Technological University of the Philippines
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SoilgANic: AUTOMATED SOIL NUTRIENTS AND PH LEVEL TESTING AND ASSESSMENT WITH FERTILIZER RECOMMENDATION THROUGH DIGITAL IMAGE PROCESSING USING UNITY

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APPROVAL SHEET

This Project Study entitled **"SoilgANic: AUTOMATED SOIL NUTRIENTS AND PH LEVEL TESTING AND ASSESSMENT WITH FERTILIZER RECOMMENDATION THROUGH DIGITAL IMAGE PROCESSING USING UNITY"**, has been prepared and submitted by the following proponents:

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ABSTRACT

In this research study, SoilgANic was established to improve the conventional method of soil testing and developed it into an automated soil tester and assessor to help the farmers determine if their soil is ready for production and determine the fertility rate of their soil. It was developed to reduce time consumed in conventional method, to guide the farmers to acquire higher crop productivity and to provide more accurate and systematic analysis regarding the nutrient level of the soil. This study uses Arduino as a microcontroller to help the farmers on the application of chemicals instead of manual setting. This study uses a cross-platform game engine called Unity, which is used for creating a program that interprets input data and provides a corresponding processed output, to efficiently identify the Macronutrients, Micronutrient and pH level of Soil in the farmland of Philippines: (1) Nitrogen, (2) Phosphorus, (3) Potassium, (4) Calcium, (5) Zinc, (6) Magnesium and (7) pH. The system provides a real time comparison of the acquired results from the automated soil testing to the colorimetric chemical chart guide of the soil testing kits. The direct color comparison will be processed by the system using direct formula and based on the result, the program will generate a report in printed form. Overall, this study identifies the soil nutrients and pH level, and gives fertilizer recommendation, both organic and inorganic, for Inbred rice plant, Inbred corn, Tobacco, Sugarcane, Pineapple, Mango, Coconut, Abaca, Coffee, Banana, Sweet Potato, Eggplant, Calamansi, Cassava and Peanut. Implementation of the system was done using 30 soil samples by comparing the results with the soilgANic and conventional way of testing and was proven 94.28%.

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CHAPTER 1

THE PROBLEM AND ITS SETTING

1.1 Introduction

Soil characteristics play an important part for the ability of the plant to obtain sufficient water and nutrients. In able for the plants to grow, the soil must provide an adequate environment for plant growth. Soil provides anchorage, water, oxygen, temperature modification, and nutrients that is vital to plant growth. The natural capability of the soil to supply sufficient amount of nutrients to the plants refers to the soil fertility status. It is an essential element for the proper growth of plants for a fruitful harvest.

Complete nutrition plays a significant role for plant growth in order to maximize the yields. There are two groups of soil nutrients specifically macronutrients and micronutrients. Macronutrients are the nutrients needed at huge amounts in the plants. It is divided into primary and secondary macronutrients. Primary macronutrients are composed of the familiar Phosphorus (P), Nitrogen (N), and Potassium (K), it is called as "NPK", while the secondary macronutrients consist Magnesium, Sulfur, and Calcium. Micronutrients include Boron (B), Chloride (Cl), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), and Zinc (Zn). These Micronutrients are required at low levels because it takes an important role in balanced crop nutrition that is essential for plant growth. These are as important as the primary and secondary macronutrients to plant nutrition even though plants do not require as much. An absence in any of these micronutrients can affect and limit plant's growth, even when all other nutrients are present in sufficient amounts.

Fertilizers are materials that provides plants with the vital nutrients needed for growth as well as optimal yields. Fertilizers may be natural or artificially manufactured and at the same time

be organic and inorganic. Inorganic fertilizers are synthetic nutrients that are chemically based. These are non-biodegradable materials, which simulate the nutrients found in the soil. Largely the primary macronutrients, which are the NPK elements. Organic fertilizers are highly biodegradable materials usually made from naturally decaying materials like solid wastes, decomposing matters, green manure, and crop residues.

Soil Test is a method of removing the elements of each soil nutrients from the soil done through a laboratory chemical analysis and soil test kits. The conventional way of chemical analysis takes long time to analyze the nutrients of soil. The Soil Test Kit of the Bureau of Soils and Water Management (BSWM) takes a couple of minutes to determine the amount of macronutrients, micronutrients, and PH level of the soil. The analysis of the result is prepared manually by comparing the color of the soil with chemical reagents to the standard color chart.

The automation of the whole process of the conventional way of analyzing soil nutrients is done through the use of digital image processing in replacement to the conventional comparison to the color chart. The automation of the conventional way provided more accuracy, more convenience, and has eliminated human error and prejudice in coming up with the results. This study aims to further develop the previous studies by adding the automation of the secondary macronutrients, micronutrients, and the addition of organic fertilizer on the recommendation. The chemical testing of the soil is to be done with the same process from the previous studies; using gear motor, hydraulic pumps, and an Arduino. The analyses of macronutrients, micronutrients, and pH level of the soil are to be done digitally using image processing supported by different algorithm through Unity.

1.2 Background of the Study

Farmers need to know the pH level of the soil before planting any crops. They must determine if the soil is capable of growing quality crops. A different soil analysis were introduced to farmers to evaluate. One method of examining the nutrients in the soil is through the use of soil test kit (STK) created by the University of the Philippines, Los Baños and industrialized by the Bureau of Soils and Water Management.

According to the Laboratory Service Division of the Bureau of Soils and Water Management, the soil testing kit comprises of chemical solutions in small bottles enclosed in a small bag to transport conveniently. To analyze the pH level, nitrogen, phosphorus, potassium, and saltiness of the soil. The soil sample inside the test tube is added with the solutions, after a couple of minutes the color of the mixture indicates the level of acidity, salinity and the adequacy of the nutrients present in the soil sample. Even though the kit gives an approximate fertility status of the soil, it serves for a fertilizer recommendation to be made for specific crops and disregard presumptions about the nutrient needs of the soil.

The Rapid Soil Test Kit (RST) developed by the Bureau of Soils and Water Management is a low-cost, portable and easy to use testing kit. It is made especially for the farmers and agricultural technicians to quickly analyze the macro and micro-nutrient deficiencies in the soil that hinders the production of quality crops. With the use of RST, the farmers will be provided a more precise data about the sufficiency level of the macronutrients and micronutrients in the soil.

According to an article of the Nations Encyclopedia, the following are the country's main agricultural crops; abaca, banana, coconut, coffee, corn, mango, pineapple, rice, sugarcane, and tobacco. On the other hand, the secondary crops include calamansi, cabbage, camote, cassava, cotton, eggplant, onion, garlic, peanut and rubber.

In this research study, the conventional method of soil testing will be improved into automation to make it easier for the farmers to determine if the soil is ready for production. It will be Arduino-based automated machine for the chemical testing and digital image processing for the analysis and evaluation of the results. The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins, 4 UARTs, 16 analog inputs, 16 MHz crystal oscillator, power jack, USB connection, ICSP header, and a reset button. Digital image processing technology uses computer algorithms to sample an input digital image and will get an enhanced image or extract useful parameters from it. It has been incorporated with machines to perform visual automation such as feature- and pattern- recognition. This digital image processing technology is then supported by Unity.

1.3 Statement of the Problem

This project aims to answer the following question:

1. How to fully automate the conventional way of determining soil nutrient and pH level testing through digital image processing using Unity?
2. How to develop graphical user interface, software, and algorithm of SoilgANic?
3. How to provide both organic and inorganic fertilizers on the recommendation results?
4. How to compare the results and performance to the Bureau of Soils and Water Management's conventional way of testing?
5. How to determine the difference between a plant cultivated with fertilizer and a plant cultivated without fertilizer?

1.4 Objective of the Study

1.4.1 General Objective

This study aims to develop an Arduino-based automated soil micronutrients, macronutrients and pH level tester and assessor using digital image processing through Unity for the top fifteen agricultural crops in the Philippines and to provide the fertilizer recommendation needed.

1.4.2 Specific Objectives

The study aims to meet the following goals needed for the development of an Arduino-based soil micronutrients, macronutrients and pH level tester and assessor for an at least fifteen of the major agricultural crops in the Philippines:

1. To fully automate the conventional way of determining soil nutrient and pH level testing through digital image processing using Unity.
2. To develop graphical user interface, software, and algorithm of SoilgANic.
3. To provide both organic and inorganic fertilizers on the recommendation results.
4. To compare the results and performance to the Bureau of Soils and Water Management's conventional way of testing.
5. To compare the growth of plants with fertilizer to plants without fertilizer.

1.5 Significance of the Study

The healthiness of the soil is the basis for a healthy plant as well as healthy environment. For a soil to be productive, soil testing is one way of determining how to prepare a land suitable for farming. In this study, an automated tester and assessor will be constructed for the soil testing to reduce probabilities of human error.

There are variety of ways and means used by the farmers to protect their crops from pests, weeds and disease-causing organisms such as bacteria, viruses, and fungi. Nowadays, almost all farmers, rely on chemicals to control pests, particularly in established countries, while other farmers still relied on natural fertilizer. These natural fertilizers are materials such as manure, fish or fish parts, ground bones, bird and bat waste, and wood ash to replenish or increase nutrients in the soil. (Agriculture, n.d.)

The system in this study will introduce a different method in determining, testing, and assessing the macronutrients, micronutrients and pH level of the soil. Since the system will do the testing and the analysis, this will be very helpful for the farmers to lessen their work.

Furthermore, digital image processing system will be applied in this study to determine the levels of potassium, nitrogen, phosphorus, magnesium, calcium, zinc and pH of the soil. The amount of macronutrients, micronutrients and the level of pH will benefit the farmers to determine the fertilizer required by the soil for farm preparation. Moreover, the automated tester and assessor will provide recommendation for the amount of fertilizer needed and an informative printed summary of the analysis.

1.6 Scope and Delimitations

The research study majorly focuses on developing the software that assesses pH level, macronutrients and micronutrients of the soil through digital image processing that generates both organic and inorganic fertilizer recommendation. Unity, a cross-platform game engine that is developed by Unity Technologies, will be utilize by the study.

The research study is only limited to assess 15 major crops in the Philippines namely; abaca, banana, cassava, rice, eggplant, peanuts, sweet potato, calamansi (Phil. Citrus), pechay,

coconut, okra, tomato, coffee, corn and mango. Also, this research study will only provide results based on Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Zinc.

1.7 Definition of Terms

Algorithm – An algorithm is a well-ordered set of definite and feasible steps that defines a complete process.

Arduino – Arduino refers to an open-source electronics platform used to write and upload computer code to the physical board.

Calcium – Calcium is a nutrient needed for plant growth and development which is responsible for stimulating microbial increment, escalating seed production as well as the stability of root development of the plant.

Colorimetric – Colorimetric is a process of identifying the composition of a chemical compound or chemical element in a solution thru the help of a color reagent.

Digital Image Processing – Image Processing refers to an operation in which some procedures are being done to an image for it to have a better-quality and improved image with some useful information provided from it.

Fertilizer – Fertilizer is a natural substance or chemical that is applied to soil or plant to supply nutrients and increase its fertility.

Gear Motor – Gear Motor refers to a device used to moderate speed to a series of gears, which in turn generates more torque.

Graphical User Interface – Graphical User Interface is a program interface that allows a person to communicate and interact to an electronic device with the use of symbols, icons, or buttons.

Hydraulic hose – A hydraulic hose is a variety of elastic hose intended for transferring liquid from one place to another contained by a hydraulic device or equipment.

Macronutrients – Macronutrient refers to a substance or chemical element that is usually needed in relatively great amounts for the growth and development of a certain living organism. Its primary nutrients are potassium, nitrogen, and phosphorus, while the secondary nutrients are magnesium, sulfur, and calcium.

Magnesium – Magnesium is a necessary nutrient for plant growth and development which supports in the stimulation of plant enzymes essential for growth and contributes to protein synthesis.

Micronutrients – Micronutrient refers to a substance or chemical element that is as important as macronutrients and is usually needed in very small amounts for the growth and development of a certain living organism. The micronutrients are zinc, chlorine, iron, boron, molybdenum, manganese, and copper.

Nitrogen – Nitrogen is a nutrient necessary for plant growth and development which is responsible for making plants greener, stronger, and healthier.

Pesticide – A pesticide refers to a substance that is used for destroying insects and other organisms that are destructive in plant development.

Phosphorus – Phosphorus is a nutrient necessary for plant growth and development which is responsible in regulating protein synthesis, improving the quality and yield of grains, and increasing the formation of root lumps in legumes.

Potassium – Potassium is a nutrient necessary for plant growth and development which increases the efficiency of the leaf in producing starch and sugars and also improves the quality and formation of seeds and fruits.

Rapid Soil Test Kit – Rapid Soil Test Kit is a quick method of analyzing a soil sample to determine composition, nutrient content, and other characteristics of Magnesium, Zinc, and Calcium.

Software – Software refers to a program that runs on a computer and performs certain functions.

Soil Fertility – refers to the capability of a soil to provide plant nutrients. A fertile soil produces healthier yield.

Soil pH level – Soil pH level is a method of measuring the acidity and alkalinity level of a soil.

Soil Test Kit – Soil Test Kit is a quick method of analyzing a soil sample to determine composition, nutrient content, and other characteristics of pH, Phosphorus, Potassium and Nitrogen.

Unity – Unity is a cross-platform game engine that is used for creating a program that interprets input data and provides a corresponding processed output.

Zinc – Zinc is a nutrient necessary for plant growth and development which helps in the formation of growth chlorophyll and hormones and is essential for starch and carbohydrate formation.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter covers the background theories, principles, and studies useful in the development of the idea in conceptualizing the project. This includes some technical terminologies from previous and present project developed.

Conceptual Literature

2.1 Soil

The soil is a major source and natural medium for plant growth, which has a direct impact on yield and quality of crops growing on it. Basically, soil plays a very important role in all living things with just the fact that plants rely on soil that human, animals, and even the environment need to live. It is one thing that people should be grateful to farmers. However, not everyone is aware what farmers has to go through to provide people's necessities to live. From soil preparation, planting time, to harvesting. Farmers exert much effort but receive less than what they

deserve. This chapter aims to provide information about soil testing which is included at the soil preparation.

2.1.1 Nutrients in soil

Most plants raise by absorbing nutrients from the soil. Soil is a major source of nutrients needed by plants for growth and development. There are two main classification of nutrients in the soil; Macronutrients and Micronutrients.

Carbon (C), Hydrogen (H), and Oxygen (O) are also essential for plant growth, but not considered as soil nutrient because these taken from the air and in water. (Tucker, 1999)

Plant roots include definite conditions to achieve these nutrients from the soil. First, the soil must be sufficiently moist to let the roots to adopt and transfer the nutrients. Occasionally, modifying improper watering technique will eradicate nutrient deficiency indications in the soil. Second, the pH of the soil must be within a definite range for nutrients to be release-able from the soil particles. Third, the temperature of the soil must drop within the range for nutrient reception to occur. The ideal range of pH, moisture and temperature is dissimilar for different type of plants. Knowledge of history, texture, and soil pH, and can be valuable for predicting what nutrients may become deficient. (Streich, 2014)

2.1.2 Macronutrients in soil

Macronutrients are vital elements used by plants in relatively large amount for plant growth.

The primary macronutrients are Nitrogen (N), Phosphorus (P) and Potassium (K). They are the most frequently essential in a crop fertilization program. Also, they are need in the utmost total quantity by plants as fertilizer.

Moreover, the secondary macronutrients are Calcium (Ca), Magnesium (Mg), and Sulfur (S). These three are required in lesser amount than the primary nutrients. (Roles of 16 essential nutrients in crop development, n.d.)

2.1.3 Micronutrients in soil

Micronutrients are essential for plant growth and play a significant part in balanced crop nutrition. The minor of trace elements include Boron (B), Copper (Cu), Chlorine (Cl), Iron (Fe), Molybdenum (Mo), Manganese (Mn), and Zinc (Zn).

Plant needs micronutrients for their growth, however requires only lesser amount of it, but they are just important as Macronutrients. A deficiency of these elements will lead to leaf or shoot symptoms. (Tucker, 1999)

2.1.4 Soil Nutrient Deficiency and Toxicity

The fertility of the soil is one of numerous factors that affects crop yield. Classifying and preventing plant from soil nutrient deficiencies and toxicities is a significant part of planting or farming. Nutrient deficiency occurs when an essential element is insufficient to meet the necessity of the growing plant. The symptoms of Nutrient deficiencies and toxicities can be seen first in the leaves, this depends on the mobility of the nutrient. Deficiencies are first seen in older leaves for mobile nutrients (N,

P, K and Mg) while deficiencies for immobile nutrients (Ca, B, Cu, Zn and Fe) are first seen in youngest leaves and/or growing tissue. (Nutrient and Physiological Disorder, n.d.)

2.1.5 pH level of soil

Soil pH is the measurement of alkalinity or acidity of the soils. pH level affects the availability of nutrients to plants for identifying the productivity of the soil. Soil with low pH levels prohibit plant growth however can be treated with lime to increase plant growth.

A pH scale ranges from 0 to 14 such that a pH level of 7.0 is considered. The acidity of the soil has a pH level below 7.0 while the alkalinity of the soil has a pH level above 7.0. (Soil: Understanding pH and testing soil, n.d.)

2.1.6 Nitrogen in soil

Nitrogen is one of the primary macronutrients vital to all living cells. It is an element of enzymes, proteins, and DNA and is involved in metabolic processes and energy transfer. It can also be seen in chlorophyll, the green pigment in plants liable for photosynthesis. Nitrogen in the soil is normally supplied by decomposition of organic material, nitrogen-fixing bacteria, and commercial fertilizers. Nitrogen improves the quality of yields, improves plant growth, and surges seed and fruit production. The necessary amount varies between crops however; excessive nitrogen can have contrary effects. (Bradford)

2.1.7 Potassium in soil

Potassium plays a significant role in the biochemical and physiological functions of plants. Plants absorbed large amounts of potassium. It is used to build proteins; increases cuticle (waxy layer) to inhibit water loss; increases resistance to disease by strengthening stalks and stems; helps prevent sagging; and improves flavor, texture, fruit size, and fruit improvement. The existence of clay in the soil increases the amount of potassium present. The amount of potassium necessary in soil depends on the crop. Potassium can be added to soil thru fertilizers and organic material. Potassium deficiency is also known as potash deficiency. (Bradford)

2.1.8 Phosphorus in soil

Phosphorus is also vital in photosynthesis and is involved in energy transfer. It increases resistance to disease. It also improves root development, encourages blooming, and rapid growth. It also improves microbial activity in the soil. An excess amount of phosphorus does not cause damage to plants. Phosphorus can be added to soil through bone meal and fertilizers. Soils ought to contain at least 75 pounds of phosphorus per acre. (Bradford)

2.1.9 Calcium in soil

Calcium is one of the secondary macronutrients that helps in the development and growth of cell walls. It is essential because well-developed cell walls aid resist disease. It lessens plant respiration and aids translocation of photosynthesis from leaves to fruiting organs. It is also vital for nut development in peanuts and helps stimulates microbial

activity. An excess amount of calcium induces alkalinity and lessens uptake of other nutrients. Calcium deficiency usually limit growth, and in some cases, the root may rot.

2.1.10 Magnesium in soil

Magnesium is the key element of chlorophyll production. It improves utilization and mobility of phosphorus. It is involved in photosynthesis and an activator of many enzymes. It is essential for formation of carbohydrates, fats and vitamins. It also stimulates phosphorus uptake and transport.

2.1.11 Zinc in soil

Zinc is one of the most essential element needed for plant to have a balanced and normal growth. It acts as an activator to the enzymes and involved in biosynthesis of tryptophane and indole acetic acid. It also assists Phosphorus and Nitrogen in plants and in hormone production. Zinc, helps plants to grow well by the use of different enzyme activity. The source of Zinc is inorganic fertilizer in the form of zinc sulphate.

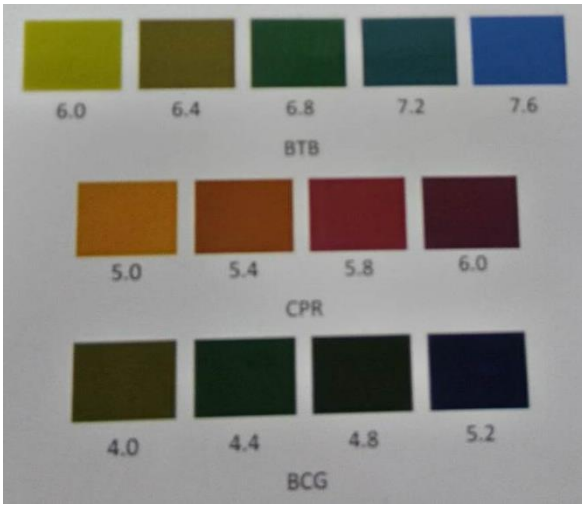
2.1.12 Fertilizer Management

Fertilizer provides one or more of the chemical elements vital for plant growth. It is either organic or inorganic, natural or synthetic. Fertilizers hold the three basic plant nutrients: nitrogen, potassium, and phosphorus. Several fertilizers also contain definite micronutrients, such as zinc, iron, molybdenum and other metals, which are required for plant growth. Fertilizers are applied to replace the essential nutrients for plant growth to the soil after they have been depleted.

Soil sampling is required every year to decide the crop nutrient needed for precise fertilizer recommendations. Other sources that contribute nitrogen and phosphorus to the soil should be considered to calculate the optimal rate of application. Manure and organic matter contribute phosphorus. Crops can quickly take up nitrate forms of nitrogen, but are subject to leaching loss. Fertilizer with nitrogen should be limited when leaching potential is moderate to high. If the leaching potential is moderate to high, ammonium nitrogen fertilizers should be used because they are not subject to leach immediately. However, in warm moist conditions ammonium quickly turns into nitrate. More slowly available nitrogen fertilizers should be used in these situations. Although phosphorous is less prone to leach, loss through surface runoff is common so phosphorous should only be applied as needed and at recommended rates.

2.1.13 Soil Test Kit

Soil Test Kit is an express method in assessing the fertility status of a soil. It analyze the chemicals of a qualitative amount of nutrients in the soil that are existing for the plant. Results are elucidate and used as foundation for recommending the right reagent and amount of fertilizer needed to apply for a certain crop grown in the soil being tested. Soil Test Kit applies a method called simple colorimetric analysis where chemical reagents are made to react with a soil sample in a test tube, and provide a characteristic color depending in the amount of existing nutrient in the



soil. (Bureau of Soils and Water Management, 2013)

Figure 2.1 pH Color Chart

Figure 2.1 shows the color chart provided by the BSWM for assessing the value of pH.

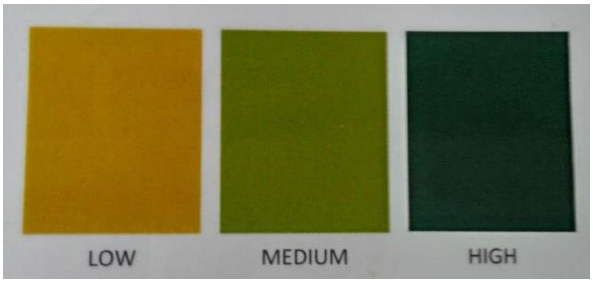


Figure 2.2 Nitrogen Color Chart

Figure 2.2 shows the color chart provided by the BSWM for assessing the value of Nitrogen.

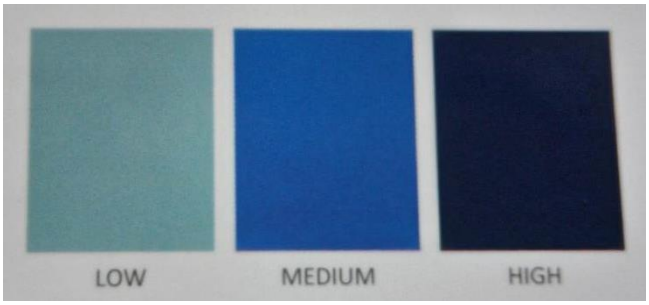


Figure 2.3 Phosphorus Color Chart

Figure 2.3 shows the color chart provided by the BSWM for assessing the value of Phosphorus.

The colors produced are then matched with a standard color in the color chart. It indicates whether the soil is low, medium or high in available nitrogen, phosphorus or potassium and the soil pH acidity.

Matching the colors produced to the standard color in the color chart will specifies whether the soil is low, medium or high in available nitrogen, phosphorus or potassium and the soil pH acidity.

2.1.14 Rapid Soil Test Kit

Rapid Soil Test Kit is used for assessing and identifying micronutrients deficiency in soil that limits crop production. It contains quick field analysis of ammonium, calcium, lime, magnesium, nitrate, sulfur, and zinc. Rapid soil test kit provide direct information about the deficiency and adequacy level of nutrients in soil that leads for precise fertilizer recommendation. (Bureau of Soils and Water Management, 2013)

2.1.15 Soil Test

Soil Testing is used to determine the amount of nutrients in the soil. Results of soil testing will be the basis in making soil test report or recommendation. There are three steps in soil testing program: soil sampling, soil chemical analysis and the data interpretation and recommendation.

1. The first and most important process is the soil sampling. The methods that will be used to test varies depends on the nutrients of the soil. Thus, right soil sampling must be utilized so that the soil test results for a certain needed nutrient recommendation will represent the entire field.
2. The next step in soil testing process is the analysis of chemicals in the soil, is conducted in the laboratory. Each countries are using different method in analyzing the chemicals found in the soil. The attained data cannot be easily comparable.
3. Interpretation of data and recommendation interpretation are the final step in process of testing soil. After the soil testing, data or numbers would be gotten in the library, and there is someone specialized in soil testing will interpret or read the result of the data. In interpreting data, there are two means: “fertilize the crop” and “fertilize the soil”. “fertilize the crop” is the process that means the fertilizer required by the crop at a given soil test level whereas “fertilize the soil” is means to be the fertilizer required by the existing crop to reach the level of nutrients needed by the crop.

2.1.16 Soil Technologies

OTG (On-the-go) sensors are presently used sensors for onsite soil analysis and may possibly be ranged for precisely monitoring and controlling of nutrient. Optical or

Electromechanical Sensing is most commonly used in on-the-go soil sensors, however, there are a lot of sensor design concepts. In optical sensing, the basis of it is the reflectance spectroscopy in which it spots the energy level that is reflected or immersed by soil particles. Furthermore, ion-selective electrodes are used in electromechanical sensing to produce a current or voltage output in reaction to the ion of the selected or desired nutrient (HJ, KA, & JW, 2009)

Table 2.1 On the go Soil Sensor Technologies

Sensor Type	Example Application	Reference
Electrochemical	Soil pH, Potassium (K), Nitrate	Adamchunk et al.(2007;2004)
Electrical and Electromagnetic	Soil moisture content, soil texture(silt, clay, sand), soil depth variability (depth to hardpan, depth of topsoil), cation exchange capacity	Kim et al. (2009); King et al. (2005): Sudduth et al. (2003)
Radiometric and Optical acoustic	Soil moisture, soil organic matter, texture of soil (salt, clay, sand), soil depth variability (depth of hardpan, depth of topsoil), salt bulk density (compaction)	Rossel et al (2006); Chang et al (2001); Grift et al (2002)
Mechanical	Compacted soil layers, soil compaction,	Stafford and Werner (2003); Menor and Clark (2001)

2.2 Arduino MEGA

ATmega2560 is the basis of microcontroller board based Arduino Mega. It has fifty four (54) i/o digital pins (14 digital pins can be used as PWM outputs), sixteen analog inputs, four

UARTs hardware serial ports or Asynchronous Receiver/Transmitter, a 16MHz crystal oscillator, connected thru USB, a power jack, an in-circuit serial programming header, and a button for reset. It has the whole thing necessary to sustain the microcontroller; to get started, just connect the Arduino to a computer using a Universal Serial Bus cable or plug it with an AC-to-DC adapter or battery.

The Arduino Mega partakes some services for interconnecting by way of a CPU, a different Arduino, and or other microcontrollers. For transistor-to-transistor logic or TTL (5V) serial communication, ATmega2560 provides four (4) hardware UARTs. Virtual com port is provided of FTDI drivers which is included with software of Arduino from the CPU and channel it using FTDI FT232RL as a USB. Arduino software consists of a serial display that permits simple word-based data to be directed to and from the Arduino board. When there is data being passed through FTDI chip and Universal Serial Bus connection to CPU (however, 0 and 1 pins are not for serial communication) the RX and TX LEDs will flash.

2.2.1 Technical Specifications

Below is the given table of specifications for the Arduino MEGA:

Table 2.2 Arduino MEGA's Technical Specifications

(Arduino Mega 2560 Rev3, n.d.)

Microcontroller	**ATmega1280**
Operating Voltage	5 V
Analog Input Pins	16
Input Voltage (recommended)	7 to 12 V
Input voltage (limits)	6 to 20 V
DC Current for 3.3V Pin	50 mA
DC Current per I/O Pin	40 mA
Digital I/O Pins	54 (of which 15 provide PWM output)

Flash Memory	128 KB of which 4 KB used by bootloader
Clock Speed	16 MHz
EEPROM	4 KB
SRAM	8 KB

2.2.2 Programming

ATmega2560 was designed to reset and run using software in computers connected to it. On the hardware (DTR) of the mini stepper motor driver is interconnected to the reset pin of the ATmega2560. Once the reset pin is low, it will reset the chip. Arduino software allows the user to compile and upload the code by pressing compile and upload button in the Arduino environment.

Each time USB supply will connect to Arduino mega, it will automatically reset and it will intercept some data (even it is programmed to disregard malformed data). When a sketch is operating on the board and obtains a former configuration or information during it started, the user must be sure that the software has to wait for a second after opening the connection and sending another data.

The Arduino Mega has traced that can be changed to deactivate the auto-reset. Two side pads of the trace can be connected together to re-activate the auto-reset. It can also be able to deactivate by attaching a 110 ohms resistor connected to 5V to the reset line. It is labelled in Arduino mega as “RESET-EN”.

2.2.3 Differences with Other Boards

The Arduino Mega was designed compatible to shields designed for Duemilanove. 0 to 13 digital pins and the AnalogReference and Ground (GND) pins, 0 to 5 analog inputs,

and ICSP and power header are in alike locations. The Main Asynchronous Receiver/Transmitter port is positioned on both pins 0 and 1, and pins 2 and 3 for external interrupts of 0 and 1.

2.2.4 Power

Arduino Mega can be powered using both power supply and USB connected to the computer or laptop. Power source for external supply can be from a battery or an AC-to-DC adapter. The convertor can be plugged into the power jack's board. Positive and negative leads of the battery can be connected in the Ground and Input (Vin) pins of the power connectors.

The Arduino Mega board can function on 6 to 20 volts of power supply DC. If it is provided less than 7V, the board might be unstable, and if it is supplied more than 12 volts, it may harm the board, so the suggested range is from 7 to 12 volts. (Arduino Mega 2560 Rev3, n.d.)

Power pins are as follows:

- V_{IN}. Pin for input voltage connected to the Arduino Mega board while using an external power supply. Voltage supply can be through this pin or, if providing voltage using the power jack.
- 5V. Controlled supply used to power microcontroller and other components on the Arduino Mega board. It can be from V_{IN} (voltage input) in an on-board regulator or provided by Universal Serial Bus.

- 3V3. Voltage supply (3.3V) created by the FTDI chip, and the current maximum draw is 50mA.
- GND. Negative input or ground pins.

2.2.5 Memory

The ATmega2560 has a flash memory of 128KB used for code storage where 4KB is allocated for the bootloader, 4KB of EEPROM that can be written and read thru the EEPROM collection and 8KB for SRAM. (Arduino Mega 2560 Rev3, n.d.)

2.2.6 Input and Output

Arduino Mega has fifty four digital pins. With the use of pinMode(), digitalWrite(), and digitalRead() function, each pin of it can be used by way of both output and input. Pins individually operates at 5V, and can supply or receive 40 mili amperes (maximum) and has an internal pull-up resistor of 20K to 50K ohms. In addition, other pins have its dedicated functions:

- Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). These pins are used to transmit (TX) and receive (RX) the TTL serial information. 0 and 1 digital pins are connected to the matching pins or slot of the FTDI Universal Serial Bus-to-Transistor Transistor Logic serial chip.
- External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). Designed to initiate an interrupt on a low value, rising or falling edge, or variation in value.

- PWM: 2 to 13 and 44 to 46. These pins offer 8-bit Pulse Width Modulation output through analogWrite() function.
- SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins are presently not included in the Arduino language, on the other it hand supports SPI communication.
- LED: 13. This pin is a built-in LED connection. The LED will be lighted when the pin is HIGH, and if the pin is set to LOW, LED will turn off.
- I^2C: 20 (SDA) and 21 (SCL). Pins supported I^2C (TWI) communication by the use of documents on the Wiring Website or Wire Library. Note that these slots are not located in the similar position where the I^2C pins of Duemilanove.

Arduino Mega has sixteen analog inputs. For each input or pins offer ten bits of resolution. Input pins measure from ground to 5V by default, on the other hand, it is probable to modify the upper end of the range by the use of AnalogRerefence pin and function analogReference ().

Here are some pins on the board:

- AREF. This pin is the reference (REF) voltage. It is used using the function analogReference().
- Reset. This pin needs to be LOW to reset the ATmega2560 microcontroller. Also, it is commonly used to add a reset key that protects and block the pin on the circuit board.

2.2.7 Communication

The Arduino Mega has services for interconnecting into a different Arduino, and microcontrollers and with a computer. The ATmega2560 offers 4 hardware UARTs for Transistor-Transistor-Logic in five volts for serial communication. Arduino consist of a serial display that permits textual information from its software to the Arduino in vice versa. Receiver and Transmitter LEDs built-in on the board will lighted as soon as information is being transmitted from computer or laptop.

Arduino mega has a software serial library for its digital pin serial communication.

ATmega2560 supports SPI communication (see the ATmega2560 datasheet) and a wired library to make simpler use of the I2C bus (TWI).

2.3 Image Processing

The process of altering an image into digital arrangement to acquire an improved image or extract useful and important data from it is called Image Processing. It is a form of management of signal that the input use is an image, or a video frame. Output may be an image or colors related to the captured image. (Engineersgarage, 2012)

Digital Image Processing (DIP) is an under the field of signals and systems, but it is focused strictly on images. It focuses on developing a computer system that is capable of processing an image. To produce an output from the image processed, the input image must be processed by the system using operational algorithms. (tutorialpoint.com, 2014). DIP uses a digital camera, webcam or any capturing device to capture an image to be used for the next process. Each part of the image is examined by the system to extract the essential features and colors, and these can be another

input to be analyzed by another system and also can be represented graphically to evaluate the result.

2.4 Soil Fertility Management

To simulate money budgets, crop nutrient inputs should be considered in Nutrient management planning. Defining what you own, to determine the existing fertility status of the soil, only needs using a well-made program for soil testing. The complete numeral amount specified for K or P per acre isn't typically the utmost significant information specified on the report. There is an index value for the nutrient minerals which is greatly essential. These indices are commonly very low, low, medium, high or very high. Various laboratories are staring to use the phrase "adequate" to define the medium or high indices.

It is very not probable that plants would benefit from the treatment of added nutrient for an index of high (or frequently very high) for a nutrient. While a very low index for soil equipped K or P specifies a developing harvest would probably have a quantifiable reaction from the addition of the nutrient. (Mississippi State University, 2014)

2.4.1 Foreign Study

According to Chelabi, et al (2016) in their study: Canadian Journal of Soil Science, deficient and uncertain soil sample establishment methods can lead to inappropriate lime and fertilizer recommendations and trouble in soil test analysis. The steps in soil preparation techniques, commonly crushing and drying, need regularization to lessen the alteration of the complete process of soil testing.

According to Hazelton, et.al (2016) in their study: Interpreting Soil test Results: What do all numbers mean?, understanding soil data and understanding soil behavior and soil properties are specifically significant for countless land and environmental management matters fronting the community such as prevention of land degradation, urban advancement, irrigation development, control of salinity, clearance of native vegetation, and regulation of wind and water erosion.

According to Balasundram, (2012) in their study: International Journal of Soil Science, increasing concerns subject to the call to rise crop production without producing environmental damage have led to the placement of site-specific techniques in management of soil nutrient, where nutrients are added in adaptable rates to apt local qualification. Variable amount utilization of nutrients is usually depend on a time-consuming data analyses and laborious sampling system. It is greatly necessary the capability to observe soil nutrient accumulation efficiently. Onsite observing of soil nutrient absorption allows the chance for greater density measurements at comparatively lesser expenses. This would consent for an effective charting of nutrient variability to assist the progress of variable-rate nutrient application. Enactment of nutrient management procedures using sensor technology possibly stimulates environmental conservancy while stabilizing crop profitability and productivity. Fast and non-damaging assessment of spatially-variable soil nutrients has been completely feasible with on-the-go sensors such as electrochemical, optical and electromagnetic sensors.

According to Gaskell, et.al (2007) in their study: Crop Nutrients Requirements, the nutrient-supplying capability and crop nutrient necessities of the soil determine the management procedures essential for efficient crop yield. Soil testing is frequently

requisite for organic authorization, and it is important for the evaluation of nutrient levels. Organization of nutrients such as phosphorus, potassium, magnesium, sulphur, and calcium should be conducted into increasing these nutrients to topmost levels in the soil as defined by soil testing.

