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SOIL NUTRIENT DETECTOR FOR CROP PRODUCTION OPTIMIZATION WITH MOBILE APPLICATION

Engr. Dennis S. Tibe, MIT

Leyte Normal University, Tacloban City, Leyte, Philippines

ABSTRACT

Farmers and gardeners have worked with their soils over many centuries to produce increasing amounts of food to keep pace with the needs of a burgeoning world population. The aim of this study was to develop a device and an android application that will detect the available nutrients of the soil for the increase in crop production and to provide accurate information for the suitable crop to grow in the field. The descriptive and developmental research method was used in this study. There were 32 farmers from the Association of farmers in Paranas, Western Samar (AFPWS) and the Department of Agriculture – Paranas. 25 farmers and 7 employees of the Department of Agriculture – Paranas were interviewed and given questionnaires for their experiences in using the mobile application and the soil nutrient detector. Findings indicated that the mobile application and the device were cost-effective and give the farmers the chance to save time and effort in detecting the nutrient available in the soil and what crop is best suited to plant in their areas. It also improved the task efficiently and conveniently between them. Using other sensors that are more accurate can be replaced in the existing device.

Keywords: Android Application; Mobile Application; Soil Nutrient; Device; Sensor; Information

INTRODUCTION

Farmers and gardeners have worked with their soils over many centuries to produce increasing amounts of food to keep pace with the needs of a burgeoning world population. The soil's natural cycles go a long way in ensuring that the soil can provide an adequate physical, chemical and biological medium for crop growth. The farmer and horticulturalists have also become skilled in managing soils so that these natural cycles can be added to as necessary to facilitate adequate soil support and increasing yield to enhance production.

Smartphones have become a useful tool in agriculture because their mobility matches the nature of farming, the cost of the device is highly accessible, and their computing power allows a

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variety of practical applications to be created. Moreover, smartphones are nowadays equipped with various types of physical sensors which make them a promising tool to assist diverse farming tasks. This shows an opportunity for future applications to utilize other sensors such as an accelerometer to provide advanced agricultural solutions.

The reason that the "Soil Nutrient Detector for Crop Production Optimization through Mobile Application" was developed is to solve this particular problem of the farmers in Paranas since soil nutrient detector is the best way to check the growing potential of our garden or field and to know the qualities the soil should have. Agricultural information is a key component in improving small-scale agricultural production and linking increased production to remunerative markets, thus leading to improved rural livelihoods, food security, and national economies. Improvement of agricultural productivity will be realized when farmers are linked to market information. There have been quite a few studies that explored how mobile phones impact the livelihood of farmers (Rashid and Elder, 2009). Correspondingly, a positive view that mobile phones offer good value for money appears to support the uptake of mobile phone applications. The importance of knowledge and information sharing in research for development (R4D) settings has been firmly established through research. Access to appropriate information and knowledge is an overriding factor for successful natural resource management (NRM) planning, implementation, and evaluation processes, and it is known to be one of the most determinants of agricultural productivity. Knowledge and innovation are now widely regarded as key drivers of economic growth and it is clear that information and communication technologies (ICTs) are deeply implicated in knowledge flow and innovation (Verlaeten, 2002).

Agricultural production is vital for feeding the human population. Production of crops, however, show variation in space and time due to changes in weather conditions, different management practices, and other external factors. Information on the day-to-day factors influencing crop growth has been important for farmers for ages. In the past farmers mainly used direct human observations to recognize these factors. In the last decades, however, more and more automatic sensor systems such as soil moisture sensors, weather stations, and satellite or airborne sensors have been adopted. Automatic sensors and sensor networks enable local and (near) real-time observations and monitoring, and may foster more sustainable crop production practices and, thus, lower negative environmental impacts of agriculture and food safety risks. Sensor and communication technology has quickly developed from off-line sensors using field loggers and manual downloading to wireless on-line sensor networks and is moving toward interoperable and autonomous sensor webs. This sensor web concept is based on the Sensor Web Enablement (SWE) framework of the Open Geospatial Consortium (OGC). Within this framework, standard protocols, interfaces and web services to discover, task, exchange and process data from different sensors and sensor networks have been defined. Geo-sensors were loosely defined by Nittel et al.

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in 2008 as sensors that monitor phenomenon in a geographical place. Until now the development of sensors and sensor networks has mainly been driven by technological innovations. However, this technological push has been supported by growing needs for food and fiber, demands for reducing environmental effects of agriculture and concerns over food safety. Also increasing competition in the global food market and decreasing profitability of European farms have been seen to support adoption of new technology in the farms.

OBJECTIVES OF THE STUDY

The general objective of the study was to develop a device and an android application that will detect the available nutrients of the soil for an increase in crop production and to provide accurate information for the suitable crop to grow in the field.

Specifically, this study aims to answer the following objectives:

1. Develop a device that will detect the available nutrients in the soil for farming.
2. Design a mobile application that will give accurate information to the farmers the soil nutrient available in the field where they grow their crops
3. Provide near-real-time crop and soil information and good advice for crop quality and yield improvement in crop production.

