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A survey on soil testing technique

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ABSTRACT

Continuous cropping without the adequate measurement and provisioning of the soil nutrient may endanger the sustainability of the agriculture. Soil nutrient measurement s greatly required for proper plant growth and effective fertilization. A key in soil testing for formulated fertilization is to determine the number of soil nutrients, followed by recommendation of the nutrient needs and site-specific fertilization. Nitrogen, Phosphorus and Potassium are the three important nutrients required for plant growth.

Keywords— *Phosphorous (P), Potassium (K), Nitrogen (N)*

1. INTRODUCTION

Production of the crop depends on the interaction between soil and plant properties. Maximization of production of crops is reflected by the biological, physical, chemical condition of the soil. Root absorbs required amount of nutrients and water from the soil where biochemical reactions take place. Plant rate of nutrient absorption depends on the minerals available in the soil. Production of crops degrades with the insufficient rate of supply of any necessary nutrients. Although the requirement of a particular nutrient is determined by the plant in the soil, some of the nutrients are necessary for all the plants in a great amount known as Macro moles or Macronutrients. Root environment of the plant can be changed by supplying the nutrient from outside the soil is known as fertilization. However, the proper distribution of fertilizer is required for proper crop production. Over and under provisioning of the fertilizer can greatly reduce the harvest production rate. Traditional fertilization system in Bangladesh relies on farmers experience in cultivation and weather condition. This type of manual fertilization without the proper justification of soil condition is error prone. To fulfil the increasing demand of growing population over years there is a need for increasing food production. Improper use of fertilizers, in turn, results in poor quality of fruits, vegetable lagging in size, taste, quality, quantity. The quantity of NPK is dependent on crop type and on plant growth status. How much quantity of fertilizer to be used is further dependent on the present contents of NPK nutrients in the soil. Since the macronutrients vary even on small scale throughout the cultivated field, numerous researchers have attempted to develop the sensor to map these nutrient contents.

Table 1: Describes five types of Soil and Crop suggested for that particular Soil

Types of soil	Crop
Black Soil	Cotton, Mirch
Red Soil	Groundnut, Castor, Cotton
Sticky Black Soil	Cotton, Sugarcane, Paddy
Clay and Sandy Soil	Bengal Gram
Sandy Soil	Coconut, Pal, gardens

2. TYPES OF SOIL

Soil can be categorized into sand, clay, silt, peat, chalk and loam types of soil based on the dominating size of the particles within a soil.

- **Sandy soil** is light, warm, dry and tends to be acidic and low in nutrients. Sandy soils are often known as light soils due to their high proportion of sand and little clay (clay weighs more than sand). These soils have quick water drainage and are easy to work with. They are quicker to warm up in spring than clay soils but tend to dry out in summer and suffer from low nutrients that are washed away by rain. The addition of organic matter can help give plants an additional boost of nutrients by improving the nutrient and water holding a capacity of the soil.
- **Clay soil:** are heavy soils that benefit from high nutrients. Clay soils remain wet and cold in winter and dry out in summer. These soils are made of over 25 per cent clay, and because of the spaces found between clay particles, clay soils hold a high amount of water. Because these soils drain slowly and take longer to warm up in summer, combined with drying out and cracking in summer, they can often test gardeners.
- **Peat soil**: are high in organic matter and retain a large amount of moisture. This type of soil is very rarely found in a garden

and often imported into a garden to provide an optimum soil base for planting.

- **Silt soil:** are light and moisture retentive soils with a high fertility rating. As silt soils compromise of medium-sized particles they are well drained and hold moisture well. As the particles are fine, they can be easily compacted and are prone to washing away with rain. By adding organic matter, the silt particles can be bound into more stable clumps
- **Chalk soil**: can be either light or heavy but always highly alkaline due to the calcium carbonate or lime within its structure. As these soils are alkaline they will not support the growth of ericaceous plants that require acidic soils to grow. If a chalky soil shows signs of visible white lumps then they can't be acidified and gardeners should be resigned to only choose plants that prefer alkaline soil.

So, based on the type of soil and also its Ph value we can determine types of crop that can be grown in that soil.

