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ROLE OF TECHNOLOGIES IN AGRICULTURE: A SYSTEMATIC REVIEW

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Abstract: Indian economy much depends on Agriculture Production. Farmer plays an important role in Agriculture. Farmers always give their best in the field but due to some reasons like soil quality degradation, improper watering, drought, climate change, Plant diseases, farmers are facing some problems in farming. To overcome these problems farmer, need to aware and adopt new technologies. Technology is extremely essential because it enables the more effective, faster and somewhat easier methods for managing a work. The main aim of this paper to review advance Technologies which are used to increase agriculture production and can be utilized for the common Indian farmer.

Index Terms **- Sensors, Machine Learning, Soil Nutrients, Arduino, spectrometer, IoT.**

I. INTRODUCTION

Agriculture is main occupation of India. It contributes about sixteen percent (16%) of total GDP and ten percent (10%) of total exports in India. Around 60% of people in India depends on agriculture directly or indirectly for their livelihood. It falls under foremost sector of Indian economy. Agriculture is the main source of food, fodder and fuel. Over 60 % of India's land area is cultivable making it the second largest country in terms of total arable land. But due to improper watering, lack of Soil Nutrients, unaware about weather forecast, inappropriate knowledge, unprofessional implementation of techniques and various crop diseases, the quantity and quality of the agricultural product are reducing day by day.

Village areas have limited resources specially agriculture areas which are mainly depends on Natural water resources and Rain. The per hectare productivity is much lower than world average. There is a need to increase productivity. Achieving this goal will be possible only if we develop and implement advance technologies in farming. Proper knowledge of new techniques and natural resources is one of the most basic pre-requisites to employ effectively and in a sustainable manner. The stream of agricultural engineering is striving to develop technologies for enhancing agriculture productivity.

Green revolution began in India with an objective to give greater emphasis on Agriculture. Significant increase in the production of food crops, the productivity of land will provide huge economic boost to the nation. Thus, proper harvesting and efficient utilization of new technologies in agriculture is of great importance.

II. LITERATURE SURVEY

Agni Biswas and Sarthak Prakash [1] intends to present methods to monitors Soil moisture levels, PH levels, Humidity and temperature of the soil and according to inputs from these variables pipe valve will be turn on & off. The data Indication system consists of Atmega328 attached to Bluetooth module which is used to send signals to android or windows smart phones and timings of irrigation is displayed on android screen when connected through Bluetooth [1].

After studying this paper [1] we think that, rapid technological advances and timely policy interventions have not only helped to stop food crisis in India but also ensured steady increase in food production.

Chetan Dwarkani et al [2] described advanced farming by linking a sensible sensing system and smart irrigation system through wireless communication technology. Their system includes some physical parameters such as soil moisture content, nutrient content, and pH of the soil and based on the detection of essential parameters of the soil, the required quantity of green manure, compost, and water is splashed on the crops using a smart irrigation system [2]. In this paper author describe moisture sensor content based sufficient amount of water was sprinkled by the irrigator system.

Akshay Sankpal and Krishna K. Warhade [3] reviewed sensing technology and other portable various methods like electrochemical, mechanical, optical etc which were useful in the determination of soil nutrients viz. NPK. Mainly optical methods were studied for the determination of soil nutrients with the uses of optical LED's and VIR-NIR methods [3]. In this paper author studied various methods which were used to determine soil nutrients and they found optical method is efficient and of low power consumption.

Tamal Adhikary et al. [4] developed a sensing system using Photo Diode, Light Emitting Diode (LED), microcontroller, analog-to-digital converter (ADC) for detecting soil macronutrients like Phosphorus (P), Ammonium Nitrogen (NH_4-N) and Nitrate Nitrogen (NO_3-N). They have integrated a GPRS modem with sensing unit for remote data collection to a server. Author compares the results by sensors with Chemical laboratory-based test results [4].

D. Rupa et al [5] developed a soil testing system using Embedded System which involves sensing the amount of Nutrients in soil and Sensing environmental Factors then it Calculate the amount of fertilizers required for the particular Crop and if any abnormal condition occurs then a message will be send to the farmer through GSM. The block diagram for Soil Testing using Embedded System is shown in Figure 1 [5].