CONCEPTUAL FRAMEWORK OF THE STUDY

The conceptual framework as shown in figure 1 shows the schema of how the proponents conceptualized the flow of the conducted study. The bottom box of the figure shows the respondents of the system, which were the Association of Farmers of the Department of Agriculture in Paranas, Samar. The Farmers do not have the basic data on agricultural land resources and soil quality since its islands landform and soils, the extent of soil degradation brought about by climate change and farmers activities. In fact, the local government unit and even the national government offices do not have an updated profile of its land use more so an updated profile of soil characteristics cultivated by farmers.

The next box represents the proposed system of the research regarding the function of the system on how it helped the respondents in the detection of available soil nutrients. To detect soil nutrients, the device must connect to the Mobile Application, then the result will be sent to the application and displayed on the screen. The next box shows the findings, conclusion, a recommendation regarding the feedback of the evaluated system of the respondents. The results of the system were evaluated effective of the respondents based on the accuracy and reliability of the system and at the topmost box was the effectiveness of Soil Nutrient Detector for Crop

Production Optimization with Mobile Application that has been concluded according to the findings of the study.

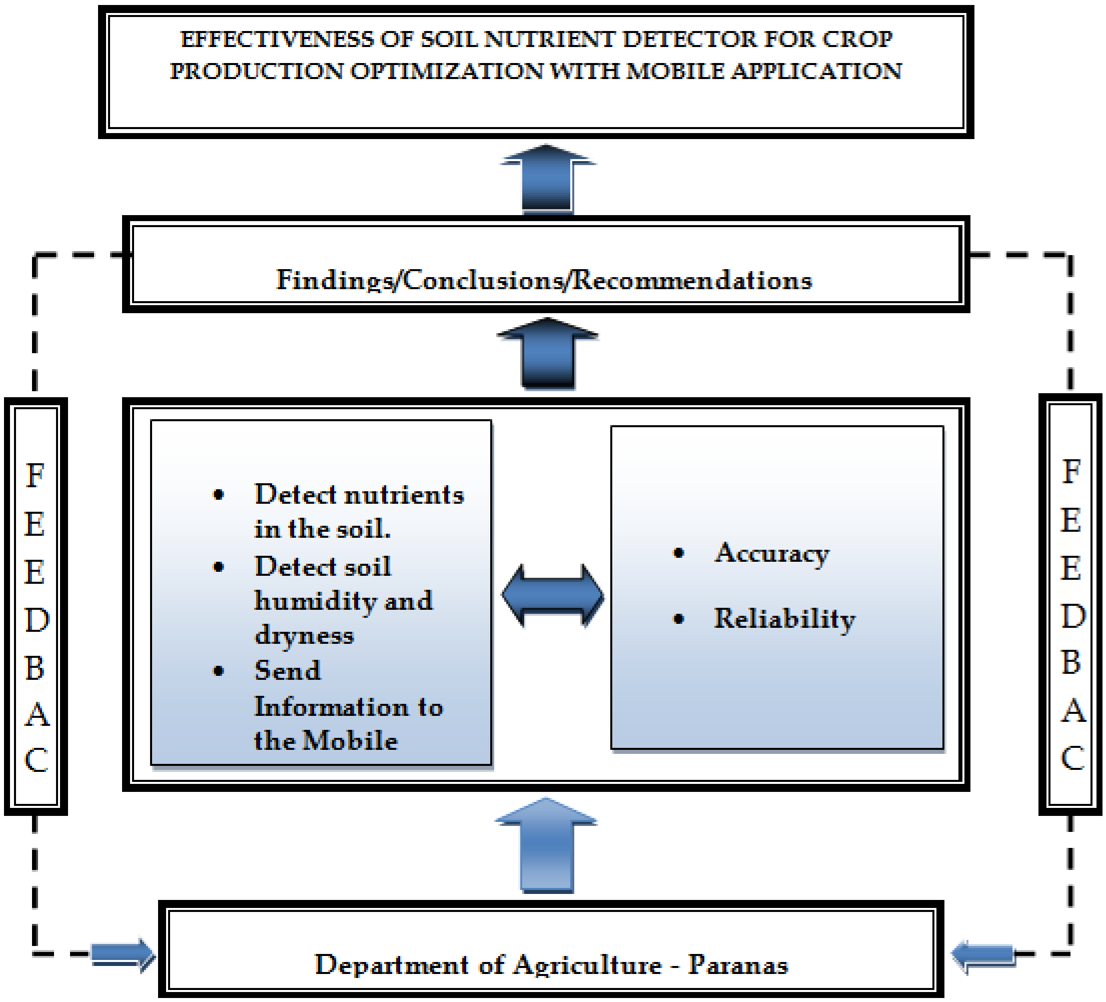

Figure 1: Conceptual Framework of the Study

MATERIALS AND METHODS

Collecting data requires a series of methods and procedures to be done, the researcher followed a standard process in conducting all the steps necessary to analyze and design the system.

