A COMPARATIVE STUDY ON THE APPLICATION OF INTERNET OF THINGS IN SMART FARMING FOR MONITORING THE FARMING

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Abstract . The Internet of Things (IoT) is a game-changing piece of technology that promises to have far-reaching repercussions for a variety of business sectors. The fact that it is able to bestow intelligence on commonplace items has important ramifications for both the present and the future of the industries in question. The network is made up of a number of different devices, each of which has the capability to set itself up automatically. Conventional agricultural practises are undergoing a sea change as a result of the IoTs technology that is being used in the area of smart farming. This is accomplished through increasing the profitability of farming operations, decreasing the amount of crop loss, and maximising the output of all agricultural activities. The purpose of this project is to come up with a technology solution that will allow for the transmission of messages to farmers through a variety of different communication channels. The purpose of the suggested solution is to provide farmers with data from their farms that is updated in real time in order to help them improve their agricultural practises. The information gathered consists of things like temperature, humidity, the UV index, and infrared. The technology is intended to provide farmers with the ability to make choices based on accurate information and carry out the steps required to engage in intelligent farming. It is hoped that this would result in increased agricultural yields as well as the preservation of available resources.

There are several difficulties that are linked with farmers using IoT-based agriculture in their operations. It is essential that engineers come up with answers to the particular problems that are related by utilizing smart farming practises. The automation of agricultural engineering procedures is facilitated by the use of non-traditional mechanisation technologies, which are part of the application of smart farming practises. One of the primary responsibilities of an en-

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gineer is the development and use of fresh strategies and cutting-edge technology with the goal of improving the accuracy of agricultural equipment. This work may be done either alone or in collaboration with other engineers. In order to generate ideas and knowledge that are founded on synergy, the current research pulls on a wide variety of technical domains, such as mechatronics, instrumentation, control systems, agricultural mechanisation, as well as experience in artificial and computational intelligence. The area of precision agriculture has been profoundly influenced by the incorporation of big data, satellite images, and aerial photography. These cutting-edge technologies have given farmers the capacity to maximise their production efficiency while simultaneously maintaining a healthy balance between their productivity and their impact on the environment. Combining one's technical expertise with a solid understanding of business practises is required to be successful in the field of engineering, which serves as a system integrator in both the public and private sectors.

Keywords: Internet of things, Smart Farming, Crop management, Discriminant analysis

1 INTRODUCTION

- In the future, it is projected that the IoTs will serve as the primary foundation upon which intelligent computing will be built. The transition from "Traditional Technology" to "Next Generation Everywhere Computing" is an important endeavour that must be undertaken by both private homes and commercial establishments. The idea of an "IoTs" has recently emerged as one of the most significant topics of conversation in research groups all around the globe, with a special emphasis placed on cutting-edge wireless communication technology. The IoTs is presently having a significant influence on people in a broad variety of settings all around the world. IoT is providing the groundwork, from the perspective of the average user, for the creation of a wide variety of goods, such as intelligent automation, intelligent living solutions, and intelligent healthcare services. In addition, it is often used for business reasons across a wide variety of industries, including manufacturing, transportation, agriculture, and corporate management, to name a few.
- The IoTs has received the greatest attention and study in the realm of agriculture more than any other industry. The capacity of this business to provide food security is one of its most important aspects. This ability is becoming more important as the population of the world keeps growing at an alarming rate. Researchers in this discipline first used methods that were based on Information and Communication Technology (ICT). Despite the fact that these strategies offered certain advantages, they were not a long-term answer to the problem that we were facing. The researchers are now investigating the possibilities of IoT in the agriculture area as a feasible alternative to ICT [1]. There are many different applications that are re-

quired for agricultural goods, such as managing supply chains, maintaining infrastructure, and monitoring soil moisture, temperature, and moisture levels in the surrounding environment. The use of IoTs technology within the agricultural realm has resulted in the birth of a fresh agricultural management paradigm referred to as "smart farming." This strategy seeks to maximise the amount of produce that can be harvested from agricultural land by using a wide range of technological instruments. In order for farmers to enhance both the quality and quantity of the agricultural products they yield, "smart farming" practises must be put into practise. These practises require farmers to make use of many resources, including fertilisers. It has been noticed that agricultural labourers are not able to sustain a continuous presence in the field. In addition, it is conceivable that farmers do not possess the necessary expertise to assess the ideal environmental conditions for their crops via the use of a variety of technical instruments, and this is a possibility that should be taken into consideration. The farmers are given access to an IoT-based automated system that may function on its own and alert them to any possible issues that may arise in connection with farming. Because the technology is able to warn farmers even when they are not physically present in the field, it enables farmers to more effectively manage many farms and increase the agricultural production that they produce.

