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A Technical Seminar Report on

"Artificial Intelligence and Internet of Things for Sustainable Farming and Smart Agriculture"

Submitted in partial fulfillment of the requirements for the award of degree of

BACHELOR OF ENGINEERING
IN
COMPUTER SCIENCE AND ENGINEERING

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Certificate

This is to certify that Technical Seminar entitled "**Artificial Intelligence and Internet of Things for Sustainable Farming and Smart Agriculture**" is work carried out by Mr. Vishwanath Haveri (2AG23CS416) in partial fulfillment of the requirements for the award of the degree of **Bachelor of Computer Science & Engineering under Visvesvaraya Technological University, Belagavi** during the year 2025-2026. It is certified that all the correction/suggestion indicated for internal assessment have been incorporated in the report. The Final Year Seminar report has been approved as it satisfies the academic requirements in respect of Final Year Seminar work prescribed for the Bachelor of Engineering degree.

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Mr. Vishwanath Haveri
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Vision of the Department
To impart quality education in computer science and engineering with emphasis on professional skills to meet the global challenges in IT paradigm.
Mission of the Department
M1: Impart knowledge in current and emerging computing technologies by adopting various pedagogical approaches. **M2:** Develop a conducive environment to inculcate and nurture analytical and communication skills along with societal and ethical responsibility in all professional endeavors. **M3:** Enable students to be successful globally by being effective problem solvers and lifelong learners.

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Program Educational Objectives (PEOs)
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ABSTRACT

Technologies like AI and IoT have been employed in farming for some time now, along with other forms of cutting-edge computer science. There has been a shift in recent years toward thinking about how to put this new technology to use. Agriculture has provided a large portion of humanity's sustenance for thousands of years, with its most notable contribution being the widespread use of effective agricultural practices for several crop types. The advent of cutting-edge IoT know-how with the ability to monitor agricultural ecosystems and guarantee high-quality production is underway. Smart Sustainable Agriculture continues to face formidable hurdles due to the widespread dispersion of agricultural procedures, such as the deployment and administration of IoT and AI devices, the sharing of data and administration, interoperability, and the analysis and storage of enormous data quantities. This work initially analyses existing Internet of-Things technologies used in Smart Sustainable Agriculture (SSA) to discover architectural components that might facilitate the development of SSA platforms. This paper examines the state of research and development in SSA, pays attention to the current form of information, and proposes an Internet of Things (IoT) and artificial intelligence (AI) framework as a starting point for SSA.

***Keywords**: Smart agriculture, Internet of Things (IoT), artificial intelligence (AI), smart sustainable agriculture (SSA), smart farming.*

CHAPTER 1

INTRODUCTION

The Introduction comprises of Brief on Technology, Applications, Advantages and Limitations.

1.1 BRIEF ON TECHNOLOGY

Agriculture that is considered sustainable is characterized by long-term viability and ecological compatibility in its grain production practice. Sustainable agriculture serves to support techniques and methods that are beneficial to the long-term survival of humans and natural resources. It is practical from a financial standpoint, and it protects the quality of the soil, slows down the rate at which the soil degrades, conserves water resources, increases the biodiversity of the land, and guarantees a healthy and natural atmosphere. The practice of sustainable farming plays a vital role in the protection of natural resources, the slowing of the loss of biodiversity, and the reduction of greenhouse gas emissions.

‘‘Sustainable agriculture’’ is a technique for maintaining nature without sacrificing the ability of future generations to meet their fundamental requirements. In addition, it is a technique for making farming more efficient. Sustainable agriculture is largely attributable to the central successes of intelligent farming, which include ‘‘harvest alternation, the management of nutrient deficits in crops, the control of pests and diseases, recycling, and water harvesting’’. These accomplishments lead to an overall safer world.

However, an ever-expanding worldwide population with increased hunger, rapidly changing climate conditions, over use of resources, and wastage of food and water are obscuring the effect of sustainable agriculture. The need of time is to develop technologies and infrastructure capable of meeting the demands of the present as well as the future. Techno logical innovations have always been the fundamental means for the development of agriculture, from the pre-historic era to today, as illustrated. Breakthroughs like the development of simple tools and the utilization of animals; the use of fertilizers, pesticides, and small machinery; and the application of robots helped agriculture evolve to its present status, and now, with the use of smart technology, agriculture is impending to become smart. Smartfarming has become an important component of sustainable agriculture. Traditionally, a huge amount of time, money, and effort is invested in growing any crop. It is worth mentioning the time and effort required in the processing, transportation, and marketing of harvested crops and all other logistics associated with them. Technologies of smart farming present a way to deal with and alleviate these problems, offering an improved way of doing argon-businesses.

Fig 1.1 IoT for Smart agriculture.

