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A Survey on Smart Agriculture Using IoT, AI and Modern Technologies

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Abstract

The traditional farming processes face difficulties meeting the food demands of the rising world population because of several factors, including lack of water resources, adverse weather conditions, poor agricultural productivity, and inefficient use of available resources. Therefore, there is an increasing tendency towards employing smart technology in agriculture, which will improve its effectiveness and sustainability. This survey paper explores several existing and emergent technologies used in smart agriculture, which include the Internet of Things (IoT), Wireless Sensor Network (WSN), Artificial Intelligence (AI), machine learning, cloud computing, and drone technology. These technologies allow real-time monitoring of the fields, irrigation systems, health state and growth of crops, detection of plant diseases, and estimation of yields. The survey paper compares different types of smart agriculture approaches concerning their efficiency, scalability, energy consumption, and costs of implementation. The results reveal that the IoT and sensor networks are effective for monitoring the environmental parameters of the field, AI helps improve the quality of decisions and forecasts, and drones are beneficial for monitoring the growth of large crop areas. Nonetheless, the widespread use of smart agriculture technologies faces obstacles related to their high cost of implementation, lack of infrastructure, and low technical skills of workers.

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1. Introduction

Traditional forms of agriculture are faced with a number of major obstacles, including wasting water and fertilizer, relying heavily on variable weather, and being unable to monitor crop and soil health more than once a season or so. Most traditional farming systems operate on manual observation and the experience of farmers, which often do not allow for making fast and accurate decisions and thus reduce agricultural productivity [1], [3].

As digital technologies continue to advance at a rapid pace, agriculture is moving towards using more intelligent and automated systems. A smart farm uses several foundational technologies are the Internet of Things or IoT, Wireless Sensor Networks or WSN, Artificial Intelligence or AI, Cloud Computing, and Remote Sensing to improve the management and efficiency of farms [1], [4]. These technologies allow farmers to obtain continual data from soil moisture, temperature, relative humidity, crop health, and weather conditions, and then enable them to make data-driven decisions in real time using the information they have acquired through these technologies [2], [6], [18].

The findings from earlier research support the use of advanced technology for agriculture. Utilizing wireless sensor networks to monitor environmental conditions was one of the findings noted so far by Ruiz-Garcia et al. [1]. Similarly, Wolfert et al. [3] found that digital technologies and analytics improve productivity and resource utilization within an agricultural system. These two studies indicate how technology can be used very effectively for the improvement of agricultural systems through increased productivity and effectiveness.

Smart agriculture has many components. These components include but are not limited to sensing devices, communication networks, data processors and user interfaces. These components work together to collect environmental data, process that data for use and provide input for making intelligent decisions [4], [7]. Sensor nodes located in various parts of an agricultural field collect data on a real-time basis. The sensor nodes transmit this data through a communication network to a cloud server for storage and processing as shown in Figure 1.

