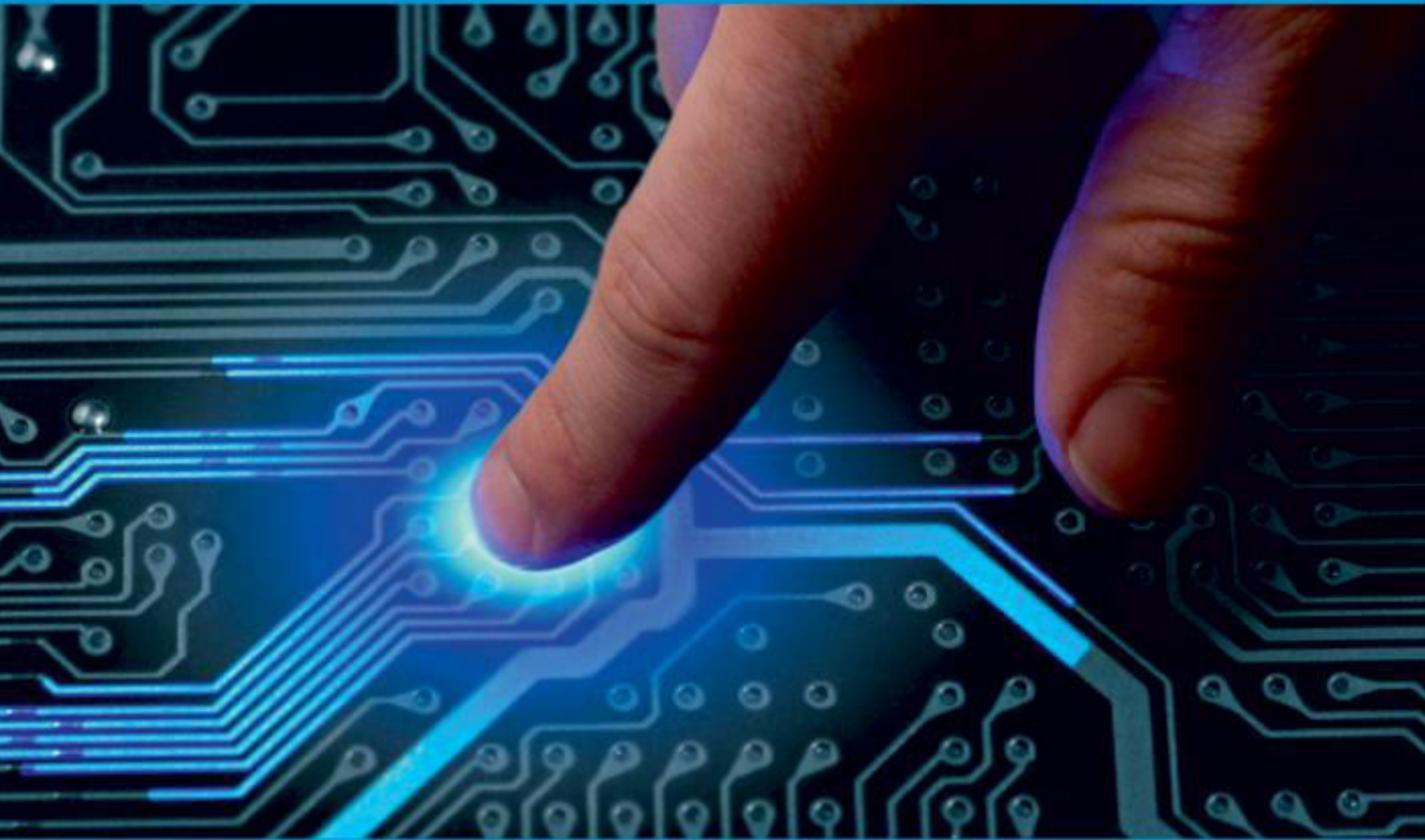
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 11, November 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.542

9940 572 462 | 6381 907 438 | ijircce@gmail.com | www.ijircce.com

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911047 |

Internet of Things - A Way towards Proper Monitoring of Agriculture for Better Yields