Research Locale

The respondents of the said project are the Association of Farmers in Paranas Western Samar and the Department of Agriculture-Paranas.

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Development of the product

The researcher noticed that today's main concern of the society is the issue in the advancement of environmental deterioration. One of the major problems the society is facing nowadays is the increase in demand in the food supply and the limited crop resources. The research conducted the interview in the Department of Agriculture- Paranas about the current system to help solve the issue.

The interview was conducted to identify the deficiency of manual process in farming and propose a solution to enhance and increase crop production. Moreover, the researcher gathered the necessary information to establish an accurate and effective approach to developing the system.

Data Gathering Procedure

An observation was conducted to gather information about the way of farming done by the farmers. The observation helps a lot in find how the system will be designed to improve the current system in farming.

System Development Life Cycle method was used in the development of the software product. The sequential phases in Waterfall model are Requirement Gathering and Analysis, System Design, Implementation, Integration and Testing, Deployment of System and Maintenance.

Questionnaires were also used to conduct interviews as the main instrument of data gathering. These were supplemented by other methods such as, personal interviews and actual observation in verifying some initial information and responses that was gathered through the use of the main instrument. The researcher determined and analyzed the results of the survey in order to identify the problem and solutions given by the respondents to come up with a good and effective Soil Nutrient Detector Device with Mobile Application for Crop Production Optimization.

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Waterfall Model Diagram (SDLC)

