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Role of IoT and AI in Agriculture Technology

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Abstract: *Internet of Things and Artificial Intelligence are the most popular digital transformation technologies today. Real atmospheric data is collected by sensors, and data analysis is done with the aid of artificial intelligence (AI) algorithms to make devices behave in an intelligent manner. The topic of this article is how IoT and AI have transformed the agricultural industry. It discusses the agricultural revolution due to the technological advancements in the fields of AI as well as IoT based applications such as drones, UAVs etc. Using such technology makes it simple to forecast weather conditions like temperature, precipitation, humidity, the demand for fertilizers, water usage, etc. The agriculture sector is able to increase crop yield and decrease waste thanks to the IoT and AI-driven technological advancement. The application of IoT and AI in smart farming has the potential to positively revolutionize conventional farming.*

Keywords: Artificial Intelligence, Internet of things, Agriculture, machine learning, AgTech, smart farming

I. INTRODUCTION

Industrial processes are rapidly being transformed globally by IoT and AI.

Smart energy grids, predictive maintenance sensors, and wearable gadgets like smartwatches —IoT and AI have combined to unleash the potential of data quicker than ever. No sector of the economy is exempt from the advantages that IoT and AI have to offer. It is not different in the case of agriculture.

Modern, technologically enhanced techniques are assisting farmers in overcoming the difficulty by increasing yield in comparison to conventional techniques.

We are enthralled with the term "smart." But what we have now is still a long way from becoming intelligent like a person.

Artificial Intelligence is an engineering technology which instils intelligence into machines so that they reduce the jobs performed by humans by replacing the human intellect with machines. It consists of mathematical algorithms which help us derive accurate decisions and outcomes. AI-based systems are rapidly emerging.

Application, adaption, processing speed, and capacities are all factors to consider. Machines are increasingly capable of taking over regular and easy human jobs.

Data collection from IoT nodes/sensors has become more efficient because of advancements in wireless connectivity and standardized communication protocols. Data may now be collected practically everywhere, at any time, and in any quantity.

In this method, AI decision-making can emulate human behaviours to specific situations up to a tolerable degree of performance.

Technology has been employed in agriculture for a very long time to increase productivity and lessen the amount of demanding manual labor needed for farming. Since the advent of farming, humankind and agriculture have evolved together, from better ploughs through irrigation, tractors to contemporary AI.

Computer vision's expanding and more accessible availability could represent a big advancement in this area.

Given the significant changes in our climate, environment, and food needs worldwide, AI has the potential to improve 21st-century agriculture by:

- Increasing the productivity of labor, time, and resources.
- Improving the sustainability of the environment.
- Enhancing resource allocation.
- Real-time monitoring is provided to encourage improved produce quality and health.

Simply described, smart farming is a high-tech, expensive technology that aids farmers in producing food in an environmentally friendly and sustainable manner. Some of the IoT gadgets used in intelligent farming include agricultural

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drones, animal monitoring systems, and smart greenhouses.

Agricultural robots, predictive analytics, crop and soil monitoring, computer vision, and deep learning algorithms are some of the most widely used applications of artificial intelligence in agriculture.

1.1 Scope

A true game-changer in smart agriculture is predictive analytics. With AI, farmers can process and gather a vastly increased amount of data than they could without it. Farmers may use AI to address several major issues, including market demand analysis, pricing predictions, and choosing the best window for planting and harvesting.

Having said that, AI can also monitor the weather, track the readiness of crops, make fertiliser suggestions, and acquire insights into the condition of the land. All of that enables farmers to choose wisely during the entire process of crop cultivation.

Following are few of the benefits of using AI and IOT in agriculture:

- Making better agriculture decisions with data analytics.
- Automated farming equipment to enhance crop quality.
- It is cost saving due to boosting food production while using fewer resources.
- Using fewer chemicals and improving soil quality.
- Risk reduction in business and sales procedures.
- AI helps in handling labor shortages.

II. LITERATURE REVIEW

The risks encountered by farmers must be reduced or, at the absolute least, controlled. The potential global use of artificial intelligence in agriculture is among the most intriguing ones.