Fig 1.1 monitored remotely, and the data processing is done via the use of cloud servers [4]. While reducing the need for human interaction, the smart greenhouse keeps track of the quantity of temperature, light, and humidity in the environment. by unscrambling sick animals from the rest of the herd. This helps safeguard the product and keeps the cost of cattle down.

DRONES FOR AGRICULTURE

The drones that can operate both on the ground and in the air can help in the evaluation of crop health, the monitoring of infestations, and the examination of soil more efficiently. In addition, they may be used for the collection of real-time field data, the sowing of seeds, the management of irrigation systems, and the spraying of crops [5]. The information that was acquired may be used to make production forecasts, evaluate nutrient levels, and map external impacts. This capability allows for the development of personalized avatars—digital representations of users characterized by customized body measurements and facial similarities-employed in virtual try-on spaces [4],[3].

SYSTEMS FOR PRECISION FARMING

One of the most common applications of agricultural technology is precision farming. It provides services such as variable rate irrigation (VRI) optimization, soil moisture testing, and cloud-based centralized water management. Through the use of sensors, autonomous equipment, and an internet connection, the system makes efficient use of the resource water.

SOLUTIONS FOR TRACKING AND MONITORING LIVESTOCK

Wireless Internet of Things networks and linked devices may reduce the amount of labour required at the ranch by keeping an eye on the cattle. Internet of Things devices are able to determine the location of an animal and even monitor its overall health [6]. On big farms, the farmers are able to quickly detect the animal and even halt the spread of illness by unscrambling sick animals from the rest of the herd. This helps safeguard the product and keeps the cost of cattle down.

SENSORS FOR CROP AND SOIL MONITORING

Robots and unmanned aerial vehicles armed with thermal or multispectral sensors are used to conduct continuous assessments of the state of crops and soil. This makes the application of fertilizer spray and controlled watering easier. The sensors analyse the levels of the various biomes In the soil in order to ensure that the crops have a high nutritional value. Additionally, in order to select the most profitable crops, AI analyses the features of the soil.

CURRENT WEATHER MONITORS

Smart sensors connected to the Internet of Things can assist gather real-time weather and climate data. Farmers are able to better analyse their crop requirements with the help of a thorough projection [7]. Farmers may also get alerts from some systems, allowing them to safeguard their crops in the event that severe weather strikes.

ROBOTS FOR AGRICULTURE

Agricultural robots lessen the need for manual work and save time by performing a number of tasks simultaneously on farms. They assist in agricultural monitoring and harvesting in a way that is more effective than using humans.

DEVICES FOR ESTIMATING FUTURE HARVESTS AND PRICES

When estimating the yield of their crops, farmers are using a variety of new technologies, including AI, ML, and big data. When harvest time comes around, it is important to make price predictions by looking at historical data to analyse price fluctuations.

1.2 APPLICATIONS

Here's a clear and concise explanation of Artificial Intelligence (AI) and Internet of Things (IoT) in Sustainable Farming and Smart Agriculture They include:

- **Precision Farming:** Precision Farming involves the use of Artificial Intelligence (AI) and Internet of Things (IoT) sensors to continuously monitor soil moisture, nutrient content, and overall crop health, enabling farmers to make data-driven decisions that optimize irrigation schedules, fertilizer application, and resource utilization for improved productivity and sustainability.
- **Crop Disease Detection:** AI-based image recognition helps identify pests and diseases early using camera or drone images.
- **Weather Forecasting:** Weather Forecasting in smart agriculture utilizes Internet of Things (IoT)–based weather stations to gather real-time environmental data such as temperature, humidity, and rainfall, while Artificial Intelligence (AI) analyses this information to accurately predict climate patterns, helping farmers make informed decisions about the optimal timing for sowing, irrigation, and harvesting to enhance crop yield and reduce risks caused by unpredictable weather conditions.
- **Smart Irrigation Systems:** IoT sensors automate irrigation based on soil moisture data, saving water and energy.
- **Livestock Monitoring:** Livestock Monitoring uses wearable Internet of Things (IoT) devices to continuously track animal health, movement, and feeding behavior allowing farmers to detect diseases early, monitor reproduction cycles, ensure proper nutrition, and improve overall livestock management efficiency and productivity through real-time data analysis and automated alerts.
- **Drone and Robot Operations:** AI helps reduce waste by forecasting demand and improving logistics and storage conditions. AI-powered drones and robots perform planting, spraying, and harvesting efficiently.
- **Yield Prediction:** including soil composition, weather conditions, crop growth patterns, and historical yield records—to generate accurate forecasts of agricultural output, enabling farmers to plan resource allocation, optimize harvesting schedules, and improve overall farm productivity and profitability through data-driven insights.

