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A SMART FARMING ASSISTANT – COLLABORATIVE HELP FROM INTERNET AND AGRICULTURAL EXPERTS

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Abstract: Internet of things is an area comprised of actuators or sensors or both to give availability to the web straightforwardly or in a roundabout way. Farming, the foundation of Indian economy, adds to the general financial development of the nation. Yet, our profitability is less when contrasted with world measures because of the utilization of out of date cultivating innovation, and these days individuals from country regions relocate to an urban region for other gainful organizations, and they can't concentrate on agribusiness. Web of Things (IoT) advances can be utilized in cultivating to make it savvy cultivating by upgrading the nature of farming. Advancement in cultivating isn't new yet IoT is set to push brilliant cultivating to next level. With the help of sensors, Google services, collaborative suggestions from experienced farmers and researchers a farming assistant is implemented. This system focuses on various features like Humidity and temperature sensing, fertilizer estimation, detection of crop diseases and solution to those diseases and crop estimation. A Farming assistant system based on IOT technologies is created to deal with all the necessary data and the multifaceted nature of plants development to increase the productivity and yield with less human power.

Keywords: Internet of things, farming assistant, temperature, crop, sensors, diseases, fertilizer

INTRODUCTION

All out people has extended from 1.75 billion of each 2000 to 7.4 billion today. The jump of this extension isn't changing and Earth is evaluated to have 12.4 billion preceding this present century's finished. Strikingly with that advancement, the arable land is reduced from 0.5 Ha per individual in 1960 to 0.2 Ha for every person in 2020. The world won't have enough sustenance to cover the prerequisites of the extensive number of tenants with no changing the way in which we do agribusiness today [1]. This gives the noteworthiness to Agriculture in the bleeding edge world.

In the cutting edge world, Agriculture assumes a key job being developed of the provincial economy. Mechanical work, ecological observing has been generally in customary agribusiness creation. Because of spillage, vanishing and assimilation inside the profound soil layer farming water is squandered. Soil checking data and other type of observing in the zone of intrigue are gathered by utilizing remote sensor arranges. It can possibly change the methods for making agribusiness smarter by gathering the information in the farming creation process and making agriculture smarter by collecting the data in the agricultural production process [2].

To increase the agricultural productivity knowing the soil nutrients are very important. The soil nutrients can find the plant growth and survival, chemical elements which are important. Hydrogen (H), oxygen (O), and Carbon (C) are significant for non-minerals. The three primary supplements are: Nitrogen (N), Phosphorus (P), Potassium (K), known as NPK [4] and the plant convert CO2 and H2O into starches and sugar.

For increasing a production of crops in agriculture field, we analysed the climate data and weather data from the field to make the effective decisions. With the help of sensors the soil nutrients, temperature and humidity are monitored. If the high amount of water required for crops, if the environmental condition is hot, sunny, dry, wind and less water are needed. When factors are like cold, humidity, clouds and little wind is the need of the agricultural field [6].

Additionally, another part of cultivating can be the diverse temperature and mugginess of the environmental factors by various yields. A few yields require less measure of soil dampness and some require more. The temperature and dampness of the environmental factors likewise matter to various harvest designs. Customary technique for estimating temperature and moistness was through thermometers. Simple thermometers were not as exact and exact as the computerized strategies. The DHT11 sensor comprises of a part that senses stickiness and a segment called thermostat which senses the temperature. There is likewise an IC/incorporated circuit on the rear of the sensor [5].

A fertilizer or excrement is any material of customary or built initiation that is applied to soil or to plant tissues for the improvement of plants. Various wellsprings of compost exist, both trademark and precisely made. An arrangement under smart farming serves to precisely assess the fundamental part of enhancements level and finally limit their negative effects on the earth and ground surface estimations over a whole vegetation period are analysed [8] - [9]. So to make this important farming as smart farming, Internet of Things (IoT) can be used.

The Internet of things is a huge network of connected things and people all of which gather and share information about nature around them on the planet. A thing can be an individual with a heart, screen embeds framework in current innovation, a livestock with a biochip transponder are utilized, a car that has worked on sensors to caution the

driver when weight is low or some other characteristic or man-made article that can be relegated by the IP address and can move information over a system with the assistance of web of things.

