# A Study on Application of Internet of thing &Wireless sensor Network in smart farming

**Jyoti1and Dr. Kavita Mittal2**

1Jagannath University, Bahadurgarh Department of Electronics & communication Engineering

2Jagannath University, Bahadurgarh Department of Computer Science& Engineering

**ABSTRACT:**

The agriculture industry faces numerous challenges in meeting with the highly increasing demand of food production, resource management with sustainability development. In the trend of new technology all human being should be know about the food security in term of smart farming. For crop production latest and more effective methodologies are used for the existing problem of reduction of the arable land and increasing the food demand to the whole world people. For more production of the crop yield there should be growth of new technology and increasing acceptance of Agri land by accepting the new innovative idea of the people as a genuine occupation. The aim of this study to use the IoT and sensor technology in agriculture to provide the high yield and high-quality product. This paper also studies the various application of wireless sensor network and IoT in agriculture with tools and equipment that are used. This study aims to create the IoT and wireless network system which are consisting of software application and hardware designed which help to reduce the farmer work load and increase the overall productivity and also solve the many of the farmer problem. By implementing of sensor in agriculture field, the condition of air, soil, water and humidity is monitored. This research provide insight into the benefit, challenges and future direction of employing WSN and IoT in smart farming.

**Key Words: Wireless Sensor Network, Internet of Thing, Smart Farming**

## I.INTRODUCTION

The population of India mainly depends on the farming. Currently in India agriculture is the recompense due to the lack of clearness of fund, And the prevision for the productivity of crop. Agriculture faces continuous many of the challenges. Largest production of agriculture yield is done by the India, and over the world the farm productivity holds about 33%. So that there is necessary requirement of the farmer that they can get more wage from their crop production with fewer labor. As a response, there are so many techniques that are planned to complete all desire of farmers.

Wireless Sensor Networks (WSNs) are a fascinating and rapidly evolving field of technology that combines the power of wireless communication and sensing capabilities. These networks consist of numerous small, autonomous devices called wireless sensors, which are connected with sensors node to capture the data from the farming environment. The sensors communicate to each other with a central node, often referred to as a sink node or base station, by using wireless communication protocols. The main purpose of a wireless sensor network is to collect, process, and send all figures from sensor nodes to the base node for further investigation and decision-making. These nodes are installed in a distributed manner, that cover a large area or specific locations of interest, such as a battlefield, a forest, a smart building, or an industrial plant. Wireless sensor networks are an exciting technology that integrates sensing, wireless communication, and data processing to enable intelligent monitoring and control systems. With their vast potential for data collection and analysis, WSNs have the power to revolutionize various industries and contribute to the development of smart and interconnected systems.

The term IoT is stand for the Internet of thing that is describe as the technology and device that is used for interconnection of various devices, physical object, and systems through the internet. It involves embedding sensors, actuators, and other hardware components into daily life object, allowing them to collect, exchange and transmit the data. Fundamental idea across IoT is to create the network where objects can communicate with each other and with humans, forming a seamless and intelligent ecosystem. This network can range from small-scale deployments in homes and businesses to large-scale implementations in cities and industries.

## II. LITERATURE SURVEY

Atharv [2023] proposed a system which are used to check the humidity and moisture level of the sensor for finding the level of water. If the level of water is below to the given value, then system start the watering automatically. Level of moisture and humidity value is also provided by the internet of thing. New technology in IoT help to make the data together for increasing the productivity of soil and protection of atmospheric temperature. This technology also upgrades the standard of farmer by increases the efficiency of crop and decrease the production cost. This is not only finding the permeant methods of farming but also give a new work road for the new opening. The system provided by the researcher is also reduces the human labors and simplifies the new way of farming which helps to start the method of smart farming.

Nifasath [2022] This survey introduces the sensor network which contain many of the sensing node for sensing and compute data, for wireless communication. The agriculture area used wireless sensor network technique to control and monitor soil moisture data and humidity parameter of the environment. WSN plays an important role for the agriculture to many of the solution that provide clarification and increase the overall crop production with a low power feasting and collected the spread data. Water management consider a main portion of the agriculture. Many of the environmental constraints like temperature, humidity and soil moisture supervised which is controlled by IoT wireless sensor network technique. This also provide more care in so many of research areas such as for monitoring the health care, environment parameter and also monitoring of structural health. Now a day WSN provide a better solution for precision agriculture.