1.3 ADVANTAGES

Use of Artificial Intelligence (AI) and Internet of Things (IoT) in Sustainable Farming and Smart Agriculture. The following are the five most effective advantages that were established through literature review as well as through actual implementations:

- **Resource Optimization:** smart agriculture refers to the efficient use and management of available farming resources such as water, soil nutrients, fertilizers, energy, and labour through technologies like Artificial Intelligence (AI) and the Internet of Things (IoT).
- **Higher Productivity:** These technologies help farmers monitor soil, weather, and crop conditions in real time, automate irrigation and fertilization, and detect diseases or pests early. As a result, farming operations become more precise and efficient, leading to increased crop growth, reduced losses, and overall improvement in agricultural productivity.
- **Early Problem Detection:** Sensors, cameras, and drones collect real-time data from the farm, which AI analyzes to detect abnormal patterns or warning signs. By identifying problems early, farmers can take quick corrective actions, prevent large-scale crop damage, reduce losses, and ensure healthier and more sustainable agricultural production.
- **Cost Reduction:** Reduced labour and operational costs due to automation. Continuous monitoring ensures timely medical attention.
- **Environmental Sustainability:** These technologies help minimize water and fertilizer waste, reduce pesticide usage, lower greenhouse gas emissions, and prevent soil degradation by ensuring precise and efficient resource use. As a result, farming becomes more eco-friendly, maintaining soil health, conserving biodiversity, and supporting a balanced ecosystem while still meeting the growing demand for food.
- **Data-Driven Decision Making:** This approach reduces guesswork, improves efficiency, increases yields, and ensures that agricultural practices are both cost-effective and environmentally sustainable.

1.4 LIMITATIONS

Although Artificial Intelligence (AI) and Internet of Things (IoT) in Sustainable Farming and Smart Agriculture, they still have certain limitations that hinder their widespread application. The most important limitations as seen in the paper are as follows:

- **Technical Complexity:** These systems require specialized knowledge for data analysis, device integration, and software management, which can be difficult for farmers without technical expertise. Additionally, managing large amounts of data, ensuring system compatibility, and keeping equipment updated can be complex and time-consuming, often requiring skilled professionals and continuous technical support.
- **Internet Connectivity Issues:** smart agriculture refer to the problems that arise when farms, especially those in remote or rural areas, lack reliable internet access needed for AI and IoT devices to function effectively.
- **Data Privacy and Security:** Ensuring data privacy and security involves implementing strong encryption, secure networks, and proper access controls to protect farmers' information from cyber threats and to maintain trust in digital agricultural systems.
- **High Initial Cost:** Installation of IoT devices and AI systems is expensive. The expenses include purchasing sensors, drones, automated machinery, data management software, and reliable network infrastructure
- **Maintenance Challenges:** refer to the difficulties involved in keeping AI and IoT systems, sensors, drones, and automated machines functioning properly over time. These technologies require regular calibration, software updates, and repairs, which can be costly and time-consuming.

CHAPTER 2

LITERATURE SURVEY

[1] J. Wu, L. Pin, X.Ge, Y.Wang,and J. Fu, ''Cloud storage as the infrastruc of cloud computing,'' in Proc. Int. Conf. Intell. Comput. Cogn. Inform. (ICICCI), Kuala Lumpur, Malaysia, Jun. 2010.

presented at the *International Conference on Intelligent Computing and Cognitive Informatics (ICICCI)* in Kuala Lumpur, Malaysia, J. Wu, L. Ping, X. Ge, Y. Wang, and J. Fu discussed the critical role of cloud storage in supporting cloud computing systems. They explained that cloud storage acts as the foundational infrastructure that enables users and organizations to store, manage, and access data remotely over the internet. The paper highlighted how cloud storage enhances data scalability, flexibility, and availability while reducing the need for physical storage hardware. It also emphasized the importance of distributed storage systems for ensuring data reliability and fault tolerance. The paper also discusses ethical considerations in AR/VR use. It projects a future where AR/VR will be integral to human-computer interaction. The study encourages further interdisciplinary research and investment to unlock full potential.

[2] K. Gai, M. Qiu, H. Zhao, L. Tao, and Z. Zong, ''Dynamic energy-aware cloudlet-based mobile cloud computing model for green computing,'' J. Netw. Comput. Appl., vol. 59, pp. 46–54, Jan. 2016.

In their 2016 journal paper titled "Dynamic Energy-Aware Cloudlet-Based Mobile Cloud Computing Model for Green Computing," published in the *Journal of Network and Computer Applications (J. Netw. Comput. Appl.)*, volume 59, pages 46–54, K. Gai, M. Qiu, H. Zhao, L. Tao, and Z. Zong proposed a new model aimed at improving the energy efficiency of mobile cloud computing systems. The authors introduced a cloudlet-based architecture, where small-scale cloud servers located closer to mobile devices reduce latency and energy consumption. Their research focused on dynamically managing computing tasks between mobile devices, cloudlets, and cloud data centers to achieve green computing goals.

