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## Low-Power Wireless Sensor Networks for Smart Agriculture



### Abstract

It is well acknowledged that no organism can survive without sustenance; hence, agriculture is essential globally, not alone in India. Agriculture is the main source of revenue for our country. Agriculture depends on precipitation, soil, sunlight, and moisture, among other factors. The current and forthcoming developments in agriculture may be monitored using the invention known as the Internet of Things. It is a developmental process that converts traditional agriculture into smart agriculture for enhanced results. This invention enhances harvest efficiency, reduces costs, increases production, and minimizes waste. Pests and insects that damage the crop may also be managed, therefore safeguarding the harvest. This technology enables farmers to monitor temperature, humidity, soil moisture, and other variables that influence productivity, therefore enhancing yield and conserving resources. The cloud-based storing of field-collected data facilitates the proper functioning of IoT devices. This agricultural framework may be monitored remotely using networking technology. The study examines the social and technical changes that will proliferate with the widespread use of smart agriculture technology by farmers globally.

**Keywords :** Arduino, Temperature Sensor, Humidity Sensor, Soil Moisture Sensor, Raindrop Sensor, WIFI, Networking, Cloud computing

### Introduction

A Wireless Sensor Network (WSN) consists of a collection of several tiny sensor nodes strategically distributed. Sensors are densely scattered across extensive regions. These sensor hubs are compact, low-power devices capable of executing several functions. A Wireless Sensor Network (WSN) is a geographically dispersed array of sensors designed to monitor different parameters, including sound, pressure, and temperature, and to collectively transmit their data over the network to a specified destination. Wireless communication may be accomplished using Wireless Sensor Networks (WSN). Data acquired from the sensor node may be aggregated at the base station (BS). The collected data will undergo processing and detailed analysis. Wireless sensor networks (WSNs) serve several applications, including communication, agriculture, industry, smart health, monitoring, and surveillance. All sectors, including health, environment, education, entertainment, industry, and domestic spheres, are adopting the Internet of Things (IoT) revolution. Agriculture has undergone several modifications and has included various equipment to enhance productivity. Monitoring of soil and environmental characteristics, together with crop

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health, is crucial for achieving higher quality and greater yield. Recent years have seen several technical improvements in agriculture, resulting in enhanced yield and resilience of crops. Approximately 70% of the world's freshwater is used by the agricultural sector. The implementation of soil moisture sensors may enhance the irrigation process and improve water usage. The important technology in this context is the Internet of Things (IoT) [5].

Conventional agriculture is evolving into smart agriculture as a result of the integration of the Internet of Things (IoT) inside the agricultural industry. IoT networks are diminishing the need for human labor by remotely monitoring crop health and field conditions. The Internet of Things (IoT) employs a wireless sensor network (WSN) as its foundational framework for collecting data for monitoring and control applications. The monitoring system comprises end devices outfitted with diverse sensors to measure factors such as temperature, humidity, sun radiation, and soil moisture, and is capable of transmitting this data to other devices. The Internet of Things (IoT) assists farmers by monitoring crop development phases, detecting illnesses, and estimating output, enabling low-power, low-cost devices to access enhanced processing capabilities over the Internet. Drones are being used in agriculture for remote sensing purposes. They are reducing the significance of satellites in agricultural monitoring and imaging by offering more control and flexibility [9]. IoT solutions for agricultural monitoring should be cost-effective to ensure affordability for farmers and energy-efficient to extend the network's lifespan. A conventional monitoring network has several sensor nodes, several sink nodes, and a gateway, contingent upon the network structure and the field's dimensions. The sink aggregates data from the sensor nodes and transmits it to the server [10]. In the majority of wireless networks, the sink remains always active, resulting in significant power consumption [11].