Elsa [3] Study a literature on highlighting the openings the implementation of Artificial intelligence in agriculture business. Cyber-security provides a potential of threats, which are very urgent for the well- behaved business, but many of the time there is a missing of new technical information within any of the organization. The paper also studied the main trending macro words which give a new information for a smart farming change. In agriculture three sectors are examined: precision farming, best quality milk production and moan production. This paper also includes a varied point of view that allow and block the Transaction of the techniques. It is very important to find the main chance in smart farming for implemented the new strategic so that overall industry is growth with the stakeholders. The normal trend of software engineering is to provide a service with the shared machinery and provide the large amount of data for the farmer so they can implement the new technologies. Concluding the study, the main footraces is the technical and statutory tasks to gain the own data.

Harshit [2020] Proposed in the sensor network the main issue facing is the energy efficiency. Solving of this kind of issue many of the approaches have been planned. There are two method, first method used an algorithm which are further categories in other way. One method is single agent based and 2$^{nd}$ is multi agent based. This research, also provides a short summery of the energy efficient processes. All the procedures are using technique agents. Many of the procedure are single agent based and many of them are multi agent based. From this survey it concludes that method of multi agent outdoes from the process of single agent method.

Jerrin Smile [2021] proposed Agriculture plays a significant role for the growth of the world economy. In the recent a small amount of labor wants to work in the farming area due the low earning. This effect the owner of the farm or agriculture. Farmer always facing the fear of wild animal and thieves in their agriculture land, so all these farming activities should be monitored and regulated. This can be done by the smart farming. Farmers must be agreed with the new innovation of technology so that they can overcome their problems and solve them. If the farmer wants their work effectively then this technology is very helpful for the farmer and they should support the new technique to work in better way. Internet of thing is one of most advanced technology who can help the farmer and monitor their field remotely.,

To analyses the performance of the IoT network the main supportive parameter are the consumption of power and security

## III. LITERATURE ANALYSIS

What system is going to implement, what kind of techniques that need to be used is discussed in the project.

**Table 1 Area and Technology/ Application**

| Reference | Year | Author | Areas | Technology/Application |
|---|---|---|---|---|
| 4 | 2022 | C. Vijaya et al., | Use of IoT in agriculture sector | IoT, Sensor, Microcontroller, GPS, Wi-Fi, Real time sampling of environment parameter. |
| 5 | 2022 | S. Rutuja et al., | IoT based automatic irrigation system | Cloud server, IoT & WSN, Automatic drip irrigation system, wireless module, Soil moisture. |
| 6 | 2022 | S. Nifasath et al., | WSN in Agriculture | WSN, fertilizer usage precision agriculture, Smart farming & Decision-making system |
| 10 | 2021 | M. Balasubramanian et al., | IoT in smart agriculture | Sensor, IoT, Climate Change, soil erosion, water efficiency. |
| 11 | 2021 | L. Jaime et al., | IoT in Precision agriculture | IoT in Precision agriculture |
| 5 | 2020 | P. Supachai | Data analytic in agriculture through IoT | Data analytic in agriculture through IoT |
| 23 | 2017 | A.M. Ezhialzhahi et al., | Integration of WSN with IoT for soil moisture monitoring | Integration of WSN with IoT for soil moisture monitoring |
| 9 | 2022 | Juliana Ngozi, N. et al., | WSN & IoT based Smart irrigation system | Smart irrigation system, Cloud computing Soil Moisture, temperature, rain and light monitoring |
| 8 | 2022 | Khaled, O., et al., | smart irrigation systems using IoT. | Sensor & IoT based irrigation System, Achieving Sustainable agriculture of water management. |

**Table 2 Research Gap**

| Reference | Year | Vertical/Area | Analysis / finding | Research Gaps |
|---|---|---|---|---|
| 16 | 2020 | Smart agriculture | Smart agriculture by the adoption of IoT as a review art of state | IoT application for the balancing of project cost, usability and regional challenges |
| 7 | 2022 | WSN based smart agriculture | measurements of required parameters of the crops | Not discuss about upcoming direction and challenges using WSN in agriculture field |
| 3 | 2023 | Smart farming based on IoT | automatically irrigation of water detection of plant disease by using KNN algorithm | Not discusses about any other technique for irrigation for smart farming |
| 13 | 2020 | IoT in arable farming | implementation of IoT in agriculture and discussed about the various tasks, application and potential | Leck of product for precision agriculture, limitation of power consumption, limited range of communication |
| 9 | 2021 | Smart agriculture | Discussed the challenges & communication IoT technology for smart farming. | Not discuss about the IoT in architecture and transmission of data |

## IV. RESEARCH METHODOLOGY

Smart farming, is define as leverage progressive technology and collecting the data for driven methods to enhance agricultural practices and manage the overall production, efficiency, and sustainability in the field of farming. Its also known as precision agriculture. It controls by the various technology like Internet of Things, sensors and analysis of big data to enable farmers to make knowledgeable decisions and manage their work more effectively. In smart farming, sensors are deployed throughout the farmland to gather the actual data for many of the parameters like temperature, moisture, harvest growth and nutrient levels. These sensors are often connected to a central system, which can be accessed by farmers remotely. The collected data is then analyses by using the sensor node and send to the cloud for further operation.