In an Internet of Things (IoT) environment, two things are significant: the Internet and physical gadgets like sensors and actuators. The primary motivation behind sensors is to gather information from the general condition. Sensors, or 'things' of the IoT framework, structure the front end. These are associated legitimately or in a roundabout way to IoT arranges after significant change and preparing. Be that as it may, all sensors are not the equivalent and distinctive IoT applications require various kinds of sensors. For example, advanced sensors are direct and simple to interface with a microcontroller utilizing Serial Peripheral Interface (SPI) bus. But for analogue sensors, either analogue-to-digital converter (ADC) or Sigma-Delta modulator is utilized to change over the information into SPI output. Some mentioned IoT sensors are temperature sensor, humidity sensor, motion sensor, gas sensor, smoke sensor, pressure sensor, image sensor, accelerometer sensor, IR sensor, etc. The normal utilization of sensor is in our cell phone to screen the temperature.

An IoT platform is a set of components that allows developers to spread out the applications, remotely collect data, secure connectivity, and execute sensor management. The sensor collected information can be seen by using some of the IoT platform services. One of them is ThingSpeak. Thingspeak is an IoT analytics stage service that permits you to total, picture and break down live information streams in the cloud. By using this platform, we will be connecting the sensors to read the sensed data using API. Likewise, many other platforms are there to read the sensed data. In our work ThingSpeak is used to read the sensed data, there we can keep our information either public or even private. ThinkSpeak will work as follows: Right off the bat Humidity and Temperature Sensor detects the Humidity and Temperature Data. Besides Arduino UNO extracts the sensor's information as a reasonable number in rate and Celsius scale, and sends it to Wi-Fi Module. Thirdly Wi-Fi Module ESP8266 sends the information to Thingspeak Sever. Lastly Thingspeak investigations the information and shows it in a Graph structure. Discretionary LCD is likewise used to show the Temperature and Humidity. Like this feature, a lot more service and platforms are there in IoT to assist the farming and which results in smart farming. It reduces the human power needed, timely monitoring of fields and the crops. Figure 1 shows the IoT on agriculture with different kinds features in farming.

Progressively, associations in a huge number of ventures are utilizing web to work all the more viably, better comprehend to the clients to convey upgraded client support and improve dynamic and increment the estimation of the business in the cutting edge world to the web.

To computerize this cultivating activities in a few natural parameters that incorporate temperature, dampness and water level. These have sway on cultivating, are required to find at various area to mechanize the cultivating activity. To screen these ecological parameters by various sorts of sensor conveyed in the field and joined with a microcontroller.

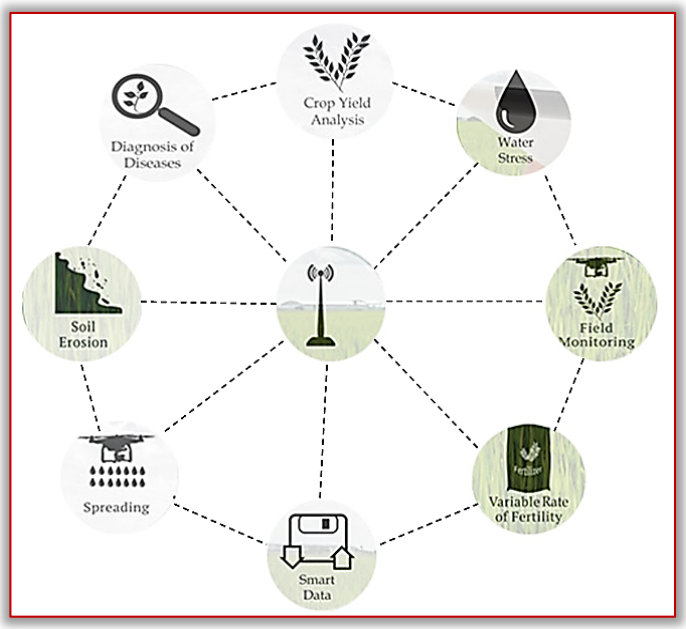

Figure 1. IoT on Agriculture

Beside these the recognized data can be taken care of in the cloud. Microcontroller got together with Wi-Fi module sends those distinguished data to the cloud and put away in it. GSM based or (DMA or GPRS) innovation, utilize remote condition checking framework and this uses the wireless environment monitoring system.

In this paper section 2 describes about the existing farming assistants or IoT application to make the farming smarter. In section 3 gives the detailed explanation about the proposed system called Farming Assistant and section 4 gives the result analysis of the proposed work and final section 5 gives the conclusion.