[3] M. Alam and I. Khan, ''IoT and AI for smart and sustainable agriculture,'' presented at the Int. Conf. Comput. Techn. Intell. Mach. (ICCTIM), Bathinda, India, Nov. 2020.

In their 2020 conference paper titled "IoT and AI for Smart and Sustainable Agriculture," presented at the *International Conference on Computing Technologies and Intelligent Machines (ICCTIM)* in Bathinda, India, M. Alam and I. Khan discussed the integration of Internet of Things (IoT) and Artificial

Intelligence (AI) technologies to transform traditional agriculture into a more efficient and eco-friendly system. The authors explained how IoT devices, such as sensors and drones, collect real-time data on soil, weather, and crop conditions, while AI algorithms analyze this data to support precise decision-making in farming activities. Their study emphasized that combining these technologies helps in optimizing irrigation, reducing resource wastage, and improving crop productivity.

[4] M. Dhanaraju, P. Chenniappan, K. Ramalingam, S. Pazhanivelan, and R. Kaliaperumal, ‘‘Smart farming: Internet of Things (IoT)-based sustain able agriculture,’’ Agriculture, vol. 12, no. 10, p. 1745, Oct. 2022.

In their 2022 journal article titled "Smart Farming: Internet of Things (IoT)-Based Sustainable Agriculture," published in *Agriculture*, volume 12, issue 10, page 1745, M. Dhanaraju, P. Chenniappan, K. Ramalingam, S. Pazhanivelan, and R. Kaliaperumal explored how IoT technology can revolutionize modern farming and promote sustainability. The authors explained that IoT-based smart farming uses interconnected sensors, devices, and cloud platforms to collect and analyze real-time data on soil moisture, temperature, humidity, and crop growth. This data helps farmers make informed decisions about irrigation, fertilization, and pest control, leading to more efficient resource utilization. The study highlighted that IoT reduces water and fertilizer wastage, enhances crop productivity, and minimizes environmental pollution. The study emphasizes co-creation and participatory design for effective MR implementations. It concludes that immersive tech reshapes both destination marketing and visitor behavior. This work is pivotal in redefining the future of tourism.

[5] M. S. Farooq, S. Riaz, A. Abid, K. Abid, and M. A. Naeem, ‘‘A survey on the role of IoT in agriculture for the implementation of smart farming,’’ IEEE Access, vol. 7, pp. 156237–156271, 2019.

In their 2019 research article titled "A Survey on the Role of IoT in Agriculture for the Implementation of Smart Farming," published in *IEEE Access*, volume 7, pages 156237–156271, M. S. Farooq, S. Riaz, A. Abid, K. Abid, and M. A. Naeem presented a comprehensive review of how the Internet of Things (IoT) is transforming traditional agriculture into smart farming systems. The authors examined various IoT applications such as precision farming, automated irrigation, crop monitoring, and livestock management. They discussed how IoT-enabled sensors and devices collect real-time data on soil, weather, and crop conditions to support better decision-making. The paper also highlighted the benefits of IoT in improving productivity, conserving resources, and promoting sustainable agricultural practices. Additionally, the researchers analyzed the challenges faced in adopting IoT technologies, including connectivity issues, data security, and high implementation costs. They emphasized the importance of integrating IoT with Artificial Intelligence (AI) and cloud computing for efficient data

[6] M. Shahbandeh. (Sep. 2, 2022). AI in Agriculture Market Value World wide 2020–2026. [Online]. Available: https://www.statista.com/statistics/ 1326924/ai-in-agriculture-marketvalue-worldwide.

In the 2022 online report titled “AI in Agriculture Market Value Worldwide 2020–2026,” published by M. Shahbandeh on *Statista* (September 2, 2022), the author presented detailed statistics and analysis on the global market growth of Artificial Intelligence (AI) applications in agriculture. The report highlighted that the AI in agriculture market has been expanding rapidly due to increasing demand for automation, data-driven decision-making, and sustainable farming practices. It provided insights into how AI technologies—such as machine learning, computer vision, and predictive analytics—are being used for crop monitoring, soil management, and yield prediction. The report also discussed factors driving this growth, including advancements in IoT, smart sensors, and drone technology. Furthermore, it emphasized the role of AI in addressing global food security challenges by improving efficiency and reducing resource wastage. The projected data indicated a significant rise in market value between 2020 and 2026, reflecting the growing adoption of AI in modern agriculture worldwide. Overall, the report demonstrated how AI is becoming an essential component of the future of smart and sustainable farming.

[7] E. Alreshidi, ‘‘Smart sustainable agriculture (SSA) solution underpinned by Internet of Things (IoT) and artificial intelligence (AI),’’ Int. J. Adv. Comput. Sci. Appl., vol. 10, no. 5, pp. 93–102, 2019.