### *(1 )RESEARCH OBJECTIVES & METHODOLOGY*

Due to the wide variety of applications, Wireless sensor network play an important part for engineering, science, agriculture and some other fields of surveillance, military, smart home and smart city. Implementation of various sensor network in agriculture field make it smart. The major objectives of the proposed research work are as follows:

1. To study the various sensor and their performance.
2. Development of smart agriculture technique by concentrating on the issue like irrigation management, soil moisture management, pest detection and overall crop production by Using sensor technology
3. Analysis of soil quality and remove the scarcity of water by smart farming using WSN.
4. To perform comparative analysis of the proposed method with the existing techniques.

The development of a conceptual framework for smart farming there is a requirement of methodology. With the help of these methodology there is trying to solving the aim of the problem. The various case study approaches are used for appraising the applicability of the existing outline for smart farming situation. Some of approaches are given below

**Sensor Deployment**: Wireless sensors will be strategically deployed throughout the agricultural field to monitor essential parameters. Sensors for soil moisture, temperature, humidity, and crop health will be chosen based on their accuracy, reliability, and compatibility with the IoT framework.

**Data Acquisition and Transmission:** The deployed sensors will continuously collect the facts and transmit wirelessly to the central node of gateway. The gateway behaves like a data aggregator which is uses IoT protocols to establish connectivity with the cloud-based server.

**Cloud Infrastructure:** The cloud-based server will receive, store, and process the sensor data. It will utilize data analytics algorithms to derive meaningful insights and generate real-time reports and alerts. The server will be scalable, secure, and most talented for handling a large amount of data.

User Interface and Mobile Application: A user-friendly interface and a mobile application will be developed to provide farmers with access to the collected data and system controls. The application will display real-time sensor readings, historical trends, and actionable recommendations. Farmers can remotely monitor and manage their agricultural operations using any internet-connected device.

## Sensor

There are so fast challenges in society to detect the forecasting of weather, reason of decreasing rainfall, and increasing the extra food demand to endure the large population globally are facing of so many impacts on farming. All this make a bed impact on the exercise of traditional farming. So that for the smart farming a sensors technology is adopted.

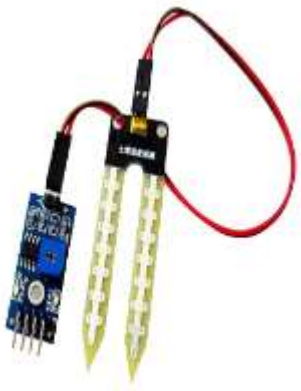
The sensors which are used for smart farming in agriculture are known agriculture sensors.

### Temperature sensor

Temperature sensor is that electronics sensor which is used to measure the temperature of the environment and convert the raw data or input into the form of electronic data which are to recorded, monitor and changes into temperature signal. LM35 sensor is the type of temperature sensor which are most widely used because of the its function of output parameter. Voltage is measure corresponds to the Celsius temperature. Its performance rate is very wide. And it provides the extreme output is 5V. The terminals used in this type of sensor are three named as VCC terminal, Ground and analogy logic. The electricity used by this is very small. So that it saves large energy. In agriculture area its widely used and also do best works.

### Soil Moister Sensor

This type of sensor is basically used to measure content of water present in soil. It's also used as a device for find out the volumetric amount of water in soil. For the irrigation of field and watering in the plant the main role is the moisture of soil. The nutrients given by the soil for the food of the plants is play a very important role to change the temperature of the plants. This type of sensors mainly used to find out the volumetric level of water, and different type of sensors is used to measure the property of soil moisture.