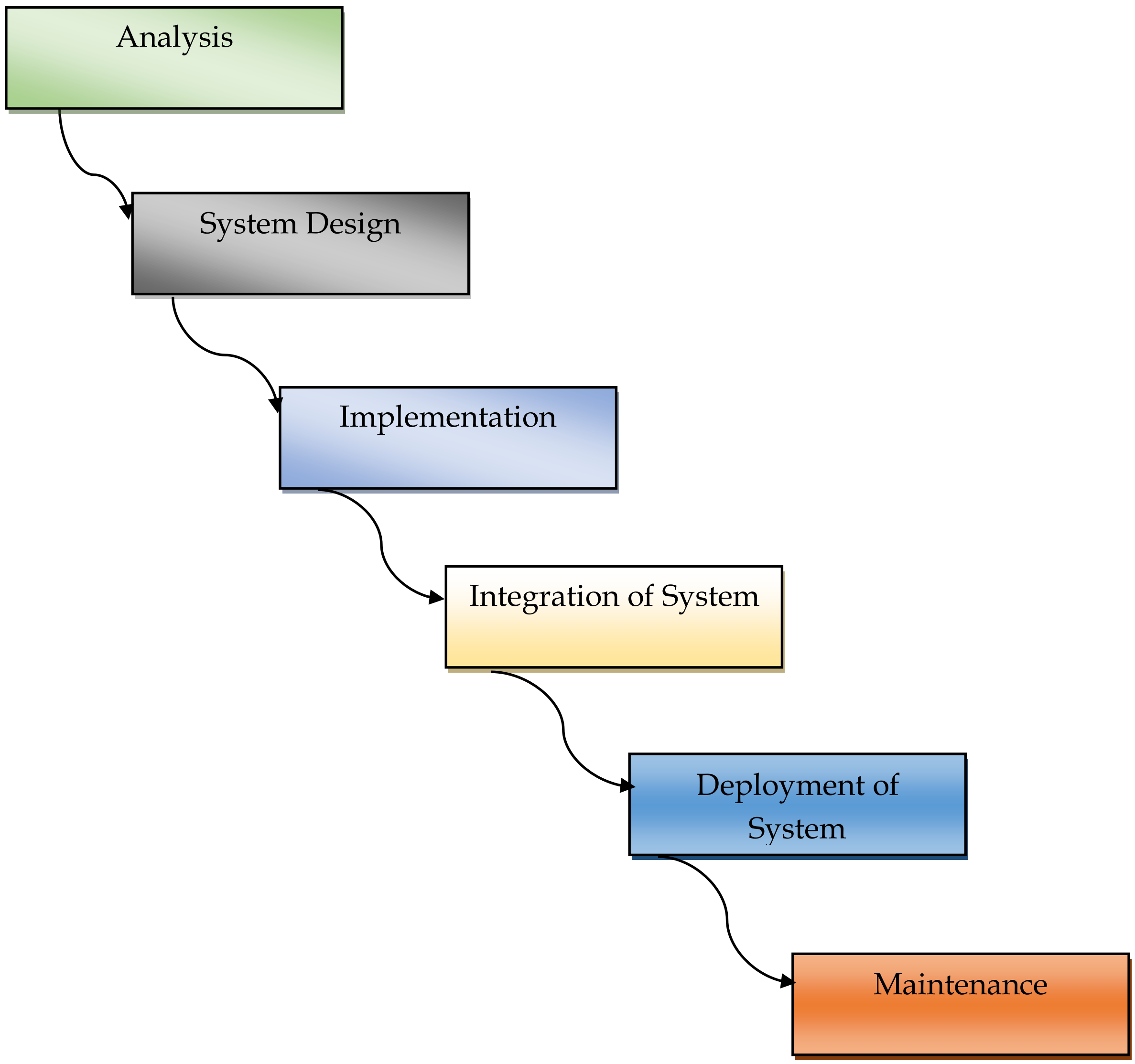

Figure 2: Waterfall Model Diagram

Requirement Analysis. In this phase, the researcher gathered information about the current manual system of producing crops. It was found out that there were many farmers using the traditional way of farming, wherein they do not undergo soil testing for their crop yield. To solve the problem, the researcher came with a solution in creating a device and a mobile application that will detect the soil nutrient available in the area where they grow their crops to maximize their crop production.

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System Design. The researcher designed a device that will be capable of detecting the soil nutrient of the soil and capable of transferring the data obtained from the sensor.

Implementation. It deals with the inputs from system design, the system is developed in small programs called units, which are integrated into the next phase. Each unit is developed and tested for its functionality.

Integration of System. In this phase, the changeover of the new system, from manual to improved system has been migrated. The device will be tested to ensure the effectiveness of the system and that the design was meet specifically. The entire system is tested for any faults and failures.

Deployment of System. Once the system is completed and free from errors and bugs. It will be deployed in the customer environment or in the market.

Maintenance. It deals with the continuous service and support for improvement to continue it service.

Validation of Instruments

The proponents conducted an interview and gave survey questionnaires to the respondent regarding on the study. The survey questionnaires serve as the assurance of the functionality of the device through the response from the respondents. The evaluation of the respondents serves as a guide if there will be a need to improve the current status of the study.

Statistical treatment of the data

The data through questionnaire were analyzed, evaluated and interpreted. A statistical measure like frequency counts weighted mean and sloven's formula was applied to test the result. The following statistical tools were utilized accordingly.

Frequent Count. This was used in reporting the respondent's evaluations of the product that was evaluated. The number corresponding the tally in the given items under respondent's evaluation is the frequency.

Percentage. This tool was used in the analytical and interpretation of data on sex, age, etc.

$$P=f/n \times 100\%$$

Where:

F= is the frequency

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N= is the population

Mean/Average. This statistical tool was used in determining the qualitative characteristic of the respondents like their age and others.

$$\text{Mean} = \frac{\sum x}{N}$$

Where:

N= number of population
X= sample mean average

Weighted mean. This tool was the most important measure of effectiveness. This formula was used in getting the effectiveness of each item by the respondents.

$$WM = \frac{\sum WiXi}{\sum Wi}$$

Where:

WM = Weighted Mean
$\sum$Xi = Summation of X;
$\sum$Wi = Summation of W;

RESULTS AND DISCUSSIONS

Description of the product

This study primarily focuses on the "Soil Nutrient Detector for crop production optimization with the mobile application". The researcher observed that farmers have work on their farm for many centuries without knowing the soil nutrients available in their soil, they grow their crops without the knowledge which crops are suitable for planting. With this proposed device and mobile application, the farmers will be informed on the available nutrients in their soils and the crops that are suitable to be planted.

The researcher used smartphones to get the result from the device since there are the trending products nowadays. The application is user-friendly since it will no longer require a password to open the application, as long as the device and the application is paired and it will be ready to use.

Evaluation of the Product

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In gathering the questionnaires, the proponents conducted first the dry run with thirty-two farmers as respondents which are the user and who will manipulate the system. The receiver of the information from the system, after that the proponents conduct beta-testing with the respondents as the beneficiaries and users. **The effectiveness of the device "Soil Nutrient Detector for Crop Production Optimization with Mobile Application" as perceived by the respondents.** The researcher used appropriate statistical analysis. This study obtained the feedbacks and opinions of the respondents on the system accuracy and reliability.

Table 1: The effectiveness of the Proposed System Entitled Soil Nutrient Detector for crop Production Optimization with Mobile Application as perceived by the Respondents according to its Accuracy

INDICATOR	Respondents					Total	WM	Interpretation
4.1 ACCURACY	5 (HA)	4 (MA)	3 (A)	2 (LA)	1 (NA)			
The Soil Nutrient Detector can detect the soil nutrients available in the soil.	(135) 27	(20) 5	-	-	-	(155) 32	4.84	HA
The Mobile Application can provide the soil information needed by the user.	(105) 21	(44) 11	-	-	-	(149) 32	5	HA
The Mobile Application can provide the nutrients information needed by the user	(80) 16	(64) 16	-	-	-	(144) 32	4.5	MA
The Mobile Application can provide the crop information needed by the user	(150) 21	(32) 8	(9) 3	-	-	(145) 32	4.53	HA
Total							18.52	
Grand mean							4.63	HA