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ABSTRACT: With new technologies including the Internet of Things (IOT), it is critical to raise the production of farming and agricultural activities in order to enhance yields and cost-efficiency. The Internet of Things technologies are implemented to current agricultural productivity in terms to enhance the smart farming system and an effective agricultural development is built in this article. Internet of Things, in particularly, can improve the efficiency of farming and agriculture processes by eliminating human involvement through automation. The goal of this research is to establish an overview of sensor data collects by analysing newly established IOT technologies in the farming and agriculture industries.Furthermore, data visualisation analytics and clustering algorithms are utilised to identify essential techniques in the development of smart farming that may efficiently increase performance productivity and enhance agricultural product reliability. Related agricultural tasks can be accurately accomplished using the Internet of Things' feedback capabilities, monitoring, sensing, transmission, and identification, which not only minimizes farmers' effort(time) but also enhances yield of crops and, eventually, benefits the farm owners.This research should be utilized as a guide for agriculture industry members who want to increase and expand their usage of IOT to boost agriculture efficiency. As a result, it is also used to identify the most important technology in the application process in order to create effective agricultural, intelligent, and scientific.

KEYWORDS: Internet of things (IOT), Smart Agriculture, Monitoring, clustering, Data visualisation.

I. INTRODUCTION

Throughout history of mankind, significant advances have been developed to boost agricultural productivity with limited materials and labour demands. Despite this, the huge growth rates have never allowed supply and demand to meet during these periods. According to projections, the global population will reach 10 billion (approx.) in 2050, up almost 25percent from the present level (fig 1). Developed states are expected to account for nearly all of the population growth stated. On the other hand, urbanisation is expected to intensify, with roughly 70percent of the worldwide population expected to be urbanized by 2050.Moreover, average incomes would be many times higher than they are now, driving up food requirements, particularly in developing places(Madushanki, Wirasagoda, and Halgamuge 2019). As a response, these countries will be more conscious of their food reliability and diet; as an outcome, need of customer may shift away from cereals and wheat and toward legumes and, eventually, meats. Agricultural productions should double in 2050 to support these greater, more urbanized, and wealthier populations. In specifically, the present yearly cereal production of 2.2 billion tonnes should enhance to almost 3.0 billion tonnes, and yearly production of meat should improve by more than 200 million tonnes to meet the demand of 480 million tonnes(Boursianis et al. 2020).

Moreover, in order for a monitoring technology to perform effectively, energy consumption is generally a top issue. If a sensor network stopped transmitting, data from its monitoring region will be lost, and the network will no longer be able to provide correct information(Jiajin et al. 2014). When using WSN in PA applications, chargers are needed to energize the sensor network when they are outside. This is a significant problem because the battery will eventually need to be replaced or, if feasible, recharged. Energy harvesting and Rechargeable batteries systems could be employed because the node is outside.Solar energy is a viable alternative because it is inexpensive and easy to harvest, allowing the sensor node to operate for longer periods of time. Farming is managed precisely and smartly with IOT technologies. Agriculture information could also be acquired through the big data processing technology, and Internet of Things is utilised to proper equipment, regulate crops, and related resources, resulting in a more efficient manufacturing method(Pillai and Sivathanu 2020).

The Internet of Things (IOT technologies) has developed as a result of the rapid advancement of Internet technology. Furthermore, data transmission has been achieved by connecting items and people to the Internet via sensing functions, locating, recognition, and induction. On the other hand, it has the potential to increase financial

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advantages and reduce expenses to the maximum extent possible; on the other hand, it has the potential to give technical momentum for worldwide financial recovery. The Internet of Things (IOT) is now being used in a variety of industries, including individuals, and society, the intelligent environment, health care, industrial manufacturing, and transportation and logistics(Navulur, Prasad, and others 2017). It also handles a variety of complex challenges. The marriage of the Internet of Things with farming would undoubtedly aid in the resolution of existing issues with agriculture infrastructural effectiveness, as well as the speedy and productive expansion of farming.The rest of this paper is formalized as follows; section II defines the related works on monitoring of agriculture for better yields using different methods. Section III designates in detail the workflow of the proposed algorithm. Section IV represents the discussion of smart agriculture by IOT applications. Finally, section VI concludes the study(Shaout et al. 2015).

