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E-Agriculture – Resource Sharing using Internet of Things in Agriculture

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Abstract*: The traditional agriculture cultivation technique is improved by incorporation of IoT based resource allocation and monitoring technique to improve high quality coconut production. In this technique, the humidity, mineral values and pH values are calculated with the help of sensor nodes. The sensed values are aggregated with the help of gateway sensor and pass the information to the task manager node. The task manager node utilizes fuzzy logics to watch and control resource allocation. Based on the real time experiment, the yield has been improved 30% compared from natural way of development.

Keywords: Environmental monitoring, resource allocation, Internet of Things.

I. INTRODUCTION

Agriculture plays a vital role in India and acts as backbone of Indian economy. India secures second rank in agriculture and shows a major role in development of Indian economy. However, recent studies on Indian's GDP prove that economy contribution of agriculture is steadily declining. The younger generation pays less importance to agriculture due to very less ROI in agriculture. Increase of Indian population also steadily affecting the growth of agriculture by converting agricultural lands into residential and industrial area and made the land unfit for agriculture. Most of the rivers and agricultural lands destroyed by depositing industrial wastes and made unfit for irrigation [4,5,6]. Apart from these, most of the farmers are wasting resources like water, minerals and pesticide by over usage than the required amount. This excess usage of resources will increase the investment and hence the profit is lesser. In this regard, an effective resource utilization and monitoring are performed with the help of IoT based solution [1,2]. In this research paper a novel technique to improve coconut production using IoT presented and experimentally proven. The experimental result validates 32% increased coconut production with 28% of less investment compared to conventional method of coconut farming.

A. Internet of Things

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The Internet of Things(IoT) is capability of the electronic device to sense the information and forwards to the user as digital data.

The IoT utilizes the sensor to sense the environmental condition and forward them to the user for processing. The IoT devices are used for monitoring, sensing and controlling the environment remotely. In IoT each device is identified with unique value called internet protocol address [1]. These address will represent the location of the device and the data can be identified based on the address and location. The Sink node acts as the collection node that collects the sensed information of all sensors of a specific area and forward to the base station. The base station is normally a user end where the data are aggregated and waits for user confirmation. IoT makes easy availability of the information and make decision even from remote location [2]. The controls system which maintains the sink nodes and aggregates the information and forwarded to the user.

B. Implementation

The incredible growth of wireless technology and MEMS contributed to extensive growth of IoT. The installation and implementation of wireless network are more feasible and economical in various environment conditions compared to conventional wired network. The wireless network comprises of sensor nodes for sensing the environmental conditions and transmitting the information to the user [1,2]. Each sensor node consists of microcontroller, transceivers, memory units and battery resources powered by solar panels and various sensors to measure humidity, pH values, minerals, and even acid conditions of the environment. Each tree is fixed with a sensor node and identified with an identification number and geographical location information. These unique id and location value will be stored in the database of task manager node. The sensor network is an ad-hoc network, utilizes available sensor node for communication. Each sensor node uses multi-hop routing to transmit the sensed information.Fig.1. represents the architecture of e-agriculture IoT based resource sharing. The sensor node senses the information and passes the sensed information to the gateway sensor. The gateway sensor in-turn sends the sensed information to the task node. The task node evaluates the values and calculates the amount of resources required by the specific tree.

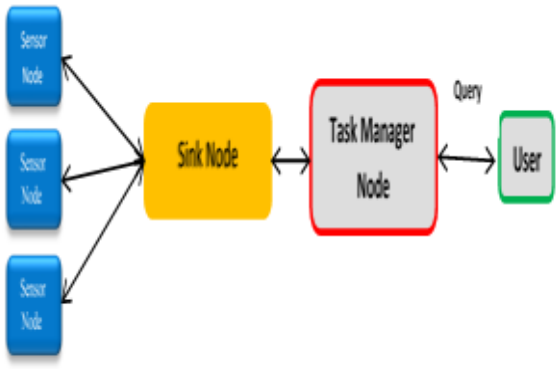

Fig.1. Model of e-agriculture IoT based resource sharing

C. Tradition way of adding fertilizer

Cow dung is basically chosen as the fertilizer in traditional way. 4X4X4 sized hole is taken between 2 trees manures are added in the fertilizer pit. They are added with organic wastes and water it daily. The trees absorb the fertilizer through the soil and the helps in the natural growth of the tree and yields coconut. However, it may effect with malnutrition.