Legend:	4.51 - 5.00	Highly Accurate (HA)
	3.51 - 4.50	Moderately Accurate (MA)
	2.51 - 3.50	Accurate (A)
	1.51 – 2.50	Less Accurate (LA)
	1.00 – 1.50	Not Accurate (NA)

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Table 1 presents the evaluation of the Department of Agriculture-Paranas respondents on the accuracy of the system. As shown in the table below, the indicator no.1 that states" The Soil Nutrient Detector can detect the soil nutrients available in the soil" got 135 interpreted as highly accurate which means 27 respondents have agreed that the proposed system was helpful to them. The 20 results were from the 5 respondents who mark a checked in MA the total number, all in all, was 155 from 135 added to 20 that lead the results of the weighted mean as 4.85. Indicator number 2 that states "The Mobile Application can provide the soil information needed by the user." got a total of 105 in HA which means 21 respondents were satisfied that the Mobile Application can provide soil information to the user, 11 respondents agreed that the system was moderately accurate in indicator 2. The total number was 149 that lead to 4.65 as the weighted mean which interpreted as HA. Indicator number 3 got a total of 80 in Highly Accurate which means 16 respondents agreed that the system able to provide the soil nutrients information needed by the user and 16 respondents believed that the Mobile Application was Moderately Accurate weighted mean results is 4.5 which interpreted as MA. Indicator number 4 got a sum of 150 which means 21 respondents believed that the system could give accurate crop information, 8 respondents believed that it was moderately accurate and 3 respondents believed that crop information of the system was accurate that got a total of 145 that lead to 4.53 weighted mean which interpreted as HA, and overall, the grand mean was 4.63 interpreted as Highly Accurate which proved that the proposed system was effective in terms of Accuracy.

Table 2: The effectiveness of the Proposed System Entitled Soil Nutrient Detector for crop Production Optimization with Mobile Application as perceived by the Respondents according to its Reliability

INDICATOR 4.2 RELIABILITY	Respondents					Total	WM	Interpretation
	5 (HE)	4 (ME)	3 (E)	2 (LE)	1 (NE			
1. The Mobile tion provides reliable tion	(110 22	(36) 9	-	-	-	(146) 32		HE
2. The device is in sending data to the application	(100 20	(36) 9	9 3	-	-	(145) 32	4.53	ME

3. The mobile ion is error free	(105 21	(44) 11	-	-	-	(149) 32	4.64	HE
4. The system s with less time and effort	(125 25	(28) 7		-	-	(153) 32	4.65	HE
Total							**18.53**	
Grand mean							**4.63**	**HE**

Legend:

4.51 - 5.00	Highly Effective (HE)
3.51 - 4.50	Moderately Effective (ME)
2.51 - 3.50	Effective (E)
1.51 – 2.50	Less Effective (LE)
1.00 – 1.50	Not Effective (NE)

Table 2 presents the evaluation of the Department of Agriculture-Paranas respondents on the reliability of the system. As shown in the table below, the indicator no.1 that states" The Mobile Application provides reliable information" got 110 interpreted as highly effective which means 22 respondents was agreed that the proposed system was reliable. The 36 results were from the 9 respondents who marked a check in ME. The total number all in all was 146 from 110 added to 36 that lead the results of the weighted mean as 4.54. Indicator number 2 that states "The device is reliable in sending data to the Mobile application." got 100 total in HE which means 20 respondents was satisfied that the device is reliable in sending data to the Mobile Application, 9 respondents agreed that the system was moderately effective in indicator 2, and 3 respondents agreed that it was Effective. The total number was 145 that lead to 4.53 as the weighted mean which interpreted as HE. Indicator number 3 got a total of 105 in Highly Effective which means 21 respondents agreed that the Mobile Application is error-free and 11 respondents believed that the Mobile Application was Moderately Effective, weighted mean results is 4.64 which interpreted as HE. Indicator number 4 got a sum of 125 which means 25 respondents believed that the system functions with less time and effort, 7 respondents believed that it was moderately effective that got a total of 153 that lead to 4.65 weighted means which interpreted as HE, and overall, the grand mean was 4.63 interpreted as Highly Effective which proved that the proposed system was effective in terms of Reliability.