LITERATURE SURVEY

There are many applications and systems to assist the farming. Each application uses different sensors and different IoT platforms or services to process the data and different features. In this section we are describing about the existing systems to assist the farming. In [3] the proposed field monitoring which focuses on the feature called temperature monitoring, which provides farm productivity and agricultural efficiency without continuous manual supervision to meet rapidly rising food demand. The smart farming provides the collection of useful data which can improve and also has high precision. Humidity, temperature of soil is monitored by field monitoring system. Based on the value it takes the necessary action without the use of humans.

The proposed field monitoring system in paper [6], monitors the temperature, moisture, humidity and also does the monitoring through the sensor using Arduino board and if any discrepancy happens it will send an SMS notification with the application developed by using Wi-Fi/3G/4G. Using the Aerial photography and Satellite Imagery from [7], NDVI track crop growth rates using Landsat Thematic Mapper (TM) to better identify spatial variations in plant

growth and relatively stable soil components of organic carbon components of the surface soil in agriculture.

Weeds, herbicides, and other unwanted plants are sensed by using Optoelectronic sensors in [9]. It splits the plant type, particularly in the wide-push crops. It can delineate weed appropriation and goals by consolidating optoelectric sensor and area data. Optoelectronic sensors are in like manner fit for isolating among the vegetation and soil reliant on reflection spectra.

Some application focus on the feature called fertilizer estimation which are given in [10] and [11]. Compost is a characteristic or inorganic substance that will improve the enhancement level for the advancement of the plants. Plants need three key full scale supplements specifically:

- nitrogen (N) improves the leaf advancement;
- phosphorus (P) is fantastic for root, flowers, and regular item progression;
- potassium (K) is valuable for stem advancement and water minutes [10].

Huang Damon and et al proposed a system to increase the plant and crop yield. Slow-release water, fertilizer-nutrition agent is a crystal in soil, which absorbs water and releases the stored moisture regardless of the soil condition [11]. There are many types of fertilizers that can be used in agriculture field. If we use fertilizers it will improve the product quality and then it will increase the crop yield level and the direct form of fertilizers are supply the essential nutrients to crops, including the NPK fertilizers, micro-element fertilizer, etc.

Crop production is a branch of agriculture; it plays a vital role in economic development and food security. China pulled in an extraordinary worry in the economy and in entire nation, even leads to food emergency. To address this issue, in [12] creators has executed Normalized Difference Vegetation Index (NDVI), is broadly utilized in the crop yield estimation. Standardized Difference Vegetation Index (NDVI) is an Effective gathers checking apparatus in cultivating.

The target of paper [13] is to build the complete volume of maize and estimation of yield creation by utilizing spot-five satellite pictures and experimental models. Data is given by advanced information from satellite images examined together with crop displaying parameters that empowers crop yield estimation. This model expressed the form of yielding such as yield as an element of LAI and NDVI. The proposed crop estimation system in [14], gives approach based on the suggestion that time series of subsets of pixels with similar agro. They characterize the crop growth over a small zone are obtained.

From the survey of smart farming, it's found that there are many features to give assist to the farmers to improve the productivity and the yield. All the above features are implemented with the help of IoT services and the sensors. So by using it a new system called A Smart Farming assistant is implemented which is given in section 3.

A SMART FARMING ASSISTANT – COLLABORATIVE HELP FROM INTERNET AND FARMERS

In the last section we analysed some of the smart systems to assist the farmers. In our work we utilized the benefits of IoT services and sensors in agriculture to increase the productivity and yield by reducing the human power needed. With the help of this smart farming assistant, farmers can immediately react to the important changes in weather, humidity, as well as the health of each crop or soil in the field. The proposed smart farming assistant system focuses on the following key features to support the farmers. They are:

- weather monitoring
- fertilizer estimation
- analyses of crop diseases
- crop estimation
- farming assistant