II. RELATED WORKS

International advanced countries began collecting agricultural data previously, and their study and implementation of smart agriculture is more advanced. The agriculture environmental monitoring software technology was conceived and developed by(Hou et al. 2016).The device collected photos of agricultural crops using wireless sensor systems and Global positioning technologies, allowing for remote crop observation and crop management, as well as the utilisation of solar energy to assure the equipment's proper functioning. The Weather Organization used weather, geographical region, and other factors to give environmental hazard assurance to farmers, ensuring that agricultural productivity was protected to some extent(Manogaran et al. 2018).Following that, PepsiCo created an agricultural monitoring technology that efficiently raised crop output and farmers' revenue(Arslan et al. 2015).China is continually learning from experiences and actively expanding agriculture as part of its research and innovation, so that agriculture becomes modernised, intellectualised, data-driven, and informationized. WenFujiang created a framework for agriculture information exchange that allowed information resources to be shared(Taylor 2018).Researchers from the Zhejiang Academy of Agricultural Sciences established and constructed a data transmission framework for dynamically observation of agricultural supplies, which expanded China's agriculture administration structure, by gathering productivity information and accurate monitoring information. With the advancement of data, humans are confronted with a higher data network, which has drawn the interest of local and international researchers who specialise in agricultural data analysis. Lamehari et al. built the agriculture framework by studying the agriculture environmental information they gathered(Long, Blok, and Coninx 2016), It could aid producers and intermediate businesses in generating excellent selections, streamlining the decision-making processes and achieving the objective of increased agricultural output and scientific management of natural resources. Alves, Gabriel, and colleagues created and implemented a method for monitoring soils and analysing soil quality, as well as giving farmers with actionable recommendations for soil improvement.(Thierfelder et al. 2016) proposed a visual online system that could deliver network data services to users and make analysis of data easier.

III. PROPOSED METHODOLOGY

3.1 Internet of things

The Internet of Things (IOT) is a technology that connects all items using the Internet and existing telecommunications networks to create connectivity and compatibility. Subsequently, it was viewed as a huge number of end devices and services that were not restricted by geographical boundaries. "External enablement" and "Internal intelligence" were among the terms used. Video surveillance systems, Sensors, home intelligent facilities, numerical control systems, mobile terminals, and industrial systems other devices make up internal intelligence. External enablement encompasses a wide range of assets, including (Radio Frequency Identification)RFID-tagged assets, intelligent products, and humans and cars with wireless terminal.In the Internet, Local Area Network, and other environments, efficient data security measures could offer protection and even personalised real-time virtual tracking, GPS positioning remote maintenance, security prevention, traceability, remote control, and early warning maintenance through a variety of wireless or interconnected short-distance or long-distance networks for application integration, transmitting data, as well as cloud computing-based service operation and software modes.

The application layer, processing layer, network layer, and perception layer are the 4 levels that make up the IOT architecture. Sensors are mostly employed for data identification at the perception layer, including such RFID for getting electronic tags, in order to access the essential front-end data. The background servers that sends data via the telecommunication networks and the Internet is referred to as the network layer. Certain associated prediction, advanced warning, and intelligent control based on known information were accomplished in the processing layer. The perception layer's data is processed by the application layer, which then realises the product applications(Chen and Yang 2019).

