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Automatic Soil Testing System For Crop Fertility

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Abstract: Precision agriculture is essential to ensure that site-specific crop management is implemented, which includes soil nutrient remedies per crop requirement. Though fertilization is key in boosting productivity, there is need for analysis of the potentials and limitations of soil as a basis of recommending the correct type, quantities and application time of fertilizers to counter uncertainty in fertilizer use. The complexity of finding the optimal fertilization range greatly contributes to major inefficiencies like productivity losses, resource wastage and increased environmental pollution caused by farmers, use of intuition, trial and error, guesswork and estimation. With these, farmers unable to predict what impact their decisions will have on the resulting crop yields and the environment. Some solutions implemented for soil fertility management such as use of mobile laboratories or imported equipment have had their share of challenges such cost of implementation, ease of use and adaptation to the local environment. Other available solutions including taking soil to laboratories for testing is tedious, time consuming and inconsistent. This study proposed model which will be able to find pH of given soil sample after that system will predicts micronutrients (NPK) level of soil sample and recommend the best fertilizer for sampled soil. The complete data will handle by IoT server firstly after that same data will be handover to local host server for user report formation.

***Keywords* —pH, Micronutrients, IoT, Fertilizer, local web server and cloud server**

I. INTRODUCTION

Majorly, farmers' choice of crop, planting and fertilizing decisions are made based on reference, such as history of use or advice from friends, fellow farmers or extension officers when no consideration is made in regards to specific farm fertility analysis . The use of upgraded tools and precision farming techniques has influenced the yields in the recent years [1]. This dynamism calls for farmers to adapt to the changes in the sector; taking into consideration suitability of soil to sustain crop, weather changes, precautions in disease and fertilizer management among other aspects [2]. Agricultural productivity is affected by many factors among them soil fertility. Different factors influence soil fertility such as environmental, human or biotic, which affect the nutrient levels and influence crop health sustainability. Soil PH, soil temperature, microbial activity and moisture content influence nutrient release from fertilizers [3]. Precise measures of the aforementioned elements therefore guide the amount of fertilizer to supplement and time of application to ensure maximum consumption. Weather plays a key role in deciding when to apply as rain or sunshine affects the nutrient flow in the soil. These nutrients include macro and micro nutrients. The macronutrients include Nitrogen, Phosphorus and Potassium (NPK) while the micronutrients include Calcium, Magnesium, Manganese and Iron amongst others which constitute major fertilizers. NPK is a complex fertilizer that incorporates the named macro and micronutrients with different ratios of the nutrients. Soil fertility analysis is a basis of recommending correct type and quantities of fertilizers considering the complex fertilizers have different nutrient ratios that may be little or too much for the crops.

It is important for the farmer to identify their 'necessary time' as this may vary and apply the correct ratio of fertilizer as it is important to ensure efficient soil nutrient management [4].

Various solutions have been proposed and implemented to help the farmer understand their farm needs. Some include use of agricultural laboratories tests, mobile laboratories tests, and smart systems other than home remedies. Each have their challenges making it difficult for the farmer to use. This research involves development of a model that checks NPK levels based on the temperature, and PH levels and recommend fertilizer to a farmer and best time to apply to avoid fertilizer burn, leaching, wash off, denitrification and volatilization which are caused by extreme weather conditions; specifically, sunshine and rainfall

Many farmers have a problem choosing the right fertilizer to apply to their fields KARI (2006). Farmers' fixated mind-sets, guesswork, trial and error and use of intuition are a bottleneck as most trust the fertilizer they think is right according to previous use or copied techniques. This can be caused by either lack of information on available solutions or lack of interest in the existing solutions. One's intuition and experiences vary, not all have the same judgment and this leads to inconsistency in decision-making in regards to fertilization.

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There is need for site-specific real time soil testing to replace the tedious, time wasting offsite soil testing practices. Most farmers may not go into this but instead take up other homemade solutions like use of litmus paper or bare observation where precision is questionable To overcome these all problems we are proposing the solution in which NPK value to be measure and suggest the proper fertilizer for the given soil. In this proof of concept model first we are finding pH value of soil which is used to predict the NPK values and depending the NPK value which type of fertilizer supposed to be use for the soil. The detailed are given succeeding points.

The complete proof of concept model is developed for the testing soil nutrients which completely described in following points.

II. SYSTEM DEVELOPMENT

The complete system is divided into the three parts: first, one is sensing pH value and sends it towards the controller i.e. Node MCU, second part is receive pH value on cloud server and process on it and convert it to Nitrogen (N), Potassium (P) and Potash (K) and then same N, P, K value send to local host server.

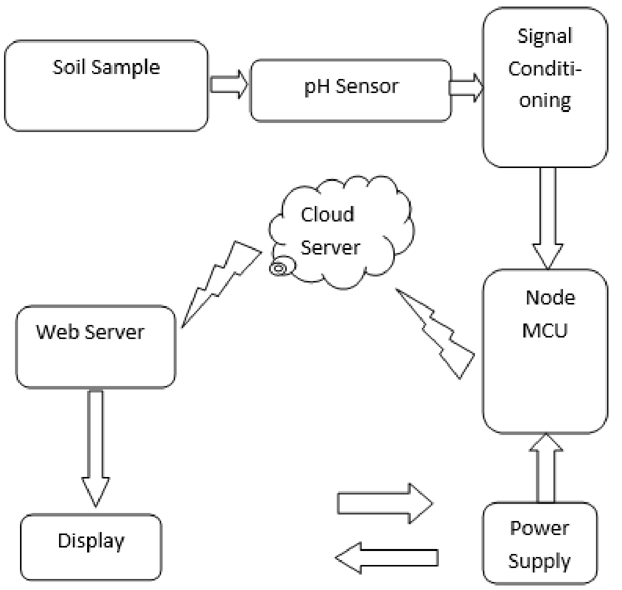

Fig. 1 Block Diagram of System

A. Nutrient Sensing

The amount of macro-nutrients and micro-nutrients present in soil analyzed from the pH value. Figure 2 gives the relationship between the nutrient levels and pH value [6]. In figure green color indicates the proper quantity; yellow color indicates sufficient quantity and red color indicate less quantity of element present in soil. As shown in figure it's been concluded that when pH value become zero then soil has equal proportion of nitrogen, phosphorus, potassium, Sulphur, calcium and magnesium.