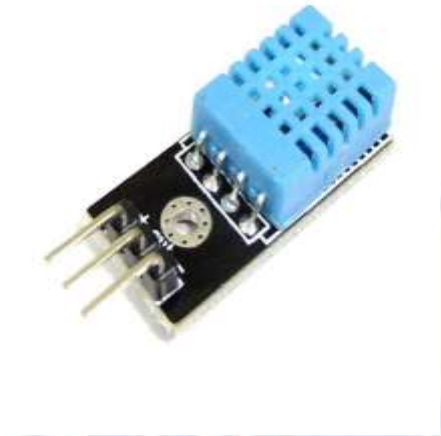


### Humidity Sensor

Humidity sensor is defined as a device which is used to find the accurate moisture or water vapor present in the environment. It's also known as hygrometer. It is commonly used in various applications, including weather monitoring, HVAC systems, manufacturing processes, agriculture and indoor environmental monitoring.

There are several types of humidity sensors available, each utilizing different principles to measure humidity.

The main aim of this type of sensors to find the humidity level which is detected through the humidity-sensitive capacitor. As humidity increases, the dielectric constant of the sensor material changes, leading to a change in capacitance. These sensors work based on the principle that some materials change their electrical resistance when A humidity-sensitive material, such as a polymer or a ceramic, is used in the sensor, and its resistance varies with the moisture content in the air.



## Proposed Model

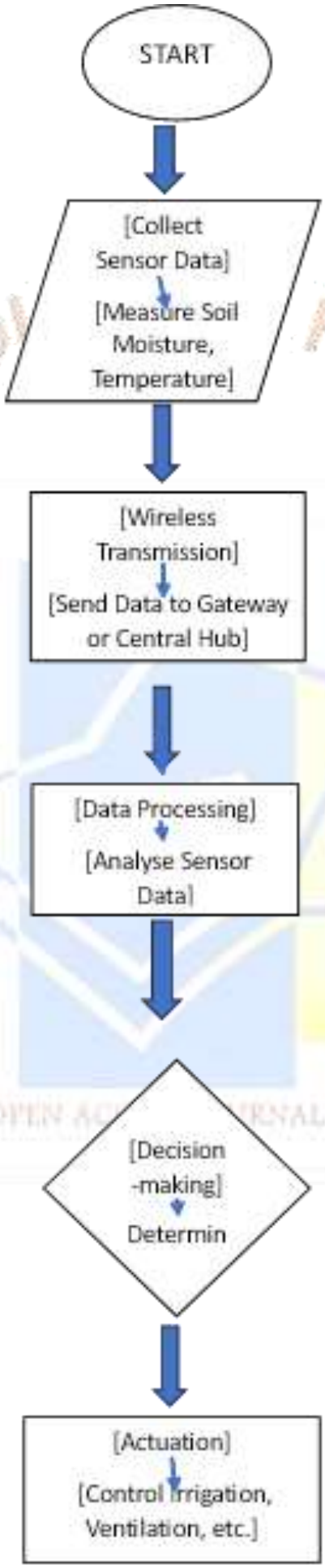
Smart farming is an approach that utilizes advanced technologies to optimize agricultural processes, increase crop yield, and improve overall efficiency in farming operations. One of the key technologies used in smart farming as Wireless Sensor Networks is merged with the technology of internet of things

A Wireless Sensor Network contains of many small, battery-powered sensing nodes that's are strategically deployed throughout a farm. These nodes are equipped with various sensors, such as soil moisture, humidity, temperature, and light sensors, for monitor different environmental parameters relevant to agriculture. All the nodes are connected wirelessly with each other node and a central base station or gateway.

The term Internet of Things (IoT) is defined as the network of physical devices, appliances, vehicles and many objects which are embedded with sensors and software, and the connectivity enabling them to connect and change data. In other way of smart farming, the sensor nodes in the WSNs form a part of the IoT infrastructure.

Sensor Node are the small devices deployed in the field to collect data. They are equipped with sensors to measure parameters like soil moisture, humidity, temperature, pH level, and sunny strength. The sensing nodes communicate wirelessly with each other using protocols like Zigbee, Bluetooth, or Wi-Fi. They form a network to relay data to a central base node or gateway. The base node serves as a central hub for sensor nodes. It collects data from the nodes and acts as a bond between the WSN and the internet. It may also perform data processing tasks and control the network. The collected sensor data is transmitted from the base station to a cloud platform for storage and analysis. Cloud platforms offer scalability, real-time data processing, and data visualization tools for decision-making. The cloud platform performs data analysis using algorithms and machine learning techniques. It provides insights into harvest health, growth patterns, and conservational conditions. Farmers can access this information through web or mobile applications to make up-to-date decisions. Based on the analysed data, the smart farming system can trigger actuators like irrigation systems, fertilizer dispensers, or pest control mechanisms. Automation enables timely interventions to optimize resource usage and enhance crop productivity.