A newsletter titled *News and Views: Soil Fertility Research for Production Agriculture* by the Potash and Phosphate Institute (PPI) states that the fertilizer industry is committed to the betterment of crop production. They have made a brief review of the research projects in the Eastern Canada and Northern U.S. region to show a reflection of that commitment. For example, in Ontario they had a two-year research at a site with low soil K. A positive K fertilization were positively correlated and yield was also positive.

2.4.2 Local Study

According to Ranada, (2015), the FutureRice program by the Philippine Rice Research Institute (PhilRice) have their perception of Philippine farms in the future – farms that are linked to apps, automated, save on water, harness green energy, and make use of natural fertilizers and pesticides. Roger Barroga, the FutureRice program director, said the sample farms purpose to prepare farmers for two probable future circumstances: mechanized, high-tech farming to make Philippine rice economical in the world market, and regular farming for a world where fuel has become limited and costly. The ten innovations of a Philippine farm of the near future are as follows: renewable energy, multiple crops, water harvesting, high-tech sensing equipment, own weather station, farming machines, makes the most of extreme conditions, connected to apps, right rice variety, and natural fertilizer and pesticide.

According to Dar (2017), the use of technology to increase incomes and farm yields becomes more critical now because climate is changing and is estimated to further lessen global agricultural production by 10-20 percent by the year 2050 whereas the demand for food will increase by 70 percent. For beginners, a good way to increase farm production is by using improved varieties and hybrid technologies.

According to Reganold, et.al. (2016), organic farming method produce lower yields compared to the conventional agriculture. On the other hand, organic farming technique distribute equally or more nutritious foods without or with fewer pesticide residues, are more environmentally friendly, and are more profitable, in comparison with traditional farming. Moreover, early documentation specifies that organic agricultural schemes make superior social ecosystem services and benefits.

According to Lapoot, et.al. (2010), a field research conducted in leading plant growing regions in Bukidnon, Mindanao, Philippines. The main reasons for the conduction of the study was to improve the productivity and fertility of vegetable soils in the region, to observe the outcome of addition of fertilizer on improving the production of vegetables, to improve nutrient addition to vegetable management.

According to R.N. Concepcion and N.H. Batjes, A Farmer-guided Soil Classification System for the Philippines, the farmers in Santa Rosa and Triala have developed an amount of knowledge-based guidelines about the inherent belongings of their soils that conclude the appropriateness of these soils for a specific use, with due consideration for ecological and food- security preservation.

CHAPTER 3

METHODOLOGY

This chapter presents the methods and procedures used in the development and implementation of the project. The proponents also included the image processes, program algorithms, and the design flow process in making the whole system.

3.1 Research Design

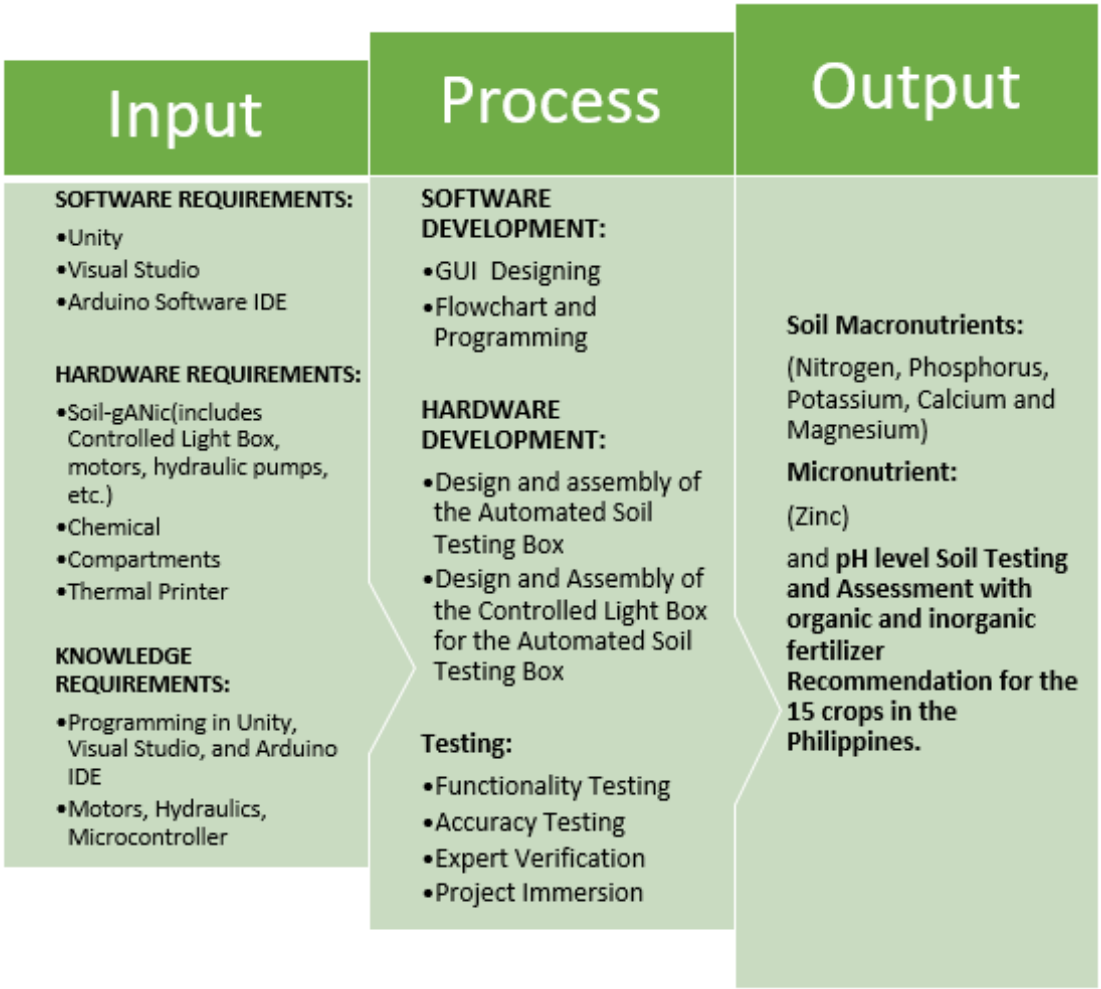


Figure 3.1 Input-Process-Output (IPO) Model of the Study

Figure 3.1 shows the Input-Process-Output of SoilgANic. The input consist of programming platform and materials for SoilgANic Automated module box. The process consists of Graphical User Interface (GUI) and main program development, and assembling a working device. Process also includes functionality and accuracy verification. The last is the output, where it generate and print the soil nutrient summary result with fertilizer recommendation for 15 major crops in the Philippines.

3.2 Research Process Flow

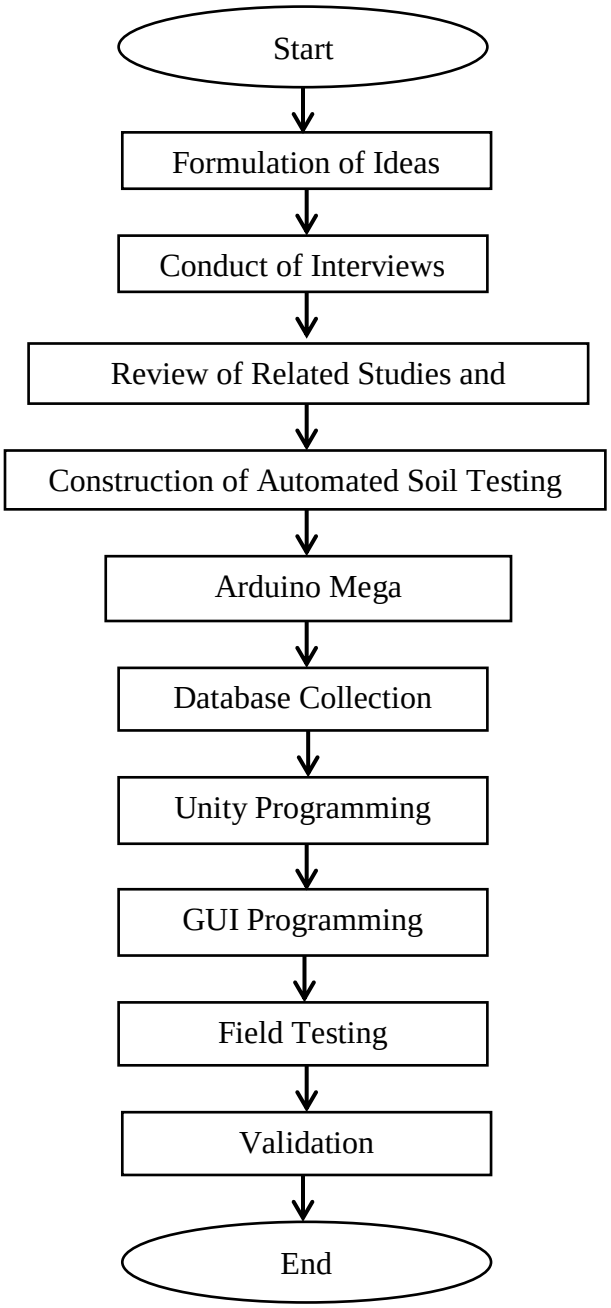


Figure 3.2 Research Process Flow

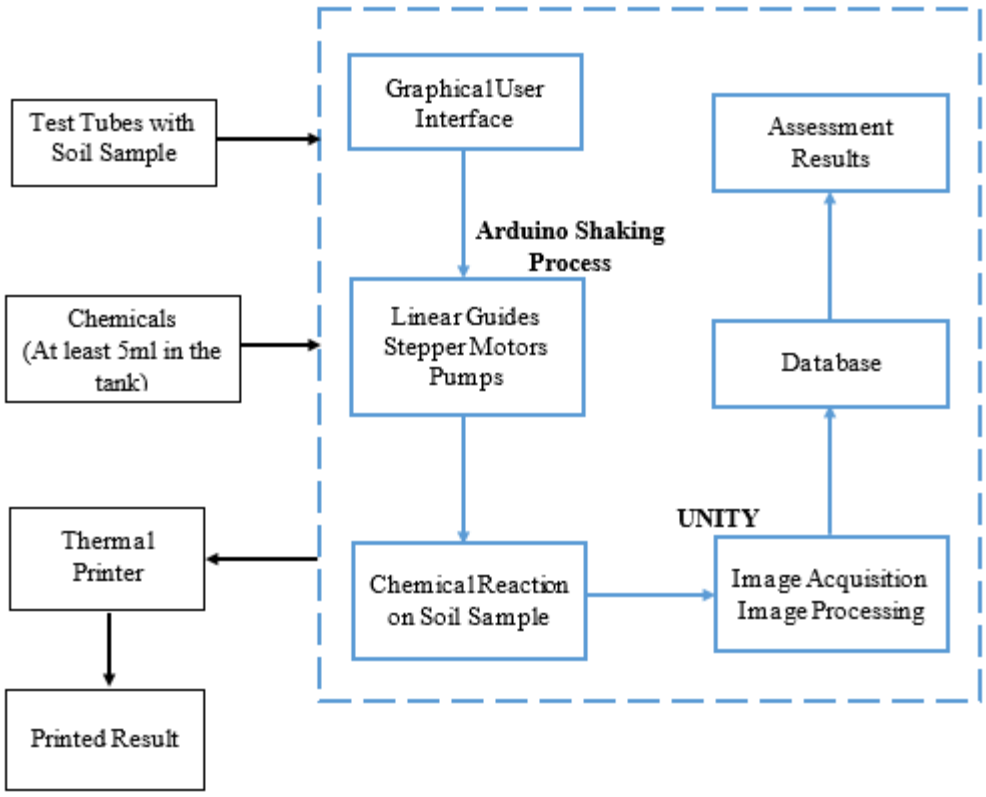


Figure 3.3 Testing and Assessment Block Diagram

Figure 3.3 shows the testing and assessment block diagram of SoilgANic. Test tubes with soil sample and chemical with a minimum of 5ml per compartment will proceed into automated module box to be tested. GUI with motors and pumps are responsible in processing, testing. Using Unity platform and webcam in assessing the colorimetric reaction of each nutrients, and printer for printed assessment result.

Arduino-Based Automated Soil Nutrients and pH Level Testing and Assessment with Fertilizer Recommendation through Digital Image Processing Using Unity called SoilgANic.

The system is composed of five sections namely the automated soil testing, image acquisition, image processing, training system, and fertilizer recommendation. A controlled-light

module included in the automated soil test box, and a 1080p Full-HD Webcam with sixteen megapixels that is responsible for obtaining images for image acquisition.

Image processing has sections consist of image enhancement and segmentation, and color extraction. In image enhancement, noise reduction and contrast adjustment will be performed. In image segmentation, thresholding and masking will be included. In color extraction, Color pixel area will calculated.

For the training system section, the processed images will serve as input. The macronutrients, micronutrients level and pH level assessment will base on the standards given by the supporting institution and this will serve as a database for the system. The input will processed in this section and the system trained using Unity to improve the accuracy of the program.

The recommendation section will generate a hard copy of the report in a form of receipt based on the analysis of the system and will consist the following:

For Macronutrients, Micronutrients and pH Level Assessment:

- Qualitative Result of Macronutrients: N, P, K, Ca, Mg; Micronutrient: Zn and pH level.
- Appropriate amount of Fertilizer to be applied per hectare or per plant (for trees)
- Total amount of fertilizer
- When to apply

3.2.1 Conceptualization of the Design

The image of the colorimetric chemical result of soil test serves as the input of the system. The procedure are processed using linear guide motors, which are used to align the

inputs to its terminals; Hydraulic pumps to place the needed chemicals in the procedure; Arduino Mega as a microcontroller for the whole automation process; and a 1080p Camera to capture the results of the process. These images will uploaded in Visual Studio. The images will be processed using Unity software and will undergo several stages to achieve accurate result. Based on the result, the program will generate a report in hardcopy format.

The Unity will serve as an Integrated Development Environment for image processing. This process includes the image acquisition, image enhancement, and image segmentation.

A GUI made in built-in Visual Studio in Unity will allow the user to capture images. The compiled Unity functions will called to perform the image analysis. After finishing the process, a hardcopy report will generated with recommendation provided by BSWM.

3.2.2 Gathering of the Related Facts or Information

- Research on soil nutrient deficiency for different crops.
- Research on Linear motors, Hydraulic pumps and Arduino Mega for the automation process
- Research on other studies related or similar to the project. Research on 15 major agricultural crops in the Philippines

3.3 Project Development

3.3.1 Hardware Construction Process

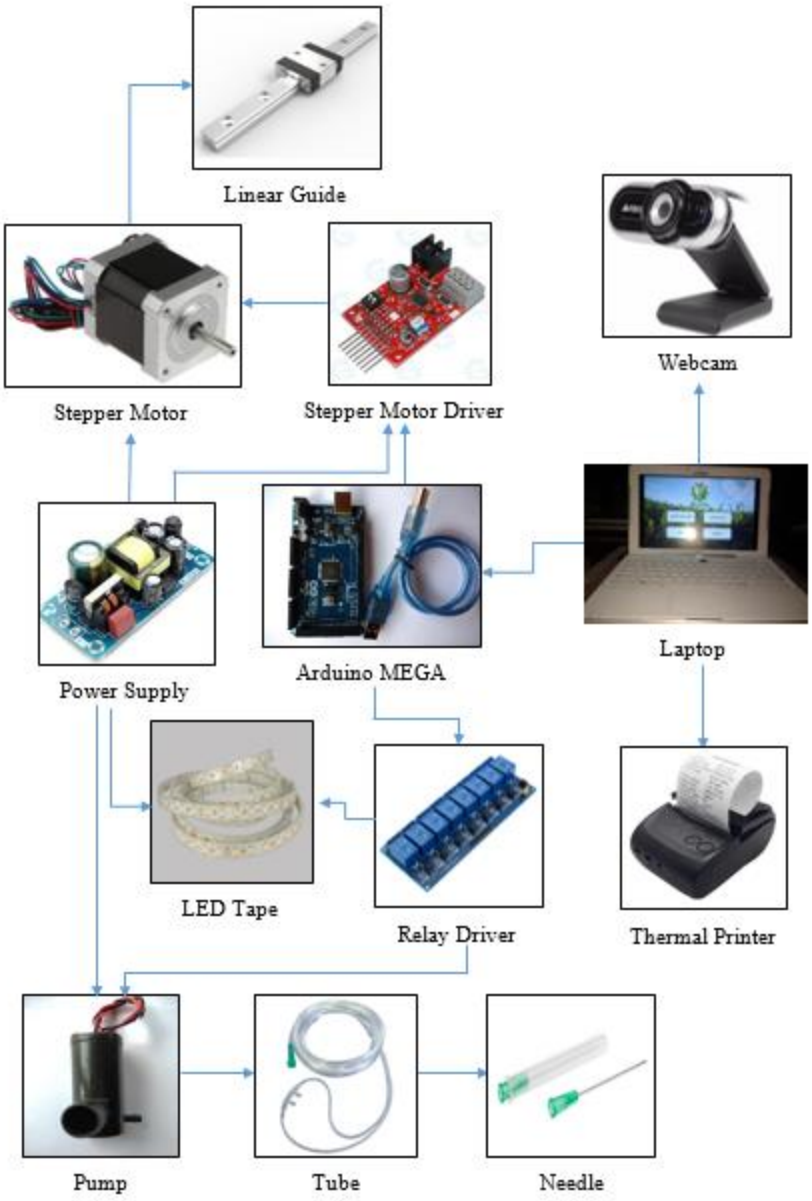


Figure 3.4 Hardware Block Diagram

Figure 3.4 shows the block diagram of the module box which consists mostly of the hardware components. The power supply produces an output of 12V for the stepper motor, stepper motor driver, LED tape, and pumps. Connected from the stepper motor is a linear guide that serves as the path of the tray movements and terminals. Connected from the laptop are the Arduino MEGA, webcam, and thermal printer. The laptop also serves as

the supply of the said components. The Arduino controls the stepper motor driver that excites the stepper motor, and the relay driver module that controls the pumps and the LED tape. Each pumps has a connected tube, and the needles are connected and set fixed at the tube.

3.3.2 Physical Setup

For acquirement of soils samples, a controlled light module box is used to control the lighting when the picture is taken. It is contained within in the Automated Soil testing box which comprises of a webcam (attached on the box) and lighting system inside.

For the materials of this light box, wooden casing is used to achieve the durability, and the natural color of the liquid inside the test tube. Two meters of LED Strips are used to produce enough lighting to the test tubes. These LEDs are placed at the side of the box where the test tube is well lightened, thus, the white paint served as the diffuser to dispense the light evenly to the side of the box. The LED is supplied by 12v power supply.

3.3.3 Project Plan

3.3.3.1 Automated Module Box

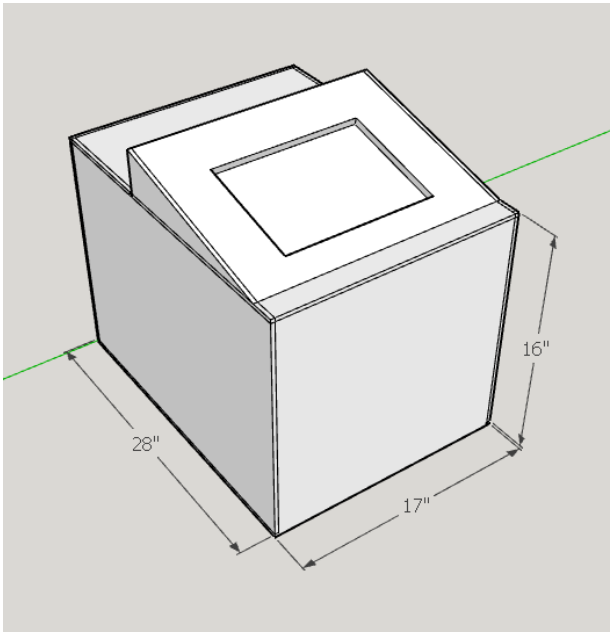


Figure 3.5 3D design of the Automated Module

Figure 3.5 shows the dimensions of the Automated Soil Test are as follows: 17 inches in length, 28 inches in width and 16 inches in height. The proponents came up to the said measurements based on experimentation and research. The length and width of the box is measured for the desired distance of object from lens with acceptable focus from web camera, to meet the size for the motors and to provide proper and enough space for the light on the seven test tubes. The height of the box is approximated based on the height of the test tube, the position of the webcam and the pressure of each needles.

3.3.3.2 Test Tube

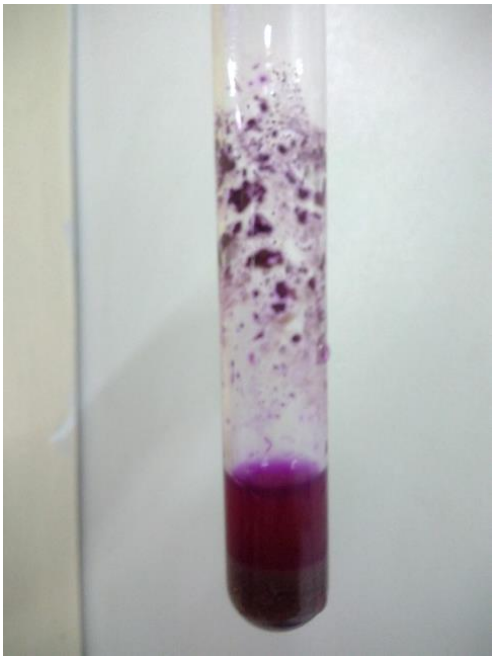


Figure 3.6 Test Tube with Soil sample

Figure 3.6 shows the test tube with soil sample after the procedure of initial pH testing. The process requires the input of test tubes with 3 to 5 grams of soil sample for the chemicals to be able to fully react and determine the nutrient contents of the soil. The color shown in the figure is the reaction of chemical for initial pH testing.

3.3.3.3 Soil Test Kit

Figure 3.7 Soil Test Kit

Figure 3.7 shows, a fast method of determining the fertility and nutrient contents of a soil called Soil Test Kit (STK). It includes testing of chemicals and analyses which defines the quantity of nutrients the soil contains that also exists to the plant. The recommendation of the precise amount and type of fertilizer to be added for a specific crop grown in the soil sample being tested will be determined using the interpretation of the results. STK analyses Potassium (K), Nitrogen (N), Phosphorus (P), and pH level of the soil.

3.3.3.4 Rapid Soil Test Kit

Figure 3.8 Rapid Soil Test Kit

Figure 3.8 shows the Rapid Soil Tet Kit (RST). RST is similar to STK that also analyses the amount of soil nutrients in the soil. The only difference is between the nutrient element STK and RST analyses and the method of interpreting the chemical reaction to the soil. STK uses the colorimetric method which uses solid colors to determine the nutrient level while on the other hand, RST interprets the density and thickness of precipitate the chemical reaction made. The nutrient element RST analyses are Calcium (Ca), Magnesium (Mg), and Zinc (Zn).

3.3.3.5 Mini Hydraulic Pump

Figure 3.9 Mini Hydraulic Pump

Figure 3.9 shows the 2”x2.7” programmable mini hydraulic water pump that was used in the device. It is used to deliver the chemicals from the chemical compartment to the designated test tubes for testing. The Arduino MEGA was used to program and control the flow and amount of chemicals for the suction and delivery the pump will perform. It is programmed for the desired quantity of chemicals for a period of time that is needed for the testing of soil samples. Each pumps are connected to the designated relay driver that also controls the latching of the pump. Another thing considered in choosing the pump used is the pump’s resistance and ability to perform in toxic liquids and chemicals.

3.3.3.6 Tube

Figure 3.10 Oxygen Nasal Cannula O-Ear 2m Tube

Figure 3.10 shows the tube used for moving chemicals. The tube is used in conjunction with the pump for the delivery of chemicals from the chemical compartment to the test tubes. A medical tube is used for it is advisable to use a medical tube because most medical tubes are capable of withstanding toxic liquids and chemicals. It is also important to consider the diameter of the tube in order to hold the needles that will also minimize and control the sudden dropping and amount of chemicals. The length of the tube used is also calculated because it contributes to the travel time of the chemicals from the pump to the needles, and from there will come the calculation of time for the amount of chemicals to be delivered.

3.3.3.7 Chemical Glass Compartment

Figure 3.11 Actual Picture of the Chemical Glass Compartment

Figure 3.11 shows the glass chemical compartment used in the device. It is a customized glass tank specifically designed for the device. The design of the chemical compartment is a three layer tank that has seven compartments in every layer to fit all the necessary chemicals for the testing. The thickness of glass, height and width of every compartment, and spacing are all computed to specifically fit inside the testing box and fit all the pumps and tubes to be used. Every compartments are secured with silicone gel to prevent leakage of chemicals that will result to contamination. It is made sure that silicone gel is chemical resistant and will result no reaction. The chemical compartments should remain closed, and should just be opened whenever it is needed to refill the chemicals.

3.3.3.8 Webcam

Figure 3.12 PK-920H 1080p Full HD Wide Angle 16MP Webcam

Figure 3.12 shows the webcam used that is capable of recording 1080p Full HD quality video at up to 30fps and capable of capturing image resolution of up to 16MP. It has a sensor to capture and record superior sharpness and image quality of photos and videos. The specification of webcam is important because it will perform on the much crucial part of the system which is the image processing. It captures the real time process of the soil testing process and also captures the color value for STK and precipitate for RST from the final testing process that will determine and interpret the results.

3.3.3.9 Arduino MEGA

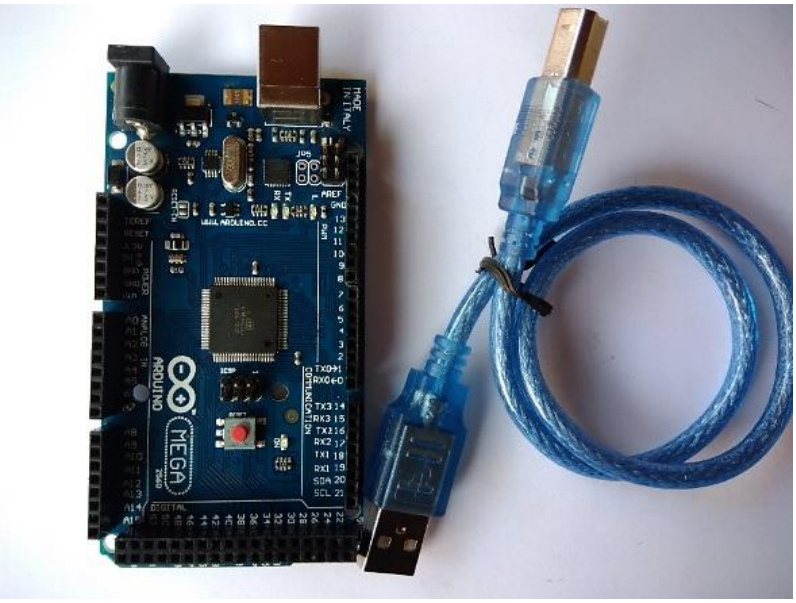


Figure 3.13 Arduino MEGA

Figure 3.13 shows the Arduino MEGA. ATmega2560 is the basis of microcontroller board based Arduino Mega. It has fifty four (54) i/o digital pins (14 digital pins can be used as PWM outputs), sixteen analog inputs, four UARTs hardware serial ports or Asynchronous Receiver/Transmitter, a 16MHz crystal oscillator, connected thru USB, a power jack, an in-circuit serial programming header, and a button for reset. It has the whole thing necessary to sustain the microcontroller; to get started, just connect the Arduino to a computer using a Universal Serial Bus cable or plug it with an AC-to-DC adapter or battery.

3.3.3.10 Relay Driver

Figure 3.14 5V 8 Channel Relay Board Module for Arduino

Figure 3.14 shows the 5V 8 channel active low relay module used in the device. The system used 22 relay drivers. Each pumps for each chemicals has a specific relay module, as well as the lights and switch inside the testing box also has a specific relay and relay driver. The relay driver is responsible for controlling the pump when a specific pump is needed to perform and its time duration. The time duration needs to be precise for the reason that the amount of chemicals is calculated through the time duration of the activation of pump.

3.3.3.11 Stepper Motor

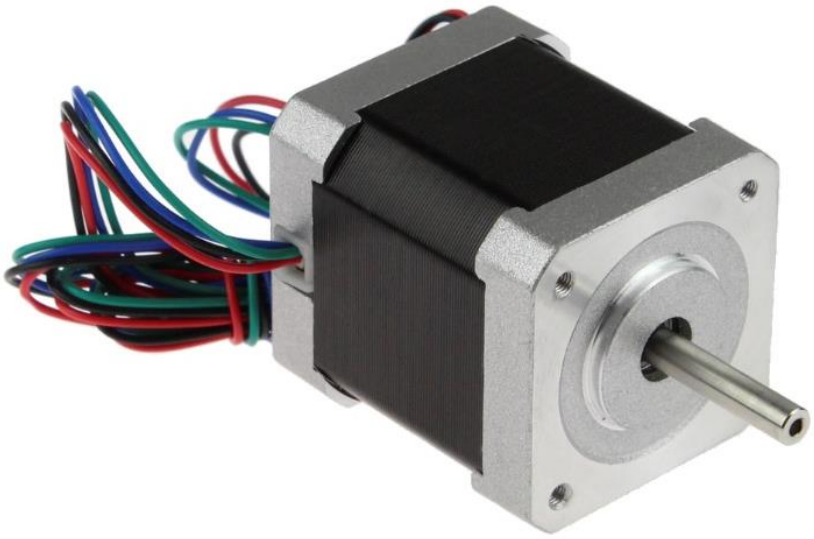


Figure 3.15 Stepper Motor

Figure 3.15 shows the stepper motor used in the device which is a stepper motor with micro steps. The micro steps helps in the matching of the exact position of the test tube trays and the position of terminals of the needles to prevent the leakage of chemicals on the chemical dropping process. A gear was set fixed on the stepper motor, and a belt was connected to it that enables the test tube trays to move back and forth with the help of a linear guide device. The Arduino MEGA is used to program the stepper motor. The speed, distance, and movement of the test tube trays that is connected to the stepper motor are all calculated and precise and controlled by the Arduino MEGA.

3.3.3.12 Stepper Driver

Figure 3.16 Stepper Driver

Figure 3.16 shows the stepper driver used in the device. For a stepper motor to work, it requires a stepper motor driver. Stepper motor drivers serve as a digital controllers for the stepper motor. Accurate synchronization of a stepper motor from every pulse signal can be achieved with the use of a stepper motor driver. It has the ability to reduce vibration while producing high torque at low speeds. It is also the one responsible for the stepper motor to be programmable. Stepper motor drivers has designated pins connected to the Arduino MEGA and pin connections for the stepper motor. Other than the program, the speed of the stepper motor can be manually controlled because it contains switches that enables to manipulate the speed of the motor.

3.3.3.13 Laptop

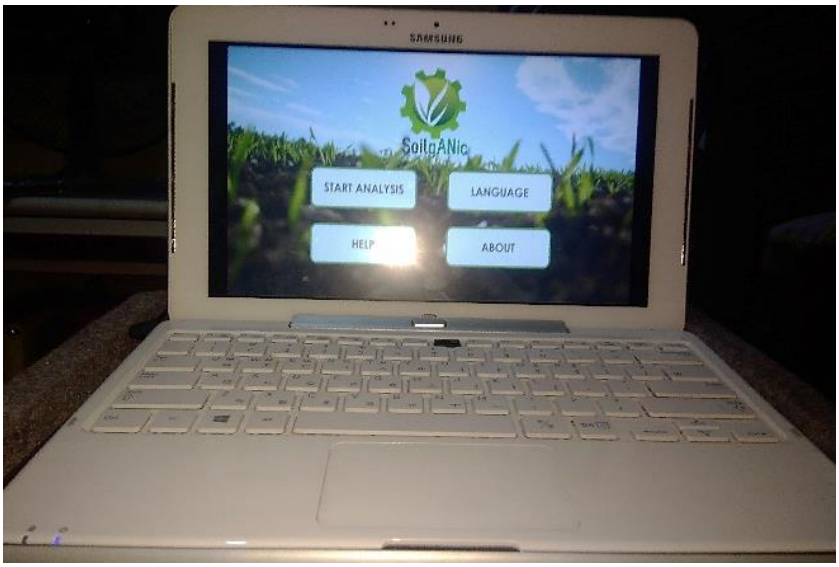


Figure 3.17 Samsung xq500t1c-a52

Figure 3.17 shows a 12-inch detachable LCD laptop used for the device. The device was designed to be portable so it requires a detachable LCD laptop that will serve as the screen of the device. It displays the Graphical User Interface of the system and allows access to the device. It is a screen touch LCD that allows to enter the necessary details the system demands. It also allows the user to watch the real time process happening inside the box, and also allows the user to choose different types of crops, and display the results thereafter. A screen touch detachable LCD laptop was used instead of a tablet due to the higher specifications of the laptop that is needed for the system and the software interface to work efficiently, and also provides numerous ports that will be needed by the system.

3.3.3.14 Thermal Printer

Figure 3.18 58mm portable mini thermal printer

Figure 3.18 shows the thermal printer used for the system. On the latter part of the testing, the results of the testing will be posted on the laptop screen and the user will be allowed to choose whatever crops for the fertilizer recommendation. The fertilizer recommendation will also be displayed on the screen and will be saved on the laptop that can be easily accessed whenever the user needs a copy of it. But, other than displaying the results on the screen, the device has a thermal printer that automatically prints the results together with the fertilizer recommendation whenever the user clicks on the crops the user desires. It is a thermal printer similar to every thermal printer on shops that prints receipts, so the printed copy will serve as your guide and receipt of the testing.

3.3.3.15 Flight Case Box

Figure 3.19 Flight Case Box

Figure 3.19 shows the case of the device, a customized flight case box with a dimension of 17” by 28” by 16”. The design of the box contains doors on both front and back portion. The front portion gives access to the main process of the system which is the shaking process and gives entry for the test tubes of the soil samples. The back portion gives access to the glass chemical compartment. Also provided on the back portion are layers of shelf container for the bottles of the ready and in-stock chemicals for refills. The top portion of the box is an inclined holder for the detachable LCD screen. The box has handles on both sides for lifting and also has small wheels for easy transport of the device.

3.4 Software Development

The program is to be done using:

1. Arduino Software IDE
2. Unity
3. Visual Studio

The Arduino Software will used as the IDE for the programming of the Arduino MEGA. It will specifically control the soil nutrient testing process. Programming in this software will control the direction and speed of the rotation of the motor, and the hydraulics from the pumps to the hose that manages the chemical contacts.

The Visual Studio will serve as the IDE for developing the GUI that will allow the user to upload images and generate a report in PDF format, and printed using the thermal printer.

Unity is a cross-platform game engine that is used for creating a program that interprets input data and provides a corresponding processed output.

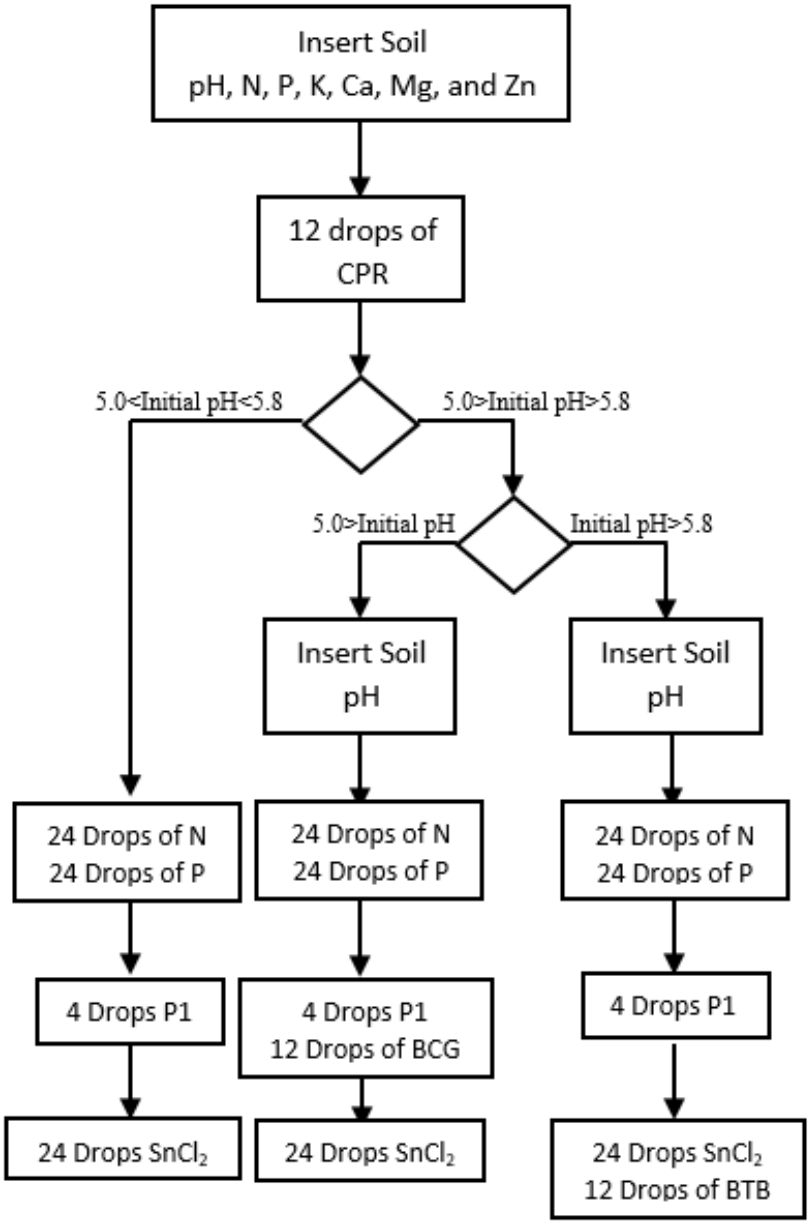


Figure 3.20 Automation Process Flow Chart (pH, N and P)

Figure 3.20 shows the flowchart of automation process for the Initial and Final pH level, Nitrogen, and Phosphorus. The first step of the process is to insert all 7 soil samples. The testing will begin when the user clicked “start” from the GUI. For the initial pH testing, tray 1 will move to terminal 2 and the system will pour 12 drops or 0.5mL of CPR then it will shake for 2 minutes.