K. O. Flores et al. [12] developed an economical sensor system using Xbee radios as sensor nodes to monitor agricultural metrics, with a Raspberry Pi serving as the Internet gateway. The authors in [13] presented a three-tier design for precision agriculture, whereby data processing occurs on the server. It exhibits increased power consumption owing to redundant transmissions. The study [14] proposes the Multi-mode, Multi-parameter, Multi-application Soil Sensing (M3SS) sensor node for agricultural monitoring. The node has been engineered to communicate via three wireless protocols: WiFi, ZigBee, and Bluetooth, therefore enhancing flexibility in range, connection choices, and redundancy, but at the expense of increased power consumption.

#### **Categories of Wireless Sensor Networks (WSNs):**

Wireless networks are often used in terrestrial, subterranean, and aquatic environments. Network frameworks have several obstacles and limitations dictated by their context. We examine five kinds of wireless sensor networks:

**Terrestrial Wireless Sensor Networks:** In TWSNs (Terrestrial Wireless Sensor Networks), the nodes are situated above the ground surface. MEMS technology has been developed via the fabrication of intelligent, compact, and economical sensors. A substantial quantity of inexpensive nodes, ranging from hundreds to thousands, are put on land in a specific region in an ad-hoc fashion. Sensor nodes in terrestrial wireless sensor networks must possess the capability to connect with other nodes and transmit data to the base station in a densely populated area.

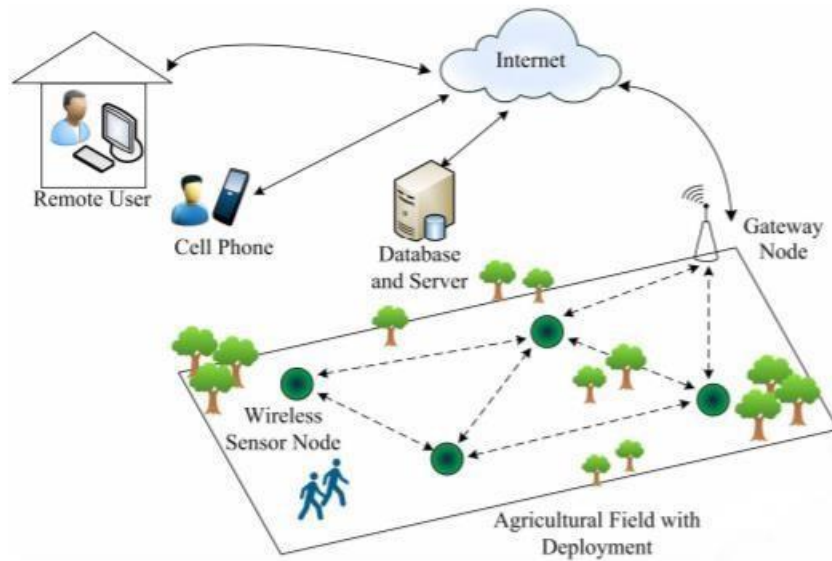


Figure 1: A typical wireless sensor network deployed for agricultural applications [1]

Wireless beneath Sensor Networks consist of a collection of sensor nodes deployed in subterranean environments such as caverns and mines to monitor beneath conditions. To relay information from the subterranean sensor nodes to the base station, supplementary sink nodes are positioned above ground. These networks are more costly than terrestrial WSNs because to the need for specialized equipment to provide dependable communication over dirt, rocks, and water.

### Applications of wireless sensors and networks in agriculture

Agriculture has a significant part in human growth and productivity. We use various agricultural sensors, such as soil sensors, air sensors, temperature sensors, water sensors, and humidity sensors. Agriculture is seen as one of the most appropriate applications for Wireless Sensor Networks (WSNs) to improve food production, increase crop yields, and alleviate the strain on farmers [2].

What is the rationale for using sensors in agriculture?

Sensors are used to collect and monitor environmental parameters, whilst actuators are used to retain feedback and regulate conditions. Agriculture demands a range of prerequisites.