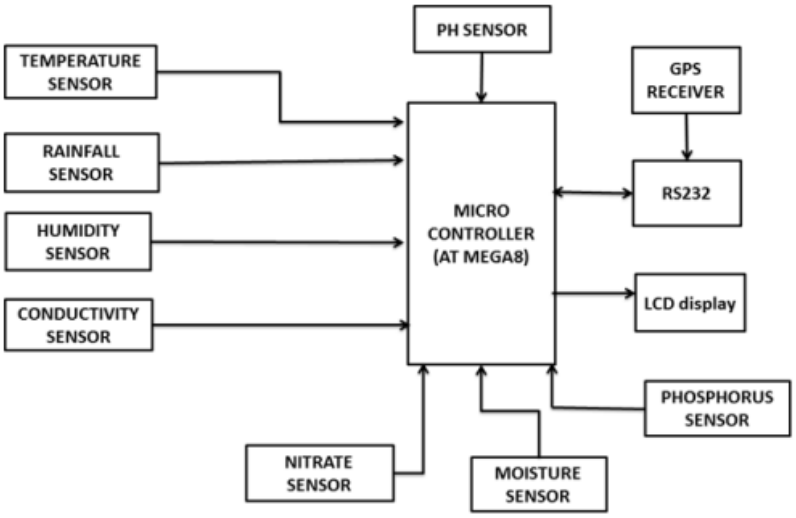

Figure 1: Block Diagram of Soil Testing using Embedded System

Abdullah Na et al. [6] presented a system with MCU (STM32L152RE). MCU initializes the peripherals to be used to control and manage the various sensing values and communication blocks of the devices. Node MCU takes samples from sensors one by one and also checks if the device is connected or not. If it is, it transfers data to mobile, otherwise takes another sample. The system was incorporated with Bluetooth for the transfer of data to a nearby cell phone. The flowchart of Firmware showing its working is given in Figure 2. [6].

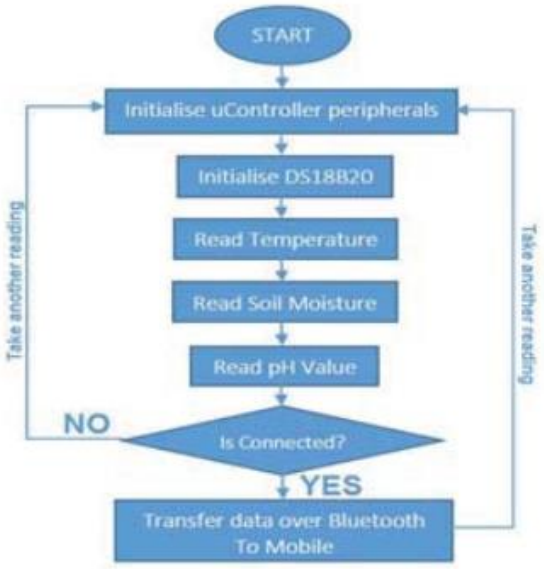

Figure 2: Firmware Flowchart

In this paper, researcher has been presented IoT based system for soil pH, temperature, and moisture measurement. Sensor designs for pH, temperature and moisture have been implemented and tested. [6].

R.Sindhuja and B.Krithiga [7] developed a sensitive, reliable and automatic electrochemical sensor system for monitoring the nutrients in soil using Arduino UNO Microcontroller. Electrochemical sensor and Arduino rapidly responds to targeted ions in minutes, suitable for in-field rapid Detection. The flow-through electrochemical sensor system with twoelectrode system work based on flow injection analysis (FIA) technique for detecting the nutrients of the soil.

Laxmi C. Gavade and Mr. A.D. Bhoi [8] reviewed different techniques of detection of N, P and K contents, humidity of the soil by using different sensors and also monitor the temperature and sunlight in the farmland. Authors compared different types of sensors that can be used to sense various properties of soil. Chemical analysis i.e. actual measurement of NPK is generally done by three techniques named as A] Conductivity Measurement Technique, B] Electrochemical Method, C] Optical Method.
After reading this paper [8], we found that overall, these techniques are similar and all the process will take place using chemical laboratory to detect the presence of soil macronutrients.

Dharesh Vadalia et al [9] determined the average percentage of basic soil nutrients Nitrogen, Phosphorous and Potassium with the help of pH meter and predict the suitable crops for the particular soil type in real time. The System was built with Arduino UNO R3. The block diagram for soil Quality Analyzer and Crop Prediction System is shown in Figure 3 [9].

