Analysis of Crop Detection Based on Various Soil Testing Methods

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Abstract— Agriculture has the largest contribution in the GDP of our country. But still the farmer's don't get worth price of the crops. It is mostly happens due to improper irrigation or inappropriate crops selection or also sometimes the crop yield is less than that of expected. By analyzing the soil and atmosphere at particular region best crop in order to have more crop yield and the net crop yield can be predict. This prediction will help the farmers to choose appropriate crops for their farm according to the soil type, temperature, humidity, water level, spacing depth, soil PH, season, fertilizer and months. The objective of this study is to develop a methodological framework to define the accuracy requirements for early estimators of cropland area, crop area and crop yield in Senegal. These requirements are made according to (i) the inter-annual variability and the trend of historical data, (ii) the calendar of official statistics data collection, and (iii) the time at which early estimations of cropland area, crop area and crop yield can theoretically be available. All this can be done using the smart phones and IOT devices. Farmers can get the required data or information as well as monitor his agriculture sector. IOT connects the whole world with the help of sensors, acutators and other embedded devices. There lies an urgent need for using IOT in agriculture which makes it more reliable for farmers.

Keywords: Microcontroller, Agriculture, Prediction, IOT, Data analytics, Arduino

I. INTRODUCTION

INTERNET of Things (IoT) has found its in several areas, such as connected industry, smart city [1], [2], smart-home [3] smart-energy, connected car [4], smart-agriculture [5], connected building and campus [6], health care [7], logistics [8], among other domains. IoT aims to integrate the physical world with the virtual world by using the Internet as the medium to communicate and exchange information [9]. IoT has been defined as a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A key area of interest in this paper is the application of IoT in agriculture. The application of IoT in agriculture is about empowering farmers with the decision tools and automation technologies that seamlessly integrate products, knowledge and services for better productivity, quality, and profit.

The Data Analysis is process of inspecting cleansing, modelling data with the goal of discovering useful information and conclusions. It is a process of analysing, extracting and predicting the meaningful information from huge data to extract some pattern. This process is used by companies to turn the raw data of their customer to useful information. This analysis can also be used in the field of Agriculture. Most farmers were relied on their long-terms experiences in the field on particular crops to expect a higher yield in the next harvesting period But still the they don't get worth price of the crops. It is mostly happens due to improper irrigation or inappropriate crops selection or also sometimes the crop yield is less than that of expected. Agricultural researchers insist on the need for an efficient mechanism to predict and improve the crop growth and Majority of research works in agriculture focus on biological mechanisms to identify cropgrowth and improve its yield. The outcome of crop yield primarily depends on parameters such as variety of crop, seed type and environmental parameters such as sunlight (Temperature), soil (ph), water (ph), rainfall and humidity. By analysing the soil and atmosphere at particular region best crop in order to have more crop yield and the net crop yield can be predict. This prediction will help the farmers. To choose appropriate crops for their farm according to the soil type, temperature, humidity, water level, spacing depth, soil PH, season, fertilizer and months.

A. Motivation:

Farming is the main occupation of India. About 70 percent of primary and secondary business is based on farming. So for the betterment of farming many farmers have started using the new technologies and methods. But people don't have awareness about the cultivation of the crops in a right time and at a right place. In this case an idea to identify the suitability of crops and yield based on various factors that affect the production can increase the quality and the yield of crops, thereby increase the economic growth and attain profitability.

Development of agriculture using technology will be very much useful in cultivation. For a new agricultural area, without knowing or monitoring the important parameters of the soil, cultivation will be difficult and so the farmers suffer financial losses. This project provides a brief overview of the soil monitoring system using sensors. Various soil sensors are used to measure temperature, moisture and light, humidity and Ph value. The information from the sensors in the soil is sent to the MCP3204 A/D converter then from A/D converter it sent to the cloud through Raspberry pi. Finaly we can see the information saved to cloud on mobile phone as well as laptop. On the basis of information we know which crop is suitable with given soil parameter. Thus this advanced technology helps the farmers to know the accurate parameters of the soil thus making the soil testing procedure easier.

The application of IoT in agriculture is about empowering farmers with the decision tools and automation technologies that seamlessly integrate products, knowledge and services for better productivity, quality, and profit. Recent surveys on the IoT in agriculture have focused on the challenges and constraints for large-scale pilots in entire supply chain in the agrifood sector [5], [20]. Some of the key issues addressed are the need for new business models, security and privacy, and data governance and ownership solution. The IoT integrates several technologies that already exist, such as WSN, RF identification, cloud computing, middleware systems and end-user applications. The application of IoT in agriculture is about empowering farmers with the decision tools and automation technologies that seamlessly integrate products, knowledge and services for better productivity, quality, and profit.

