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# Role of smart sensors and Internet of Things in agriculture: Scope and Challenges

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**ABSTRACT:**

For the human community to survive, agriculture is a vital industry. A number of actions have been done to increase crop yields. Nonetheless, unfavorable weather patterns and a high frequency of pest infestation cause agricultural loss. Under such circumstances, integrating cutting-edge technologies—like sophisticated sensors and the Internet of Things (IoT)—could increase agricultural output and reduce financial loss. Research from all around the world has satisfactorily shown how integrated IoT-smart sensors can be used to monitor temperature, humidity, moisture content, and other environmental factors that are vital to crop growth. Moreover, automated sensors are used to measure greenhouse gases like carbon dioxide, methane, and others. The measurement of soil nitrogen contents made possible by smart farming also enables farmers to decide the quantity of fertilizers to be used in crop yielding. Unmanned aerial vehicles and some IoT-enabled equipment are helpful in precisely monitoring pest attacks and related diseases in farm vegetation. Even though smart farming has a lot of potential, there are some obstacles to overcome, including high implementation costs, data security concerns, and a lack of adequate digital literacy among farmers. In the future, digital literacy, data encryption, and special economic policies may make IoT-enabled smart farming easier.

**Keywords**: Internet of Things, Soil monitoring, pest control, sensors.

## 1.INTRODUCTION

In the modern world, artificial intelligence (AI) is one of the technologies that is developing the fastest. Artificial Intelligence is currently widely used in a number of industries, from environmental monitoring to robotics development [1]. Unquestionably, artificial intelligence (AI) has applications in healthcare systems, self-driving cars, satellite imaging, mapping

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landscapes, and monitoring climate change [2]. AI has accelerated the global development of robotics, which has improved people's quality of life and made life much easier. Automation enabled by AI in a number of industries, including agriculture, will produce high-quality goods with fewer adverse environmental effects [3]. AI uses a range of intelligent sensors that process data more accurately and in real time. As a result, AI has improved any device's performance many times over, producing results that are more sensitive and accurate. The Internet of Things (IoT) is an advanced technology that has been developed as a result of AI and smart sensors. IoT serves as a central hub for wireless systems, and AI processes data instantly to produce relevant results. Almost all fields of science and research have embraced this technology. Digital technologies built on the Internet of Things (IoT) have the potential to produce creative models for more effective consumer product production, including agro products [4].

Excellent opportunities for real-time monitoring of temperature, humidity, pollution, water content, soil quality, radiation, and other factors are provided by AI and IoT. Precision is enhanced by smart farming through more effective management of farm operations and timely decision-making based on collected data [6]. In a shorter amount of time and over a larger area, farmers can better manage crops and vegetables with the help of IoT and a variety of smart sensors. Furthermore, the Internet of Things may make it easier to determine when and why to apply fertilizer and pesticides in the field. Overuse of fertilizer and pesticides can contaminate the environment and pose health risks [7–12].

The Internet of Things has the potential to save farmers' revenue and minimize resource waste. IoT-based technologies are used in precision farming to track various agricultural variables. For improved environmental protection and ongoing agricultural production sustainability, IoT provides real-time vital data on crop, soil, water, and air conditions. In order to speed up the irrigation process, irrigation can be converted into a smart irrigation system. Unmanned aerial vehicles (UAVs) are a type of equipment that is used to quickly and extensively gather data on critical agricultural factors such as pest attack, soil quality, and water availability [14]. When combined with spectrum analysis technology, unmanned aerial vehicles (UAVs) can detect pest infestation in farms even from remote areas by taking high-resolution images that are stored in cloud server databases for later analysis [1]. The use of smart greenhouses in cultivation processes with minimal human intervention is expanding. For improved yield, it entails sensor-based continuous monitoring of temperature, humidity, light, and soil moisture [15]. These automated sensors support decision-making for the implementation of more

