Ideal Crop Selection in a Specific Location: Measuring Temperature, Humidity, pH level and Purity of Air Through Usage of Arduino

Adittya Soukarjya Saha[1], Junaed Iqbal[1], Md Shehabul Islam[1], Nadia Tasnim Mim[1]
Tarek Ferdous[1]

[1] Department of Computer Science and Engineering, BRAC University,
66 Mohakhali, Dhaka 1212, Bangladesh
{sahaadittya, junaedromim, shehabul97,
mimnadiatasnim, tarekferdous3}@gmail.com

Abstract. This paper is about a way to test the soil for plantation by measuring soil components and surrounding environment of target area. This device consists of 4 modules: (1) Arduino as microprocessor, (2) Necessary sensors, (3) Power source and (4) Display to show results of each test. Sensors are used to get the desired result and then shown for display. Each line of output is then compared to standard soil measurement for that particular plant to detect compatibility.

1 Introduction

There exists a huge variation in kingdom of plants. Each of them require some sets of specific environment and nutrients to grow and continue to the next generation. This concept got so much attention for growing cash crops. Soil can lose fertility for growing crops years after years. So, there has to be some ways to maintain soil fertility and suitable environment. This device shows a technological approach to make sure healthier growth to cash crops. When thinking about plants we have to consider some factors. pH is such a factor that ensure many important chemical reactions. The level of pH stimulates some required metabolic reaction. Temperature hastens internal reactions and also helps external metabolic reactions. Therefore, temperature as a parameter has to be taken into consideration. Some gas pollutants like CO, CH_4, SO_4, smokes etc. can affect the expected growth of plants. And lastly, to consider hydration certain levels of humidity and moisture is required for specific plants. Taking into account the aforementioned parameters the device has been designed.

The rest of the paper is organized as follows. Section 2 addresses the literature review. Section 3 is about the proposed model, which is made up of the components, dataset, the workflow and the program code. Section 4 contains the experimental setup and result that consists of the environment, pc configuration, and results and analysis. Finally section 5 ends the paper with the conclusion.

2 Literature Review

Borah (2014) proposed a smoke identification framework which utilizes optical fiber to recognize smoke around some territory. This structure is exceedingly sensitive just as expensive. The optical fiber may distinguish the standard CO2 or CO gas from nature and caution the ranchers which will be distracting. The accessibility and cost will still be out of general farmers' range, regardless of whether sensitivity can be controlled [6].

Oberoi, Basavaraju & Lekshmi (2017) proposed about testing the Nitrogen, Phosphorous and Potassium content of the soil using a pH sensor in order to find the macronutrient deficiency in the soil. Then they will use those information to reduce the deficiency through fertilization. However, soil contains many other nutrients that are necessary and only removing the deficiency of only those macronutrients based on that pH level is not enough. Farmers need to choose the suitable crops according to the right pH level [7].

Regalado & Cruz (2016) proposed of using image processing and artificial neural network to accurately recognize the nutrients and pH level of soil. This process is expensive as well as hard to implement. Besides the farmers of our country are not well advanced and they don’t have the proper knowledge to implement this technique. Moreover, their financial condition are not well off enough for them to be able to afford this complicated system [8].

Rajpal, Jain, Khare & Shukla (2011) proposed the structure for a microcontroller based irrigation system with the use of moisture sensors that will irrigate places in need of water and avoid places that has necessary soil moisture level. This paper mentions of need of a system to provide water to farms according to soil types in order to ensure plant development as it mainly relies on monsoons for water. However, to ensure proper growth besides the level of soil moisture, pH level, temperature etc. are important too. Therefore, only assuring moisture level is not enough [9].

Janani et al. (2018) proposed of an automated irrigation system using humidity sensor which will be connected with arduino and with Bluetooth in order to monitor the soil moisture and informing farmers about the status of their field. This system saves farmers from the hard work of irrigating field. However, farmers need to be able to ensure the accurate pH level for their crops as well. If they do not choose the right crops according to the pH level of their field, even when the temperature and soil moisture level is maintained the crops will not be good. Therefore, farmers need to know the pH level of their field along with soil moisture and temperature [12].