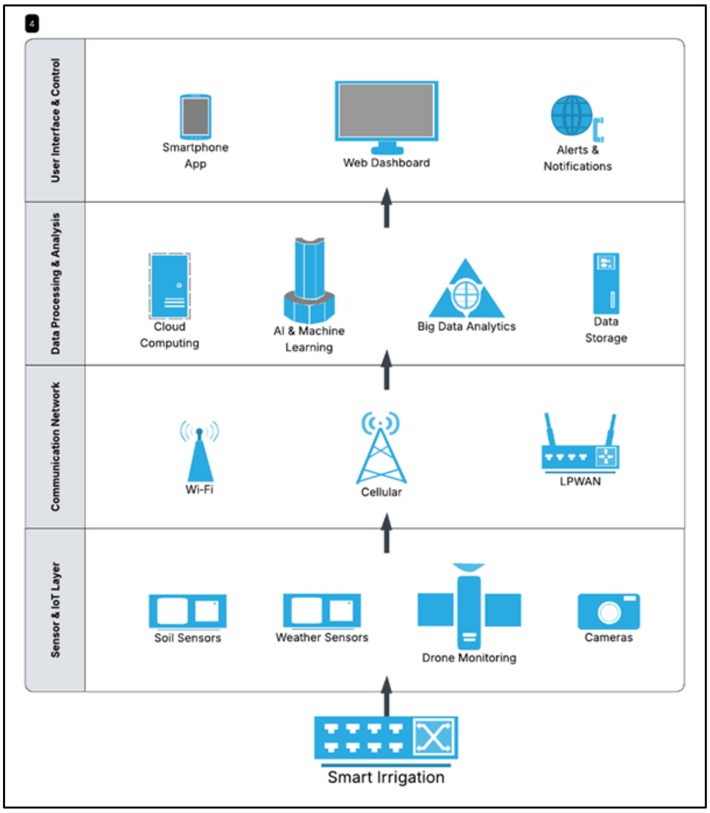

Figure 1. Architecture of a Smart Agriculture System

1.1 Background of Smart Agriculture

For many years, traditional farming practices have employed manual labor and farmer skill along with the natural environment to provide food. The limitations of these traditional methods are that they are often inefficient and inflexible as conditions of the environment change. Factors such as the quality of soil, availability of water, temperature fluctuations and pests all play a significant role in influencing how successful crops will be, thus requiring reliable and data-driven agricultural methods [2], [5]. A method that uses new technology in conjunction with traditional farming methods to circumvent these issues is referred to as smart agriculture. Smart agriculture uses modern technologies including internet of things (IoT) sensors, wireless networks, artificial intelligence (AI), drones and satellite imagery to collect data about the agricultural environment and automate the majority of agricultural activities needed by farmers. Real-time data on the environment is collected through various sensors, which can then be processed to provide actionable data to the farmer based on the data collected. Smart agriculture also includes precision farming, where an agricultural input such as water, fertilizers or pesticides is only applied when absolutely necessary to minimize the amount of resources such as water or fertilizers wasted, improve the yield from crops and encourage more sustainable farming techniques than traditional farming systems do [2].

1.2 Emergence of Smart Agriculture Technologies

The agricultural industry has seen major changes due to new technologies, resulting in smart and connected agricultural systems. The Internet of Things (IoT) is one of these new technologies because it allows for communication between sensors, devices, and cloud-based systems, which allows for real-time monitoring of agricultural environments [5], [6]. Furthermore, Wireless Sensor Networks provide additional value by allowing the connection of many different distributed sensors, which allows for the efficient collection and transmission of collected data from all over the farm landscape. Khanna and Kaur [5] state that IoT-based monitoring systems provide improved precision farming and better overall management of farms. Also, more and more farms are using Artificial Intelligence (AI) and Machine Learning (ML) technologies to analyse their data, thus providing assistance in their decision-making. Examples of how AI and ML are used include crop growth prediction, disease detection, and irrigation planning. Additionally, remote sensing technologies, such as drones and satellites, enable large-scale monitoring of and provide insight into how crops and fields vary from one another [7].

1.3 Motivation for Smart Agriculture

An increasing demand for food, the limited supply of natural resources, and climate change negatively affect food production; this drives the need for smart agriculture. With the continuous increase in the world's population, there is a significant need to improve agricultural yields while optimizing the use of land, water, and other vital agricultural inputs [3], [6]. Real-time data has historically not been available to farmers using traditional farming techniques, which have resulted in slow responses to significant agricultural problems (drought, pest issues, and nutrient shortages). This lack of real-time data has caused lower crop production rate and increased farming cost [2], [7]. Smart agriculture technology solves this issue by providing farmers with the ability to access real-time information, do automated irrigation, and make decisions based on data collected from sensors and analyzed with intelligent analytical solutions. Smart agriculture provides farmers with the ability to maximize the efficiency of their resources and subsequently increase their productivity. Smart agriculture technologies allow remote access and control of operations to improve the ability of farmers with large agricultural operations to manage their operations in a resource-efficient manner while reducing their reliance on people to run their operations [3].

1.4 Contributions of this Survey

The goal of this survey is to present a comprehensive summary of contemporary technologies in smart agriculture and their use in increasing agricultural productivity and sustainability. The main contributions include:

- It identifies the limitations of traditional farming practices and highlights the necessity of smart agriculture solutions.
- It classifies key enabling technologies, including IoT, WSN, AI, cloud computing, and remote sensing.
- It presents a comparative analysis of existing systems based on performance metrics such as efficiency, scalability, cost, and energy consumption.
- It discusses practical applications, including automated irrigation, crop monitoring, greenhouse management, and livestock tracking.
- It identifies current research challenges and outlines future directions for advancing smart agriculture technologies.

