



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

**DEPARTMENT OF AGRICULTURAL MECHANIZATION AND
IRRIGATION ENGINEERING**

**DESIGN AND SIMULATION OF A DEMONSTRATION IRRIGATION SCHEME FOR
BUSITEMA UNIVERSITY**

SUUNA RONALD

BU/UG/2011/53

SUPERVISORS: Mr. Kavuma Cris and Mr. Okiring Patrick



A final year Project submitted to the Department of Agricultural Mechanization and Irrigation Engineering in the faculty of Engineering in partial fulfillment of the requirements for the award of the degree of Agricultural Mechanization and Irrigation Engineering of Busitema University.

May 2015

ABSTRACT

Busitema is the only University in Uganda, East Africa at large, that offers a Bachelor's degree in Agricultural mechanization and irrigation engineering. However all the irrigation courses covered under this program are more of theoretical than practical. This leaves students with a limited understanding of the irrigation systems, which calls for need of a university owned demonstration irrigation scheme to boost the student's understanding of irrigation engineering.

This project was therefore focused on the design and simulation of a demonstration irrigation scheme for the University. It therefore handled the above mentioned task and provided guide lines and procedures for the construction of the system in case the institution decides to implement the project.

On that matter therefore, this project covers the design and simulation of the demonstration irrigation scheme for Busitema University. The construction was not done under this scope because of the high costs involved in the purchase and installation of irrigation systems. However the construction can go on in case the university is willing to fund the project.

In the course of the study, laboratory tests were carried out on the soil samples from the field to establish which crop grows best on the selected soil, and irrigation water requirements were also established. The simulation part was accomplished using EPAnet water simulation software and solidworks. An economic evaluation including cost benefit analysis was also carried out and all expenses and the total cost of the project were established.

At the end of the study, two crops to be used for demonstration were established: ginger for the sprinkler system and hot-pepper for the drip system, after knowing the soil type and properties. two different types of irrigation systems were designed, that is: drip and sprinkler irrigation. The irrigation system and processes were simulated, and an economic evaluation of the project was done and presented.

DEDICATION

This piece of work is dedicated to my parents Ssalongo Kateregga Ronnie and Ms. Namakula Magret for their support and love throughout my entire academic life.

ACKNOWLEDGEMENT

Thanks be to the Lord Almighty for seeing me through this entire project period, may His precious Name be glorified.

I appreciate Busitema University staff for the knowledge they have imparted in me for the four years I have spent with them. I thank, particularly my two supervisors, Mr. Kavuma Cris and Mr. Okiring Patrick for working closely with me during this period. Thanks so much for your efforts and support.

Special thanks go to my parents and family for the financial support provided to me during my studies and project period.

Thanks to my friends for the support and encouragement. May the Almighty God bless you abundantly.

DECLARATION

I, SUUNA RONALD to the best of my knowledge and with a sound mind do declare that this thesis paper consists of my personal data obtained from the research and literature review done. All the information therein has not been copied from any other person's work and where such has happened all the sources have been cited (referenced).

~~.....~~
.....
.....31.06.2015.....
SUUNA RONALD
BU/UG/2011/53



APPROVAL

This project is submitted in to the department of Agricultural Mechanization and Irrigation Engineering, faculty of Engineering, Busitema University as a partial fulfillment of the requirements for the award of a Bachelor's Degree in Agricultural Mechanization and Irrigation Engineering by the approval of:

.....

.....

Mr. Kavuma Cris

And

.....

.....

Mr. Okiring Patrick

Table of Contents

ABSTRACT.....	ii
DEDICATION.....	iii
ACKNOWLEDGEMENT.....	iv
DECLARATION.....	v
APPROVAL.....	vi
Acronyms.....	ix
CHAPTER I: INTRODUCTION.....	1
1.1 Background.....	1
1.1 Problem Statement.....	2
1.2 Justification.....	2
1.3 Purpose of the study.....	2
1.4 Objectives.....	2
1.5.1 Main Objective.....	2
1.5.2 Specific Objectives.....	3
1.6 Significance of the study.....	3
1.7 Scope of the study.....	3
CHAPTER II: LITERATURE REVIEW.....	4
2.1 Introduction.....	4
2.2 Theoretical review.....	4
2.2.1 Irrigation System.....	4
2.2.2 Irrigation types.....	7
2.2.3 Soil infiltration rate.....	11
2.2.5 Determination of crop water requirement.....	12
2.2.6 Pipe Selection.....	14
CHAPTER III: METHODOLOGY.....	15
3.0 Introduction.....	15
3.1 Establishing the crops to use for demonstration.....	15
3.1.2 Soil pH test – Electrometric method was used.....	16
3.1.3 Meteorological data.....	18
3.1.4 Topographical survey.....	18

