



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 6, June 2024

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)

# Internet of Things in Agriculture

**Rutuja Rohidas Tulsankar, Prof. Minaxi Gurav**

Department of MCA, Finolex Academy of Management and Technology, Ratnagiri, Maharashtra, India

**ABSTRACT:** The rapid development of Internet of Things (IoT) technologies created tsunamis almost in every industry across the world and particularly in agriculture. This massive changes are shaking the existing agriculture methods and creating new wave of opportunities. Due to the increase of world population by 30%, agriculture products will have a very high demand by 2050. Human resources for agriculture development is becoming less due to migration of young people to big cities and land use for agriculture cultivation is being used for rapid development. As a result, most of the agriculture activities need to be automated to fulfill the food demand. IoT and related technologies will be the potential solution to solve the above agricultural and food demand issues. This paper will explore the latest trends in IoT agriculture applications and highlight the issues and challenges particularly in network and open source software for smart agriculture.

**KEYWORDS:** IoT, smart farming, agriculture, network, architecture, wireless sensors and open systems.

## I. INTRODUCTION

IoT technologies and devices will sense, collect, store and communicate data to various components in an application such as smart agriculture. The smart agriculture revolution refers to the use, integration and deployment of the latest technologies such as Internet of Things (IoT) in agriculture, with the aim of improving and increasing the quantity and quality of crop harvest. The adoption of smart agriculture can be further improved among farmers in many ways. However, it is very crucial for farmers to be given comprehensive knowledge and know-how advice on the use of smart agriculture techniques before the proposed system is widely introduced. Agriculture will continue to be an important source of economy for many countries and in near future smart agriculture will change the country's agricultural landscape. IoT technologies will enable farmers to view and manage their farms remotely and at the same time big scale agriculture farms could easily be implemented and monitored precisely.

## II. THE INTERNET OF THINGS

Internet of Things is a concept of an interactive environment with sensing the vitals and then providing the desired controlled and compatible output to the next level with further networking progressively and then finally establishing the interconnections among different ubiquitous entities present. Major components of Internet of Things can be described as three elements; first physical objects, second Controller, Sensor, and Actuators and third the internet itself. Internet of Things can be referred as a smartly formulated computing strategy in which sensors and controllers act as processors, collecting real world data and then providing required output response to the real world objects as the terminal object of this embedded system.

The Internet of Things architecture consists broadly four layers.

**a. Sensors connectivity and networks:** This is the basic layer for the architecture. Sensors are used to perform real time collection of data by sensing the environment as well as system variables and then this data is used by controllers to perform designed operations on the data. Sensors and controllers can be connected wirelessly as well as with a structured connected approach among the Internet of Things. The interconnected object (things) can be identified by their respective contributing attributes like temperature, size, and location. In this way, the physical attributes and the virtual data regarding these contributing factors can be easily correlated with formulated relative equations. The most critical factor is the formulation of algorithms for interaction of physical and cyber data along with the overall databases and network layers. Data can be collected, processed in a desired way through some basic techniques with the Internet of Things. For example, Radio-Frequency Identification (RFID) and bar-code techniques offer these functionalities.

**b. Gateway and network:** Gateway and network present the second layer in the architecture. The routers with the capabilities of working autonomously can be programmed and established to perform two way communications. The sensing devices collect data by a scanning process which is constant and capturing real time omnidirectional data and can be programmed to capture data for any anomalies appearing in the standard norms. The wireless sensing technologies attribute several properties, including hierarchical network, network topology single and multi-tier, and coverage for example, sparse, dense, and redundant. Major examples include RFID (Radio-frequency identification), Bluetooth, ZigBee, Wi-Fi, Ethernet, techniques of infrared data collection, WAN.

**c. Management services:** Management services represent third layer of structure architecture. Entity level management in the Internet of Things can be referred as elemental management system, managing the basic components like sensing devices, controllers, network gateway devices, end user products. For example, network management includes activities associated with network devices, the firewall protocols, access management for different operations for basic tasks as well as maintenance. Service management directly exhibits and influences the user's experiences about Internet of Things. It mainly comprises device modeling, configuration and management, data flow management, security control management.

