

Agriculture Revolutionized by Artificial Intelligence: Harvesting the Future

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Abstract: According to the United Nations FAO (Food and Agriculture Organisation), the world population would expand by another 2 billion in 2050, but extra land area under cultivation will account for only 4% of total land area at that time. In such cases, more efficient farming practises can be achieved by utilising recent technical developments and solutions to current farming bottlenecks. Crop metrics could be constructed over hundreds of acres of cultivable land using remote sensing (RS) techniques and 3D laser scanning. AI-based crops produced a 30% increase in average crop output per ha and provided a rapid GTM (go-to-market plan) approach for crops. This article raise an image of boosting agriculture and analyses the AI-powered concepts in the future and the obstacles that are expected.

Keywords: Crop farming; Food production; Artificial intelligence; Agriculture production

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1. Introduction

By 2050, the world's population is projected to reach close to 10 billion, which would result in an increase in agricultural production of up to 50% compared to 2013 despite little financial development [1]. Currently, 37.7% of the earth's surface is dedicated to growing crops. Agriculture has a significant role in the nation's economy and in creating jobs. It makes a substantial contribution to the economic success of industrialized countries and actively influences the economies of developing nations as well. The per-capita income of the rural population has significantly increased as a result of the expansion of agriculture. Therefore, putting more of an emphasis on the agriculture sector will be sensible and appropriate [2].

Since agriculture is the backbone of the global economy, it is everyone's duty to feed the world's growing population by doubling current productivity by 2050 [3]. The production of food must expand to feed a growing population, and there is a potential big market for bioenergy. Additionally, agriculture must adapt to climate change and adopt more efficient and sustainable production techniques [4]. More food is needed to feed the expanding population. Growing more food on less land is one of the issues farmers deal with. To address the growing population, farmers and inventors must work together to develop solutions to help farmers fulfill rising production demands [5]. Weeds, and protect their crops from them. If artificial intelligence (AI) is used in agriculture, farmers can increase the yield from their land while conserving resources. Innovative technologies have seen steady change in the last few decades. A recent idea called "smart agriculture" aims to monitor and enhance agricultural operations by using technology like robotics, the Internet of Things (IoT), drones, and artificial intelligence (AI) [6].

Precision agriculture (PA) is a concept of management that attempts to optimize economic agricultural production while minimizing environmental impact in a certain region. It takes into consideration the unpredictability of the soil environment. The 4R idea, often known as application of the correct material in the proper amount at the proper site and time, is the foundation of PA [7]. Technology development over the past couple decades has improved PA's standing as a novel management concept. Digital sensors for measuring real-world parameters are still for sale on the market at fair prices [8]. In the early 1900s, it was always hoped that robots will replace human labor in all conceivable domains by performing jobs with better accuracy. Artificial intelligence, or AI as it is known scientifically, has advanced over the past several years, surpassing human performance in areas like object identification and computer vision [9].

In addition to the quality of raw data, when using a large dataset to train AI models, research has shown that performance is outstanding even when noisy data is involved, suggesting that the volume of training data is essential in developing robust AI models for agriculture applications [10]. IoT and big data have actually attracted significant interest from a broad range of internet users in the previous five to six years, whereas AI has maintained its popularity for well over a decade, according to statistics from Google Trends search histories for these topics. In fact, as communication devices proliferate, more data is being produced, and AI is becoming increasingly well-integrated into the lives of a sizable portion of the global population. IoT, which largely focuses on industrial technologies, continues to be less popular with the general public than AI. Making the most of these new information technologies to feed the world sustainably is a natural area of interest for engineers and agriculturists [11]. The use of AI-based technologies helps to increase productivity across all industries, including the agricultural sector, by addressing issues with crop yield, irrigation, soil content sensing, crop monitoring, weeding, and crop establishment [12]. In order to supply high-value AI applications in the aforementioned industry, agricultural robots are constructed. The agriculture industry is in trouble as a result of the rising global population, but AI has the ability to provide a critical remedy. Artificial intelligence (AI)-based technical advancements have allowed farmers to generate more output with less input and product quality increase, as well as ensuring a quicker go-to-market for the crops that were produce [2].

Agriculture is one industry where AI is still a developing technology. A new level has been reached in today's agriculture sector thanks to equipment and machinery powered by AI. Real-time monitoring, harvesting, processing, and marketing of crops have all improved because to this technology [13]. New automated methods using farm robots and drones have considerably improved the agro-based industry. Several high-tech computer-based systems are created to determine important elements including weed identification, yield detection, crop quality, and many more methods [14].

