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IoT Contributions in Smart Farming Techniques

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ABSTRACT
In today's world, technology has advanced significantly, although various methodologies are available in the agricultural sector. Agriculture is the mainstay of Economic growth and development. Climate change seems to be the most major impediment which conventional farming faces. The Internet of Things (IoT) is amongst the most effective and important strategies for developing problem-solving approaches. There is a need to move toward digital technology known as the Internet of Things to increase production, competitiveness, and global market, and reduce human interference, time, and expense. IoT is a collection of networks that transmit data but without human intervention.The function of IoT in farming, which contributes toward smart framing, is the main focus of this paper. This systemic study aims primarily to accumulate all applicable investigations into IoT farming application areas, sensor systems, programming interfaces, and different kinds including a computer system. This also goes through both the major issues and problems which have been researched in the farming sector. In the future, these studies can provide some foresighted preview of the current technologies to over the technology adoption in different fields of the IoT implementation for the agricultural implementation of those applications into real-time usage.
KEYWORDS: *Agriculture, Applications, Farmers, Information, IoT, Technology.*

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INTRODUCTION

As a result of huge technological development, agriculture has become more widespread and important. For the development of the agricultural sector, various tools and techniques are available. The vast majority of people can benefit from advanced technologies. The IoT has started to play a significant part in daily life in recent years, enhancing our perceptions and the willingness to customize our environment. In diagnosis and treatment and power, IoT especially applies to the agro-industrial and environmental sectors. To increase productivity, IoT can play an important role in achieving a huge global market, and a new idea of crop trends. Refers to the interconnection of pervasive computing that can productively transmit information without human intervention[1], [2].

In any respect, agricultural development and precise agriculture are very different. Modern agriculture uses ancient traditional agriculture techniques and has them for the work and temporary cultivation of these old appliances without a preliminary investigation of customer requirements, prices, weather forecasts, etc. Today, numerous farm enterprises have adopted IoT technologies to boost production, productivity, and global demand as well as other characteristics such as reduced intrusion by human beings, time and money, etc. Technological progress means that the instruments get narrower, more versatile, and cheaper[3], [4].

Intelligent cultivation enables agriculture simple, cost-effective, reduces the cost of labor and increases agricultural productivity, and provides improved yield. The networks can also be accessed worldwide conveniently so that intelligent agriculture can be reached through promise. Precision farming has been the response to the challenges facing this sector today and is focused on promoting creativity in agriculture. Both these can be achieved by utilizing IoT and smartphones. Farmers may obtain any necessary information or knowledge and track their farming industry[5], [6].

The introduction of different techniques, such as web, database, and IoT computers, is intelligent cultivation. As the population grows today in the world and is expected to amount to around 9,7 billion in 2050, we, therefore, need to increase crop production to feed these thousands of people. On the other hand, because of different factors such as industrialization, business markets, and residential buildings, we are producing on those farmlands and to feed these trillions, we need to increase demand and that is achieved by introducing IoT in agriculture. The population has increased and food production declines[7]. In the present context, farmers don't profit from the produce of agriculture, because of numerous reasons such as pest invasion, environmental contamination, unawareness of important agricultural supplementation, and other difficulties. They need technical innovation to remove these barriers to make agriculture rentable, intelligent, and pleasant for farmers.

In agriculture, data mining was used to detect information. To uncover fascinating relationships among variables throughout massive data, the method of classification algorithms is used. It helps to determine and create secret ties between the characteristics of farm data and facilitates decision-making[8].

Smart farming uses emerging technology such as smart machines, IoT sensors, the Internet, and a network of farmers who talk, time by time, evaluating the different factors such as plant conditions, how much nutrients are needed, soil quality, water quality inspections, etc. In this way, agricultural optimization increases the productivity of producers by creating the Wireless Sensor Network (WSN). It may assist in assessing field factors, including soil, ambient environments, as well as plant or animal biomass. It could also be used to evaluate and track variables including weather, moisture, pressure, or shocks during the transport of products[9]–[11].

Factors impacting crop growth and return may also be monitored and controlled with WSN. You may want to use them to decide which farmers are best matched to the conditions, the infection identification, the control devices, etc.[12]. In the research, we concentrate on temperature, moisture, and soil humidity data in fields of crops. We need data storage to build a proper structure as well as an approach to information from existing information and user-related experiences. As a web-based framework, a database infrastructure will be developed and implemented. The data collected would be used to decide if crops are automatically watered.To improve and change the climate and forecast the water needs of crops throughout the future, agricultural production information will be summarized. This study used data mining to derive the most benefit from accurate measures through automated computerized instruments that track crops, land, and the environment as being among the leading contributors[13], [14].