- By the year 2050, the world populace is anticipated to have reached a total of 9 billion people, according to predictions. For maximizing the available resource usage and keep up with the requirements of a fast-expanding population, it is essential for the agricultural industry to make use of applications of the IoT. The effects of global warming on farmers have resulted in significant losses owing to the increased frequency and severity of harsh weather conditions [2]. However, the deployment of the IoTs smart farming application provides a method to offset these losses by allowing farmers to rapidly adapt to changing weather conditions. This enables the farmers to save more money. Researchers have provided an in-depth analysis of the relevance of "smart farming" as well as the possible future uses of the IoTs.

2 LITERATURE REVIEW

- The IoTs makes use of mobile devices such as smartphones to obtain data wirelessly from other mobile devices and to monitor the activity of living organisms such as plants and animals. Farmers are able to estimate output levels and evaluate weather conditions because to the widespread use of sensors and gadgets in their operations. In the realms of water harvesting, flow monitoring and management, crop water needs assessment, supply scheduling, and water conservation, the IoTs is finding a growing amount of use. Through the usage of sensors and cloud connection that is provided by a gateway, remote monitoring of the water supply and status can be carried out. This monitoring is performed in accordance with the particular demands that are placed on the soil and plants. It is not possible for farmers to do manual monitoring of each plant in order to treat nutrient deficits, eliminate pests, or prevent illnesses [3]. In spite of this, the IoT utilization proved to be helpful, and it has provided farmers with the opportunity to attain a new level of success in contemporary agriculture.

- The expansion of IoTs technology in recent years has brought about substantial advantages for the agricultural business, especially in respect to its connection infrastructure. The incorporation of smart devices, remote data collecting, the utilisation of sensors and vehicles via mobile usage and the internet, cloud-assisted intellectual analysis and decision-making, and the automation of farming activities have all been vital components of this phenomena. The agricultural industry has undergone a sea shift due to the skills that have been developed in areas such as resource optimisation, climate change effect mitigation, and crop yield improvement [4].
- For the purpose of collecting and sending agricultural data throughout different development phases, researchers have suggested several methods, strategies, and instruments. These approaches, techniques, and tools vary according to the kind of crop and area. For the purpose of data collection and dissemination, a number of different firms provide communication tools, sensors, robots, huge machinery, and drones. Food and agricultural agencies, in addition to other governmental organisations, are working together to set standards and procedures for the use of technology in the preservation of the quality of food and the environment [5,6].
- Several methods, including photoelectricity, electromagnetics, conductivity, and ultrasound, are used in the process of analysing the texture and structure of the soil, as well as its nutrient content, vegetation, humidity, vapour, air, and temperature, as well as other elements linked to this topic. According to the findings of earlier studies [7], data collected by remote sensing may be employed to recognise a variety of crop varieties, categorise different kinds of pests and weeds, ascertain levels of stress in soil and plant conditions, and monitor levels of dryness.
- The general health of a plant may be affected by a number of elements, including the amount of moisture in the soil, the availability of nutrients, the intensity of the light, the humidity, the amount of precipitation that falls, and the coloration of the leaves. The plants are being watched while the temperature and light conditions are kept at their ideal levels, and just a little amount of micro irrigation is being applied. A wide variety of sensors are employed in order to detect a myriad of properties. According to the conclusions of the investigation, it has been noticed that the sensor is able to detect changes that are greater than a predefined threshold. This is something that has been seen. When the predetermined limit is breached, the sensor starts communicating the changes it has noticed with the microcontroller. The microcontroller will subsequently conduct the necessary actions in accordance with the predetermined protocol until the parameter reaches the level that is considered to be ideal [8].
- A wide sensor varieties, such as those for temperature, humidity, soil patterns, airflow, location, CO_2, pressure, light, and wetness, are routinely used into sensing systems. According to findings from earlier studies, the appropriateness of sensors for use in agricultural settings is reliable on a number of important features, includ-

ing but not restricted to dependability, storage capacity, mobility, robustness, breadth, and computational effectiveness [9]. The usage of wireless sensors has developed into an essential component in the gathering of data pertaining to crops and the presentation of supplementary information. The integration of different kinds of sensors with more complex agricultural gear and equipment may be adapted to meet the particular demands of a given application in a manner that is completely customizable [10].

