BUSITEMA UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

A Microcontroller Based Soil Fertility Measurement and Land Usage System for Small Scale Farmers.

BY

Kuteesa Gideon
Reg. No: BU/UG/2012/69
Tel: +256703496030
Email:gidkuts@gmail.com

SUPERVISOR
MR. MATOVU DAVIS

A Project Report Submitted to the Department of Computer Engineering in Partial Fulfillment of the Requirements for the Award of a Bachelor's Degree in computer Engineering of Busitema University.

May 2016

DECLARATION

I, Kuteesa Gideon, registration number BU/UG/2012/69 do hereby declare this project entitled "A Microcontroller Based Soil Fertility Measurement and Land Usage System for Small Scale Farmers" as my original work except where explicit citation has been made and it has never been submitted to any institution of higher learning for academic award.

Signed: …………………………….   Date: …………………………

Kuteesa Gideon

APPROVAL

This is to certify that the project Report entitled "*A microcontroller based soil fertility measurement and land usage system for small scale farmers"* has been done under my supervision and is now ready for examination.

Signed: …………………………………. Date: ……………………………….

Matovu Davis

Head of Department, Computer Engineering

Faculty of Engineering, Busitema University

DEDICATION

I dedicate this project report to my dear brothers and sisters who have worked tirelessly to facilitate me throughout this project period and the whole Education process. May the Almighty God reward them abundantly.

ACKNOWLEDGEMENT

First and fore most I would like to take this opportunity to thank the Almighty Lord for providing protection and life to me and everyone around me during the time of my research. For it was through the health and strength I had that I was able to make it to this level

Secondly I would thank my parents and family who have looked after my welfare and finances and assured that I carried on my education successfully may the good Lord award them abundantly.

Furthermore I extend my sincere gratitude to my supervisor **Mr. Matovu Davis** who has tirelessly worked with me to ensure that all the works in this report are up to the recommended standards.

I thank Busitema University Department of Computer Engineering for rendering us enough time for us to ensure we learn a lot as computer engineering is concerned and this has made it possible for me to come up with this project.

Lastly but not least I would convey my thanks to all my friends who stood by my side to help me come up with better structures as required for my project research to make it to this level. May the good lord provide for them in their times of need.

ABSTRACT

The system development was motivated by the need to reduce the losses in form of low or poor quality crop yields in the time of harvesting being caused as a result of inaccurate methods used by farmers while determining the type of crop to plant on given piece of land.

The system comprises of a hardware and software part. The hardware part comprises of an a conductivity probe sensor for measuring the conductivity (EC) value of a given soil sample which represents its level of soil fertility plus and circuit connected with and an Arduino board whose purpose is to store and interpret the commands to be used by the conductivity probe in measuring the soil fertility levels of a given soil sample plus sending the obtained values to database server on the P.C.

The software part comprises of a database server consisting of the threshold E.C values of the different crops below or above which crops can't be able to yield maximamly. These values are compared with the values measured by the sensor from a given soil sample to determine the type of crops suitable for given piece of land which are then displayed on a graphical user interface on a person computer.

This helps farmers in making wise decisions on the type of crops to type on a given piece of land plus other good farming practices to avoid making losses at the end of a season.

TABLE OF CONTENTS

TABLE OF FIGURES

\

LIST OF ACRONYMS

AC	Alternating Current
CEC	Cation Exchange Capacity
DC	Direct Current
EC	Electrical Conductivity
EEPROM	Electrically Erasable Programmable Read Only Memory
EMI	Electro Magnetic Induction
GSM	Global systems for Mobile information
LCD	Liquid Crystal Display
PCB	Printed Circuit Board
PH	Potential Hydrogen
PHP	Hypertext Pre Processor
RAM	Random Access Memory
RTEBSAS	Real Time Embedded Based Soil Analyzer System
TSA	Transport Safety Administrators

CHAPTER ONE

INTRODUCTION

1.1 Background

Uganda has a total area of 241,038 sq. km, with a land area of about 236,000 sq. km comprising cultivated areas, arable but uncultivated land, rangelands, mountains and built up areas. 16% of the total area constitutes water and swamps while 7% is under forests. Over88% of Uganda's population lives in rural areas and is engaged in agriculture (MAAIF, 2006). Arable land comprises 75% of the total land area, but only 10% can be considered as agriculturally productive land. The remaining land surface is rated as moderate, implying the sort of soils that will support crops under good management. The land area under cultivation is about 4.6 million hectares (ha), with 4.3 million ha cultivated to food crops, while cash crops cover about 0.3 million ha [1].