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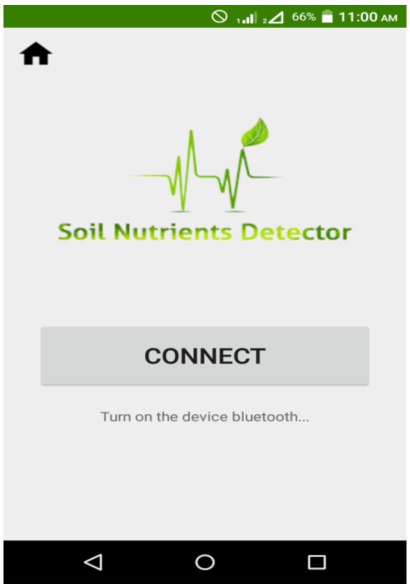
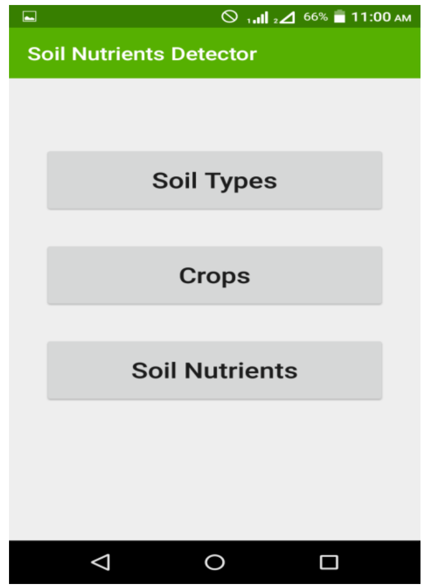
SYSTEM OUTPUT

Mobile Application:

1. The user interface of the mobile application



Home page of the mobile application



2. Soil types category and its soil type description

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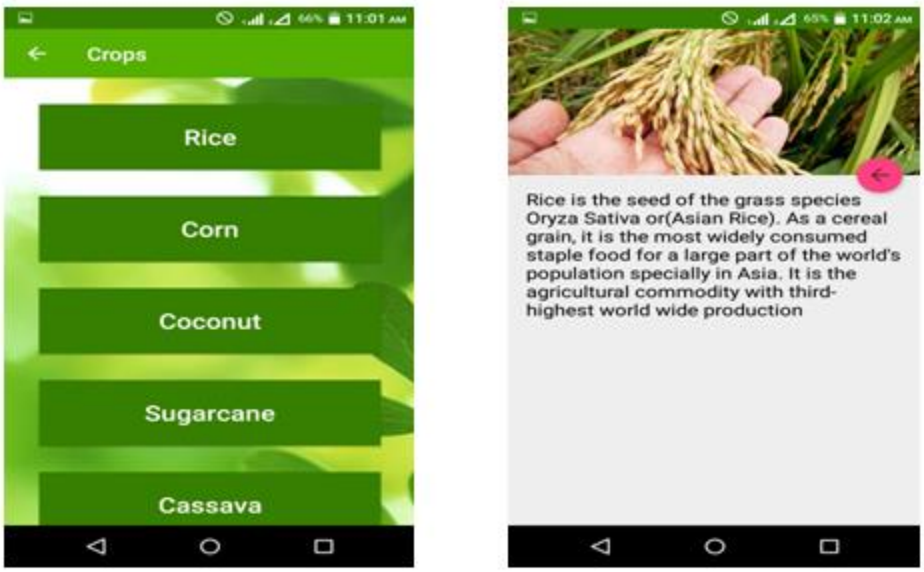
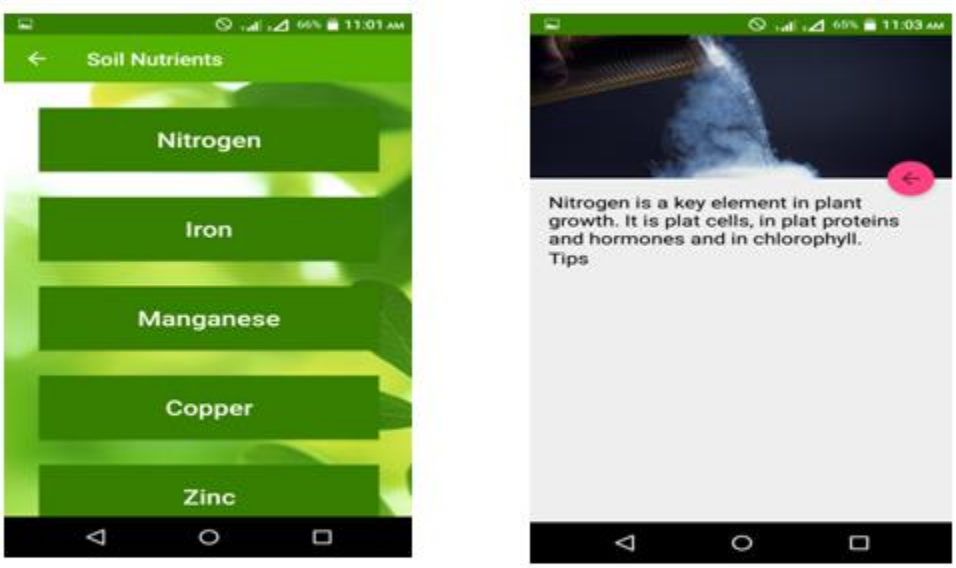
3. Crop Categories and their description