1. Collect data on meteorological conditions, agricultural produce, and soil composition.
2. Monitoring allocated land and other agricultural properties.
3. A multitude of crops is flourishing on the land.
4. Fertilizer and water needs differ according on the kind of irregular terrain.
5. Criteria for crops and seeds applicable across various climatic and soil conditions.
6. Instead of reacting, choose suitable or proactive remedies.

### Literature Survey

A concise summary of the research conducted in many articles that have been cited for implementation. K. Lakshmi Sudha et al., "Shrewd Accuracy Based Farming Utilizing Sensors"; This study focuses on developing

instruments and devices for the management, visualization, and notification of users, leveraging the advantages of a wireless sensor network system.

In "IoT-Based Smart Agriculture," by G. Sujatha and Sushanth. The article intends to integrate IoT and smart agriculture, two burgeoning technologies, with automation. Monitoring environmental conditions is the paramount stage in enhancing the output of productive crops. The development of a system capable of monitoring the movements of crop-damaging animals while simultaneously tracking temperature, humidity, and wetness using sensors and an Arduino board.

In "Providing Smart Agriculture Solutions to Farmers for Better Yielding Using IoT," M.K. Gayatri and J. Jayasakthi examine cloud computing devices capable of creating a comprehensive computing system that integrates sensors and tools to accurately transmit data, including GPS coordinates from human operators and images of agricultural fields, into repositories.

"Design and Development of a Wireless Sensor Network-Based Precision Agriculture System" authored by Chetan Dwarkani et al. This proposal presents an innovative approach to smart farming by using wireless communication technologies to connect a smart sensor system with a smart irrigation system. Dr. V. Vidya Devi and G. Meena Kumari's "RealTime Automation and Monitoring System for Modernized Agriculture" proposes a method for creating an automated irrigation system that optimizes agricultural water use efficiency. A gateway device is responsible for managing the sensor data.

[6] S. R. Nandurkar et al., "Agricultural Protection System Based on IoT"; This system is designed for IoT-based monitoring, capable of analyzing harvest data and crop conditions to facilitate expedited decision-making.

## **Methodology**

### **Soil Moisture Sensor**

Soil moisture sensors are used to quantify the water content in the soil, hence providing insights into the overall volume of water retained within it. Soil moisture meters gather data on plant irrigation and indicate soil moisture levels. The sensor shown in Figure 2 effectively aids in irrigation control. It assists irrigators in understanding the precise conditions inside the soil's root system.

### **Temperature and Humidity Sensor**

The temperature and humidity sensors seen in figure 3 are used to monitor the humidity and temperature of the surrounding environs. Relative humidity is quantified by a sensor transducer measuring water vapor. Water vapor is transformed into electrical impulses via transducers. There are three kinds of humidity sensors: resistive, capacitive, and thermal. The DHT 11 sensor is used in this model because of its affordability and widespread recognition. The DHT11 sensor utilizes a negative temperature coefficient (NTC) function to monitor temperature and humidity as serial data. The DHT11 has humidity sensors and thermistors. This device can measure temperature ranging from 0°C to 50°C and humidity levels from 20% to 90%.