In the 2019 journal article titled “Smart Sustainable Agriculture (SSA) Solution Underpinned by Internet of Things (IoT) and Artificial Intelligence (AI),” published in the *International Journal of Advanced Computer Science and Applications (IJACSA)*, volume 10, issue 5, pages 93–102, E. Alreshidi explored how combining IoT and AI technologies can create innovative solutions for achieving sustainable agriculture. The author explained that IoT devices, such as sensors and actuators, collect real-time data on environmental and crop conditions, while AI algorithms analyze this data to support intelligent decision-making in farming operations. The study highlighted how this integration enables precise control of irrigation, fertilizer use, and pest management, resulting in improved resource efficiency and higher productivity.

CHAPTER 3

METHODOLOGY

This study utilizes a variety of methodological approaches to Artificial Intelligence (AI) and the Internet of Things (IoT) in Sustainable Farming and Smart Agriculture.

3.1 METHODOLOGY

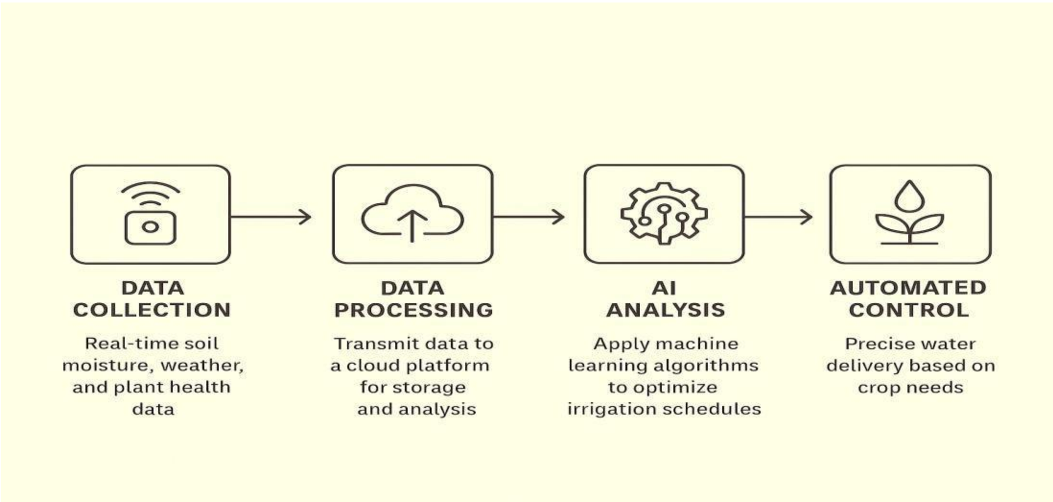

Fig 3.1 Methodology.

The figure 3.1 In the Data Collection stage, IoT sensors, drones, and weather stations gather real-time data about soil conditions, temperature, humidity, and crop health. This data is then transferred to cloud platforms, where Data Processing takes place to clean, organize, and prepare it for analysis. After that, in the AI Analysis stage, Artificial Intelligence and Machine Learning algorithms study the processed data to detect patterns, predict crop diseases, estimate yields, and provide recommendations for irrigation and fertilization.

DATA COLLECTION

- Objective: The main goal of data collection is to gather accurate, real-time information about various environmental and crop parameters.
- Approach: IoT sensors and devices are installed in the field to continuously monitor environmental factors.
- Outcome: Provides accurate, continuous, and up-to-date field information.

DATA PROCESSING

- Objective: The main objective of data processing is to organize, store, and prepare the raw data collected from sensors, drones, and IoT devices so that it can be analyzed effectively by AI systems
- Approach: The raw data from various IoT devices (soil sensors, weather stations, cameras, drones, etc.) is transmitted to a cloud platform or central database.
- Outcome: Creates a centralized data repository, supporting long-term monitoring and smart planning for sustainable farming

AI ANALYSIS

- Objective: The main objective of AI analysis is to interpret and analyze processed agricultural data to generate intelligent insights and predictions that support decision-making in farming. It helps in identifying patterns, forecasting outcomes, and suggesting the most efficient farming practices for sustainability and productivity.
- Approach: Machine Learning (ML) algorithms and Artificial Intelligence models are applied to the processed data. The AI model continuously learns and improves from new data to enhance accuracy over time.
- Outcome: Provides accurate predictions on irrigation, fertilizer use, pest control, and crop yield.

AUTOMATED CONTROL

- Objective: The main objective of automated control is to implement AI-generated decisions automatically through smart farming equipment and systems. It aims to reduce manual labor improve precision, and ensure efficient use of agricultural resources such as water, fertilizers, and energy.
- Approach: AI recommendations are sent to IoT-enabled devices such as automatic irrigation systems, drones, and smart tractors.
- Outcome: Promotes sustainable farming by minimizing environmental impact and conserving natural resources.