Hemageetha & Nasira (2016) proposed in their paper to use data mining classification techniques based on pH level in order to decide whether the soil of Salem district is appropriate for harvesting. But only pH level cannot determine if a soil is suitable for cultivation or not. If the soil moisture or temperature or humidity of the soil is not in the accurate range, then the soil will not be suitable for farming either. Therefore, while measuring the pH level of soil, soil moisture, temperature and humidity needs to be measured as well to decide upon the suitability of soil [13].

3 Proposed Model

Our proposed model implements the whole system so that the users can clearly identify which crops to plant as well as monitor the conditions of the soil. The system contains Arduino Uno as the micro-controller and four different sensors. The modules and sensors continuously read value from the surroundings and then takes the average of those values. If any value exceeds the threshold value which has been set, then messages are displayed on the screen accordingly.

3.1 Components Used

The components used in our project are as follows: DHT Temperature and Humidity sensor module, Gravity : Analog pH sensor / Meter Kit for Arduino, Arduino UNO R3, Male to Male Jumper Wire, Male to Female Jumper Wire, MQ9 CO Combustible gas sensor module, Soil moisture sensor.

DHT Temperature and Humidity sensor module

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1% [1].

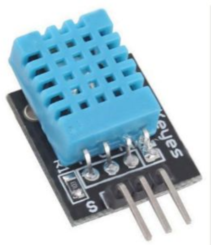


Fig.1. Temperature and Humidity Sensor module

Gravity: pH Sensor Module

The Analog pH Meter Kit is exceptionally intended for Arduino controllers and has worked in straightforward, advantageous and reasonable association and highlights. It has a LED which functions as the Power Indicator, a BNC connector and PH2.0 sensor interface. To utilize it, simply associate the pH sensor with BND connector, and fitting the PH2.0 interface into the simple information port of any Arduino controller. In the event that pre-customized, the pH esteem can be measured effectively. Comes in conservative plastic box with froths for better versatile capacity. The Applications are: Water Quality Testing and Aquaculture [2].

MQ9 CO Combustible Gas Sensor Module

MQ-9 gas sensor has high sensitivity to Carbon Monoxide, Methane and LPG. The sensor could be utilized to identify distinctive gases contains CO and burnable gases, it is with minimal effort and reasonable for various application. The affectability of the sensor can be balanced by utilizing the potentiometer [3].

Fig.2. MQ9 Gas Sensor Module

Soil Moisture Sensor

The Soil Moisture Sensor utilizes capacitance to gauge the water substance of soil (by estimating the dielectric permittivity of the dirt, which is a component of the water content). Basically embed this tough sensor into the dirt to be tried, and the volumetric water substance of the dirt is accounted for in percent [4].