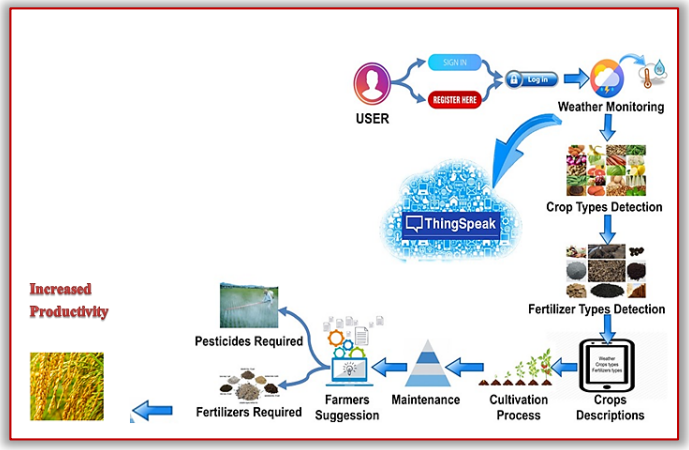

Figure 2. Architecture of Smart Farming Assistant System

Figure 2 represents the smart farming assistant system architecture. Much of the technology is evolving rapidly in the modern world. By using those IoT technologies like thingspeak, sensors, the system is developed. The system architecture starts with user login where the farmers have to give his land information like area coverage, soil type, crop type cultivated and other information. With the help of the temperature and humidity sensor DTH11 the field weather is monitored and based on that water need of the field and other needs will be decided and suggestions will be given to the farmers for that particular land. Then continuous with crop estimation in which based on the soil type the system will give suggested crop types to cultivate in the land. The suggestion is actually based on the productivity, temperature and soil type through which the yield will be more comparable to the normal one.

The system will continue with fertilizer estimation. This feature will find the fertilizer need in the field based the weather, soil type and also the crop type. Based on the system suggests the farmers have to feed the fertilizer to increase the yield. This module also focuses on the diseases of the crops and gives the correct solution to get rid of that disease. The new feature of the system included is farming assistant. In this module the farmers will be given with solutions and suggestions based on the experienced farmers as well as from the researchers and internet information for the raised query

on the farming assistant forum page. The following subsection will give the implementation details of each feature of smart farming assistant system.

— **Weather Monitoring**

As described above weather monitoring feature will find the temperature and humidity in the field. The system framework finds the temperature and humidity with an assistance of DHT11 sensor and Node MCU. Fig 3 shows the temperature and humidity sensor of DHT11 [15]. The sensor distinguishes water, fume by estimating the electrical obstruction between two anodes. The mugginess detecting segment is a dampness holding substrate with cathodes applied to the surface. At the point when water, fume is consumed by the substrate, particles are discharged by the substrate which builds the conductivity between the terminals. The adjustment in obstruction between the two terminals is corresponding to the relative dampness. Higher relative humidity diminishes the obstruction between the cathodes, while lower relative moistness expands the opposition between the anodes.

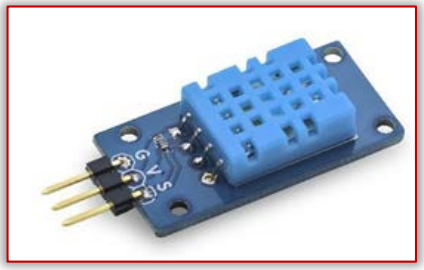

Figure 3. Temperature and Humidity sensor (DHT11)

The proposed framework utilizes the cloud computing stage for recording diverse agrarian field information. Right now channels are made, each compares to explicit parameter field in the Thingspeak cloud for putting away field information for temperature and humidity esteem. Node MCU sends the detected information to the individual channel occasionally through correspondence convention. Figure 4 shows the Node MCU which is an open-source firmware and improvement pack that encourages you to model or fabricate IoT product.

Figure 4. Node MCU (ESP8266)

The continuous condition checking and control framework uses remote sensor system, for example, LoRa WAN. The checked sensor information incorporates humidity and temperature. Furthermore, we are utilizing the DHT11 sensor for finding the temperature and mugginess for the extremely compelling cultivating. There are numerous different sensors to discover the temperature yet for cultivating field DHT11 sensor is the extremely compelling one to utilize.

Figure 5. ThingSpeak – Cloud

Figure 5 is the thingspeak cloud platform is an open information platform gave by IoT. At the point when our application speaks with thingspeak utilizing API, the information can be kept either private information or even open information. Thingspeak is an IoT examination platform service that permits you to total, imagine and investigate live information streams in the cloud [16].

