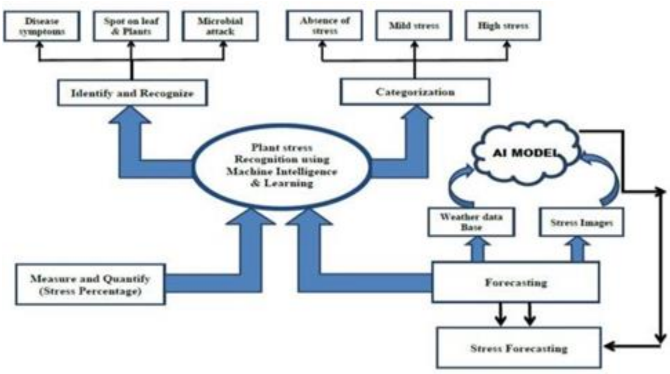
Profitability
Recognize crops and market strategically as well as prefiguring ROI (Return on Investment) based on cost and gross profit.

Efficiency
By putting in precision algorithm, improved, rapid and low cost farming opportunities can be utilized. This lets the overall use of resource efficiently.

Sustainability
Better socio-economic and environmental operation assures additive improvements in each season for all the performance indicators.

Cases of precision farming management
The AI-assisted detection of various stress levels in a plant using high-resolution photos and data from numerous sensors. It is necessary to use the whole set of data collected from various sources as machine learning input. This makes it possible to combine these data with feature identification factors to recognise plant stress.

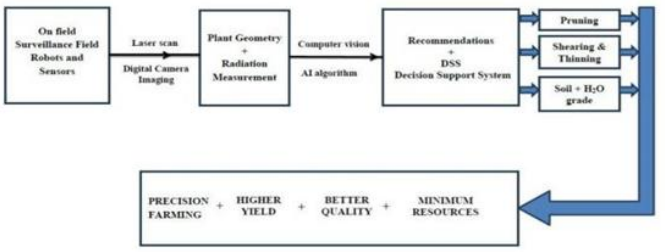
The various levels of stress in plants can be identified by AI machine learning models that have been trained on a variety of plant photos. To make better and better decisions, this entire strategy can be divided into four sequential stages: recognition, categorization, quantification, and forecasting.



Yield management using AI
An ecosystem for smart, efficient, and sustainable farming is emerging with the development of cutting-edge technologies like artificial intelligence (AI), cloud machine learning (ML), satellite imagery, and sophisticated analytics. Farmers are now able to increase their average yield per hectare and have more control over the price of food grains, ensuring that they continue to make a profit.

The Cortana Intelligence Suite, which includes Machine Learning and Power BI, is being used by Microsoft Corporation to provide agriculture advice services to farmers in the Indian state of Andhra Pradesh. This allows for the transformation of data into Intelligent Actions.
This pilot project makes use of an AI-based sowing application that gives farmers recommendations for sowing dates, cultivable land preparation, fertigation based on soil analysis, FYM requirements and application, seed treatment and selection, and optimum sowing depth. These recommendations have increased the average crop yield per ha by 30%.

Using real-time Moisture Adequacy Data (MAI) from daily rainfall figures, soil moisture, and statistical climate data, AI models can also identify the ideal time to sow in different seasons, generate forecast charts, and provide farmers with advice on when to sow.
In order to predict possible pest attacks, Microsoft is working with United Phosphorus Limited to create a Pest Risk Prediction Application Programming Interface (API) that strategically uses AI and machine learning to signal the likelihood of a pest attack in advance (Figure 3). Based on the weather and the crop's stage of development in the field, insect attacks are predicted to be high, medium, or low.



Challenges of practical application of AI-based techniques in agriculture

Despite the fact that AI offers enormous opportunities in agricultural applications, there is still a lack of familiarity with advanced high-tech machine learning solutions in farms around the world.

Farming is exposed to external factors such as weather, soil conditions, and pests. The vulnerability to pest attack is high. A crop raising plan planned at the beginning of the season may not appear to be good at the start of harvesting because it is influenced by external parameters.

