

TRANSFORMING THE GROWTH RATE USING IOT FOR AGRICULTURE

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Abstract- Agriculture satisfies the food demand of every living being in the world. The world's growing population will increase the food demand. The farmers could not achieve high yield due to growing population, shrinking natural resources, vast climate change and lack of technological adaptation. Adaption of IoT in agriculture performs the tremendous changes in traditional agriculture. Precision Agriculture helps the farmers to predict the exact amount of water, fertilizer and pesticides that are directly related to the growth of the crops. It also helps to predict the climate variation, soil nutrition, plant growth and plant disease for enhancing the yield rate and profit. The use of IoT and its enabling technologies helps to optimize the declining agricultural resources for obtaining high yield. Precision Agriculture uses Temperature, Humidity, Pressure, Soil Moisture, Light intensity, leaf wetness, and solar radiationsensors for gathering parameters directly from the farm land. These parameters are sent to the cloud database through local gateway for further processing. The collected data are analyzed in the cloud database for taking predictive decision. The acquisition of these environmental data enables the farmers to take accurate decision, improve quality with minimum environmental pollution. Precision Agriculture insists the farmers to react quickly for optimizing the scared natural resources, monitoring their plant growth, quality, and diseases for achieving high yield and profit

Keywords: CloudComputing, DataAnalysis, IoT,

I. INTRODUCTION

India is one of the largest agricultural countries in the world. India is the largest supplier of various grains, pulses, and spices in the world. More than 60 percent of Indian population is belonging to Agriculture for their livelihood. Agriculture pays a major contribution to GDP growth rate. Indian Agriculture faces several challenges in the past decades due to urbanization, poor income, unpredictable climate changes, diminishing natural resources and arable land. The farmers are not aware of using the scared resources such as water, fertilizer, and pesticides in an appropriate manner. They could not predict the climate change in advance. The farmers are not

capable to produce high yield for meeting the global food demand. Agriculture sector is not modernized after green revolution.

Indian agriculture requires a sustainable modern approach to meet the gap in food supply and demand. Adoption of ICT technology in agriculture

transforms the economy of our farmers as well as our country. Internet consists of wide range of networks that are interconnected with each other for massive information sharing. The scope of the internet is being expanded beyond the computing devices. It is used to connect physical objects in and around us. IoT helps to connect computing devices, machines, sensors, objects through internet by wireless technologies. The applications are being developed by combining various technologies embedded systems, cloud computing, big data, machine learning and networking. IoT is an interaction between the physical and digital world using sensors and actuators with unique identifiers. It enables objects to collect and exchange data. It is needed to interact, contribute, and collaborate to things. IoT can be used in various sectors. IoT applications are integrated applications. The major applications are

- Smart Parking
- Trafficcongestion
- SmartGrid
- Smart Agriculture
- Earthquakedetection
- Healthcare
- HomeAutomation
- Smartcities
- Industrialcontrol
- Intelligent shopping
- Explosivegas leakagedetection

Internet of Things (IoT) is an emerging technology that transforms traditional agriculture to meet global food demand. The statistics from the existing literature clearly showed that IoT devices in agriculture will reach more than 75 million by 2020. IoT integrates the physical world with the virtual world by using the internet. IoT has a broad range of interactions. IoT interacts between devices, things, and people. IoT helps to automate various activities by analyzing the rich set of data. This paper presents an overview of IoT with its various enabling technologies and their impact in the agriculture sector. Agriculture using IoT authorizes the farmers to make accurate decisions in time. It also

guarantees high yield, profitability, and quality with fewer natural resources. Precision Agriculture uses several sensors, Wireless Sensor Networks (WSNs), communication technologies, middleware technologies, satellite, cloud computing and Big Data Analytics to monitor and control the variations of agriculture activities. IoT helps the farmers to apply required levels of water, pesticides, and fertilizers to their agricultural land by mainly concentrating on conservation of limited natural resources. It also helps to identify the variability in farm land, the growth rate of plants. It helps the farmers to apply different levels of inputs for every plant. IoT uses Machine Learning algorithms for taking efficient predictive decisions. This paper concludes the importance of adoption of IoT in traditional agriculture and its immediate requirement.