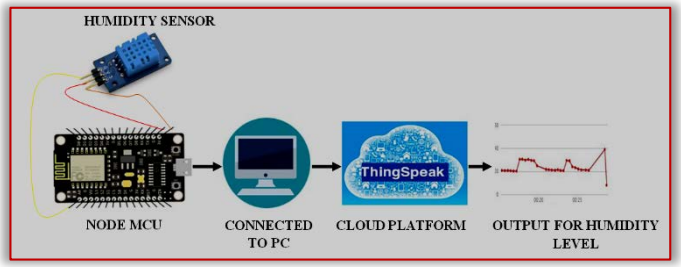

Figure 6. Humidity sensor Connection with ThingSpeak

With the above mentioned sensor, node MCU and ThingSpeak the filed temperature and humidity is analysed. Figure 6. Show Humidity sensor Connection with ThingSpeak. With the help of NODE MCU, the sensor is connected to the PC. The PC is connected with the network to access the ThingSpeak cloud service to read the sensed data. Finally the output of this connection is the humidity and temperature graph of the field.

This information (temperature and humidity esteem) is plotted concerning time and can be utilized for future examination. Agrarian field status (temperature and moistness) can be checked remotely as far as chart in the Thingspeak web service. Applications can be made identified with cultivating which is sent in the cloud and can be utilized by ranchers or specialists. The Node MCU speaks with the portal remotely through a Wi-Fi module. Node MCU sends HTTP request to the Thingspeak cloud for composing detected an incentive to the corresponding channel.

— **Fertilizer Estimation**

Fertilizer is a characteristic or inorganic substance that will improve the enhancement level for the advancement of the plants. Plants need three key full scale supplements specifically: nitrogen (N) improves the leaf advancement; phosphorus (P) is fantastic for root, flowers, and regular item progression; potassium (K) is valuable for stem advancement and water minutes [10].

In general, crops retain not exactly a large portion of the nitrogen applied as manure, while remaining may produce in the climate or may lose as run off for this circumstance [10], they assists with assessing the required loss of supplements,

eventually it will limit their negative impacts on the earth with the assistance of compost required.

To solve this issue the fertilizers need to be continuously monitored and feed the crops. To detect the fertilizer moisture level IR-3000 sensor is used. By utilizing this sensor the fertilizer is continuously monitored manually or automatically to feed the crops with its need. And also another sensor is utilized to determine the level of nitrogen present in the crop and based on the sensed value the fertilizer being used. An analysis is made to find how much fertilizer need to be used for each and every type of crops and based on the sensor values the crops are given with needed fertilizers [17]. Figure 7 shows the IR-3000 Moist Tech sensor and Yara N-sensor.

Figure 7. IR-3000 Moist Tech & Yara N-sensors

But in [18], Tsuyoshi Sonoda et al used the pulsed electric field the growth of crops is increased and it is detected by attaching the PEFs to the root of the lettuce.

— **Analysis of Crop Diseases**

Like each other, living life form, plants are defenceless to sicknesses. Harvest malady includes any destructive deviation or modification from the ordinary working of the physiological procedures. Along these lines, unhealthy plants experience the ill effects of ordinary life forms and their indispensable capacities.

The temperature and moisture level of the soil plays a major role in parts of the crop like its leaf, stem, flowers, etc. So by utilizing the DHT11 sensor the crop temperature and moisture is found to check whether the crop is healthy or with the disease. Set of analysis is made to find how much temperature and moisture level should a type of crop have and based on that if the sensor value is below or above the threshold value, then it's a defective crop or it's affected by some disease else not [19]. The defected crop image will be sent to the server to find a solution to the problem. If is matched with the information stored in the database, then required information to solve the problem will be given. So that crop production will be increased.

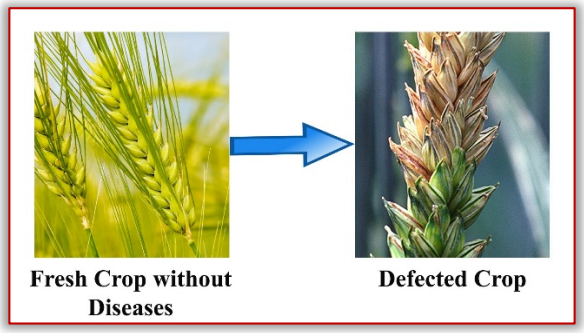

Figure 8. Analysis the defected crop

Figure 8 shows the crop disease analysis. The input crop is compared with the stored non-defect crop to find the disease or defect crop [16]. There is also another sensor to find the crop defect namely TCS3200 which will use the RGB color values of the crop to find the defect [16].