- The exploitation of satellite images has the ability to unearth differences in crop yield and soil quality that are influenced by the topographical elements that are located in the surrounding area. In order to obtain precise management of the production ingredients that boost productivity and effectiveness, such as seeds, fertilisers, and pesticides, this goal must first be accomplished.
- One of the oldest methods used in this area, the practise of producing crops in a controlled environment, also known as smart farming, gained popularity throughout the 1800s as one of the approaches available in this area. According to the information shown in reference 118, some practises were seen to become more prevalent in nations that had more severe weather conditions during the course of the 20th century. When crops are grown inside, their vulnerability to the effects of the surrounding environment is significantly decreased [11]. The growing of crops, which was formerly confined to locations with optimum circumstances, has become possible at any time and any location thanks to the sensors and communication technology utilization. The crop production in controlled settings is based on a variety of elements including the design of sheds and materials used to limit wind impacts, aeration systems, reliable monitoring data, decision-support systems, and other variables connected to agricultural production. In greenhouse settings, accurate monitoring of the environment's many different factors is a substantial problem. As a consequence of this, a number of different measurement points are needed in order to make accurate predictions about the numerous factors required for the regulation and maintenance of the ambient temperature [12]. The IoTs greenhouse makes use of sensors to monitor and measure inside characteristics like as temperature, light pressure, and humidity.
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3 RESEARCH HYPOTHESIS

There is no significant difference between application of IoT in smart farming and Better crop management

There is no significant difference between application of IoT in smart farming and Site specific nutrition management

There is no significant difference between application of IoT in smart farming and Support in achieving strategic goals

4 ANALYSIS AND DISCUSSION

This part of the study is involved in performing detailed data analysis based on the data collected by the researches, IBM SPSS package is used to make the analysis.

Table 1. Frequency analysis(Prepared by the authors)

Gender Composition	Frequency	Percent
Male	77	60.2
Female	51	39.8
Age Classification	Frequency	Percent
Less than 30 years	37	28.9
31 - 40 years	45	35.2
41 - 50 years	15	11.7
Above 50 years	31	24.2
Place of residence	Frequency	Percent
Semi Urban	84	65.6
Rural	44	34.4
No. of dependents	Frequency	Percent
1 - 2	79	61.7
3 and Above	49	38.3
Current role	Frequency	Percent
Farmer	65	50.8
Working in agricultural company	45	35.2
Land owner	18	14.1
Work experience	Frequency	Percent
Less than 4 years	35	27.3
4 - 8 years	30	23.4
8 - 12 years	22	17.2
12 - 16 years	9	7
Above 16 years	32	25

From the above table it is noted that 60.2 % of the respondents were male, 35.2% were in the age group between 31 - 40 years, 65.6% were living in semi urban area, 61.7% have 1 – 2 dependents to take care of, 50.8% were farmers and 27.3% possess experience of less than 4 years.

Discriminant analysis

. This part of the analysis explores in understanding the significant differences between the independent and dependent variables, for this purpose discriminant analysis is used. The main goal of using discriminant analysis is to classify the various mutually exclusive data groups into one based on the predictor value.

Table 2. Group Statistics (Prepared by the authors)

IoT in sustainable farming	Dependent variables	Mean	Std. Deviation
Strongly Disagree	Better crop management	2.00	0.00
	Site specific nutriton management	2.00	0.00
	Support in achieving strategic goals	1.00	0.00
Disagree	Better crop management	1.75	0.45
	Site specific nutriton management	1.50	0.52
	Support in achieving strategic goals	1.75	0.45
Neutral	Better crop management	3.00	0.00
	Site specific nutriton management	3.19	0.40
	Support in achieving strategic goals	3.19	0.40
Agree	Better crop management	4.74	0.44
	Site specific nutriton management	4.91	0.28
	Support in achieving strategic goals	4.49	0.66
Strongly Agree	Better crop management	4.77	0.42
	Site specific nutriton management	4.89	0.32
	Support in achieving strategic goals	4.56	0.50
Total	Better crop management	4.20	1.12
	Site specific nutriton management	4.30	1.19
	Support in achieving strategic goals	4.02	1.13

From the able above it is noted that the mean value of all the independent variables for agree and strongly agree are more than 4 also their corresponding standard deviation is less, this shows that most of the respondents have agreeing to the statement that the application of IoT enable in better crop management, site specific nutrition management of crops and support in achieving the strategic development goals (SDG)

Table 3. Test of Wilks Lamba (Prepared by the authors)

Tests of Equality of Group Means	Wilks' Lambda	F	df1	df2	Sig.
Better crop management	0.12	218.24	4.00	123.00	0.00
Site specific nutriton management	0.08	351.15	4.00	123.00	0.00
Support in achieving strategic goals	0.22	111.98	4.00	123.00	0.00

Based on the evaluation, it is noted that the significance value of Wlks Lambda is 0.00, this shows that the independent variables possess significant difference towards the dependent variable.