APPLICATION OF IOT IN AGRICULTURE

Several examples of IoT applications in agriculture are available. For example, irrigation and drainage performance measurement of soil surveillance and mechanization and accuracy of chemical pesticides are agricultural and livestock mechanisms. The IoT technology is described in the subsequent areas: surveillance, surveillance and tracing, farm equipment, cultivation efficiency, and development of greenhouses.

Monitoring

Several conditions can even be tracked in farming that relies on either the farming sector. The main monitoring variables will be outlined and addressed as described.

Crop Farming

There are also several ecological variables influencing agricultural production in crop farming. The acquisition of such knowledge leads to understanding farm trends and processes. This data covers precipitation, leaf wetness, weather, precipitation, the temperature of the water, salinity, atmosphere, dry circle, sunlight, the passage of the plague, human activity, etc. The purchase of this kind of comprehensive data allows for optimal decision-making to increase the efficiency of agricultural products, reduce risk as well as optimize earnings. The specified by the user for example provides input on plants that are exposed to sunlight, where even the producer could determine whether the fields are sufficiently exposed or overexposed.

The amount of rainfall includes soil water knowledge that can contribute to soil control and reduce the likelihood of weeds. Relative humidity value. In addition, prompt and reliable weather forecasts such as climate change and precipitation will increase the degree of production. Furthermore, these data will aid farmers in project planning and reduce labor costs. Following the given knowledge, farmers should take corrective or preventative steps in advance. The data on pest motion can be gathered and fed to agriculturists live for pest extermination or can also be used for guidance on the records of pests and diseases by producers.

Aquaponics

Aquaponics is the aquaculture and hydroponic hybrid in which sewage sludge is introduced into plant fields to supply the adequate nutrition that plants need. The consistency of water, the level of water, the

weather, the quality of fish, salinity, the pH level, moisture, as well as sunshine, should be tracked continuously in these farms. Precise data will increase the yields of fish and plants because they enable the transfer of nutrients among plants and animals. The data can be used with less human interference for computation[15].

Forestry

Throughout the carbon cycle forests play a prominent part, and harbor more than 2/3 of the world's recognized biodiversity. Forestry considerations are soil, climate, moisture; and the related gas levels, such as carbon monoxide, carbon dioxide, sulfur, toluene, oxygen, hydrogen and isobutene, hydrogen, methane, ammonia, hydrogen supplied, and nitrogen dioxide. These specifications can be used to alarm and notify the forest of velvet burning and to relate to the chemical.

Livestock Farming

The variables to have been evaluated in animals depend on the animal forms being considered. The permeability of milk by buffalos as well as cows, for example, should provide data on animals' health status. Temperature, moisture, production, insect attack, and water quality are other considerations. Farmers can also monitor the position of their animals and scan for these items by labeling each animal with such an RFID system, thereby avoiding animal robbery. Certain fields including water, fuel, and feedstock can sometimes be tracked as well as the data that can be helping employees prepare would save on cost. More information can be obtained from farmers[16], [17].

Tracking and Tracing

IoT may also be used to enhance the supply chain management of businesses for asset monitoring. IoT can provide data that enables farmers to take smart judgments, schedule, and communicate constructively and maybe save time and resources. The RFID and platform Global Positioning System (GPS) will control data such as names, and asset identification [18]. Chain surveillance and monitoring help customers to identify their entire model background, thereby enhancing the customer's interest through regulatory compliance and wellbeing concerns[19][20]. Following up on the support of the commodity to be separated from underwater to ashore as it can monitor, gather, and archive data relating to the distribution chain from upstream to upstream. Monitoring and tracking make many data gathered across the distribution network, ensuring the origin, destination as well as the personal background of the commodity for the customer and certain other stakeholders.

Several considerations, including the increasing climate, manufacturing requirements, pesticide factors, organizational characteristics, handling and storage, distribution, and competitive advantage can be followed. These may also pose a danger to customers directly or potentially healthy. Soil, water, and air are the important factors that influence the growing conditions. The implementation of insecticides, fertilizers, and pesticides is influencing product quality. The category of feed as well as farmed animal antibiotics can also be monitored because then they can cause serious health problems directly. The entire process, which can affect the product's quantity and quality, may generally involve pests in agricultural commodities and may help farmers track the products to improve their production and distribution channel. The basics of the systems for monitoring and tracing must be the input, collection, transmission, and output of the process data.