The proposed model of our system is also shown in below fig with explanation.



Let's go through each step-in detail:

**Collect Sensor Data:** In this step, the data for the temperature, soil moisture and light level is collected by placing the various sensor in the agriculture area.

**Wireless Transmission:** The collected sensor data is wirelessly transmitted from the sensors to a central gateway or hub using a wireless communication protocol such as Wi-Fi or Zigbee.

**Data Processing:** The received sensor data is processed and analysed at the central hub or gateway. This involve the techniques of data filtering, normalization, and statistical analysis.

**Decision Making:** Based on the processed sensor data, intelligent algorithms or decision-making models determine the appropriate actions to be taken. For example, if soil moisture levels are low, the system may decide to activate irrigation.

**Actuation:** The determined actions are executed through actuation devices connected to the farming infrastructure. These devices can control irrigation systems, ventilation systems, or other relevant components to optimize the farming conditions.

**Monitoring:** After the actions are taken, the sensor data is continuously monitored to track the effects of the applied changes. This step ensures that the desired outcomes are achieved and helps identify any anomalies or issues in the farming environment.

**Feedback Loop:** Based on the monitoring data, the system adjusts its settings or actions accordingly. For example, if the monitored data indicates excessive soil moisture, the system can reduce irrigation to avoid overwatering.

The flowchart represents a cyclic process where data is collected, processed, and acted upon, with continuous monitoring and feedback to maintain optimal farming conditions. This model leverages WSN and IoT technologies to automate and optimize agricultural processes, resulting in improving the efficiency of crop growth with the reduction of reserve consumption, and increased the overall production crop.

*(2) SMART FARMING APPLICATION BASED ON IOT SENSOR*

IoT based sensor (Internet of Things) technology has numerous applications in smart farming, revolutionizing traditional agricultural practices. Here are some key areas where sensor-based IoT is utilized in smart farming:

a. **Soil Monitoring:** sensors are applied in fields for monitoring the soil conditions like as humidity content, pH value, temperature, and nutrient value. All the data used by the farmers to optimize water level, fertilization and planting timing, leading to improved crop yields and resource conservation.

b. **Weather Monitoring:** The base stations of weather is connected with sensors node which collect environment data. By integrating the information with crop-specific algorithms, farmers can make informed decisions about irrigation, disease control, and harvesting, minimizing losses due to adverse weather conditions.

c. **Crop Health Monitoring:** Sensor-based IoT devices enable continuous measuring the health of crop with parameters likes that leaf moisture, chlorophyll levels and plant diseases. This helps farmers detect early signs of plant stress or disease outbreaks, enabling prompt intervention and reducing the need for chemical treatments.

d. **Livestock Monitoring:** These sensors and wearable devices look for control the health, location and behavior of livestock. This includes tracking vital signs, identifying estrus cycles in breeding animals, detecting disease symptoms, and monitoring grazing patterns. Such data allows farmers to optimize animal management, improve breeding efficiency, and promptly address health issues.

e. **Precision Irrigation**: IoT sensors combined with automation systems provide precise and localized irrigation management. Soil moisture sensors collect real-time data, enables the farmers to transport the water exactly where and when it is needed, lessening water waste with reducing irrigation costs.

f. **Crop Yield Estimation**: For this process sensors and cameras are equipped with a device named drone which can capture the high-quality images of plants and analyses vegetation indices. By applying machine learning algorithms, farmers can estimate crop yields, identify areas of low productivity, and take corrective actions in a timely manner.

g. **Pest and Disease Management:** IoT-based smart traps and sensor networks can detect and monitor the presence of pests, insects, and diseases in crops. Early detection allows farmers to take appropriate pest control measures, reducing crop damage and minimizing the use of pesticides.

h. **Supply Chain Management:** IoT sensors can track and monitor various parameters during storage and transportation, such as temperature, humidity, and shock/vibration levels. This ensures optimal storage conditions, minimizes post-harvest losses, and helps maintain the quality and freshness of agricultural produce throughout the supply chain.