Overall, this study emphasizes the importance of integrating advanced technologies into agriculture to achieve enhanced productivity, efficient resource utilization, and sustainable farming practices [4], [6].

2. Literature Review

In recent years, smart agriculture has emerged as a significant area of research due to the various challenges associated with increasing food demand, climate variability, and sustainable resource management. Many methods currently being used in the agricultural sector do not produce consistent yields because they depend on manual observation and do not support real-time data collection.

Recent advances in technology including Internet of Things (IoT), Wireless Sensor Networks (WSN), Artificial Intelligence (AI), Machine Learning (ML), cloud computing and drone-based monitoring systems. are being used to improve agricultural practices by providing continuous monitoring, real-time data, and automation for many important functions related to farming, including irrigation scheduling, crop monitoring, and detecting diseases. There are also three categories of smart agriculture as shown in Figure 2, which includes IoT and sensor-based systems, AI-driven analytical models, and drone or remote sensing-based monitoring approaches.

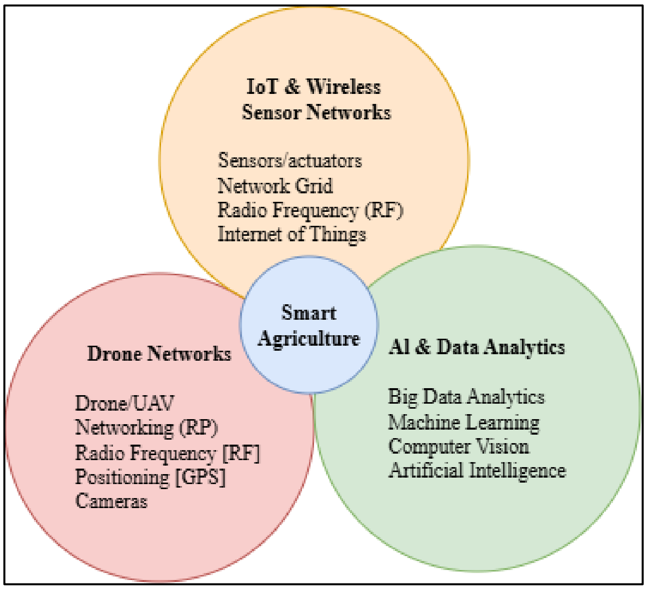

Figure 2. Taxonomy of Smart Agriculture

2.1 IoT and Wireless Sensor Network-Based Agriculture Systems

The backbone of smart agriculture technologies is IoT and WSN solutions that allow companies to collect real-time data from their farms. Through use of distributed sensor networks that monitor environmental variables like soil moisture, temperature, humidity, and light levels, IoT and WSN improved producers' visibility of the environment and supported better decisions.

Ruiz-Garcia et al. [1] verified that wireless sensor networks can be very helpful for environmental monitoring and making it easier to gather information about farming. Likewise, Khanna and Kaur [5] stated that IoT-enabled systems can improve precision farming through the optimization of irrigation and increasing efficiency in managing farms. Verdouw et al. [6] also recognized how IoT platforms help support digital agriculture, especially by linking sensors with cloud-based services to help make decisions based on data collected. Other contributions include Ray et al. [9] who provided an automated irrigation system that uses real-time soil moisture data, and Mekala and Viswanathan [10] who created a framework for supporting remote agricultural management with the use of cloud technology. Although there have been improvements in these areas, such things as high amounts of energy needed to operate the devices, inability to scale, and unreliable communication still keep many IoT-based agricultural systems from being deployed on a large scale.

2.2 Artificial Intelligence and Machine Learning-Based Agriculture Systems

Artificial Intelligence and Machine Learning have tremendously enhanced the analytics involved in smart agriculture systems through the use of predictive modeling and intelligent decision support systems. These methodologies can be applied to several areas in smart agriculture, including the detection of crop diseases, precision irrigation, and predicting yields.