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appropriate safeguards against harm to agriculture.The farm management system (FMS) is an integrated approach that combines AI and IoT. In order to improve the quality and quantity of agricultural output, it provides a more advanced tracing system for analyzing different physical, chemical, and biological agricultural factors. It uses real-time data processing capabilities with fewer laborers. Thus, with less work and time, FMS can support the sustainability and quality of agricultural production. The management of agricultural sectors can significantly reduce the amount of human intervention when IoT is combined with an intelligent decision-making system. All accessories that could determine whether the automated algorithm succeeds or fails rely on the decision making system. When combined with IT, IoT has the potential to be more accurate and data-processing efficient than human decision-making. In order to sense speech recognition, visual perception, decision making, and automated data processing, artificial intelligence (AI) systems execute tasks that are comparable to those of human intelligences [16]. Undoubtedly, the Internet of Things and artificial intelligence are crucial elements of a more accurate and efficient automated agricultural management network. Massive amounts of data are generated by IoT, necessitating quick data analysis. AI algorithms are capable of handling this task with greater efficiency and superior decision-making. The automation process in agriculture has been enhanced by new reasoning and techniques such as machine learning, machine vision, artificial neural networks, natural language processing, etc. Global research on the automation of the agriculture sector most commonly uses artificial neural networks and machine learning among these technologies [17]. Both supervised and unsupervised learning algorithms are used by machine learning algorithms.

However, supervised algorithms are employed by the majority of automated systems. The multilayered architecture of human neurons serves as an inspiration for artificial neural networks. It is the goal of artificial neural networks to learn non-linear relationships. Deep learning-based computer vision techniques, which are being extensively researched for agricultural automation, are now connected to conventional neural networks.

Before being used, AI models are first created using known data sets, and their accuracy is evaluated. AI has the ability to generate data, and from that data, it can make intelligent decisions and recommend actions. Farmers receive these messages via SMS on their smartphones, enabling them to take the appropriate action.

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This article discusses how the Internet of Things and smart sensors may be used to precisely monitor a number of physico-chemical factors, including soil quality, humidity, temperature, moisture and nitrogen contents, and greenhouse gas emissions in agricultural areas. Furthermore, the implications of smart traps with high-definition cameras will be showcased. The paper's final section will address the issues that currently stand in the way of the widespread deployment of IoT-based devices as well as potential solutions.

## 2. Agriculture and Internet of Things

In order to monitor soil health, water contents, crop quality, and crop production at a site, IoT, smart sensors, and AI have enormous potential for real-time data acquisition and interpretation [35]. Smart farming, which is characterized by increased yield, is taking the place of traditional agricultural methods thanks to the Internet of Things and smart sensors. Assessing soil health, soil erosion, fertilizer needs, soil fertility, and crop quality are further benefits of IoT-enabled agricultural technology [36]. Additionally, it facilitates optical irrigation, seed quality, and crop growth monitoring at different phases. Notably, real data from IoT and remote sensing can be processed for forestry and agriculture with precision. Techniques for sensing topological data of an agricultural land have been developed, such as infrared thermography in conjunction with smart sensors. In agricultural lands, preharvesting and postharvesting status are determined using IoT and smart soil moisture sensors.

Multiple sensors' worth of data are interpreted using deep learning techniques. Temperature, moisture, soil condition, and crop types in a given area can all be precisely measured using sensors from the Internet of Things, ZigBee, and Arduino [42]. As a result, the Internet of Things can analyze data to plan ahead and increase crop and agricultural yields. The two main elements of smart farming—IoT and UAVs—allow for better yields to be produced with fewer laborers. Consequently, the application of machine-deep learning techniques and Arduino-based controls can enhance smart farming [43]. Smart farming is further enhanced by the more precise real-time data that flying IoT offers. Assessing soil health, ground water irrigation status, crop quality, and drought control could have been made simpler by IoT. The main indices to support smart farming are the Vegetation Health Index (VHI), Standardized Abnormality Index (SAI), and Evaporative Stress Index (ESI). Retrieving crucial data from satellites and GPS systems enables real-time, accurate monitoring of field cultivation, water

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content, and fertilizer requirements in numerous developed nations. Farmers can improve their planting and crop management strategies by combining agricultural IoTs with expert systems. The key feature of the system is the use of continuous soil measurements to complement climatic parameters to accurately forecast the irrigation needs of the crops, in contrast to previous studies that are solely based on weather factors or do not indicate how much water is needed by the crops [48].