3.2 DESIGN AND ARCHITECTURE

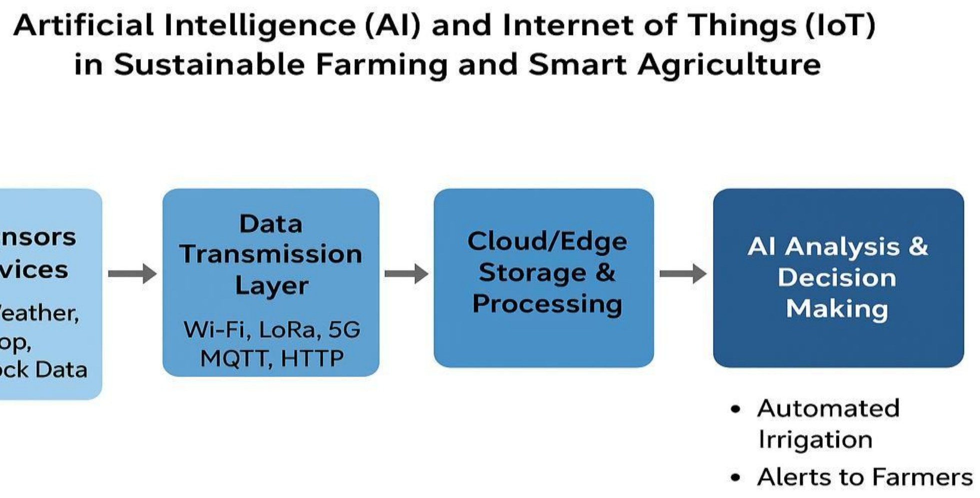

Fig 3.2 Design and Architecture

To enable AR and VR in an e-commerce environment, strong system architecture is crucial. Below we outline the major components of such system architecture:

- The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) in farming creates a smart and sustainable agricultural system that operates through four main stages — IoT Sensors and Devices, Data Transmission Layer, Cloud/Edge Storage & Processing, and AI Analysis & Decision Making.
- IoT Sensors & Devices: The IoT Sensors and Devices used in smart agriculture are intelligent tools placed throughout the farm to collect real-time data. These sensors monitor important parameters such as soil moisture, temperature, humidity, weather conditions, and the health of crops and livestock. Examples include soil moisture sensors, drones for crop imaging, smart collars for livestock monitoring, and weather stations. The main objective of this stage is to gather accurate environmental and biological data that can be analyzed to improve farming practices
- Data Transmission Layer: where the collected information is transmitted from sensors to the processing unit using various communication technologies. Common methods include Wi-Fi, LoRa, 5G, MQTT, and HTTP protocols. The objective of this layer is to ensure a reliable and fast transfer of large volumes of agricultural data. The approach involves using wireless

cloud-based networks to provide real-time connectivity between IoT devices, servers, and storage systems.

- Cloud/Edge Storage & Processing: The data is stored and processed using cloud computing or edge computing platforms. Edge computing allows faster processing closer to the data source, reducing delays, while cloud computing handles large-scale data storage and complex analytics. The main objective is to organize, clean, and prepare the data for AI-based analysis. As a result, farmers and systems obtain structured and accurate data that can easily be analyzed for decision-making.
- AI Analysis & Decision Making: Artificial Intelligence (AI) algorithms and machine learning models analyze the processed data to detect patterns, predict future trends, and make intelligent decisions. This helps in automating irrigation, detecting crop diseases, forecasting weather, and predicting yields. AI systems also send alerts to farmers about specific actions such as watering, fertilizing, or pest control. The main objective here is to make intelligent, data-driven decisions that enhance productivity, reduce wastage, and promote sustainable farming.

- The overall outcome of integrating AI and IoT in agriculture is the creation of a smart, efficient, and eco-friendly farming system. It ensures optimal use of resources such as water, fertilizers, and energy while minimizing human effort and operational costs. This technology improves crop yield and quality, reduces environmental impact, and supports sustainable and data-driven agricultural practices for the future.

CHAPTER 4

RESULTS

4.1 RESULTS

There are many other benefits that smart farming offers resulting in increased productivity by investing less labour and allowing better time management. All the data collected through various IoT devices are employed to gain knowledge regarding significant parameters such as soil conditions, water requirements, infestations, plant diseases, herbicidal growth, etc.