Data on the entire product life cycle, geographic origin, current location/destination, and stakeholders participating in the supply chain have been used in the feedback information. The devices can also provide memory, which is used for improvement purposes for a specific amount of time. Data transfer refers to the way all data is unified and structured. The monitoring and trace system is supposed to process the gathered data and then provide it to all participating parties in the supply chain. It allows information to be processed, analyzed, and interpreted at high speed throughout a remote location.

Precision Agriculture

Precision agriculture may simply be described as the selection and application of machine learning to increase real information from agricultural variables. Examples of agricultural variables include temperature, air quality and soil, cultivable maturity, and also machinery and labor prices of related goods. Yields, environmental damage minimization, and cost reduction. Precision farming depends on different technologies like GPS and large DA sensor nodes, for increased crop yields. The intelligent decision made by the DA also leads to a reduction in energy, such as drainage, fertilizers, pesticides, etc.For researchers in the field of automation, image recognition, weather sensing, and so forth, Precise farming poses a tough opportunity. The GPS and GNSS allow farmers to identify accurate locations and map sites with many statistical techniques which are then applied to the optimum distribution of agricultural resources, such as seed, spraying, and many other services through variable rate technologies. Even though precise farming technology can increase yields, the availability of technologies that growers can effectively use instead of training to empower medium and small producers to leverage from either of the systems is crucial.

Greenhouse Production

Greenhouse technology is also known as the glasshouse technique and the method of cultivating plants under sterile environments. It provides the advantage of growing every plant in every location, providing adequate climatic conditions at all times. Several experiments on the use of WSNs for environmental monitoring have been carried out in greenhouses. Recent work has shown how IoT can be used to minimize people's time, save electricity, improve hybrid intrusion detection performance, and directly link green producers to clients[21], [22].

Issues in Implementing IoT Sectorial Issue

Vividness of the area: If it is an innovation, commercial or organizational structure, no one agreement can meet or meet all of the specifications. In the EU, for example, comprehensive farmers of Central and Northern Europe have commonly used precision farming proofs in arable farming to take into account the final purpose of building production and quality enhancement. In every other event, the current fiscal strength in Southern Europe in agribusiness, the higher ranch subdivision and dispersion, and the growing lack of water mainly involve the production of water-based precise method techniques to reduce the usage of properties.

Capital business ranch proportions and costs: Greater capital-concentrated homes' response to IoT developments significantly increase and therefore are advantageous to innovation as an essential part of a persistent engagement in existing equipment (e.g., tractors and ranch gear). Emerging shrewd guiding systems for automated cultivation were either intended for large farms. The testing is designed to make IoT offers available for fresh creativity and remarkable sensations of dread of knowledge exploitation to small-scale farmers with constrained risk.

Action plans and business information: adaptive management strategy is necessary with the requisite degree of confidentiality and data tracking that farmer's request, but allows farms and several other agro-food characteristics to change the data they provide. The American Farm Bureau Federation waged a fight for farmers in the United States, to have access to and control of the records. Customer and social recognition: Training and angle preparation are necessary to allow customers to understand the utilization and suitability of these new developments.

LITERATURE REVIEW

Many businesses and markets around the world have embraced IoT-based applications. Agriculture is one of these sectors, and IoT innovations profit in several respects. On the other hand, cloud computing and wireless communications incorporate strategies to provide a service to facilitate agricultural knowledge management using Big Data analytics.

In various contexts, IoT-based innovations were successfully implemented. As a consequence, many businesses invest in the production of IoT-based agriculture applications. Today, many software products are available on the market that helps various agricultural processes.

A couple of possibilities for IoT applications in agriculture are available. Instances include crop and poultry, equipment, water and irrigation surveillance and water quality, weather forecasting, soil protection, disease, and insect prevention, technology, and accuracy. The introduction of IoT is addressed in the following areas: control, mapping, farming, and greenhouse development. The applications of IoT are debated based on the given functionalities like tracking and tracing, greenhouse production, monitoring, agriculture machinery, and precision agriculture.

Fang et al. released a new IoT-based Regional Ecological Surveillance and Administration Interconnected Information System (IIS) to enhance the performance of dynamic work[11]. The innovative IIS incorporates IoT, Cloud Computing, and Geoinformatics, and are among the most acute world problems, including a case study on international climate change and its environmental responses. The findings have demonstrated great benefits from such an IIS, not only in IoT-enabled data sets but also in the use of cloud storage and e-science systems to provide online resources and applications. Monitoring and decision-making efficiency have been enhanced.