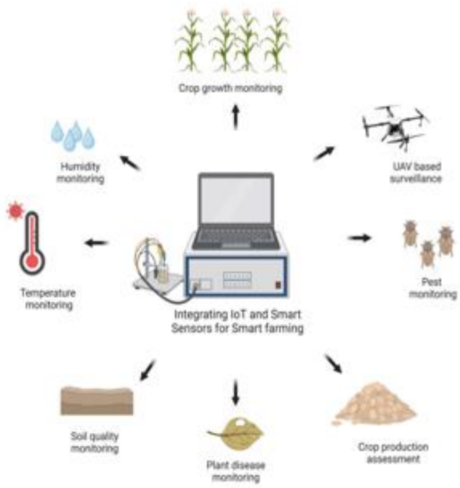


Figure 1: smart sensors for smart farming

### 2.1 Crop Monitoring

IoT has brought about a paradigm shift in crop monitoring, turning it from an experience-based, qualitative task into a quantitative, data-driven endeavor that includes soil, microclimate, and crop sensing. Farmers can accurately track the health and growth of their crops thanks to IoT-based technology [5]. Additionally, it helps agricultural workers detect plant diseases and pest attacks instantly. Farmers and researchers can benefit greatly from the acquisition and processing of real-time data from Internet of Things (IoT) tagged sensors for the intelligent management of crop cultivation, fertilizer application, irrigation, and plant surroundings [49]. The main components of IoT-based smart crop monitoring systems are sensors that are deployed in the field to collect data on various environmental parameters, such as temperature, humidity, soil moisture, and nutrient levels. Due to the frequent networking of these sensors, real-time data transmission to a centralized cloud-based platform is made possible. The information obtained from these sensors is then analyzed using machine learning and other

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data analytics methods to obtain insights into crop health, growth rates, and yield potential. With this information, farmers can decide how best to manage their crops, including when to water, control pests, and harvest.

The use of wireless sensor technologies can notify farmers and administrators of equipment malfunctions and start the troubleshooting process.

Additionally, automated repair tools may aid in lowering energy usage, speeding up data processing, and improving actuation [50]. IoT-enabled unmanned aerial systems (UAS) are a growing trend in agriculture. These systems enable farmers to capture real-time landscape imagery while maintaining a smooth workflow for processing and data storage. Agricultural environmental parameters like plant growth morphology, air temperature, light intensity, soil moisture, humidity, CO2 concentration, pH levels, and crop water use efficiency can also be effectively monitored by IoT-based systems.

Abba et al. conducted a performance evaluation of a Smart IoT-based irrigation monitoring and control system in 2019 [54], and the findings were deemed satisfactory. Since loamy and sandy soils are the most common soil types appropriate for self-sufficient irrigation farming, they were chosen. The system counter was calibrated to range from 0 to 300, and multiple moisture measurements were captured using distinct counter values. It was noted that the soil tended to absorb water more slowly when irrigation was applied. It's interesting to note that at one point it also held onto water, which led to the water pump gradually turning off. This illustrated how the intelligent IoT-based irrigation tracking and Fig. 1. Smart sensor and integrated IoT applications for precision farming. Smart sensors that are based on the Internet of Things can precisely track environmental variables like humidity, moisture, and temperature. Certain sensors use the amount of water and nitrates in the soil to evaluate its quality. Plant diseases and insect pests can be identified with a GPRS system and high resolution camera. Farm land topology and crop growth are monitored with the aid of unmanned aerial vehicles (UAVs). Mass flow sensors that are automated can be used to estimate crop production. control systems can provide adequate irrigation for farmland with loamy soil. Moreover, by stopping the water pump when the moisture content surpassed 400%, the electricity costs were decreased [54].