However, most soils in Uganda are older than 500 million years and are in their final stage of weathering. The predominant minerals in the soils are quartz and kaolinite that don't directly supply nutrients to soils. The soils are acidic and infertile with low Cation exchange capacity (CEC). Nutrients such as phosphorus occur in inorganic and organic forms that are not readily available to crops.

Over the years, food production has been characterized by subsistence farming. A subsistence production system usually focuses on a maximizing short-term profit, consuming natural stocks of plant nutrients. Such a farming system has resulted in soil fertility degradation through nutrient mining. In the past, when Uganda's population was still low, lost soil fertility was restored through long periods of fallows. With an average land holding of about 2 ha per household, fallows are no longer practical or the periods greatly shortened. Research has clearly demonstrated that fertilizer inputs and appropriate land management practices are important components of technology required to increase crop yields in Uganda [2].

Many farmers also do know to some extent how to practice judicious management of their soils, using nutrients available in their vicinity and adopting agricultural practices geared towards soil fertility improvement such as improved fallow, agroforestry and biomass transfer. Admittedly, soil fertility management is highly complex given the myriad of interacting factors that dictate the extent to which farming households invest in the fertility of their soils. These interacting factors must be understood, as judicious soil fertility management is of vital importance for sustaining food production in small holder communities. The complexity of soil fertility management in smallholder farms calls for active participation of farmers and other stakeholders.

The traditional systems of restoring and maintaining soil fertility such as crop rotation and fallowing are no longer able to cope with the rate of soil fertility decline. Smallholder farmers use low-input production technologies, without appropriate soil and water management practices, which together with the export of produce to urban areas have contributed to increased export of nutrients from the fields. Furthermore small scale farmers lack financial resources to purchase sufficient fertilizers to correct the inherent low fertility levels and replace the nutrients exported with harvested produce. With the outweighed disadvantages associated with those traditional systems, I therefore designed a more accurate system for measuring and determining the level soil fertility of a sampled field based on soil conductivity to help a farmer decide the type of crops to plant on a given sampled field as well making other good farming practice decisions on irrigation and fertilizer application based on the graphs showing the rate of increase and decrease in soil fertility of a given piece of land over seasons [3].

1.2 Problem statement

Farmers use traditional methods of restoring and maintaining soil fertility such as crop rotation in determining the type of crop to plant on a given piece of land without actual knowledge about its soil fertility levels [3]. They end up planting any type of crop on a given piece of land leading to losses in form of low and poor quality yields than the expected at the end of the season.

There is a need for greater understanding of a farmer's soils, water and nutrient composition and to develop practical skills for their management to help increase agricultural productivity. This therefore calls for a microcontroller based soil fertility management system that can determine the amount of nutrients available in a given piece of land to be cultivated to help a farmer make wise decisions on what type of crop to plant on a given sampled piece of land.

1.3 Objectives

1.3.1 Main objective

To design and implement a microcontroller based soil fertility measurement and land usage system that measures and analyzes the soil fertility of a given field to help a farmer make wise decisions on the type of crops to plant on a given field for maximum yields.

1.3.2 Specific objectives

- **(i)** To review the existing literature on soil management systems with regard to soil nutrients and salinity
- **(ii)** To identify and analyze the requirements needed to accomplish the development of the system.
- **(iii)** To design and implement a microcontroller based soil fertility measurement and land usage system.as proposed using the properly analyzed requirements.
- **(iv)** To test and validate the microcontroller based soil fertility measurement and land usage system implemented.

1.4 Justification

Many of the agricultural sectors do not produce enough food to meet the country's need because farmers now-a-days don't have appropriate and accurate methods of determining the levels of soil nutrients in a given field of land. They end up planting any type of crop in a given field at any season using assumptions based on crop rotation. This results into losses in form of low yields at the time of harvest resulting to low food production for both home consumption and sale.