In this paper, an extensive review of IoT in agriculture is carried out. The review includes a survey of published articles, white paper and existing solutions. The IoT ecosystem for agriculture is discussed in detail based on four major components which are IoT devices, communication technology, Internet, data storage, and processing. The application of IoT and DA and how it is enabling smart agriculture is presented. Furthermore, the benefits, challenges. open issues, future trends and opportunities are discussed.

Laboratory tests often check for plant nutrients in three categories:

- Major Nutrients: Nitrogen(N), Phosphorous(P), Potassium(K).
- Secondary Nutrients: Sulphur, Calcium, Magnesium
- Minor Nutrients: iron, manganese, Copper, Zinc, boron

To achieve good yield and quality, nutrient balance has to be maintained. Nutrient imbalance may result in deficiencies, toxicities or interference of one nutrient with the absorption of others. This may result in stress to the crop, causing a decrease in quality and/or yield

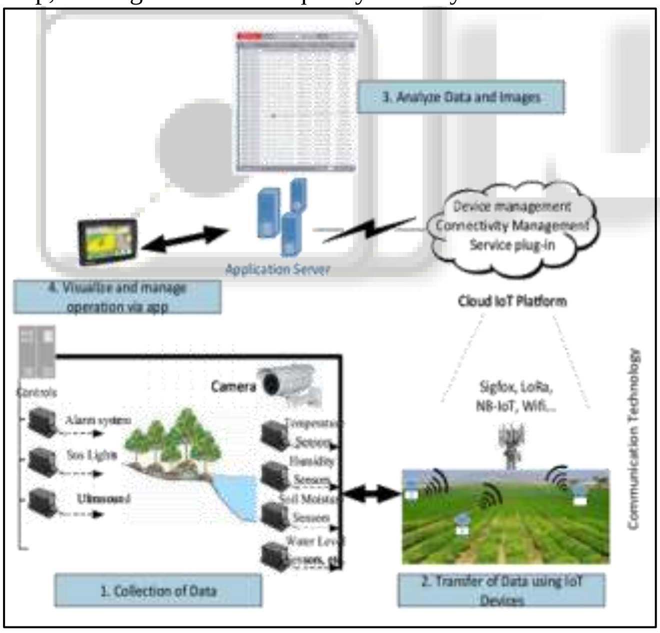

Fig. 1: Illustration of IOT ecosystem for agriculture.

IoT ecosystem consists of four major components which are: 1) IoT devices; 2) communication technology; 3) Internet; and 4) data storage and processing. Fig. 1 illustrates the IoT ecosystem. The four major components are essential for any IoT application. The description of the IoT components as it relates to agriculture is provided as follows.

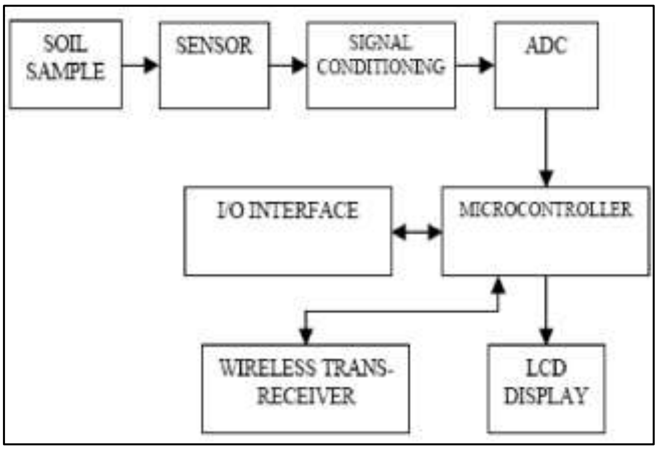

Fig. 2: System architecture.

Atmospheric Digital Temperature & Humidity Sensor: DHT11 sensor is chosen to monitor ambient temperature and humidity. This sensor proved to be reliable and stable. The output from DHT11 is a calibrated digital signal which can be interfaced directly to Arduino Uno port pin. It utilizes exclusive digital-signal-collecting-technique and humidity sensing technology that calibrates automatically. With its small size, low power consumption, and ability to function in all kinds of harsh application occasions, makes the DHT11 suitable to use as a drought monitoring sensor. Earth included bedrock and the weathered bedrock called soil. Soil is a blend of inorganic mineral particles and natural matter of differing size and arrangement.