**Application of Sensor Based IoT**

*(3) INTEGRATION OF WSN & IOT IN SMART FARMING A THEIR BENEFIT*

In smart farming Internet of thing and wireless sensor network are integrated for brings out the numerous benefits and enables advanced agricultural practices that pay for improving the efficiency. Here are some key aspects and benefit of their integration:

i. **Real-time monitoring:** WSNs consist of interconnected sensors which are placed in the surrounding area to monitor all these such as soil moisture, humidity, temperature, and light intensity. The IoT enables these sensors to transmit data wirelessly to a central system or cloud platform in real-time. This allows farmers to access the crucial information of the situations in their fields, facilitating timely decision-making and interventions.

ii. **Data-driven decision-making:** The collected data from WSNs, combined with other relevant information such as weather forecasts and historical data, can be processed and analyses using AI and data analytics algorithms. By integrating IoT, this data analysis can be performed in real-time, providing farmers with valuable insights and actionable recommendations. It helps optimize resource allocation, determine appropriate irrigation schedules, detect crop diseases or pest infestations, and enhance overall crop management strategies.

iii. **Precision agriculture:** The integration of WSNs and IoT supports the implementation of precision agriculture techniques. Site-specific crop management can be achieved by deploying sensors that capture data at a fine-grained level, allowing farmers to tailor their interventions based on specific areas of the farm. For example, irrigation can be adjusted based on localized soil moisture measurements, leading to efficient water usage and minimizing water wastage.

iv. **Automation, efficiency and control:** WSNs and IoT facilitate automation and remote control in smart farming. With the help of actuators and controllers, farmers can remotely control irrigation systems, adjust nutrient levels, activate pest control mechanisms, and perform other essential tasks. This level of automation improves efficiency, reduces labor requirements, and ensures timely actions, even in large-scale farming operations.

v. Enhanced resource management: The integration of WSNs and IoT enables efficient **resource management in smart farming.** By continuously measuring soil conditions and weather designs, farmers can optimize irrigation schedules and precisely apply fertilizers and pesticides only where and when needed. This targeted approach minimizes resource wastage, reduces costs, and mitigates environmental impacts associated with excessive use of inputs.

vi. **Connectivity and mobility:** IoT connectivity allows farmers to access real-time facts and systems which access by the mobile applications remotely. This flexibility enables farmland owner to monitor and manage their farms from anywhere, at any time. They can receive alerts and notifications regarding critical conditions, remotely troubleshoot issues, and make timely decisions, increasing operational efficiency and productivity.

vii. **Scalability and interoperability:** WSNs and IoT systems can be easily scaled and expanded to accommodate larger farms or include additional sensors and devices. The integration of uniform protocols and communication frameworks to ensure different sensors, devices and platforms. This compatibility allows farmers to leverage a wide range of IoT-enabled technologies and choose from various vendors without facing compatibility issues.

viii. The combination of Internet of Things & Wireless Sensor Networks for smart farming enables actual monitoring, data-driven decision-making, precision agriculture, automation, enhanced resource management, connectivity, and scalability. This integration empowers farmers to optimize their farming practices, improve productivity, reduce costs, and promote sustainable and efficient agricultural operations.

*(4) CHALLENGES AND LIMITATION OF WSN AND IOT IN SMART FARMING*

While the amalgamation of Wireless Sensor Networks and Internet of Things in smart farming takes many benefits, also challenges and limitations that need to be considered. some of them are:

1. **Connectivity and network coverage:** WSNs and IoT rely on wireless connectivity for data transmission and communication. However, in remote or rural areas, network coverage may be limited, unstable, or non-existent, which can hinder the seamless operation of smart farming systems. Ensuring reliable connectivity and network coverage throughout the farm can be a challenge, requiring the use of appropriate communication technologies or infrastructure.
2. **Power management:** WSNs and IoT devices often rely on battery-powered sensors and devices. Managing the power consumption of these devices can be a challenge, especially in large-scale farming operations. Ensuring that batteries are adequately charged or replaced, optimizing power usage, and implementing energy-efficient designs are important considerations to prolong device lifespan and reduce maintenance efforts.
3. **Data management and analysis:** The deployment of WSNs and IoT in smart farming generates large amount of data. Analysis and managing this data effectively challenging, as it requires robust storage, processing capabilities, and data analytics expertise. Farmers need to have the necessary infrastructure and skills to handle and make the sense of data produced by the sensors to derive actionable insights.
4. **Data security and privacy:** WSNs and IoT systems in smart farming involve the collection and transmission of sensitive data, including crop data, farm layouts, and even personal information. Guaranteeing the safety and secrecy of the data becomes very critical to protect against illegal access, data breaks, and cyber-attacks. Implementing encryption protocols, access controls, and data anonymization techniques, is essential to safeguard the integrity and privacy of farm-related data.
5. **Interoperability and standardization:** The lack of homogenous protocols and interoperability among many sensor device, communication technologies, and platforms that can face challenges in the integration of WSNs and IoT systems. Ensuring compatibility and seamless communication between various devices and systems becomes important to enable the exchange of data and seamless integration of different components in a smart farming ecosystem.
6. **Cost and affordability:** The initial investment and ongoing costs associated with deploying WSNs and IoT systems in smart farming can be a significant barrier for small-scale farmers or those with limited financial resources. The cost of acquiring sensors, devices, network infrastructure, and data management systems, as well as maintenance and technical support, need to be carefully considered. Ensuring affordability and a favorable return on investment is crucial for the widespread adoption of smart farming technologies.
7. **Technical expertise and training:** The successful implementation and operation of WSNs and IoT in smart farming require technical expertise and training for farmers and agricultural stakeholders. Understanding the technology, configuring and managing the systems, and interpreting the data generated by the sensors require adequate training and support. Lack of technical knowledge and training can impede the effective utilization of the technology and limit its benefits.
8. **Reliability and robustness:** WSNs and IoT systems should be reliable and robust to withstand harsh environmental conditions, such as extreme temperatures, humidity, and exposure to dust or water. Ensuring the durability and resilience of the deployed devices and infrastructure is crucial to maintain consistent performance and minimize system downtime.