Liakos et al. [8] have provided a detailed review of machine learning applications in agriculture, including its ability to improve predictive capability and increase operational efficiency. Kamilaris and Boldú [4] have considered deep learning techniques as well, with particular attention paid to the use of convolutional neural networks for image-based crop watching and the early detection of diseases; thus placing the possibility of using AI as a means for decreasing the amount of loss that occurs through timely intervention. Wolfert et al. [3] have discussed the usage of big data within the context of smart farming, focusing on the role that large-scale data analysis plays in making agricultural productivity more efficient and improving resource management. Zhang et al. [2], have discussed the precision agricultural systems and have also highlighted the importance of intelligent processing of data in making agricultural operations more efficient.

However, it should be noted that AI-based solutions often demand high-quality data sets, computing power, and skills. It makes the implementation of AI-based solutions problematic and restricts its application, particularly in agriculture in terms of limited resource availability.

2.3 Drone and Remote Sensing-Based Agricultural Monitoring

The use of drone technology and remote sensing systems is another innovation that can be successfully used in agriculture on a large scale. The use of these innovations allows obtaining high-quality spatial data, allowing farmers to evaluate the condition of crops, identify any diseases, and track environmental parameters.

According to Zhang and Wang [7], unmanned aerial vehicles (UAVs) can be used for field surveys that can allow detecting problems with crops in a timely manner. As an alternative to UAVs, satellite-based remote sensing systems can be utilized as they provide a larger coverage area with data on vegetation indices and soil moisture content. There are also recent advances in integrating drone imaging with machine learning algorithms aimed at detecting crop diseases and yield estimation. Despite the advantages of these innovations, their adoption is limited by costs and technical difficulties related to drone operation.

3. Smart Agriculture System Model

The example of a smart agriculture system model demonstrates the transition of traditional agricultural practices into modern intelligent farming that leverages technological advances. Knowing the smart agriculture system design principles is crucial for creating effective and sustainable solutions that contribute to increased efficiency and improved resource use. The structure of the smart agriculture ecosystem, including IoT-based monitoring, AI-powered analysis, and sustainable development, is presented in Figure 3. A regular smart agriculture system usually includes several interrelated elements such as sensors, communication network, computing resources, and user interface that provide capabilities for data gathering, processing, and decision making [4], [6].

3.1 Impact of IoT-Based Monitoring Systems

As one can see, the smart agriculture system cannot operate without IoT technologies due to their significant role in continuous monitoring and automation of farming activities. As part of such systems, sensors are installed on agricultural lands in order to track various parameters related to environmental characteristics and soil properties, like soil moisture, humidity, temperature, light intensity and nutrient content. [1], [5].

The data gathered is then transferred using communication devices like Wi-Fi, ZigBee, LoRaWAN, and cellular connectivity to central servers or clouds. This helps in remote monitoring of the field, which helps farmers react immediately to any changes in the environment. For example, automated irrigation could be started when the soil moisture falls below certain levels [9].

In terms of precision farming, the use of IoT-based monitoring system helps in reducing the need for human labor and ensures effective utilization of resources such as water, fertilizers, and pesticides [19]. This not only makes the entire process environmentally friendly but also allows farmers to obtain important information regarding the development of crops [2], [6].