- Soil Moisture Sensor: In spite of the significance of soil moisture data, broad and additionally ceaseless estimation of soil dampness is everything except non-existent. "The absence of a persuading approach regarding estimation of soil dampness is a significant issue". Unmistakably, a need exists for ceaseless estimations of surface soil dampness. Soil Moisture sensor FC-28 accompanies a couple of tech tests that can be embedded in the dirt. A little current stream through the tests and the level of protection will be measured. The protection increments if the dirt is dryer. The yield from the sensor is a simple yield that can be associated with one of the simple to advanced port (ADC) accessible on the microcontroller board. FC-28 soil dampness sensor module has been adjusted keeping in mind the end goal to confirm precise operation of the gadget. A pot with gardening soil was taken and the dampness levels are changed frequently.
- PH value sensor: Soil pH refers to the acidity or alkalinity of the soil. It is a measure of the concentration of free hydrogen ions (H+) that are in the soil. Soil pH can be measured in water (pHw) or a weak calcium chloride solution (pHCaCl). The pH range is from 0-14, with value of 7 being neutral. Soil pH values (as measured in a water and soil solution) indicate:
  - Strong acidity if less than 5.0
  - Moderate acidity at 5.0 to 6.0
  - Neutral between 6.5 and 7.5
  - Strong alkalinity for values of 8.5 and above
- Lcd display: That uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light

directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of many small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance.

- Why Minerals are important?
- Nitrogen. The nitrogen-deficient plants are light green in colour. The lower leaves turn yellow and in some crops they quickly start drying up as if suffering from shortage of water. The growth is stunted and stems or shoots are dwarfed. In cereals tillering is restricted. In corn if nitrogen deficiency persists the yellowing will follow up the leaf midrib in the typical V-shaped pattern with the leaf margins remaining green. The drying up of lower leaves is generally referred to as firing. In small grains, namely, wheat, barley and oats, the nitrogen- starved plants are erect and spindly and the leaves have yellowish-green to yellow colour. The stems are purplish-green. In potato, in the later stages of growth, the margins of lower leaflets lose their green colour and become pale-yellow. In cotton the blades and petioles are reduced in size, turn yellow or brown and die. Plants produce fewer lateral branches, reduced number of fruiting branches, and very much reduced number of flowers and bolls. In legumes the growth is stunted and the lower leaves are pale-yellow or brownish in colour. In citrus the leaf shedding is heavy. Their leaves are small in size, thin and fragile and have light green colour. In deciduous fruit trees the leaves have yellowish green appearance. The old, mature leaves are discoloured from base to tip. Under prolonged deficiency twigs become hard and slender. In vegetables there is retarded growth with leaf chlorosis. The stems are slender, fibrous and hard.
- Phosphorus: Generally the plant is dark-green but the lower leaves may turn yellow and dry up. Growth is stunted and leaves become smaller in size. In corn, leaves and stems have a tendency to become purplish; young plants are stunted and dark-green in colour. Small grains have dark-green colour and often have purplish tinge. They have retarded growth. In potato, in early stages, the plants have stunted spindly growth. The tubers have rusty-brown lesions in the flesh in the form of isolated flecks which sometimes join together to produce larger discoloured areas. The cotton plants have dark-green colour, leaves and stems are small, and the bolls mature late. Besides the dark-green colour of legume plants their petioles and leaflets are tilted upwards. The plants are spindly and stunted. Their stems often turn red. In citrus the plants show reduced growth. The older leaves at first lose their deep-green colour and luster, and develop faded green to bronze colour. Necrotic areas develop on such leaves. In deciduous fruit trees the young leaves have dark-green colour while mature ones have bronze or ochre dark-green colour. The new twigs are slender. In vegetables although the growth is retarded the leaves do not show symptoms of chlorosis. In many crops the under surface of leaves develops reddish-purple colour. The stems are slender and woody. They bear small, dark-green leaves.
- Potassium. The margins of leaves turn brownish and dry up. The stem remains slender. In tobacco there appear small spots of dead tissue between the veins, at leaf tips and margins which are tucked or cupped up. In maize, in the young stage, the edges and tips become dry and appear scorched or fired. At a later stage in well-grown plants the leaves are streaked with yellow and yellowish-green colour, and the margins dry up and get scorched. Similar symptoms are shown by oats, wheat and barley. In potato the deficiency of potassium is acutely manifested. The plant growth is retarded, the internodes are somewhat shortened, the leaf size is reduced and they form a sharper angle with the leaf petiole. The leaflets become crinkled and curve downward. The older leaves become yellowish, develop a brown or bronze colour, starting from the tip and edge and gradually affecting the entire leaf, and finally die. Malnutrition symptom in cotton is observed in 'cotton rot', which first appears as yellowish-white mottling and then changes to yellowish-green; subsequently yellowish spots appear between the veins. The centres of these spots die and numerous brown specks occur at the top, around the margin and between the veins. The breakdown first occurs at the tip and margin of the leaf. The leaf curls downwards before it becomes reddish-brown and dries up. In legumes the first symptoms consist of yellow mottling around the edges of the leaf. This area soon dries up and dies. The plants have stunted growth. In citrus there occurs there occurs excessive shedding of leaves at blossom time. There is a tendency for the young shoots to shed before they become hardened. The leaves are small. In deciduous trees the necrosis (death of tissues) in foliage occurs, the necrotic areas varying in size from very small dots to patches or extensive marginal areas. Foliage, especially of peach, becomes usually crinkled. Twigs are usually slender. In vegetable crops in the older leaves bronze and yellowish-brown colours are manifested near the margins. Specks develop along the veins of the leaf. Ultimately the tissue deteriorates and dies.