D. Difficulties of coconut farming

The farmers of coconut farming are mainly facing biggest issue with water management. The awareness towards watering the tree varies from region to region and based on humidity of the soil and atmosphere [7,8]. The rain plays a vital role and the underground water and area around the farm matters the watering. Secondly, the farmers are lack of recent development in the agricultural and crop development. The production of the coconut can effectively increase by adding fertilizers and new recent improved techniques [9,10].

E. Importance of the nutrients

- Nitrogen: Nitrogen play the vital role in the growth of the tree. It improves the vegetative part of the tree. The Nitrogen also improves the growth of leaves.
- Sulphur: Sulphur is an essential mineral in coconut's oil content. However, the increase of sulphur reduces the Potassium and sugar in the coconut.
- Potassium: Coconut are rich in potassium. The potassium is essential for the development of the root. They also help in improved sugar, fat and fibre material in the coconut. Potassium regulates the water usage of the tree.
- Magnesium: Magnesium promotes the production of coconuts. They are more vital for development of female flowers and leads to more coconuts. Magnesium and Nitrogen plays a vital role in photosynthesis.

II. E-AGRICULTURE IOT BASED RESOURCE SHARING

In IoT based e-agriculture, Wireless sensor nodes are fixed in the tree and specific sensors are fixed to evaluate minerals and humidity condition of the soil. Each IoT device consist of Sensor, Analog to Digital Convertor to convert the environmental data to Digital record. Fig.2. represent architecture of sensor node. The Sensed environmental data will be an analog data and it is converted to Digital data. Memory is used to store the temporary data recorded and forwarded to sink node.

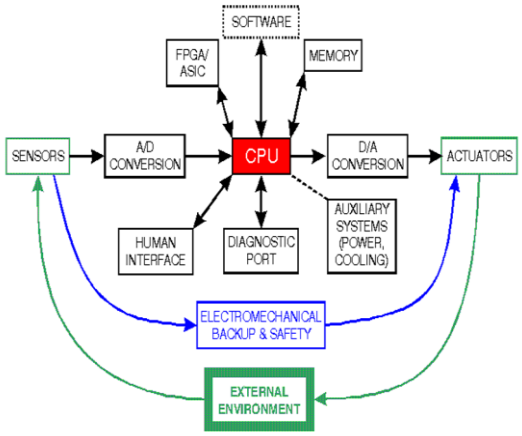

Fig.2. Architecture of Sensor node

In this research, node mcu module is used with Raspberry PI is used for processing the information from the soil. The node mcu is a microcontroller with wifi module can be used to sink with the network or transmit the data to the short distance Bluetooth communication also. The sensors are fixed to node MCU for scanning the information continuously and forward the data to the base station. Fig.3. represents the structure of node MCU connected with raspberry pi and sensor.

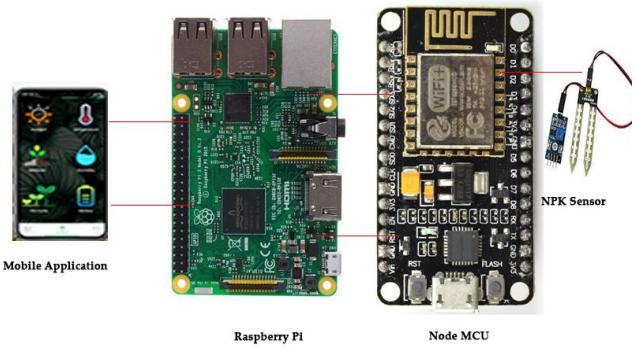

Fig.3. Working model of e-agriculture sensing unit

A. Architecture of e-agriculture

The sensor unit encompasses Node MCU, fixed sensors, Raspberrry PI for processing the data and forward to the sink node. Fig.4. represents the model of the e-agriculture. The sink node is a cluster head of a given area that aggregates the information and forwards to the user. The user gets the information from the base station. The base station forwards the information to the user's mobile devices using web view and waits for user's response. The user can choose different options like pumping minerals or water more than the prescheduled. Each trees are connected with sensory unit in water proof box to prevent from damages due to extensive sunlight or rain. The sensor is fixed to the soil and the measures the environmental changes. The sensor sense the information like humidity, pH values, mineral values and atmospheric temperature. Based on the condition, base station takes decision and pumps water, mineral and other resources.