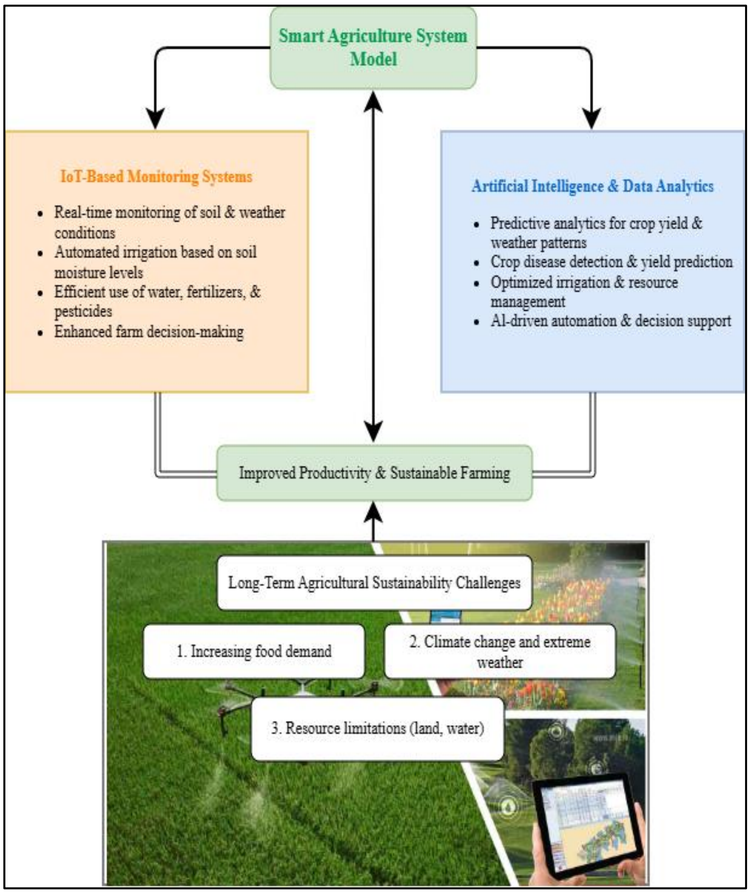

Figure 3. Smart Agriculture System Model Infographic

Some of the major issues that need to be considered while implementing an IoT-based agriculture system include the consumption of energy by sensor nodes, network robustness, and scalability.

3.2 Impact of Artificial Intelligence and Data Analytics

The use of AI and big data technology plays an essential role in improving the decision-making ability of smart agriculture. They make it possible for smart agriculture systems to analyze data, recognize patterns, make predictions, and take decisions based on their findings [3], [8].

There are numerous applications of machine learning algorithms in areas including crop disease identification, crop yield prediction, irrigation planning, and pest detection. One of the most common examples is the application of AI in analyzing images to detect crop diseases and nutrient deficiency [4].

Moreover, predictive analytics is important as it allows for the prediction of changes in environmental conditions such as precipitation and temperature. Also, AI-powered systems may adjust irrigation schedules based on real-time analysis of soil and climate data allowing for more efficient use of water resources and increased efficiency [2], [3]. However, the efficiency of these systems relies on good data and sufficient computing power, which may create obstacles for implementation in underdeveloped regions.

3.3 Long-Term Agricultural Sustainability Challenges

Despite considerable benefits offered by the use of smart agriculture solutions, there are certain challenges that should be accounted for in order to implement the system successfully. Firstly, rising demand for food due to an increasing population exerts additional strain on natural resources used in farming such as land and water [3], [6]. Furthermore, changing climate increases unpredictability of weather conditions and creates problems with floods and draughts making traditional approaches to agriculture inefficient. Smart agriculture systems seek to overcome such challenges through the implementation of IoT for data gathering and AI for analysis. Data obtained from sensor systems is analyzed using analytical models producing information about plants' condition and environment.

Nevertheless, the implementation of these technologies faces several barriers due to high upfront capital cost, infrastructure dependency, lack of technological knowledge among farmers, and privacy issues concerning data security. Overcoming these barriers through technological advancements, training programs for farmers, and conducive policies enacted by the government will be vital for the sustainable operation of smart agriculture [5], [7].

4. Categories of Smart Agriculture Technologies

The technologies used in smart agriculture can be systematically categorized into types according to the sensing process, data analysis, and decision-making. Together, these technological groups make it possible to create intelligent and efficient farming operations that increase production and minimize resource consumption. The main categories of smart agriculture technologies are shown in Figure 4.