AI systems, too, require a large amount of data to train machines and make accurate forecasts or predictions. Only in the case of a very large area of agricultural land could spatial data be collected easily, whereas temporal data is difficult to obtain.

The various crop-specific data could only be obtained once a year, when the crops were planted. Because the database takes time to mature, it takes a significant amount of time to build a robust AI machine learning model. This is a major reason why AI is used in agronomic products such as seeds, fertiliser, and pesticides rather than on-field precision solutions.

In conclusion, adopting cognitive solutions will play a significant role in the future of farming. The farming industry is still not receiving enough support and is still underserved, despite the fact that extensive research is still ongoing and numerous apps are already available. While using AI decision-making systems and predictive solutions to address the genuine demands and issues faced by farmers, farming with AI is still in its infancy.

To fully capitalise on AI's enormous potential in agriculture, applications must be more robust. Then it will be able to handle frequent shifts and changes in external conditions on its own. This would allow for real-time decision making and the sequential use of appropriate models/programs for efficiently gathering contextual data.

The exorbitant cost of the many cognitive farming solutions that are readily available on the market is the other important factor. To ensure that this technology reaches the farming community, the AI solutions need to become more commercially viable. If cognitive AI solutions are made available in an open source platform that would lower the cost of the solutions, which in turn would speed up adoption and provide farmers more knowledge.

Possible uneven future distribution of mechanization
According to the prediction of robot shipments for the years 2011 to 2013, an average 9% annual increase in the United States, a 12% annual increase in nations in Asia and Australia, and an 8% annual increase in Europe are expected.
This trend is predicted to result in a 15% robot penetration rate by 2030 and a 75% robot penetration rate by 2045. But given that some regions lack access to resources and are in precarious situations that can't be improved by advances in science and technology, the distribution of mechanisation may be uneven. Since most AI systems rely on the Internet, for instance, their use in remote or rural locations may be limited due to the lack of a web service and lack of expertise with handling AI operations. Therefore, a slower and unequally distributed adoption process of AI in agriculture should be expected, and meanwhile, whether the adoption would increase food production beyond certain natural limits of land or not remains uncertain.

Discrepancies between control experiments and actual implementation Because of variables like fluctuating lighting, complicated backgrounds, angle of capture, etc., the photographs captured when applied differ from the images utilised in control situations.

Furthermore, even at the same site, grains grown in the field are physically heterogeneous due to the influence of other factors including insects, soil, and inert materials. Consequently, a larger and more varied set of control data was needed to increase the present classification accuracy since the physiological features of individuals make the variables that must be taken into account while processing images more complex.
Nevertheless, despite the limited number of case studies, algorithms like DBN (Deep Belief Networks) and CNN (Convolution Neural Network) suggest intriguing future applications for processing massive volumes of complex data. Additionally, the most pertinent data should be processed in order to reduce a system's reaction time. The ability of a system to complete activities accurately and quickly determines its economic value and has a significant impact on user choice. Customers prioritise accuracy and reduce the amount of work required on their part.

Security and privacy
Because they might be left unattended in an open area for extended periods of time, many physical devices, like the IoT, are first susceptible to attacks on the hardware. Data encryption, tag frequency modification, tag destruction policies, the usage of blocker tags, etc. are examples of common security countermeasures. Location-based services are also vulnerable to device capture attacks, which implies that once the device has been taken, the attacker can extract any cryptographic implementations and so have unrestricted access to any data that is on it. Data transfers from the device to the gateway, where it is then uploaded to other infrastructures like the cloud, are similarly vulnerable to assault.

The cloud servers are susceptible to data manipulation, which could cause unwanted interference with the farm's automated processes. Cloud infrastructures may potentially be affected by techniques such as session hijacking, login abuse, and denial of service (DoS). Cryptographic methods, data flow control rules, identity authentication techniques, etc. are some of the corresponding security policies. As a result, security concerns are having a major impact and need to be addressed at several levels.

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