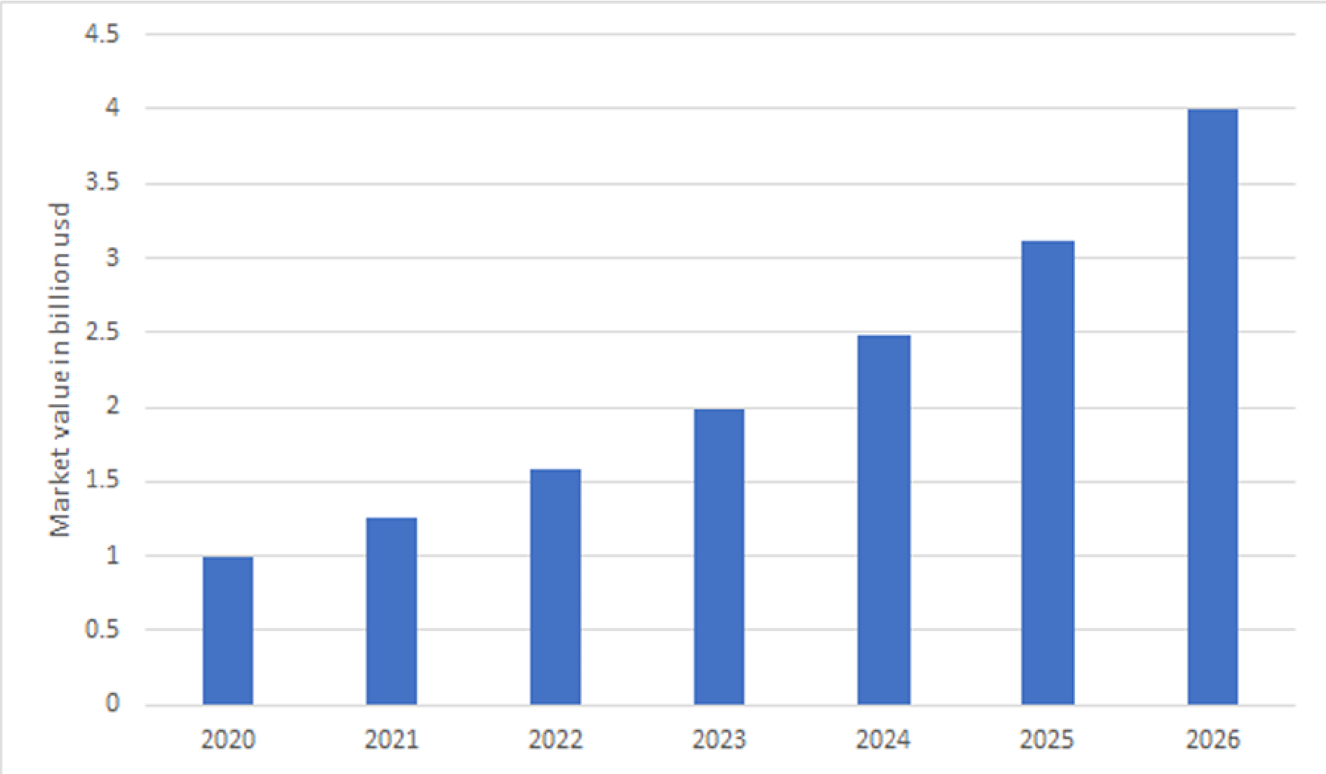

Fig 4.1 Results

Key Findings:

- **Improved Resource Efficiency:** AI-driven analytics and IoT sensors help farmers use water, fertilizers, and energy more efficiently, reducing waste and lowering operational costs.
- **Higher Crop Yield and Productivity:** Real-time monitoring of soil, weather, and crop health enables timely interventions, resulting in higher yields and better crop quality.

- **Early Detection of Pests and Diseases:** AI image analysis and IoT cameras detect pest attacks and plant diseases early, helping farmers take action before major crop losses occur.
- **Data-Driven Decision Making:** farmers use real-time data collected from IoT sensors and AI analysis to make smarter, faster, and more accurate farming decisions.
- **Reduced Environmental Impact:** AI and IoT technologies help farming become more eco-friendly by cutting down harmful practices and protecting natural resources.
- **Automation of Farm Operations:** Automation of farm operations means using AI-powered machines, robots, and IoT devices to perform farming tasks automatically with very little human effort.
- **Better Market Forecasting:** By their nature, people are more willing to explore and spend time in immersive experiences.

smart farming cooperative ecosystem connecting IoT devices on a community level with continuous incorporation of computational and physical components. This newly developed ecosystem adds small farmers to complicity with regulations and policies.

They then discussed the benefits of the system classifying it into four broad categories of marketing and distribution, resources and equipment, labour, and service and supply. This system can prove beneficial in drawing small farmers towards the implementation of IoT for better crop production.

Digital technologies like IoT may help achieve economic, environmental, and social sustain ability objectives. However, it is difficult to assess how much such technologies contribute to sustainable development casting doubt on their influence. This study presents a stepwise method for assessing and monitoring IoT sustainability in real life. The approach's typology and presentation of sustainability as a business opportunity are based on the UN SDGs. The EU-funded IoF2020 project created and tested 33 use cases. The study shows how the measuring and monitoring tool is used in five agricultural subsectors to verify the strategy

This newly developed ecosystem adds small farmers to complicity with regulations and policies. They then discussed the benefits of the system classifying it into four broad categories of marketing and distribution, resources and equipment, labour, and service and supply. This system can prove beneficial in drawing small farmers towards the implementation of IoT for better crop production.