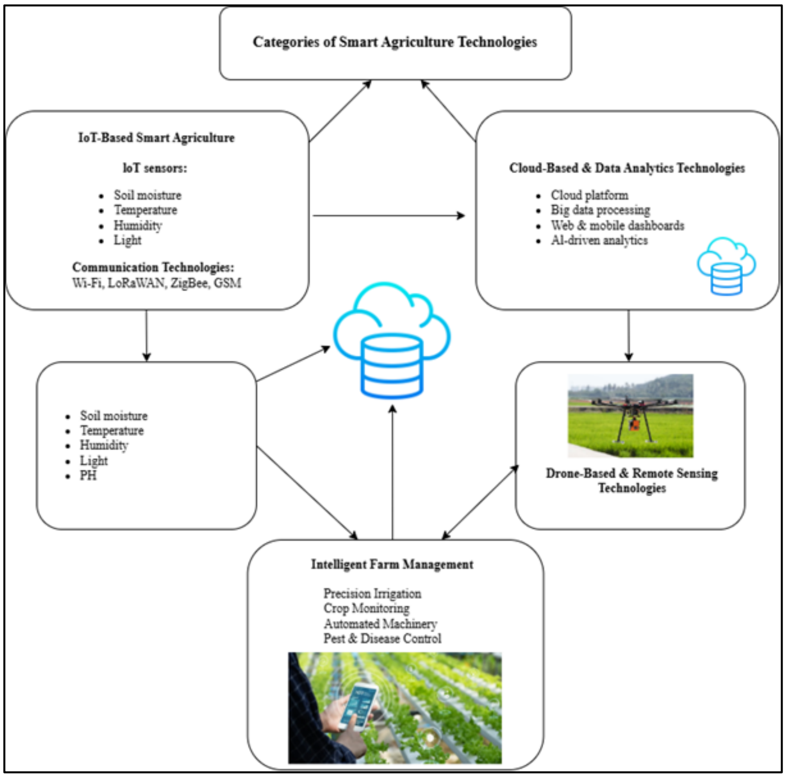

Figure 4. Categories of Smart Agriculture Technologies

4.1 IoT-Based Smart Agriculture

The IoT-based approach can be considered the most popular paradigm used in smart agriculture due to its ability to monitor in real time and control automatically the process of farming. In such systems, sensor nodes distributed in an agricultural field collect information about soil conditions such as soil moisture, temperature, humidity, pH level, and intensity of sunlight [1], [5]. The obtained information is transmitted using Wi-Fi, Zigbee, LoRaWAN, and GSM communication technologies to a central point [6] where data is processed and used to control various processes automatically. Smart irrigation systems are one of the key examples of how IoT technology can be used in smart agriculture. Such technology allows controlling irrigation based on real-time data about soil moisture content, thus decreasing the amount of water used [9]. In addition, IoT systems used in smart agriculture include applications that help to control farming operations remotely by means of mobile and web interfaces. Nevertheless, energy usage of sensor nodes, network reliability, and high infrastructure cost are the key challenges in implementing IoT systems in farming [10], [11].

4.2 Cloud-Based and Data Analytics Technologies

Cloud computing emerges as an important aspect of smart agriculture because it provides an infrastructure where agricultural data collected through IoTs are processed, analyzed, and stored. It allows for real-time access to the data and centralized management of farms via web-based dashboards or mobile applications [3], [6]. The use of more sophisticated methods of analyzing agricultural data collected on cloud computing platforms helps to detect patterns and anomalies in agricultural data to support decisions related to water usage, fertilizers, and pest control practices [2]. Nevertheless, the application of cloud computing technologies may face certain challenges, such as the dependence on reliable internet connections, data privacy, and increased operational expenses.

4.3 Drone-Based and Remote Sensing Technologies

The application of drone and remote sensing technologies proves to be very helpful in the process of agricultural monitoring. Drones with high-quality cameras and sensors take pictures of the fields, which makes it possible to monitor crops' condition and health [7]. The information obtained can then be processed using computer vision and machine learning techniques, making it easier to identify any plant diseases or deficiency of nutrients. Remote sensing technologies, such as satellite imagery, can provide information about vegetation indexes, soil moisture content, and climate changes [12]. Thus, in comparison with traditional methods of inspection, the new technologies allow conducting analysis more rapidly and accurately, covering a much larger area. Unfortunately, they also face numerous barriers in terms of expensive equipment and high labor intensity.

5. Comparative Analysis of Smart Agriculture Technologies

The comparative study of smart agriculture technologies becomes imperative for understanding the performance, drawbacks, and applicability of the technologies under different agricultural settings. Numerous methodologies like IoT-driven monitoring systems, AI-powered analytical platforms, and drone-supported remote sensing systems have been extensively investigated in the past few years. Each technology possesses its own strengths and weaknesses when it comes to scaling, affordability, energy efficiency, and deployment.