II. APPLICATION OF IOT IN AGRICULTURE

Type	Spectrum	Transmission Distance	Type of Network	Frequency Bands	Bi-directional link	Data Rate
802.11a/b/g/n/ac	Unlicensed	6 - 50 m	WLAN	2.4/5 GHz	✓	2 Mbps - 7 Gbps
802.11ah	✓	1000 m	✓	various, sub -1 GHz	✓	78 Mbps
802.11p	Licensed	<1 km	✓	5.9 GHz	✓	
802.11af (white space)	✓	1 km	✓	54-790	✓	26.7 - 568.9 Mbit/s
SigFox	✓	Rural: 30-50 km Urban: 3-10 km	LPWA	868 or 902 MHz	✓	100 bps(UL), 600 bps(DL)
LoRaWAN	✓	<20 km	✓	various, sub-GHz	✓	0.3-37.5 kbps
Ingenu/OnRamp	✓	15	✓	2.4 GHz	χ	78 kbps (UL), 19.5 kbps (DL)
Telensa	✓	1 km (Urban)	✓	60 MHz, 200 MHz, 433 Mhz, 470 MHz, 868 MHz, 915 MHz	✓	62.5 bps(UL), 500 bps(DL)
3GPP NB-IoT	Licensed (cellular)	<35 km	✓	450 MHz - 3.5 GHz	✓	250 kbps
3GPP LTE-MTC (Cat-M1)	✓	<5 km	WWAN	1.4 MHz	✓	200 kbps
EC-GPRS	✓	✓	✓	GSM licensed bands	✓	240 kbps
WiMAX	Licensed and Unlicensed	up to 50-80 km	✓	2 - 11 Ghz, 10 - 66 Ghz	✓	70 Mbps
Bluetooth	Unlicensed	< 100 m	WPAN	2.4 GHz	✓	2 Mbps - 26 Mbps
ANT+	✓	<30 m	✓	2.4 GHz	✓	
MiWi	✓	<50 m	✓	Sub-GHz, 2.4 GHz	✓	256
ZigBee	✓	< 1 km	WHAN	2.4 GHz	✓	250 kbps
Z-Wave	✓	< 100 m	✓	900 MHz	✓	100 kbps
Thread (6LoWPAN)	✓	< 30 m	✓	868/915/2450 MHz	✓	250 kbps
Enocean/ (ISO/IEC 14543-3-10)	✓	< 30 m	✓	900 MHz	✓	125 kbps
WirelessHART	✓	< 228 m	WFAN	2.4 GHz	✓	250 kbps
NFC	✓	< 20 cm	P2P	13.56 MHz	χ	424 kbit/s

Fig. 3: Communication Technology.