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2.2 Monitoring properties of soil

Smart sensors in conjunction with IoT technologies allow for the monitoring of several farm soil parameters that are essential to the growth and development of plants.

Farmers can receive information from IoT about soil moisture, temperature, and nutrient contents [62]. Farmers can remotely access and calibrate this data in order to take adequate preventative measures against pests and crop diseases. Consequently, farmers may find it beneficial to practice smart farming [58]. Farmers can also monitor the pH of the soil and the rhizosphere zone multiparameter from a distance using IoT, allowing them to take preventative action [51]. It is also possible to track the growth and development of plants in different types of soil [51]. Thus, farm workers can receive real-time updates on temperature, moisture, and soil condition from smart IoT systems.

2.3 Weather Sensing

IoT, which combines wireless networks and intelligent sensors, offers real-time environmental parameter information to support more meticulous farming in wineries and vineyards [55]. When vital environmental parameters are altered beyond a certain point, sensors connected to the Internet of Things immediately alert the administrator, enabling them to take appropriate action to prevent impending challenges. Additionally, the smart system has real-time temperature, humidity, brightness, and $CO_2$ content surveillance for crop growth [56]. Using an Internet of Things-enabled ecosystem to exchange data between smart sensors and devices is the newest technology for weather monitoring and better agricultural decision-making [57]. Growers can monitor microclimates and obtain insight into crop growth environments in greenhouses by utilizing IoT sensor nodes in conjunction with MATLAB Simulink, which has flexible architecture and self-tuning reference input facilities [59]. Microclimate data can be gathered using specially designed hardware tagged with Internet of Things (IoT) based software, such as Low-Power Wide-Area Network (LoRaWAN) transmitter nodes, a multi-channel LoRaWAN gateway, and a web-based data monitoring dashboard.

The collected data is processed using multiple MATLAB Simulink blocks in order to identify any changes in the microclimate parameters. Consequently, farmers can better understand the crop growth environment with the help of the Simulink model and IoT sensor node [60]. Using multi-tier cloud-based Internet of Things platforms with sensors, controllers, and actuators, farmers can keep an eye on, regulate, and oversee crop growth and weather conditions from a distance.

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## 3. Sensors for smart farming

The use of multiple sensors in smart farming is becoming more prevalent. These sensors may be useful for measuring crop yields, monitoring environmental conditions, and automatically harvesting crops. Smart sensors are sensors that have been integrated with chips. In agricultural setups, smart sensors can more accurately and automatically record a variety of environmental data as well as other relevant information, which can then be stored on drives. Microprocessors are used to process these data in order to analyze and interpret them. The essential components of the Internet of Things are smart sensors, and data is transferred over it. It consists of an actuator and wireless network system with tens of thousands to hundreds of nodes linked to sensor hubs. Thus, to enable remote surveillance of multiple agricultural factors, a smart sensor consists of a sensor device, microprocessors, and wireless communication technology. To improve their functionality, smart sensors can be connected to additional parts like analog to digital converters, amplifiers, transformers, and analog filters. We've covered a few helpful sensors below.

### 3.1 Electromagnetic Sensors

When it comes to identifying contaminated agricultural soil, electromagnetic sensors are helpful. It also helps with the mapping of agricultural lands' topological features. A broad range of electromagnetic waves that are emitted by different objects can be detected by electromagnetic sensors. The method uses electrical circuits to record electrical impulses that condense or accumulate in soil. Unmanned aerial vehicles (UAVs) are typically used to deploy sensing techniques and equipment, such as electromagnetic induction, ground-penetrating radar, and gamma radiometric devices, to collect high-resolution data on vegetation types and surface processes. Electric magnetic induction and ground penetrating radar have been linked to the estimation of soil-water content [68]. Additionally, the sensors can be used to measure the amount of residual nitrate, the concentrations of organic matter in the soil, and the rate of transpiration in real time [69]. An electromagnetic induction sensor (EM38) was used in a study to establish a correlation between the electrical conductivity of soil and various soil properties, such as field capacity, cation exchange capacity, moisture content, and clay content. Findings showed a strong correlation between soil electrical conductivity measurements obtained from sensors and laboratory testing [71]. According to the research, electromagnetic sensors may be useful for precisely identifying a range of soil's physico-chemical characteristics in agricultural settings.