II. LITERATURE SURVEY

Sjaak wolfert et al 2017[1] emphasizes the adoption of IoT in their review article Big Data in Smart Farming. It ensures that Precision Agriculture with Big Data technology will increase production massively. It also elaborates various processes involved in precision farming which transforms traditional agriculture. It helps the farmers to improve their yields with minimum expenditure for meeting the global food demand. It influences the entire food supply chain. It uses IoT for monitoring the data directly from the farm. Huge volume of data collected through several sensors for every second. IoT devices contribute to the generation of Big Data. These data need to be stored for further analytics. The collected data are sent to the cloud database through a gateway for analytical processing. This Big Data is stored in the cloud. These data can be accessed for data analytics. This review article elaborates the state - of - the - art of IoT and Big Data in Precision Agriculture. This article concludes that the adoption of IoT and Big Data in farming is still in the development stage. Most of the foreign countries implemented Precision Agriculture for their massive yield.

Antonis Tzounis et al 2017[2] has clearly mentioned the need for adopting IoT technology advancement in the agricultural sector in their review article Internet of Things in Agriculture recent advances and Future challenges. Adoption of IoT will guarantee massive yield in agriculture. Precision Agriculture uses IoT technology, sensors for generating huge volumes of data directly from the farm land. The collected data are sent to the cloud database for data analytics purposes. Precision Agriculture is mainly used to automate the processes of agriculture and predict the outcome of yield in the early stage. The predictive decision is sent to the farmers through message alerts. The farmers can monitor and control various activities without visiting their farms in person. The authors emphasized the importance of adoption of the Meta processing model in basic monitoring systems. They summarized various IoT devices, technologies, sensors, Micro controllers used in the market for the past decades. They gave various guidelines for an effective implementation using Edge computing devices

and Micro controllers in an appropriate manner. They urged the need of adopting Edge computing for taking immediate decisions from the farm itself. They elaborated various applications of IoT in agriculture such as controlled environment agriculture, livestock applications, food supply chain tracking etc. The authors discussed several challenges and issues in the implementation of Precision Agriculture in the developing countries. It is a predominant technology that optimizes high yield in agriculture. It achieves high yield in the form of variable rate farming by applying agricultural inputs in a precise manner. It also enhances the conservation of water resources and reduces the impact of environmental pollution

Jira pond Muangprathub et al 2019[3] elaborated the benefits of precision agriculture in their journal paper IoT and agriculture data analysis for Smart Farm. This system was developed to optimize the usage of water in agriculture based on soil moisture level. It was developed with a control system using various sensors, hardware equipment, web application and smart irrigation system. Temperature, Humidity, soil moisture sensors were used to monitor the environment factors in the farm field. The data collected from sensors are transferred to web applications for further data processing. Web application collects the data and manipulates the data using several data mining algorithms for taking predictive decisions. Water irrigation system is activated through a smart phone based on predictive data analysis.

This system was implemented with DHT22 sensor, soil moisture sensor, ultrasonic sensor, solenoid valve and Node MCU. These environment data are analyzed by web applications for accurately predicting the growth of plants, water level etc. Automatic water irrigation systems were activated through smart phones. Graphical representation of environmental factors was sent as notification to the farmers along with a message alert. The farmers can take the decision and control their farms through their mobile phones. They can opt for either manual or automated irrigation systems according to their requirements. The authors concluded that Precision Agriculture is used to improve crop yields, improve quality with minimum expenditure and minimum environment pollution.

Koksal 2018[4] clearly depicted the importance of architecture design of IoT based farm management in their journal Architecture design approach for IoT based Farm Management Information Architecture design approach for IoT based Farm Management Information Systems. Precision Agriculture lays the foundation for the adoption of the Farm Management Information System (FMIS) that supports the automation of data acquisition, processing, monitoring, planning, and decision making. This journal also gave the guidelines to choose the appropriate network layered architecture according to the user requirements. It also defines the step-by-step procedure for designing IoT based FMIS architecture. Precision Agriculture represents the adoption of ICT into agriculture. It uses several sensors, hardware devices, IoT, cloud computing and big data. Precision Agriculture helps the farmers increase their production, optimize the quality

of the crop with minimum resources and with less environmental pollution. The authors concluded that Precision Agriculture is an integrated information and production-based farming system to increase yield for site specific and whole farms with minimum resources and with less environmental pollution.