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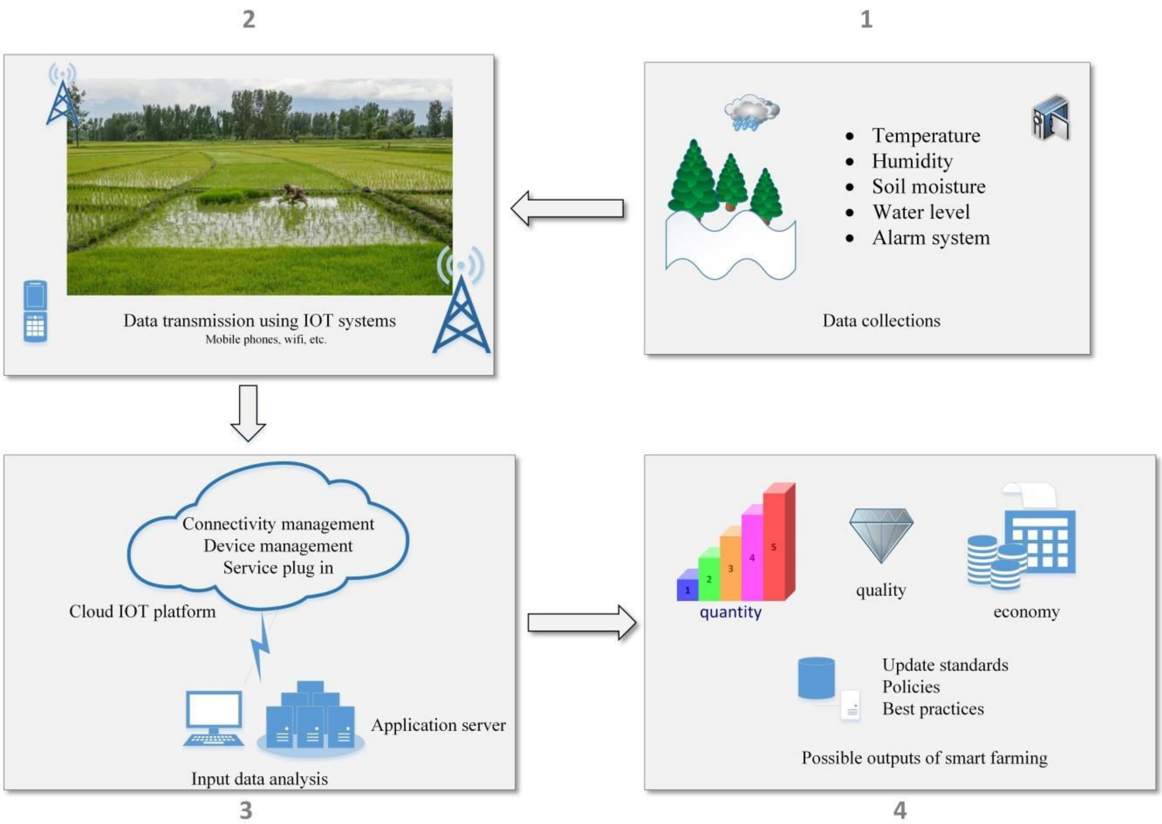

Figures 2: Block diagram for proposed methodology

3.2 Smart Agriculture

Smart agriculture is an intelligent network of farming specialists, an interconnected farming product management platform, and an organically agricultural product monitoring structure. It connects the Internet device and cloud computing approach, enabling the intellectualization of agricultural management, the advancement of agricultural data, and the automation of agricultural production in order to build an advanced green agricultural performance with minimal carbon, high yield, energy efficiency and to modify conventional agriculture practises through technology and science(Zachariadis and Kaskalis 2012). Agriculture has progressed to the level of smart agriculture.It is based on the manufacturing site's business components, which include data gathering, earlier-time detection, and real-time observation in the environment, as well as artificial and agricultural development phases. It also covers water and soil source tracking, as well as pesticide, seed, and feeding requirements, and fertiliser screening, in order to achieve scientific productivity and lean management, as well as enhances the effectiveness of agriculture products cultivation and aquaculture(Elijah et al. 2018).

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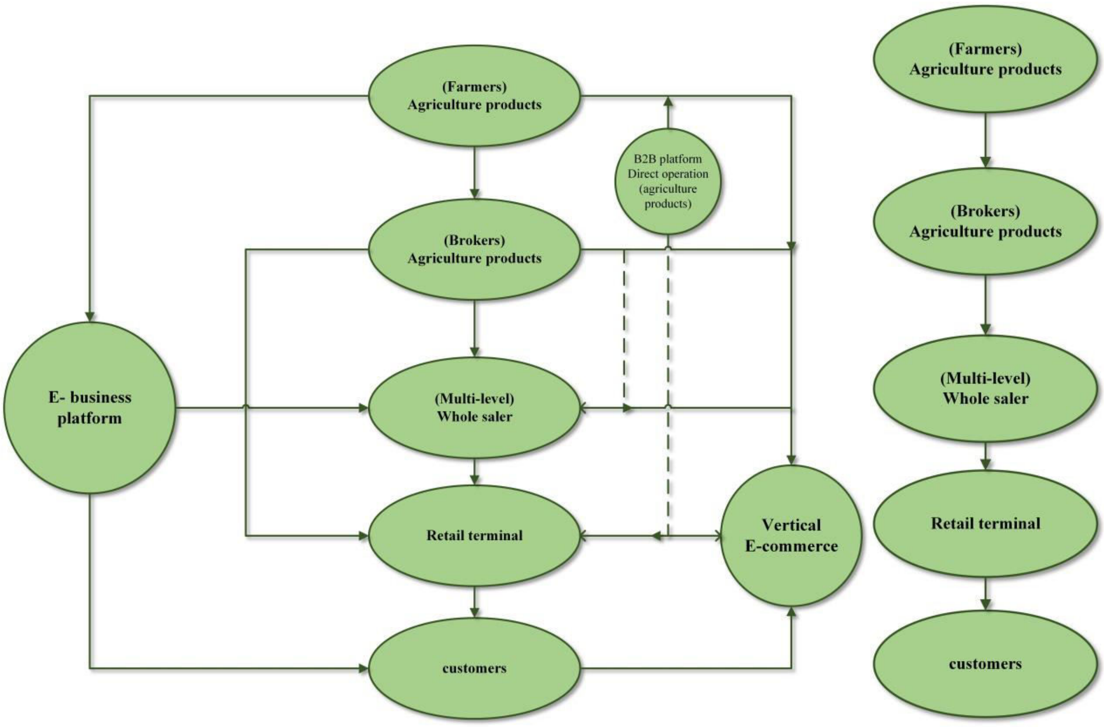