## V. FUTURE TREND AND RESEARCH DIRECTION OF WSN AND IOT IN SMART FARMING

In the field of smart farming, the Internet of Things & Wireless Sensor Networks play vital roles in collecting and analyzing data to optimize agricultural processes.

1. **Precision agriculture:** Precision agriculture aims to optimize resource usage, like fertilizers, water and pesticides, by providing targeted precise application based on actual data. WSN and other IoT devices can measure data on soil moisture, temperature, humidity and crop health that enable the farmers to make accurate data-taking decisions and reduce waste.
2. **Autonomous farming systems:** The integration of WSNs and IoT technologies with autonomous farming systems, such as robotic platforms and drones, allows for efficient data collection and automated tasks. These systems can monitor crop conditions, detect pests and diseases, and perform targeted interventions, thereby reducing manual labor and improving overall farm productivity.
3. **Data analytics and machine learning:** The increasing volume data collected by sensors and IoT devices advanced data analytics techniques, including machine learning and artificial intelligence, are becoming essential for smart farming. These techniques can analysis large datasets to provide valuable insights, such as predictive models for crop yield, disease detection, and optimal resource allocation.

4. **Wireless communication protocols:** Future research in WSN and IoT for smart farming will focus on developing energy-efficient and reliable wireless communication protocols. Low-power wide-area networks Lo-Ra WAN and NB-IoT are gaining popularity due to their long-range coverage and low energy consumption, making them suitable for remote agricultural areas.
5. **Sensor development and integration:** There is ongoing research to develop new sensors and improve existing ones for more accurate and specific measurements in smart farming. For example, multispectral and hyperspectral sensors can provide detailed information about crop health and nutrient content, aiding in precision agriculture practices.
6. **Edge computing and fog computing:** This architectures involve processing the data to the network control, closer to the data source. These paradigms reduce latency, enhance real-time decision-making, and reduce the reliance on cloud computing infrastructure. Implementing edge and fog computing in WSNs and IoT systems for smart farming can enable faster response times and improved system scalability.
7. **Security and privacy:** As the connectivity and data exchange between devices increase, ensuring the security and privacy of data becomes crucial. Future research will focus on developing robust security mechanisms and encryption techniques to protect sensitive information and prevent unauthorized access to smart farming systems.
8. **Integration** with other technologies: WSNs and IoT in smart farming can be integrated with other emerging skills of blockchain, remote sensing, and satellite imagery. This integration can enhance traceability, supply chain management, and data accuracy, enabling farmers to make more informed decisions and improve overall sustainability.

## VI. CONCLUSIONS

The study was help to describe the significant potential of WSN and IoT to develop the smart agriculture. This paper provides a study that present the sensor technology-based environment for smart farming. The implementation of IoT based sensor, NODEMCU has been also introduced as an important device. This study is designed to reduce the human burden, increase overall productivity and solve many of the farmer problem in agriculture has formed an IoT system consisting of mobile application and hardware. The status of air, soil, temperature, water and fertilizer can be monitored by placing the sensor in agriculture field. This data can be collected through wireless sensor network which are placed in the farm, providing farmer with full insight into the crop condition and environmental pattern by studying this information farmer can make data driven decision to optimize resource allocation, improve crop yield and increase overall efficiency.