Chandra shekhara K.T et al 2017[5] presented the importance of adoption of IoT in agriculture in their journal Precision Irrigation using Integrated Intelligent Systems. This journal presented an alternative and efficient way to solve the issues in traditional agriculture. The Precision Agriculture system collects the data from the environment, analyses data and monitors the data in a feedback loop and activates the control unit on a predetermined threshold value. It uses sensor networks such as temperature, Humidity, Ph level, soil moisture and light intensity sensors for collecting environmental data directly from the farm. The collected data are processed, analyzed and the decision is taken based on the threshold value. The actuator irrigates the water based on the predictive decision. This work clearly demonstrates that an automatic irrigation system is more efficient and suitable than a scheduled irrigation system. Precision Agriculture increases production, improves quality, optimizes the chemical usage with less environmental pollution.

Demonstrated the importance of modern technology adoption in farming practice in their review article Precision Farming for small agricultural Farm: Indian Scenario. Precision Subrata K r Mandal et al 2013[6] Agriculture provides an environment by applying IoT technology in agriculture. This article explained the benefits by implementing various processes involved in it. It also gives the guidelines for utilizing the right resource in the right time for massive yield with minimum environment pollution. It gave the step-by-step procedure for applying Precision Farming techniques in agriculture. Precision Agriculture clearly dissects the agriculture into various components. The components, sensors, and IoT devices are interconnected with wireless networks. The components are simply classified into farm components, data processing components and data analytics components.

Precision Agriculture connects farm components with the cloud database using GPS and GIS mechanism. The farm data Temperature, Humidity, Soil moisture, Soil nutrition, and soil related properties are directly collected from the farm and sent to cloud databases via wireless network. The farm data is stored in the cloud database for further processing to be carried out. The data extracted from the cloud for applying some data mining procedures. The predictive analysis is carried out on the cloud data. The predictive decision is taken through efficient algorithms. The decision is sent to the farmers through mobile phones.

The authors concluded that Precision Agriculture is mandatory to optimize the yield with minimum resources and reduced environmental impact. An and Nayyar et al [7] critically analyzed the development of IoT and its adoption in agriculture in their journal article titled "Smart Farming: IoT Based sensors agriculture stick for live temperature and Moisture monitoring using Arduino,

Cloud computing and Solar Technology". This article depicted various benefits of IoT that transformed agriculture. It also listed various projects and applications that are integrated in the agricultural field. It clearly showed the impact of IoT adoption over 20 years by connected devices. Smart agriculture consists of various sensors that are used for collecting various field data. The data were analyzed and intimated to the farmers through their mobile phones. This article strongly recommended that the adoption of smart agriculture will increase yield and quality with minimum environmental pollution.

Muhammad Shoaib Farooq et al [8] critically analyzed the need for adoption of IoT in agriculture in their Systematic Literature Review paper "Role of IoT Technology in Agriculture: A Systematic Literature Review". They classified the agricultural applications into four major categories. They narrated various types of IoT agricultural applications.

The authors clearly explained various activities, devices, protocols involved in the above applications. They also insisted the importance of data visualization in each and every application for taking the right decision at the right time.

This article concluded that adoption of IoT in agriculture will be more useful in Farm management, Predictive decision making and data visualization that are directly related to the yield and quality of the products.

Vippon Preet Kour et al [9] elaborated the developments of the Internet of Things (IoT) in the agriculture sector in their journal article titled "Recent Developments of the Internet of Things in Agriculture: A Survey". This article addressed various limitations of the existing system. It clearly provided the architectural and implementation details of IoT modules, various IoT platforms, analytics software and IoT protocols. The authors suggested that most of the data were self-acquired data using sensors and cameras. They suggested developing a model or prototype to gather generalized parameters irrespective of a particular problem. They also discussed various challenges and issues in IoT implementation. This article concluded that several technological advancements in agriculture will improve both quality and quantity of production.