Figure 1: Product distribution of agriculture in E-commerce mode and conventional mode.

On the another side, smart agriculture could use data techniques to control manufacturing processes in a consistent and computational manner, assign resources based on agricultural product cultivation conditions, and local manufacturing conditions, decrease consumption of resources, achieve green agriculture, and mentor the good health progression in the agricultural industry(Srbinovska et al. 2015). As a result, developing smart agriculture is a critical stage toward achieving long-term agricultural growth. Figures 1 depict the conventional form of agricultural product distribution as well as e-commerce mode.Conventional agricultural products can't ensure the reliability of agriculture products after going through multiple levels of processing, which takes longer and costs more in terms of people and materials. Given the challenges facing China's agricultural development, it is critical to incorporate the Internet of Things and smart agriculture, as well as the integration of technology and science into agricultural production, the reform of the Internet of Things prototype, and the support of appropriate nation - wide guidelines. Table 1 depicts the smart agricultural project development(Nuvvula et al. 2017).

Processes	Smart agriculture	Conventional Agriculture
Features	Sensor information diversity; detecting, collection, analytics, and linkage integration; remotely control and monitoring; smart data processing and transmission; and a variety of alarm ways.	Manually management and a lack of adequate technology ways to gather crop development environmental factors; exhaust fan control, shading net, water curtain, and manual irrigation; time-consuming and labour-intensive characteristics; and a large error rates.

Table 1: Smart agriculture is in the process of being developed.

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3.3 Applications of IOT in smart agriculture

In agriculture, there are various instances of IOT applications. Disease and pest control, precision, automation, soil monitoring, irrigation and water quality monitoring, weather monitoring, crop and livestock monitoring, and machinery are instances of these use cases. The following functions are used to describe IOT applications:

3.3.1 Monitoring

Numerous elements in agriculture could be monitored, depending on the type of agriculture being considered. The following are some of the most important aspects to keep an eye on.

i. **Crop farming:** Various environmental conditions have an impact on farm production in crop farming. Obtaining such information aids in understanding the farm's trends and processes. Human activities, pest migration, solar radiation, dry circle, Rainfall, humidity, leaf wetness, soil moisture, temperature, and climate are examples of such information(Ronaghi and Forouharfar 2020). Pest movements' information could be gathered and provided immediately to farmers for pest treatment, or it can be used to give recommendations to farmers depending on pest assault records.

ii. **Aquaponics:** Aquaponics is a hybrid of fishing and hydroponic systems in which fish excrement is fed into plant farms to give the vital nutrients those plants require. It's critical to keep an eye on the quality and level of water, fish condition, sunlight, pH level, temperature, humidity, and salinity in such farming(Morfi, Degottex, and Mouchtaris 2015).With minimal human involvement, the information could also be utilized for automation.Although numerous monitoring technologies have been developed, acceptance in limited and moderate level farms is restricted, particularly in developing countries, leading to a shortage of awareness and deployment costs. The possibility for developing expense agricultural IOT solutions remains untapped(Citoni et al. 2019).