.4.2 DISCUSSION ON RESULTS

In an attempt to affect a different outcome, the agriculture industry embraced AI with great fervour. As a by-product of advancements in artificial intelligence, the methods by which our food is produced are undergoing transformation, and as a consequence, the emissions produced by the agricultural sector have decreased by 20%. AI lends a hand in the manage ment and regulation of any unanticipated natural situations.The majority of new businesses entering the agricultural sector have chosen to implement an AI-enabled approach in order to boost the efficiency of agricultural output. AI provides assistance to the agricultural industry in the processing of data in order to minimise the occurrence of undesirable results.

Recent studies have uncovered a number of efforts aimedatfostering smart farming techniques, such as the digitalization of farm cooperatives as agricultural producers, the nascent development of a start-up ecology, and ‘‘government-led digital farming projects’’. Other actions include the modernization of farm collectives as farmer-producer organisations. Unmanned aerial vehicles, often known as UAVs, find the greatest amount of use in the field of agriculture.According to the research findings, as the country’s agricultural sector continues to develop, more businesses are anticipated to invest in reasonably priced drones. These drones may provide assistance to farmers and help them enhance their information, while also creating employment opportunities for

It is clear that the administration is helping to foster an environment that is conducive to the growth of farm technology businesses by funding and operating incubators. Under the banner of ‘‘AI for all,’’ the government of India has developed comprehensive rules to be followed in order to cultivate India’s AI ecosystem via the NITI Aayog. The good news is that it is projected that agriculture will have a substantially young individuals living in rural areas.better structure in the not too- distant future than it has right now.

FUTURE TRENDS AND INNOVATION

AI and IoT will lead to fully automated farms using robots, drones, and driverless tractors. Digital twin technology will help farmers simulate and test decisions before applying them. Advanced AI will improve predictive farming, forecasting weather, diseases, and market trends. Smart irrigation will optimize water use automatically based on real-time data. Blockchain will improve food safety and traceability, ensuring transparency from farm to consumer., we can expect the innovations to focus on several key trends:

- **Autonomous farming:** Autonomous farming means future farms will use driverless tractors, robots, and AI-powered drones to perform tasks like planting, spraying, and harvesting without human effort. using AI-powered robots, drones, and driverless tractors to perform tasks like planting, watering, and harvesting automatically with little or no human involvement.
- **Digital twin farming:** create a virtual copy of the actual farm to test decisions, predict outcomes, and improve planning before applying changes in real life. Digital twin farming means creating a virtual model of the real farm so farmers can test decisions, predict outcomes, and monitor crop conditions digitally before applying changes on the actual field.
- **Blockchain-based food traceability:** As will allow every stage of food production to be recorded, making it easier to track food safety and quality from farm to consumer. blockchain technology to record every step of food production so that the journey from farm to consumer is transparent, secure, and easy to track for safety and quality.
- **Climate-resilient farming technologies:** Climate-resilient farming technologies means using AI, IoT sensors, and advanced tools to help farmers predict extreme weather, protect crops from drought or floods, and adapt their farming practices to changing climate conditions will help farmers prepare for extreme weather events like droughts and floods by giving early warnings and planning support.
- **5G-enabled real-time farming:** 5G-enabled real-time farming uses high-speed 5G networks to connect farm sensors, drones, robots, and machines instantly. With 5G, data from soil sensors, weather stations, and crop monitors is transmitted in real time without delay.This helps farmers make quick and accurate decisions, such as when to irrigate or apply fertilizers. 5G also supports autonomous machines like driverless tractors and drones, allowing them to operate smoothly across large farms.

CONCLUSION

This study has shown that the use of contemporary and mod ern computer technologies, notably AI and IoT, is crucial to the success of the agricultural industry. Agriculture is often regarded as an essential component to the sustained existence of humans. Improving the efficiency, quality, and quantity of produce in conventional farming by incorporating more.The AI or IoT technology framework for SSA is the key contribution that this paper brings to the table. As a direct result of this, there has been an increased emphasis placed on the investigation and advancement of an integrated AI and ‘‘IoT platform for SSA’’.

This is being done with the intention of successfully fixing problems that have surfaced as a direct result of the fragmentary nature of farming production This is being done with the intention of successfully fixing problems that have surfaced as a direct result of the fragmentary nature of farming production In this study, an analysis of the current IoT and AI technologies was carried out using primary research journals in the field of agriculture. In addition to this, it provided a categorization of the most important aspects of intelligent and sustainable agriculture. These aspects include crops, human resources, soil, weather, fertilizer, agricultural products, pests, irrigation/water, animals, machinery, and fields.

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