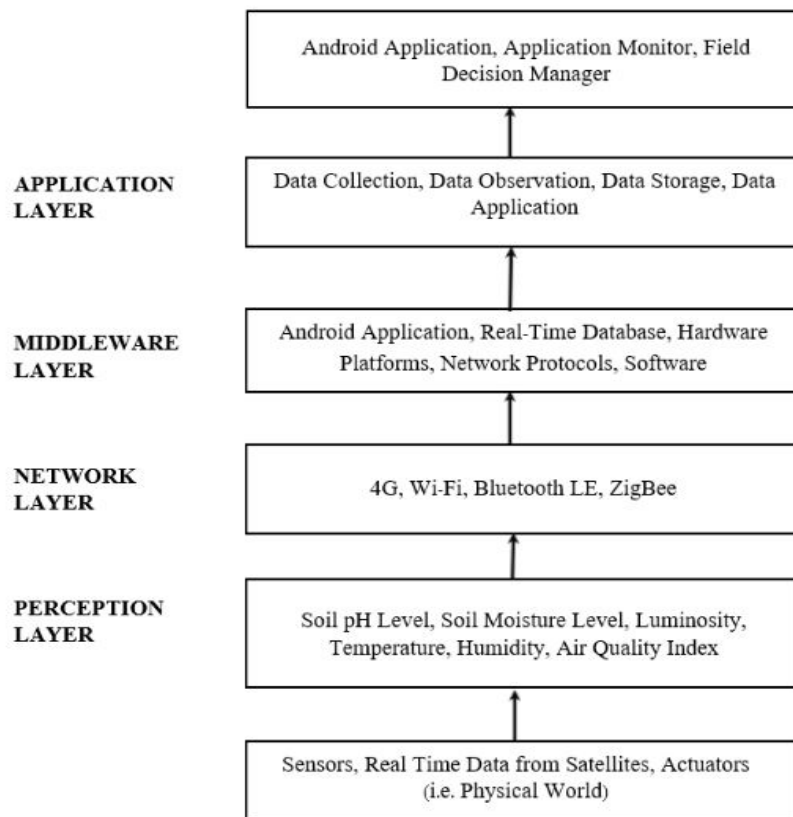
**d. Application:** Each sector whether its environment, energy, agriculture, transport, healthcare, military, education has abundant opportunities for Internet of Things to explore and to get automated. Under application area the markets covered by Internet of Things are highly versatile. Asset management, supply chain, tracking of assets, farming, smart education, smart house, smart city, and smart planet, there is certainly no limits to application of Internet of Things. Real life example of Smart City is The Amsterdam Smart City.

### III. OBJECTIVES

The establishment of stakeholder engagement programs to understand how industry leaders perceive the adoption of precision agriculture technologies is needed. Their understanding and vision about technology adoption in precision agriculture will aid in eliminating of barriers to precision agriculture adoption. Another approach to engage farmers is by providing access to high speed internet connectivity. Furthermore, it will benefit on-site data analysis of yield limiting factors. Through highspeed broadband connectivity to the cloud, the traffic demands of the novel precision agriculture applications can be met. Despite the high costs associated with deployment of rural broadband networks, the internet service providers can reap higher returns on investment helped by ubiquitous precision agriculture adoption in rural areas.

Our academic institutions must organize to more effectively perform the research driving innovations in precision agriculture to educate next generation students to use and creatively adapt both themselves and these new technologies for the future, and catalyze cross-fertilization of ideas and disciplines bridging education and research. Innovations in precision agriculture training are needed. The development and implantation of training programs will help to strengthen the technology expertise the researchers need to deal with precision agriculture big data analytics. The enhancement of undergraduate curriculum to include technology solutions and opportunities in precision agriculture is also a current need. Particularly, development of training materials to offer education and outreach to farmers will help in the areas of sustainable agricultural management systems, sustainable agriculture production and management. The improved MS and PhD curriculum for precision agriculture will lead to growth in expertise in precision agriculture.

#### IV. IOT ARCHITECTURE



There are four layers of IoT architecture such as (1) perception layer, (2) network layer, (3) middleware layer and (4) application layer. The details of each layer are given:

**a. Perception Layer:** Perception layer is the physical layer which consists mainly of sensors, detectors and all other hardware devices (soil moisture, temperature, humidity, air quality, ground water level), connected to a micro controller/processor to aid in real-time data collection. In our system sensors are more adept to fetch data regarding agriculture industry. All of the collected data is stored first on a local server on which error analysis is done and only the precise, accurate data is encoded and transmitted over to the cloud server.