The system will then analyze the reaction of the chemicals. If the system got a reading of less than 5.0 or greater than 5.8, it will require the user to enter another soil sample for pH. After putting soil and clicking start, the system will move the tray to terminal 1 and will pour 24 drops or 1mL of N and P. For the reading of less than 5.0 the system will then move the tray to terminal 3, pour 4 drops of P1 and 12 drops of BCG, then it will move the tray to terminal 4, pour 24 drops of $SnCl_2$, then it will shake for 2 minutes. For the reading of greater than 5.8, the system will move the tray to terminal 3, pour 4 drops of P1, then it will move the tray to terminal 4, pour 24 drops of $SnCl_2$, and then shake. The system will then be able to read and determine the value of pH level, Nitrogen, and Phosphorus after shaking and letting the soil settle.

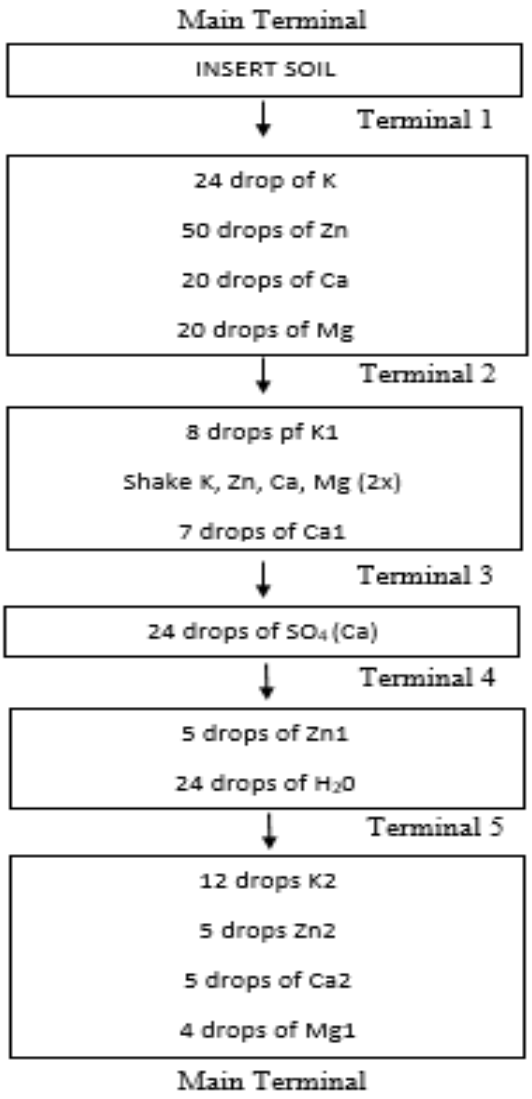


Figure 3.21 Automation Process for (K, Zn, Ca, and Mg)

Figure 3.21 shows the flowchart of automation process for Potassium, Calcium, Magnesium and Zinc. The rack that holds K, Ca, Mg, and Zn is called tray 1 in the system. The first step is putting all seven soil samples on the rack then click start. The system will move tray 1 on terminal 2 and will pour 24 drops of K, 50 drops of Zn, 20 drops of Ca and 20 drops of Mg. Next, the system will move tray 1 on terminal 3 and will pour 8 drops of K1. After pouring K1, tray1 1 will shake then will move back to terminal 3 after shaking and will pour 7 drops of Ca1.

Tray 1 will then move to terminal 4 and pour 24 drops of SO_4. Then, tray 1 will move to terminal 5, pour 5 drops of Zn1 and 24 drops of H_2O. Last, Tray 1 will move to the main terminal, pour 12 drops of K2, 5 drops of Zn_2, 5 drops of Ca2, and 4 drops of Mg1, from there the system will move the tray to the position where it will read and analyze the chemical reactions from the soil samples.

3.4.1 Programming

The proponents used Unity in creating functions because of its computing power and the availability of toolboxes.

For the programming of the Arduino MEGA the Arduino Software will be used as the IDE. It will exactly control the soil nutrient testing process. Programming in this software will manage the direction and speed of the linear guide motor, and the hydraulics from the pumps to the hose that controls the chemical contacts.

The built-in Visual Studio in Unity is use to create a GUI that will allow the user to view the real time process and generate .txt file to hardcopy format.

3.4.2 Image Processing Flow

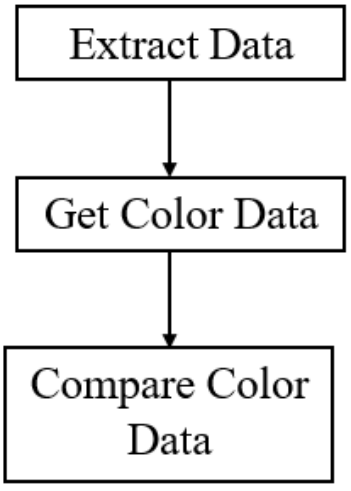


Figure 3.22 Flowchart of Image Processing

In Figure 3.22, Image processing section includes of extracting color data, get color data and comparing color data. In extracting data, each frame of video composed of pixels, from preset coordinates of markers pointed on the pixels the value will be picked and stored as data for the specific level. In Figure 3.23 below, get color data, from that preset color pixel obtained, values will assigned corresponding on its color (R, G and B). In Figure 3.23, Compare color data, actual extracted pixel value will be compared to save data corresponding to its color table of test.

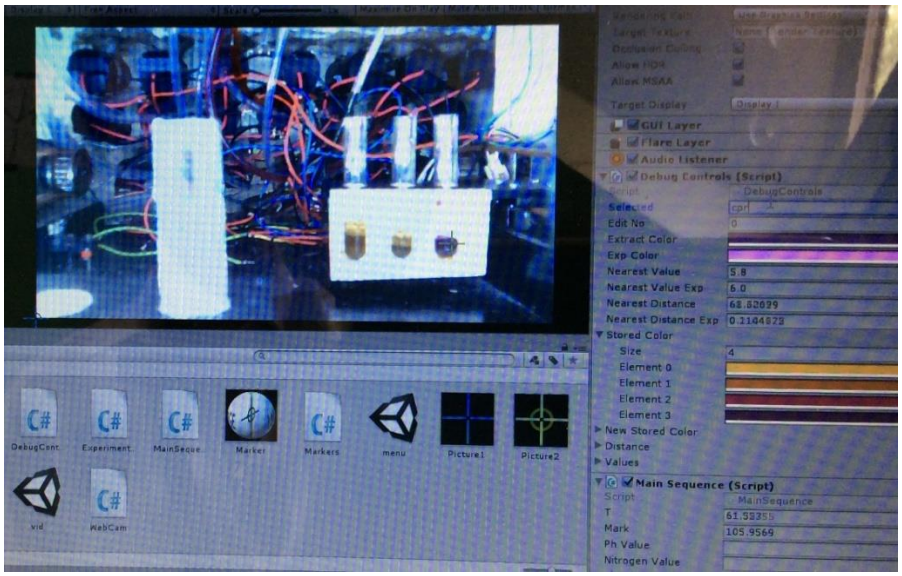


Figure 3.23 Get Color Data and Compare Color Data Process

3.4.3 Graphical User Interface

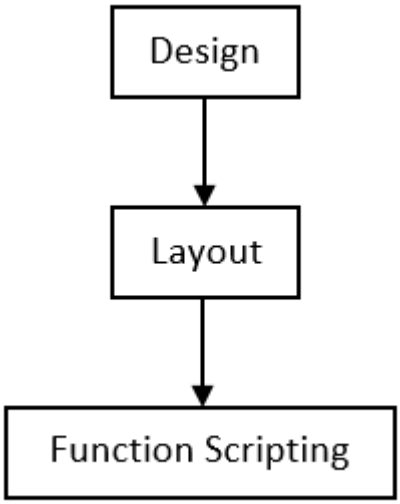


Figure 3.24 Flowchart in developing Graphical User Interface

Figure 3.24 shows the process of making the graphical user interface (GUI). The first process is planning and designing of the GUI. Next is lay outing, where the designs (background, text, and icons) converted into image form (.png or .jpg) and insert to the Unity platform. The last process is function scripting using c# to program each tasks of icons or images.

3.5 Testing and Operational Procedure

3.5.1 Testing Procedure

1. The proponents collected 30 soil samples that will be used for testing procedure. 10 of the soil samples were given by BSWM, and 20 of the soil samples were gathered from different areas around Cavite mostly from Bacoor.
2. For the soil samples to be suitable for soil testing, the soils need to be air-dried and pulverized.

3. For the main testing process, the test tubes should be filled with 3-5 grams of soil samples. The two trays inside the box contains seven holder for seven test tubes with soil samples.
4. The testing will first perform the initial pH testing. The analysis for the initial pH testing will determine whether the system will need another soil sample for pH or will just proceed to the next process.
5. The trays inside the box will move to different terminals corresponding to the program and to the terminal of the chemicals needed for a certain nutrient element.
6. After pouring chemicals on the test tubes, the trays will shake to help the chemicals react in the soil. Zn, Ca, Mg, and K does not involve shaking after pouring the last chemicals of their element to prevent the disturbing of their precipitate.
7. The trays will move to their corresponding places where the system will analyze the reaction made. The soils need to be settled first before the system interpret the reactions so the system will have to wait for a certain period of time to get a clearer analysis of the reaction.
8. The results will be displayed at the screen afterwards, and the user will be allowed to choose crops for fertilizer recommendation.
9. The system automatically prints the results and the fertilizer recommendation that serves as guide and receipt.
10. After the soil analysis, the proponents planted same crops in the same soil but the first crop is applied with fertilizer based on the fertilizer recommendation and the

other one is planted without fertilizer, this was done to determine the comparison and effectiveness of the SoilgANic.

3.5.1 Operational Procedure

To Run the SoilgANic, these are the following procedures:

1. To set up the tablet, just place it to the tablet slot. Plug the USB connector to the tablet.

Figure 3.25 Tablet PC

In Figure 3.25 shows the Tablet Pc of SoilgANic where the user will put the required information to proceed with the soil testing.

2. Put the chemicals into the compartment. Filled with a minimum of 50 mL of each chemical.

Figure 3.26 Chemical Tank

In Figure 3.26 shows the Chemical Tank of SoilgANic

3. Connect the printer to its USB port.
4. Open the SoilgANic App.
5. Enter the details of the user

Figure 3.27 Screenshot of Fill up form

Figure 3.27 shows the screenshot of fill up form where the user will fill the information required.

6. Insert the first soil sample for N, P, K, Ca, Mg, Zn, and pH testing.
7. Wait until the testing is done (you can also view the real time process.)

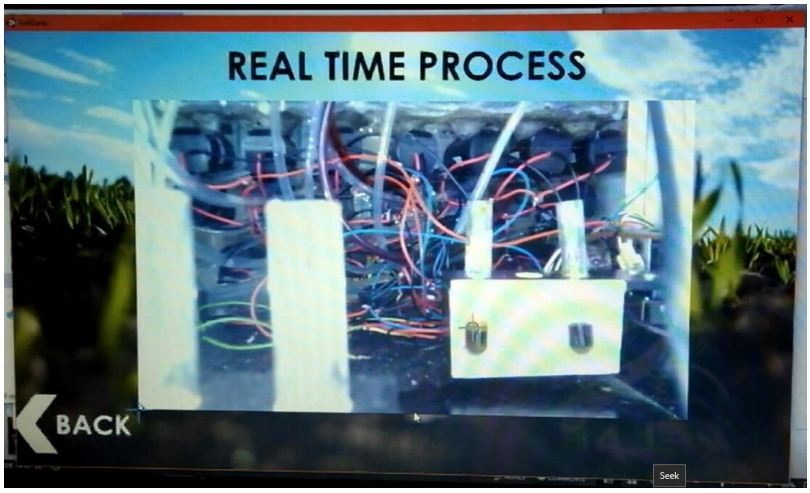


Figure 3.28 Screenshot of Real Time Process

In Figure 3.28 shows the screenshot of Real Time Process of Soil Analysis

8. Insert another soil sample if soil pH is greater than or equal 6 and if it is less than or equal to 5.
9. After the final result, choose crop for fertilizer recommendation.

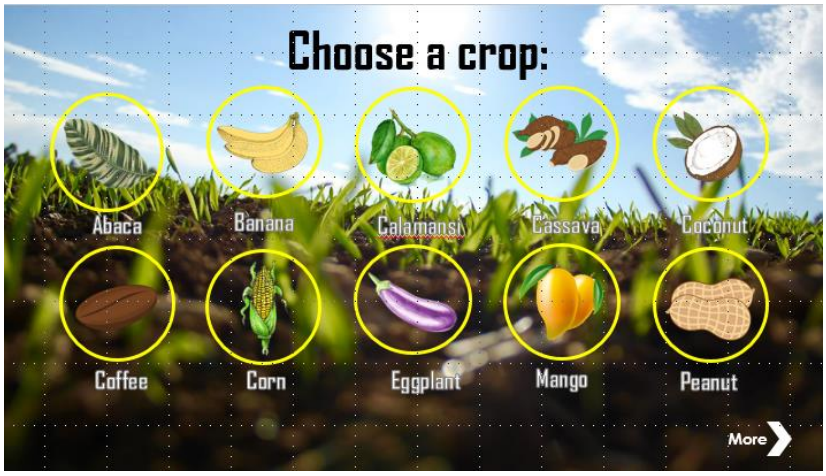


Figure 3.29 Screenshot of choose a crop

In figure 3.29 shows the variety of crops to choose from after the soil test is done.

10. Click the “Generate Report” to see the results.

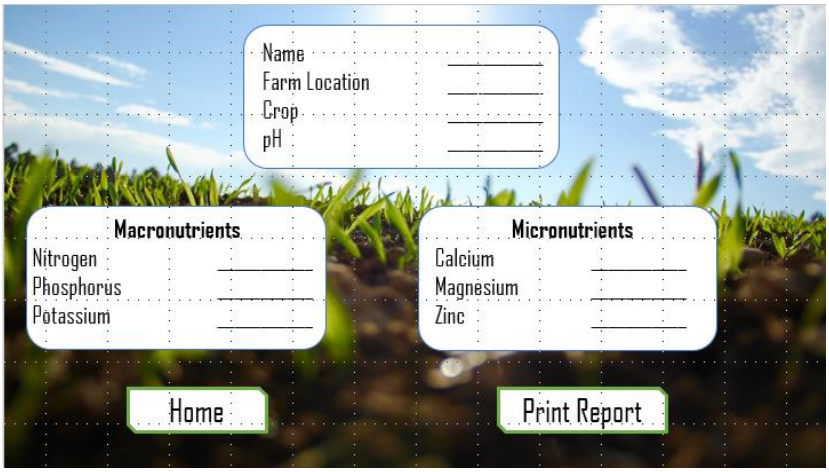


Figure 3.30 Screenshot of Soil Test Report

In figure 3.30 shows the result of soil test analysis

11. Click the “Print Report” for printed results.

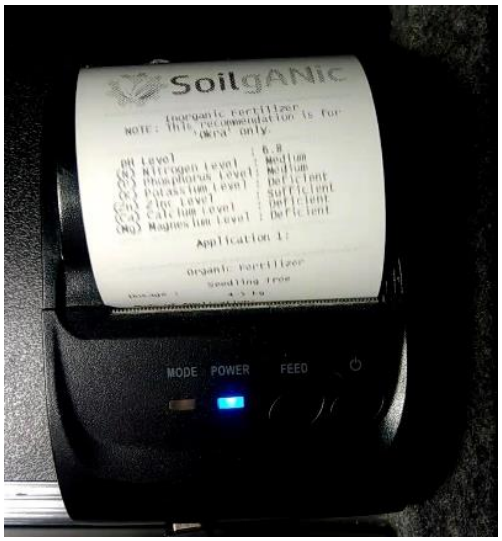


Figure 3.31 Thermal Printer

In figure 3.28 shows the thermal printer used in the device to produce a printed copy of the soil report.

3.4 Materials and Equipment

The required materials and tools for the development of the project were gathered from different sources. The Unity was from Unity Technologies, the Arduino IDE was from Arduino, while the Visual Studio was from Microsoft.

Table 3.1 Bill of Materials for Automated Module Box

Automated Module Box	
Materials	**Amount**
Acrylic	900
Plywood	850
LED Strips	300
Power Supplies	1,100
Wires	300
Pin Connectors	160
Chemical Compartment	3,200
Pumps	7,350
Needles	50
Arduino MEGA	900
Relay Set	2,400
Linear Guide Motors	2,800
Flight Case	9,700
Total	**30,010**

Table 3.1 shows the components and materials with its prices for making the SoilgANic automated module box.

Table 3.2 Bill of Materials for SoilgANic

SoilgANic	
Material	**Amount**
Laptop	8,000
Webcam	1,060
Thermal Printer	4,600
Soil Test Kit	1,500
Rapid Soil Test Kit	1,260
Chemical Refills	3500
Test tubes	150
Automated Module Box	30,010
Total	**50,080**

Table 3.2 shows the summary of materials and expenses spent in constructing the project which includes the hardware, test kits, chemical refills, and SoilgANic's automated module box has a total amount of 50,080 pesos.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the collected data and its interpretation of findings relative to the tests conducted.

4.1 Project Structural Organization

In Figure 4.1 is the home screen of SoilgANic, if the user click "Start Analysis", they can proceed to soil testing. In "Language", the user can choose their preferred language. "Help" is for the procedures or on how to use the device. "About" is for the description of the device.

Figure 4.1 Home Screen of SoilgANic in English

Figure 4.2, it is when the soil sample will be inserted for soil testing.

Figure 4.2 Insert Soil sample for pH level, Macronutrient and Micronutrient testing in English

Figure 4.3 shows the display while the soil testing is on process

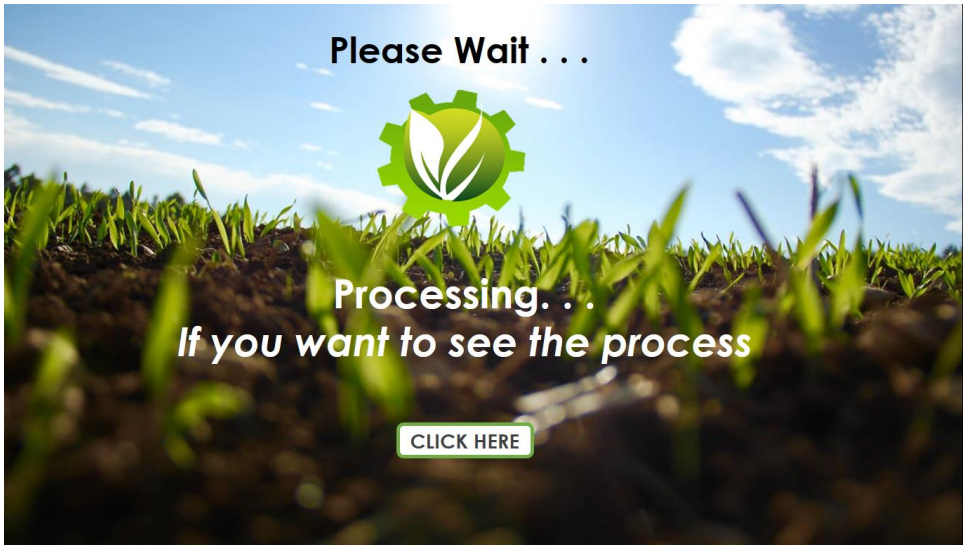


Figure 4.3 Please wait in English

The result of the soil Nutrients and pH level of the soil is shown in Figure 4.4.

Figure 4.4 pH level, Macronutrients and Micronutrient result

In Figure 4.5, shows the printed results and fertilizer recommendation for the chosen crop.

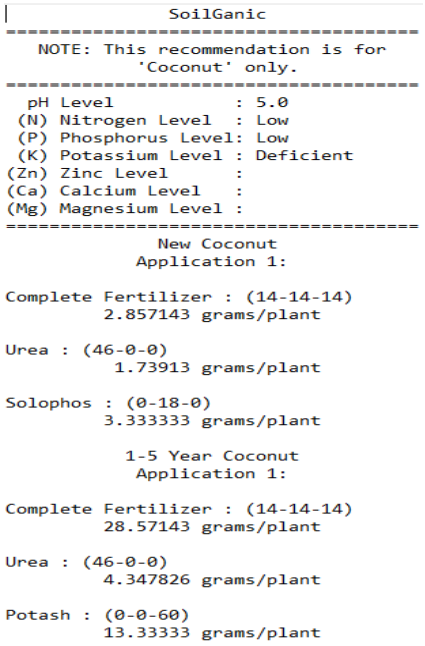


Figure 4.5 Soil Test Report

4.2 Project Limitations and Capabilities

The project SoilgANic is limited to the assessment and testing of pH level, Macronutrients (Nitrogen, Phosphorus and Potassium), Secondary Macronutrients (Magnesium and Calcium) and one Micronutrient (Zinc). These were due to the expert advices of Supervising Agriculturist, Ms. Beatriz C. Magno and Senior Agriculturist, Ms. Agnes Morada, of Bureau of Soils and Water Management (BSWM).

The limitations of the project are as follows:

1. SoilgANic can only analyze the level of pH, Macronutrients (Nitrogen, Phosphorus, and Potassium), two secondary Macronutrients (Calcium, and Magnesium) and one Micronutrient (Zinc).

2. Color recognition was the only feature observed in identifying the levels.
3. The fertilizer recommendation is limited only for Rice, Corn, Coconut, Banana, Mango, Abaca, Coffee, Calamansi, Cassava, Eggplant, Peanut, Tomato, Okra, Sweet Potato, Pechay.
4. Arduino Mega is the only microcontroller that can be used in the Project.

4.3 Project Implementation

4.3.1 Soil Sample Location

4.3.1.1 Soil Sample Mapping

In Figure 4.6 shows, the graphical representation of soil samples gathered in different locations throughout Cavite.

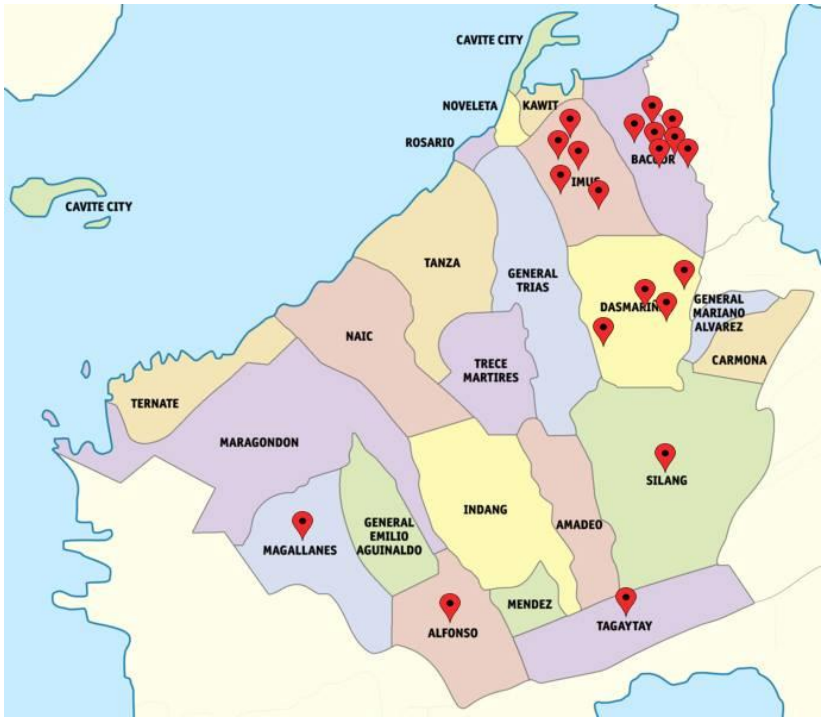


Figure 4.6 Mapping of Soil Samples gathered from various areas in Cavite

Table 4.1 Summary of Soil Sample gathered from various location in Cavite

Soil Sample #	Address
1	Barangay Kaong, Bayan ng Silang
2	Barangay Kaybagal South, Tagaytay
3	Barangay Mangas II, Bayan ng Alfonso
4	Barangay Baliwag, Magallanes
5	Barangay San Nicolas I
6	Barangay San Nicolas II
7	Barangay Bayanan
8	Barangay Molino I
9	Barangay San Nicolas III
10	Barangay Molino VI
11	Barangay Molino II
12	Barangay Alapan I-A
13	Bucandala IV
14	Bucandala V
15	Malagasang I-C
16	Anabu II-C
17	Barangay Paliparan III
18	Barangay Sampaloc IV
19	Barangay Paliparan I
20	Barangay Langkaan I
21-30	BSWM Soil Samples

In Table 4.1 shows the summary of soil samples and exact address of the soil samples gathered in various areas of Cavite.

4.3.2 pH Level Assessment Performance

Table 4.2 Final pH Level Accuracy Assessment Performance

Classification		Automated Soil Testing (SoilgANic)													
		pH Final Values													
		4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	SUM	Commission	Accuracy	Total Accuracy
Conventional Soil Testing (BSWM)	4.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	
	4.4	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	
	4.8	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	
	5.2	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	
	5.6	0	0	0	0	4	0	0	0	0	0	4	0	100.0%	
	6.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	
	6.4	0	0	0	0	0	0	10	0	0	0	10	0	100.0%	
	6.8	0	0	0	0	0	0	0	7	0	0	7	0	100.0%	
	7.2	0	0	0	0	0	0	0	0	8	0	8	0	100.0%	
	7.6	0	0	0	0	0	0	0	0	0	1	1	0	100.0%	
	SUM	0	0	0	0	4	0	10	7	8	1	30			
	Omission	0	0	0	0	0	0	0	0	0	0				
	Accuracy	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%	100.0%	100.0%	100.0%				
	Total Accuracy														100%

Table 4.2 shows error matrix for map comparison or accuracy assessment. The table shows the summary of performance in assessing pH level between conventional soil testing that BSWM used and automated soil testing that SoilgANic used for 30 soil samples. The quantitatively assessment result for Final pH level is 100% accurate, having 0% of omission and commission.

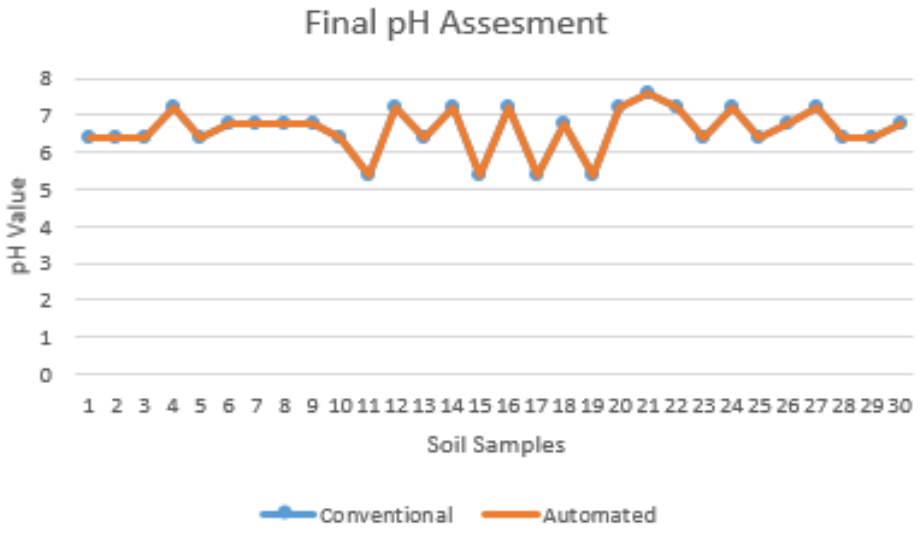


Figure 4.7 Final pH Level Accuracy Assessment Plot

In Figure 4.7 shows the graphical representation of final pH Level Accuracy. Where 30 out of 30 samples matched with the conventional way of assessing pH Level using SoilgANic.

Table 4.2a Demographics of the Soil Samples in various areas of Cavite (pH, N, P, K)

Soil Sample	Address	pH	Nitrogen	Phosphorus	Potassium
1	Barangay Kaong, Bayan ng Silang	6.4	Low	Low	Sufficient+
2	Barangay Kaybagal South, Tagaytay	6.4	Low	Low	Sufficient++
3	Barangay Mangas II, Bayan ng Alfonso	6.4	Low	Low	Sufficient
4	Barangay Baliwag, Magallanes	7.2	Low	Moderately Low	Sufficient+
5	Barangay San Nicolas I	6.4	Low	Medium	Sufficient++
6	Barangay San Nicolas II	6.8	Low	Medium	Sufficient+
7	Barangay Bayanan	6.8	Low	Low	Sufficient++
8	Barangay Molino I	6.8	Low	Moderately High	Sufficient+
9	Barangay San Nicolas III	6.8	Low	Medium	Sufficient++
10	Barangay Molino VI	6.4	Low	High	Sufficient++
11	Barangay Molino II	5.4	Low	Low	Sufficient+
12	Barangay Alapan I-A	7.2	Low	Moderately Low	Sufficient++
13	Bucandala IV	6.4	Low	Low	Sufficient+
14	Bucandala V	7.2	Low	Moderately High	Sufficient++
15	Malagasang I-C	5.4	Low	Low	Sufficient+
16	Anabu II-C	7.2	Low	Moderately Low	Sufficient+
17	Barangay Paliparan III	5.4	Low	Low	Sufficient+
18	Barangay Sampaloc IV	6.8	Low	Low	Sufficient+
19	Barangay Paliparan I	5.4	Low	Low	Sufficient
20	Barangay Langkaan I	7.2	Low	High	Sufficient+

In Table 4.2a shows the summary of the nutrient content present in soil samples gathered in different areas in Cavite. For pH level, if it is less than or equal to 5.5 the soil is considered acidic, if it is 5.6 it is neutral, and if the soil is alkaline, the pH level is greater than or equal to 5.7 the soil is said to be alkaline. For Nitrogen, there are three levels, low, medium and high. All of the soil samples gathered are low in nitrogen. For Phosphorus there are 5 levels, low, moderately low, medium, moderately high and high. For potassium, it has also five levels, deficient, sufficient, sufficient+, sufficient++ and sufficient +++.

Table 4.2b Demographics of the Soil Samples in various areas of Cavite (Ca, Mg, and Zn)

Soil Sample	Address	Calcium	Magnesium	Zinc
1	Barangay Kaong, Bayan ng Silang	Sufficient	Sufficient	Sufficient
2	Barangay Kaybagal South, Tagaytay	Sufficient	Sufficient	Sufficient
3	Barangay Mangas II, Bayan ng Alfonso	Sufficient	Sufficient	Sufficient
4	Barangay Baliwag, Magallanes	Sufficient	Sufficient	Sufficient
5	Barangay San Nicolas I	Sufficient	Sufficient	Sufficient
6	Barangay San Nicolas II	Sufficient	Sufficient	Sufficient
7	Barangay Bayanan	Sufficient	Sufficient	Sufficient
8	Barangay Molino I	Sufficient	Sufficient	Sufficient
9	Barangay San Nicolas III	Sufficient	Sufficient	Sufficient
10	Barangay Molino VI	Sufficient	Sufficient	Sufficient
11	Barangay Molino II	Deficient	Sufficient	Sufficient
12	Barangay Alapan I-A	Sufficient	Sufficient	Sufficient
13	Bucandala IV	Deficient	Sufficient	Sufficient
14	Bucandala V	Sufficient	Sufficient	Deficient
15	Malagasang I-C	Deficient	Sufficient	Sufficient
16	Anabu II-C	Deficient	Sufficient	Deficient
17	Barangay Paliparan III	Deficient	Sufficient	Sufficient
18	Barangay Sampaloc IV	Sufficient	Sufficient	Deficient
19	Barangay Paliparan I	Deficient	Sufficient	Sufficient
20	Barangay Langkaan I	Sufficient	Sufficient	Sufficient

In Table 4.2b shows the summary of the nutrient content present in soil samples gathered in different areas in Cavite. The present nutrients are Calcium, Magnesium, and Zinc. Healthy soils in each locations can be easily determined just by looking at the table.

4.3.3 Nitrogen Level Assessment Performance

Table 4.3 Nitrogen Accuracy Assessment Performance

Classification		Automated Soil Testing (Soil-Ganic)								
		Nitrogen Values								
		Low	Moderately Low	Medium	Moderately High	High	SUM	Commission	Accuracy	Total Accuracy
Conventional Soil Testing (BSWM)	Low	30	0	0	0	0	30	0	100.00%	
	Moderately Low	0	0	0	0	0	0	0	0.00%	
	Medium	0	0	0	0	0	0	0	0.00%	
	Moderately High	0	0	0	0	0	0	0	0.00%	
	High	0	0	0	0	0	0	0	0.00%	
	SUM	30	0	0	0	0	30			
	Omission	0	0	0	0	0				
	Accuracy	100.00%	0.00%	0.00%	0.00%	0.00%				
	Total Accuracy									100%

Table 4.3 shows error matrix for map comparison or accuracy assessment. It also shows the summary of performance in assessing Nitrogen level between conventional soil testing that BSWM used and automated soil testing that SoilgANic used for 30 soil samples. The quantitatively assessment result for Nitrogen level is 100% accurate, having 0% of omission and commission.

4.3.4 Phosphorus Level Assessment Performance

Table 4.4 Phosphorus Accuracy Assessment

Classification		Automated Soil Testing (Soil-Ganic)								
		Phosphorus Values								
		Low	Moderately Low	Medium	Moderately High	High	SUM	Commission	Accuracy	Total Accuracy
Conventional Soil Testing (BSWM)	Low	15	0	0	0	0	15	0	100.00%	
	Moderately Low	0	3	0	0	0	3	0	100.00%	
	Medium	0	0	3	0	0	3	0	100.00%	
	Moderately High	0	0	0	4	0	4	0	100.00%	
	High	0	0	0	0	5	5	0	100.00%	
	SUM	15	3	3	4	5	30			
	Omission	0	0	0	0	0				
	Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%				
	Total Accuracy									100%

Table 4.4 shows error matrix for map comparison or accuracy assessment, it also shows the summary of performance in assessing Phosphorus level between conventional soil testing that BSWM used and automated soil testing that SoilgANic used for 30 soil

samples. The quantitatively assessment result for Phosphorus level is 100% accurate, having 0% of omission and commission.

4.3.5 Potassium Level Assessment Performance

Table 4.5 Potassium Accuracy Assessment

Classification		Automated Soil Testing (Soil-Ganic)								
		Potassium Values								
		Deficient	Sufficient	Sufficient +	Sufficient ++	Sufficient +++	SUM	Commission	Accuracy	Total Accuracy
Conventional Soil Testing (BSWM)	Deficient	1	0	0	0	0	1	0	100.00%	
	Sufficient	0	5	1	0	0	6	16.67%	83.33%	
	Sufficient +	0	0	12	1	0	13	7.69%	92.31%	
	Sufficient ++	0	0	0	10	0	10	0.00%	100.00%	
	Sufficient +++	0	0	0	0	0	0	0.00%	0.00%	
	SUM	1	5	13	11	0	30	0.00%		
	Omission	0.00%	0.00%	7.69%	9.09%	0.00%				
	Accuracy	100.00%	100.00%	92.31%	90.91%	0.00%				
	Total Accuracy									93%

Table 4.5 shows error matrix for map comparison or accuracy assessment, it also shows the summary of performance in assessing Potassium level between conventional soil testing that BSWM used and automated soil testing that SoilgANic used for 30 soil samples. The quantitatively assessment result for Potassium level is 93% accurate, having 7% of omission and commission.

Table 4.6 shows the qualitative comparison of two variables, it also shows the summary of performance in assessing Calcium level between conventional soil testing that BSWM used and automated soil testing that SoilgANic used for 30 soil samples. The quantitatively assessment result for Calcium level has 4 unmatched (in soil sample number 5, 13, 15 and 21) over 30 soil samples.