— **Crop Estimation**

Depending upon the plant stature, leaf length, and dry issue; being evaluated with the particular functions. The particular capacities which show the connection between the vegetation spread zone of plants and the deliberate real plant measurements were dissected utilizing a growth curve (the Gompertz bend) and an exponential function. The Gornpertz bend was utilized for the estimation of the dry mass of the plants. For the leaf length and the plant tallness, the exponential function functioned admirably contrasted with the development bend. In view of the outcomes, the yield, developing status could be assessed utilizing crop pictures [20]-[22]. But also the sensor values guide the farmers to cultivate the right type of crop for suitable soil and the diseases are detected and solutions are advices to solve the issue. So it actually increases the productivity with less human intervention.

There were numerous endeavours in the past to set up the connection between remote detecting factors, for example, NDVI and real ground estimated LAI. The rice crop LAI estimation model proposed by Inoue et al., [23] utilizes the Radarsat-2, C-band 5.405 Ghz. SAR information.

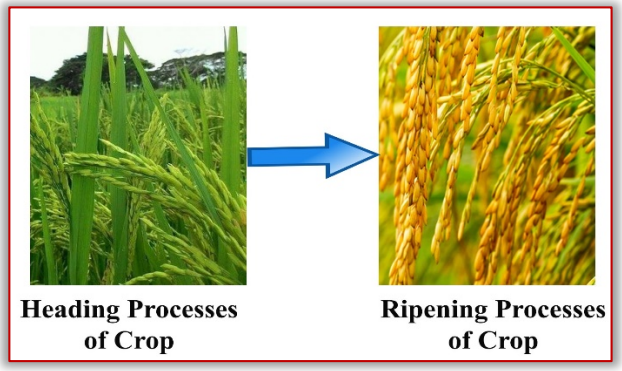

Figure 9. Crop Estimation Processes

Based on the analysis the crop images are stored on server stage by stage. The crop images at 120 days of its cycle are taken and feed to the server to know about its growth. The images will be compared to the stored non defective and healthy 120 days crop images. If both the images match, then

the growth is in right level else suggestions will be given like what fertilizer may help the farmers solve the issue.

This Figure 9 shows the crops at two different stages like growing stage (120 days) and at the harvesting stage (150 days). If the input crop image match with the healthy 120 day's crop image, then it will give the output as the crop is in right growth else suggestions will be given as said above.

— **Farming Assistant**

Farming assistant feature is the unique feature of this system. It actually takes collaborative help from experienced farmers, researchers and also from internet information. In farming assistant forum page the farmers can raise their doubts regarding what kind of crops can be cultivated, doubts about crop dieses and fertilizer usage and a lot. The experienced farmers and the researchers will clear the doubts and give a better solution. It provides the real suggestion from the experienced farmers to get more real information than the internet. So it actually helps the new farmers to learn a lot. The set of stored information from the internet is also provided to the doubts of the farmer from the Farming assistant system.

Our fundamental target of this work is to design an IoT based smart cultivating to control condition process like temperature and moistness. Without human mediation relying upon ecological parameters like temperature and stickiness level the ranchers are given with a total horticultural guide. These parameters are put away in cloud for future information investigation.

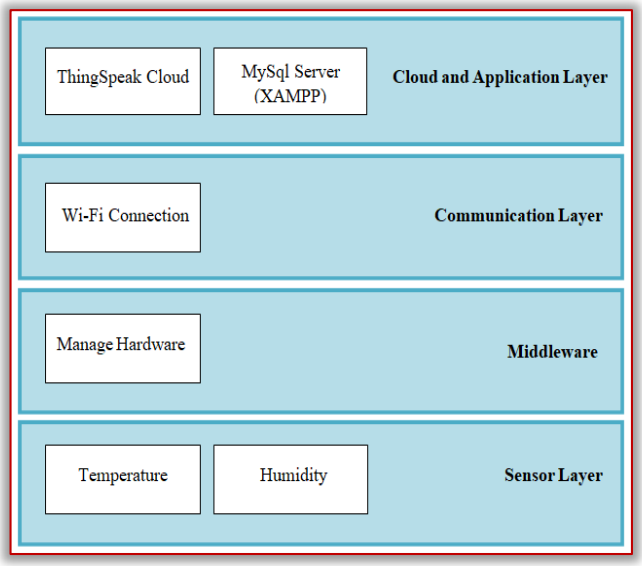

Figure 10. Different layers of
Smart Farming Assistant System

The following Figure 10 shows the different layers of Smart Farming Assistant system. ThingSpeak and MySql Server are the application layer through with the farmers will interact with the system (GUI). Wifi connection is used to store and retrieve the data to and from the cloud. Managing hardware is the aurdino UNO board and node MCU and the lowest level layer is the sensor layer [24].