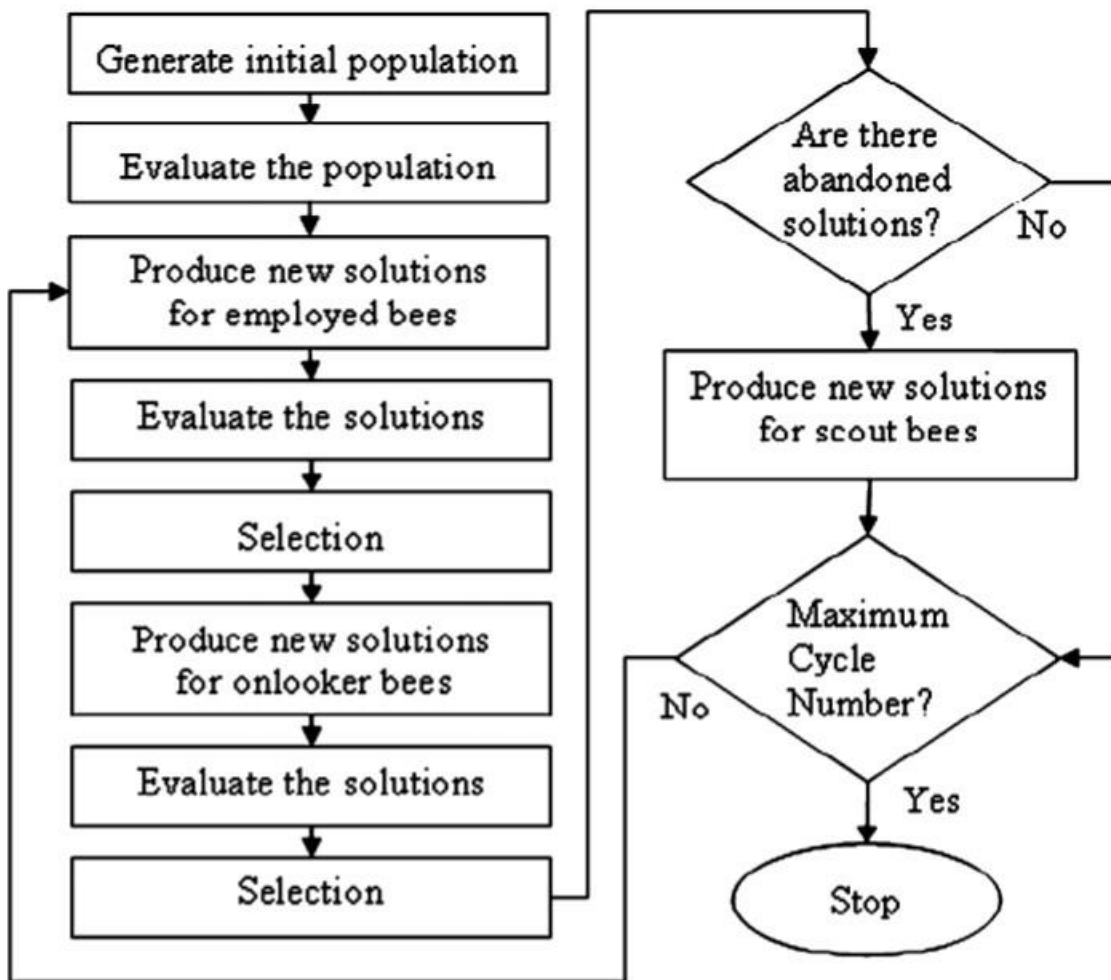
### **Photodetector**

A photoelectric sensor, seen in figure 4, is synonymous with a light sensor. Light sensors can transmute light energy into electrical energy. Variations in light intensity are used for illumination using light sensors. The light sensor operates as a particle, so it is designated as a photon. Electrons will absorb light energy, resulting in

increased kinetic energy, and will be released from the metal surface when a photon impacts it. Infrared Sensor

An infrared sensor used for measuring an object's thermal radiation. This sensor detects certain items by emitting light. Certain items emit thermal radiation. Infrared sensors can identify these radiations since they are generally imperceptible to the human eye. LEDs and infrared photodiodes generally function as the emitter and detector of the infrared sensor. The incident infrared light influences both the resistance of the photodiode and the output voltage. When the item gets infrared light from the emitter, it reflects it to the detector photodiode.

**Implementation**



**Figure 2: Flow chart of ABC Algorithm**

- Step 1. Establish a network in a localized region. This region will be allocated with a number of nodes. The location of each node is determined randomly.
- Step 2. Identify the CH according to the fitness value assessed by each node.
- Step 3. Initiate the parameters N and n; and enter the worker bee phase for the generation of new food sources.
- Step 4. Monitor the observer bee phase to alternate food sources based on quality.
- Step 5. Outrider bee phase for identifying novel food sources.