4.3.6 Calcium Level Assessment Performance

Table 4.6 Calcium Accuracy Assessment

Soil Sample	**Conventional Soil Test (BSWM)**	**Automated Soil Test (SoilgANic)**	**Result**
1	Sufficient	Sufficient	Matched
2	Sufficient	Sufficient	Matched
3	Sufficient	Sufficient	Matched
4	Sufficient	Sufficient	Matched
5	Sufficient	Deficient	**Unmatched**
6	Sufficient	Sufficient	Matched
7	Sufficient	Sufficient	Matched
8	Sufficient	Sufficient	Matched
9	Sufficient	Sufficient	Matched
10	Sufficient	Sufficient	Matched
11	Deficient	Deficient	Matched
12	Sufficient	Sufficient	Matched
13	Deficient	Sufficient	**Unmatched**
14	Sufficient	Sufficient	Matched
15	Deficient	Sufficient	**Unmatched**
16	Deficient	Deficient	Matched
17	Deficient	Deficient	Matched
18	Sufficient	Sufficient	Matched
19	Deficient	Deficient	Matched
20	Sufficient	Sufficient	Matched
21	Sufficient	Deficient	**Unmatched**
22	Sufficient	Sufficient	Matched
23	Sufficient	Sufficient	Matched
24	Sufficient	Sufficient	Matched
25	Sufficient	Sufficient	Matched
26	Sufficient	Sufficient	Matched
27	Sufficient	Sufficient	Matched
28	Deficient	Deficient	Matched
29	Deficient	Deficient	Matched
30	Deficient	Deficient	Matched

4.3.7 Magnesium Level Assessment Performance

Table 4.7 Magnesium Accuracy Assessment

Soil Sample	**Conventional Soil Test (BSWM)**	**Automated Soil Test (SoilgANic)**	**Result**
1	Sufficient	Sufficient	Matched
2	Sufficient	Sufficient	Matched
3	Sufficient	Sufficient	Matched
4	Sufficient	Sufficient	Matched
5	Sufficient	Sufficient	Matched
6	Sufficient	Sufficient	Matched
7	Sufficient	Sufficient	Matched
8	Sufficient	Sufficient	Matched
9	Sufficient	Sufficient	Matched
10	Sufficient	Sufficient	Matched
11	Sufficient	Sufficient	Matched
12	Sufficient	Sufficient	Matched
13	Sufficient	Sufficient	Matched
14	Sufficient	Sufficient	Matched
15	Sufficient	Sufficient	Matched
16	Sufficient	Sufficient	Matched
17	Sufficient	Sufficient	Matched
18	Sufficient	Sufficient	Matched
19	Sufficient	Sufficient	Matched
20	Sufficient	Sufficient	Matched
21	Sufficient	Sufficient	Matched
22	Sufficient	Sufficient	Matched
23	Sufficient	Sufficient	Matched
24	Sufficient	Sufficient	Matched
25	Sufficient	Sufficient	Matched
26	Sufficient	Sufficient	Matched
27	Sufficient	Sufficient	Matched
28	Sufficient	Sufficient	Matched
29	Sufficient	Sufficient	Matched
30	Sufficient	Sufficient	Matched

Table 4.7 shows the qualitative comparison of two variables, and it also shows the summary of performance in assessing Magnesium level between conventional soil testing

that BSWM used and automated soil testing that SoilgANic used for 30 soil samples. The quantitatively assessment result for Magnesium level has 0 unmatched over 30 soil samples.

Table 4.8 shows the qualitative comparison of two variables, and it also shows the summary of performance in assessing Zinc level between conventional soil testing that BSWM used and automated soil testing that SoilgANic used for 30 soil samples. The quantitatively assessment result for Calcium level has 6 unmatched (in soil sample number 8, 9, 12, 16, 21 and 29) over 30 soil samples.

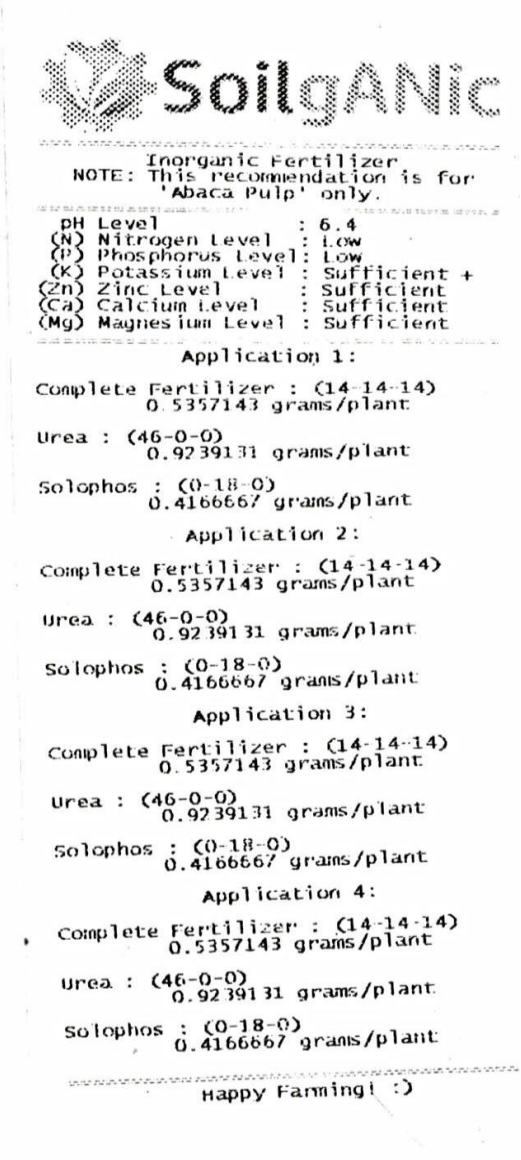
4.3.8 Zinc Level Assessment Performance

Table 4.8 Zinc Accuracy Assessment

Soil Sample	**Conventional Soil Test (BSWM)**	**Automated Soil Test (SoilgANic)**	**Result**
1	Sufficient	Sufficient	Matched
2	Sufficient	Sufficient	Matched
3	Sufficient	Sufficient	Matched
4	Sufficient	Sufficient	Matched
5	Sufficient	Sufficient	Matched
6	Sufficient	Sufficient	Matched
7	Sufficient	Sufficient	Matched
8	Sufficient	Deficient	**Unmatched**
9	Sufficient	Deficient	**Unmatched**
10	Sufficient	Sufficient	Matched
11	Sufficient	Sufficient	Matched
12	Sufficient	Deficient	**Unmatched**
13	Sufficient	Sufficient	Matched
14	Deficient	Deficient	Matched
15	Sufficient	Sufficient	Matched
16	Deficient	Sufficient	**Unmatched**
17	Sufficient	Sufficient	Matched
18	Deficient	Deficient	Matched
19	Sufficient	Sufficient	Matched
20	Sufficient	Sufficient	Matched
21	Sufficient	Deficient	**Unmatched**
22	Sufficient	Sufficient	Matched
23	Sufficient	Sufficient	Matched
24	Sufficient	Sufficient	Matched
25	Sufficient	Sufficient	Matched
26	Sufficient	Sufficient	Matched
27	Deficient	Deficient	Matched
28	Sufficient	Sufficient	Matched
29	Deficient	Sufficient	**Unmatched**
30	Sufficient	Sufficient	Matched

4.3.9 Field Testing

4.3.9.1 Printed Results


SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Abaca Pulp' only.

pH Level : 6.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.4166667 grams/plant

Application 2:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.4166667 grams/plant

Application 3:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.4166667 grams/plant

Application 4:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.4166667 grams/plant

Happy Farming! :)

Figure 4.8 Printed Result of Soil Sample No. 1

Figure 4.8 shows the printed result of soil sample no. 1. It is the summary of nutrients of the soil after tested, it has fertilizer recommendation for organic and inorganic fertilizer and modes of application depend on the chosen crop.

4.3.10 Plant Growth

4.3.10.1 Mustard

Figure 4.9a Treated Mustard **Figure 4.9b** Deficient Mustard

In figure 4.9a and 4.9b shows the comparison between a Mustard applied with fertilizer based on the fertilizer recommendation and a mustard that does not applied with fertilizer

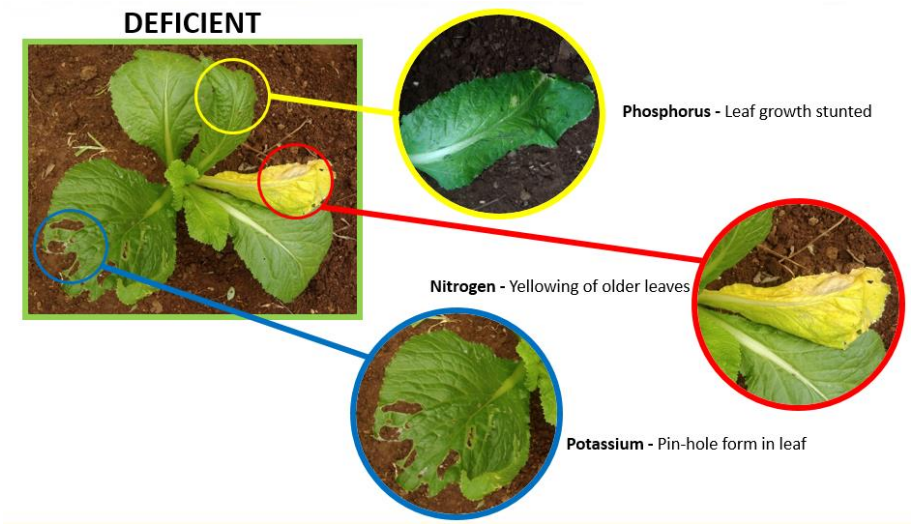


Figure 4.10 Mustard's Nutrient Deficiencies

Figure 4.10 shows the specific deficiencies of the mustard if not applied with fertilizer.

4.3.10.2 Tomato

Figure 4.11a Treated Tomato **Figure 4.11b** Deficient Tomato

In Figure 4.11a and 4.11b shows the comparison between a Tomato applied with fertilizer based on the fertilizer recommendation and a Tomato that doesn't applied with fertilizer

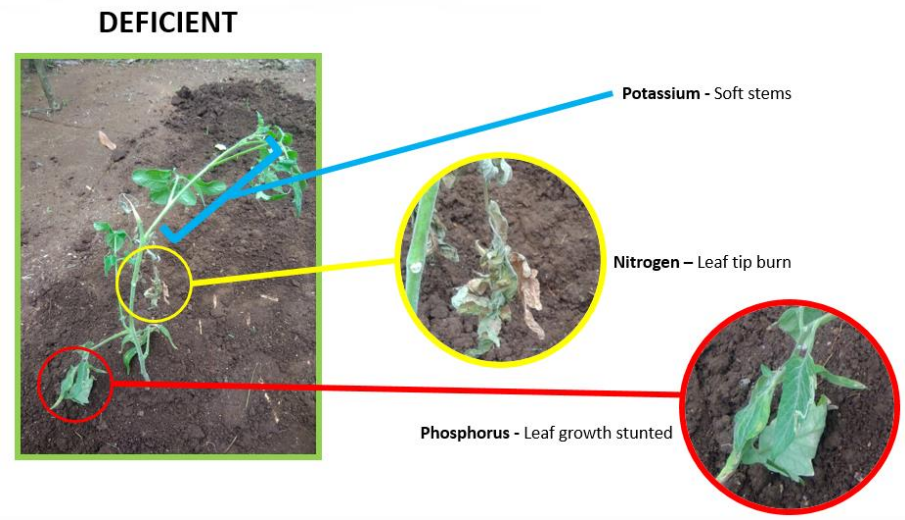


Figure 4.12 Tomato's Nutrient Deficiencies

Figure 4.12 shows the specific deficiencies of the tomato if not applied with fertilizer.

4.3.10.3 Okra

Figure 4.13a Treated Okra **Figure 4.13b** Deficient Okra

In Figure 4.13a and 4.13b shows the comparison between an Okra applied with fertilizer based on the fertilizer recommendation and an Okra that doesn't applied with fertilizer.

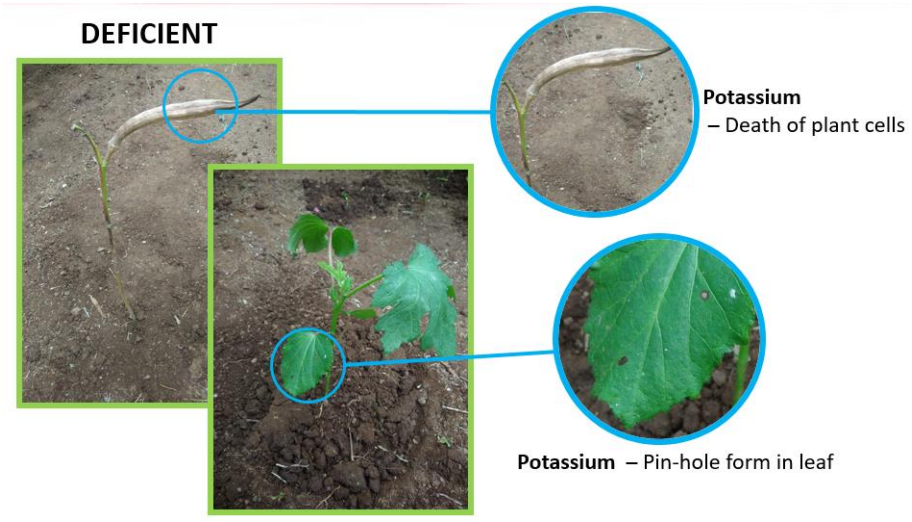
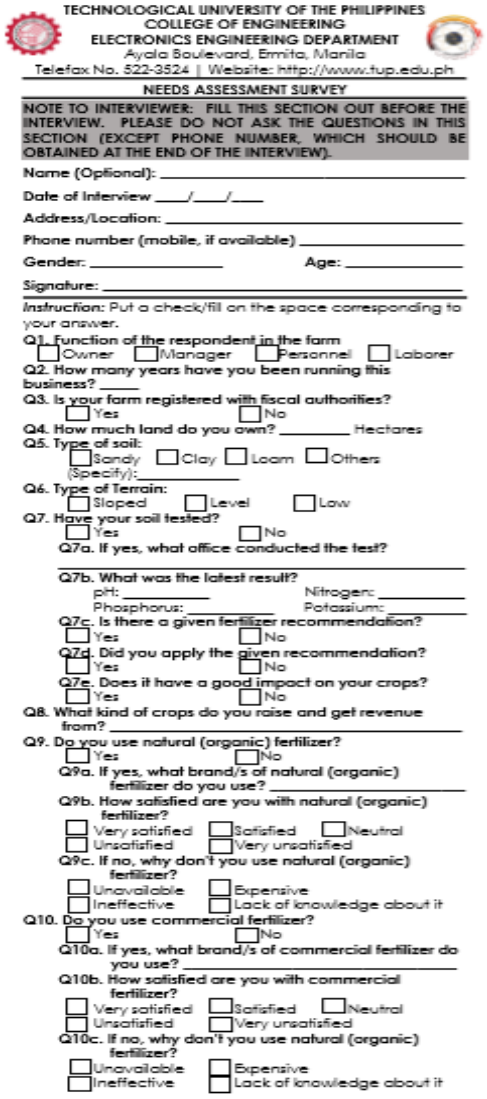


Figure 4.14 Okra's Nutrient Deficiencies

Figure 4.14 shows the specific deficiencies of the Okra if not applied with fertilizer.

Based on the plant growth's outcome, fruitful yields will be produced if the fertilizer recommendation is properly followed.

4.3.11 Surveys



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NEEDS ASSESSMENT SURVEY

NOTE TO INTERVIEWER: FILL THIS SECTION OUT BEFORE THE INTERVIEW. PLEASE DO NOT ASK THE QUESTIONS IN THIS SECTION (EXCEPT PHONE NUMBER, WHICH SHOULD BE OBTAINED AT THE END OF THE INTERVIEW).

Name (Optional): _____

Date of Interview ____/____/____

Address/Location: _____

Phone number (mobile, if available) _____

Gender: _____ Age: _____

Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☐ Personnel ☐ Laborer

Q2. How many years have you been running this business? ____

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☐ No

Q4. How much land do you own? _____ Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☐ Loam ☐ Others
(Specify):_____

Q6. Type of Terrain:
☐ Sloped ☐ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☐ No

Q7a. If yes, what office conducted the test?
_____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? _____

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☐ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☐ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? _____

Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

Figure 4.15 Sample of Survey Form

Figure 4.15 shows the survey form used in conducting surveys to some locals in Cavite.

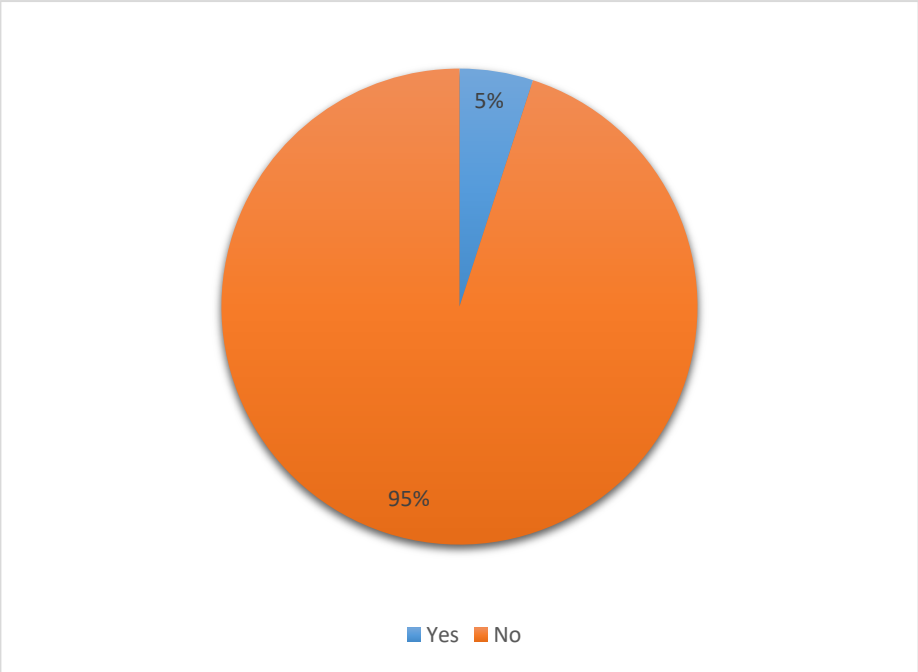


Figure 4.16 Response to the question "Have your soil tested?"

In Figure 4.16, out of 20 people surveyed, only one of them have been to a testing center to test their soil. Most of them are not aware of the importance soil testing and its effect to their yields.

In Figure 4.17, out of 20 respondents, only 3 of them are using natural or organic fertilizer and the other 17 are not because they believe that it is ineffective.

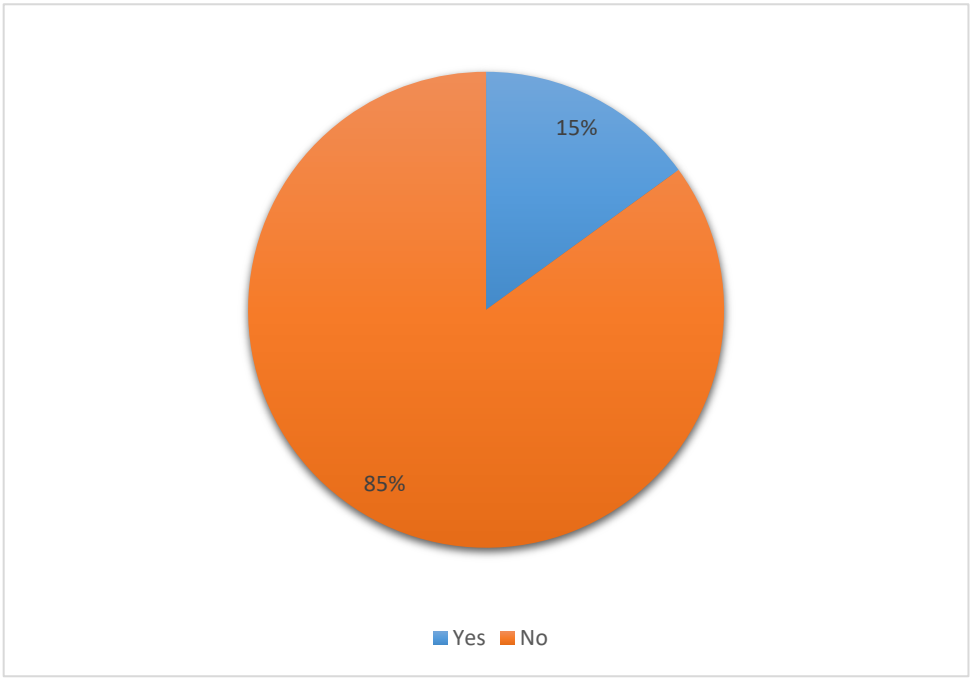


Figure 4.17 response to the question "do you use organic fertilizer?"

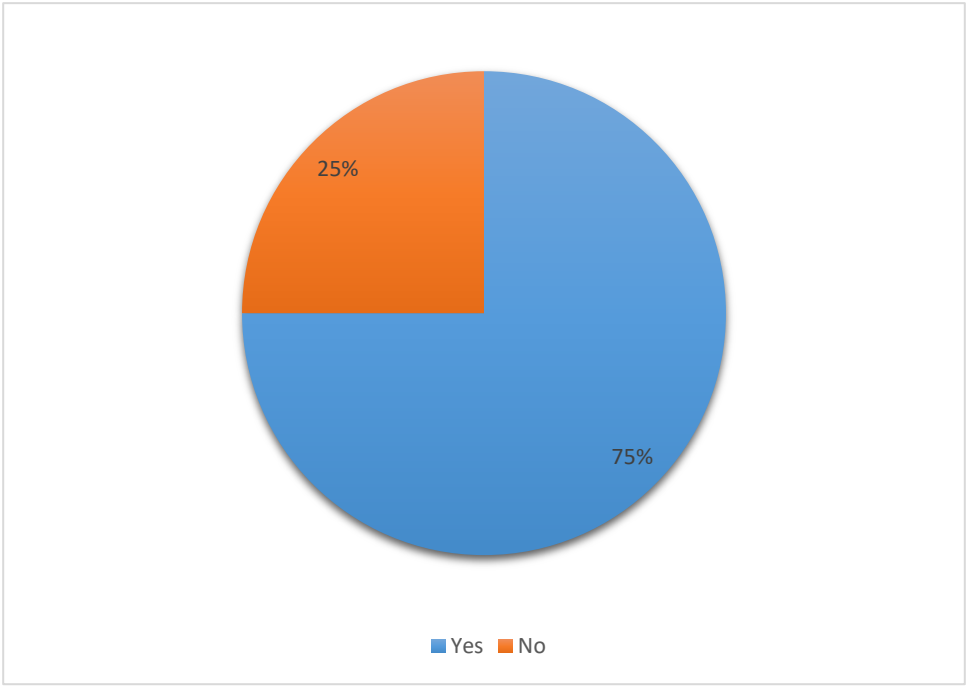
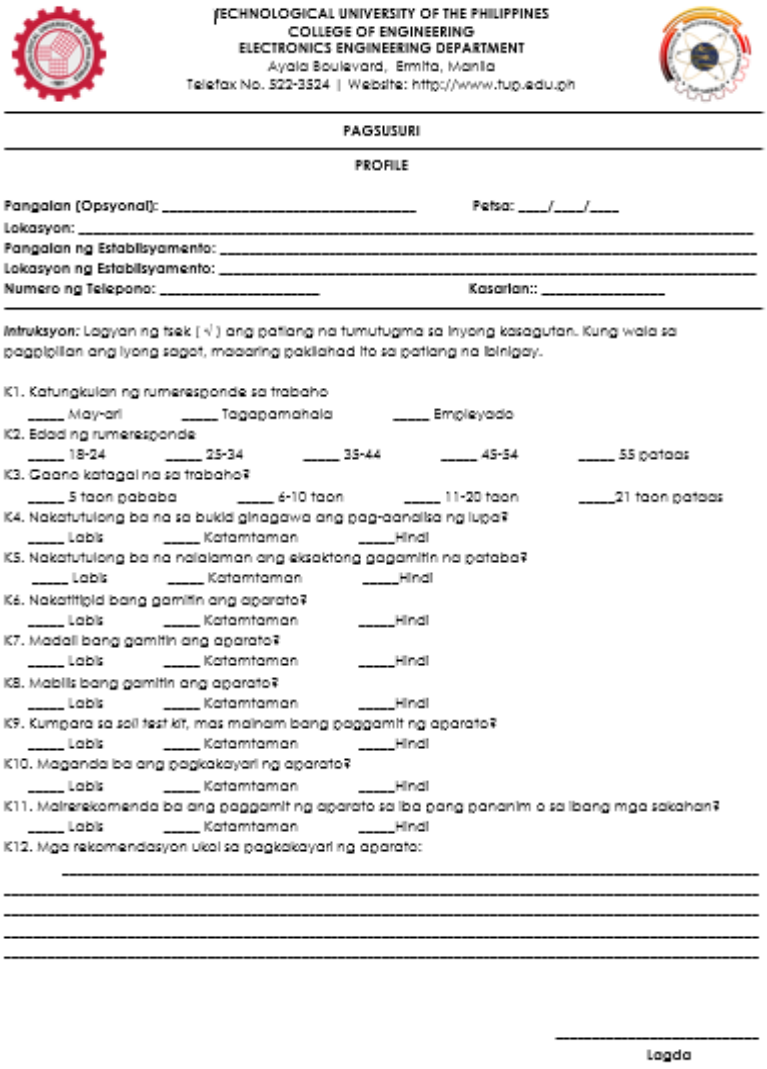


Figure 4.18 Response to the question "do you use commercial fertilizer?"

In Figure 4.18, out of 20 respondents, only 5 of them are using organic fertilizer, the rest are using commercial fertilizer because they are satisfied to the quality of crops they produced.



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PAGSUSURI

PROFILE

Pangalan (Opsyonal): _____ **Petsa:** ____/____/____
Lokasyon: _____
Pangalan ng Establisyamento: _____
Lokasyon ng Establisyamento: _____
Numero ng Telepono: _____ **Kasarian::** _____

Intruksyon: Lagyan ng tsek (√) ang patlang na tumutugma sa inyong kasagutan. Kung wala sa pagpipilian ang iyong sagot, maaaring pakilahad ito sa patlang na ibinigay.

K1. Katungkulan ng rumeresponde sa trabaho
_____ May-ari _____ Tagapamahala _____ Empleyado
K2. Edad ng rumeresponde
_____ 18-24 _____ 25-34 _____ 35-44 _____ 45-54 _____ 55 pataas
K3. Gaano katagal na sa trabaho?
_____ 5 taon pababa _____ 6-10 taon _____ 11-20 taon _____21 taon pataas
K4. Nakatutulong ba na sa bukid ginagawa ang pag-aanalisa ng lupa?
_____ Labis _____ Katamtaman _____Hindi
K5. Nakatutulong ba na nalalaman ang eksaktong gagamitin na patabá?
_____ Labis _____ Katamtaman _____Hindi
K6. Nakatitipid bang gamitin ang aparato?
_____ Labis _____ Katamtaman _____Hindi
K7. Madali bang gamitin ang aparato?
_____ Labis _____ Katamtaman _____Hindi
K8. Mabilis bang gamitin ang aparato?
_____ Labis _____ Katamtaman _____Hindi
K9. Kumpara sa soil test kit, mas mainam bang paggamit ng aparato?
_____ Labis _____ Katamtaman _____Hindi
K10. Maganda ba ang pagkakayari ng aparato?
_____ Labis _____ Katamtaman _____Hindi
K11. Mairerekomenda ba ang paggamit ng aparato sa iba pang pananim o sa ibang mga sakahan?
_____ Labis _____ Katamtaman _____Hindi
K12. Mga rekomendasyon ukol sa pagkakayari ng aparato:
_____
_____
_____
_____
_____

_____
Lagda

Figure 4.19 Sample of Evaluation Form

Figure 4.19 shows the evaluation form used in conducting evaluations with the staff of BSWM.

Table 4.9 Summary of Evaluation

Evaluator	Criteria	Rating		
		Satisfied	Average	Unsatisfied
Evaluator 1	Speed	⟋		
	Convenience	⟋		
	Cost	⟋		
	Innovation		⟋	
	Aesthetics		⟋	
Evaluator 2	Speed	⟋		
	Convenience	⟋		
	Cost	⟋		
	Innovation	⟋		
	Aesthetics	⟋		
Evaluator 3	Speed		⟋	
	Convenience		⟋	
	Cost		⟋	
	Innovation		⟋	
	Aesthetics		⟋	
Evaluator 4	Speed	⟋		
	Convenience	⟋		
	Cost		⟋	
	Innovation		⟋	
	Aesthetics		⟋	
Evaluator 5	Speed		⟋	
	Convenience		⟋	
	Cost	⟋		
	Innovation		⟋	
	Aesthetics		⟋	

Table 4.9 shows the summary of five evaluators from BSWM. The evaluator's recommendation focused on the enhancement of the physical appearance and the improvement of the portability of the device

CHAPTER 5

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the synopsis of the study and conclusions drawn based on the results discussed. Recommendations were stated for future project improvement.

5.1 Summary of Findings

Automated Soil Nutrients and pH Level Testing and Assessment with Fertilizer Recommendation through Digital Image Processing Using Unity is a study which integrates a program whose main system is image processing. The project focused on how precisely determines the qualitative value of macronutrients, micronutrient and pH in soil as a sign of fertility status through image processing.

The project utilized the software called Arduino IDE to control the mechanical parts of it. The system has 3 sections which are; Microcontroller, Shaking Method and Chemical Propelling. The project also used Unity a cross-platform game engine that is used to create an image processing system. This image processing system has three sections: image enhancement, image segmentation, and color extraction.

Overall, the study successfully fulfilled its objective of fully automating the conventional method of performing RST and STK. To prove the credibility of the performance, the proponents conducted 30 tests for 30 soil samples of different areas around Cavite and resulted to an accuracy of 94.29% verified by 5 experts from BSWM headed by Ms. Agnes Morada, Senior Agriculturist of BSWM. Thus, SoilgANic provides greater accuracy and convenience than doing the conventional method that uses visual analysis from the naked eye.

5.2 Conclusions

Based on the results and findings of the research, the following conclusions have been made by the proponents:

1. As per objective 1, the Project was able to fully automate the conventional way of soil testing with the use of Arduino to utilize the chemicals and Unity for the Image processing system.

2. As per objective 2, the Graphical User Interface was successfully improved using Visual Studio and the program that determines the Macronutrient, Micronutrient and pH level of the soil for through digital image processing was successfully implemented using Unity.

3. As per objective 3, the project generated a printed copy of the organic and inorganic fertilizer recommendations for the 15 major agricultural crops based on the results of the Macronutrient, Micronutrient and pH level assessment of the soil.

4. As per objective 4, the project was compared with the Bureau of Soils and Water Management's conventional way of testing and verified 94.29 % accurate by Ms. Agnes C. Morada, Senior Agriculturist of BSWM.

5. As per objective 5, the growth of plants applied with fertilizer is healthier and prosperous than those plants without fertilizer.

5.3 Recommendation

The project was successfully implemented and done; however, the proponents would like to make the following recommendations to further improve the project:

1. Add more soil nutrients to test to have a better yielding of crop.
2. Use a camera that provides higher quality resolution, for accurate color result.
3. Use peristaltic pump for more accurate and reliable flow of chemicals, because accurate volume is important for color pointers where the color pixel is picked.
4. Add more type of crops for fertilizer recommendation.

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Appendix A – Survey and Evaluation Forms

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NEEDS ASSESSMENT SURVEY

NOTE TO INTERVIEWER: FILL THIS SECTION OUT BEFORE THE INTERVIEW. PLEASE DO NOT ASK THE QUESTIONS IN THIS SECTION (EXCEPT PHONE NUMBER, WHICH SHOULD BE OBTAINED AT THE END OF THE INTERVIEW).

Name (Optional): Winifred R. Vidallon
Date of Interview 12 / 17 / 17
Address/Location: Brgy 183 mangas 1
Phone number (mobile, if available) _____
Gender: Male Age: 65
Signature: [signature]

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer

Q2. How many years have you been running this business? 19

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? 2 Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test? _____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? Coffee

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☑ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? Planters / Vikings

Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☑ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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NEEDS ASSESSMENT SURVEY

NOTE TO INTERVIEWER: FILL THIS SECTION OUT BEFORE THE INTERVIEW. PLEASE DO NOT ASK THE QUESTIONS IN THIS SECTION (EXCEPT PHONE NUMBER, WHICH SHOULD BE OBTAINED AT THE END OF THE INTERVIEW).

Name (Optional): _____
Date of Interview ___/___/___
Address/Location: _____
Phone number (mobile, if available) 0977-143-9908
Gender: Male Age: 30
Signature: [signature]

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☐ Personnel ☑ Laborer

Q2. How many years have you been running this business? 0

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? _____ Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test? _____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? Coffee

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☑ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? _____

Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☑ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): JAYZONE LANDICATO
Date of Interview ___/___/___
Address/Location: MANGAS, ALFONSO CAVITE
Phone number (mobile, if available) _____
Gender: MALE Age: 35
Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☐ Personnel ☑ Laborer
Q2. How many years have you been running this business? 0
Q3. Is your farm registered with fiscal authorities?
☑ Yes ☐ No
Q4. How much land do you own? 0 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? CORN, BANANA, PINEAPPLE, TOMATO
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☑ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? UREA
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☑ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Ricardo Rodriguez
Date of Interview ___/___/___
Address/Location: mangas 1, Alfonso Cavite
Phone number (mobile, if available) 09360541368
Gender: male Age: 86
Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer
Q2. How many years have you been running this business? 6
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 2 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____
Q6. Type of Terrain:
☑ Sloped ☐ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? papaya, guyabano, coconut
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☑ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? 14-14-14
Q10b. How satisfied are you with commercial fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Reynante Coprada
Date of Interview ___/___/___
Address/Location: Salubad Marahan Alfonso Cavite
Phone number (mobile, if available) _____
Gender: Male Age: 40
Signature: Coprada

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer
Q2. How many years have you been running this business? ____
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 2 Hectares
Q5. Type of soil:
☐ Sandy ☑ Clay ☐ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☑ Sloped ☐ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? Banana, Cacao, Coffee, Pominta
Q9. Do you use natural (organic) fertilizer?
☑ Yes ☐ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☑ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☐ Yes ☑ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? _____
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☑ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): German Vidallon
Date of Interview 12/23/17
Address/Location: Mangas 1 Alfonso, Cavite
Phone number (mobile, if available) 09054991623
Gender: Male Age: _____
Signature: German Vidallon

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☐ Personnel ☑ Laborer
Q2. How many years have you been running this business? 0
Q3. Is your farm registered with fiscal authorities?
☑ Yes ☐ No
Q4. How much land do you own? 0 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☑ Yes ☐ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☑ Yes ☐ No
Q7d. Did you apply the given recommendation?
☑ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☑ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? Corn, Banana, Pineapple, Cassava
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☑ Expensive
☐ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☐ Yes ☑ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? _____
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☑ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Nemisia Javier
Date of Interview 12/16/17
Address/Location: Mangas 1, Alfonso Cavite
Phone number (mobile, if available) _____
Gender: Female **Age:** 34
Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer
Q2. How many years have you been running this business? 15
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 2 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? Banana, Coconut
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☑ Expensive
☐ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? Urea
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☑ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Jay Cubelo
Date of Interview ___/___/___
Address/Location: Mangas 1, Alfonso, Cavite
Phone number (mobile, if available) _____
Gender: _____ **Age:** _____
Signature: JCubelo

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer
Q2. How many years have you been running this business? 15
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 1 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? Banana, Coffee
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☑ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☐ Yes ☑ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? _____
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☑ Lack of knowledge about it

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Name (Optional): Regine B. Grisologo
Date of Interview 12/16/17
Address/Location: MANGAS 1, ALFONSO / CAVITE
Phone number (mobile, if available) 09364268607
Gender: FEMALE Age: 19
Signature: Regine

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☐ Personnel ☑ Laborer
Q2. How many years have you been running this business? 0
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 0 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? coffee
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? planters
Q10b. How satisfied are you with commercial fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Leoncio R. Yidalion
Date of Interview 12/23/2017
Address/Location #150 Balubad Marathon Rd Mangas Alfonso Cavite
Phone number (mobile, if available) _____
Gender: _____ Age: 72
Signature: Leoncio Yidalion

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer
Q2. How many years have you been running this business? 50
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 2 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? banana / coffee
Q9. Do you use natural (organic) fertilizer?
☑ Yes ☐ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☑ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? Plantors / Complet / Autotoxic
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☑ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Christian Perez
Date of Interview 12/23/17
Address/Location: Marahan Alfonso Cavite
Phone number (mobile, if available) 09758129376
Gender: Male Age: 28
Signature:

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer
Q2. How many years have you been running this business? ____
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 2 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☐ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? Banana, Coffee
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☑ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? _____
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☑ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Jundy Caylas
Date of Interview 12/23/17
Address/Location: 404 Mangas I alfonso Cavite
Phone number (mobile, if available) _____
Gender: M Age: 67
Signature:

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☐ Personnel ☑ Laborer
Q2. How many years have you been running this business? 0
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? _____ Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? banana, coffee
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☑ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? _____
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☑ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Telefax No. 522-3524 | Website: http://www.tup.edu.ph

NEEDS ASSESSMENT SURVEY

NOTE TO INTERVIEWER: FILL THIS SECTION OUT BEFORE THE INTERVIEW. PLEASE DO NOT ASK THE QUESTIONS IN THIS SECTION (EXCEPT PHONE NUMBER, WHICH SHOULD BE OBTAINED AT THE END OF THE INTERVIEW).

Name (Optional): _____

Date of Interview ___/___/___

Address/Location: 186 Mangas I Alfonso

Phone number (mobile, if available) _____

Gender: _____ Age: 54

Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer

Q2. How many years have you been running this business? ____

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? 1.5 Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test?
_____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? Banana, Coffee, Coconut

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☑ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? _____

Q10b. How satisfied are you with commercial fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Reynalyn B. Pasanustan

Date of Interview ___/___/___

Address/Location: Mangas I, Alfonso Cavite

Phone number (mobile, if available) 09101441128

Gender: Female Age: _____

Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☑ Personnel ☐ Laborer

Q2. How many years have you been running this business? 0

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? 0 Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test?
_____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? Coffee.