RESULT ANALYSIS

From the above segment you will realize how to set up the DHT11 Humidity and Temperature sensor on your Node MCU. Also, find out about how the Humidity sensor attempts to discover the temperature, imperfection in crops, just as for crop estimation.

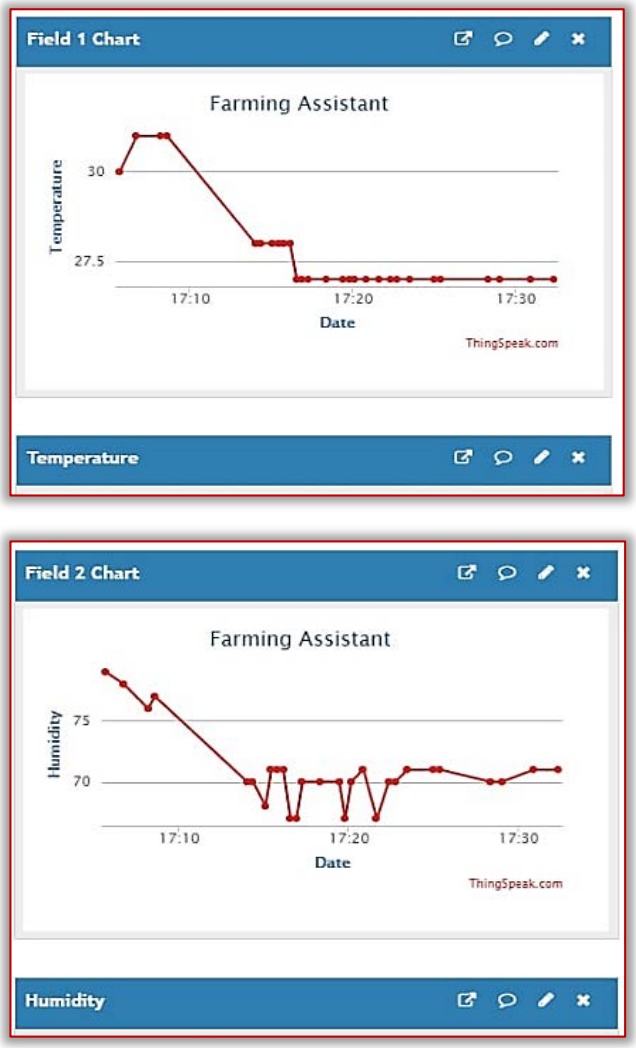

Figure 11. Temperature and humidity graph by DHT11 sensor

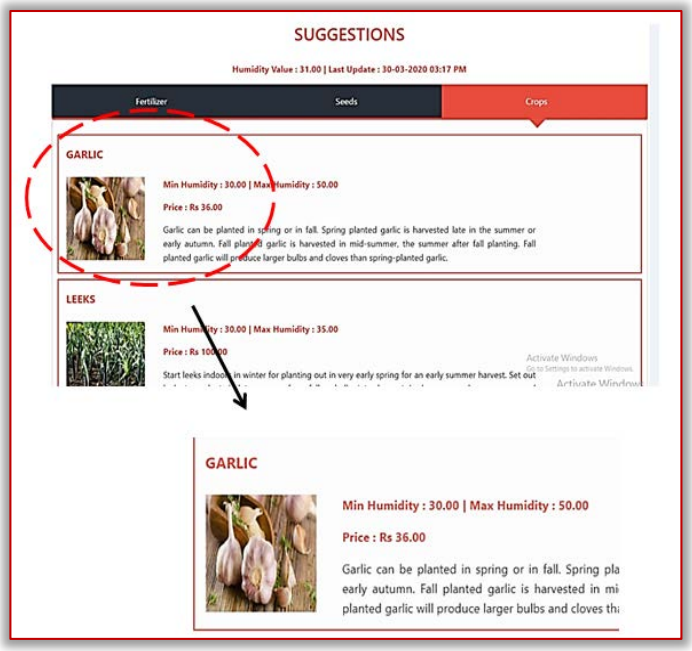

Figure 12. Suggestion for crop cultivation

The Figure 11 represents the temperature and humidity graph of sensed data produced by DHT11 sensor. Based on the field humidity and temperature, Smart farming assistant gives suggestion for crop cultivation, which is shown in Figure 12. With the help of IR-3000 Moist Tech and Yara N-sensors the nutrients and fetilizers needed for the crop are identified and intimated to the farmers. The below fig 13 shows the suggestion for garlic plat to increase the productivity.