In agriculture several factors can be monitored, these factors depend on the sector of agriculture under considerations. The key factors to be monitored are highlighted and discussed as follows. 1) Crop Farming: In crop farming, there are several environmental factors that affect farm produce. Acquiring such data help to understand the patterns and process of the farm. Such data includes, the amount of rainfall, leaf wetness, temperature, humidity, soil moisture, salinity, climate, dry circle, solar radiation, pest movement, human activities, etc. The acquisition of such detailed record enables optimal decision making to improve the quality of the farm produce, minimize risk, and maximize profits. For instance, the solar radiation data gives information about the plants exposure to sunlight from, where the farmer can identify if the plants are properly exposed or over exposed. The soil moisture content gives information on the dampness of the soil which can help in controlling soil conditions and reduce the risk of plant diseases. Furthermore, timely and accurate weather forecasting data, such as, climatic changes and rainfall, can improve the productivity level. In addition, such data can help farmers in the planning stage and reduce the cost of labor. The farmers can also take corrective and preventive measures in advance based on the data provided. The pest movement data can be collected and remotely fed live to the farmers for pest control or used to provide advice to the farmers based on record tracking of pest attacks.

Agricultural Machinery: IoT-based agricultural machinery can help improve crop productivity and reduce grain losses. By proper mapping, use of GPS and global navigation satellite systems (GNSSs) the machinery can be operated in autopilot mode. The machines which include vehicles, unmanned aerial vehicles (UAVs) and robots can be remotely controlled based on the available information collected via the IoT system for precise and efficient application of resources to required farm areas. The machinery can also collect data and such data can help farmers in mapping their field for planning programs, such as fertilizing, irrigation, nutrition. For example, CLAAS, an agricultural machinery manufacturer has implemented IoT on their equipment, enabling their machinery to be operated in auto pilot mode. Another solution is the Precision hawk's UAV sensors, which can provide farmers information, such as wind speed, air pressure, among other parameters. The solution can also be used for imagery and mapping of agricultural plots.

Prediction: IoT provides big data that can be studied over time to estimate the present environmental conditions. The data collected across different types of networks sensors can be studied using DA and smart algorithm can be developed to predict the environmental changes and provide data driven solutions. Although IoT data can help in controlling various aspects of a farm, such as the irrigation systems, the data can also be used to predict and warn farmers against disease or extreme weather conditions, such as flood or drought. For instance, in forestry, the sensors can be used to monitor fire outbreak or predict the region in a forest that provides high risk of fire outbreak. This information can help the firefighters to take preventive measures on the exact location. Other area of prediction includes early warning against natural disasters to improve emergency response.

III. IOT AND DATA ANALYTICS IN AGRICULTURE

Accurate data analysis in farming plays a major role in improving the operational efficiency and increasing productivity. DA has been categorized into types based on requirement of IoT applications This includes real-time analytics, off-line analytics, memory-level analytics, business intelligence level analytics, and massive analytics. The data consist of sensor data, audio, images, and video. Image processing has been extensively used in agriculture for various purposes ranging from detection of disease in leaf, stem, and fruit, quality of fruits, and weed detection and irrigation. Recently, the combination of image processing and IoT in agriculture is being carried out to achieve higher quality produce and reduce crop failure. This involves the use of drones to capture aerial images at regular interval as well as monitoring of environmental factors using the IoT devices. There are several DA methods which has been discussed in detail. The methods are categorized into classification, clustering, prediction, and association rule. The discussion of these methods is outside the scope of this paper. We discuss the importance of DA in agriculture and how DA can help in insurance, prediction, storage management, decision making, farm management, and precision.

IV. SYSTEM DESIGN

All computer software needs certain hardware components or other software resources to be present on a computer. These prerequisites are known as system requirements. In other words, system requirements are giving to be met in the design of a system or sub-system.

A. Methodology:

1) Prepare Soil Solution.
2) Place test tube containing solution near color sensor.
3) NPK values will displayed on LCD display.
4) Paste the same values in UI.
5) Prediction of crop using Difference Algorithm for entered NPK values.
6) If user want another crop instead suggested can select another one using dropdown.
7) Sending same result to user mail id and mobile number.

B. Arduino:

Fig. 4: Arduino board

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC- to- DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino

C. *Color Sensor:*

Fig. 5: Color Sensor

Color Sensor Module has 4 LEDs with TCS3200 Color Sensor IC.Module is designed in such way that 4 bright LEDs will light the object and reflections from that object will strike the TCS3200 Color Sensor IC to detect the colour of an object. As its name gives us clear idea about its application, it is basically used to detect colour of an object. It has variety of applications in industrial, medical as well as consumer's areas. Note that, as per TCS3200 datasheet, TCS3200 product is not designed to use in critical applications, where failure or malfunction of this product may result in any lives injury or death. Any such use by customer is completely at the customer's risk.