Partha Pratim Ray et al [10] reviewed various IoT applications, issues, challenges in the adoption of IoT in agriculture in their journal article "Internet of Things for Smart Agriculture: Technologies, practices, issues, and challenges. The authors suggested developing specific devices, communication technologies as per unique requirements. They analyzed various case studies and solutions for the improvement of precision agriculture by recommending various factors for the improvement of the existing system. They gave direction for the development of various IoT agriculture applications. The authors clearly depicted the implementation of precision agriculture using state-of-the art of various enabling technologies. They strongly recommended that the adoption of IoT helps the farmers to control their farms and perform various agriculture activities in an efficient manner. They paved the way to the development of precision agriculture through their future research.

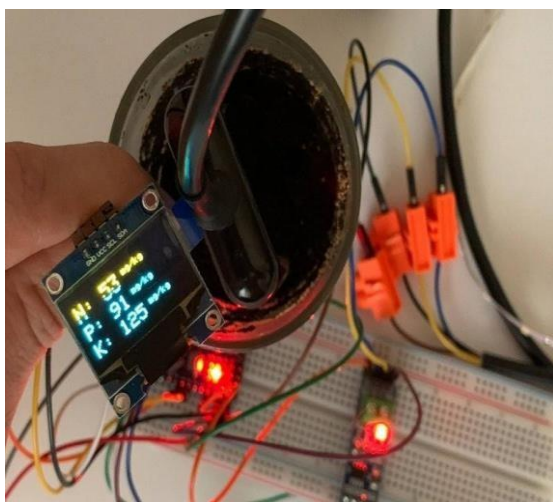
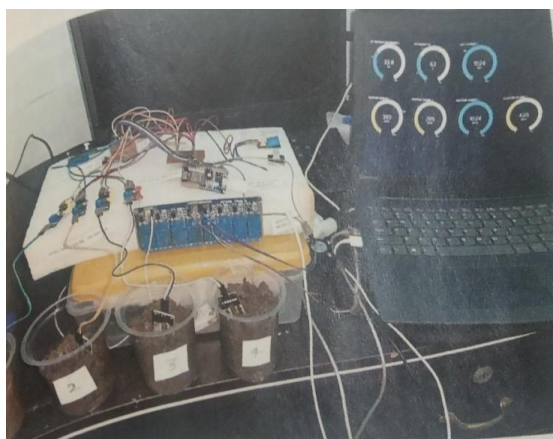


Fig .5 Overview of Implementation

Agriculture data collected from various sensors are sent to Node MCU ESP 8266 for further processing. All sensors, devices, GSM modules and actuators are interconnected with ESP 8266. Data collected from sensors are recorded continuously then the data is sent to a cloud database for making efficient decisions. Smart Agriculture defines Decision Support System by using big data techniques to maximize the agricultural yields by minimizing various valuable resources.

Benefits

Optimized water usage

- Restricts the excessive use of fertilizers and pesticides
- Sustain high yielding
- Improves product quality, nutrients, and taste
- Minimizes the environment pollution

Success parameters

- Effective irrigation
- Improved soil fertility
- Crop protection
- Plant growth
- Plant disease identification

Findings

- Most of the existing studies did not give much focus on soil nutrition and plant growth detection.

- NPK sensors play a vital role in plant growth detection and soil nutrition management
- Soil nutrition helps the farmers to apply the required quantity of fertilizers based on the need of each plant.
- By applying the minimum fertilizers and pesticides, the quality of the product will be increased.
- Accurate details about soil and soil nutrition also optimizes the efficiency in water irrigation.

IV. RESULTS AND DISCUSSION SENSORS

It is used in the prototype model were installed in farms directly. The data is collected periodically from the farm for taking predictive decision. The output of the test result is shown in the below table

Date	Temp(c)	Humidity (%)	Soil Moisture
22-Oct	34	40	22
23-Oct	33	44	19
24-Oct	32	45	21
25-Oct	35	42	21
26-Oct	27	44	23
20-Nov	30	45	24
24-Nov	28	42	20
28-Nov	26	40	24
30-Nov	24	36	20
10-Dec	28	30	24
12-Dec	30	34	24
16-Dec	32	40	20
18-Dec	30	36	22