This study by Dlodlo *et al*. identifies the potential uses for rural development growth of the Internet of Things in agriculture[23]. This text discusses various market possibilities relating to agriculture and its advantages across the Internet of Things. This research aims to stimulate IoT adoption strategy in agricultural production. Developers may use IoT technology to create agricultural domain-based, countries-specific technologies, according to the literature. Technological development would raise people's standards and promote sustainable development.

Many problems in the field of agriculture have been discussed in the study by Mohanraj *et al*.[24]. There was also an infrastructure planned to overcome these problems. According to another document, farmers during the various stages of crop growth should be directed at the right moment. An information base is built in this study. There is different crop information on this awareness basis. This crop information

addresses the accumulation of expertise, business responsibility, geospatial data flow as well as weather forecast data. The interest in the program refers to the monitoring of different phases of plant production, catastrophe surveillance, irrigation preparation, estimation of crop benefit, etc.

The paper by Zhao et al. proposes a 'Greenhouse surveillance scheme' combined with Wireless as well as Digital communications[22]. The greenhouse surveillance system, built with IoT, has definite control and track accuracy, is very simple to run and its guide is user-friendly, actually providing surveillance of the greenhouse's meteorological condition. This system has features such as high reliability, and reliability of running and can be considered successful.

Li et al. implemented a distributed infrastructure IoT-based agriculture information systems[25]. The entire farm development cycle was monitored and traced with dispersed IoT servers in this analysis. In addition, a knowledge discovery method was developed in which food production information was implemented, captured, standardized, managed, located, and transacted by the industry.

To notify final consumers of the sources and properties of the commodity, Pang *et al*. suggested a Collaborative Architecture Process for Valued Business-Technology [10]. It is a joint concept system for value-centered business technology. It defines and assesses the income-centered value added including the shelf-life projection, revenue premium, precision agriculture, and reduced costs. The appropriate sensor portfolios would then be created and introduced.

For agricultural preparation in olive groves, Fourati *et al*. suggested a web-based decision-making framework interacting with WSN[26]. To monitor moisture, solar radiation, temperature, and rain, the authors used sensors. Conducting an internet decision-making framework to connect in the sense of developed countries with either the wireless sensor network on agricultural preparation. The system further supports the farmer to use maps of the Geographic Information System to restructure agricultural lands and offers the information required in terms of soil and environment measures relating to mathematical approaches and algorithms such as the Penman-Monteith method used by the Food and Agriculture Organization.

The control system was tested by Hashim et al. using an electronic temperatures and soil humidity interface, which was used for flexibility and accessibility on an Android-based smartphone device[9].They originate benefits through lower costsas well as flexibilities for a farming regulator with contrasts along with affluent components for example high-ended personal usage computer systems.

Li et al. (2012) suggested a farm-centered, greenhouse management system based upon IoTs, which combines the Internet, a wireless network, and a broadband connection to provide remote, real-time verification of greenhouse information resources[27].

A modern convenient online IoT management system based on cloud storage is suggested by Kehua Xian[28]. The simulation of necessary technical needs was displayed to facilitate the implementation of a major data gathering in agriculture following the accumulation of sufficient data from an agriculture IoTs method. However, there have been few studies that use data gathering to extract meaningful information and expertise, so the present study will mine IoT data.

A lengthy tracking system for water levels for pools of water with the WSN based on LoRa transmissions was developed by Lukas et al. which helps the cattleman in the case of the barn 1 or 3 kilometers to examine drinkable water for livestock[29].

Wong and Kerkez introduced a web application and a normally distributed architecture that comprises an adaptive controller which, based on some previously specified policies, updates the parameters of any sensing node within a WSN[30].

Sarangi et al. have suggested a Wisekar-based network of farming to help continue providing integrated valuation solutions integrating compatibility with an agriculture call center with an IoTs web repository[31].

Community agriculture

In farming contexts, IoT-based devices are cameras and communications connectivity, used to create communication channels and analyze them. On the other hand, perhaps one of the most excellent tools listed in the work includes a framework supporting removable energy programs, commodity and sustainable technology systems, precise farming decision support systems, and wireless sensor networks' great contribution to hierarchical farming technologies.

The sharing of ideas should be facilitated by IT workers and agricultural scientists. In specific, they acknowledge cultivating IT and can encourage agricultural modernizations. Agriculture modernization would increase agricultural productivity and management, and the objective of protecting the atmosphere and saving resources will be accomplished. With their IoT in agriculture, farmers may address the changing option of the countryside and know which grains in today's stage are suited for farming, via knowledgeable research and improved performance, certain environmental knowledge of

farming. Any use of IoT in farming will lead to many benefits. However, these were some of the advantages[32].