The designed system measures and determines the level of soil fertility of a given field based on the soil nutrients within a given field and then analyses and interprets the results to provide a list of crops that can be planted on given field of to ensure maximum returns and helping the farmer to make wise decisions about irrigation, fertilizer application by monitoring the fertility of the sampled field from one season to another.

1.5 Scope of the study

The project design and implementation of the system focused mainly on small scale farmers with pieces of land of about 1-2 acres of land. A soil sample obtained from a given field of land to be cultivated of about 2 acres is measured using a soil conductivity sensor and then connected to a database to provide a list of crops that can be planted on that sampled field so as to ensure maximum yields on the time of harvest plus monitoring the sampled field so as to determine the trend in soil fertility decrease or decrease over seasons.

REFERENCES

[1] Young Professional, EPRC Prepared by Marilyn Kamanyire, "Sustainability Indicators for Natural Resource Management and Policy," *The effects of policy and institutional environment on natural resource management and investment*, p. 5, February 2000.

[2] Jacob Aniku, Kafu Awuma, and Christina.H. Gladwin Peter Nkedi-Kizza, "Gender and Soil Fertility in Uganda: A Comparison of Soil Fertility Indicators for Women and Men's Agricultural Plots," *African Studies Quarterly* , vol. 6, no. 1 & 2, p. 28, spring 2002.

[3] Crammer Kayuki Kaizzi, "Strategies, Cost and Benefit of Soil Fertility replenishment in Soils with different productivity potential in Uganda," Centre for Development Research (ZEF) University of Bonn,.

[4] NRCS. (2006, may) National resources Conservation service. [Online]. http://websoilsurvey.nrcs.usda.gov/app/

[5] (2013, july) [Online]. http://www.macaulay.ac.uk/soilposters/1.pdf

[6] (2015) Biology discussion. [Online]. http://www.biologydiscussion.com/soil/soil-fertility-its-meaning-causes-and-maintenance-with-diagram/7262

[7] Dr. F. A. Olowokere Dr. C.O. Adejuyigbe, "SOIL FERTILITY AND PLANT NUTRITION (SOS 511)," 2008.

[8] D.S Dhote, S.G shauda G.D Agrahari, "Acquisition of soil parameters and data logging using advance Microcontroller," *internal journal of basic and applied research*, pp. 58-63, july 2012.

[9] K.A Sudduth andS.T Drummond N.R Kitchen, "Soil Electrical Conductivity as a CropmProductivity Measure for Claypan Soils," vol. 12, october 1999.

[10] Columbus, Ohio 43210 590 Woody Hayes Dr. (2009, February) Ohio State University Fact Sheet. [Online]. http://ohioline.osu.edu/aex-fact/0565.html

[11] Second Year Student M.Tech, Dept of CSE, Basappa B Kodada Asst. Professor, Dept of CSE of Canara Engineering College, Mangalore Vitthal S Saptasagare, "Real-Time Implementation and Analysis of Crop-Field forAgriculture Management System based onMicrocontroller with GPRS (M-GPRS) and SMS," *International Journal of Computer Applications (0975 – 8887)*, vol. 98, July 2014.

[12] D.V.PUSHPA LATHA SWATI DEVABHAKTUNI, "Soil Moisture and Temperature sensor based intelligent irrigation water pump controlling system using PIC 16F72 Microcontroller," *International Journal of Emerging Trends in Engineering and Development*, vol. IV, no. 3, June-July 2013.

[13] S.Sivachandran, K.Balakrishnan, K. Navin J.Jayaprahas, "real time embedded based soil analyzer," *IJARCCE8D a smart navin real time embedded_4*, March 2014.

[14] Dept of CSE Canara Engineering College, Mangalore, Basappa B Kodada Asst. Professor, Dept of CSECanara Engineering College, Mangalore Vitthal S Saptasagare Second Year Student M.Tech, "Real-Time Implementation and Analysis of Crop-Field forAgriculture Management System based on Microcontroller with GPRS (M-GPRS) and SMS," vol. 98, july 2014.

[15] Faculty of Agriculture Jordan University of Science and Technology MunirJami lMohammadand Bayan M.Athamneh Department of NaturalResources and the Environment, "Changes in SoilFertility and Plant UptakeofNntrients and HeavyMetalsin Responseto SewageSludgeApplication to Calcareous Soils," *Journal ofAgronomy*, vol. III, no. 3, 2004.