D. *Algorithm:*

```
step 1: Initialize NPK_SOIL_SAMPLE
step 2: For crop_name,CROP_NPK in dataset.items():
        diff_npk <-- difference between soil NPK_SOIL_SAMPLE and CROP_NPK
        list_diff[crop_name] <-- diff_npk
        list_sum[crop_name] <-- sum(diff_npk)
      end for
step 3: Initialize best_crop[] to NONE
step 4: For crop_name,CROP_NPK in list_sum:
      if CROP_NPK==0 then
        best_crop.add(crop_name)
      end if
      end for
step 5: if best_crop is NONE:
excess_npk_crop <-- [crop_name for crop_name,CROP_NPK in list_sum<0]
        lack_npk_crop <-- [crop_name for crop_name,CROP_NPK in list_sum>0]
        if excess_npk_crop.length>0 then
             suitable_crop <-- excess_npk_crop[0]
             for crop_name in excess_npk_crop:
if list_sum[crop_name] >= list_sum[suitable_crop] then
                   suitable_crop <-- crop_name
                   best_crop.add(suitable_crop)
             end if
end for
        else then
             suitable_crop <-- excess_npk_crop[0]
             for crop_name in lack_npk_crop:
if list_sum[crop_name] >= list_sum[suitable_crop] then
                   suitable_crop <-- crop_name
                   best_crop.add(suitable_crop)
             end if
          end for
step 6: print best_crop
```

V. RESULTS

The operator enter NPK values in textbox and click apply button then respective npk scroll bar will set automatically. Immediate effect system shows best suitable crop(s) for that land. Operator enters the user mail id in mail box, mobile number in mobile number text box then click send button to send report. This report contains details of NPK value of tested soil and suitable crop's details like adding extra NPK to crop and diluting excess NPK in soil.

Agriculture are gradually being replaced and enhanced by more sophisticated and accurate digital and electronic device. A high percentage of agriculture revenue is lost to power loss, incorrect methods of practicing. This is reduced by the use of smart sensors. The proposal is to perform the agriculture in smart land more efficient way. In addition, this method advocates for the use of the Internet of Things. Internet of things need enabled the farming worker crop checking not difficult Also proficient should improve those benefit of the crop and henceforth benefits to the rancher. Sensors for distinctive sorts are used to gather information the majority of the data of crop states and Ecological transforms and this data will be transmitted through organize of the farmer/devices that initiate restorative activities. Farmers are associated and mindful of the states of the agriculture field in anytime and anyplace in the world.

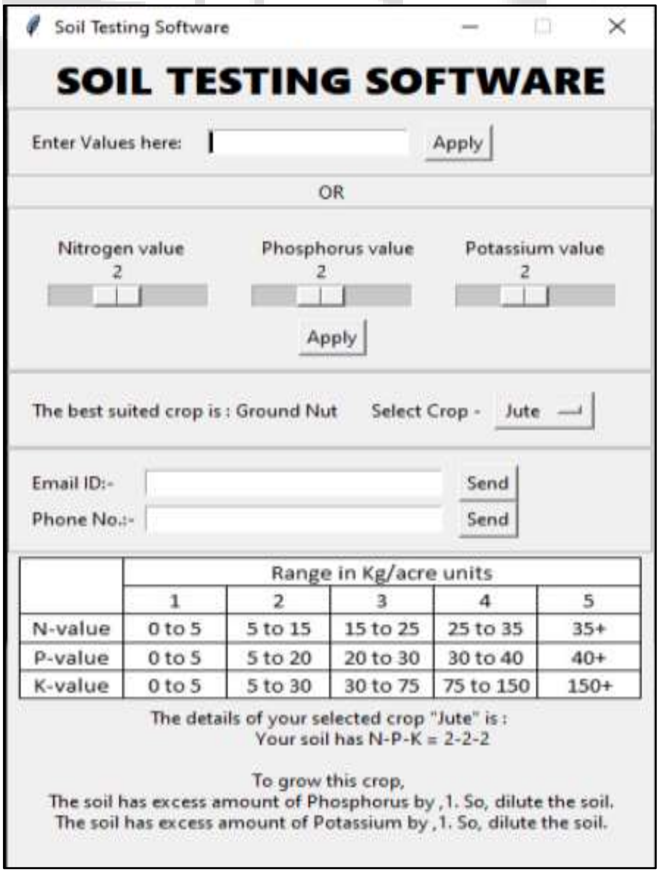

Fig. 6: UI of system

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