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☑ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? Planters

Q10b. How satisfied are you with commercial fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Mela Batiles
Date of Interview __/__/__
Address/Location: Mangas 1 Alfonso
Phone number (mobile, if available) 09358359823
Gender: F **Age:** 50
Signature: M.Batiles

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☑ Personnel ☐ Laborer
Q2. How many years have you been running this business? 0
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 0 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? Coffee
Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☑ Yes ☐ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? _____
Q10b. How satisfied are you with commercial fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): Rosmarie D. Ladiao
Date of Interview __/__/__
Address/Location: Mangas 1 Alfonso Cavite
Phone number (mobile, if available) _____
Gender: F **Age:** 28
Signature: Rme

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer
Q2. How many years have you been running this business? 0
Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No
Q4. How much land do you own? 0 Hectares
Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____
Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low
Q7. Have your soil tested?
☐ Yes ☑ No
Q7a. If yes, what office conducted the test?
_____
Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____
Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No
Q7d. Did you apply the given recommendation?
☐ Yes ☐ No
Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No
Q8. What kind of crops do you raise and get revenue from? Coffee
Q9. Do you use natural (organic) fertilizer?
☑ Yes ☐ No
Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____
Q9b. How satisfied are you with natural (organic) fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it
Q10. Do you use commercial fertilizer?
☐ Yes ☑ No
Q10a. If yes, what brand/s of commercial fertilizer do you use? _____
Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied
Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☑ Lack of knowledge about it

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Name (Optional): _____

Date of Interview ___/___/___

Address/Location: 186 MANGAAS I, ALFONSO, CAVITE

Phone number (mobile, if available) 09956316899

Gender: Male Age: 59

Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer

Q2. How many years have you been running this business? 59

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? 1.5 Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test?
_____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? BANANA, COFFEE, COCONUT, BLACK PEPPER

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☑ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? PLANTERS

Q10b. How satisfied are you with commercial fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): _____

Date of Interview ___/___/___

Address/Location: _____

Phone number (mobile, if available) 09129175043

Gender: _____ Age: 28

Signature: _____

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☑ Owner ☐ Manager ☐ Personnel ☐ Laborer

Q2. How many years have you been running this business? 8

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? 1 Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify):_____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test?
_____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? Banana, Coffee, Coconut

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☑ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? _____

Q10b. How satisfied are you with commercial fertilizer?
☑ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): _____

Date of Interview ___/___/___

Address/Location: _____

Phone number (mobile, if available) 09104311364

Gender: Male Age: 25

Signature: Mr. Lacap

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☐ Personnel ☑ Laborer

Q2. How many years have you been running this business? 0

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? 0 Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test?
_____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? Coffee

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☑ Yes ☐ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? Planters

Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☑ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☐ Lack of knowledge about it

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Name (Optional): _____

Date of Interview ___/___/___

Address/Location: _____

Phone number (mobile, if available) _____

Gender: Male Age: 26

Signature: Allodatlan

Instruction: Put a check/fill on the space corresponding to your answer.

Q1. Function of the respondent in the farm
☐ Owner ☐ Manager ☑ Personnel ☐ Laborer

Q2. How many years have you been running this business? 0

Q3. Is your farm registered with fiscal authorities?
☐ Yes ☑ No

Q4. How much land do you own? 0 Hectares

Q5. Type of soil:
☐ Sandy ☐ Clay ☑ Loam ☐ Others
(Specify): _____

Q6. Type of Terrain:
☐ Sloped ☑ Level ☐ Low

Q7. Have your soil tested?
☐ Yes ☑ No

Q7a. If yes, what office conducted the test?
_____

Q7b. What was the latest result?
pH: _____ Nitrogen: _____
Phosphorus: _____ Potassium: _____

Q7c. Is there a given fertilizer recommendation?
☐ Yes ☐ No

Q7d. Did you apply the given recommendation?
☐ Yes ☐ No

Q7e. Does it have a good impact on your crops?
☐ Yes ☐ No

Q8. What kind of crops do you raise and get revenue from? Banana, Coffee

Q9. Do you use natural (organic) fertilizer?
☐ Yes ☑ No

Q9a. If yes, what brand/s of natural (organic) fertilizer do you use? _____

Q9b. How satisfied are you with natural (organic) fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q9c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☑ Ineffective ☐ Lack of knowledge about it

Q10. Do you use commercial fertilizer?
☐ Yes ☑ No

Q10a. If yes, what brand/s of commercial fertilizer do you use? _____

Q10b. How satisfied are you with commercial fertilizer?
☐ Very satisfied ☐ Satisfied ☐ Neutral
☐ Unsatisfied ☐ Very unsatisfied

Q10c. If no, why don't you use natural (organic) fertilizer?
☐ Unavailable ☐ Expensive
☐ Ineffective ☑ Lack of knowledge about it

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PAGSUSURI

PROFILE

Pangalan (Opsyonal): ACNES C. MORADA **Petsa:** ___/___/___
Lokasyon: BSWM - Q.C
Pangalan ng Establisyamento: BSWM (BU. OF SOILS & WATER MNG'T)
Address of enterprise: ELLIPTICAL RD. COR. VISAYAS AVE. DIL Q.C
Numero ng Telepono: 923 04 92 **Kasarian::** F

Intruksyon: Lagyan ng tsek (√) ang patlang na tumutugma sa inyong kasagutan. Kung wala sa pagpipilian ang iyong sagot, maaaring pakilahad ito sa patlang na ibinigay.

K1. Katungkulan ng rumeresponde sa trabaho
____ May-ari ____ Tagapamahala ✓ Empleyado

K2. Edad ng rumeresponde
____ 18-24 ____ 25-34 ____ 35-44 ✓ 45-54 ____ 55 pataas

K3. Gaano katagal na sa trabaho?
____ 5 taon pababa ____ 6-10 taon ____ 11-20 taon ✓ 21 taon pataas

K4. Nakatutulong ba na sa bukid ginagawa ang pag-aanalisa ng lupa?
✓ Labis ____ Katamtaman ____Hindi

K5. Nakatutulong ba na nalalaman ang eksaktong gagamitin na pataba?
✓ Labis ____ Katamtaman ____Hindi

K6. Nakatitipid bang gamitin ang aparato?
✓ Labis ____ Katamtaman ____Hindi

K7. Madali bang gamitin ang aparato?
✓ Labis ____ Katamtaman ____Hindi

K8. Mabilis bang gamitin ang aparato?
✓ Labis ____ Katamtaman ____Hindi

K9. Kumpara sa *soil test kit*, mas mainam bang paggamit ng aparato?
____ Labis ✓ Katamtaman ____Hindi

K10. Maganda ba ang pagkakayari ng aparato?
____ Labis ✓ Katamtaman ____Hindi

K11. Mairerekomenda ba ang paggamit ng aparato sa iba pang pananim o sa ibang mga sakahan?
✓ Labis ____ Katamtaman ____Hindi

K12. Mga rekomendasyon ukol sa pagkakayari ng aparato:

PATULOY NA PAGSASAYOS SA TEKNIKAL NA ASPETO NG NABUONG INSTRUMENTO; MAAYOS AT MALIWANAG ANG PAGKAKABUO NITO.

Acnes Morada
Lagda

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PAGSUSURI

PROFILE

Pangalan (Opsyonal): CHRISTOPHER EDALGAL **Petsa:** 03/08/18
Lokasyon: _____
Pangalan ng Establisyamento: BSWM
Address of enterprise: VISAYAS AVE., DILIMAN, QUEZON CITY
Numero ng Telepono: _____ **Kasarlan::** MALE

Intruksyon: Lagyan ng tsek (√) ang patlang na tumutugma sa inyong kasagutan. Kung wala sa pagpipilian ang iyong sagot, maaaring pakilahad ito sa patlang na ibinigay.

K1. Katungkulan ng rumeresponde sa trabaho
_____ May-ari _____ Tagapamahala ___/___ Empleyado

K2. Edad ng rumeresponde
_____ 18-24 ___✓___ 25-34 _____ 35-44 _____ 45-54 _____ 55 pataas

K3. Gaano katagal na sa trabaho?
___✓___ 5 taon pababa _____ 6-10 taon _____ 11-20 taon _____21 taon pataas

K4. Nakatutulong ba na sa bukid ginagawa ang pag-aanalisa ng lupa?
_____ Labis ___✓___ Katamtaman _____Hindi

K5. Nakatutulong ba na nalalaman ang eksaktong gagamitin na pataba?
___✓___ Labis _____ Katamtaman _____Hindi

K6. Nakatitipid bang gamitin ang aparato?
___✓___ Labis _____ Katamtaman _____Hindi

K7. Madali bang gamitin ang aparato?
___✓___ Labis _____ Katamtaman _____Hindi

K8. Mabilis bang gamitin ang aparato?
___✓___ Labis _____ Katamtaman _____Hindi

K9. Kumpara sa *soil test kit*, mas mainam bang paggamit ng aparato?
___✓___ Labis _____ Katamtaman _____Hindi

K10. Maganda ba ang pagkakayari ng aparato?
___✓___ Labis _____ Katamtaman _____Hindi

K11. Mairerekomenda ba ang paggamit ng aparato sa iba pang pananim o sa ibang mga sakahan?
___✓___ Labis _____ Katamtaman _____Hindi

K12. Mga rekomendasyon ukol sa pagkakayari ng aparato:
FURTHER IMPROVEMENT ON INTERFACE. UPGRADING TO IP WEBCAM & 4K RESOLUTION IS ALSO AVIABLE OPTION.

CEdgal
Lagda

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
COLLEGE OF ENGINEERING
ELECTRONICS ENGINEERING DEPARTMENT
Ayala Boulevard, Ermita, Manila
Telefax No. 522-3524 | Website: http://www.tup.edu.ph

PAGSUSURI

PROFILE

Pangalan (Opsyonal): SHIRLEY S. BUDUAN **Petsa:** 3/8/18
Lokasyon: BUREAU OF SOILS & Water Mgt, DILIMAN, Q.C
Pangalan ng Establisyamento: Bureau of Soils & Water Mgt.
Address of enterprise:
Numero ng Telepono: 9230492 **Kasarian::**

Intruksyon: Lagyan ng tsek (√) ang patlang na tumutugma sa inyong kasagutan. Kung wala sa pagpipilian ang iyong sagot, maaaring pakilahad ito sa patlang na ibinigay.

K1. Katungkulan ng rumeresponde sa trabaho
____ May-ari ____ Tagapamahala ✓ Empleyado

K2. Edad ng rumeresponde
____ 18-24 ____ 25-34 ____ 35-44 ____ 45-54 ✓ 55 pataas

K3. Gaano katagal na sa trabaho?
____ 5 taon pababa ____ 6-10 taon ____ 11-20 taon ✓ 21 taon pataas

K4. Nakatutulong ba na sa bukid ginagawa ang pag-aanalisa ng lupa?
✓ Labis ____ Katamtaman ____Hindi

K5. Nakatutulong ba na nalalaman ang eksaktong gagamitin na pataba?
✓ Labis ____ Katamtaman ____Hindi

K6. Nakatitipid bang gamitin ang aparato?
____ Labis ✓ Katamtaman ____Hindi

K7. Madali bang gamitin ang aparato?
____ Labis ✓ Katamtaman ____Hindi

K8. Mabilis bang gamitin ang aparato?
____ Labis ✓ Katamtaman ____Hindi

K9. Kumpara sa *soil test kit*, mas mainam bang paggamit ng aparato?
____ Labis ✓ Katamtaman ____Hindi

K10. Maganda ba ang pagkakayari ng aparato?
____ Labis ✓ Katamtaman ____Hindi

K11. Mairerekomenda ba ang paggamit ng aparato sa iba pang pananim o sa ibang mga sakahan?
____ Labis ✓ Katamtaman ____Hindi

K12. Mga rekomendasyon ukol sa pagkakayari ng aparato:

Maganda ang nagawa ng mga estudyante sa aspeto ng STK-RST. automation. Napadali ang pag-analyze ng lupa gamit ang Automated STK-RST. FURTHER improvement especially in the mobile aspect to transfering of the machine from one place to another.

Buduan
Lagda

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
COLLEGE OF ENGINEERING
ELECTRONICS ENGINEERING DEPARTMENT
Ayala Boulevard, Ermita, Manila
Telefax No. 522-3524 | Website: http://www.tup.edu.ph

PAGSUSURI

PROFILE

Pangalan (Opsyonal): MYLA TEPASE **Petsa:** 03/08/18
Lokasyon: BSWM ~~EAST~~ AVE.
Pangalan ng Establisyamento: BSWM
Address of enterprise: SKDC Bldg. VISAYAS AVE. Q.C.
Numero ng Telepono: _____ **Kasarian::** F

Intruksyon: Lagyan ng tsek (√) ang patlang na tumutugma sa inyong kasagutan. Kung wala sa pagpipilian ang iyong sagot, maaaring pakilahad ito sa patlang na ibinigay.

K1. Katungkulan ng rumeresponde sa trabaho
____ May-ari ____ Tagapamahala ___/___ Empleyado

K2. Edad ng rumeresponde
___/___ 18-24 ____ 25-34 ____ 35-44 ____ 45-54 ____ 55 pataas

K3. Gaano katagal na sa trabaho?
___/___ 5 taon pababa ____ 6-10 taon ____ 11-20 taon ____21 taon pataas

K4. Nakatutulong ba na sa bukid ginagawa ang pag-aanalisa ng lupa?
____ Labis ___/___ Katamtaman ____Hindi

K5. Nakatutulong ba na nalalaman ang eksaktong gagamitin na pataba?
___/___ Labis ____ Katamtaman ____Hindi

K6. Nakatitipid bang gamitin ang aparato?
____ Labis ___/___ Katamtaman ____Hindi

K7. Madali bang gamitin ang aparato?
___/___ Labis ____ Katamtaman ____Hindi

K8. Mabilis bang gamitin ang aparato?
___/___ Labis ____ Katamtaman ____Hindi

K9. Kumpara sa *soil test kit*, mas mainam bang paggamit ng aparato?
____ Labis ___/___ Katamtaman ____Hindi

K10. Maganda ba ang pagkakayari ng aparato?
____ Labis ___/___ Katamtaman ____Hindi

K11. Mairerekomenda ba ang paggamit ng aparato sa iba pang pananim o sa ibang mga sakahan?
____ Labis ___/___ Katamtaman ____Hindi

K12. Mga rekomendasyon ukol sa pagkakayari ng aparato:
PAGANDAHIN PA ANG DESIGN NG APARATO.

Lagda

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
COLLEGE OF ENGINEERING
ELECTRONICS ENGINEERING DEPARTMENT
Ayala Boulevard, Ermita, Manila
Telefax No. 522-3524 | Website: http://www.tup.edu.ph

PAGSUSURI

PROFILE

Pangalan (Opsyonal): Rizalynne Mae Andrada **Petsa:** ___/___/___
Lokasyon: BSWM - Q.C.
Pangalan ng Establisyamento: Bureau of Soils & Water Management
Address of enterprise: Elliptical Rd. Cor. Visayas Ave. Dist. Q.C
Numero ng Telepono: 933 04 92 **Kasarian::** F

Intruksyon: Lagyan ng tsek (√) ang patlang na tumutugma sa inyong kasagutan. Kung wala sa pagpipilian ang iyong sagot, maaaring pakilahad ito sa patlang na ibinigay.

K1. Katungkulan ng rumeresponde sa trabaho
____ May-ari ____ Tagapamahala ✓ Empleyado

K2. Edad ng rumeresponde
✓ 18-24 ____ 25-34 ____ 35-44 ____ 45-54 ____ 55 pataas

K3. Gaano katagal na sa trabaho?
✓ 5 taon pababa ____ 6-10 taon ____ 11-20 taon ____21 taon pataas

K4. Nakatutulong ba na sa bukid ginagawa ang pag-aanalisa ng lupa?
✓ Labis ____ Katamtaman ____Hindi

K5. Nakatutulong ba na nalalaman ang eksaktong gagamitin na pataba?
✓ Labis ____ Katamtaman ____Hindi

K6. Nakatitipid bang gamitin ang aparato?
✓ Labis ____ Katamtaman ____Hindi

K7. Madali bang gamitin ang aparato?
____ Labis ✓ Katamtaman ____Hindi

K8. Mabilis bang gamitin ang aparato?
____ Labis ✓ Katamtaman ____Hindi

K9. Kumpara sa *soil test kit*, mas mainam bang paggamit ng aparato?
____ Labis ✓ Katamtaman ____Hindi

K10. Maganda ba ang pagkakayari ng aparato?
____ Labis ✓ Katamtaman ____Hindi

K11. Mairerekomenda ba ang paggamit ng aparato sa iba pang pananim o sa ibang mga sakahan?
✓ Labis ____ Katamtaman ____Hindi

K12. Mga rekomendasyon ukol sa pagkakayari ng aparato:

Lagda

Appendix B - Validation and Proofread

Department of A
BUREAU OF SOILS AND WA
SRDC Building, Elliptical rd. (
Diliman Quez
Tel. No. 923-

February 22, 2018

ENGR. NILO M. ARAGO
Professor, Project Study 2
Technological University of the Philippines – Mar
Ayala Boulevard, Ermita, Manila

Dear Engr. Arago:

Good Day!

This letter is to certify that the 5th year Bachel students from Technological University of the Ph Agnas, Sheryl Anne M. Bautista, Nodebelle C Solomon conducted a 2-day research study v Management (BSWM).

In line with this, the data and results of testing document that is verified with the supervision of of BSWM verified that the research study entitle **Testing and Assessment with Fertilizer Recomme Using Unity"** is proven **94.29%** accurate.

God bless and more power.

Respectfully Yours,

AGNAS, KRISTINE JOY B.

BAUTISTA, SHERYL ANNE M.

BULE, NODEBELLE C.

PRADO, CECILE P.

SOLOMON, EDUARDO T.

Noted By:

MS. AGNES C. MORADA
Senior Agriculturist, BSWM

Department of Agriculture
BUREAU OF SOILS AND WATER MANAGEMEN
SRDC Building, Elliptical rd. cor. Visayas Aven
Diliman Quezon City
Tel. No. 923-0462

CONVENTIONAL TESTING (BSWM)

Soil Sample	pH Level	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)
1	6.4	Low	Low	Sufficient+	Sufficient
2	6.4	Low	Low	Sufficient++	Sufficient
3	6.4	Low	Low	Sufficient	Sufficient
4	7.2	Low	Moderately Low	Sufficient+	Sufficient
5	6.4	Low	Medium	Sufficient++	Sufficient
6	6.8	Low	Medium	Sufficient+	Sufficient
7	6.8	Low	Low	Sufficient++	Sufficient
8	6.8	Low	Moderately High	Sufficient+	Sufficient
9	6.8	Low	Medium	Sufficient++	Sufficient
10	6.4	Low	High	Sufficient++	Sufficient
11	5.4	Low	Low	Sufficient+	Deficient
12	7.2	Low	Moderately Low	Sufficient++	Sufficient
13	6.4	Low	Low	Sufficient+	Deficient
14	7.2	Low	Moderately High	Sufficient++	Sufficient
15	5.4	Low	Low	Sufficient+	Deficient
16	7.2	Low	Moderately Low	Sufficient+	Deficient
17	5.4	Low	Low	Sufficient+	Deficient
18	6.8	Low	Low	Sufficient+	Sufficient
19	5.4	Low	Low	Sufficient	Deficient
20	7.2	Low	High	Sufficient+	Sufficient
21	7.6	Low	Low	Sufficient+	Sufficient
22	7.2	Low	Moderately High	Sufficient	Sufficient
23	6.4	Low	Moderately High	Sufficient+	Sufficient
24	7.2	Low	High	Sufficient	Sufficient
25	6.4	Low	High	Sufficient	Sufficient
26	6.8	Low	High	Sufficient++	Sufficient
27	7.2	Low	Low	Sufficient	Sufficient
28	6.4	Low	Low	Sufficient++	Deficient
29	6.4	Low	Low	Deficient	Deficient
30	6.8	Low	Low	Sufficient++	Deficient

Ver
Ms.
Sen

Department of Agricu
BUREAU OF SOILS AND WATER M
SRDC Building, Elliptical rd. cor. V
Diliman Quezon Cit
Tel. No. 923-0462

AUTOMATED TESTING (Soil-

Soil Sample	pH Level	Nitrogen (N)	Phosphorus (P)	Potassium (K)
1	6.4	Low	Low	Sufficient+
2	6.4	Low	Low	Sufficient+
3	6.4	Low	Low	Sufficient
4	7.2	Low	Moderately Low	Sufficient+
5	6.4	Low	Medium	Sufficient+
6	6.8	Low	Medium	Sufficient+
7	6.8	Low	Low	Sufficient+
8	6.8	Low	Moderately High	Sufficient+
9	6.8	Low	Medium	Sufficient+
10	6.4	Low	High	Sufficient+
11	5.4	Low	Low	Sufficient+
12	7.2	Low	Moderately Low	Sufficient+
13	6.4	Low	Low	Sufficient+
14	7.2	Low	Moderately High	Sufficient+
15	5.4	Low	Low	Sufficient+
16	7.2	Low	Moderately Low	Sufficient+
17	5.4	Low	Low	Sufficient+
18	6.8	Low	Low	Sufficient+
19	5.4	Low	Low	Sufficient+
20	7.2	Low	High	Sufficient+
21	7.6	Low	Low	Sufficient+
22	7.2	Low	Moderately High	Sufficient
23	6.4	Low	Moderately High	Sufficient+
24	7.2	Low	High	Sufficient
25	6.4	Low	High	Sufficient
26	6.8	Low	High	Sufficient+
27	7.2	Low	Low	Sufficient
28	6.4	Low	Low	Sufficient+
29	6.4	Low	Low	Deficient
30	6.8	Low	Low	Sufficient+

Department of Agriculture
BUREAU OF SOILS AND WATER MANAGEMENT
SRDC Building, Elliptical rd. cor. Visayas Avenue,
Diliman Quezon City
Tel. No. 923-0462

SUMMARY OF RESULTS

pH and Soil Nutrients	Accuracy
pH Level	30 out of 30 samples 100%
Nitrogen (N)	30 out of 30 samples 100%
Phosphorus (P)	30 out of 30 samples 100%
Potassium (K)	28 out of 30 samples 93.33%
Calcium (Ca)	26 out of 30 samples 86.67%
Magnesium (Mg)	30 out of 30 samples 100%
Zinc (Zn)	24 out of 30 samples 80%

Over-all Accuracy: **94.29%**

Verified

Ms. Ag
Senior

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
Ayala Blvd., Ermita, Manila
COLLEGE OF ENGINEERING
ELECTRONICS ENGINEERING DEPARTMENT
electronics@tup.edu.ph

Mary Jane T. de Padua, LPT
License # 1610314

March 9, 2018

ENGR. BENEDICTO N. FORTALEZA
Dean, College of Engineering
Technological University of the Philippines

Attn: Engr. Nilo M. Arago
Faculty-in-Charge, Project Study
College Secretary, College of Engineering

Engr. Lean Karlo S. Tolentino
Head, ECE Department

Sir:

This is to certify that I have proofread and edited the group's project study entitled **"SoilgANic: Automated Soil Nutrients and pH Level Testing and Assessment with Fertilizer Recommendation through Digital Image Processing Using Unity"** final manuscript.

Appendix C - Program Codes

Program codes:

Main Program

```
using System.Collections;
using
System.Collections.Generic;
using UnityEngine;
using System;
using System.IO;
using System.IO.Ports;

public class MainSequence :
MonoBehaviour {

        RaycastHit hit;
        SerialPort stream;
        DebugControls controls;
        public GameObject
clickHere;
        public GameObject next;
        public GameObject back;
        public GameObject
chooseCropButton;
        public TextMesh phText;
        public TextMesh
nitrogenText;
        public TextMesh
phosphorusText;
        public TextMesh
potassiumText;
        public TextMesh
zincText;
        public TextMesh
calciumText;
        public TextMesh
magnesiumText;
        public float t;
        public float mark;
        public string phValue;
        public string
nitrogenValue;
        public string
phosphorusValue;
        public string
potassiumValue;
        public float suff, suffP,
suffPp, suffPpp;
        public string zincValue;
        public string
calciumValue;
        public string
magnesiumValue;
        bool initDone = false;
        bool finalDone = false;
        bool once = false;
        public bool tray1only;
        public bool testing;

        public float progress;
        public float estTime;
        public float timeElasped;
        public float addTime;
        public float startTime;

        // Use this for
initialization
        void Start () {

        Application.runInBackgr
ound = true;
                string portInfo =
File.ReadAllText
(Application.dataPath +
"/StreamingAssets/ArduinoPortA
ssignment.txt");
                controls =
GameObject.Find ("Main
Camera").GetComponent<Debug
Controls> ();
                stream = new
SerialPort ("\\\\.\\" + portInfo,
9600);

        stream.ReadTimeout =
50;
                stream.Open ();
                Lights (false);
                mark =
Time.time;
                StartCoroutine
(Initialize ());
```

```
                addTime = 979.6f;
        }

        // Update is called once per frame
        void Update () {
                timeElasped = Time.time - startTime;
                progress = timeElasped / estTime;
                if (progress > 1f) {
                        progress = 1f;
                }
                GameObject.Find ("ProgressBar").transform.position = new Vector3 (1091f - (1 - progress)*115, 1050.9f, 68f);
                GameObject.Find ("ProgressBar").transform.localScale = new Vector3 (230 * (progress), 10, 10);
                phText.text = phValue;
                nitrogenText.text = nitrogenValue;

        phosphorusText.text = phosphorusValue;

        potassiumText.text = potassiumValue;
                zincText.text = zincValue;
                calciumText.text = calciumValue;

        magnesiumText.text = magnesiumValue;
                Ray ray = Camera.main.ScreenPointToRay (Input.mousePosition);
                if (Physics.Raycast (ray, out hit)) {
                        if (hit.transform.name == next.name) {
                                if (Input.GetMouseButtonUp (0)) {

        startTime = Time.time;

        if (testing) {


        Camera.main.transform.position = new Vector3 (91f, 55f, -131.7f);

        }


        if (!tray1only) {


        Camera.main.transform.position = new Vector3 (1091f, 1055f, -131.7f);

                if (phValue == "" || testing) {


        StartCoroutine (Tray2Sequence (0));

                        estTime = 251.1f;

                } else {

                        if (phValue == "5.0") {


        StartCoroutine (Tray2Sequence (1));

                        } else if (phValue == "6.0") {
```

```
        StartCoroutine
(Tray2Sequence (3));

                        }

                }

        } else {

                StartCoroutine
(Tray1Sequence ());

        }
                                }
                        } else if
(hit.transform.name ==
clickHere.name) {
                                if
(Input.GetMouseButtonUp (0)) {

        Camera.main.transform.p
osition = new Vector3 (91f, 55f,
-131.7f);
                                }
                        } else if
(hit.transform.name ==
back.name) {
                                if
(Input.GetMouseButtonUp (0)) {

        Camera.main.transform.p
osition = new Vector3 (1091f,
1055f, -131.7f);
                                }
                        } else if
(hit.transform.name ==
chooseCropButton.name) {
                                if
(Input.GetMouseButtonUp (0)) {

        Camera.main.transform.p
osition = new Vector3 (-1091f, -
1055f, -131.7f);
                                }
                                } else if
(hit.transform.name == "Home")
{
                                        if
(Input.GetMouseButtonUp (0)) {

        Application.LoadLevel
(0);
                                        }
                                } else if
(hit.transform) {
                                        if
(Input.GetMouseButtonUp (0)) {

        chooseCrop
(hit.transform.name);
                                        }
                                }
                        }
                        t = Time.time -
mark;
        }

        IEnumerator Initialize() {
                yield return new
WaitForSeconds (1f);
                SendData
("tray1at1");
                yield return new
WaitForSeconds (2f);
                SendData
("tray2at1");
                yield return new
WaitForSeconds (2f);
                if (!once) {
                        once =
true;
                        Lights
(true);

        Camera.main.transform.p
osition = new Vector3 (1091f,
55f, -131.7f);
                }
        }
```

```
        IEnumerator Tray2Sequence(int x){
                if (x == 0) {
                        yield return new WaitForSeconds (0.1f);

        controls.selected = "cpr";
                        SendData ("tray2at2");
                        yield return new WaitForSeconds (2f);
                        SendData ("cpr");
                        yield return new WaitForSeconds (0.5f);
                        SendData ("");
                        yield return new WaitForSeconds (2f);
                        SendData ("shake2");
                        mark = Time.time;
                        yield return new WaitForSeconds (60f);
                        SendData ("stop");
                        yield return new WaitForSeconds (0.5f);
                        SendData ("tray2at2");
                        yield return new WaitForSeconds (2f);
                        SendData ("cpr");
                        yield return new WaitForSeconds (0.5f);
                        SendData ("");
                        yield return new WaitForSeconds (2f);
                        SendData ("shake2");
                        mark = Time.time;
                        yield return new WaitForSeconds (60f);
                        SendData ("stop");
                        yield return new WaitForSeconds (0.5f);
                        SendData ("tray2at0");
                        mark = Time.time;
                        yield return new WaitForSeconds (118f);
                        Lights (true);
                        yield return new WaitForSeconds (2f);
                        phValue = controls.nearestValue;
                        yield return new WaitForSeconds (1f);

                        if (phValue == "5.0" || phValue == "6.0") {

        Camera.main.transform.position = new Vector3 (1091f, 55f, -131.7f);

        SendData ("tray2at1");

        yield return new WaitForSeconds (2f);

        Lights (true);
                        } else {

        startTime = Time.time;
```

```
        estTime = 203.4f;

        estTime += addTime;

        yield return new
WaitForSeconds (0.1f);

        SendData ("tray2at2");

        yield return new
WaitForSeconds (2f);

        SendData ("n");

        yield return new
WaitForSeconds (4f);

        SendData ("p");

        yield return new
WaitForSeconds (2f);

        SendData ("");

        yield return new
WaitForSeconds (0.5f);

        SendData ("tray2at3");

        yield return new
WaitForSeconds (2f);

        SendData ("p1");

        yield return new
WaitForSeconds (2f);

        SendData ("");

        yield return new
WaitForSeconds (2f);

        SendData ("shake2");

        mark = Time.time;

        yield return new
WaitForSeconds (60f);

        SendData ("stop");

        yield return new
WaitForSeconds (0.5f);

        SendData ("tray2at4");

        yield return new
WaitForSeconds (2f);

        SendData ("sc");  //for
review

        yield return new
WaitForSeconds (4f);

        SendData ("");

        yield return new
WaitForSeconds (2f);

        SendData ("tray2at0");

        mark = Time.time;

        yield return new
WaitForSeconds (118f);

        Lights (true);

        yield return new
WaitForSeconds (2f);

        controls.selected =
"Nitrogen";

        yield return new
WaitForSeconds (0.1f);

        nitrogenValue =
controls.nearestValue;
```

```
        controls.selected =
"Phosphorus";

        yield return new
WaitForSeconds (0.1f);

        phosphorusValue =
controls.nearestValue;

        StartCoroutine
(Tray1Sequence ());
                        }
                }
                if (x == 1) {
                        estTime =
204.4f;
                        estTime
+= addTime;
                        yield
return new WaitForSeconds
(0.1f);
                        SendData
("tray2at2");
                        yield
return new WaitForSeconds (2f);
                        SendData
("n");
                        yield
return new WaitForSeconds (4f);
                        SendData
("p");
                        yield
return new WaitForSeconds (2f);
                        SendData
("");
                        yield
return new WaitForSeconds
(0.5f);
                        SendData
("tray2at3");
                        yield
return new WaitForSeconds (2f);
                        SendData
("p1");
                        yield
return new WaitForSeconds (2f);
                        SendData
("bcg");
                        yield
return new WaitForSeconds (1f);
                        SendData
("");
                        yield
return new WaitForSeconds (2f);
                        SendData
("shake2");
                        mark =
Time.time;
                        yield
return new WaitForSeconds
(60f);
                        SendData
("stop");
                        yield
return new WaitForSeconds
(0.5f);
                        SendData
("tray2at4");
                        yield
return new WaitForSeconds (2f);
                        SendData
("sc");  //for review
                        yield
return new WaitForSeconds (4f);
                        SendData
("");
                        yield
return new WaitForSeconds (2f);
                        SendData
("tray2at0");
                        mark =
Time.time;
                        yield
return new WaitForSeconds
(118f);
                        Lights
(true);
                        yield
return new WaitForSeconds (2f);
```

```
        controls.selected = "bcg";
                        yield
return new WaitForSeconds
(0.1f);
                        phValue =
controls.nearestValue;

        controls.selected =
"Nitrogen";
                        yield
return new WaitForSeconds
(0.1f);

        nitrogenValue =
controls.nearestValue;

        controls.selected =
"Phosphorus";
                        yield
return new WaitForSeconds
(0.1f);

        phosphorusValue =
controls.nearestValue;

        StartCoroutine
(Tray1Sequence ());
                }
                if (x == 3) {
                        estTime =
287.9f;
                        estTime
+= addTime;
                        yield
return new WaitForSeconds
(0.1f);
                        SendData
("tray2at2");
                        yield
return new WaitForSeconds (2f);
                        SendData
("n");
                        yield
return new WaitForSeconds (4f);
                        SendData
("p");
                        yield
return new WaitForSeconds (2f);
                        SendData
("");
                        yield
return new WaitForSeconds
(0.5f);
                        SendData
("tray2at3");
                        yield
return new WaitForSeconds (2f);
                        SendData
("p1");
                        yield
return new WaitForSeconds (2f);
                        SendData
("");
                        yield
return new WaitForSeconds (2f);
                        SendData
("tray2at4");
                        yield
return new WaitForSeconds (2f);
                        SendData
("btb");
                        yield
return new WaitForSeconds (8f);
                        SendData
("");
                        yield
return new WaitForSeconds (2f);
                        SendData
("shake2");
                        mark =
Time.time;
                        yield
return new WaitForSeconds
(60f);
                        SendData
("stop");
                        yield
return new WaitForSeconds
(0.5f);
```

```
                SendData
("tray2at4");
                yield
return new WaitForSeconds (2f);
                SendData
("btb");
                yield
return new WaitForSeconds (8f);
                SendData
("");
                yield
return new WaitForSeconds (2f);
                SendData
("shake2");
                mark =
Time.time;
                yield
return new WaitForSeconds
(60f);
                SendData
("stop");
                yield
return new WaitForSeconds
(0.5f);
                SendData
("tray2at4");
                yield
return new WaitForSeconds (2f);
                SendData
("sc");  //for review
                yield
return new WaitForSeconds (4f);
                SendData
("");
                yield
return new WaitForSeconds (2f);
                SendData
("tray2at0");
                mark =
Time.time;
                yield
return new WaitForSeconds
(118f);
                Lights
(true);
                yield
return new WaitForSeconds (2f);

        controls.selected = "btb";
                yield
return new WaitForSeconds
(0.1f);
                phValue =
controls.nearestValue;

        controls.selected =
"Nitrogen";
                yield
return new WaitForSeconds
(0.1f);

        nitrogenValue =
controls.nearestValue;

        controls.selected =
"Phosphorus";
                yield
return new WaitForSeconds
(0.1f);

        phosphorusValue =
controls.nearestValue;

        StartCoroutine
(Tray1Sequence ());
                }
        }

        IEnumerator
Tray1Sequence(){
                yield return new
WaitForSeconds (0.1f);
                SendData
("tray1at6");
                yield return new
WaitForSeconds (3f);
                SendData ("k");

        //24 drops
                yield return new
WaitForSeconds (8f);
```

```
                SendData ("");
                yield return new
WaitForSeconds (1f);
                SendData
("shake1");
                mark =
Time.time;
                yield return new
WaitForSeconds (60f);
                SendData
("stop");
                yield return new
WaitForSeconds (0.5f);
                SendData
("tray1at6");
                SendData ("zn");
                        //50 drops
                mark =
Time.time;
                yield return new
WaitForSeconds (3f);
                SendData ("ca");
                        //20 drops
                mark =
Time.time;
                yield return new
WaitForSeconds (2f);
                SendData ("mg");
                        //20 drops
                yield return new
WaitForSeconds (2.5f);
                SendData ("");
                yield return new
WaitForSeconds (1f);

                SendData
("tray1at5");
                yield return new
WaitForSeconds (2f);
                SendData ("k1");
                        //8 drops
                yield return new
WaitForSeconds (2f);
                SendData ("");
                yield return new
WaitForSeconds (1f);
                SendData
("shake1");
                mark =
Time.time;
                yield return new
WaitForSeconds (60f);
                SendData
("stop");
                yield return new
WaitForSeconds (0.5f);
                SendData
("tray1at5");
                mark =
Time.time;
                yield return new
WaitForSeconds (300f);
                SendData ("ca1");
                        //7 drops
                yield return new
WaitForSeconds (1f);
                SendData ("");
                yield return new
WaitForSeconds (1f);
                SendData
("tray1at4");
                yield return new
WaitForSeconds (2f);
                SendData ("so4");
                        //24 drops
                yield return new
WaitForSeconds (4f);
                SendData ("");
                yield return new
WaitForSeconds (1f);
                SendData
("tray1at3");
                yield return new
WaitForSeconds (2f);
                SendData
("k2");//zn1                    //5
drops
                yield return new
WaitForSeconds (1f);
                SendData ("h2o");
                        //24 drops
```

```
                yield return new
WaitForSeconds (4f);
                SendData ("");
                yield return new
WaitForSeconds (1f);
                SendData
("tray1at2");
                yield return new
WaitForSeconds (2f);
                SendData
("zn1");//k2
        //12 drops
                yield return new
WaitForSeconds (2f);
                SendData ("zn2");
                        //24 drops
                yield return new
WaitForSeconds (1f);
                SendData ("ca2");
                        //5 drops
                yield return new
WaitForSeconds (1f);
                SendData
("mg1");                        //4
drops
                yield return new
WaitForSeconds (2f);
                SendData ("");
                yield return new
WaitForSeconds (1f);
                SendData
("tray1at0");
                Lights (true);
                yield return new
WaitForSeconds (2f);



                controls.selected
= "Sufficient+++";
                yield return new
WaitForSeconds (1f);
                GameObject.Find
("Sufficient+++").GetComponent
<RapidMarkers> ().snapColor ();
                controls.selected
= "Sufficient";
                yield return new
WaitForSeconds (1f);
                GameObject.Find
("Sufficient").GetComponent<Ra
pidMarkers> ().storedColorData
[0]
                =
GameObject.Find
("Sufficient+++").GetComponent
<RapidMarkers>
().storedColorData [0] ;

                controls.selected
= "Sufficient+";
                yield return new
WaitForSeconds (1f);
                GameObject.Find
("Sufficient+").GetComponent<
RapidMarkers>
().storedColorData [0]
                =
GameObject.Find
("Sufficient+++").GetComponent
<RapidMarkers>
().storedColorData [0] ;

                controls.selected
= "Sufficient++";
                yield return new
WaitForSeconds (1f);
                GameObject.Find
("Sufficient++").GetComponent<
RapidMarkers>
().storedColorData [0]
                =
GameObject.Find
("Sufficient+++").GetComponent
<RapidMarkers>
().storedColorData [0] ;

                controls.selected
= "Sufficient+++";
                yield return new
WaitForSeconds (1f);
```

```
                GameObject.Find
("Sufficient+++").GetComponent
<RapidMarkers>
().storedColorData [0]
                =
GameObject.Find
("Sufficient+++").GetComponent
<RapidMarkers>
().storedColorData [0] ;
                yield return new
WaitForSeconds (1f);

                controls.selected
= "Zinc";
                yield return new
WaitForEndOfFrame ();
                GameObject.Find
("Zinc").GetComponent<Rapid
Markers> ().snapColor ();
                yield return new
WaitForSeconds (1f);
                controls.selected
= "Calcium";
                yield return new
WaitForEndOfFrame ();
                GameObject.Find
("Calcium").GetComponent<Rap
idMarkers> ().snapColor ();
                yield return new
WaitForSeconds (1f);
                controls.selected
= "Magnesium";
                yield return new
WaitForEndOfFrame ();
                GameObject.Find
("Magnesium").GetComponent<
RapidMarkers> ().snapColor ();
                yield return new
WaitForSeconds (1f);
                mark =
Time.time;
                yield return new
WaitForSeconds (120f);
                //read k
                controls.selected
= "Sufficient";
                yield return new
WaitForSeconds (1f);
                suff =
controls.distance[0];
                controls.selected
= "Sufficient+";
                yield return new
WaitForSeconds (1f);
                suffP =
controls.distance[0];
                controls.selected
= "Sufficient++";
                yield return new
WaitForSeconds (1f);
                suffPp =
controls.distance[0];
                controls.selected
= "Sufficient+++";
                yield return new
WaitForSeconds (1f);
                suffPpp =
controls.distance[0];

                if (suffPpp > 20f)
{

        potassiumValue =
"Sufficient +++";
                } else if (suffPp >
20f) {

        potassiumValue =
"Sufficient ++";
                } else if (suffP >
20f) {

        potassiumValue =
"Sufficient +";
                } else if (suff >
20f) {

        potassiumValue =
"Sufficient";
                } else {
```

```
        potassiumValue =
"Deficient";
                }

                mark =
Time.time;
                yield return new
WaitForSeconds (180f);
                //read here
                finalDone = true;
                controls.selected
= "Zinc";
                yield return new
WaitForSeconds (1f);
                Debug.Log
(controls.distance [0]);
                if
(controls.distance [0] > 15f) {
                        zincValue
= "Sufficient";
                } else {
                        zincValue
= "Deficient";
                }
                controls.selected
= "Calcium";
                yield return new
WaitForSeconds (1f);
                Debug.Log
(controls.distance [0]);
                if
(controls.distance [0] > 20f) {

        calciumValue =
"Sufficient";
                } else {

        calciumValue =
"Deficient";
                }



                mark =
Time.time;
                yield return new
WaitForSeconds (240f);
                controls.selected
= "Magnesium";
                yield return new
WaitForSeconds (1f);
                Debug.Log
(controls.distance [0]);
                if
(controls.distance [0] > 8f) {

        magnesiumValue =
"Sufficient";
                } else {

        magnesiumValue =
"Deficient";
                }
                yield return new
WaitForSeconds (1f);

        StartCoroutine(GetComp
onent<DocumentMaker>
().TakePhoto ());
                yield return new
WaitForSeconds (1f);

        Camera.main.transform.p
osition = new Vector3 (2091f,
55f, -131.7f);
                yield return new
WaitForSeconds (2f);
                Lights (false);
                StartCoroutine
(Initialize ());
        }

        void chooseCrop(string
chosenCrop){

        GetComponent<Docume
ntMaker> ().chosenCrop =
chosenCrop;

        GetComponent<Docume
```

```
ntMaker> ().nitrogenValue =
nitrogenValue;

        GetComponent<Docume
ntMaker> ().phosphorusValue =
phosphorusValue;

        GetComponent<Docume
ntMaker> ().potassiumValue =
potassiumValue;

        GetComponent<Docume
ntMaker> ().phValue = phValue;

        GetComponent<Docume
ntMaker> ().zincValue =
zincValue;

        GetComponent<Docume
ntMaker> ().calciumValue =
calciumValue;

        GetComponent<Docume
ntMaker> ().magnesiumValue =
magnesiumValue;
                StartCoroutine
(GetComponent<DocumentMake
r> ().MakeDocument ());
        }

        void Lights(bool x) {
                if (x)
                        SendData
("lighton");
                else
                        SendData
("lightoff");
        }

        public void
SendData(string s) {

        stream.WriteLine(s);

        stream.BaseStream.Flush(
);
                Debug.Log
("Sending: " + s);
        }
}
```