**b. Network Layer:** The network layer consists of modules which help in transfer of data. It hides the sensitive information from the sensors and sends abstracted data to the processing unit of the machine. Its primary objective is to connect the hardware (i.e. sensors, actuators, etc.), the perception layer to the software (i.e. Database, WebGIS etc.), and the middleware layer. The sensor devices are connected through the long-range or the short-range wireless networks like 4G, Wi-Fi, Bluetooth LE, ZigBee, etc. The embedded systems which consist of small modules providing network, helping in transmitting of data more safely and precisely can be used to implement the system. In this way, the agriculture system would be more efficient. In this smart agriculture system, a small embedded system would be used to transmit the information about various different factors such as soil moisture, temperature, humidity, air quality, ground water level about a specific region. Hence, the network layer serves a crucial role in transmission of data, from the sensor devices to the software or the database, where the calculations are performed based on the transfer of data.

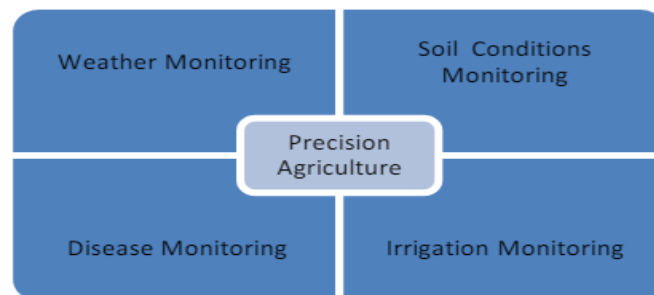
**c. Middleware Layer:** The middleware layer serves as the connection between network layer and application layer. The middleware layer serves as the interconnection between the different components of IoT, making communication possible between the hardware and software. The communication between the hardware sensors, operation system and network protocols are enabled with this layer. The middleware layer manages the services and resources and essentially

performs operation on remote database. It makes the integration of software and hardware easier. In this system, the large amount of data which is received from the remote terminal unit, in the perception layer, is stored in a remote database. Based on those predicted values the desired block of instructions is performed. The instructions include automatic watering the crops, automatic providing shade to the crops, etc. These instructions are responsible for making changes in the application gateway of the system. The analytical operations play an important role, as the weather in the world is constantly changing and the best yield in the farm is expected. These operations based on real-time changing data can be useful for the user to manage the crop yield.

**d. Application Layer:** It consists of communication protocols, interface methods used for hosting in a communication network such as MQTT, AMQP, CoAP, etc. Data from the middleware layer is routed towards the application layer devices such as a website or an android application, these devices receive the encrypted data and internally use software to decrypt and store data locally for further use. This data is used to showcase the trend which is being followed. The application monitors data and gives intelligent suggestions to gradually increase the throughput of the system.

## V. IOT APPLICATIONS IN PRECISION AGRICULTURE

Precision agriculture helps to improve the livelihood of the farmers by automating and optimizing all feasible agricultural parameters in order to enhance the agricultural cultivation and productivity. IoT sensors help to measure soil quality, weather conditions, moisture level, and finally optimize these parameters to increase the yield. In general, the IoT precision agriculture consist of four components: weather monitoring, soil conditions monitoring, plant disease monitoring and irrigation monitoring.



**a. Weather Monitoring:** Critical weather parameters that impact the growth of agriculture includes temperature, humidity, wind and air pressure etc. These data are collected using sensors (wired or wireless) and transmitted to the cloud servers. The collected data will be mapped with climate conditions, and analytic tools are used to determine the next course of actions to improve the agricultural growth.

**b. Soil Contents Monitoring:** Soil monitoring has become one of the most demanding practices in agriculture field. Soil patterns which are critical for agriculture cultivation includes soil humidity, pH, moisture and temperature.

**c. Diseases Monitoring:** Several IoT agricultural applications such as diseases monitoring and identification have been digitized which helps the farmer to make informed decisions much faster. Image processing and machine learning techniques are used to determine the healthiness of the plants. An IoT based wheat diseases and pest monitoring system has been developed.

**d. Irrigation Monitoring:** IoT helps to improve the traditional irrigation system in a more innovative way by taking into consideration the current (in real time) weather and soil conditions. Irrigation is only done when its necessary based on the above parameters. This will help the farmers to reduce irrigation cost and optimize water resources.