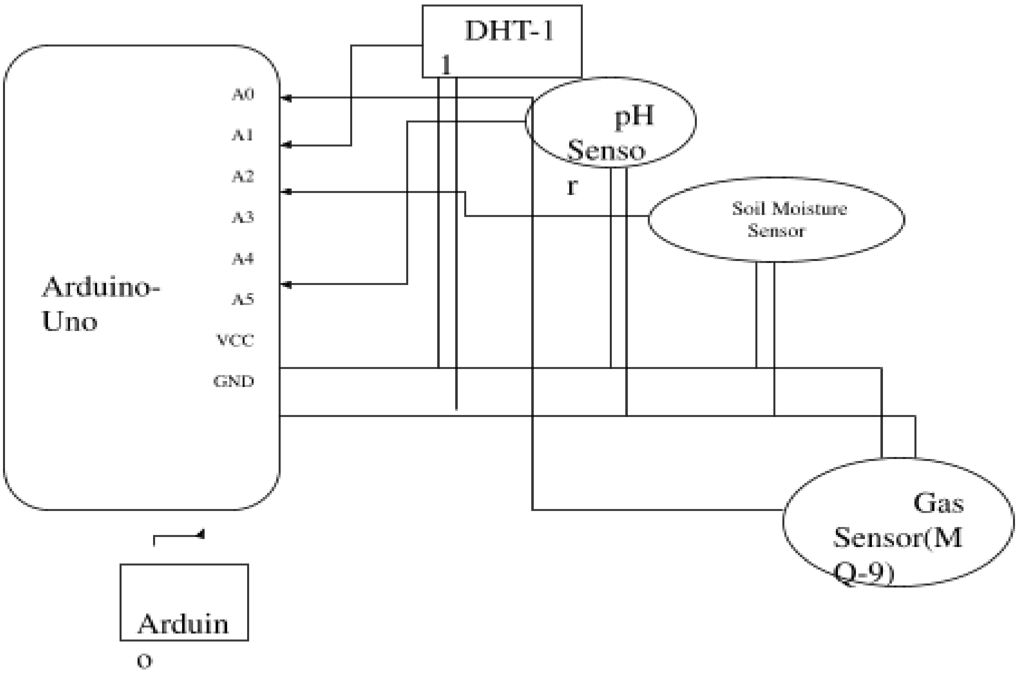


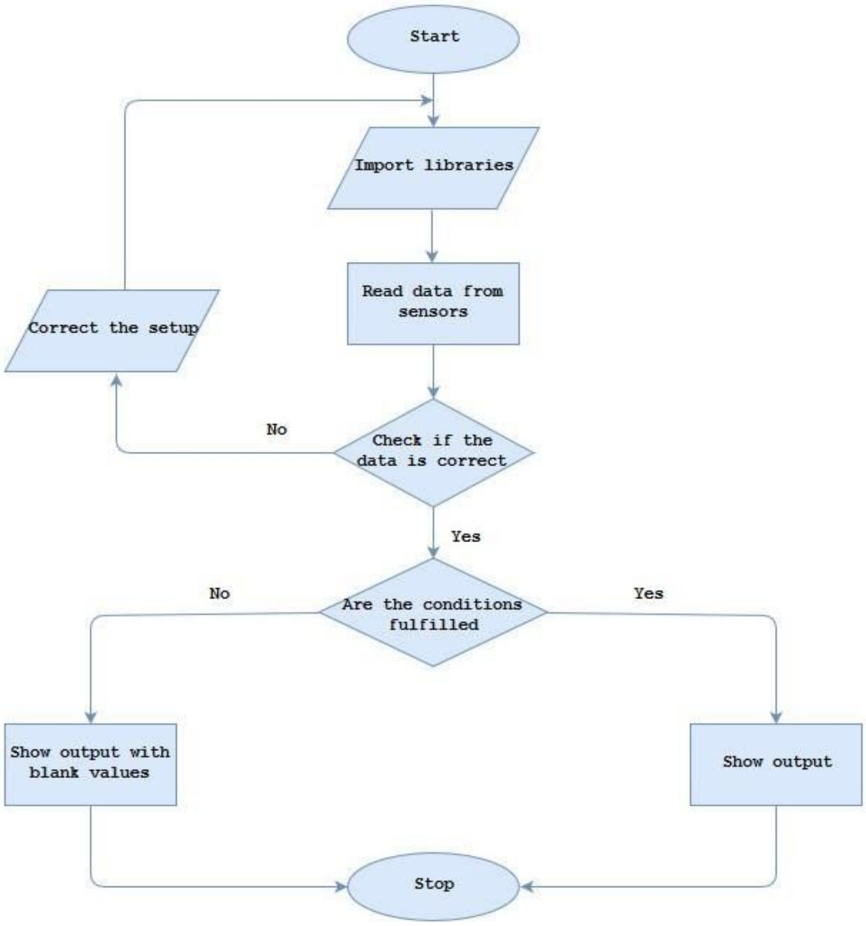
Fig.3. The simplified circuit diagram of the project showing the connections and dataflow.

3.2 Dataset

For writing the code and implementing the system, the DHT -11 library and Adafruit library needed to be installed in order to use the built in functions to make code more efficient and easy to write. All the data comes in to the Arduino IDE through the analog pins of the Arduino Uno board. Once the data has been gathered from the analog pins, these are shown on the serial monitor based on which the model was modified.