By introducing a number of benefits and enabling farmers to produce more with less effort, AI has the potential to fundamentally alter the way we think about agriculture. AI is not a stand-alone technology, though. The next stage in the shift from traditional to innovative farming is artificial intelligence (AI). AI can support already available technology.

At the same time that the global population is growing, urbanization is also continuing. Consumption patterns are shifting, and disposable income is increasing. Farmers need to find a strategy to boost output since they are under a lot of pressure to satisfy the rising demand. There will be more people to feed in 20 years. Additionally, since there is a limited supply of good soil, conventional farming methods will need to be transformed.

The research contribution that has been made in the area of agriculture using IoT and AI is included in this section. According to research, every article has its own problems and difficulties. Sensors like temperature sensors, humidity sensors, and moisture sensors came into the focus to gain the precision in detecting the true boundaries.

Bhakta et al [2] put forward a study that concentrates on precision agriculture's most recent trends. The current state, advantages, and drawbacks of the various technologies are investigated. Its objective is to review various applications of precision agriculture.

Al-Ali et al [3] proposed an irrigation optimization study. It is a model that has been put forth that optimizes the irrigation process through the precise application of water. It uses Internet of Things sensors and renewable energy.

B. Ragavi et al [4] proposed "AGROBOT" for seed sowing, powered by IoT and AI it keeps track of the weather, the need for fertilizer and pesticides, and the amount of water needed also the information is delivered to farmers for real-time field monitoring utilizing cloud services. Useful for increasing crop yield while lowering labor expenditures too.

Vaishali Patil et al [5] suggested a review that provided values to the system, such as soil moisture, temperature, and PH value, to predict crop yield and the right time for that production.

Boursianis et al [6] put forward a review that focuses on how Internet of Things sensors combined with Drones and UAVs can assist the farmer of the future.

III. METHODOLOGY

The articles included for this study's analysis came from a variety of publications and conference proceedings that can be found in most reputable research sources. Predictive analytics have been observed and effectively implemented using the majority of the findings and approaches described.

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The literature review study began with a search of the top academic databases (IEEE, Scopus, and Science Direct) for information on agriculture and related practices. "Smart farming," "irrigation facilities," "AI and IoT in farming," "Implementation of technology in agriculture," and "state of farming in India" were among the keywords and phrases covered. The initial filtering was based on two key criteria: journal quality (by taking into account impact factor and number of citations) and publication year (recent advances in the years 2018–2021). Studies were then improved based on the title and abstract. A minimum of 20 papers were logged to get insight. 10 papers were assessed based on title, and 10 were eliminated based on abstract.

Finally, a review of 10 research papers has been compiled based on the current improvement in technical agriculture activities.

The essential point to emphasize was the functioning of an implementation technique. Each strategy stated in the chosen papers was considered and worked on after a careful review of all of them.

IV. ANALYSIS

The use of IoT and AI will help businesses become more efficient, produce less waste, and meet consumer demand for food.

From the various studies it has been analyzed that AI and IoT can be used for many applications in agriculture.

Applications of AI and IoT based apps in agriculture:

1. Systems for Precision Farming

Precision farming is the AgTech method that is most widely used. It offers services like soil moisture probing, cloud-based centralised water management, and Variable Rate Irrigation (VRI) optimization. The method makes effective use of water by utilizing sensors, autonomous machinery, and internet connectivity.

2. Drones for Agriculture

Drones that are both ground-based and in the air are effective for evaluating crop health, keeping an eye on infestation, and analyzing soil. Additionally, they are utilized for real-time field data collection, seeding, irrigation control, and crop spraying. The gathered information can be used to forecast production, assess nutrients, and map external influences.

3. Smart Greenhouses in Agriculture

By developing a proportional control system, smart greenhouses use IoT to increase yield. To provide crops with a controlled environment, they use sensors. The system is remotely watched, and cloud servers are used to process data. The intelligent greenhouse monitors the amounts of light, temperature, and humidity while minimizing operator intervention.

4. Sensors for Crop and Soil Monitoring

Crop and soil health are constantly being monitored by robots and drones equipped with thermal or multispectral sensors. This facilitates fertilizer spraying and regulated irrigation. To guarantee high nutrient value in crops, the sensors also measure the biome levels of the soil. AI also examines soil characteristics to recommend the most profitable crops.