IoT-based systems are quite efficient in monitoring and automation processes. It provides a way to collect data continuously from farm lands using sensor systems in a distributed manner, enabling proper control of irrigation and environmental settings. Such systems are affordable and appropriate for small-scale and medium-sized farms. However, the efficacy of IoT technology is subject to constraints such as network stability, sensor node energy consumption, and reliance on communication channels [1], [5]. AI and Machine Learning systems allow the analysis of huge amounts of agricultural data through data analytics. This system helps perform predictive analysis, such as estimating crop yields, diagnosing diseases, and irrigation scheduling. The AI systems make the decision-making process much more efficient. Nonetheless, the need for quality data sets and high computing capacity limits their use in rural areas [3], [8].

Drones and remote sensing are highly accurate forms of monitoring which work particularly well for extensive agricultural operations because they provide high resolution and spatial information useful in evaluating crop condition, detecting stress and optimizing resource allocation. Yet despite their significant benefits, high cost of implementation, regulatory concerns and difficulties in processing the obtained data can be major problems [7]. Cloud solutions assist in using these technologies because they facilitate scalability of data storage, real-time accessibility and analytics. They serve as an infrastructure for aggregating data generated by multiple sources. Yet data security and privacy issues as well as dependence on connectivity might hinder the adoption of cloud computing [6].

Despite the differences, none of the technologies described above alone can cope with agricultural problems efficiently. Thus, integrated agricultural solutions based on IoT, AI, cloud computing, and remote sensing seem to be the way to go to achieve smart agriculture. Comparative Analysis of Smart Agriculture Technologies is presented in Table 1 below.

Table 1. Comparative Analysis of Smart Agriculture Technologies

Ref	Technology	Key Features	Advantages	Limitations	Suitable Applications
[14]	IoT-Based Systems	Real-time sensing, data collection	Low cost, continuous monitoring	Network dependency, energy consumption	Irrigation control, soil monitoring

[15]	AI/ML-Based Systems	Predictive analytics, automation	High accuracy, intelligent decisions	Requires large datasets, high computation	Disease detection, yield prediction
[10]	Cloud Computing	Data storage, remote access	Scalable, centralized management	Internet dependency, data security issues	Farm management systems
[20]	Drone/Remote Sensing	Aerial imaging, large-area monitoring	High-resolution data, fast analysis	High cost, regulatory issues	Crop health monitoring, mapping

Table 2. Comparative Performance Analysis of Existing Proposed Works

Ref	**Method / Model**	**Accuracy / Performance Value**
Abuzanouneh et al. (2022) [13]	Proposed IoTML-SIS Method	97.5%
Aldossary et al. (2024) [14]	Random Forest and Neural Network Classifier	92%
Dahane et al. (2020) [15]	LSTM-Based Models (Air-Temperature, Soil-Moisture, Air-Humidity)	98.59%
Tace et al. (2022) [16]	Results Data Training Model	K-NN Accuracy = 98.3% NN Accuracy = 97.2%
Syed et al. (2024) [17]	Proposed Ensemble Machine Learning	99.7%
Hossain et al. (2023) [18]	Proposed Neural Network Performance Parameters	89.47%

As can be seen from Table 2 above, each of the technologies described above performs its unique function within smart agriculture. IoT and wireless sensors are responsible for continuous collection and monitoring of real time environmental parameters thus providing a good understanding of field conditions. On the other hand, artificial intelligence and machine learning are mostly used for data analysis purposes and making predictions. Moreover, drones and remote sensing provide valuable insight into crops' health status at a larger scale, while robots and automation help improve farm performance and reduce human intervention.

Nevertheless, despite these achievements in technology, a number of drawbacks still persist, which can impede further progress. Firstly, the initial deployment costs remain relatively high, along with the lack of appropriate infrastructure in rural areas. Moreover, the limited knowledge and skills of local farmers in working with technology and data analysis represent another challenge. Finally, integration of heterogeneous data remains complex and cumbersome. These issues necessitate creation of unified and affordable smart agriculture ecosystems, which will be an area for future research.