Graphic User Interface

```
using System.Collections;
using
System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;

public class Raycast :
MonoBehaviour {
        RaycastHit hit;
        private bool fil;
        public GameObject
tagalog;
        public Texture
tagalogTexture;
        public Texture
tagalogPressedTexture;
        public GameObject
english;
        public Texture
englishTexture;
        public Texture
englishPressedTexture;

        public GameObject
startButton;
        public GameObject
helpButton;
        public GameObject
languageButton;
        public GameObject
aboutButton;
        public GameObject
continueButton;
        public GameObject
returnButton_0;
        public GameObject
returnButton_1;
```

```
	public GameObject
helpScreen;
	public GameObject
aboutScreen;
	public GameObject
detailScreen;
	public GameObject
canvas;

	public Text name;
	public Text location;
	public Texture start;
	public Texture help;
	public Texture language;
	public Texture about;
	public Texture cont;
	public Texture ret;
	public Texture
aboutWindow;
	public Texture
helpWindow;
	public Texture
enterDetails;

	public Texture
startPressed;
	public Texture
helpPressed;
	public Texture
languagePressed;
	public Texture
aboutPressed;
	public Texture
contPressed;
	public Texture retPressed;

	public Texture
startTagalog;
	public Texture
helpTagalog;
	public Texture
languageTagalog;
	public Texture
aboutTagalog;
	public Texture
contTagalog;
	public Texture
retTagalog;
	public Texture
aboutWindowTagalog;
	public Texture
helpWindowTagalog;
	public Texture
enterDetailsTagalog;

	public Texture
startPressedTagalog;
	public Texture
helpPressedTagalog;
	public Texture
languagePressedTagalog;
	public Texture
aboutPressedTagalog;
	public Texture
contPressedTagalog;
	public Texture
retPressedTagalog;

	public string filePath;

	System.Diagnostics.Proce
ss myProcess;

	// Use this for
initialization
	void Start () {

	Application.runInBackgr
ound = true;
		myProcess = new
System.Diagnostics.Process ();
		filePath =
Application.dataPath +
"/StreamingAssets/OSK/On-
ScreenKeyboardPortable.exe";

	myProcess.StartInfo.File
Name = filePath;
		fil = false;
		if
(PlayerPrefs.GetInt ("Filipino",
0) == 1) {
```

```
                    fil = true;

        startButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
startTagalog;

        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpTagalog;

        languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
languageTagalog;

        aboutButton.gameObject.
GetComponent<Renderer>
().material.mainTexture =
aboutTagalog;


        continueButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
contTagalog;

        returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;

        returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;

        aboutScreen.gameObject.
GetComponent<Renderer>
().material.mainTexture =
aboutWindowTagalog;

        helpScreen.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpWindowTagalog;

        detailScreen.gameObject.
GetComponent<Renderer>
().material.mainTexture =
enterDetailsTagalog;

                }
        }

        // Update is called once
per frame
        void Update () {
                Ray ray =
Camera.main.ScreenPointToRay
(Input.mousePosition);
                if
(Physics.Raycast (ray, out hit)) {
                        if
(hit.transform.name ==
tagalog.name) {
                                if
(Input.GetMouseButton (0)) {

        tagalog.gameObject.GetC
omponent<Renderer>
().material.mainTexture =
tagalogPressedTexture;
                                }
else if (Input.GetMouseButtonUp
(0)) {

        Camera.main.transform.p
osition += Vector3.right * 100f;

        startButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
startTagalog;

        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpTagalog;
```

```
        languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
languageTagalog;

        aboutButton.gameObject.
GetComponent<Renderer>
().material.mainTexture =
aboutTagalog;


        continueButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
contTagalog;

        returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;

        returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;

        aboutScreen.gameObject.
GetComponent<Renderer>
().material.mainTexture =
aboutWindowTagalog;

        helpScreen.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpWindowTagalog;

        detailScreen.gameObject.
GetComponent<Renderer>
().material.mainTexture =
enterDetailsTagalog;


        fil = true;

        tagalog.gameObject.GetC
omponent<Renderer>
().material.mainTexture =
tagalogTexture;
                        }
else {

        tagalog.gameObject.GetC
omponent<Renderer>
().material.mainTexture =
tagalogTexture;
                        }
                    }
                    if
(hit.transform.name ==
english.name) {
                        if
(Input.GetMouseButton (0)) {

        english.gameObject.GetC
omponent<Renderer>
().material.mainTexture =
englishPressedTexture;
                        }
else if (Input.GetMouseButtonUp
(0)) {

        Camera.main.transform.p
osition += Vector3.right * 100f;

        english.gameObject.GetC
omponent<Renderer>
().material.mainTexture =
englishTexture;
                        }
else {

        english.gameObject.GetC
omponent<Renderer>
().material.mainTexture =
englishTexture;
                        }
                    }
                    if
(hit.transform.name ==
startButton.name) {
```

```
                    if (Input.GetMouseButton (0)) {

        if (fil)


        startButton.gameObject.GetComponent<Renderer> ().material.mainTexture = startPressedTagalog;

        else


        startButton.gameObject.GetComponent<Renderer> ().material.mainTexture = startPressed;
                    }
else if (Input.GetMouseButtonUp (0)) {

        if (fil)


        startButton.gameObject.GetComponent<Renderer> ().material.mainTexture = startTagalog;

        else


        startButton.gameObject.GetComponent<Renderer> ().material.mainTexture = start;

        Camera.main.transform.position += Vector3.left * 200f;

        try{


        //GameObject.Find ("ErrorHandler").GetComponent <TextMesh> ().text = "Opening: " + filePath;

                myProcess.Start ();

        }

        catch(System.Exception e){

                GameObject.Find ("ErrorHandler").GetComponent <TextMesh> ().text += "\n" + e;

        }

        canvas.active = true;

        if (fil) {

                GameObject.Find ("NamePlaceholder").GetComponent<Text> ().text = "Ilagay ang pangalan";

                GameObject.Find ("LocPlaceholder").GetComponent<Text> ().text = "Ilagay ang lokasyon";

        }
                    }
else {

        if (fil)


        startButton.gameObject.GetComponent<Renderer> ().material.mainTexture = startTagalog;

        else
```

```
        startButton.gameObject.G
etComponent<Renderer>
().material.mainTexture = start;
                                }
                            }
                            if
(hit.transform.name ==
helpButton.name) {
                                if
(Input.GetMouseButton (0)) {

        if (fil)


        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpPressedTagalog;

        else


        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpPressed;
                                }
else if (Input.GetMouseButtonUp
(0)) {

        if (fil)


        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpTagalog;

        else


        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture = help;

        transform.position = new
Vector3 (0f, 100f, -26.38f);
                                }
else {

        if (fil)


        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpTagalog;

        else


        helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture = help;
                                }
                            }
                            if
(hit.transform.name ==
languageButton.name) {
                                if
(Input.GetMouseButton (0)) {

        if (fil)


        languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
languagePressedTagalog;

        else


        languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
languagePressed;
                                }
else if (Input.GetMouseButtonUp
(0)) {
```

```
            if (fil)


            languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
languageTagalog;

            else


            languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
language;

            Camera.main.transform.p
osition -= Vector3.right * 100f;

            startButton.gameObject.G
etComponent<Renderer>
().material.mainTexture = start;

            helpButton.gameObject.G
etComponent<Renderer>
().material.mainTexture = help;

            languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
language;

            aboutButton.gameObject.
GetComponent<Renderer>
().material.mainTexture = about;


            continueButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture = cont;

            returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture = ret;

            returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture = ret;

            aboutScreen.gameObject.
GetComponent<Renderer>
().material.mainTexture =
aboutWindow;

            helpScreen.gameObject.G
etComponent<Renderer>
().material.mainTexture =
helpWindow;

            detailScreen.gameObject.
GetComponent<Renderer>
().material.mainTexture =
enterDetails;


            fil = false;
                                    }
else {

            if (fil)


            languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
languageTagalog;

            else


            languageButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
language;
                                    }
                                }
                                if
(hit.transform.name ==
aboutButton.name) {
```

```
                    if (Input.GetMouseButton (0)) {

                        if (fil)

                            aboutButton.gameObject.GetComponent<Renderer>().material.mainTexture = aboutPressedTagalog;

                        else

                            aboutButton.gameObject.GetComponent<Renderer>().material.mainTexture = aboutPressed;
                    } else if (Input.GetMouseButtonUp (0)) {

                        if (fil)

                            aboutButton.gameObject.GetComponent<Renderer>().material.mainTexture = aboutTagalog;

                        else

                            aboutButton.gameObject.GetComponent<Renderer>().material.mainTexture = about;

                        transform.position = new Vector3 (0f, -100f, -26.38f);
                    } else {

                        if (fil)

                            aboutButton.gameObject.GetComponent<Renderer>().material.mainTexture = aboutTagalog;

                        else

                            aboutButton.gameObject.GetComponent<Renderer>().material.mainTexture = about;
                    }
                }
                if (hit.transform.name == continueButton.name) {
                    if (Input.GetMouseButton (0)) {

                        if (fil)

                            continueButton.gameObject.GetComponent<Renderer>().material.mainTexture = contPressedTagalog;

                        else

                            continueButton.gameObject.GetComponent<Renderer>().material.mainTexture = contPressed;
                    } else if (Input.GetMouseButtonUp (0)) {

                        if (fil)

                            continueButton.gameObject.GetComponent<Renderer>().material.mainTexture = contTagalog;

                        else
```

```
                continueButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture = cont;

                PlayerPrefs.SetString
("FarmerName", name.text);

                PlayerPrefs.SetString
("FarmerLocation",
location.text);

                if (!fil)

                        PlayerPrefs.SetInt
("Filipino", 0);

                else

                        PlayerPrefs.SetInt
("Filipino", 1);

                //myProcess.Kill ();

                StartCoroutine
(LoadNextLevel ());
                                }
else {

                if (fil)


                continueButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture =
contTagalog;

                else


                continueButton.gameObj
ect.GetComponent<Renderer>
().material.mainTexture = cont;
                                }
                        }
                                if
(hit.transform.name ==
returnButton_0.name) {
                                        if
(Input.GetMouseButton (0)) {

                if (fil) {


                returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retPressedTagalog;


                returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retPressedTagalog;

                } else {


                returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retPressed;


                returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retPressed;

                }
                                        }
else if (Input.GetMouseButtonUp
(0)) {

                if (fil) {


                returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;
```

```
        returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;

        } else {


        returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture = ret;


        returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture = ret;

        }

        transform.position = new
Vector3 (100f, 0f, -26.38f);
                                }
else {

        if (fil) {


        returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;


        returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture =
retTagalog;

        } else {


        returnButton_0.gameObje
ct.GetComponent<Renderer>
().material.mainTexture = ret;

        returnButton_1.gameObje
ct.GetComponent<Renderer>
().material.mainTexture = ret;

        }
                                        }
                                }
                        }
                }
        }

        IEnumerator
LoadNextLevel(){
                AsyncOperation
async =
Application.LoadLevelAsync
(1);
                GameObject.Find
("ErrorHandler").GetComponent
<TextMesh> ().text = "Loading:
" +
(int)(async.progress*100f/0.9f) +
"%";

                while
(!async.isDone) {

        GameObject.Find
("ErrorHandler").GetComponent
<TextMesh> ().text = "Loading:
" +
(int)(async.progress*100f/0.9f) +
"%";
                        yield
return null;
                }
                GameObject.Find
("ErrorHandler").GetComponent
<TextMesh> ().text = "Loading:
" +
(int)(async.progress*100f/0.9f) +
"%";
                yield return new
WaitForSeconds (0.5f);
```

```
                Debug.Log
("Loading Finished.");
        }
}
```

Arduino (Pumps, Switch, and Motor Control)

```
#include <SoftwareSerial.h>
int SW1 = 6;
int SW2 = 7;
int DIR1 = 2;
int STP1 = 3;
int GND1 = 4;
int VIN1 = 5;
int DIR2 = 8;
int STP2 = 9;
int GND2 = 10;
int VIN2 = 11;
int delay_ms = 1200;

void setup() {
  Serial.begin(9600);
  while (!Serial);
  for(int i = 22; i <= 49; i++){
    pinMode(i, OUTPUT);
  }
  resetAll();
  pinMode(STP1,OUTPUT);
  pinMode(DIR1,OUTPUT);
  pinMode(STP2,OUTPUT);
  pinMode(DIR2,OUTPUT);
  pinMode(VIN1,OUTPUT);
  pinMode(GND1,OUTPUT);
  pinMode(VIN2,OUTPUT);
  pinMode(GND2,OUTPUT);
  pinMode(SW1,INPUT);
  pinMode(SW2,INPUT);
  pinMode(13,OUTPUT);
  digitalWrite(13, HIGH);
  digitalWrite(VIN1,HIGH);
  digitalWrite(GND1,LOW);
  digitalWrite(VIN2,HIGH);
  digitalWrite(GND2,LOW);
  digitalWrite(DIR1,HIGH);
  digitalWrite(DIR2,HIGH);
}

void loop () {
  String out = "";
  while(Serial.available()){
    char c = Serial.read();
    out += c;
    delay(2);
  }
  if(out.length() > 0){
    resetAll();
    if (out.indexOf("k2") == 0){
      digitalWrite(22, LOW);
    } else if (out.indexOf("k1") ==
0){
      digitalWrite(36, HIGH);
    } else if (out.indexOf("k") ==
0){
      digitalWrite(23, HIGH);
    }
    if (out.indexOf("zn2") == 0){
      digitalWrite(24, LOW);
    } else if (out.indexOf("zn1")
== 0){
      digitalWrite(38, HIGH);
    } else if (out.indexOf("zn") ==
0){
      digitalWrite(25, HIGH);
    }
    if (out.indexOf("ca2") == 0){
      digitalWrite(26, LOW);
    } else if (out.indexOf("ca1")
== 0){
      digitalWrite(44, HIGH);
    } else if (out.indexOf("ca") ==
0){
      digitalWrite(27, HIGH);
    }
    if (out.indexOf("mg1") == 0){
      digitalWrite(28, LOW);
    }
    else if (out.indexOf("mg") ==
0){
      digitalWrite(29, HIGH);
    }
```

```
  if (out.indexOf("n") == 0){
    digitalWrite(30, LOW);
  }
  if (out.indexOf("cpr") == 0){
    digitalWrite(34, HIGH);
  }
  if (out.indexOf("h2o") == 0){
    digitalWrite(40, HIGH);
  }
  if (out.indexOf("so4") == 0){
    digitalWrite(42, HIGH);
  }
  if (out.indexOf("p1") == 0){
    digitalWrite(46, HIGH);
  }
  else if (out.indexOf("p") ==
0){
    digitalWrite(32, LOW);
  }
  if (out.indexOf("bcg") == 0){
    digitalWrite(48, HIGH);
  }
  if (out.indexOf("sc") == 0){
    digitalWrite(31, HIGH);
  }
  if (out.indexOf("btb") == 0){
    digitalWrite(33, HIGH);
  }
  if (out.indexOf("tray1at0") ==
0){
    movePos(1, 0);
  }
  if (out.indexOf("tray1at1") ==
0){
    movePos(1, 1);
  }
  if (out.indexOf("tray1at2") ==
0){
    movePos(1, 2);
  }
  if (out.indexOf("tray1at3") ==
0){
    movePos(1, 3);
  }
  if (out.indexOf("tray1at4") ==
0){
    movePos(1, 4);
  }
  if (out.indexOf("tray1at5") ==
0){
    movePos(1, 5);
  }
  if (out.indexOf("tray1at6") ==
0){
    movePos(1, 6);
  }
  if (out.indexOf("tray2at0") ==
0){
    movePos(2, 0);
  }
  if (out.indexOf("tray2at1") ==
0){
    movePos(2, 1);
  }
  if (out.indexOf("tray2at2") ==
0){
    movePos(2, 2);
  }
  if (out.indexOf("tray2at3") ==
0){
    movePos(2, 3);
  }
  if (out.indexOf("tray2at4") ==
0){
    movePos(2, 4);
  }
  if (out.indexOf("shake1") ==
0){
    movePos(1, 3);
    while(!out.indexOf("stop")
== 0){
      out = "";
      shake(1);
      while(Serial.available()){
        char c = Serial.read();
        out += c;
        delay(2);
      }
    }
  }
  if (out.indexOf("shake2") ==
0){
```

```
    movePos(2, 3);
    while(!out.indexOf("stop")
== 0){
      out = "";
      shake(2);
      while(Serial.available()){
        char c = Serial.read();
        out += c;
        delay(2);
      }
    }
  }

  if (out.indexOf("lighton") ==
0){
    digitalWrite(49, HIGH);
  }
  if (out.indexOf("lightoff") ==
0){
    digitalWrite(49, LOW);
  }

 }
}

void shake(int x){
 for(int i = 0; i <= 50; i++){
  if (x == 1) {
   movement(STP1);
  }
  if (x == 2) {
   movement(STP2);
  }
 }
 delay(100);
 setDirection(x,
"BACKWARD");
 for(int i = 0; i <= 50; i++){
  if (x == 1) {
   movement(STP1);
  }
  if (x == 2) {
   movement(STP2);
  }
 }
 setDirection(x, "FORWARD");
 delay(100);
}

void resetAll(){
 for(int i = 22; i <= 48; i++){
  if(i == 22 || i == 24 || i == 26 ||
i == 28 || i == 30 || i == 32){
   digitalWrite(i, HIGH);
  }
  else {
   digitalWrite(i, LOW);
  }
 }
 delay(100);
}

void movement(int x){
 digitalWrite(x, HIGH);
 delayMicroseconds(delay_ms);
 digitalWrite(x, LOW);
 delayMicroseconds(delay_ms);
}

void setDirection(int i, String s){
 if (i == 1) {
  if (s == "FORWARD") {
   digitalWrite(DIR1,LOW);
  }
  if (s == "BACKWARD") {
   digitalWrite(DIR1,HIGH);
  }
 }
 if (i == 2) {
  if (s == "FORWARD") {
   digitalWrite(DIR2,HIGH);
  }
  if (s == "BACKWARD") {
   digitalWrite(DIR2,LOW);
  }
 }
}

void initPos (int x) {
 if (x == 1) {
  setDirection(1,
"BACKWARD");
```

```
    while (!digitalRead(SW1)) {
      movement(STP1);
    }
    setDirection(1,
"FORWARD");
  }
  if (x == 2) {
    setDirection(2,
"BACKWARD");
    while (!digitalRead(SW2)) {
      movement(STP2);
    }
    setDirection(2,
"FORWARD");
  }
}

void movePos (int x, int y) {
  int loopNo = y;

  if(x == 1){
    if (y == 1) {
      loopNo = 350; //sagad
    }
    if (y == 2) {
      loopNo = 265; //ok
    }
    if (y == 3) {
      loopNo = 215; //ok
    }
    if (y == 4) {
      loopNo = 148; //ok
    }
    if (y == 5) {
      loopNo = 90; //ok
    }
    if (y == 6) {
      loopNo = 28; //ok
    }
  }
  if(x == 2){
    if (y == 1) {
      loopNo = 370; //kulang
    }
    if (y == 2) {
      loopNo = 270; //abante
    }
    if (y == 3) {
      loopNo = 225; //atras
    }
    if (y == 4) {
      loopNo = 170; //ok
    }
  }

  initPos(x);
  for(int i = 0; i <= loopNo; i++){
    if (x == 1) {
      movement(STP1);
    }
    if (x == 2) {
      movement(STP2);
    }
  }
}
```

Webcam (Color Picker)

```
using System.Collections;
using
System.Collections.Generic;
using UnityEngine;

public class Markers :
MonoBehaviour {

        private WebCamTexture
wct;
        public int colorNo;
        public Vector2
coordinates;
        public Vector2
defaultCoordinates;
        public string
nearestValue;
        public float
nearestDistance;
        public Color
extractColor;
        public Vector3 colorData;
        public Vector3[]
storedColorData;
```

```
	public Color[]
storedColor;
	public float[] distance;
	public string[] values;
	public Texture actv;
	public Texture inactv;
	private bool kgroup;

	// Use this for
initialization
	void Start () {
		kgroup = false;
	}

	void Update(){
		if
(this.gameObject.name == "btb"
|| this.gameObject.name ==
"Nitrogen") {
			colorNo =
5;
		}
		if
(this.gameObject.name == "cpr"
|| this.gameObject.name ==
"bcg") {
			colorNo =
4;
		}
		if
(this.gameObject.name ==
"Phosphorus") {
			colorNo =
6;
		}
		if
(storedColor.Length != colorNo)
{

	storedColor = new
Color[colorNo];
			distance =
new float[colorNo];

	storedColorData = new
Vector3[colorNo];
				values =
new string[colorNo];
				if
(this.gameObject.name == "btb")
{

		values [0] = "6.0";

		values [1] = "6.4";

		values [2] = "6.8";

		values [3] = "7.2";

		values [4] = "7.6";
				}
				if
(this.gameObject.name == "cpr")
{

		values [0] = "5.0";

		values [1] = "5.4";

		values [2] = "5.8";

		values [3] = "6.0";
				}
				if
(this.gameObject.name == "bcg")
{

		values [0] = "4.0";

		values [1] = "4.4";

		values [2] = "4.8";

		values [3] = "5.2";
				}
				if
(this.gameObject.name ==
"Nitrogen") {

		values [0] = "Low";
```

```
        values [1] = "Moderately
Low";

        values [2] = "Medium";

        values [3] = "Moderately
High";

        values [4] = "High";
                        }
                        if
(this.gameObject.name ==
"Phosphorus") {

        values [0] = "Low";

        values [1] = "Moderately
Low";

        values [2] = "Medium";

        values [3] = "Moderately
High";

        values [4] = "High";

        values [5] = "Medium";
                        }

        coordinates = new
Vector2 (PlayerPrefs.GetFloat
(this.gameObject.name + "x"),
PlayerPrefs.GetFloat
(this.gameObject.name + "y"));

                }
                for (int i = 0; i <
colorNo; i++) {
                        distance [i]
= (storedColorData [i] -
colorData).magnitude;
                }
                int smallestIndex
= 0;
                for (int i = 0; i <
colorNo; i++) {
                        if (i == 0)
{

        smallestIndex = i;
                        }
                        else if
(distance [smallestIndex] >
distance [i]) {

        smallestIndex = i;
                        }
                }
                int max =
colorNo;
                if
(this.gameObject.name == "btb")
{

        storedColorData [0] =
new Vector3 (192f, 215f, 126f);

        storedColorData [1] =
new Vector3 (136f, 142f, 99f);

        storedColorData [2] =
new Vector3 (55f, 113f, 108f);

        storedColorData [3] =
new Vector3 (69f, 110f, 155f);

        storedColorData [4] =
new Vector3 (40f, 114f, 248f);
                }
                if
(this.gameObject.name == "cpr")
{

        storedColorData [0] =
new Vector3 (211f, 188f, 109f);

        storedColorData [1] =
new Vector3 (168f, 118f, 74f);
```

```
        storedColorData [2] =
new Vector3 (157f, 65f, 103f);

        storedColorData [3] =
new Vector3 (92f, 51f, 100f);
                }
                if
(this.gameObject.name == "bcg")
{

        storedColorData [0] =
new Vector3 (88f, 106f, 63f);

        storedColorData [1] =
new Vector3 (29f, 64f, 66f);

        storedColorData [2] =
new Vector3 (30f, 48f, 53f);

        storedColorData [3] =
new Vector3 (19f, 27f, 73f);
                }
                if
(this.gameObject.name ==
"Nitrogen") {

        //storedColorData [0] =
new Vector3 (236f, 204f, 140f);

        //storedColorData [1] =
new Vector3 (197f, 195f, 132f);

        storedColorData [2] =
new Vector3 (159f, 186f, 124f);

        //storedColorData [3] =
new Vector3 (98f, 137f, 128f);

        storedColorData [4] =
new Vector3 (38f, 88f, 132f);



        storedColorData [0] =
new Vector3 (167f, 156f, 33f);

        //storedColorData [1] =
new Vector3 (197f, 195f, 132f);

        //storedColorData [2] =
new Vector3 (109f, 96f, 40f);

        //storedColorData [3] =
new Vector3 (98f, 137f, 128f);

        //storedColorData [4] =
new Vector3 (18f, 27f, 28f);
                }
                if
(this.gameObject.name ==
"Phosphorus") {

        storedColorData [0] =
new Vector3 (124f, 150f, 181f);

        //storedColorData [1] =
new Vector3 (79f, 103f, 176f);

        storedColorData [2] =
new Vector3 (34f, 56f, 172f);

        storedColorData [5] =
new Vector3 (95f, 99f, 50f);

        //storedColorData [3] =
new Vector3 (33f, 45f, 116f);

        storedColorData [4] =
new Vector3 (33f, 34f, 61f);
                }
                for(int i = 0; i <
colorNo; i++){

        //storedColorData [i] =
new Vector3 (PlayerPrefs.GetInt
(this.gameObject.name + i + "r"),
                        //
        PlayerPrefs.GetInt
(this.gameObject.name + i +
"g"),
```

```
                        //
        PlayerPrefs.GetInt
(this.gameObject.name + i +
"b"));
                        if
(this.gameObject.name ==
"Nitrogen" ||
this.gameObject.name ==
"Phosphorus") {
                                if (i
== 1 || i == 3) {

        //storedColorData [i] =
new Vector3 ((PlayerPrefs.GetInt
(this.gameObject.name + (i-1) +
"r") + PlayerPrefs.GetInt
(this.gameObject.name + (i+1) +
"r"))/2,

        //
        (PlayerPrefs.GetInt
(this.gameObject.name + (i-1) +
"g") + PlayerPrefs.GetInt
(this.gameObject.name + (i+1) +
"g"))/2,

        //
        (PlayerPrefs.GetInt
(this.gameObject.name + (i-1) +
"b") + PlayerPrefs.GetInt
(this.gameObject.name + (i+1) +
"b"))/2);

        storedColorData [i] =
new Vector3 ((storedColorData
[i - 1].x + storedColorData [i +
1].x) / 2,

                (storedColorData
[i - 1].y + storedColorData [i +
1].y) / 2, (storedColorData [i -
1].z + storedColorData [i + 1].z)
/ 2);
                                }
                        }
        storedColor [i] = new
Color (storedColorData [i].x /
255f, storedColorData [i].y /
255f, storedColorData [i].z /
255f, 1f);
                }
                nearestDistance =
distance [smallestIndex];
                nearestValue =
values [smallestIndex];



        this.gameObject.transfor
m.position = new Vector3
((int)coordinates.x / 10f,
(int)coordinates.y / 10f, -0.001f);

                coordinates =
defaultCoordinates;
                wct =
GameObject.Find
("VideoFeed1").GetComponent<
WebCam> ().wct;
                extractColor =
wct.GetPixel ((int)coordinates.x,
(int)coordinates.y);
                colorData = new
Vector3 (extractColor.r*255f,
extractColor.g*255f,
extractColor.b*255f);

                if
(GameObject.Find("Main
Camera").GetComponent<Debug
Controls>().selected ==
this.gameObject.name){

        this.gameObject.GetCom
ponent<Renderer>().material.mai
nTexture = actv;
                        if
(Input.GetKeyDown ("i")) {
                                int
i = GameObject.Find ("Main
```

```
Camera").GetComponent<Debug
Controls> ().editNo;

        storedColorData [i] =
colorData;
                        }
                } else {

        this.gameObject.GetCom
ponent<Renderer>().material.mai
nTexture = inactv;
                        if
(!kgroup)
this.gameObject.transform.positi
on = new Vector3 (0f, 0f, -
0.001f);
                }


        PlayerPrefs.SetFloat
(this.gameObject.name + "x",
coordinates.x);

        PlayerPrefs.SetFloat
(this.gameObject.name + "y",
coordinates.y);
                for(int i = 0; i <
colorNo; i++){

        PlayerPrefs.SetInt
(this.gameObject.name + i + "r",
(int)storedColorData [i].x);

        PlayerPrefs.SetInt
(this.gameObject.name + i + "g",
(int)storedColorData [i].y);

        PlayerPrefs.SetInt
(this.gameObject.name + i + "b",
(int)storedColorData [i].z);

        PlayerPrefs.SetString
(this.gameObject.name + i,
values [i]);
                }
        }
}

using System.Collections;
using
System.Collections.Generic;
using UnityEngine;

public class Experimental :
MonoBehaviour {

        public int colorNo;
        public string
nearestValue;
        public float
nearestDistance;
        public Vector3 colorData;
        public Color expColor;
        public Vector3[]
storedColorData;
        public Vector3[]
newColorData;
        public float[] distance;
        public string[] values;

                // Use this for
initialization
        void Start () {
        }

        void Update(){
                this.values =
this.gameObject.GetComponent<
Markers> ().values;
                this.colorNo =
this.gameObject.GetComponent<
Markers> ().colorNo;
                this.colorData =
this.gameObject.GetComponent<
Markers> ().colorData;

        this.storedColorData =
this.gameObject.GetComponent<
Markers> ().storedColorData;
                distance = new
float[colorNo];
```

```
                newColorData =
new Vector3[colorNo];

                /*for (int i = 0; i <
colorNo; i++) {
                        int j = 0;
                        if
(this.storedColorData [i].x >
this.storedColorData [i].y) {
                                if
(this.storedColorData [i].x >
this.storedColorData [i].z) {

        j = 0;
                                }
else {

        j = 2;
                                }
                        } else {
                                if
(this.storedColorData [i].y >
this.storedColorData [i].z) {

        j = 1;
                                }
else {

        j = 2;
                                }
                        }
                        float
divisor = 0;
                        if (j == 0)
{

        divisor =
this.storedColorData [i].x;
                        }
                        if (j == 1)
{

        divisor =
this.storedColorData [i].y;
                        }
                        if (j == 2)
{

        divisor =
this.storedColorData [i].z;
                        }

        newColorData [i] =
this.storedColorData[i] / divisor;
                }
                int k = 0;
                if (colorData.x >
colorData.y) {
                        if
(colorData.x > colorData.z) {
                                k =
0;
                        } else {
                                k =
2;
                        }
                } else {
                        if
(colorData.y > colorData.z) {
                                k =
1;
                        } else {
                                k =
2;
                        }
                }
                float divisor1 = 0;
                if (k == 0) {
                        divisor1 =
colorData.x;
                }
                if (k == 1) {
                        divisor1 =
colorData.y;
                }
                if (k == 2) {
                        divisor1 =
colorData.z;
                }
                colorData =
colorData/ divisor1;
```

```
                */

                expColor =
this.gameObject.GetComponent<
Markers> ().extractColor;

                if
(this.gameObject.name == "btb")
{

        storedColorData [0] =
new Vector3 (109f, 96f, 40f);

        storedColorData [1] =
new Vector3 (38f, 39f, 17f);

        storedColorData [2] =
new Vector3 (18f, 27f, 28f);

        storedColorData [3] =
new Vector3 (21f, 27f, 35f);

        //storedColorData [3] =
new Vector3 (69f, 110f, 155f);

        storedColorData [4] =
new Vector3 (33f, 34f, 46f);
                }
                if
(this.gameObject.name == "cpr")
{

        storedColorData [0] =
new Vector3 (167f, 88f, 0f);

        //storedColorData [0] =
new Vector3 (211f, 188f, 109f);

        storedColorData [1] =
new Vector3 (136f, 91f, 7f);

        storedColorData [2] =
new Vector3 (46f, 15f, 17f);

        storedColorData [3] =
new Vector3 (34f, 18f, 17f);
                }
                if
(this.gameObject.name == "bcg")
{

        storedColorData [0] =
new Vector3 (38f, 40f, 19f);

        storedColorData [1] =
new Vector3 (19f, 26f, 18f);

        storedColorData [2] =
new Vector3 (30f, 48f, 53f);

        storedColorData [3] =
new Vector3 (19f, 27f, 73f);
                }

                for (int i = 0; i <
colorNo; i++) {
                        distance [i]
= (storedColorData [i] -
colorData).magnitude;
                }
                int smallestIndex
= 0;
                for (int i = 0; i <
colorNo; i++) {
                        if (i == 0)
{

        smallestIndex = i;
                        }
                        else if
(distance [smallestIndex] >
distance [i]) {

        smallestIndex = i;
                        }
                }
                this.values =
this.gameObject.GetComponent<
Markers> ().values;
                nearestDistance =
distance [smallestIndex];
```

```
                nearestValue =
values [smallestIndex];
        }
}

using System.Collections;
using
System.Collections.Generic;
using UnityEngine;

public class RapidMarkers :
MonoBehaviour {

        private WebCamTexture
wct;
        private static int colorNo
= 2;
        public Vector2
coordinates;
        public Vector2
defaultCoordinates;
        public string
nearestValue;
        public float
nearestDistance;
        public Color
extractColor;
        public Vector3 colorData;
        public Vector3[]
storedColorData = new
Vector3[colorNo];
        public Color[]
storedColor = new
Color[colorNo];
        public float[] distance =
new float[colorNo];
        public string[] values =
new string[colorNo];
        public Texture actv;
        public Texture inactv;
        private bool kgroup;

        // Use this for
initialization
        void Start () {
                kgroup = false;
        }

        void Update(){
                if
(storedColor.Length != colorNo)
{

        coordinates = new
Vector2 (PlayerPrefs.GetFloat
(this.gameObject.name + "x"),
PlayerPrefs.GetFloat
(this.gameObject.name + "y"));

                }
                for (int i = 0; i <
colorNo; i++) {
                        distance [i]
= (storedColorData [i] -
colorData).magnitude;
                }
                int smallestIndex
= 0;
                for (int i = 0; i <
colorNo; i++) {
                        if (i == 0)
{

        smallestIndex = i;
                        }
                        else if
(distance [smallestIndex] >
distance [i]) {

        smallestIndex = i;
                        }
                }
                for(int i = 0; i <
colorNo; i++){

        storedColor [i] = new
Color (storedColorData [i].x /
255f, storedColorData [i].y /
255f, storedColorData [i].z /
255f, 1f);
                }
```

```
                nearestDistance =
distance [smallestIndex];
                nearestValue =
values [smallestIndex];


        this.gameObject.transfor
m.position = new Vector3
((int)coordinates.x / 10f,
(int)coordinates.y / 10f, -0.001f);

                coordinates = new
Vector2 ((int)coordinates.x,
(int)coordinates.y);
                wct =
GameObject.Find
("VideoFeed1").GetComponent<
WebCam> ().wct;
                extractColor =
wct.GetPixel ((int)coordinates.x,
(int)coordinates.y);
                colorData = new
Vector3 (extractColor.r*255f,
extractColor.g*255f,
extractColor.b*255f);

                if
(GameObject.Find("Main
Camera").GetComponent<Debug
Controls>().selected ==
this.gameObject.name){

        this.gameObject.GetCom
ponent<Renderer>().material.mai
nTexture = actv;

        coordinates =
defaultCoordinates;
                        if
(Input.GetKeyDown ("i")) {
                                int
i = GameObject.Find ("Main
Camera").GetComponent<Debug
Controls> ().editNo;

        storedColorData [i] =
colorData;
                        }
                } else {

        this.gameObject.GetCom
ponent<Renderer>().material.mai
nTexture = inactv;
                        if
(!kgroup)
this.gameObject.transform.positi
on = new Vector3 (0f, 0f, -
0.001f);
                }


        PlayerPrefs.SetFloat
(this.gameObject.name + "x",
coordinates.x);

        PlayerPrefs.SetFloat
(this.gameObject.name + "y",
coordinates.y);
                for(int i = 0; i <
colorNo; i++){

        PlayerPrefs.SetInt
(this.gameObject.name + i + "r",
(int)storedColorData [i].x);

        PlayerPrefs.SetInt
(this.gameObject.name + i + "g",
(int)storedColorData [i].y);

        PlayerPrefs.SetInt
(this.gameObject.name + i + "b",
(int)storedColorData [i].z);

        PlayerPrefs.SetString
(this.gameObject.name + i,
values [i]);
                }
        }

        public void snapColor(){
```

```
                storedColorData
[0] = colorData;
                Debug.Log
(colorData.x + ", " + colorData.y
+ ", " + colorData.z);
                Debug.Log
(storedColorData [0].x + ", " +
storedColorData [0].y + ", " +
storedColorData [0].z);
                Debug.Log
(gameObject.name + ", SNAP!");
        }
}

                } else {
                        plant =
"hectare";
                        bag = "
bags/";
                }
        }
}
```