If any panic situations like running out of water or minerals, a warning in prompted to the user mobile for the alternative actions.

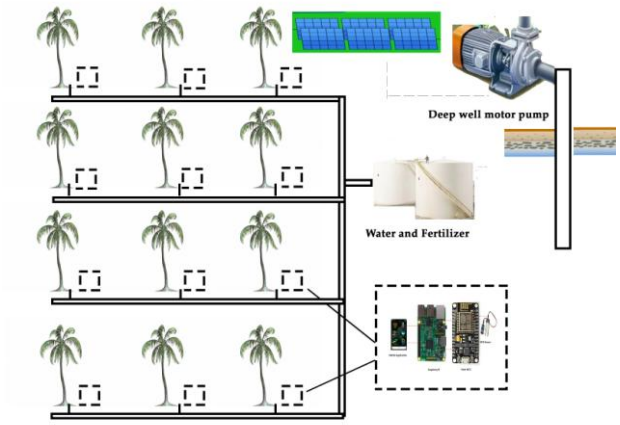

Fig.4. Model of e-Agriculture

B. Pseudocode for water and fertiliser level indicator

The water and fertiliser will be filled up in separate tank and based on the level indication, prompts the motor to pump or add filter to the tank.

```
void loop()
{
 lcd.clear();
 lcd.print("Distance in cm");
 digitalWrite(trigPin, LOW);
 delayMicroseconds(2);
 digitalWrite(trigPin, HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin, LOW);
 duration = pulseIn(echoPin, HIGH);
 long r = 3.4 * duration / 2;
 float distance = r / 100.00;
 lcd.setCursor(0, 1);
 lcd.print(distance);
 delay (300);
 if(distance<10)
    {
     digitalWrite(led,HIGH);
    }
 else
    {
     digitalWrite(led,LOW);
    }
 delay(300);
}
```

C. Working of e-agriculture System

Step:1 – The sensor node detects the water level and mineral levels of the specific tree.
Step:2 – The sensed information is forwarded to the sink.
Step:3 – The Sink node aggregates the information of the specific location and send to the task manager node.
Step:4 – The task manager node processes the sensed information and forwards the water and mineral to the specific tree.

III. EXPERIMENTAL SETUP

The coconut farm of southern part of India is chosen were each coconut trees are planted in grid format. Each coconut tree is placed 10 meters apart and 100 trees are planted in 10,000 square meters of agricultural land. Dip irrigation technique is utilized to water the trees. The production of 3 months of coconut is measured by the quality and quantity. Each sensor nodes are fixed with the 100 trees individually. Each row is planted with 10 trees. Every ten sensor nodes communicate with the one Sink node and finally all the sink nodes communicate each other in form of multitasking and forward the sensed information to the task manager node. The data will be updated to the user and the user can query based on the requirement or allocate the resource to the specific location.

IV. RESULTS AND DISCUSSIONS

The production of coconut is monitored for a period of 12 months. Two adjacent agricultural land with same properties where chosen and production rate is measured in term of quantity and quality. The farm is cultivated with West Coast coconut trees that are 12 years old. The production of such coconut trees starts after 6-7 years and lives upto 60 years. An average of 70 nuts are produced in such tree. With the introduction e-agriculture production per tree has increased with 30%. It noted trees produced an average of 112 nuts. Performance of the coconut tree is evaluated with the average value of 70 coconuts per tree in a year.

Table.1. represent the comparison of coconut production in two individual farm with e-Agriculture and natural agriculture.