3.2 Designing the various irrigation systems.....	18
3.2.2 Determination of crop-water requirement.....	18
3.2.3 Design of Sprinkler irrigation system.....	21
3.2.4 Design of Drip irrigation system.....	24
3.3 Simulation of the irrigation system and process.....	26
3.4 Economic Analysis of the Project.....	27
CHAPTER IV: RESULTS PRESENTATION AND ANALYSIS OF DATA.....	28
4.0 Introduction.....	28
4.1 Establishing the types of crops to use for demonstration.....	28
4.1.1 Moisture Content Test results.....	28
4.1.2 Soil pH Test.....	29
4.1.3 Results obtained from the soil infiltration test.....	29
4.1.4 Establishment of crops to use for demonstration.....	29
4.2 Designing the various irrigation systems.....	29
4.2.1 Topographical survey.....	29
4.2.2 Determination of crop-water requirement.....	31
4.2.3 Design of Sprinkler irrigation system.....	32
4.2.4 Design of Drip irrigation system.....	38
4.2.5 Design for the pump.....	44
4.3 Simulation of the irrigation system and process.....	46
4.4 Economic Analysis of the system.....	48
4.4.1 Initial Capital requirement.....	48
4.4.2 Operational cost/Revenue.....	50
CHAPTER V : CHALLENGES, CONCLUSION AND RECOMMENDATION.....	54
5.1 CONCLUSION.....	54
5.2 CHALLENGES.....	54
5.3 RECOMMENDATIONS.....	54
REFERENCES.....	55
APPENDICES.....	57

Acronyms

GDP	Gross Domestic Product
MFPED	Ministry of Finance, Planning and Economic Development
UBOS	Uganda Bureau of Standards
E _{to}	Reference Evapotranspiration
E _c	Crop Evapotranspiration
K _c	Crop Coefficient
RH	Relative Humidity
P	Effective Precipitation
PVC	Polyvinyl Chloride
PE	Polyethylene
FAO	Food and Agriculture Organization
LDPE	Low Density Resin
HDPE	High Density Resin
ISO	International Standards Organization
CAD	Computer Aided Design
EPA	Environmental Protection Agency
pH	Potential hydrogen
GPS	Global Positioning System
EU	Emission Uniformity
T _t	Transmission Ratio
LR _t	Leaching Requirement
BCR	Benefit Cost Ratio
PW	Present Worth
AW	Annual Worth

CHAPTER I: INTRODUCTION

1.1 Background

The Ugandan economy is predominantly supported by agriculture, which contributes almost 24 % of the National Gross Domestic Product (GDP) and accounts for over 73 % of exports. (MFPED, 2010). The agricultural sector contributes a lot to economic growth, food security, income enhancement and employment in Uganda. The 2005/06 Uganda National-Household Survey estimated that there were 4.2 million agricultural households, constituting 78.8 % of all households in the country and representing over 70% of the labour force (UBOS, 2007).

The agricultural sector is however dominated by rain-fed farming systems, the viability of which is becoming increasingly compromised by climate change, and the productivity of which is reducing in the case of some crops, due to a variety of constraints both technical and institutional. Despite the fact that improved irrigation can mitigate the risk of climate change, reduce the unit costs of improved service provision, and obviate the perceived risks of diversified farming, only some 14,420 ha in Uganda is understood to have been equipped for formal irrigation, (National Irrigation master plan, 2011). Estimates of Uganda's spatial potential for improved irrigation vary from 170,000 ha to over 560,000 ha, whereas the total potential arable area is some 4,400,000 ha, (National Irrigation master plan, 2011). It is obvious therefore that the irrigated portion of the agriculture sector is small in relation to rain-fed farming with or without climate change.

Irrigation in the Eastern part of Uganda, where Busitema University is located is mainly of the surface irrigation types. Around the university, the local people grow paddy rice where they use basin irrigation on small scale. These fields are so small and not well established to allow for study purposes. There are big farms around the University which practice irrigation, forexample, kibimba rice scheme which uses surface irrigation, Doho rice scheme which uses surface irrigation, and Kakira sugar in Jinja where both surface and pressurized irrigation are applied. The presence of these farms around the university has not helped significantly in the problem of limited skills/hands-on in irrigation among the