4. Soil nutrients category and their description



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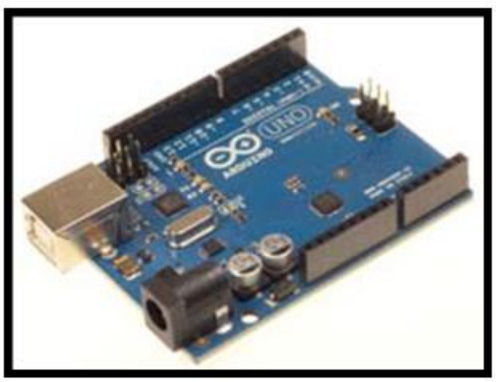
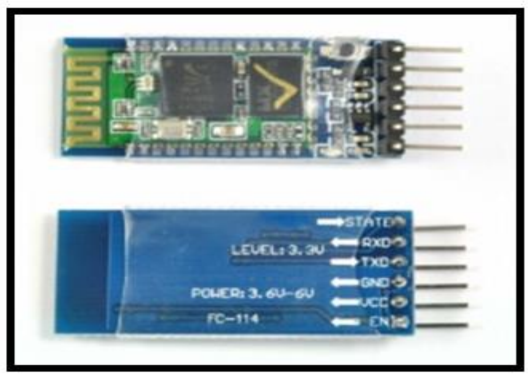
Device:

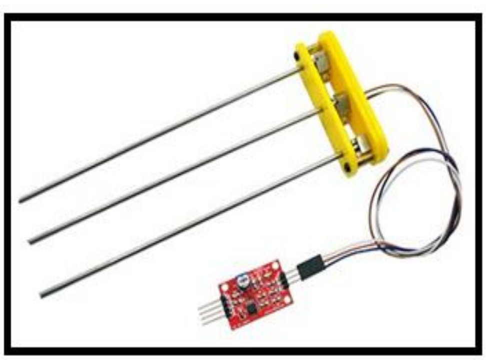
Arduino Uno



Bluetooth Module



Soil Moisture Sensor



Field Effect Sensor

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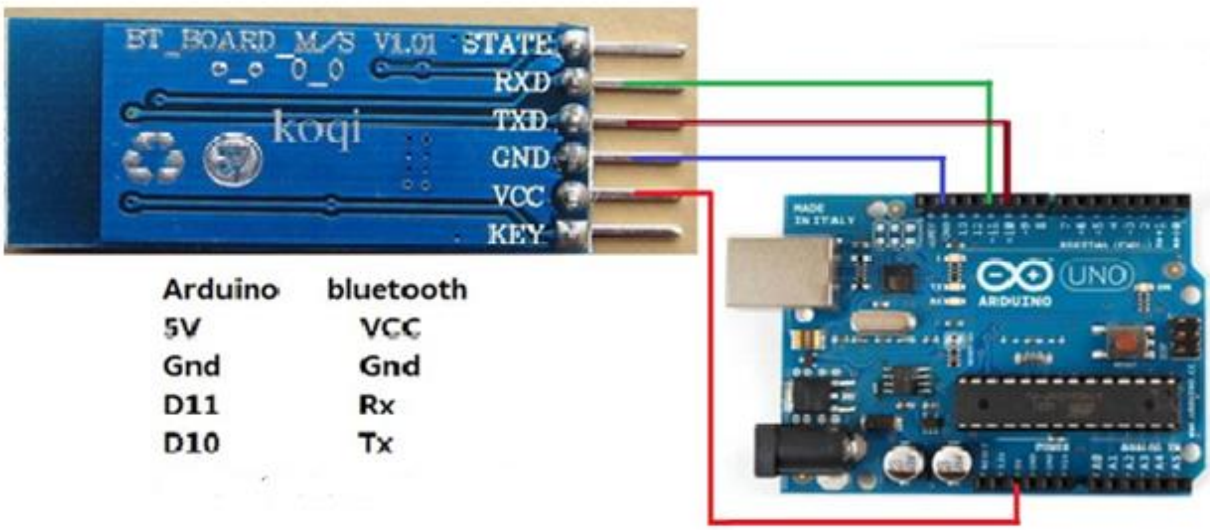
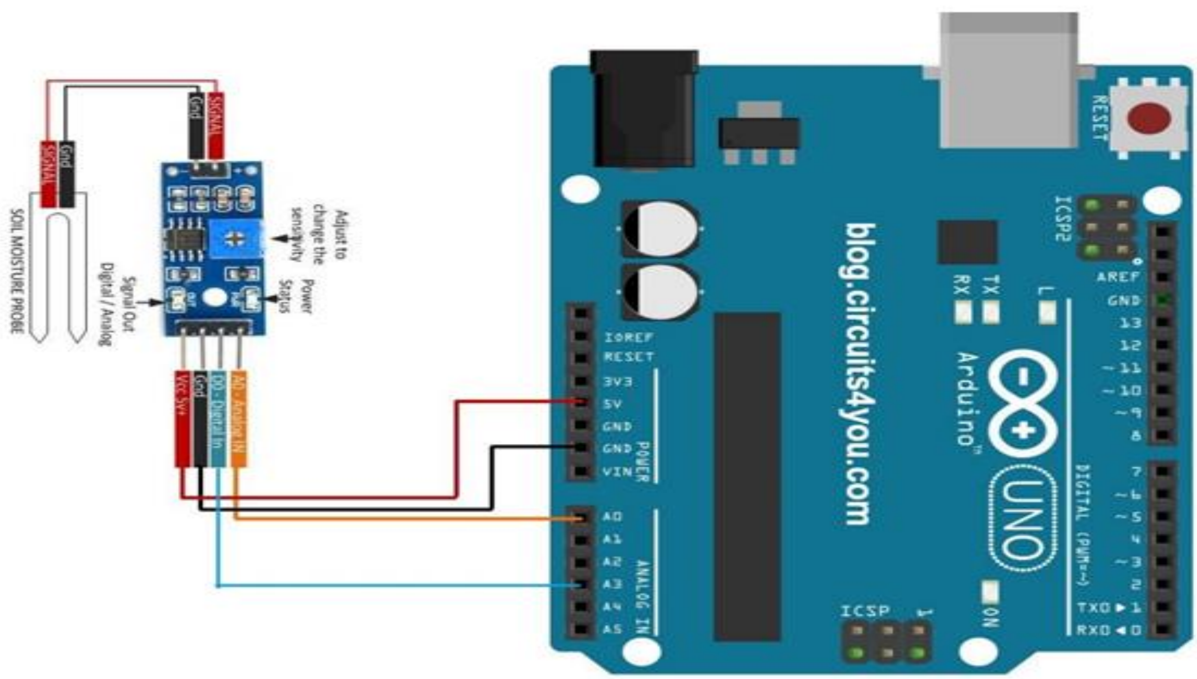
Circuit Diagram