2. Materials and method

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. The average crop yield per hectare increased by 30% as a result of this pilot project's use of an AI-based sowing application that makes recommendations to farmers regarding sowing date, preparation of cultivable land, fertigation based on soil analysis, FYM requirement and application, seed treatment and selection, and optimization of sowing depth. Using real-time Moisture Adequacy Data (MAI) from daily rainfall statistics, soil moisture, and statistical climate data, AI models may be used to build forecast charts and provide farmers advice on when to plant in different seasons. Drones with AI-capable sensors could photograph the entire farm and analyze the images nearly instantly to identify problems and offer solutions. Farmers will be able to deal with the issue of a shrinking labor force and operate more

productively while spending less on wages if they use robots, for example. Advanced robotic gadgets will also tend to and harvest plants as well as gather data on farms in order to boost food yields. AI bots (Agri-robots) can work in the agricultural industry similarly to modern combine harvesters, which can harvest crops at a higher volume and faster pace than human laborers. Computer vision is used to its utmost extent in in-vivo agriculture to help with monitoring, weeding, and spraying. One result of robotics use in Indian agriculture is lower costs: Agri-bots, which are used to tend to crops, harvest, weed, etc. in many regions of the world, can reduce the cost of fertilizer, eliminate human labor, and appeal to youth: Robotic agriculture has the potential to draw and retain young people in our country. As a result, farmers will surely benefit from the development of artificial intelligence as they search for better ways to protect their crops from weeds [15].

This flowchart describes the 6 strategies which can improve the crop productivity by using the smart ways such as Forecasts for Agricultural yield and Pricing, Intelligent spraying, Agriculture Robots, Predictive knowledge, monitor the Crop and Soil, Disease Diagnosis. These all-strategies work on the base of Artificial Intelligence.

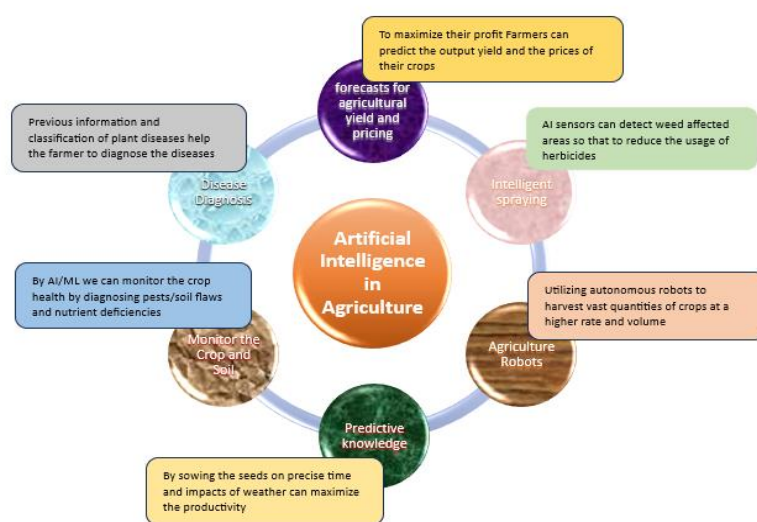


Figure 1. Methodology framework of Artificial intelligence in Agriculture.

3. Results and analysis

AI applications are important in agriculture to resolve agricultural problems and assure more harvest. Farmers depends on climate and environmental condition for the cultivation of crops. AI and machine learning function as predictive analysts by assessing previously collected data and identifying the optimal time to plant seed, defining the crop alternatives, and choosing hybrid seed to improve production. To increase yields, cropping patterns may also need to be adjusted, according to machine learning (ML) models. IoT and artificial intelligence have a far less influence on raising agricultural output since the cost of data gathering in data-driven agriculture is still relatively expensive. Artificial Intelligence based strategies has increased production up to 30%. The newest automated systems, which include drones and agricultural robots, have greatly benefited the agro-based industry. To identify essential characteristics like weed identification, yield detection, crop quality, and many other procedures, different high-tech computer-based systems are used. The usage of autonomous tractors for completing numerous jobs, which not only saves time but also money in terms of manpower, will transform the agriculture industry thanks to AI-enabled robots. Big data, AI, and ML technologies can forecast pricing, estimate crop yield, and detect pest and catastrophe infestations, guiding farmers and

the government on future price trends, demand levels, and the best crops to plant for optimum advantages [16].

Table 1. AI Applications for Monitoring Crop Health.

Utilization	Algorithm	Findings
monitoring plant growth indicators	Machine learning, threshold segmentation, CIE	obtained a really nice outcome
monitoring grape growth	Computer vision	Accurate barrier and grape bunch identification was made
nitrogen concentration in rice through diagnosis	MATLAB	Process of changing blades quantified
Observation of the wheat's heading date	Computer vision	Compared to other methods, the method's absolute inaccuracy is 10.14 percent days.
Observation of paddy growth	Remote sensing	Achieved a good result

One of the most crucial areas in agriculture where drone-based solutions are offered in conjunction with computer vision and AI is crop monitoring and crop health assessment. Drones equipped with high-resolution cameras collect precise field photos that can be run through a convolution neural network to identify weed-filled areas, crops that need more water, and the stress levels of plants at different growth stages. To define the spatial information system used for acres of farm land, the drone cameras' multi-spectral photos combine hyper-spectral images with 3D scanning methods. This gives advice a time component over the plant's whole existence. 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.