Step 6: Conserve the optimal food source identified until the conclusion, while presenting the most effective option discovered.

### Results And Discussion

The yield include the temperature, soil moisture content, and the finding of gatecrashers. The output from the integrated smartphone feature of the mobile device is as follows. It regulates temperature, adhesiveness, humidity, and the detection of intruders.

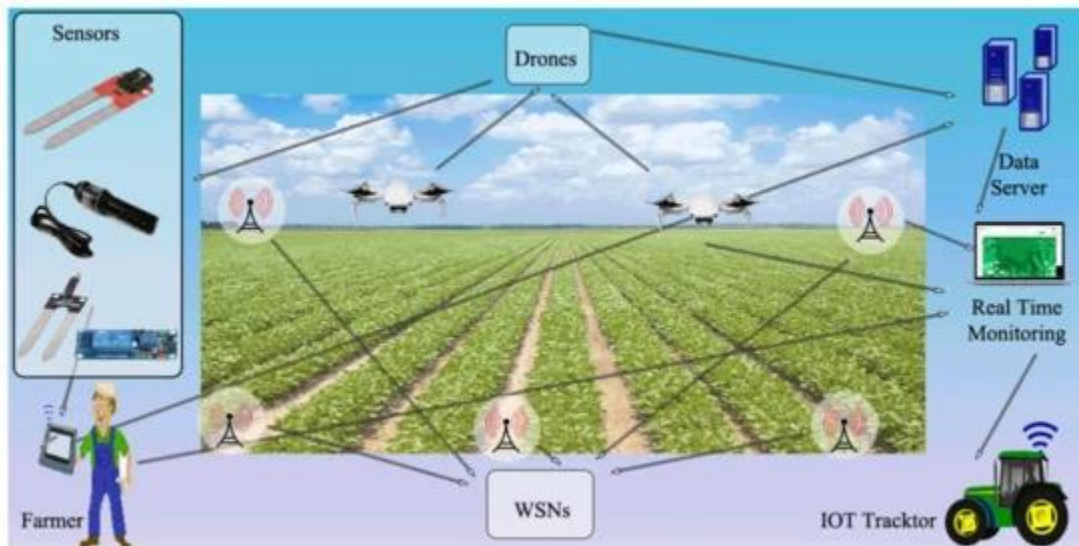


Figure 3. IoT based smart agriculture monitoring system with wireless sensor networks.

Smart farming is now viewed as an essential requirement by the Indian agriculture industry. It is much more successful than conventional agricultural practices. Smart farming can Observe the temperature, humidity, and more attributes of agricultural terrain via the use of sensors and automated irrigation techniques. Consequently, growers may oversee their crops remotely. Moreover, small farmers might gain advantages by incorporating digital and physical infrastructures via smart farming techniques. India's small and marginal farmers have challenges in integrating physical and digital infrastructures, hindering their ability to enhance their income. Agricultural start-ups may facilitate connections with farmers, enabling access to cost-effective solutions.

### Conclusion

This research presents a prototype for IoT-integrated smart agriculture. We focus the model on a descriptive analysis of how IoT-based smart agriculture fulfills SDG goals. The study indicates that the methodology is anticipated to fulfill many SDG targets.

A degree of automation is implemented, facilitating the utilization of cloud services to oversee field and product conditions over extensive distances. Sensors that function logically upon modification are used to initiate points of interest, such as water and energy conservation. The notion of modernizing agriculture is straightforward, logical, and feasible. Given these parameter values, a rancher may readily determine which fungicides and insecticides to use to enhance crop yield.

The study proposes modernizing old irrigation methods by integrating contemporary innovations into the agriculture industry, hence achieving clear profitability and a modest reduction in waste.

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