Table 4. Classification Function Coefficients (Prepared by the authors)

Classification Function Coefficients					
IoT in sustainable farming	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Better crop management	13.02	10.85	18.79	29.92	30.07
Site specific nutriton management	17.64	12.72	27.04	42.00	41.73
Support in achieving strategic goals	1.41	4.56	8.11	10.89	11.18
(Constant)	-32.97	-24.63	-85.81	-200.20	-200.87

The analysis shows that the classification functions are high for responses agree and strongly agree for all the independent variables considered in the study.

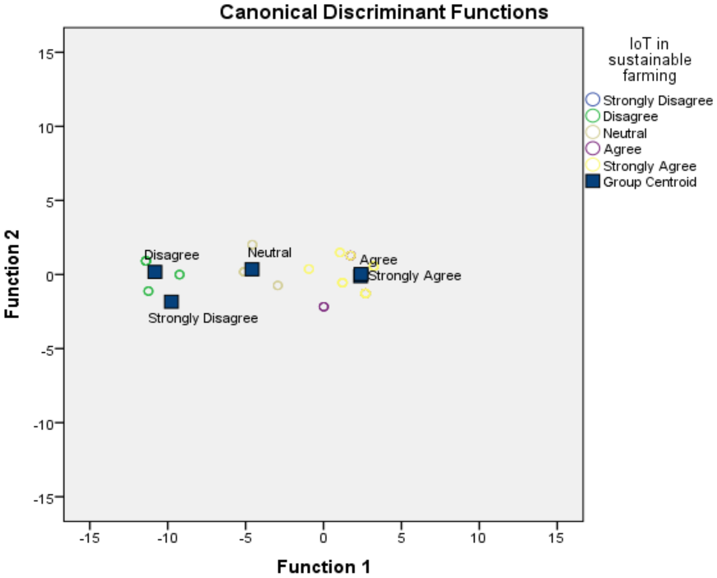

Fig. 1. Canonical Discriminant Grouping

From the above figure, it is noted that the model has created a grouping commonly for the responses agree and strongly agree as they tend to provide the similar responses towards the application of IoT in smart farming.

Table 5. Classification analysis (Prepared by the authors)

IoT in sustainable farming	Predicted Group Membership					
Original	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Strongly Disagree	3	0	0	0	0	3
Disagree	3	9	0	0	0	12
Neutral	0	0	16	0	0	16
Agree	0	0	0	24	11	35
Strongly Agree	0	0	0	30	32	62
a 65.6% of original grouped cases correctly classified.						

The analysis shows the comparison between the original values and the predicted values based on the model, it is noted that nearly 65.6% of the original cases are correctly predicted and classified and hence the model is stated to be a good fit.

5 CONCLUSION

In order to meet the issue of feeding a growing global populace on a shrinking amount of arable land, there is an urgent need for agricultural production systems that are both technologically sophisticated and highly efficient. It is of the utmost importance that people be aware of the significance of sustainable agriculture in ensuring that there will always be food available. This research aims to evaluate the elements that impact the view of farming as a respectable career choice among young people who are inventive and to investigate the potential of new technologies to improve agricultural output. Additionally, the study will investigate the factors that influence the perception of farming as a career choice among older generations. The focus of the current research is on the investigation of various agricultural technologies, with a specific concentration on the IoTs, as a method of boosting agricultural productivity and intelligence in order to satisfy future needs. Academics and engineers might profit from the highlighting of the identification of probable future prospects and industrial constraints. Increasing agricultural productivity requires careful management of every square inch of field utilising environmentally friendly sensors and communication technologies that are based on the IoTs.

The concepts of data analytics and machine learning are put to use in order to perform analyses on real-time data. The implementation of methods that are related to machine learning may be used to perform one of the most important aspects of crop production, which is the identification of genes that provide the best results. The implementation of machine learning in agriculture entails the prediction of genes that are most suited for agricultural output. This may be accomplished via the use of computer programmes. This is especially important to keep in mind while picking seed kinds that are well suited to the unique environmental conditions of a given location. The use of algorithms for machine learning has the ability to recognise things that are in great demand as well as those that are presently out of supply. Recent developments in machine learning and analytics have made it possible for farmers to properly classify their crops before processing them and distributing them to customers.

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