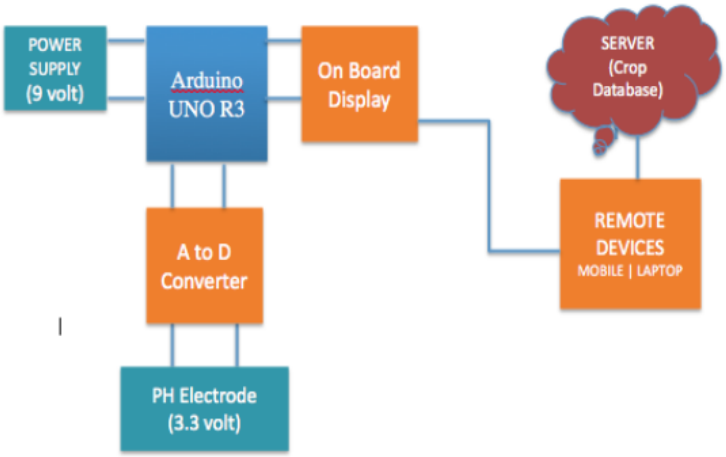

Figure 3: Block diagram of Soil Quality Analyzer and Crop Prediction System

Deepa V. Ramane et al [10] has developed a fiber optic-based color sensor to determine N, P, and K values with in the soil sample. For that colorimetric measurement of aqueous solution of soil has been used. The color detector relies on the principle of absorption of color by solution. It helps in deciding the N, P, K amounts as high, medium, low, or none. The sensor probes beside correct signal acquisition circuits were constructed

to detect the deficient element of the soil. These threshold values decide the Shortfall of the components. Table 1 shows these threshold values for three components. (x is color sensor output) [10].

Component	LOW	MEDIUM	HIGH
Nitrogen	$x \leq 15$	$15 < x \leq 20$	$20 < x \leq 25$
Phosphorous	$16 < x \leq 20$	$20 < x \leq 35$	$35 < x \leq 50$
Potassium	$20 < x \leq 25$	$25 < x \leq 40$	$50 < x \leq 60$

Table1: Threshold values for three Components [10].

After studying this [10] we found, optical fiber-based color sensor was developed to detect the absence of the nutrients N, P or K in the soil. Optical NPK sensor is worked on the principle of iteration between incident light & soil surface properties.

Md. Azahar Ali et al. [11] described electrochemical sensing technology developed for soil quality assessment. He also discussed the associated challenges, possible alternatives, and potential prospects. The potential of electrochemical soil sensor to detect multiple soil parameters are made up of various chemicals like Na+, Mg2+, Ca2+, Al3+, and Li+ interfering ions.

M. S. Amirul et al. [12] Analyzed the performances of Partial Least Square Regression (PLSR) model with different data pre-processing techniques for the prediction of nitrate content using NIR Spectroscopy and find the range of wavelength in NIR spectroscopy, which is highly correlated with nitrate properties. After going through overall testing and observation, reduced (R) pre-processing technique has been identified as the best performer for the analysis of nitrate data correlation with spectral absorbance data of the soil samples in soil analysis.

P.Sukumar [13] published the " Real Time soil fertility analyzer using IOT" : In this paper author determines soil fertility by detecting the soil condition like dry, wet, sultry depending on Physical Parameters like Temperature, Humidity, Moisture and also detect Soil nutrients like Nitrogen (N), Phosphorus (P), Potassium (K) . Figure 4 shows the block diagram of Real Time soil fertility analyzer using IOT.