## VI. IOT FOR SMART AGRICULTURE



- a) **Smart Greenhouses in Agriculture:** The Internet of Things may help enhance yield in smart greenhouses by allowing for the development of proportional control systems. They employ sensors to give a regulated environment for the crops that they grow. The system is monitored remotely, and the data processing is done via the use of cloud servers. While reducing the need for human interaction, the smart greenhouse keeps track of the quantity of temperature, light, and humidity in the environment.
- b) **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.
- c) **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.
- d) **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.
- e) **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 analyze 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.
- f) **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 analyze 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.

- g) **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. They have received instruction in AI in order to maintain the crop's quality while also preventing the spread of weeds. These devices are able to sift the produce according to quality and pack it in a far more expedient manner than traditional procedures [8]. The use of AI in agriculture provides assistance to farmers with the goals of enhancing their output and minimising negative impacts on the environment.
- h) **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 analyze price fluctuations. Farm mapping makes it feasible to calculate yields per hectare with a high degree of accuracy. Farmers take into account a wide range of criteria in order to arrive at a conclusion [9], such as the amount of precipitation, the kind and number of pesticides used, the temperature, and other meteorological conditions.

## VII. SMART AGRICULTURE BY AGCO USING INTERNET OF THINGS TECHNOLOGY

AGCO's Fuse Technology's 'Connected Farm Services' will provide farmers with high level integrated and smartly connected agriculture assets throughout the farm regardless of the product's brands they are using currently. Scientists and agriculture industry have always been trying to find efficient ways to bolster present day agriculture. AGCO's precision agriculture project has proved to be a revolution in the industry. As for the break ups GPS based guided products reduce 10% of the average cost, variable-rate application reduce 7% of average cost and automatic section control saves 5% of the average cost.

Technology under study is AGCO's Fuse Technology's 'Connected Farm Services'. This technology claims to provide an integrated network of available farm assets with the innovative strategy to make different branded products compatible to a uniform operative level to provide optimum results with farmer's ease. The concept by AGCO has been claimed as a new strategy that will surpass the existing precision farming techniques with efficiency, delivering greater revenues for farmers by reducing the input cost significantly through a complete automation of all related assets. Fuse Technology's 'Connected Farm Services' will be an integration of integrated technologies currently used in precision agriculture, an extension to AGCO's existing services and management information system. Basic level equips customers with the ability of self-monitoring, data transmission and database management along with standard setup techniques, operations related support center system via phone as well as emails. Whereas, the higher level services provide users with the benefits of remote monitoring and proactive operation handling and various types of reviews according to inspection by experts over the time as well as consultation and the required training package for the field knowledge expertise.

- a) **Enterprise Planning:** A wide approach strategy, highly flexible to use the FMIS (Farm Management Information Software), AGCO's standard management system according to farmer's requirement for crop planning, even for yearly basis. For example: Agcommand (Wireless information solution application for remote machine monitoring), AGCO's telemetry tool, one of the elemental technologies fueling Fuse Connected Services. VarioDoc and TaskDoc are field documentation systems supported by wireless communication for data transmission. It can work on Bluetooth or GPRS. Task file management system receive planned work orders including required variable rate details as well as creates record activities during each job.
- b) **Tillage and Field Preparation:** A strategy to optimize the key operations on the field for example, automatic guidance for optimum planting on the available area. For example, Auto-Guide3000 (A satellite based guidance device) guides for the minimum overlap areas and significantly reduces the conventional time at the field as well as fuel used. This allows the plantation of the seeds in the places with possible optimum usage of available field area.
- c) **Planting:** Ensures optimum planting of seeds with optimal row inserting, thus minimizing inputs efforts with optimized use of whole area of the field. For Example: 'Section Control' (Digital Control Terminal) comes with an automatic control for planting and spraying sections and thus reducing the inputs to a minimum. Go-Task Application transmits file wirelessly via any mobile to AGCO machines not equipped with TaskDoc.