Appendix D - How to Use SoilgANic

Setting up SoilgANic

1. To set up the tablet, just place it to the tablet slot. Plug the USB connector to the tablet.

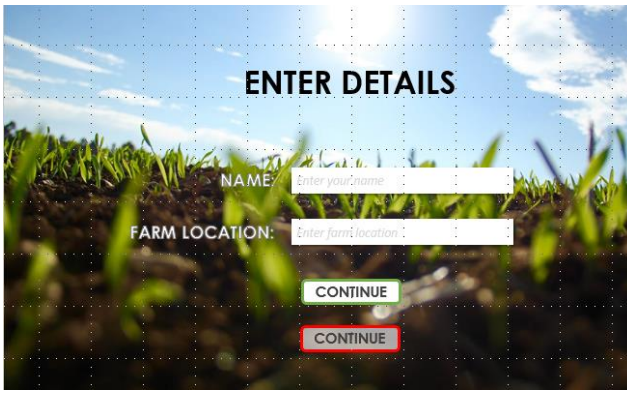
2. Put the chemicals into the compartment. Filled with a minimum of 50 mL of each chemical.

3. Connect the printer to its USB port.

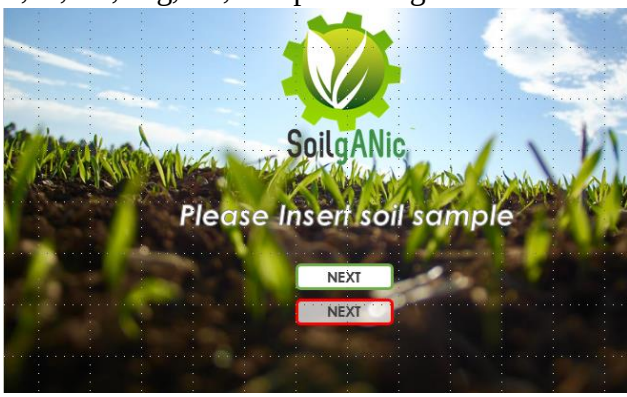
4. Turn the tablet and printer on.

How to use SoilgANic

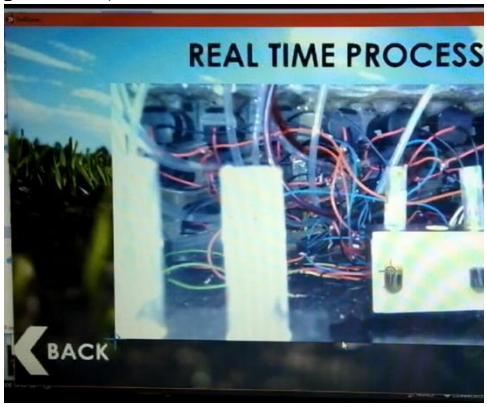
1. Enter Details.



2. Insert the first soil sample for N, P, K, Ca, Mg, Zn, and pH testing.



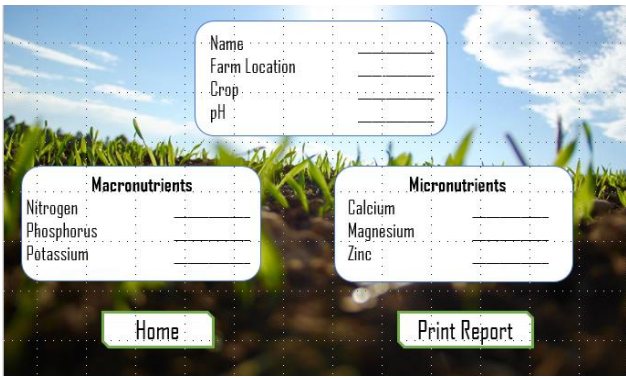
3. Wait until the testing is done (you can also view the real time process.)



4. Insert another soil sample if soil pH is greater than or equal 6 and if it is less than or equal to 5.

5. After the final result, choose crop for fertilizer recommendation.

6. Click the "Generate Report" to see the results.



7. Click the "Print Report" for printed results.

Appendix E - Ghant Chart

Activities	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Brainstorming of the Project											
Research about the Topic											
Topic Defense											
Interview											
Training											
Chapter 1: The Problem and its Setting											
Chapter 2 : Review of Related Literature											
Title Defense											
Planning and Designing											
Collecting Soil Samples											
Testing Soil Samples											
Software and Hardware Development											
Progress Presentation											
Completing the Project Study (SoilgANic)											
Functionality Test											
Pre Final Defense											
Operation and Evaluation of the Project											
Deployment											
Completing the Document											
Final Defense											

Appendix F - Tables

Results in Identifying pH level

Sample No.	Conventional	Using SoilgANic	Result (1 if equal, 0 if not)
1	6.4	6.4	1
2	6.4	6.4	1
3	6.4	6.4	1
4	7.2	7.2	1
5	6.4	6.4	1
6	6.4	6.4	1
7	6.8	6.8	1
8	6.8	6.8	1
9	6.8	6.8	1
10	6.4	6.4	1
11	5.4	5.4	1
12	7.2	7.2	1
13	6.4	6.4	1
14	7.2	7.2	1
15	5.4	5.4	1
16	7.2	7.2	1
17	5.4	5.4	1
18	6.8	6.8	1
19	5.4	5.4	1
20	7.2	7.2	1
21	7.6	7.6	1
22	7.2	7.2	1
23	6.4	6.4	1
24	7.2	7.2	1
25	6.4	6.4	1
26	6.8	6.8	1
27	7.2	7.2	1
28	6.4	6.4	1
29	6.4	6.4	1
30	6.8	6.8	1

Results in Identifying Nitrogen Level

Sample No.	Conventional	Using SoilgANic	Result (1 if equal, 0 if not)
1	Low	Low	1
2	Low	Low	1
3	Low	Low	1
4	Low	Low	1
5	Low	Low	1
6	Low	Low	1
7	Low	Low	1
8	Low	Low	1
9	Low	Low	1
10	Low	Low	1
11	Low	Low	1
12	Low	Low	1
13	Low	Low	1
14	Low	Low	1
15	Low	Low	1
16	Low	Low	1
17	Low	Low	1
18	Low	Low	1
19	Low	Low	1
20	Low	Low	1
21	Low	Low	1
22	Low	Low	1
23	Low	Low	1
24	Low	Low	1
25	Low	Low	1
26	Low	Low	1
27	Low	Low	1
28	Low	Low	1
29	Low	Low	1
30	Low	Low	1

Results in Identifying Phosphorus Level

Sample No.	Conventional	Using SoilgANic	Result (1 if equal, 0 if not)
1	Low	Low	1
2	Low	Low	1
3	Low	Low	1
4	Moderately Low	Moderately Low	1
5	Medium	Medium	1
6	Medium	Medium	1
7	Low	Low	1
8	Moderately High	Moderately High	1
9	Medium	Medium	1
10	High	High	1
11	Low	Low	1
12	Moderately Low	Moderately Low	1
13	Low	Low	1
14	Moderately High	Moderately High	1
15	Low	Low	1
16	Moderately Low	Moderately Low	1
17	Low	Low	1
18	Low	Low	1
19	Low	Low	1
20	High	High	1
21	Low	Low	1
22	Moderately High	Moderately High	1
23	Moderately High	Moderately High	1
24	High	High	1
25	High	High	1
26	High	High	1
27	Low	Low	1
28	Low	Low	1
29	Low	Low	1
30	Low	Low	1

Results in Identifying Potassium Level

Sample No.	Conventional	Using SoilgANic	Result (1 if equal, 0 if not)
1	Sufficient+	Sufficient+	1
2	Sufficient++	Sufficient++	1
3	Sufficient	Sufficient	1
4	Sufficient+	Sufficient+	1
5	Sufficient++	Sufficient++	1
6	Sufficient+	Sufficient+	1
7	Sufficient++	Sufficient++	1
8	Sufficient+	Sufficient+	1
9	Sufficient++	Sufficient++	1
10	Sufficient++	Sufficient++	1
11	Sufficient+	Sufficient+	1
12	Sufficient++	Sufficient++	1
13	Sufficient+	Sufficient+	1
14	Sufficient++	Sufficient++	1
15	Sufficient+	Sufficient+	1
16	Sufficient+	Sufficient+	1
17	Sufficient+	Sufficient+	1
18	Sufficient+	Sufficient+	1
19	Sufficient	**Sufficient+**	0
20	Sufficient+	Sufficient+	1
21	Sufficient+	Sufficient+	1
22	Sufficient	Sufficient	1
23	Sufficient+	**Sufficient++**	0
24	Sufficient	Sufficient	1
25	Sufficient	Sufficient	1
26	Sufficient++	Sufficient++	1
27	Sufficient	Sufficient	1
28	Sufficient++	Sufficient++	1
29	Deficient	Deficient	1
30	Sufficient++	Sufficient++	1

Results in Identifying Calcium Level

Sample No.	Conventional	Using SoilgANic	Result (1 if equal, 0 if not)
1	Sufficient	Sufficient	1
2	Sufficient	Sufficient	1
3	Sufficient	Sufficient	1
4	Sufficient	Sufficient	1
5	Sufficient	**Deficient**	0
6	Sufficient	Sufficient	1
7	Sufficient	Sufficient	1
8	Sufficient	Sufficient	1
9	Sufficient	Sufficient	1
10	Sufficient	Sufficient	1
11	Deficient	Deficient	1
12	Sufficient	Sufficient	1
13	Deficient	**Sufficient**	0
14	Sufficient	Sufficient	1
15	Deficient	**Sufficient**	0
16	Deficient	Deficient	1
17	Deficient	Deficient	1
18	Sufficient	Sufficient	1
19	Deficient	Deficient	1
20	Sufficient	Sufficient	1
21	Sufficient	**Deficient**	0
22	Sufficient	Sufficient	1
23	Sufficient	Sufficient	1
24	Sufficient	Sufficient	1
25	Sufficient	Sufficient	1
26	Sufficient	Sufficient	1
27	Sufficient	Sufficient	1
28	Deficient	Deficient	1
29	Deficient	Deficient	1
30	Deficient	Deficient	1

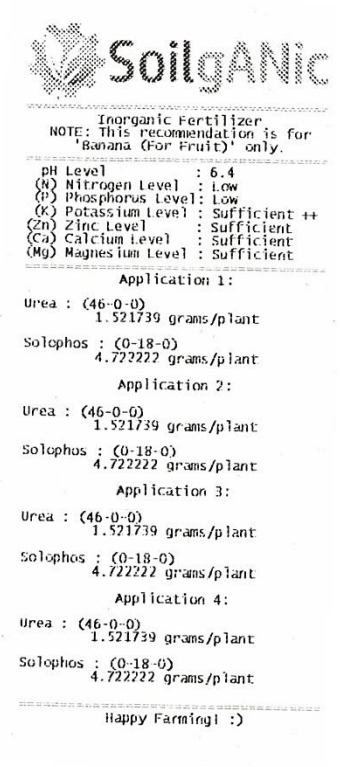
Results in Identifying Magnesium Level

Sample No.	Conventional	Using SoilgANic	Result (1 if equal, 0 if not)
1	Sufficient	Sufficient	1
2	Sufficient	Sufficient	1
3	Sufficient	Sufficient	1
4	Sufficient	Sufficient	1
5	Sufficient	Sufficient	1
6	Sufficient	Sufficient	1
7	Sufficient	Sufficient	1
8	Sufficient	Sufficient	1
9	Sufficient	Sufficient	1
10	Sufficient	Sufficient	1
11	Sufficient	Sufficient	1
12	Sufficient	Sufficient	1
13	Sufficient	Sufficient	1
14	Sufficient	Sufficient	1
15	Sufficient	Sufficient	1
16	Sufficient	Sufficient	1
17	Sufficient	Sufficient	1
18	Sufficient	Sufficient	1
19	Sufficient	Sufficient	1
20	Sufficient	Sufficient	1
21	Sufficient	Sufficient	1
22	Sufficient	Sufficient	1
23	Sufficient	Sufficient	1
24	Sufficient	Sufficient	1
25	Sufficient	Sufficient	1
26	Sufficient	Sufficient	1
27	Sufficient	Sufficient	1
28	Sufficient	Sufficient	1
29	Sufficient	Sufficient	1
30	Sufficient	Sufficient	1

Results in Identifying Zinc Level

Sample No.	Conventional	Using SoilgANic	Result (1 if equal, 0 if not)
1	Sufficient	Sufficient	1
2	Sufficient	Sufficient	1
3	Sufficient	Sufficient	1
4	Sufficient	Sufficient	1
5	Sufficient	Sufficient	1
6	Sufficient	Sufficient	1
7	Sufficient	Sufficient	1
8	Sufficient	**Deficient**	0
9	Sufficient	**Deficient**	0
10	Sufficient	Sufficient	1
11	Sufficient	Sufficient	1
12	Sufficient	**Deficient**	0
13	Sufficient	Sufficient	1
14	Deficient	Deficient	1
15	Sufficient	Sufficient	1
16	Deficient	**Sufficient**	0
17	Sufficient	Sufficient	1
18	Deficient	Deficient	1
19	Sufficient	Sufficient	1
20	Sufficient	Sufficient	1
21	Sufficient	**Deficient**	0
22	Sufficient	Sufficient	1
23	Sufficient	Sufficient	1
24	Sufficient	Sufficient	1
25	Sufficient	Sufficient	1
26	Sufficient	Sufficient	1
27	Deficient	Deficient	1
28	Sufficient	Sufficient	1
29	Deficient	**Sufficient**	0
30	Sufficient	Sufficient	1

Appendix G – Fertilizer Recommendation



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Banana (For Fruit)' only.

pH Level : 6.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient ++
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

Urea : (46-0-0)
1.521739 grams/plant

Solophos : (0-18-0)
4.722222 grams/plant

Application 2:

Urea : (46-0-0)
1.521739 grams/plant

Solophos : (0-18-0)
4.722222 grams/plant

Application 3:

Urea : (46-0-0)
1.521739 grams/plant

Solophos : (0-18-0)
4.722222 grams/plant

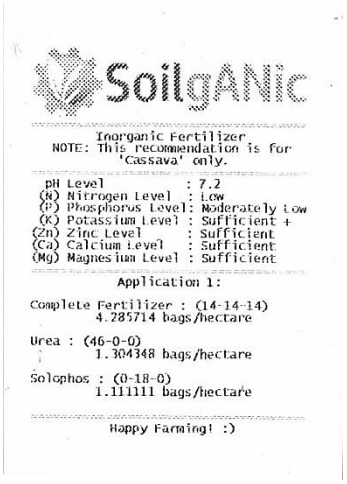
Application 4:

Urea : (46-0-0)
1.521739 grams/plant

Solophos : (0-18-0)
4.722222 grams/plant

Happy Farming! :)

Printed result of soil sample 2



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Cassava' only.

pH Level : 7.2
(N) Nitrogen Level : Low
(P) Phosphorus Level: Moderately Low
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

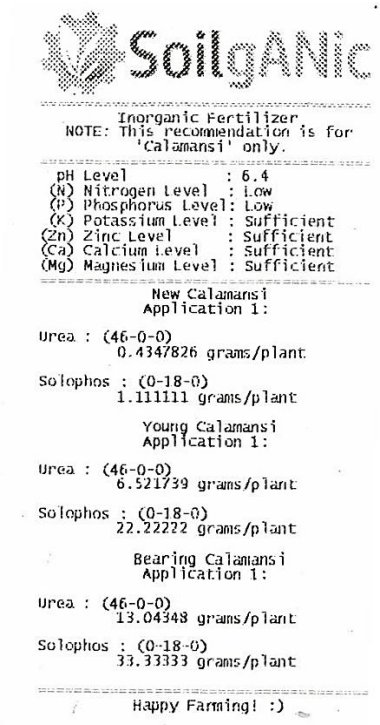
Complete Fertilizer : (14-14-14)
4.285714 bags/hectare

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
1.111111 bags/hectare

Happy Farming! :)

Printed result of soil sample 4



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Calamansi' only.

pH Level : 6.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

New Calamansi
Application 1:

Urea : (46-0-0)
0.4347826 grams/plant

Solophos : (0-18-0)
1.111111 grams/plant

Young Calamansi
Application 1:

Urea : (46-0-0)
6.521739 grams/plant

Solophos : (0-18-0)
22.22222 grams/plant

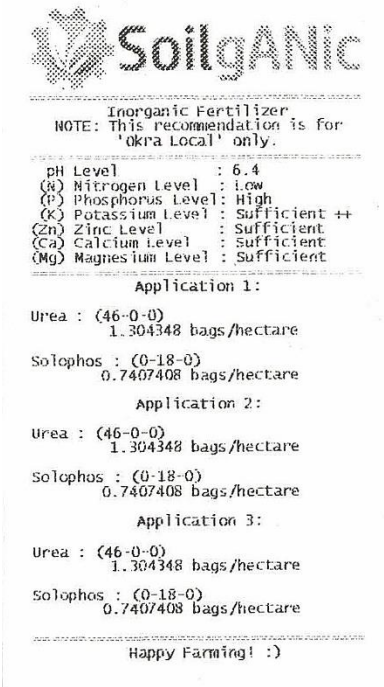
Bearing Calamansi
Application 1:

Urea : (46-0-0)
13.04348 grams/plant

Solophos : (0-18-0)
33.33333 grams/plant

Happy Farming! :)

Printed result of soil sample 3



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Okra Local' only.

pH Level : 6.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: High
(K) Potassium Level : Sufficient ++
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.7407408 bags/hectare

Application 2:

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.7407408 bags/hectare

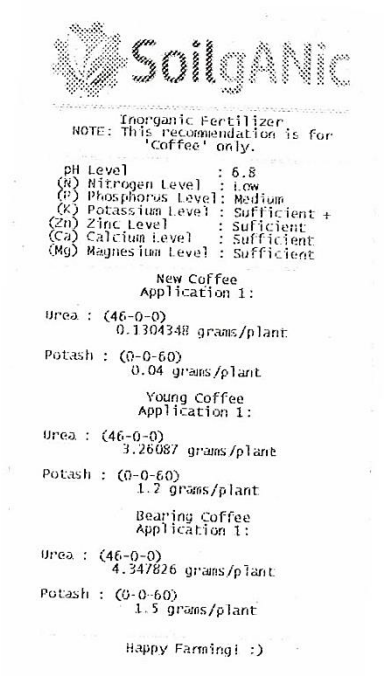
Application 3:

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.7407408 bags/hectare

Happy Farming! :)

Printed result of soil sample 5



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Coffee' only.

pH Level : 6.8
(N) Nitrogen Level : Low
(P) Phosphorus Level: Medium
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Suficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

New Coffee
Application 1:

Urea : (46-0-0)
0.1304348 grams/plant

Potash : (0-0-60)
0.04 grams/plant

Young Coffee
Application 1:

Urea : (46-0-0)
3.26087 grams/plant

Potash : (0-0-60)
1.2 grams/plant

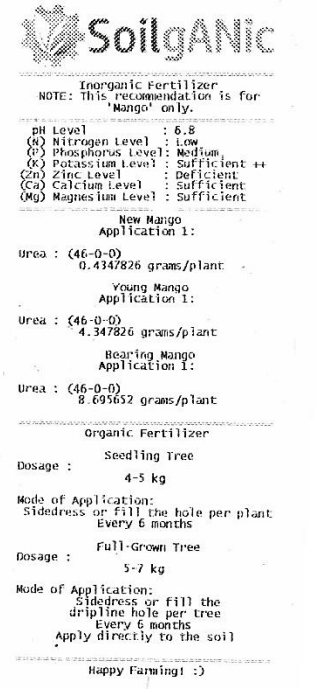
Bearing Coffee
Application 1:

Urea : (46-0-0)
4.347826 grams/plant

Potash : (0-0-60)
1.5 grams/plant

Happy Farming! :)

Printed result of soil sample 6



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Mango' only.

pH Level : 6.8
(N) Nitrogen Level : Low
(P) Phosphorus Level: Medium
(K) Potassium Level : Sufficient ++
(Zn) Zinc Level : Deficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

New Mango
Application 1:

Urea : (46-0-0)
0.4347826 grams/plant

Young Mango
Application 1:

Urea : (46-0-0)
4.347826 grams/plant

Bearing Mango
Application 1:

Urea : (46-0-0)
8.695652 grams/plant

Organic Fertilizer

Seedling Tree

Dosage :
4-5 kg

Mode of Application:
Sidedress or fill the hole per plant
Every 6 months

Full-Grown Tree

Dosage :
5-7 kg

Mode of Application:
Sidedress or fill the dripline hole per tree
Every 6 months
Apply directly to the soil

Happy Farming! :)

Printed result of soil sample 8

SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Eggplant' only.

pH Level : 6.8
(N) Nitrogen Level : Low
(P) Phosphorus Level: Moderately Hig
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Deficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

Complete Fertilizer : (14-14-14)
2.142857 bags/hectare

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.5555556 bags/hectare

Application 2:

Complete Fertilizer : (14-14-14)
2.142857 bags/hectare

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.5555556 bags/hectare

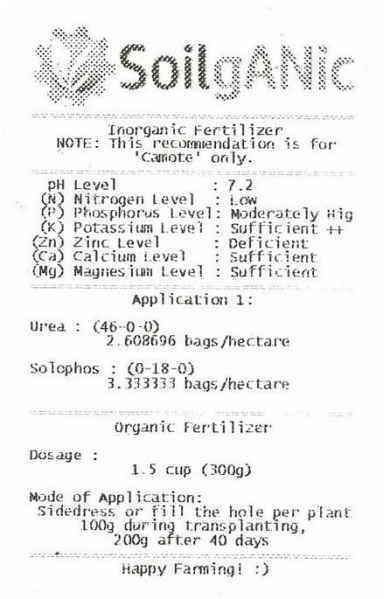
Organic Fertilizer

Dosage :
1.5 cup (300g)

Mode of Application:
Sidedress or fill the hole per plant
100g during transplanting,
200g after 40 days

Happy Farming! :)

Printed result of soil sample 7



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Camote' only.

pH Level : 7.2
(N) Nitrogen Level : Low
(P) Phosphorus Level: Moderately Hig
(K) Potassium Level : Sufficient ++
(Zn) Zinc Level : Deficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

Urea : (46-0-0)
2.608696 bags/hectare

Solophos : (0-18-0)
3.333333 bags/hectare

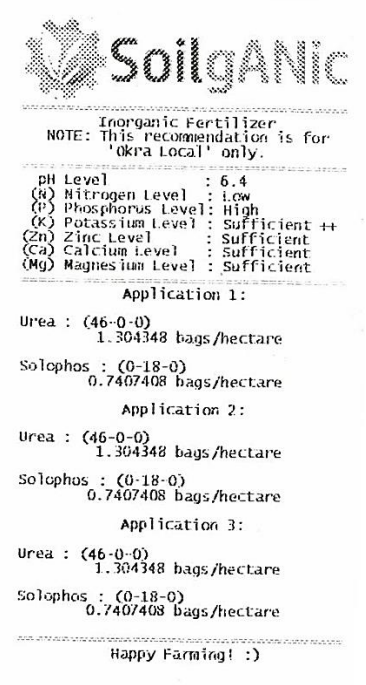
Organic Fertilizer

Dosage :
1.5 cup (300g)

Mode of Application:
Sidedress or fill the hole per plant
100g during transplanting,
200g after 40 days

Happy Farming! :)

Printed sample of soil sample 9



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Okra Local' only.

pH Level : 6.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: High
(K) Potassium Level : Sufficient ++
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.7407408 bags/hectare

Application 2:

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.7407408 bags/hectare

Application 3:

Urea : (46-0-0)
1.304348 bags/hectare

Solophos : (0-18-0)
0.7407408 bags/hectare

Happy Farming! :)

Printed result of soil sample 10

SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Peanut' only.

pH Level : 5.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Suficient
(Ca) Calcium Level : Deficient
(Mg) Magnesium Level : Sufficient

Application 1:

Complete Fertilizer : (14-14-14)
4.285714 bags/hectare

Urea : (46-0-0)
0.4347826 bags/hectare

Solophos : (0-18-0)
1.111111 bags/hectare

Organic Fertilizer

Dosage :
1.5 cup (300g)

Mode of Application:
Sidedress or fill the hole per plant
100g during transplanting,
200g after 40 days

Happy Farming! :)

Printed result of soil sample 11

SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Pechay' only.

pH Level : 7.2
(N) Nitrogen Level : Low
(P) Phosphorus Level: Moderately Low
(K) Potassium Level : Sufficient ++
(Zn) Zinc Level : Deficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Application 1:

Urea : (46-0-0)
3.26087 bags/hectare

Solophos : (0-18-0)
2.222222 bags/hectare

Application 2:

Urea : (46-0-0)
3.26087 bags/hectare

Solophos : (0-18-0)
2.222222 bags/hectare

Organic Fertilizer

Dosage :
1 cup (200g)

Mode of Application:
Sidedress or fill the hole per plant
Apply during transplanting

Happy Farming! :)

Printed result of soil sample 12

SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Rice' only.

pH Level : 6.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

Dry Season Rice
Application 1:

Complete Fertilizer : (14-14-14)
0.952381 bags/hectare

Urea : (46-0-0)
1.449275 bags/hectare

Solophos : (0-18-0)
1.481482 bags/hectare

Application 2:

Complete Fertilizer : (14-14-14)
0.952381 bags/hectare

Urea : (46-0-0)
1.449275 bags/hectare

Solophos : (0-18-0)
1.481482 bags/hectare

Application 3:

Complete Fertilizer : (14-14-14)
0.952381 bags/hectare

Urea : (46-0-0)
1.449275 bags/hectare

Solophos : (0-18-0)
1.481482 bags/hectare

Wet Season Rice
Application 1:

Complete Fertilizer : (14-14-14)
0.952381 bags/hectare

Urea : (46-0-0)
1.15942 bags/hectare

Solophos : (0-18-0)
1.481482 bags/hectare

Application 2:

Complete Fertilizer : (14-14-14)
0.952381 bags/hectare

Urea : (46-0-0)
1.15942 bags/hectare

Solophos : (0-18-0)
1.481482 bags/hectare

Application 3:

Complete Fertilizer : (14-14-14)
0.952381 bags/hectare

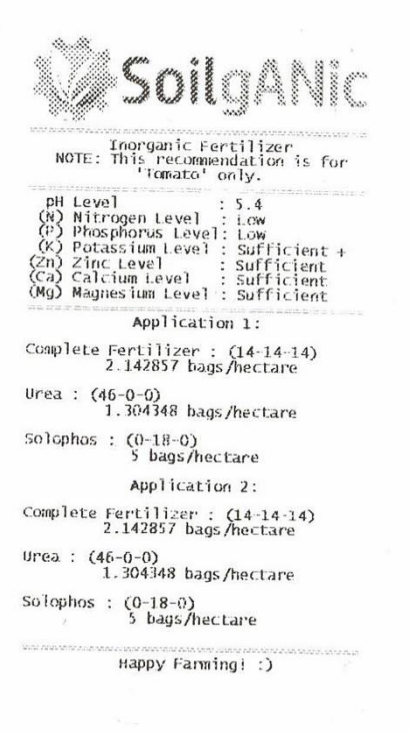
Urea : (46-0-0)
1.15942 bags/hectare

Solophos : (0-18-0)
1.481482 bags/hectare

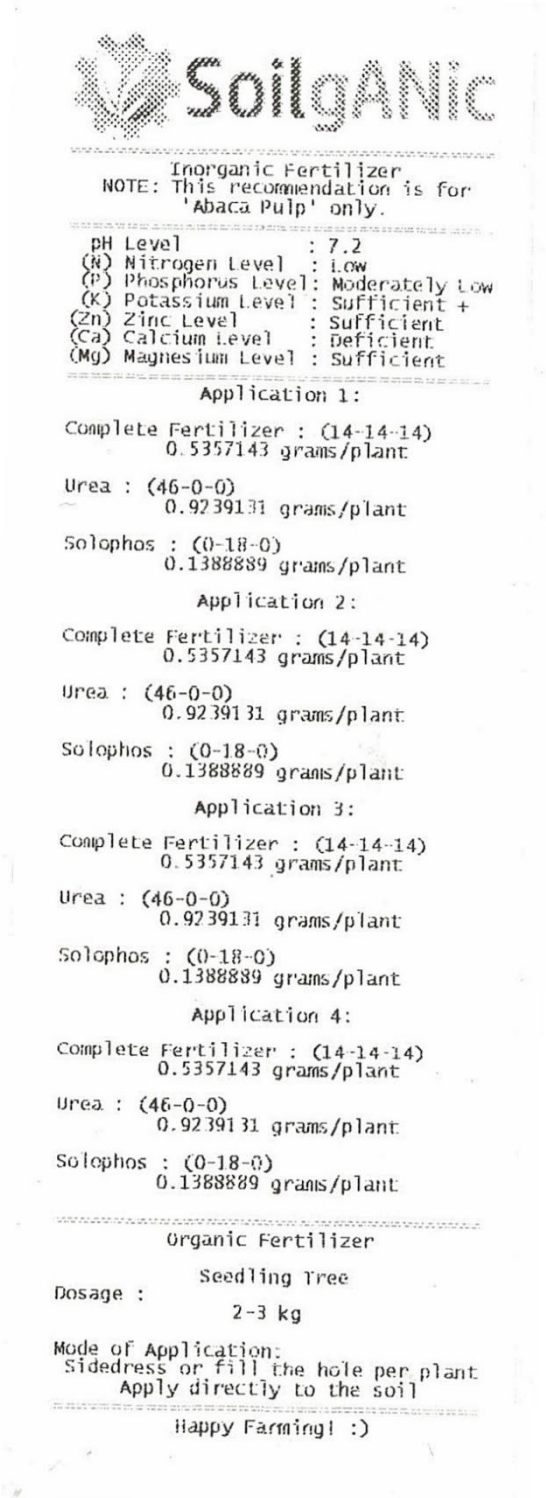
Happy Farming! :)

Printed result of soil sample 13

Printed result of soil sample 14



Printed result of soil sample 15



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Abaca Pulp' only.

pH Level	:	7.2
(N) Nitrogen Level	:	Low
(P) Phosphorus Level	:	Moderately Low
(K) Potassium Level	:	Sufficient +
(Zn) Zinc Level	:	Sufficient
(Ca) Calcium Level	:	Deficient
(Mg) Magnesium Level	:	Sufficient

Application 1:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.1388889 grams/plant

Application 2:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.1388889 grams/plant

Application 3:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.1388889 grams/plant

Application 4:

Complete Fertilizer : (14-14-14)
0.5357143 grams/plant

Urea : (46-0-0)
0.9239131 grams/plant

Solophos : (0-18-0)
0.1388889 grams/plant

Organic Fertilizer

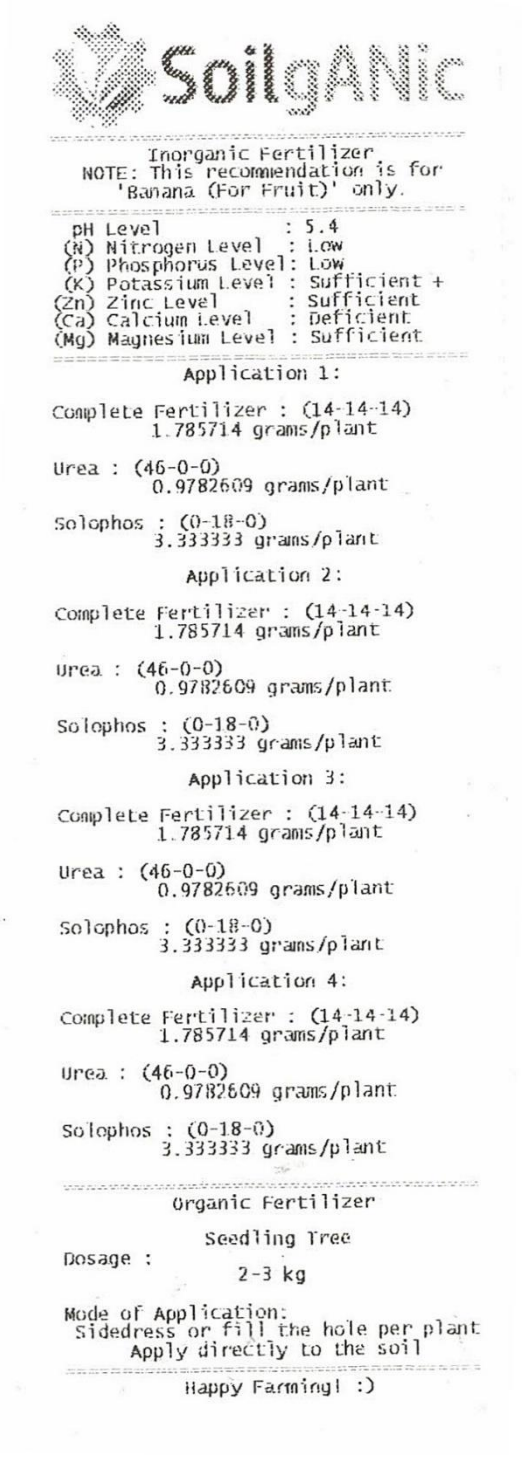
Seedling Tree

Dosage :
2-3 kg

Mode of Application:
Sidedress or fill the hole per plant
Apply directly to the soil

