BUSITEMA UNIVERSITY
Pursuing Excellence

# FACULTY OF ENGINEERING

**DEPARTMENT OF COMPUTER ENGINEERING**

**FINAL YEAR PROJECT REPORT**

# NPK SOIL FERTILITY MEASUREMENT SYSTEM AND CROP RECOMMENDATION BASED ON MACHINE LEARNING

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**A Final Year Project Report Submitted to the Department of Computer Engineering in Partial Fulfillment of the Requirements for the Award of Degree of Bachelor of Science in Computer Engineering of Busitema University**

**September, 2023**

**DECLARATION**

I, **OKWII SIMON** do hereby declare that this project report is my original work except where explicit citation has been made and has never been published and/or submitted for any other degree award to any other university or institution of higher learning for any academic award.

Signature: ……………………………………………

Date: 29/09/2023

## APPROVAL

This is to certify that the project titled "**NPK Soil Fertility Measurement System and Crop Recommendation Based on Machine Learning**" has been done under my supervision and is now ready for Board of Examiners of Busitema University.

Signature: ……………………………………………

Date: 29/09/2023……………………………………

**MR. LUSIBA BADRU**

Department of Computer Engineering and Informatics

# DEDICATION

I dedicate this report proporsal to my beloved father Mr. Okwii Apollo, my mother Miss Nakyeyune Betty (RIP), My sisters Akwii Florence, Amongin Grace, Akurut Margret, Akiror Christine, Amuge Esther Sarah, Chemeri Aida, my brother-in-law Mr. Obwokor Edward, dear friends Okwii Simon Peter for always standing with me in my struggles to achieve success.

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## ABSTRACT

The efficient management of soil fertility and optimized crop selection are crucial factors in modern agriculture, impacting both agricultural yield and environmental sustainability. This project introduces an NPK Soil Fertility Measurement System integrated with a Crop Recommendation System utilizing Machine Learning techniques. The NPK Soil Fertility Measurement System employs advanced sensor technologies to accurately assess the levels of essential nutrients - Nitrogen (N), Phosphorus (P), and Potassium (K) - in the soil. the system aims to provide real-time and accurate information about the soil's nutrient content, enabling farmers to make informed decisions regarding soil treatment and nutrient supplementation. Building upon the soil fertility data collected, the Crop Recommendation System employs state-of-the-art Machine Learning algorithms. These algorithms analyze historical crop performance data, along with the current soil nutrient composition, climate conditions, and other relevant factors, to generate tailored crop recommendations for specific plots of land. This approach helps maximize agricultural productivity while minimizing resource waste and environmental impacts.

## LIST OF ACRONYMS

IC………………………………………………………………………… Integrated Circuit

AC ………………………………………………………………………. Alternating Current

DC ……………………………………………………………………………. Direct Current

LCD ……………………………………………………………………. Liquid Crystal Display

NPK ……………………………………… Nitrogen (N), Phosphorus (P), and Potassium (K)

IDE …………………………………………………… Integrated Development Environment

USB ……….…………………………………………………..…... Universal Serial Bus

HTML ………………………………………………………….. Hypertext Markup Language

HTTP ………………………………………………………… Hypertext Transfer Protocol

CSS ………………………………………………………………... Cascading Style Sheets

PC ……………………………………………………………………… Personal Computer

VSC …………………………………………………………………… Visual Studio Code

pH ……………………………………………………………………... Potential of Hydrogen

DHT11 ……………………………………………………... humidity and temperature sensor

AI ……………………………………………………………………. Artificial Intelligence

ANN ………………………………………………………….. Artificial Neural Network

CNN …………………………………………………….. Convolutional Neural Network

RFC ………………………………………………………….. Random Forest Classifier

DTC ………………………………………………………………. Decision Tree Classifier

Lr ……………………………………………………………………… Logistic Regression

ML ……………………………………………………………………… Machine Learning

CSV ………………………………………………………….. Comma-Separated Values

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# CHAPTER ONE: INTRODUCTION

## 1.0 Background

Agriculture is a vital sector of Uganda's economy, providing employment to over 70% of the population and contributing significantly to the country's GDP[1]. However, farmers in Uganda face several challenges, including poor soil fertility, unpredictable weather patterns, and limited access to modern agricultural technologies. This poses a great challenge to meeting the continent's growing food needs. To meet increasing food demand, agricultural production must grow. However, to achieve that objective without converting more forested areas or savanna into arable land, it is critical to make optimal use of key inputs, including improved seed varieties, fertilizers, and technologies, such as soil fertility measurement and modern irrigation methods. Those inputs must be used more efficiently and in a more environmentally friendly manner in order to reduce greenhouse gas emissions per unit output.

Soil fertility is a critical factor in agricultural production[2]. It is determined by the availability of nutrients, such as nitrogen, phosphorus, and potassium in the soil. Soil Fertility measurement is also one of the fundamental components of soil productiveness, which highly correlates with the amount of crop nutrients in the soil such as Nitrogen (N), Phosphorus (P), and Potassium (K). These three nutrients are the key components of soil fertility that should be measured by the farmers before make informed decisions about fertilizer application and crop selection. The percentage of nitrogen, phosphorus, and potassium (also known as NPK) in fertile soil can vary depending on several factors, such as the type of soil, climate, and history of land use. However, fertile soil contains approximately 0.5% - 2% of Nitrogen (N), 0.1% - 0.5% of Phosphorus, and 0.5% - 2% of potassium. It's important to note that other micronutrients such as calcium, magnesium, sulfur, and iron are also important for plant growth and play a critical role in soil fertility. Therefore, the overall nutrient composition of fertile soil is more complex than just the NPK levels [3].

Traditional methods of measuring soil fertility involve collecting soil samples and sending them to a laboratory for analysis, Visual assessment, Hand feel method, Plant growth tests, and Farmer experience. This process is time-consuming and expensive, and it can delay the planting season. 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 [4].

With the outweighed disadvantages associated with those traditional systems, I therefore designed NPK Soil Fertility Measurement System and Crop Recommendation Based on

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