- d) **Growing:** Fuse application helps uploading of preplanned maps from the applications, simplifying the overall task management with reduced inputs. For example: Ag-Control (Chemical rate and section control applications) ensures the equal variation of seed distribution and chemical rate across the field which in turn provides maximum yield.
- e) **Harvesting:** Simplified harvesting with remotely accessed preplanned tasks and best required yield maps along with the help of moisture sensing devices and constant monitoring system. Fuse products and services help maximize productivity, increase uptime and facilitate data management. For example, FieldStarII (GPS integrated yield monitor) records important machine and crop data during harvest that allows growers to make adjustments for future crop production, enabling better business decisions.
- f) **Grain Drying, Monitoring & Control:** AGCO provides on-site and mobile grain drying with efficient control along with constant monitoring. GCI Vision Dryer Controls provide with past data records for better results and come with a flexibility of various types of operational modes of moisture control. When GSI is connected with Watch-Dog, all the functions can be remotely accessed with any smart device. Watch-Dog even provides notifications over email or on your mobile and it provides with features to change variables like temperature remotely.
- g) **Mobile:** AGCO's smart products are connected with one another via internet allowing farmers to know the real time operation status subtly and provide them the ability to perform the adjustment of variables and different types of operations remotely. Seamless connectivity provided by AGCO with every possible asset is managed by a single device like phone, tablet or computer.
- h) **Dealer and Decision Support:** AGCO has announced that it will launch a new solution for wireless task data transfer: Go-Task. Go-Task App provide with wireless data transmission among agriculture equipment's available on the farm. The farmers are able to be in constant support with the dealers as well as the agriculture experts every time with the help of widely connected entities.

#### Benefits of Using IoT:

The web about matters affords a number regarding benefits to organizations, enabling them to:

- a) Supervise the business processes
- b) Enhance customer experience
- c) Epoch and money benefits
- d) Enhance man productivity
- e) Adaptability to business models
- f) Enhance commercial enterprise decisions
- g) Yield extra revenue

IoT encourages businesses in conformity to rethink the approaches he strategy their businesses, industries then markets and offers to them the tools in conformity with improving their business strategies.

### VIII. CHALLENGES IN THE AGRICULTURE INDUSTRY

Agriculture may be one of the largest sectors in the global economy, but it is facing challenges. Climate changes, population growth, and food insecurity are not just bad for business but at the same time, they do have a global influence. Over time, farming has changed to adapt to the growing population.

In the near future, the world population is expecting to be growing. As of now, the current world population is 7.6 billion. By 2030, the UN has anticipated that world population can reach up to 8.6 billion and followed by 9.8 billion in 2050. This coupled with the diminishing resources and unpredictable climate changes result in major concern on food security. So, such changes in demographics have affected the global diet whereby people have consumed more protein and meat. Thus, with the increments in food demand, farmers need to escalate their crop productions by enhancing the productivity of existing technology in the agriculture industry. These lead to a water resource problem.

Next, urbanization is to be addressed as another challenge in the agriculture industry. With the global urbanization, it could lead to additional people in cities and town and it could also change diet pattern. For instance, annual per capita



for meat consumption in the year 1997 to 1999 is 36.4 kg per person and by 2030 the meat consumption is predicted to be in increment up to 45.3 kg per capita. The current natural resources, the water used in the agriculture industry are highly stressed especially in water resource. The amount of water usage in agricultural is expressed per kilogram of the product. Livestock production always uses more than crops production. Reference, it is estimated that 40% of the world's rural population lives in water scarcity area. This problem may decrease the productivity of the agriculture industry reaching from livestock to crops productions.

Currently, livestock production is one of the sectors that increases rapidly in agriculture industry. This demand is increasing driven by population growth in urbanization. With the increase of livestock production to overcome the demand in

urbanization, farmers need to utilize the clean water resource to feed their livestock. This is crucial because high usage of water can lead to water scarcity. And water global demand is projected to increase by 50% in 2025. The management of natural resources especially water is crucial for improving the productivity of the agriculture industry to meet the increasing demand in urbanization and overgrowing population.

## **IX. CONCLUSION**

This paper present a survey on IoT applications in agriculture. IoT-based agricultural applications, open source agricultural software, issues and challenges are discussed in detail. Furthermore, this paper provides an overview of how IoT technologies are going to change the agricultural sector and help the farmers to manage their farms more effectively and at the same time increase their revenues. Finally, it is expected that IoT technologies will help the agricultural sector and farmers to meet the food demand by 2050.

## **REFERENCES**

- [1] Internet of Things in Agriculture: A Decision Support System for Precision Farming
- [2] Case study of Internet of Things in area of Agriculture, 'AGCO's Fuse Technology's' 'Connected Farm Services' by Rashi Chaudhary
- [3] Agriculture monitoring and prediction using Internet of Things (IoT) by Mohit Kumar Saini, Rakesh Kumar Saini
- [4] Internet of Things in agriculture: A survey by Mahmoud Abbasi, Mohammad Hossein Yaghmaee, Fereshteh Rahnama
- [5] IoT Applications in Smart Agriculture: Issues and Challenges by Mohamed Rawidean Mohd Kassim



INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details