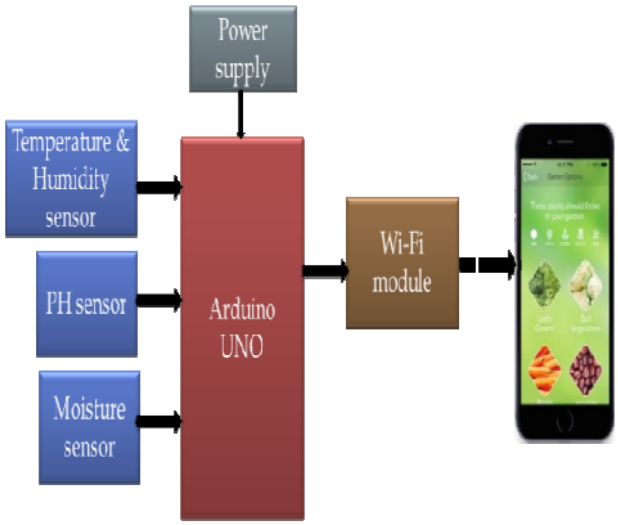

Figure 4: Block Diagram of "Real Time soil fertility analyzer using IOT

J. Indira Priyadharshini [14] proposed work will help the farmer to put fertilizers in correct ratio and in correct time by checking for necessary soil Nutrients (like pH and nitrogen, phosphorus and potassium levels). This is done by Arduino board, mix the fertilizers in the water tank and spraying it evenly so that incorrect mix of fertilizers will be avoided.
We found that, the damage due to fertilizers will be minimized by using this proposed system. This system avoids over dosage of fertilizers and it is also user-friendly to all farmers.

P. Sindhu and G. Indirani [15] published his work with microcontroller.as main component of this project. In this work, Soil characteristics are read by various sensors and then processing of soil characteristics is done by Node MCU ESP8266 WiFi shield. We found the data is stored successfully and can be accessed remotely. This system is a complete solution to test the soil health parameter for farmers.

The author Hridesh Shah[16] done his research and developed a system which suggest the list of Crops which are suitable to row in the particular Soil after checking the soil parameters and comparing it with the parameters of the crop listed in the database.

Dr V Anandkumar [17] Designed a system with NRF transceiver acts as a receiver on the reception side. This Gets the data processed through Raspberry Pi. The controller checks whether the threshold value is within the limits and accordingly Motor will e On or OFF. Notifications are sent to the user through mobile application regarding the motor functionalities. Figure 5 shows system Architecture of mentioned work [17].

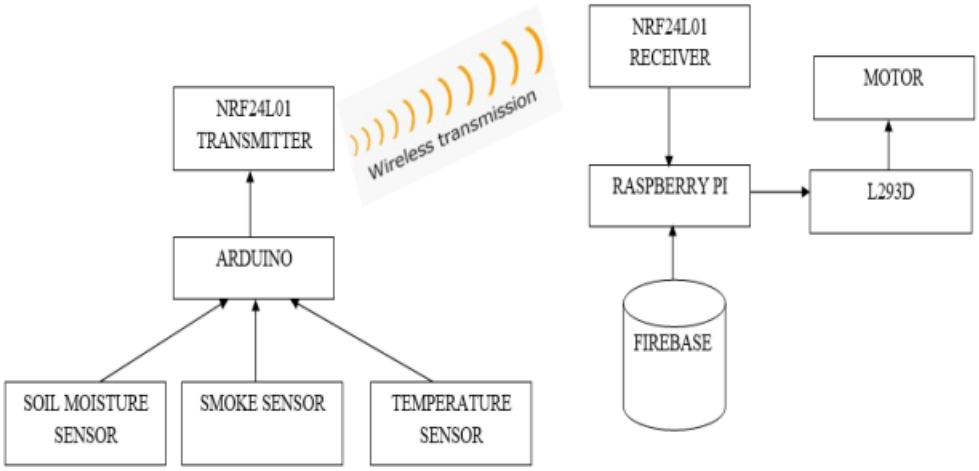

Figure 5: System Architecture

S. Brindha et al. [18] proposed a system to measure macronutrients with the help of pH sensor. The analog input from the pH sensor is converted into digital input (ADC) and send to the controller called Raspberry Pi. Then pH value is compared with the already stored threshold value and if the obtained value is less than the threshold value then the relay circuit for corresponding nutrient is switched ON using raspberry pi. The pump which is connected to the relay is switched ON.

Sabina Rahaman et al.[19] proposed a system which is useful in monitoring the field data and detecting the NPK level ratio in the soil. Author integrated a sensing module with an image processing setup to detect the important details needed for plant growth from the soil. Here NPK Level is detected by Image Processing. Soil image is processed for image enhancement and After extracting all the features from GLCM matrix i.e, Color, Shape and Texture characteristics the ration of NPK is detected. pH, Humidity and Moisture sensors are also connected to Arduino Board (Arduino Mega 2560). Wi-Fi is used as Communication Module. It Sends information about this level to the app. Based on the result farmer can monitor and take measurements to maintain the factors affecting the plant.