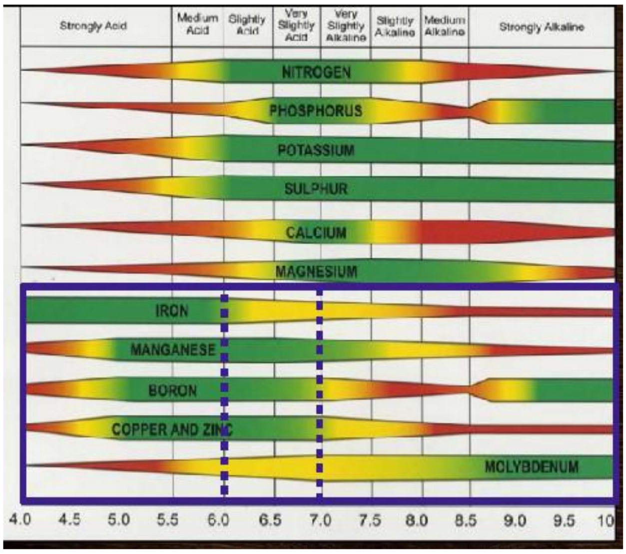

Fig. 2: Relationship between pH value and nutrient availability

pH sensor sense the pH level of given soil and do processing on it after processing the actual pH value sends toward the microcontroller. Here the microcontroller is Node MCU which is comes with built in Wi-Fi module. With the help of Wi-Fi it sends real time pH sensor values to the cloud server.

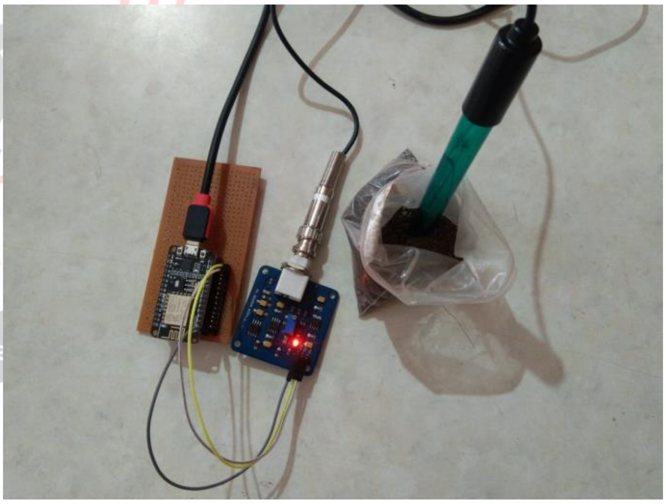

Fig. 3: Practical Model

B. Cloud Server and Data Handling

After receiving pH value on cloud server (Thinkspeak.io), here pH values get converted into N, P and K value with the help of matlab and shows the graphical representation of the same. Then according to the N, P, and K values what type of fertilizer should be used in that given sample of soil is also predicted on cloud server user interface window.

C. Local Host Server

To handle data on local computer one local host server is created. This local server receives the all corresponding real time data from cloud server like N, P, K and fertilizer and do process on it and shows the graphical representation of

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the same values. In this local server login facility is also created which helps to keep specific user data safe and can do pdf of the data.

III. Results and Discussion

Model is verified by different soils samples from the different area of Maharashtra state, India and tests the same soil in Labs and with our project. The results are shown in table.

Table-I Results Comparison

Soil	Nutrients	Soil Test Results (Lab)	Soil Test Result (Project)	Predicted Fertilizer (Kg/Hctr)
Black Soil Sangamner, A.Nagar	N	250.8	200	14-35-14=400
	P	11.31	10	17-17-17=15
	K	431.2	400	20-20=200
	pH	7.96	8	
Red Soil, Shamirpeth	N	244.61	250	14-35-14=400
	P	11.31	10	17-17-17=15
	K	464.8	440	20-20=180
	pH	6	6.9	
Red Soil, Dapoli	N	222.66	300	14-35-14=400
	P	6.69	5	17-17-17=18
	K	275.52	200	20-20=180
	PH	6.3	6.8	
Black Soil, Rahuri, A.nagar	N	241.17	200	14-35-14=400
	P	9.69	10	17-17-17=20
	K	264.32	400	20-20=200
	pH	8.22	8	

Figure 4:Experimental Results for Sangamner Soil sample

In figure 4, figure showing results of sangamner soil samples in which there are six various results fields in which top most left graph showing incoming data from pH sensor on cloud server and top most right field showing the pH value of system. Middle left shows the pH value on gauge meter, middle right figure shows the graphical representation of estimated NPK values, lower left graph shows the soil nature i.e. soil is basic, neutral or acidic in nature and the lower right graph showing the predicted fertilizer for given sample of soil.

IV. Conclusion

From the above results, it concludes that the actual results and the predicted results are much similar. The accuracy for the predicted results is up to 70-80% to the actual result. But due to the accuracy of pH sensor system does not meet to the actual result of pH. Hence, the predicted results fail sometimes and need more data to analyses to meet high accuracy. Accuracy of system may increase after applying the Artificial Intelligence algorithms and more accurate pH sensors.

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