Table- I: Comparison of coconut production

Month interval	Natural Agriculture	e-Agriculture	% of production agriculture	% of production e-agriculture
Aug – Oct	1,123	1,670	48.12857	71.57143
Nov – Jan	1,458	1,845	62.48571	79.07143
Feb-April	1,390	1,890	59.57143	81
May-July	1,800	2,340	77.14286	100

The investment cost and production values are improved with the help of IoT based solution. The sensor node evaluates the pH, minerals and humidity of the soil and control the resources allocation.

Improved production with increase of Nitrogen

In the experiment, nitrogen is increased on specific interval and found a little increase in the coconut production. The increase of nitrogen beyond a limit doesn't product higher yield. The figure, shows the release of Nitrogen over 12 hours. The production is monitored in a cycle of 3 months. It is noted production increased up to 78 nuts. CN2 refers to release of minerals in 20:20:20 of, Nitrogen, potassium and phosphorous repetitively. CN1 uses improved Nitrogen with 30:20:20 ratio

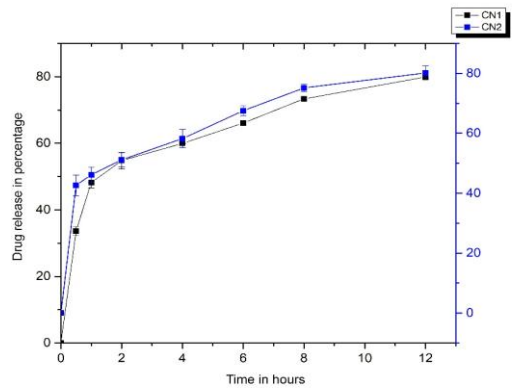

Fig. 5. agriculture production with varying nitrogen level

A. Improved production with increase of magnesium

The experiment is conducted with increasing magnesium in the soil of the specific trees. The production of the tree found to be higher and yield improved. Fig. represents the production of the nut and release of minerals over a period of 90 days.

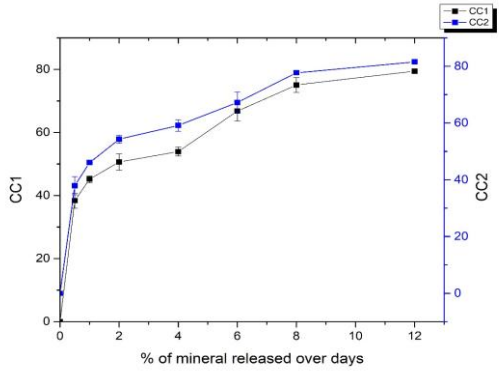

Fig.5. Agriculture production with varying magnesium

B. Solubility of mineral in the soil of testing

The farm is chosen is Kanyakumari district in Southern part of India. It has been noted the solubility of mineral in the specific area differs over time. Hence, the minerals have to processed and mixed in the soil for the utilisation of the farm in effective manner.

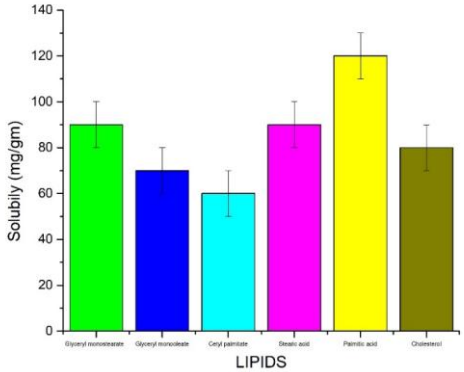

Fig. 6. Solubility of minerals in the soil of testing

V. CONCLUSION

The paper proposes an innovative approach towards increasing the production of coconut farm agriculture with the help of IoT and smart meters. The result proven an increase of production with 32% with minimum investing cost. The return of investment is higher and production rate has increased effectively. This paper presents the researchers about utilization of IoT devices in various agriculture fields and promote the production. This in-turn helps the development of the GDP of the country. The agriculture field is facing serious downfall due to less knowledge on recent trends and advancement in the technologies. The latest technological advancement must be used in the agricultural field and it will improve the growth of farmer and the nation itself.

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