IoT might contribute to promoting the agricultural culture, particularly in rural areas. The IoT can be used to encourage programs that enable the community to exchange knowledge and data and to promote interactions amongst agriculture and allied experts. Free or paying resources can also be shared within society through the use of smartphone applications and IoT devices.

Safety control and fraud prevention

Not only is there adequate production, but also for the capacity to guarantee healthy and nutritious agricultural production in the agricultural sector is the problem. Several studies have been released on food theft including corruption, counterfeiting, and artificial improvement. This scam presents a medical condition that will adversely affect the economy. Any of the components of food theft are quality completeness, process honesty, the integrity of individuals, and data integrity. IoT could also be used for transparency of transportation as well as quality food standardization.

Strategic advantages

The rise in agricultural productivity and advanced technology usage is projected to make farming very comparative. The use of IoT would also lead to a new path in the fields of trade, tracking, and selling through data-based agriculture. Capsulation through the use of agricultural inputs including pesticides and fertilizers can improve production by cutting costs and cutting waste. Real-time use of decisions gives producers who follow the IoT ecosystem a comparative edge.

Wealth Creating and Distribution

The implementation of IoT would also provide alternative market structures whereby single farmers will escape "middleman" coercion and can be in direct contact with higher-profit customers.

Avoidance of costs and waste

The capability to remotely track machines and devices has become one of the perceived benefits of IoT. In comparison to the people actively examining the field and through the use of cars or walks, IoT use in agriculture can help save time and money in inspecting big fields. Cost and waste are reduced by being capable of knowing when to administer IoT pesticides as well as insecticides.

Operational efficiency

Productivity and efficiency are nevertheless related to farmers, but also to agricultural policymakers, including national and local governments. Data collected from IoT from agricultural monitoring schemes can be used as a guideline for agricultural activities. These strategies could include avoiding disease transmission, veld natural calamities, reimbursement programs, and allocating money. The ability to log the state of health of cattle or farms automatically will enable farmers to diagnose and administer medicinally quickly and easily, either veterinary or agricultural. The use of IoT can only be used to improve the production chain. The use of IoT in the supply chain helps to balance demand with supply in actual environments.

Sensitivity

IoT is supposed to push low-cost implementations and access to markets for wireless communication services. To this end, you can navigate market statistics, costs, and services through mobile apps. Government facilities and regulatory requirements for various agricultural goods can also be made available quickly. Customers invested in organic food and seasonal goods will quickly find producers or be informed of the availability of fresh items.

The use of the equipment and technological tools and vast volumes of data is used in urban or agricultural population farming. Transportation and empirical regulatory compliance of food manufacturing, which enables cost savings and supply waste to be reduced by using real-time strategic planning data. Crop surveillance, which enables cost reduction and equipment robbery. Irrigation management systems work by sensors to the range of parameters, precipitation, and moisture levels. Automated selection of meteorological variables for any further information assessment via sensing devices.

CONCLUSION

In the next few years the region, agriculture will play an important role. Smart farming is also required. The Internet of Things would continue to improve intelligent agriculture. IoT operates in various agricultural fields to boost time productivity, irrigation, crop inspection, land management, insecticide control as well as pesticide control, and so on. In addition, intelligent farming will lead to increasing the farmer's market with a simple touch and with limited effort. To effectively perform remote plant surveillance, IoT technologies enable information on habitat, humidity, temperature, and soil fertility. Now farmers will still and from any position know the state of their crop.

In the farming climate, IoT applications are now an important factor in solving numerous issues. That is why we carried out an overview of the literature aimed at defining the key Iot systems for farming, IoT-

based technology, and agricultural equipment and the advantages that such technologies have. While the topics covered in this work are of major importance to all farmers, it is important to note the need to analyze more studies on the management of environmental challenges to implement quality food production. Using IoT for agricultural purposes, farmers would be able, by intelligent analysis and best management, to understand the current choice of soil for agriculture and to understand which crops are suitable to farm at the present stage. Agriculture Communication system is an advantage for specialists to pose health technological advancement in intensive farming through the continuous and rapid development of microelectronic technology. The use of IoT plays a very important role as a base for economic development and advancement of sustainable and intelligent farming throughout the region.

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CONFLICT OF INTEREST
The authors have no conflict of interest

AUTHOR CONTRIBUTIONS
Dr. Sonia Goel conducted the research, analyzed the data, proposed the methodology, and wrote the initial draft; Dr. Meenakshi Devi modified and supervised the initial draft; Dr. A.K. Yadav has supervised the reasech and written the final version of the manuscript. All authors had approved the final version.

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