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### 3.2 Acoustic Sensors

Electronic devices that are used to identify variations in sound frequencies are called acoustically based sensors. These sensors are capable of picking up vibrations reflected from moving objects. Many insects make noises when they are moving around, eating, and mating. Numerous acoustic devices, including microphone systems and portable accelerometers, are capable of detecting these kinds of sounds [63]. Researchers from all over the world can study the data collected by the acoustic devices and use it to further develop automated acoustic sensors that can detect pests more precisely at the species level [64]. Acoustic sensors may get covered in dust and soil particles during agricultural operations, but this doesn't affect how well they function, and the sensors keep giving more accurate informationAn essential component of automated irrigation system scheduling is the estimation of the water volume in water sources. Mechanical flow meters are gradually being replaced by ultrasound flow meters, which make use of IoT-enabled ultrasound distance sensors. Underwater ultrasonic scanning is a viable method for tracking the development of aquatic plants, and it holds great promise for identifying the growth rate and harvest stage [65]. Furthermore, it is essential for fruit harvesting [66]. Fruit ripeness estimation is an interesting use of acoustics in agriculture. According to Daosawang et al. [67], watermelons can be judged for ripeness using a sound generator and receiver.

### 3.3 Electrochemical sensors

Electrochemical sensors are environmentally friendly, lightweight sensors that are convenient to transport to agricultural areas. These sensors are capable of providing more accurate real-time monitoring of environmental pollution, plant growth, and diseases. Furthermore, electrochemical sensors have relatively little of an impact on the environment. Biochemical parameters that are essential to agricultural yields have been tested for a number of sensors.

For example, plant leaf water is sensed using graphene oxide-containing humidity sensors [15]. A NO2 sensor made of reduced graphene oxide and silver can be used to detect harmful gases in agricultural settings. For instance, metallic single-walled carbon nanotubes were used as conductive electrodes in the construction of a fully flexible device, and reduced graphene oxide coated with AgNPs served as the sensing layers. The sensor could detect as little as 0.2 ppm NO2 at room temperature. The potential for electrochemical sensors to sense a wide range of parameters in agricultural lands that could be helpful to improve agricultural production.

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3.4 Optical Sensors

A wide variety of optical sensors may have effects on agriculture. The basis for these sensors is their capacity to identify different wavelengths of light. A light source emits light with a particular wavelength in order to collide with the target object. The optical sensor detects the reflected light, creating reflectant data that is then saved as a text file. Non-destructive optical sensors like SPAD and GreenSeekerTM were used by Freidenreich et al. [78] to analyze nutrient uptake. Examined were variables such as soil leachate, total leaf carbon:nitrogen ratios, and the Normalized Difference Vegetation Index. The authors proposed that using optical sensors to measure plants' needs for fertilizer is a promising approach. When proximal optical sensors like SPAD-502, GreenSeeker, and the Canopeo App were used, crop predictions were found to be accurate. With the use of optical sensing technology, data on the distribution of weeds in agricultural fields has been successfully acquired. It was found that an optical sensor combined with spectroscopy could identify green weed-infected cells with high accuracy in a study that used a tolerance threshold. A total of 90.9% of the recorded percentage was in agreement, and the value was comparable to 90.5% and 91.2% of the two reference methods [82].

3.5 Light Detection and Ranging (LIDAR)

The foundation of LIDAR technology is the measurement of distance using light between a sensor and a target object. Light travels at a constant speed, so LIDAR can measure the exact distance between the light-emitting sensor and the object it collides with.

LIDAR creates a map of the surrounding area by periodically emitting light pulses and detecting a series of collisions. The advanced LIDAR system has fewer pulses, which increases the equipment's effectiveness.