5. Solutions for Tracking and Monitoring Livestock

By keeping an eye on the livestock, wireless IoT networks and connected devices can save labor costs at the ranch. IoT devices can detect an animal's position and even keep track of its health. On large farms, the farmers can locate the animal promptly and even stop the spread of disease by separating sick animals from the rest, protecting the produce and lowering the cost of livestock.

6. Current Weather Monitors

Smart sensors powered by the Internet of Things provide weather and climatic updates in real time. The comprehensive prediction can be used by farmers to assess crop needs. Some systems also offer alarms to farmers so they can protect their crops in the event of severe weather.

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7. Tools for Predicting Crop Yield and Crop Price

Farmers are using a combination of Big Data, AI, and machine learning technologies to estimate the output of their crops. It is possible to forecast prices at harvest time by analyzing previous data to evaluate price swings. Accurate yield per hectare calculations are made possible by farm mapping. To arrive at a figure, farmers consider a variety of factors, including rainfall, pesticide usage, pH level, temperature, and other climatic circumstances.

8. Robots for Agriculture

By handling several activities on farms, agricultural robots reduce physical labor and save time. More effectively than people, they aid in crop monitoring and harvesting. To keep weeds under control and preserve the quality of the crop, they have received AI training. These machines can pack the yield more quickly than conventional techniques and sort it according to quality.

Al in agriculture is assisting farmers with increasing their productivity and minimising adverse environmental effects. Al was enthusiastically adopted by the agricultural sector in order to change the final result. The production of our food is changing as a result of artificial intelligence, and emissions from the agriculture sector have dropped by 20%. Al helps to manage and control any unforeseen natural conditions. To improve the effectiveness of agricultural production, the majority of start-ups in this industry have adopted an Al-enabled strategy. Al assists the agricultural businesses in processing the data in order to reduce unfavourable outcomes.

V. FINDINGS

According to the most recent research, some of the actions being taken to promote smart farming practices include the modernization of Agriculture supply chains, strategies for reducing climate risk, digitization of farm collectives as farmer producer organizations, the emergence of a start-up ecosystem, and government initiatives in digital farming.

Unmanned aerial vehicles (UAVs) are most frequently used in the agriculture sector.

As per the research, the country's agriculture industry expands further, more companies are expected to invest in affordable drones, which may help farmers and improve their knowledge while also creating jobs for young people in rural areas.

Through incubators, it can be observed that the government is also supporting an institutional ecosystem for agriculture technology firms.

Through the NITI Aayog, the government has established broad guidelines for fostering India's AI ecosystem under the theme of "AI for all."

The great news is that current technology agriculture is anticipated to become significantly better structured in the future.

VI. CONCLUSION

Agriculture presents many difficulties for farmers, including issues with irrigation, understanding the precise causes of soil behaviour, when to use insecticides or pesticides, crop disease prediction, the cost of implementing the newest technologies in hardware, crop demand and supply, and—perhaps most crucially—farmers' awareness of the benefits and drawbacks of using technology on their farms. Technology is crucial in integrating agriculture infrastructure with new practices and solutions to address these problems. This paper reviews a number of studies and finds that applying IoT and AI to agricultural activities can result in useful work.

It is predicted that agriculture based on AI & IOT may lessen farmer stress for crop output, their dependence on unforeseen trends in weather forecasting, and also reduction in the cost of human labor. All the recent advancements by applying these technologies are addressed & reviewed. The article offers many ideas and methods for putting them into practice in the area of agriculture utilizing AI and IoT.

The article offers many ideas and methods for putting them into practice in the area of agriculture utilizing AI and IoT.

The majority of Indian farmers are still reliant on seasonal rainfall, and they do not use any technical irrigation facilities because of a lack of funding, small landholdings prevent farmers from implementing automated tools for farming due to high hardware costs, and a lack of technological know-how is another major barrier in modern agriculture among other concerns that have been identified through literature study.

The goals of smart farming and precision agriculture are to improve agricultural society, and it appears that the adoption

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of these technologies by the majority of farmers will be necessary for agricultural progress. Additionally, young people must have an interest in the digital age of this new agriculture in order to effectively integrate the knowledge of old traditional ways with current technologies to enhance the entire situation.

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