3.3.2 Tracking

Tracking system can also benefit from IOT to enhance a company's supply chain operations. Agricultural organisations may use data from IOT to generate improved decisions, plan ahead, interact effectively with trading contacts, and reduce time & expense. RFID and cloud-based worldwide positioning systems can track data such as asset identification and location(Salam 2020).Information input, collection, process, transmission, and output should all be included in a tracking system. The data from the product's full life cycle, as well as its geographic location, are included in the data input.The method of integrating and standardising all data is referred to as data transmission. It enables the collection, storage, and analysis of data over a great range at a high rate(Ayaz et al. 2019).

3.3.3 Precise agriculture

Precision agriculture is described as the collecting of actual data from farm variables and the application of predicted analysis to make intelligent choices in order to maximise crop maturity, soil and air quality, weather, and even equipment, as well as labour prices and accessibility, are instances of agricultural parameters(Sadowski and Spachos 2020).Yields, reduces price, and reduces environmental control Precision agriculture uses a variety of technologies to boost crop yields, including GPS, big data analytics, and sensor nodes.Though precision agricultural technologies could increase production, it is critical to offer farmers with solutions that are simple to apply and to give training so that medium & small farmers can profit from the methods(Miorandi et al. 2012).

3.3.4 Greenhouses production

Greenhouse technologies, often referred as glasshouse tech, are a method for growing crops in a regulated atmosphere. By establishing adequate environmental parameters, it allows you to cultivate any crop in any location at anytime. Numerous researches on the usage of WSNs in greenhouses to track environmental changes have been conducted(Salazar et al. 2013). Latest studies have shown how IOT may be used in greenhouses to minimise manpower, reduce energy, improve greenhouse-site tracking effectiveness, and integrate greenhouse growers directly to consumers.

IV. DISCUSSION

This research establishes the smart agricultural management framework by evaluating the significant elements impacting crop production and the major technologies employed by the Internet of Things in the establishment of smart farming.Relevant information, including such sunshine, temperature, humidity, and precipitation are gathered using frontend visualisation technology, monitoring, sensing, and identification technologies from the Internet of Things. Various modifications are conducted in real planting and monitoring based on agricultural development factors, such as

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managing fan, shade, lighting duration, and so on. These data are analysed by a smart agriculture managing structure in order to determine the ideal crop development conditions. Simultaneously, it has been discovered that in smart agricultural survey, equipment-side perception and recognition technologies, network communications technologies, management and support, data analytics are the most important technologies.

Smart agriculture, due to its application, has increasing requirements for analysis and data gathering, network connectivity, and administration. As a result, future study should concentrate on identification and front-end induction obtaining better data, and achieving disaster reductions and scientifically sowing as quickly as possible, hence boosting the overall advantages.In overview, the related information is gathered using Internet of Things (IOT) identification, detecting, and visualisation techniques, and the information is analysed using relevant technologies in the smart agricultural management framework to find the most favourable environmental variables for realise resource scheduling, effectively manage agricultural activities, crop growth, and finally realise smart agricultural management and productivity.This study only looks at the beginning phases of smart agricultural production collection and processing, but there may be a few restrictions in the particular application method, which lays the groundwork for subsequent quantitative application and research, and the particular execution of implementation front-end induction recognising technologies.

V. CONCLUSION

This proposed research provides a summary of the Internet of Things in agriculture. Numerous aspects of IOT deployment in agricultural have been thoroughly studied. According to a review of the research, there is a lot of effort being done to establish IOT technologies that may be utilised to improve plant and livestock operational performance and effectiveness. This study identifies and discusses the advantages of IOT as well as open difficulties. The agricultural sector is projected to profit from the Internet of Things in a number of ways. Therefore, a number of concerns must be identified in order for medium and small farmers to buy it. Expense and security are the most important considerations. As the agricultural industry becomes more competitive and more favourable policies are established, the rate of adoption of IOT in farming is likely to rise. The use of telecommunication equipment in agriculture is one important topic that is anticipated to get a lot of study research. Between these advancements, the Internet of Things is predicted to shine out. The smart agriculture network is built using IOT technologies, and the elements impacting agricultural productivity are analysed using visual technologies and cluster algorithms to uncover the important technology for smart agriculture's long advancement.

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