3. SOIL QUALITY TESTING

The Soil Quality Testing plays a key role in the Smart Agriculture because based on the results obtained by the tests performed on the soil we suggest the crop to the farmers.

3.1 Soil quality assess

There are 4 fundamental ways to assess soil quality and they are:

3.1.1 Soil Physics: Soil Physics tests the geometrical arrangement or pattern of soil components like soil particles, soil aggregates, water, gas and solute in the soil. Equipment such as pressure plate apparatus, sandbox, neutron moisture meter, and depth density gauge and root scanner are used.

3.1.2 Soil Chemistry and Fertility: Soil Chemistry consists of testing the chemical characteristics of the mineral composition, organic matter, PKN nutrients and Ph levels. Devices such as UV Visible Spectrophotometers, Deep Freezers, microwave digestion units and flame photometers are used. Such studies help in improving the efficiency of nutrient cycling, minimizing nutrient losses.

3.1.3 Soil Biology: It is the study of microbial activity and ecology in the soil of organisms such as earthworms, nematodes, protozoa, fungi and bacteria. Laboratory tools such as laminar flow, BOD incubator and a research microscope with camera and CCTV system are used to view inner layers of the soil. Knowledge of soil biology can help in choosing fertilizers, pesticides and composting systems.

3.1.4 Environmental Soil Science: It deals with the extent of soil pollution due to the city, industrial and agricultural wastes and indiscriminate use of fertilizers for crop production.

3.2 Soil quality test

After accessing soil quality three types of tests will be done. And they are:

3.2.1 Soil Moisture test: Soil moisture test is to be performed first because it plays a Key role in the exchange for water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration. By considering the soil moisture test results we can perform further tests like soil respiration test.

3.2.2 Soil Respiration test: Soil breathes! Soil respiration is an indicator of biological activity or soil life. This activity is as important to the soil ecosystem as healthy lungs are to us. However, more activity is not always better; it may indicate an unstable system. For efficient sampling, the soil respiration test is performed. The best time to run the soil respiration test is when soil moisture is at field capacity.

3.2.3 Soil Bulk Density test: The bulk density measurement should be performed at the soil surface and/or in a compacted zone. Measure the bulk density near the site of the respiration tests. Bulk density is the weight of soil for a given volume. The greater the density, the less pore space for water movement, root growth and penetration and seedling germination. After the completion of the three tests on the soil, the results obtained by them are used to decide which crop is suitable for that particular soil. This can be done by using Rule-based Classifier.

After sowing the seeds we need to regularly check the soil moisture levels and if moisture levels decrease we need to supply fresh water to the field in the required quantity. If water is not supplied to the field the moisture levels of the soil decrease, due to this seed germination cannot be done properly.

We need to measure the actual amount of nutrients present in the soil. For achieving sustainable agriculture maintaining and for minimizing any country's economic losses and environmental impacts, proper management of essential soil nutrients plays a vital role. Technology plays an expedient role for improvement of environment and for achieving the economic goals.

During the growth of the crop at different stages, we need to give the pesticides according to its level of growth so that healthy crop can be maintained. The pesticides which we give to the crop should be given at minimum level because if we give a high level of the pesticide the crop may damage and it also affects the soil nutrients. By using the Soil Quality Testing using Sensors in Smart Agriculture for Crop Production and Maintenance we can have an effective growth of the crop and the crop health can also be maintained. As we use less quantity of the pesticides the soil will not be affected and this also lowers cost in the crop production.

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4. IOT TECHNOLOGY AND AGRICULTURE

4.1 Internet of Things: Concept and Definition

Internet of Things (IoT) it consists of two words- Internet and Things. The term "Things" in IoT refers to various IoT devices having unique identities and have capabilities to perform remote sensing, actuating and live to monitor certain sorts of data. IoT devices are also enabled to have a lively exchange of data with other connected devices and applications either directly or indirectly, or collect data from other devices and process the data and send the data to various servers. The other term "Internet" is defined as Global Communication network connecting trillions of computers across the planet enabling sharing of information. As forecasted by various researchers, 50 Billion devices based on IoT would be connected all across the planet by the year 2020.