6. Research Gap

While many remarkable advances have been made within the scope of smart agriculture research, there are still several crucial research gaps that remain unexplored. The existing literature tends to examine various smart technologies, such as Internet-of-things monitoring system, Artificial Intelligence based prediction model, or remote sensing systems based on drones, while little research is conducted on the development of integrated approaches to smart agriculture. In fact, one of the crucial problems related to the implementation of smart technologies within agriculture is the interoperability problem associated with a large number of heterogeneous sources of data, which include data obtained from sensors, aerial imagery, and environmental data sets.

Another problem involves focusing on such factors as accuracy and speed of operation, while other equally important considerations like affordability, scalability, and feasibility in practice tend to be ignored. Besides, the security issues related to handling of agricultural data, the reliability of networks used in this process, real-time data processing problems, and others are poorly addressed. Most of the suggested systems are tested in controlled settings only. Thus, more research is needed to develop reliable and effective agricultural solutions for different farming conditions.

7. Future Research Directions

Research on smart agriculture systems is likely to be oriented toward improvement of their efficiency, scalability, and seamless integration with advanced technologies. With a shift towards data-intensive processes in agricultural applications, there arises a need for effective implementation and operation of systems in diverse environmental and infrastructure conditions.

7.1 Lightweight and Energy-Efficient Smart Agriculture Systems

First, research should be aimed at creating light and energy-efficient systems designed for resource-poor environments. Many systems proposed for agriculture use battery-powered IoT-enabled devices, which makes energy efficiency a central aspect of future innovations. Researchers should consider implementing low-power systems' architecture, energy-efficient communication algorithms, and adaptive sensing techniques. Edge computing would allow for better operation performance through efficient local processing of collected data, reducing the amount of information transferred via networks.

7.2 Hardware Acceleration and Edge Intelligence

With the fast growth of data volume associated with agriculture, effective and timely processing of data is a critical necessity nowadays. There exist various hardware acceleration solutions, among which embedded AI chips, FPGAs, and other accelerators can improve efficiency considerably. Real-time capabilities offered by edge intelligence allow making faster decisions since data processing is done locally instead of being sent via the Internet. This feature is crucial in time-bound applications such as disease detection, irrigation management, and crop monitoring.

7.3 Integrated and Interoperable Smart Farming Platforms

The integration of smart farming solutions is another important aspect to consider for the future. Smart farming systems seek to integrate various elements such as Internet of Things (IoT) sensors, artificial intelligence (AI) analytics, cloud computing, and remote sensing within one structure. The use of hybrid solutions, involving both cloud and edge computing, could be considered for better performance. The improvement of interoperability among different systems and technologies should also be considered.

7.4 Security, Privacy, and Sustainable Deployment

Systems in the future also need to tackle issues associated with data security, privacy, and sustainability. With more emphasis placed on data sharing and cloud connectivity, securing data in terms of communication and storage is critical. Future research needs to examine issues of lightweight cryptography, privacy preserving data analysis, and secure communication techniques. In addition, sustainability issues including lowering cost, designing an easy-to-use system, and training farmers are key.

8. Conclusion

From the study, it is clear that the implementation of Intelligent Agriculture Technology has resulted in a huge shift in traditional agricultural practices into a smarter, efficient, and sustainable model. Farmers have managed to harness the power of IoT, Artificial Intelligence, Machine Learning, Cloud Computing, Wireless Sensor Networks, and Drones in monitoring meteorological environment effectively, automating irrigation processes, predicting crop yield, and managing resources efficiently. In the case of challenges, it was found that IoT-based technology is quite useful in the continuous monitoring of the environmental variables while the combination of AI/ML systems can be quite handy for predictions about the crop yield and diseases. Moreover, Remote Sensing and Drones can help monitor large stretches of agricultural land quite effectively. However, there are some challenges that will continue to hamper the adoption of technology in agriculture such as cost implications, availability of infrastructure, need for energy, data privacy, among others. As such, the future of smart Agriculture will require developing a system that integrates these technologies in an energy-efficient manner. This way, sustainable agricultural practices will be promoted as well as increased global food production.

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