Figure 13. Fertilizer suggestion
by Smart Farming Assistant

The process is continuing with crop disease analysis. With the help of DHT11 sensors, temperature and humidity value, crop diseases are also identified and the solutions are given to the farmers to get rid of that crop disease. To check for the accuracy of the crop disease analysis confusion matrix is used. Table 1 shows the confusion matrix of smart farming assistant in which the A, B, C, D values are given below:

- True positive (A): Healthy crop identified as healthy
- Falese Negative (B): Healthy crop but identified as defected
- False Positive (C): Defected crop, but identified as healthy
- True Negative (D): Defected crop identified as defected

Table 1: Confusion Matrix for Smart Farming Assistant crop disease identification

100 samples		Smart Farming Assistant Result	
		Healthy	Defected
Actual	Healthy	43	4
	Defected	7	46

From the confusion matrix accuracy is calculated and it proved that the accuracy of finding the crop diseases is 89%. Finally the farming assistant feature comes in which the farmers will post their queries and the experienced farmers and the researchers will solve their doubts and they will give suggestions for better yield. Not only for the researchers but also the smart farming system responds to the farmers query which is shown in the Figure 14.

As a whole the Smart Farming Assistant system give a complete guide to the farmers to get increased productivity and better yield with the help of the above explained features in it.

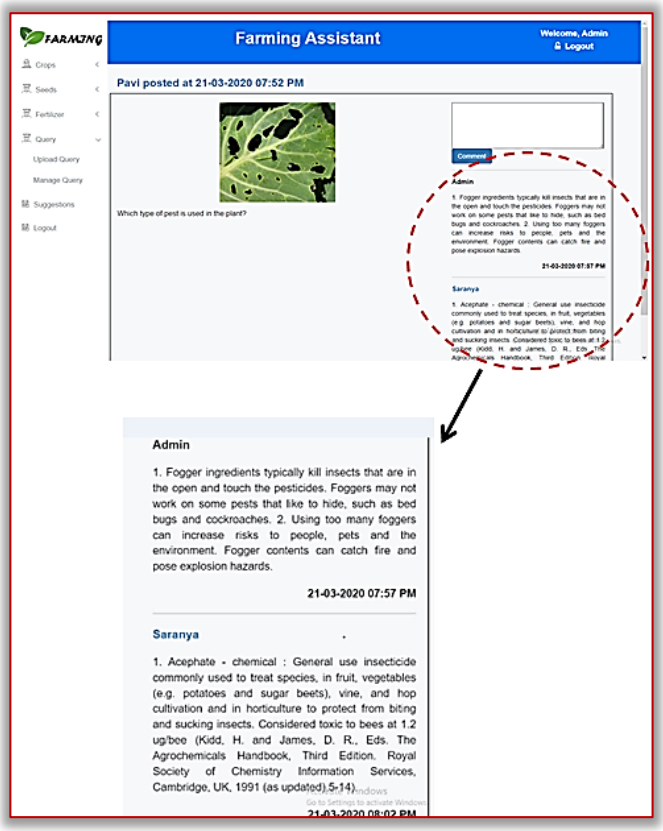

Figure 14. Farming Assistant Forum

CONCLUSIONS

In this modern world by using the IoT technologies, farming is given a new name called Smart farming to expand the amount and nature of agricultural product and give benefits to the farmers with less human power. The IOT advancement has comprehended the sharp wearable related devices, robotized machines, and self-ruling vehicles.

However, in agriculture, the IOT has brought impact. Many sensors are there to assist agriculture and in this paper, we have used the DHT11 temperature sensor for finding the humidity and crop defects, IR-3000 Moist Tech sensor and Yara N-sensors to give the better fertilizer and the cloud platforms are used to process and store the processed data. So IoT makes the agricultural works as easy with the above mentioned devices and services.

With the help of farming assistant farmer's doubts with respect to cultivation, seed, weather, nutrition, fertilizers needed, plant diseases and crop estimation are clarified. Finally the farming Assistant feature of this system provides a complete guide to the farmers to assist in agriculture with the help of IoT technologies and service.

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