Bluetooth to Arduino Uno Connection



Soil Moisture and Field Effect Sensor to Arduino Uno Connection



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SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The summary of the major findings of the study, conclusions, and recommendations was drawn in relation to the result of the data analysis that was undertaken.

Summary of findings

The following summary where drawn based on the conduct of this study.

1. The grand mean on the extent of the effectiveness of the "Soil Nutrient Detector for crop production optimization with mobile application" with regards to accuracy as perceived by the respondents is 46.21 which interpreted as highly effective.
2. The grand mean on the extent of the effectiveness of the "Soil Nutrient Detector for crop production optimization with mobile application" with regards to reliability as perceived by the respondents is 46.63 which interpreted as highly effective.
3. The Soil Nutrient Detector for crop production optimization with Mobile Application was successfully made with the use of Soil moisture sensor, Soil mineral sensor, Arduino Uno, and Bluetooth module with the high-level functionality of the product.

CONCLUSIONS

The following are the summary of conclusions based on the result of the study that has been analyzed.

1. The device and mobile application, "Soil Nutrient Detector for Crop Production Optimization with Mobile Application" can detect the soil nutrients available in the soil.
2. The device provides soil type, crop and soil nutrients information to the user.
3. The respondent of the study agreed that the device will help them to increase their crop production.

RECOMMENDATIONS

The following are the recommendations and suggestion of the respondents after careful analysis of the findings.

1. The "Soil Nutrient Detector for Crop Production Optimization with Mobile Application "should be implemented to help the farmers increase their crop production.
2. The user of the device and the mobile application should know how to use a smartphone.
3. The researcher suggests using another sensor to improve the device and another programming language to make the Mobile Application and this study would serve as a guide for future researchers conducting a similar study.

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REFERENCES

A. BOOKS

Roy, R.N.; Finck, A.; Blair, G.J.; Tandon, H.L.S. (2006). "Chapter 3: Plant nutrients and basics of plant nutrition".

Barker, AV; Pilbeam, DJ (2015). Handbook of Plant Nutrition. (2nd ed.). CRC Press. ISBN 9781439881972.

Marschner, Petra, ed. (2012). Marschner's mineral nutrition of higher plants (3rd ed.). Amsterdam: Elsevier/ Academic Press. ISBN 9780123849052

B. PUBLISHED MATERIALS

Labrador, Mirador G. Labrador, Hebe C. Uy, Ma. Lourdes P. Amante, April Ellen

E. Quebada (2014). "Development and Evaluation of GIS-Based Soil Characterization Equipment"

Devika, S.V.; (2014) Arduino Based Soil Sensing. Associate Professor, Dept. of ECE. Hyderabad, India.

Cheng, Danny C., (2003). "A framework for Mobile Learning Development."

C. ELECTRONIC AND OTHER RESOURCES

http://esciencenews.comC/article/2012/04/13/nutrient.and.toxin.all.once.how.plants.absorb.perfect.quantity.minerals.Retrieved 12 August 2016.

http://easl.ces.uga.edu/publications/plant/Nutrient.html.Retrieved08 September 2016

http://nrcca.cals.cornell.edu/soilFertilityCA/CA1/CA1_print.html.Retrieved 07 August 2016.