3.3 Workflow

General Workflow



3.4 Program Code

```
including dht sensor libraries
including adafruit libraries
initialize SensorPin A3
initialize avgValue;
initialize b,buf[10],temp,R0,hum,tempa,chk;
initialize DHTPIN A1
DHT dht(DHTPIN, DHTTYPE);

void setup() {
  start arduino at 9600 baud;

  //Gas Sensor
    initialize sensorValue;
    initialize gas=0.0;
    loop iterating 20 times
      sensorValue = analogRead(A0);
      gas = gas+(sensorValue/1024*5.0);
      delay(100);
    gas=gas/20.0;
    if(gas<=2.0){
        Display "Clean air. Safe for cultivation";
      }
    else{
      Display "Contaminated air!!! Unsafe for
cultivation";
      }
    Display"Gas sensor voltage: ";
    Display gas;
    Display "V";



  //pH Sensor
   loop iterating 20 times
       buf[i]=analogRead(SensorPin);
       delay(10);
  sorting all the values in buf array;
  initialize avgValue=0;
  loop iterating 5 times
    avgValue+=buf[i];
  float phValue=(float)avgValue*5.0/1024/6;
  phValue=3.5*phValue;
```

```
Display "pH:";
Display phValue,3;


//Temperature and Humidity Sensor
 start dht sensor;
 initialize hum=0.0;
 initialize tempa=0.0;
 loop iterating 20 times
      hum = hum+dht.readHumidity();
      tempa= tempa+dht.readTemperature();
      delay(200);
 hum=hum/20.0;
 tempa=tempa/20.0;
 Display "Humidity: ";
 Display hum;
 Display "%";
 Display "Temp: ";
 Display tempa;
 Display " Celsius";



  //Moisture Sensor
  initialize sensorPin1=A5;
  initialize lol[20];
  initialize s=0;
  initialize i=0;
  loop iterating 20 times
      lol[i]=analogRead(sensorPin1);
      delay(200);
  initialize avg=0;
  loop iterating 20 times
      avg=avg+lol[i];
  avg=avg/20;
  avg=avg-(avg/1023.00)*100;
  Display"Moist Value in %: ";
  Display avg;




 Display "Best  for planting: ";
 checking the result and finding which plant should be
planted among Rice, Corn, Cotton, Wheat, Soybean, Apple,
```

```
Citrus, Beans, Cabbage, Eggplant etc with if/else
condition.


  }
void loop() {}
```

4 Experimental Setup and Results

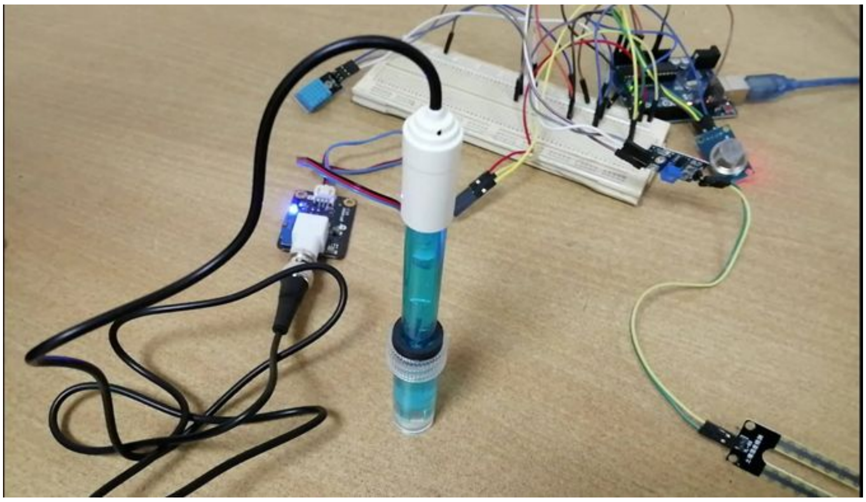


Fig.4. The experimental setup

4.1 Environment

The system was taken out in different conditions as the humidity and temperature varies from place to place and to take that into account, different environments were required. In addition to this, different type of soil samples were also taken to give out different results.

4.2 PC Configuration

The experiment can be set up on any PC that is powerful enough to run Arduino IDE. The IDE is used to write the sketch for the experiment. In order to write the sketch DHT-11 library and Adafruit Sensor library must be preinstalled and imported as a library in the Arduino IDE. The library is implemented while writing the sketch and the sketch is then compiled and uploaded into the Arduino.

4.3 Results and Analysis

The results and findings from the experimental setup has been given in a tabular format in the next page.