Laxmi C. Gavade [20] proposed System results in the designing, progression and optimization of a real time solution for application to the agricultural monitor and controlling. This system utilizes sensor for Nitrate, Phosphate, Potassium, temperature level detection, Humidity, Light intensity of Agricultural environment. It included Real-time valve controlling and pump operation and Agricultural Parameters measurement using Sensor for Agriculture crop. So by using this system productivity of crops increases and efficient use of water through sensor data, the quality of product is also improved through efficient use of fertilizer.

S. Kiruthika Devi et al. [21] Proposed a method to detect moisture content and pH level of soil by using moisture sensors and pH sensor. The output of these sensors is provided to Arduino Uno Microcontroller which makes decision whether to sprinkle water to plants or not and whether to use fertilizers for the particular soil or not. Author designed this method particularly for Household purpose.

P. Visconti et al. [22] described about designing of Wireless sensor based electronic system to detect the water level present in the soil so that the flood conditions can be detected. Various sensors are utilised to detect parameters like Solar radiation level, temperature and Moisture. The outputs from sensors will be given to board which process data and used to transmits and receives data from sensors. Here Photovoltaic cell is used to charge the complete system.

T. Sima et al. [23] studied the impact of Nitrogen fertilizer application on nitrous oxide flux. N_2O emission takes place from the soil in environment. More the use of Nitrogen Based Fertilizers, more is the emission of N_2O from soil till 21st day after fertilization. The author did surveillance of the soil at specific interval of days after fertilization. And kept record of the amount of Nitrous oxide emission.

Khairunnisa Mohd Yusof et al.[24] provided details about measurement of absorbance of soil nutrient levels using spectrometer. In his set up, DH-2000 is used as light source. A light was transmitted on the cuvette in which soil sample was placed. The study was conducted to characterised the macronutrients of soil. The soil Nutrients like Nitrogen (N), Phosphorous (P) and Potassium (K) are verified by using spectrometer.

Komal Chavhan et al. [25] Developed a smart irrigation system using IoT in which moisture sensors, ultrasonic sensors, pH sensor, DHT11 sensors are connected to Microcontroller. Microcontroller will automatically turn off the water pump machine. This is IoT based agricultural monitoring using wireless sensor networks to collects and transmits data from different sensors deployed at different nodes.

J.S. Tated et al. [26] described various sensor techniques that are used to detect soil nutrients. Author explained three methods to detect Nitrogen, Phosphorus, and Potassium in the soil. Three methods are Conductivity Measurements, Electrochemical Measurements and Optical Measurements.

Siddharth Singh Chouhan et al. [27] presented an automatic soft computing approach for identification and classification of plant leaf diseases by using Bacterial foraging optimization based Radial Basis Function Neural Network (BRBFNN) that is trained with the help of Bacterial Foraging Optimization (BFO), to find infected region on leaf. The proposed work focus upon fungal diseases identification that affects the plant on a large scale. The work is carried out by using image processing. Figure 6 shows the methodology of the proposed work [27].

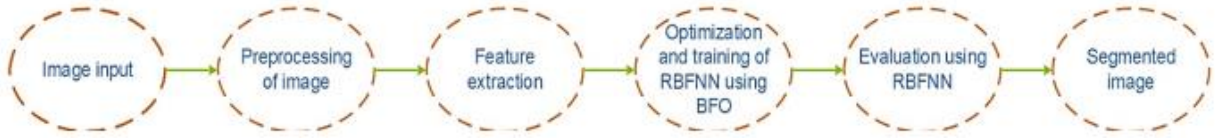

Figure 6: Methodology for the proposed work.

III.CONCLUSION

We have reviewed various methods which are useful to increase agriculture Production. Agriculture is mostly depending on Soil Structure, Soil's macronutrients (like N, P, K etc), Watering to crops, Various Fertilizers, duration of applying Fertilizers, Environmental Conditions etc. Various types of sensors have been reviewed and it has been found that, overall, these techniques have very similar and some processes takes place using chemical laboratory to detect the presence of soil macro-nutrients.

However, Plant diseases is also an important Factor which affects agriculture production and is still open challenge to overcome it. As a very small number of diseased crops can spread the infection to the whole crops in the field and thus affects further agricultural sales. There is a thirst of research in domain like Plant diseases. Our proposed work aims to focus on Various Plant diseases, Symptoms of diseases on Crops and to detect Plant diseases to avoid further loss of crop. We would like to conclude that, mostly research was done on Soil parameter and plant diseases is still insignificant area. Therefore, we are going to develop a project for crop disease identification and its solution by using algorithm.

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