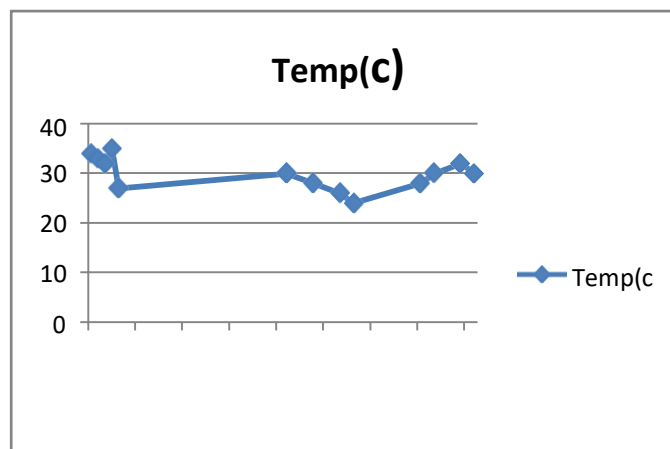


Fig.6 Temperature Sensor output (c)

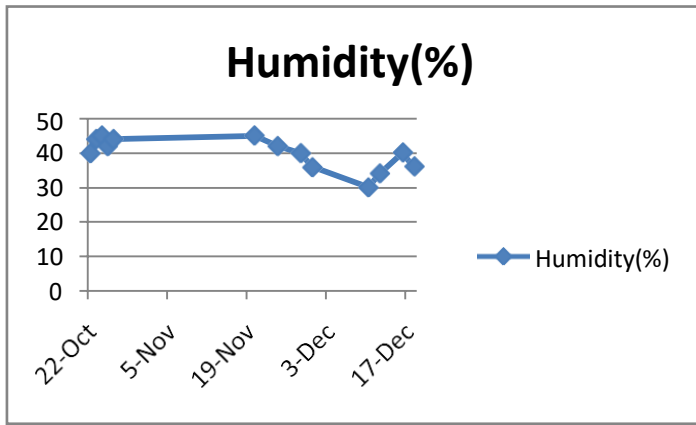


Fig.7 Humidity Sensor output (%)

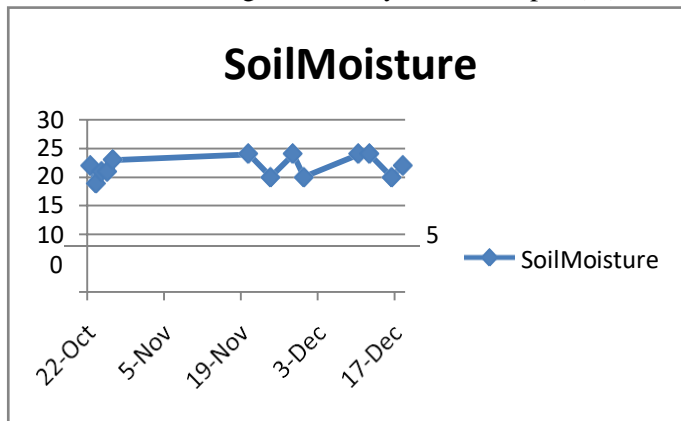


Fig.8 Soil Moisture Sensor output (15 cm (%))

V. CONCLUSION

Adoption of IoT technology in agriculture will transform the traditional agriculture processes. IoT plays a major role in Indian agriculture sector in future. Existing research works focused only on monitoring the farm land and efficient water irrigation activities. This paper gives more focus on plant growth and soil nutrition. The growth of the plant is closely monitored through sensors and IoT technologies. The collected data are processed for further predictive decision using Machine Learning. Precision Agriculture guarantees high yield and quality in agriculture products that helps the farmers for improving their economic status with minimum expenditure. It also assures ecofriendly environment by optimizing the usage of limited natural resources.

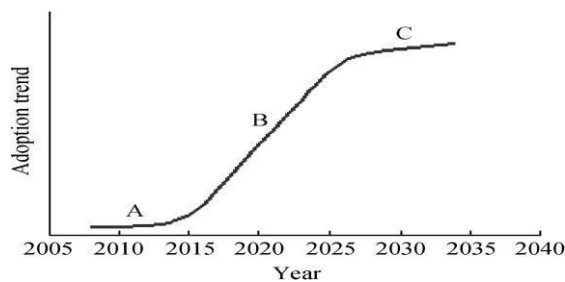


Fig.9 Proposed PA adoption trend in India

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