Name	Moisture Level	pH Level	Temperature Requirement (in Celsius)	Relative Humidity Percentage	Soil Type
Apple	21% - 60%	6.1 – 7.0	21◦ - 24◦	90% - 95%	Sandy Loam
Beans	15% - 42%	6.1 – 7.0	18◦ - 30◦	60% - 75%	Sandy and Silt Loam
Cabbage	70% - 90%	6.1 – 8.0	7◦ - 28◦	90% - 98%	Clayish Alluvial And sandy
Citrus	40% - 50%	5.5 – 7.0	15◦ - 38◦	45% - 50%	Sandy Loam
Corn	50%-70%	6.1 – 7.0	20◦ - 34◦	50% - 70%	Sandy Loam
Cotton	70% - 75%	5.5 – 6.5	21◦ - 37◦	70% - 95%	Sandy Loam
Eggplant	55% - 80%	6.1 – 7.0	22◦ - 27◦	50% - 60%	Sandy
Rice	20%-35%	5.5 – 6.5	18◦ - 38◦	80% - 85%	Alluvial
Soybean	70% - 80%	6.1 - 7.0	15◦ - 40◦	70% - 90%	Loam

Wheat	60% - 100%	5.5 – 6.5	20◦ - 38◦	50% - 60%	Loam

Table 1. The parameters for the best suited crops to be planted [5], [10] & [11]

