

# Internet of Things (IoT) in Agriculture: an Overview of the Concepts and Challenges in its Implementation

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## Abstract

India is an agriculture-based country. The increase in population and the need to increase production have made modernization of agriculture inevitable. The Application of new technology in agriculture is the only solution to make it possible. IoT is one such technology. IoT can be implemented in all fields from smart homes to smart cities. Internet of Thing plays an important role in smart agriculture. IoT helps to monitor crop growth and management of agriculture resources. This article explores the application of Internet of Things in agriculture. This paper provides considerations and inferences in the implementation of IoT in agriculture and talks of the IoT technology and problems in its the implementation in agricultural practices. Some real-world examples are used to discuss IoT in Agriculture.

**Keywords** – *IoT, Internet of Things, Smart Farming, Agriculture, Implementation, Information and Communication Technology (ICT).*

## I. INTRODUCTION

In India, 80% of the population depends on agriculture and its allied activities as the main source for their livelihood. Nearly 52% of labour depends on agriculture for employment. The population is increasing so much that it will reach around 9.7 billion by 2050 and we need to improve agricultural production to meet the growing need [1]. Nearly 14 to 15% of Gross Domestic Product (GDP) of the country is contributed by agricultural sector. In the case of most of the crops, agricultural yield in India is found to be lower than that in other countries. Agricultural growth has undergone rapid changes over the past decade from 5.8% in 2009-10 to 0.4% in 2014-15 and -0.2% in 2018-19. This variance in the growth of the agricultural sector creates impacts on the income of farmers and their ability to take profit from investing in their land holdings. Expensive farm equipment, lack of access to technology, distribution challenges due to

intermediaries are some of the challenges faced by the Indian farmer.

Problems like inadequate availability of water due to drought and unpredictable environment have made efficient use of the available water almost mandatory [2]. Apart from water-shortage, farmers have to face problems such as non-availability of quality agricultural tools, unpredictable monsoons, pest outbreaks, etc.

Agriculture has remained the core of the Indian economy. Though agriculture has remained the main source of the Indian economy, still it is a technologically backward sector. In this modern world, technology is at the heart of our everyday lives. Similar to transformations in other sectors, technology is needed to improve farming practices too. Technology will improve Indian agriculture by overcoming the problems in a number of different ways.

## II CHALLENGES IN AGRICULTURAL INDUSTRY

- Small and fragmented landholdings.
- Ignorance of weather prediction.
- Insufficient knowledge of sales and distribution.
- Lack of awareness about Information Communication Technology (ICT) infrastructure.
- Lack of awareness about the benefits of ICT usage in agriculture.
- Drastic changes in the weather conditions.
- Less involvement of educated professionals in agriculture.
- High-cost of the required tools and machinery.

The cost of IoT equipment for agriculture and the need for wider internet coverage are the major challenges faced IoT in agriculture. These two challenges have kept many farmers in developing countries away from this technology.

## III TECHNOLOGIES ENABLING IOT

The IoT in architecture consists of interconnected devices that can communicate with sensors and other devices through wireless connectivity [3]. The technologies given below are part of the Internet of Things:

**Wireless Sensor Networks (WSN):-** WSN includes different types of sensors or nodes linked with one another to monitor various types of data.

**Big Data Analytics:** Big Data Analysis is a technique to evaluate vast volumes of data. The vast amount of data is obtained from diverse sources like social media, photographs, digital images and sensors

**Cloud Computing (CC):** The network of a large pool of systems is hosted on the Internet for processing data and store and manage them rather than on a local server or a personal computer.

**Communication Protocol:** The backbone of IoT systems is communication protocol. The Communication protocol is used to enable applications to connect to each other. The exchange of data over the network is achieved by communication Protocol.

## IV INTERNET OF THINGS (IOT) IN AGRICULTURE

IoT is a network of devices where all the physical objects are connected to one another via router and communicate via the Internet. 'Internet of Things' is spread far and wide in

relating devices and gathering statistics [4]. In IoT, all the objects can be controlled and monitored remotely across the existing network infrastructure. IoT is a smart strategy that reduces energy resources and makes physical appliances easily accessible. In this technique, human interaction is not needed for control. The IoT is a network that makes devices smarter and provides remote monitoring to the user from anywhere in the world [5].

Smart farming using IoT-enabled technologies helps farmers increase productivity. Agricultural production using IoT is expected to improve food production by 70% in 2050, supply up to 9.6 billion people with food, and up to 2 billion sensors will be used in 525 million farms [6]. IoT-enabled farming is an innovative hi-tech system for growing crops. The applications of IoT in agriculture include smart farming automatic irrigation, spraying of pesticides and disease detection. Sensors can be deployed in various locations like the ground, water, and vehicles etc. for collecting data. The cloud systems are used for storing the collected data and mobile phones are used by the farmers for accessing the data via the internet.

IoT in agro-industry can be classified into four technological domains:

- (1) Monitoring
- (2) Control

(3) Prediction

(4) Logistics.

The monitoring domain deals with the use of Wireless Sensor Network (WSN) for sensing physical and environmental parameters from farms. The purpose of this domain is to collect information for analysis and simulation without manual intervention and forward it to a server or data centre. Embedded monitoring devices are used to maintain consistent coordination with the WSN and view stored information via the internet. Hence, IoT in agriculture helps farmers gather necessary data on crops and farms with the help of sensor devices.