Happy Farming! :)

Printed result of soil sample 16


SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Banana (For Fruit)' only.

pH Level : 5.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Deficient
(Mg) Magnesium Level : Sufficient

Application 1:

Complete Fertilizer : (14-14-14)
1.785714 grams/plant

Urea : (46-0-0)
0.9782609 grams/plant

Solophos : (0-18-0)
3.333333 grams/plant

Application 2:

Complete Fertilizer : (14-14-14)
1.785714 grams/plant

Urea : (46-0-0)
0.9782609 grams/plant

Solophos : (0-18-0)
3.333333 grams/plant

Application 3:

Complete Fertilizer : (14-14-14)
1.785714 grams/plant

Urea : (46-0-0)
0.9782609 grams/plant

Solophos : (0-18-0)
3.333333 grams/plant

Application 4:

Complete Fertilizer : (14-14-14)
1.785714 grams/plant

Urea : (46-0-0)
0.9782609 grams/plant

Solophos : (0-18-0)
3.333333 grams/plant

Organic Fertilizer

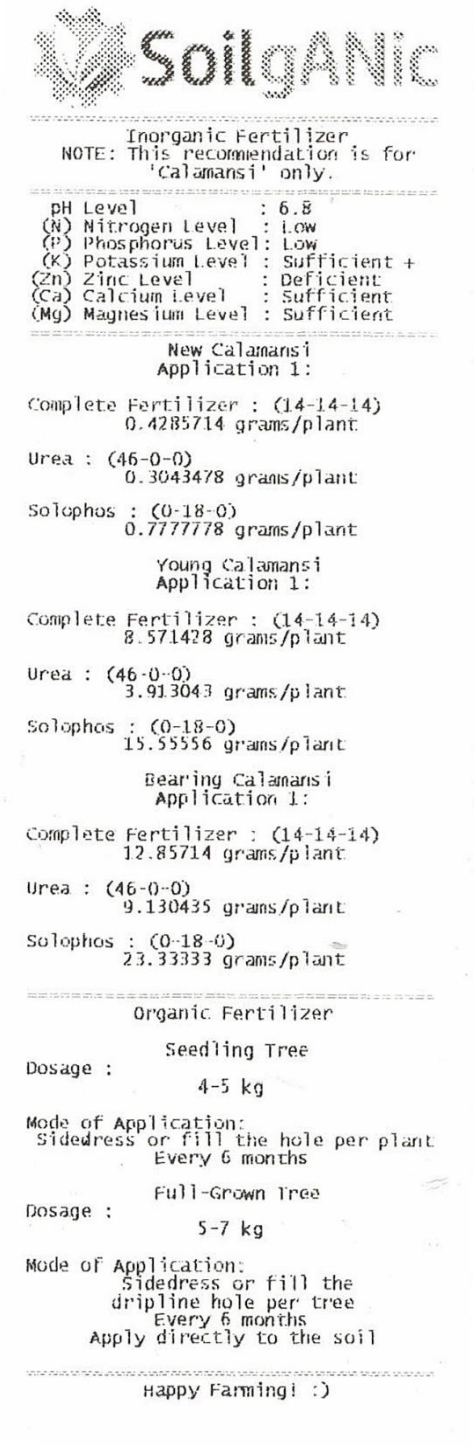
Seedling Tree

Dosage :
2-3 kg

Mode of Application:
Sidedress or fill the hole per plant
Apply directly to the soil

Happy Farming! :)

Printed result of soil sample 17


SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Calamansi' only.

pH Level : 6.8
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient +
(Zn) Zinc Level : Deficient
(Ca) Calcium Level : Sufficient
(Mg) Magnesium Level : Sufficient

New Calamansi
Application 1:

Complete Fertilizer : (14-14-14)
0.4285714 grams/plant

Urea : (46-0-0)
0.3043478 grams/plant

Solophos : (0-18-0)
0.7777778 grams/plant

Young Calamansi
Application 1:

Complete Fertilizer : (14-14-14)
8.571428 grams/plant

Urea : (46-0-0)
3.913043 grams/plant

Solophos : (0-18-0)
15.55556 grams/plant

Bearing Calamansi
Application 1:

Complete Fertilizer : (14-14-14)
12.85714 grams/plant

Urea : (46-0-0)
9.130435 grams/plant

Solophos : (0-18-0)
23.33333 grams/plant

Organic Fertilizer

Seedling Tree

Dosage :
4-5 kg

Mode of Application:
Sidedress or fill the hole per plant
Every 6 months

Full-Grown Tree

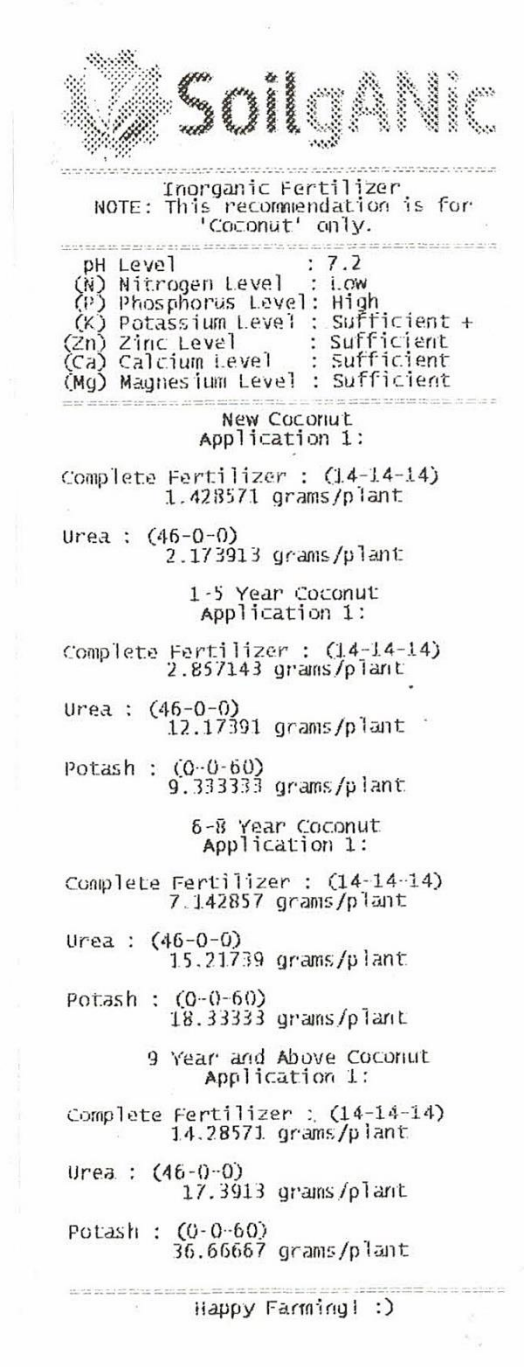
Dosage :
5-7 kg

Mode of Application:
Sidedress or fill the dripline hole per tree
Every 6 months
Apply directly to the soil

Happy Farming! :)

Printed result of soil sample 18

Printed result of soil sample 19



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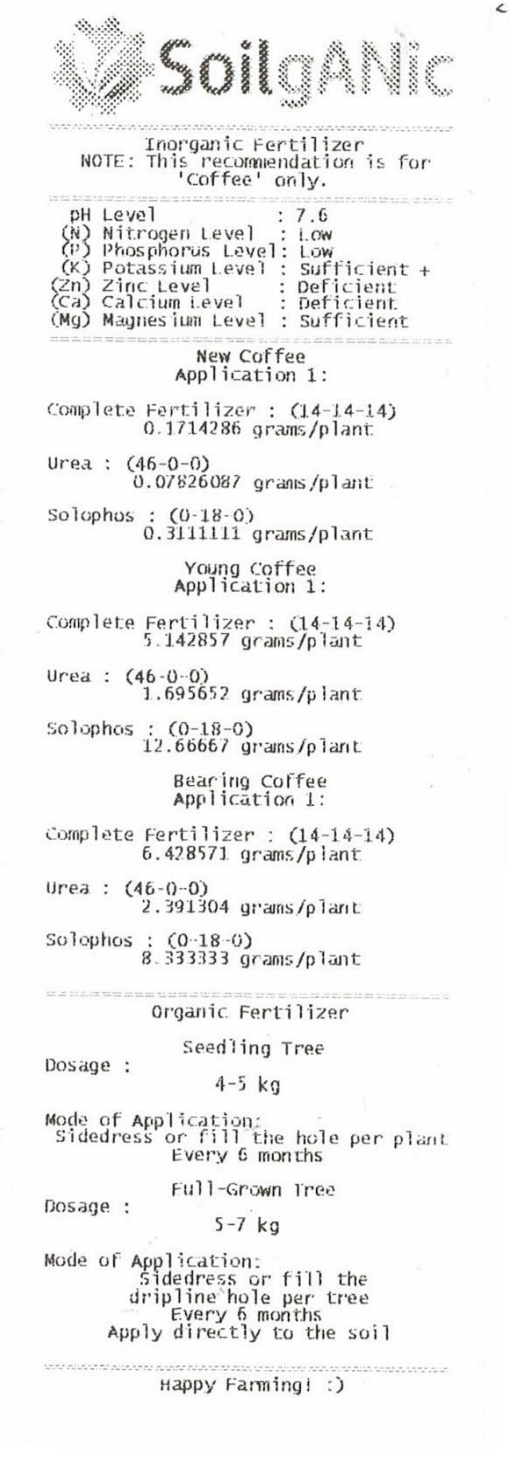


SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Coffee' only.

pH Level	: 7.6
(N) Nitrogen Level	: Low
(P) Phosphorus Level	: Low
(K) Potassium Level	: Sufficient +
(Zn) Zinc Level	: Deficient
(Ca) Calcium Level	: Deficient
(Mg) Magnesium Level	: Sufficient

New Coffee
Application 1:

Complete Fertilizer : (14-14-14)
0.1714286 grams/plant

Urea : (46-0-0)
0.07826087 grams/plant

Solophos : (0-18-0)
0.3111111 grams/plant

Young Coffee
Application 1:

Complete Fertilizer : (14-14-14)
5.142857 grams/plant

Urea : (46-0-0)
1.695652 grams/plant

Solophos : (0-18-0)
12.66667 grams/plant

Bearing Coffee
Application 1:

Complete Fertilizer : (14-14-14)
6.428571 grams/plant

Urea : (46-0-0)
2.391304 grams/plant

Solophos : (0-18-0)
8.333333 grams/plant

Organic Fertilizer

Seedling Tree

Dosage :
4-5 kg

Mode of Application:
Sidedress or fill the hole per plant
Every 6 months

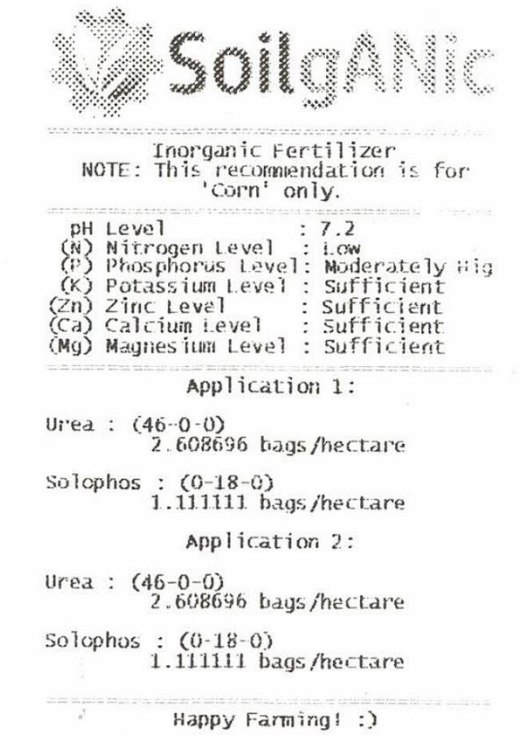
Full-Grown Tree

Dosage :
5-7 kg

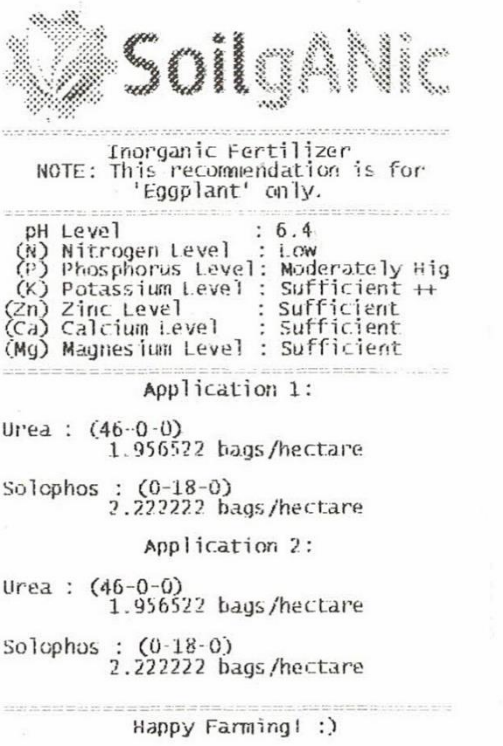
Mode of Application:
Sidedress or fill the dripline hole per tree
Every 6 months
Apply directly to the soil

Happy Farming! :)

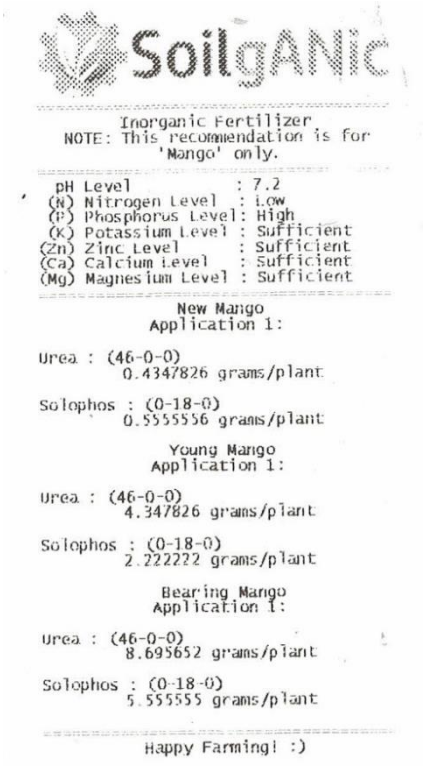
Printed result of soil sample 21



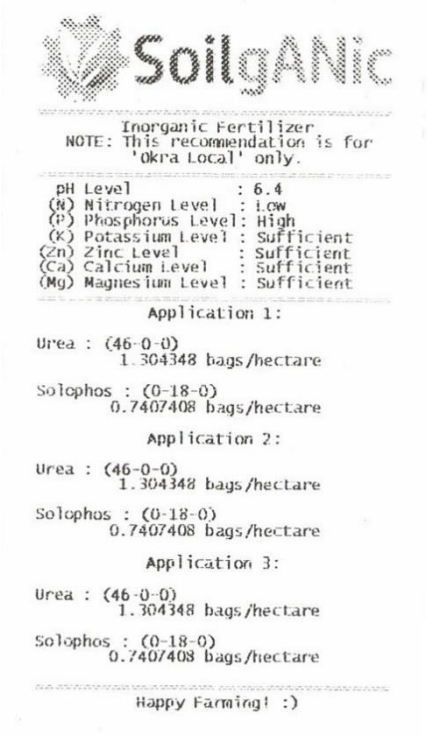
Printed result of soil sample 22



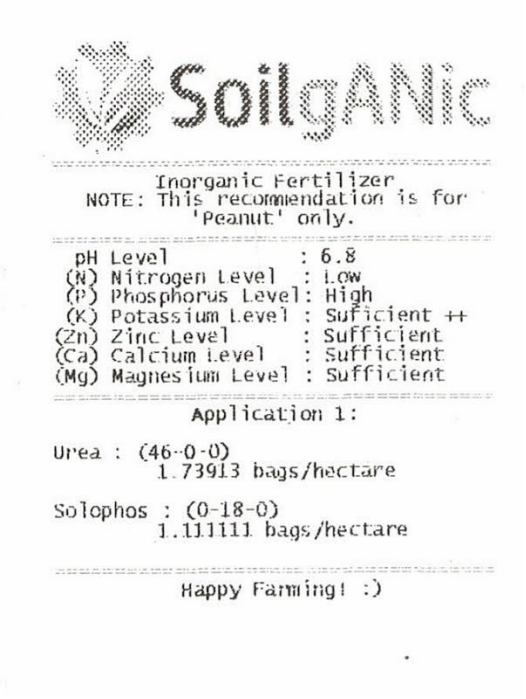
Printed result of soil sample 23



Printed result of soil sample 24



Printed result of soil sample 25



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Peanut' only.

pH Level	: 6.8
(N) Nitrogen Level	: Low
(P) Phosphorus Level	: High
(K) Potassium Level	: Suficient ++
(Zn) Zinc Level	: Sufficient
(Ca) Calcium Level	: Sufficient
(Mg) Magnesium Level	: Sufficient

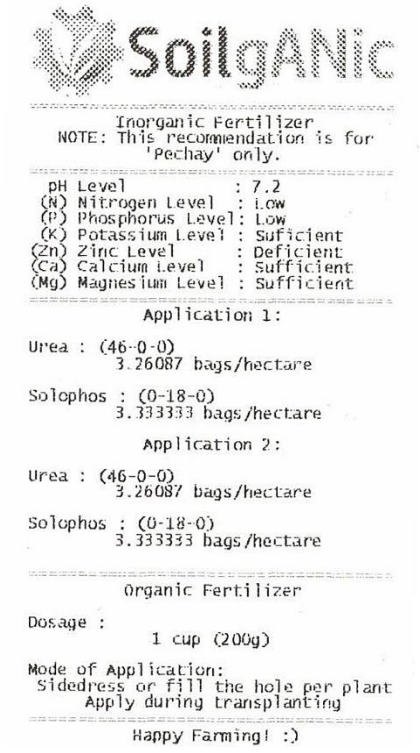
Application 1:

Urea : (46-0-0)
1.73913 bags/hectare

Solophos : (0-18-0)
1.111111 bags/hectare

Happy Farming! :)

Printed result of soil sample 26



SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Pechay' only.

pH Level	: 7.2
(N) Nitrogen Level	: Low
(P) Phosphorus Level	: Low
(K) Potassium Level	: Suficient
(Zn) Zinc Level	: Deficient
(Ca) Calcium Level	: Sufficient
(Mg) Magnesium Level	: Sufficient

Application 1:

Urea : (46-0-0)
3.26087 bags/hectare

Solophos : (0-18-0)
3.333333 bags/hectare

Application 2:

Urea : (46-0-0)
3.26087 bags/hectare

Solophos : (0-18-0)
3.333333 bags/hectare

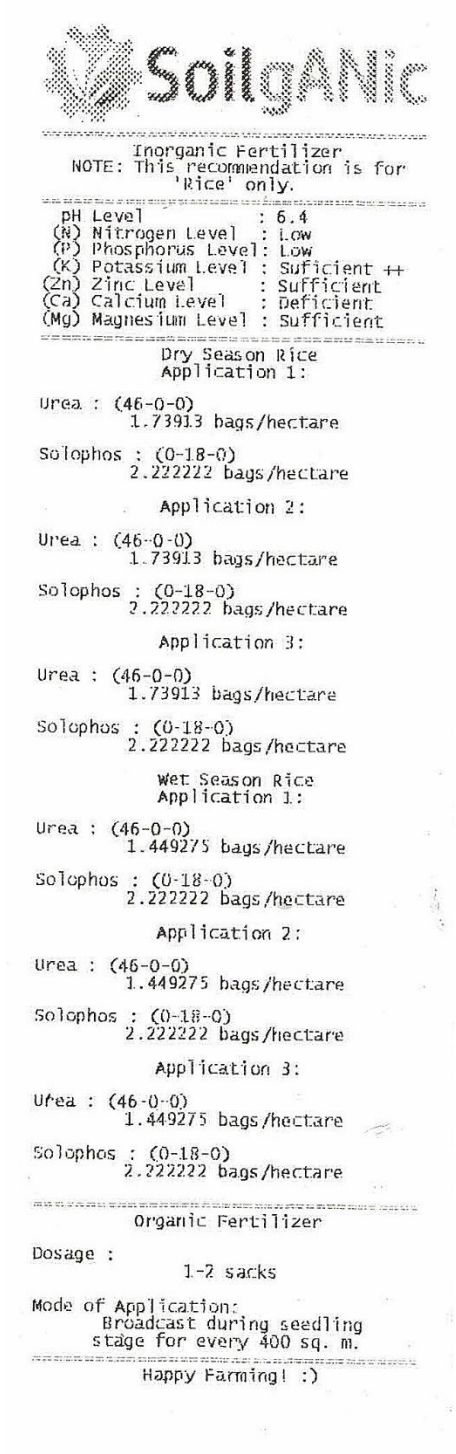
Organic Fertilizer

Dosage :
1 cup (200g)

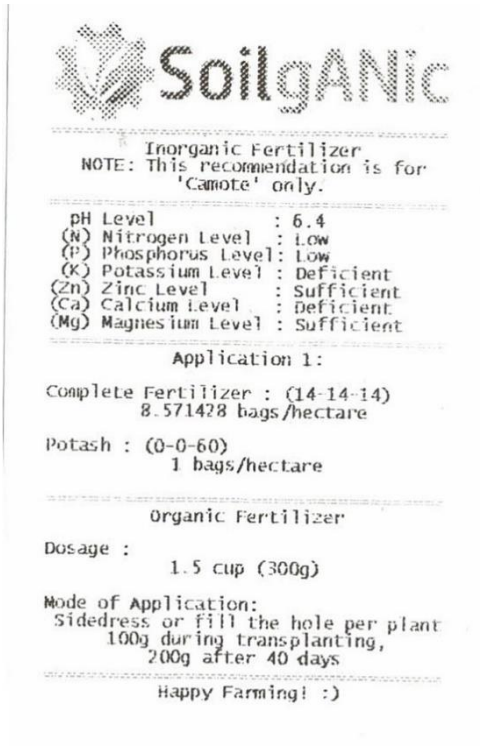
Mode of Application:
Sidedress or fill the hole per plant
Apply during transplanting

Happy Farming! :)

Printed result of soil sample 27



Printed result of soil sample 28


SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Camote' only.

pH Level : 6.4
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Deficient
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Deficient
(Mg) Magnesium Level : Sufficient

Application 1:

Complete Fertilizer : (14-14-14)
8.571428 bags/hectare

Potash : (0-0-60)
1 bags/hectare

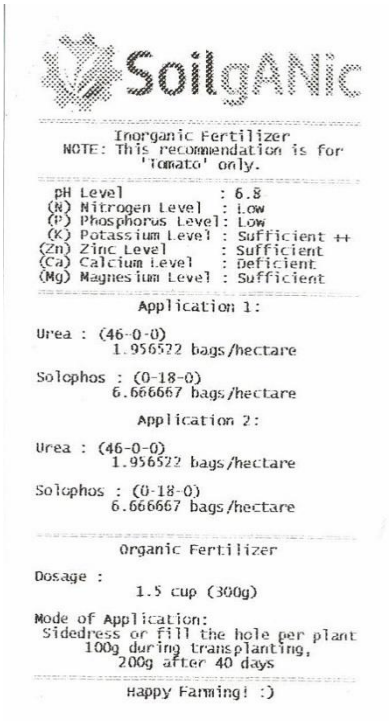
Organic Fertilizer

Dosage :
1.5 cup (300g)

Mode of Application:
Sidedress or fill the hole per plant
100g during transplanting,
200g after 40 days

Happy Farming! :)

Printed result of soil sample 29


SoilgANic

Inorganic Fertilizer
NOTE: This recommendation is for 'Tomato' only.

pH Level : 6.8
(N) Nitrogen Level : Low
(P) Phosphorus Level: Low
(K) Potassium Level : Sufficient ++
(Zn) Zinc Level : Sufficient
(Ca) Calcium Level : Deficient
(Mg) Magnesium Level : Sufficient

Application 1:

Urea : (46-0-0)
1.956522 bags/hectare

Solophos : (0-18-0)
6.666667 bags/hectare

Application 2:

Urea : (46-0-0)
1.956522 bags/hectare

Solophos : (0-18-0)
6.666667 bags/hectare

Organic Fertilizer

Dosage :
1.5 cup (300g)

Mode of Application:
Sidedress or fill the hole per plant
100g during transplanting,
200g after 40 days

Happy Farming! :)

Printed result of soil sample 30

Appendix H – Datasheets

Appendix I – Documentation

Appendix I – Documentation

Research at BSWM and Interview with Ms. Agnes Morada and Ms. Beatriz Magno

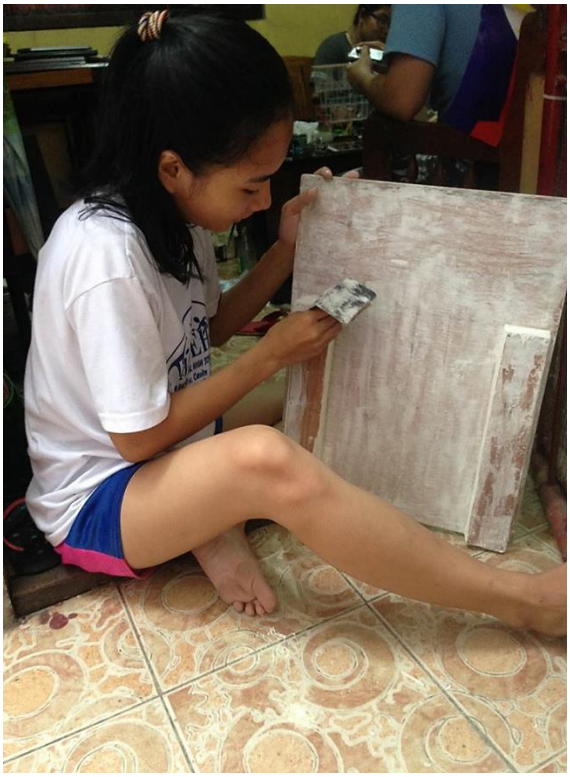
Training for Conventional Soil Testing with Ms. Agnes Morada

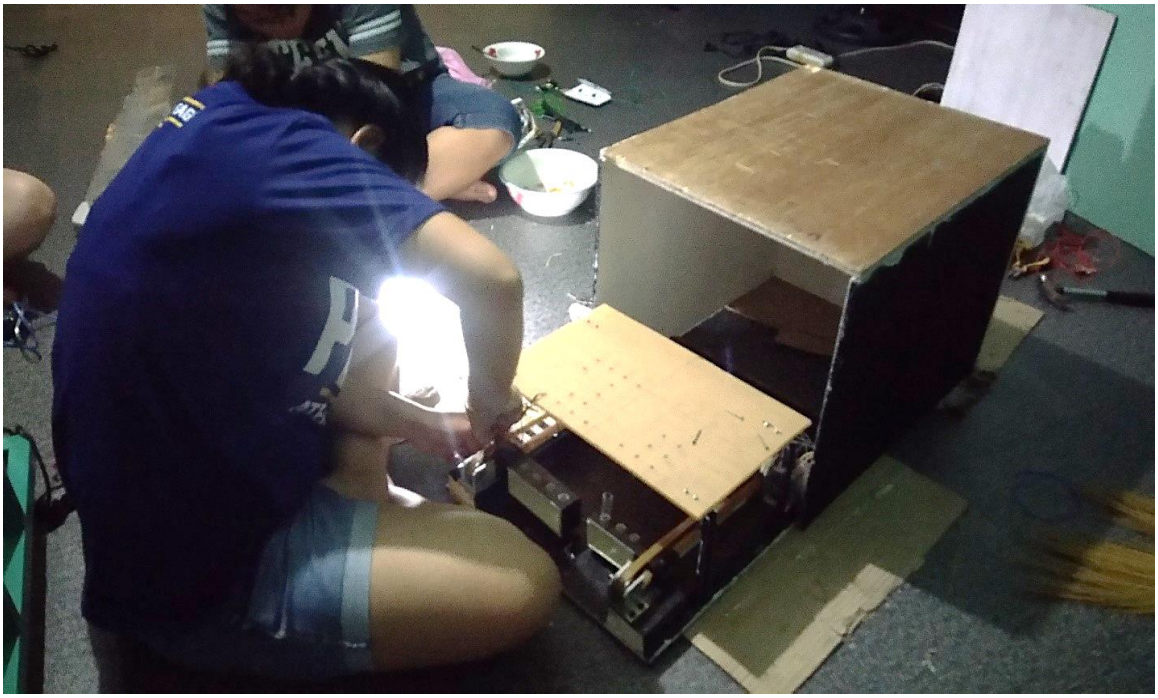
Alfonso Land Visitation and Familiarization

Interview and Project Discussion with Mr. Winifred Vidallon

Land Sizing and Preparation

Prototype Making





Project Testing and Initial Data Gathering

Final Data Gathering and Project Evaluation with Ms. Agnes Morada

Title Defense

Progress Defense

Final Defense

APPRECIATE

Appendix J – Curriculum Vitae

KRISTINE JOY B. AGNAS

CONTACT

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AFFILIATION

Institute of Electronics Engineers of the Philippines
Member, 2014 – Present

Organization of Electronics Engineering Students
Member, 2014 – Present

PERSONAL INFORMATION

Date of Birth
December 5, 1994

Place of Birth
Pasay City

Civil Status
Single

Nationality
Filipino

EDUCATIONAL BACKGROUND

Bachelor of Science in Electronics Engineering
Technological University of the Philippines – Manila
2014 – Present

Electronics Engineering Technology
Technological University of the Philippines – Manila
2010 – 2014

WORK EXPERIENCE

World Electricalmech System Management Incorporated
Cadet Engineer
640-Hours Supervised Industrial Training
April – September 2013

Civil Aviation Authority of the Philippines (CAAP)
240-Hours Supervised Industrial Training
November – December 2017

SEMINARS ATTENDED

Calculator Techniques for ECE Board Exam
Technological University of the Philippines – Manila
November 29, 2016

Auxiliary Design and Introduction to Surface Mount Technology (SMT)
Angeles City. Pampanga
January 16, 2017

Failure Mechanism of Integrated Circuits and Introduction to Place and Route (RTL to GDS2)
Technological University of the Philippines – Manila
January 30, 2017

ECE Board Exam Awareness
Technological University of the Philippines – Manila
January 30, 2017

SHERYL ANNE M. BAUTISTA

CONTACT

**266 Pag-Asa Subdivision,
Bucandala IV,
City of Imus, Cavite**

sheshebautista@gmail.com

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AFFILIATION

Institute of Electronics Engineers of the Philippines
Member, 2014 – Present

Organization of Electronics Engineering Students
Member, 2014 – Present

PERSONAL INFORMATION

Date of Birth
June 29, 1994

Place of Birth
Bacolod City, Negros Occidental

Civil Status
Single

Nationality
Filipino

EDUCATIONAL BACKGROUND

Bachelor of Science in Electronics Engineering
Technological University of the Philippines – Manila
2014 – Present

Electronics Engineering Technology
Technological University of the Philippines – Cavite
2010 – 2014

WORK EXPERIENCE

Enomoto Philippine Manufacturing Incorporated
Assistant Inspector
640-Hours Supervised Industrial Training
November 2013 – February 2014

Gatepacific Circuits, Inc.
Junior PCB Designer
April – May 2014

Ventureslink Manpower Agency
Vote Counting Machine (VCM) Technician – Presidential Election
May 9, 2016

Technological University of the Philippines – Manila
Student Assistant (University Extension Services Office)
January – March 2017

Civil Aviation Authority of the Philippines (CAAP)
240-Hours Supervised Industrial Training
November – December 2017

SEMINARS ATTENDED

Calculator Techniques for ECE Board Exam
Technological University of the Philippines – Manila
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Auxiliary Design and Introduction to Surface Mount Technology (SMT)
Angeles City. Pampanga
January 16, 2017

Failure Mechanism of Integrated Circuits and Introduction to Place and Route (RTL to GDS2)
Technological University of the Philippines – Manila
January 30, 2017

ECE Board Exam Awareness
Technological University of the Philippines – Manila
January 30, 2017

NODEBELLE C. BULE

CONTACT

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nodibhelle@gmail.com

+63 977 703 7006

AFFILIATION

Institute of Electronics Engineers of the Philippines
Member, 2014 – Present

Organization of Electronics Engineering Students
Member, 2014 – Present

PERSONAL INFORMATION

Date of Birth
April 3, 1994

Place of Birth
Quezon City

Civil Status
Single

Nationality
Filipino

EDUCATIONAL BACKGROUND

Bachelor of Science in Electronics Engineering
Technological University of the Philippines – Manila
2014 – Present

Electronics Engineering Technology
Technological University of the Philippines – Cavite
2010 – 2014

WORK EXPERIENCE

Enomoto Philippine Manufacturing Incorporated
Assistant Inspector
640-Hours Supervised Industrial Training
November 2013 – February 2014

Gatepacific Circuits, Inc.
Junior PCB Designer
April – May 2014

Technological University of the Philippines – Manila
Student Assistant (Library)
January – March 2017

Civil Aviation Authority of the Philippines (CAAP)
240-Hours Supervised Industrial Training
November – December 2017

SEMINARS ATTENDED

Calculator Techniques for ECE Board Exam
Technological University of the Philippines – Manila
November 29, 2016

Auxiliary Design and Introduction to Surface Mount Technology (SMT)
Angeles City. Pampanga
January 16, 2017

Failure Mechanism of Integrated Circuits and Introduction to Place and Route (RTL to GDS2)
Technological University of the Philippines – Manila
January 30, 2017

ECE Board Exam Awareness
Technological University of the Philippines – Manila
January 30, 2017

CECILE P. PRADO

CONTACT

Blk 3 Lot 14 New Better Landscape Subd. Molino I, Bacoor, Cavite

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AFFILIATION

Institute of Electronics Engineers of the Philippines
Member, 2014 – Present

Organization of Electronics Engineering Students
Member, 2014 – Present

PERSONAL INFORMATION

Date of Birth
December 12, 1994

Place of Birth
Parañaque

Civil Status
Single

Nationality
Filipino

EDUCATIONAL BACKGROUND

Bachelor of Science in Electronics Engineering
Technological University of the Philippines – Manila
2014 – Present

Electronics Engineering Technology
Technological University of the Philippines – Manila
2010 – 2014

WORK EXPERIENCE

Toyota Motor Philippines Corporation
Material Handling Operations
640-Hours Supervised Industrial Training
April – September 2013

Ventureslink Manpower Agency
Vote Counting Machine (VCM) Technician – Presidential Election
May 9, 2016

Civil Aviation Authority of the Philippines (CAAP)
240-Hours Supervised Industrial Training
November – December 2017

SEMINARS ATTENDED

Calculator Techniques for ECE Board Exam
Technological University of the Philippines – Manila
November 29, 2016

Auxiliary Design and Introduction to Surface Mount Technology (SMT)
Angeles City. Pampanga
January 16, 2017

Failure Mechanism of Integrated Circuits and Introduction to Place and Route (RTL to GDS2)
Technological University of the Philippines – Manila
January 30, 2017

ECE Board Exam Awareness
Technological University of the Philippines – Manila
January 30, 2017

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CONTACT

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edwardsolomon16@gmail.com

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AFFILIATION

Institute of Electronics Engineers of the Philippines
Member, 2016 – Present

Organization of Electronics Engineering Students
Member, 2013 – Present

PERSONAL INFORMATION

Date of Birth
September 16, 1996

Place of Birth
San Jose Del Monte Bulacan

Civil Status
Single

Nationality
Filipino

EDUCATIONAL BACKGROUND

Bachelor of Science in Electronics Engineering
Technological University of the Philippines – Manila
2013 – Present

WORK EXPERIENCE

Trends and Technologies Inc.
240-Hours Supervised Industrial Training
November – December 2017

SEMINARS ATTENDED

Expanding Electronics Engineers' Horizon
IRTC Conference Hall, TUP Manila
July 23, 2013

Bakit ECE? Eh meron namang iba.
IRTC Conference Hall, TUP Manila
March 5, 2014

Engineering Leadership Conference 2018
Melchor Hall, University of the Philippines Diliman
January 27, 2018

Data Science Congress 2018
Data Science Skills: A key to Global Competitiveness
Topic: Big Data Analytics
Tanghalang Pasigueño, Pasig City Philippines
Feb 25, 2018

Data Science Congress 2018
Data Science Skills: A key to Global Competitiveness
Topic: Internet of things
Tanghalang Pasigueño, Pasig City Philippines
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