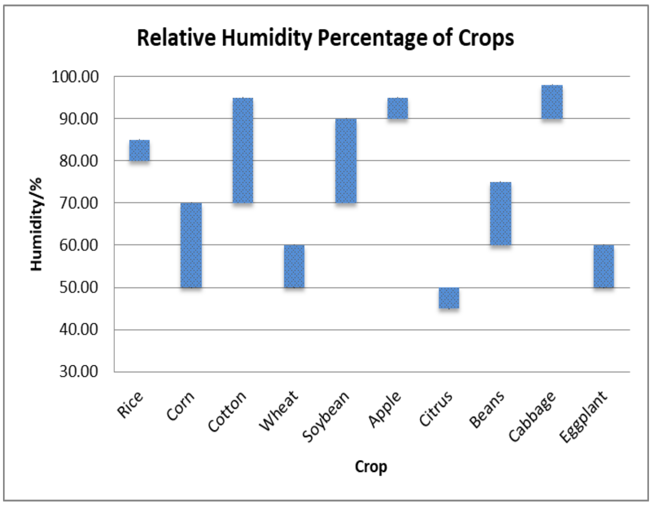


Fig.5. Best humidity (in %) for plantation of crops

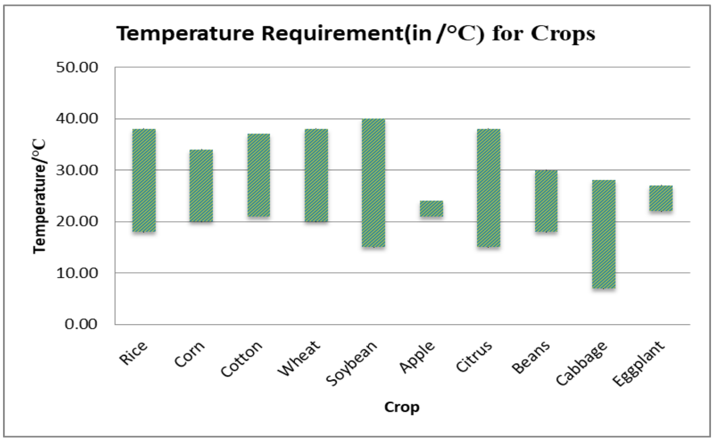


Fig.6. Best temperature levels (in ºC) for plantation of crops

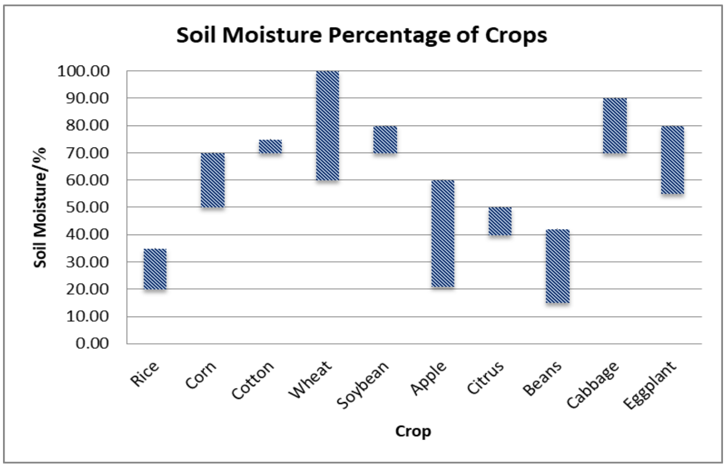


Fig.7. Best soil moisture levels (in %) for plantation of crops

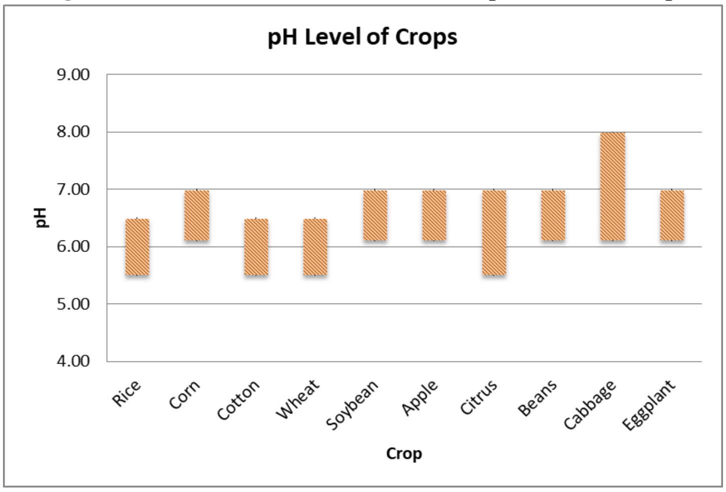


Fig.8. Best pH levels for plantation of crops

5 Conclusion

In this paper, we have proposed a soil monitoring system using arduino and related sensors. We have optimized our project to monitor all possible parameters that affects the growth of a particular crop. The proposed model is one of the easiest and cheapest solutions to provide farmers around the country to monitor the soil content as well as in taking decisions as to which crop should be cultivated.

References

1. Anon, (2019). [online] Available at: https://¬components101.com/¬dht11-temperature-sen¬sor [Accessed 8 Apr. 2019].
2. Anon, (2019). [online] Available at: https://¬www.robotshop.com/uk/¬gravity-analog-ph-met¬er-kit.html?gclid=Cj-wKCAjw-ZvlBRBbEiwANw¬9UWjk7YIxbK6mt_ipzZd-RMAxDYkgYghLhiMq9Vb7¬fi0NxV5qFXrreFKBoCKE¬IQAvD_BwE [Accessed 8 Apr. 2019].
3. Anon, (2019). [online] Available at: http://¬arduinolearning.com/¬gas-sensors/¬mq-9-gas-sensor.php [Accessed 8 Apr. 2019].
4. Anon, (2019). [online] Available at: https://¬www.vernier.com/¬products/sensors/¬sms-bta/ [Accessed 8 Apr. 2019].
5. (2018). Retrieved from https://www.acurite.com/blog/soil-ph-recommendations-and-tips-for-fruits-vegetables-trees-shrubs.html
6. Borah, B. (2014). Optical Smoke Detector. *International Journal Of Engineering Research & Technology (IJERT)*, *3*.
7. Oberoi, A., Basavaraju, S., & Lekshmi, S. (2017). Effective Implementation of Automated Fertilization Unit Using Analog pH Sensor and Arduino. *2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC).*
8. Regalado, R., & Cruz, J. (2016). Soil pH and Nutrient (Nitrogen Phosphorus and Potassium) Analyzer using Colorimetry. *2016 IEEE Region 10 Conference (TENCON).*
9. Rajpal, A., Jain, S., Khare, N., & Shukla, A. (2011). Microcontroller-based Automatic Irrigation System with Moisture Sensors. In *Proc. of the International Conference on Science and Engineering (ICSE 2011)*.
10. (2018). Retrieved from https://www.acurite.com/blog/soil-moisture-guide-for-plants-and-vegetables.html
11. Laurenzi, T. (2018). What's the Ideal Moisture Level for Soil to Grow Crops?. Retrieved from https://www.delmhorst.com/blog/whats-the-ideal-moisture-level-for-soil-to-grow-crops
12. Janani, V., Kodhai, Varshni, S., Kavipriya, K., Kameswari, K., Yellamma, P., & Alzubi, D. (2018). Automated irrigation system to monitoring soil moisture using humidity sensor in arduino with bluetooth. International Journal Of Pure And Applied Mathematics, 118.
13. Hemageetha, N., & Nasira, D. (2016). Analysis of Soil condition Based on pH value Using Classification Techniques. *IOSR Journal Of Computer Engineering (IOSR-JCE)*, *18*(6), 50-54. doi: 10.9790/0661-1806035054