An ideal IoT device consists of various interfaces for making connectivity to other devices which can either be wired or wireless.

Any IoT based device consists of the following components:

- I/O interface for Sensors.
- Interface for connecting to the Internet.
- Interface for Memory and Storage.
- Interface for Audio/Video.

4.2 IoT enabling technologies

Internet of Things has a strong backbone of various enabling technologies- Wireless Sensor Networks, Cloud Computing, Big Data, Embedded Systems, Security Protocols and Architectures, Protocols enabling communication, web services, Internet and Search Engines.

4.2.1 Cloud Computing: Cloud computing also known as on-demand computing is a type of Internet-based computing which provides shared processing resources and data to computers and other devices on demand. It can be in various forms like IaaS, PaaS, and SaaS etc.

4.2.2 Big Data Analytics: Big data analytics is the process of examining large data sets containing various forms of data types—i.e. Big Data – to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful business information.

4.2.3 Wireless Sensor Network (WSN): It consists of various sensors/nodes which are integrated together to monitor various sorts of data.

4.2.4 Communication Protocols: They form the backbone of IoT systems to enable connectivity and coupling to applications and these protocols facilitate the exchange of data over the network as these protocols enable data exchange formats, data encoding and addressing.

4.2.5 Embedded Systems: It is a sort of computer system which consists of both hardware and software to perform specific tasks. It includes microprocessor/microcontroller, RAM/ROM, networking components, I/O units and storage devices.

4.3 IoT applications in agriculture

With the adoption of IoT in the Agricultural sector, these days and this, in turn, has led to the development of "Agricultural Internet of Things (IoT)"

Table 2: Various projects and applications are integrated into agricultural fields leading to efficient management and controlling of various activities

Application Name	Description
Crop Water Management	In order to perform agricultural activities in efficient manner, adequate water is essential. Agriculture IoT is integrated with Web Map Service (WMS) and Sensor Observation Service (SOS) to ensure proper water management for irrigation and in turn reduces water wastage.
Precision Agriculture	High accuracy is required in terms of weather information which reduces the chances of crop damage. Agriculture IoT ensured timely delivery of real time data in terms of weather forecasting, quality of soil, cost of labor, and much more to farmers.
Integrated Pest Management or Control (IPM/C)	Agriculture IoT systems assures farmers with accurate environmental data via proper live data monitoring of temperature, moisture, plant growth and level of pests so that proper care can be taken during production.
Food Production and Safety	Agriculture IoT systems accurately monitors various parameters like warehouse temperature, shipping transportation management system and also integrates cloud based recording systems.

4.4 Benefits of IoT in Agriculture

The following are the benefits of IoT in Agriculture:

- IoT enables easy collection and management of tons of data collected from sensors and with the integration of cloud computing services like Agriculture fields maps, cloud storage etc., data can be accessed live from anywhere and everywhere enabling live monitoring and end to end connectivity among all the parties concerned.
- IoT is regarded as a key component for Smart Farming as with accurate sensors and smart equipment's, farmers can increase the food production by 70% till the year 2050 as depicted by experts.
- With IoT productions, costs can be reduced to a remarkable level which will, in turn, increase profitability and sustainability
- With IoT, efficiency level would be increased in terms of usage of Soil, Water, Fertilizers, and Pesticides etc.
- With IoT, various factors would also lead to the protection of the environment.

4.5 IoT and Agriculture Current Scenario and Future Forecasts

Table 3: Shows the growth of IoT based adoption in agriculture sector from the year 2000-2016 and forecasts of the year 2035

Year	Data Analysis
2000	525 Million farms connected to IoT
2016	540 Million farms till date are connected to IoT
2035	780 Million farms would be connected to IoT

5. CONCLUSIONS

The Smart Agriculture has to be used for the effective growth of the crop and by using it we can maintain the health of the crop. This is relatively a modern research field and it is expected to grow in future. There is a lot of work to be done in this emerging area. Here we get a basic knowledge that how the soil quality can be tested and based on the tested results the kit suggests the crop to the farmer which helps for the better growth of the crop and crop production, in farming of the Smart Agriculture.

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