The control domain uses the devices deployed on-site. These control system devices use the two-way communication channel. Control domain devices can be used to maximize the utilization of water, fertilizer and pesticides based on the information provided by the on-site devices. The control system helps the farmers minimize wastage and control irrigation based on the growth of plants. These devices are programmed to adapt themselves to the real-time environmental data.

The prediction domain is used to support farmers in decision making. Humidity sensors determine the environmental conditions. This domain can integrate forecasting and monitor drought and irrigation by using IoT. In agriculture, IoT based prediction domain can stabilize the demand for agricultural products and their supply. They achieve this goal by developing a prediction system that can monitor the growth and yield of crops by sensing environmental variables.

The logistics sector in agriculture involves the movement of physical goods and other data from producers to retailers to meet consumer demands. This encompasses sourcing, production, shipping, transportation, loading and unloading, processing, packaging, delivery, and other activities. The main goal of logistics is to add value to agricultural commodities, lower marketing costs, increase

delivery capacity, reduce excessive losses and, to a certain extent, lower risks.

## V. BENEFITS OF IOT IN AGRICULTURE

The benefits of applying IoT in agriculture are: the usage of inputs can be optimized by farmers, and the production cost can be reduced. The other benefits are:

- Reduces crop losses due to diseases and climatic changes and helps monitoring of crops.
- Minimize the water use.
- Farm activities can be planned.

## VI. INNOVATIONS AND CONSIDERATIONS OF AGRICULTURAL IOT

The use of IoT is a novel idea that benefits producers, stakeholders, and traders in the agriculture sector. European countries, China, and Taiwan had taken the initiative for implementing IoT in agriculture [7][8]. In these countries, smart farming or precision agriculture is the new motto. Taiwan government has initiated i236 project (Smart Living Technology Application Project), where farming is the key focus area [7]. Intelligent devices for smart farming were produced by projects like Farmbot [9]. The task is to meet future needs and make effective use of the resources available. The development in wireless-sensor-networks-related-technology made possible monitoring and controlling of parameters in smart agriculture [10]. The new technology gained popularity with its adoption and wider implementation. The platforms for the devices should be standardized and protocols must be established. The key consideration is the compatibility of various devices used in such systems. Although various non-profit organizations offer solutions, lack of local government's involvement is crucial. It is the duty of the government to popularize the solution that meets the future needs. Another major problem is the availability of suitable network technology and infrastructure. The network with less energy and

support for more devices will be the correct choice. The government has to take into account the infrastructure development, needs for nodes, devices, networking infrastructure, the involvement of local authorities and awareness among users [11].

## VII. ISSUES AND CHALLENGES IN IMPLEMENTING IOT

There are several issues and key challenges in implementing IoT in agriculture. Safety and confidentiality, data integration, control, lack of interoperability, heterogeneity of IoT devices and business model ambiguity are the challenges [12].

There is a very thin return on investment in agriculture and so a balance is important between high-end technology such as IoT and profit margin.

Lack of awareness and knowledge among farmers about technologies like IoT and its application in agriculture is the major factor affecting the adoption of IoT in agriculture. The failure of the farmer to use the information might be a significant obstacle if human intervention is not available [13].

Another challenge to the implementation of IoT devices is that such instruments are prone to physical falsification.

There are many IoT technologies developed recently. Choosing the right IoT Technology is the biggest challenge. The right decision of technology is an essential element in IoT deployment, because a lot of investment is needed to deploy new technologies. It is hard to foresee which one of the new Internet of Things technology will gain market share. Many factors need to be considered, such as support for roaming, the suitability of the technology for small-scale, medium-scale and large-scale farming, and for different geographical locations, soil types and climatic conditions.

The IoT devices are to be installed in the outdoor environment. This exposes the devices to various environmental factors that can damage sensors. As

the sensors and other systems are costly, they need protection from extreme weather conditions.

The expenses for IoT equipment and futuristic technologies will be too big for small farmers.

## VIII FUTURE TRENDS AND OPPORTUNITIES

The future developments in IoT implementation are focused on technological innovations, application scenarios, businesses and marketability in agriculture [2]. Many IoT applications will keep developing and this will introduce new technologies, particularly in the agriculture sector. Some of the possible new technologies are the universal platform, spectral and energy-efficiency and real-time monitoring. The major part of the work currently carried out in the application environment involves prototyping and small-scale. Wide-scale pilots are required for evaluating the usefulness of IoT technology in farming [14]. The business and marketability include cost reduction and policies and regulation.

The future will focus on developing affordable devices, integrating various implementation environments and exploring the use registered and unregistered communication technologies to reduce installation and running costs. Further research is required in the implementation of policies and standardization of IoT use in agriculture. The involvement of government or the agriculture department in IoT policies in farming, which may vary from regions to region, must be ensured.

## IX CONCLUSION

The use of the modern technology in every field is needed for the functioning of modern world. The progress in every field depends on incorporating innovations and the latest techniques into it. The agriculture field is still depending on traditional methods. The use of IoT in agriculture will increase farm productivity. Smart agriculture systems based on IoT can prove to be very helpful for farmers.

There are a lot of on-going research work in IoT technology. These research outputs can be used for increased agricultural productivity. The benefits of implementing IoT in agriculture and the challenges are listed and described in this paper. IoT can bring many benefits to the agriculture sector. In addition to these advantages, several issues need to be tackled to make IoT accessible to small and medium scale farmers. The issues are in security and the cost. It is expected that the outcome of researches on IoT in the agriculture sector will generate favourable policies for increasing the adoption of IoT in agriculture.

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