The operating range, the estimated error, and the scanning frequency are additional performance characteristics. Coordinates acquired via light collision are kept in a file called a "cloud point," which aids in the construction of three-dimensional space. Many uses of LIDAR technology have been found in the agricultural industry. It keeps track of the ripening of fruit and the composition of the vegetation. LIDAR sensors are also used to measure topography and agricultural landscaping. LIDAR technology is used to sense structural properties of trees, such as canopy volume and leaf area index.As a result, LIDAR may be very useful for mapping agricultural areas and launching automated farming techniques.

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3.6 EC Sensors ( Eddy Covariance)

In order to measure crop water consumption and evapotranspiration, sensible heat fluxes and latent heat are recorded by EC-based sensors.

Greenhouse gas measurements can also benefit from the use of EC. It gauges the gradients in the vertical concentrations of gases such as methane and carbon dioxide. To more accurately estimate the greenhouse gas balance and the gross and net primary productivity of crops, EC can be used in conjunction with remote sensing models [87]. Ammonia exchange between the surface and atmosphere is measured by quantum cascade laser-based EC [88]. In a field study, EC was used to measure soil heat flux and evapotranspiration during sprinkler irrigation. The findings showed that nondimensional evapotranspiration for mature cotton with a height approaching 1 m varied from 1.4 to 1.6 times the reference (non-irrigating) evapotranspiration value.

3.7 Mechanical and Mass flow sensors

Mass flow sensors offer tools for automated crop yield monitoring. A portable grain mass flow test rig was used in a study to evaluate the accuracy of mass flow sensors. According to analysis, the grain elevator's slope may have an impact on sensor calibration, which could change the system's accuracy. The mass flow sensor's accuracy was considerably modulated when the calibration was changed at a 10◦ pitch. When the device was operated with a calibrated flow rate, the mass flow sensors' coefficient of determination was recorded as 0.99, indicating a highly notable level of accuracy [93]. Grain flow sensors that are impact-based are commonly employed in agricultural yield comparisons.

Nevertheless, because of the high natural vibrations, it might generate false signals. A dynamic compensation algorithm may be useful to reduce overshoot and natural vibration signals in order to improve sensor accuracy [94].

3.8 FPGA based sensors

Fuzzy logic has been tested at the grassroots level and has proven to be successful in generating recommendations and future productivity. The accuracy of the results obtained from testing an intelligent embedded fuzzy decision support system (IEFDSS) at the ground level was 96% higher in this study than it was using the current methods [83]. It is also possible to configure FPGA for use in an agricultural environment monitoring system. A variety of sensors, a screen, a field-based FPGA, a microcontroller unit, wireless protocol, and serial protocol are all included in this type of monitoring system. Important environmental parameters like humidity,

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temperature, and soil moisture are detected by corresponding sensors and sent to the FGPA so that the data is displayed on the screen [84]. The use of a FGPA-based image processing (FIP) device in a study revealed that it was successful in getting rid of image resolution issues and processing speed of conventional imaging systems.

4. Pest Monitoring and Smart farming

Numerous pests in agricultural fields can be repelled by certain devices that produce ultrasonic sound waves. Tiwari et al. [105], for example, created an electronic pest repellent that emits powerful ultrasonic sound waves. Pests such as insects and rodents are repelled by these waves. Thus, these tools are a good substitute for chemical pesticides, which have a lot of negative effects on beneficial organisms [106–112].

Additionally, accidental exposure to chemical insect repellents may also lead to increased ultrasonic equipment usage. Electronic pest repellents are inexpensive, safe for the environment, and have no negative effects on people. These devices primarily work to repel pests by appealing to their auditory senses. There are certain image processing algorithms that are very useful for identifying pests. Utilizing unmanned aerial vehicle technology, spectral camera technology can obtain high-resolution images of the farm area at both macro and micro levels. These photos can be examined to find evidence of pest infestation and the beginning of related illnesses in crops [113]. Pest monitoring in agricultural fields can be enhanced by an integrated strategy that combines the Internet of Things (IoT) with the Parallel and Distributed Simulation Framework (PDSF). The workload on a single GPU will be lessened by this integrated system, which can also divide the workload among several cores and other available GPUs. A system like this could enhance overall performance to more effectively track the number of pests. A few automated traps with cameras can be used to manage the pest population.