The integration of IoT and WSNs technologies for smart farming which enable actual time monitoring, data collection and analysis of various environmental and crop related parameter. One key advantage of deploying IoT and WSN in smart farming is the ability to obtain accurate and detailed information about soil moisture level, temperature humidity, light intensity and other crucial factor.

## VII. REFERENCES

[1] Atharv Gajanan, B., Mayur Satish, C., Akshay, S.: Smart Agriculture Monitoring and Controlling System. Volume:05/Issue:03/March-2023
[2] Ligalem, A.: Alternative Techniques of Irrigation Water Management for Improving Crop Water Productivity. Reviews in Agricultural Science, 11: 36–53, 2023
[3] Senthi, M., Akshaya, R., Sreejith, K.: An Internet of Things-based Efficient Solution for Smart farming. Procedia Computer Science 218 (2023) 2806–2819
[4] Vijaya, C., Lakshmipriya, A., Hemapriya, K.: Soil Moisture Detection and Monitoring Through IoT. Journal of Electronics and Communication Engineering Research Volume 8 ~ Issue 4 (2022) pp: 10-13
[5Muthumanickm, D., Poongodi C..: Smart Farming: Internet of Thing (IoT) Based Sustainable Agriculture. agriculture 2022, 1745.
[6] Nifasath, S., Baulkani, s.: A Review of Wireless Sensor Networks in Agriculture. IJRASET: Volume 10 2022
[7] Mushtaque Ahmed, R., Sarang K., Rehan S.: Wireless Sensor Networks-based Smart Agriculture: Sensing Technologies, Application and Future Directions. Vol. 5, No. 2 | July – December 2022
[8] Juliana, N., Kingsley, E., Moses, A., Robert B.: Development of a Wireless Sensor Network and IoT-based Smart Irrigation System. Applied and Environmental Soil Science Volume 2022, Article ID 7678570
[9] Khaled, O., Bashria, A.,Yousef, A. , Maryam N.: An overview of smart irrigation systems using IoT. Energy Nexus 7 (2022) 100124
[10] Balasubramaniyan, M., Navaneethan, C.: Applications of Internet of Things for smart farming – A survey. Elsevier 2214-7853/_ 2021
[11] Liang, Z., Guangwen, W., Ruobing, L.: Review of the internet of things communication technologies in smart agriculture and challenges Computers and Electronics in Agriculture 189 (2021) 106352
[12] Jerrin, A., Rekha: Review on Application Layer Protocol for IoT enabled agriculture intrusion detention. 978-1-7281-9537-7/21/$31.00 ©2021 IEEE
[13] Jaime L., Sandra S., Laura G., Jose M.: A Wireless Sensor Network Deployment for Soil Moisture Monitoring in Precision Agriculture. Sensors 2021, 21, 7243.
[14] Harshit K., S., Rajendra K., D.: Energy Efficient in sensor based IoT using Mobile Agents: A Review. May 2020, IEEE Xplore. May 2020
[15] Tharindu, B.,Mansoor, R.: farm and monitoring system for measuring the environment condition using wireless sensor network- IoT technology in farming. 978-1-7281-9437-0/20/$31.00©2020 IEEE.

[16] Ole, G., Claus Aage, G. Internet of Things in arable farming: Implementation, applications, challenges and Potential biosystems engineering 191(2020) 60e8 4
[17] Puengsungwan, S.: IoT based Soil Moisture Sensor for Smart Farming. International Conference on Power, Energy and Innovations (ICPEI 2020) October 14-16, 2020,
[18] Arnab, P., B., Tsou, J., C., Hamidur, R.: IOT Based Soil Monitoring and Automatic Irrigation System.
[19] Emerson, N., Nuno, C., António P.: A Systematic Review of IoT Solutions for Smart Farming Sensors 2020, 20, 4231
[20] Renann, G., Baldovino, C., Valenzuela, Elmer P.: Implementation of a Low-power Wireless Sensor Network for Smart Farm Applications. 978-1-5386-7767-4/18/$31.00 ©2018 IEEE
[21] Lim,L., Haryati, J., Nur, R.: Preliminary Study of Water Quality Monitoring Based on WSN Technology; 978-1-5386-8369-9/18/$31.00 ©2018 IEEE
[22] Aarti Rao, J., Karishma, K., Pankaja P.: Environmental Monitoring Using Wireless Sensor Networks (WSN) based on IOT.IRJET Volume: 04 Issue: 01 | Jan -2017
[23] Sjaak, W., Lan G.: Big Data in Smart Farming – A review. Agricultural Systems 153 (2017) 69–80