Table 2. global investments in agriculture technology, \$m, 2015-2022.

Sectors	2015	2016	2017	2018	2019	2020	2021	2022
Artificial intelligence	7	152	239	412	379	953	328	217
digital media	0	0	0	61	52	26	58	30
Internet of things	0	0	7	87	55	45	105	91
Robotics	0	2	16	107	125	84	172	2
E-commerce	0	0	11	14	82	95	398	68
Advanced materials	0	0	0	0	1	0	0	12
Big data	7	2	61	222	396	189	478	4

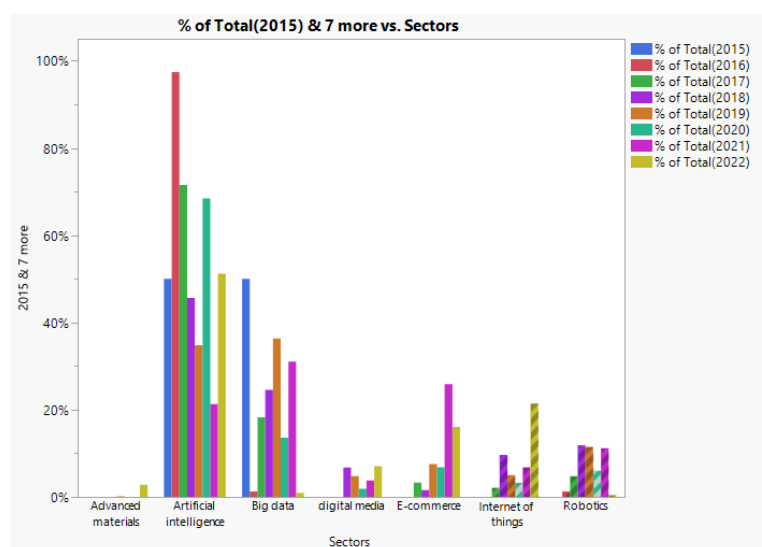


Figure 2. global investments in agriculture technology.

To increase yields and achieve the aim of a sustainable food supply by 2050, agriculture technology entrepreneurs are deciding on task-specific AI and vision solutions. Agriculture technology businesses like Ceres Imaging, Sky squirrel technology, and Blue River Technologies use computer vision technology to acquire images and analyze them spectrally utilizing robotics and drones. Startups like Centaur Analytics, Spenser Technologies, and Sen Crop are using diverse sensor data to detect anomalies in crop yields and inconsistencies in resource delivery. Sensor data can be a significant advantage in the analysis of farm aspects. AI-based technical advancements have allowed farmers to increase output while using less input, improve output quality, and ensure a quicker go-to-market for the produced crops. The various levels of stress in plants identified by AI machine learning models that have been trained on a variety of plant photos. To make better and better decisions, this entire approach can be divided into four consecutive stages: recognition, categorization, quantification, and forecasting. 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.

4. Discussion

Although AI offers tremendous potential for agriculture applications, there is currently a lack of understanding of cutting-edge high-tech machine learning solutions in farms all over the world. Agriculture is highly exposed to external elements such as weather, soil, and insect attack vulnerability. A plan for crop production made at the beginning of the season may not appear to be good after harvesting begins because it is affected by outside factors. Scientists working in agriculture can gather information on the soil's quality, the weather, the level of the groundwater, and other factors that will help to advance crop production. Robotic harvesting equipment can also be equipped with AI-enabled sensors to collect data. Scientists working in agriculture can gather information on the soil's quality, the weather, the level of the groundwater, and other factors that will help to advance crop production. Robotic harvesting equipment can also be equipped with AI-enabled sensors to collect data. Technology development over the past couple decades has improved PA's standing as a novel management concept. Digital sensors that can monitor real-world parameters are still available on the market for fair costs [17]. AI systems also need a lot of data to train their algorithms and make accurate forecasts and predictions. The collection of geographical data is simple in cases when there is a very vast amount of agricultural land, but the collection of temporal data is more difficult.

5. Conclusion

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. This would make it easier to make decisions in real time and use the right model or program in the proper order to effectively acquire contextual data. The field of artificial intelligence is rapidly developing. It is undeniable that it is already changing our society in social, economic, and political ways; consequently, whether or not the public and commercial sectors adopt the technology relies on governmental policy.

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