5. Challenges and future directions

The fact that Internet of Things devices are installed outdoors, where they are subjected to inclement weather, wind, dust, and other elements, is one of their main issues.

Such unfavorable environmental circumstances could cause the sophisticated devices to unexpectedly malfunction mechanically. Therefore, in order to prolong the lifespan of sophisticated devices with more consistent output, makers of IoT devices for smart farming should use raw materials that can withstand such harsh environmental factors. Another issue

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that could seriously hinder the widespread adoption of IoT and smart systems is data security and privacy.

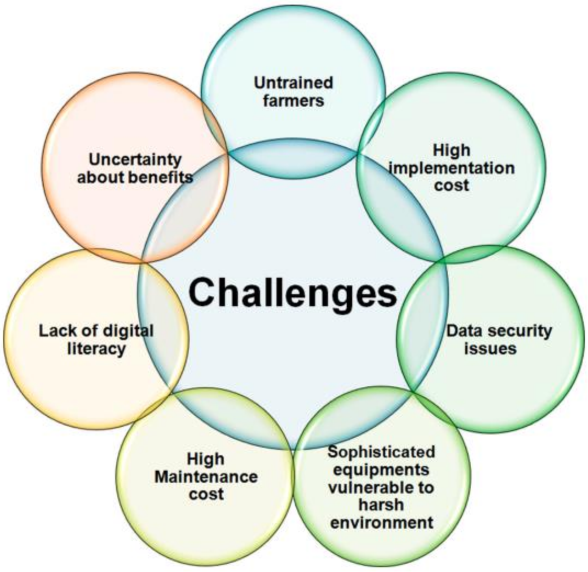


Figure 2: Challenges encountered in deploying IoT based smart sensors for Smart Farming

Attackers may manipulate data kept on cloud servers to harm farmlands' automated farming operations. Such assaults may also have an adverse effect on the improper management of environmental factors and the overall productivity of the farmland. Thus, among the main causes of the sluggish adoption of smart farming technologies are concerns about the security of IoT data [119]. A trustworthy encryption system is necessary for smart farming in order to safeguard digital systems and critical data from international cybercriminals. The use of strong keys in conjunction with cryptography could help prevent cyberattacks on cloud servers. The financial burden associated with deploying and installing IoT-tagged sensors and accessories across a sizable area of agricultural land is one of the main obstacles. Furthermore, there is uncertainty surrounding the relationship between implementation costs and profit margins. The primary expenses associated with deploying IoT-enabled technology comprise the acquisition of hardware, software setup, and system maintenance. The energy consumption, system upkeep, service registration, and labor costs associated with running the integrated hardware devices and related software will all incur additional costs. An extensive global push to improve farmers' technological literacy is necessary for the IoT to be applied globally.

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## 6. Conclusion

The future of IoT-enabled smart farming looks very promising.

For optimal agricultural yield, sophisticated sensors can be used to track environmental variables like temperature, moisture content, and rainfall. IoT-enabled tools may be used to measure the amount of nitrogen and water in the soil. Furthermore, evapotranspiration rates can be efficiently monitored to improve crop health surveillance based on the CO2 level in agricultural lands. Additionally, by managing the pest population with IoT-enabled traps outfitted with a high-resolution camera and additional accessories, pest attacks can be minimized. Despite these benefits, the cost of purchasing and maintaining advanced hardware and software remains a significant barrier to the wider use of IoT-based smart sensors in agriculture. Furthermore, farmers who live in rural areas don't know enough about how to use IoT devices. Finally, by causing damage to the cloud servers that house critical data, cybercriminals may have an impact on automated smart farming.

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