BUSITEMA UNIVERSITY
Pursuing Excellence

FACULTY OF ENGINEERING

DEPARTMENT OF AGRICULTURAL MECHANISATION AND IRRIGATION ENGINEERING

FINAL YEAR PROJECT REPORT

PERFORMANCE OPTIMISATION OF A FURROW IRRIGATION SYSTEM

A Case study of Aloet Demonstration Site – Bukedea

BY

NUWAINE RAYMOND

REG. NUMBER: BU/UG/2014/5

+256776900125/+256752428711

Email: raykat6@gmail.com

SUPERVISOR (s): Miss. Nakabuye Hope Njuki

Mr. Eriau Emmanuel

Performance Optimization of a Furrow Irrigation System project submitted in partial realization for the award of a bachelor's degree in agricultural mechanization and irrigation engineering, Busitema University.

May 2018

ABSTRACT

Surface irrigation systems are the commonly used irrigation systems in most areas due to their energy saving nature and easy management. Inadequate management and design however show low performance. To increase the sustainability of irrigated agriculture, an important aspect that has been considered in several studies is to design an efficient irrigation system at the farm level, this will contribute to the enhancement of water use efficiency, the sustainability of water resource utilization, the increase of agricultural production and farm income and, hence, the empowerment of rural community.

In this case, furrow irrigation is the widely used surface irrigation method. In furrow irrigation, the goal of optimisation is to achieve the required irrigation conditions.

This research study focussed on optimisation of the performance of furrow irrigation system (Aloet demonstration site-Bukedea). The slope of the study area was determined using ArcGIS version 10.1 and the soil type of the demonstration site determined. The parameters that affect the furrow irrigation system were analysed and they included; the inflow rate, inflow length, cut off time and the infiltration characteristics and also the design parameters such as wetted perimeter, cross-sectional area, slope, flow rate, furrow width. The furrow irrigation system of Aloet demonstration site was optimised and a physical design that can give a better performance was simulated using WinsRFR 3.1 software.

The Aloet demonstration site was found to have a slope of 0.00027 to 0.00031 and an infiltration rate of 27mm/hr, indicating a sandy loam type of soil. The performance efficiency for the current furrow system was found to be 38.3% and the simulated physical design of the furrow system gave a performance efficiency of 87.7%

DECLARATION

The work contained in this report is a tireless and tremendous record of my work.

Therefore, it has never been submitted, duplicated or published for any qualification however any replication or publishing of it requires my authority.

Name: NUWAINE Raymond

Signature: .....

Date: 06/06/2015

APPROVAL

This piece of work has been approved by;

Supervisor (s)

Ms. Nakabuye Hope Njuki

……..

Signature

……..

Date

……

Mr. Eriau Emmanuel

……

Signature

……

Date

DEDICATION

I dedicate this report to my parents. ***Mr. KATABARWA ELLY*** and ***Mrs. GRACE KATABARWA*** for the love they have showed me in my life. May the good Lord bless them abundantly. With profound greatness, I can't forget to dedicate this report to my uncle, Mr. MAHITIRA ASAPH for the great job he has done towards my academia journey, may the Lord reward you abundantly.

ACKNOWLEDGEMENT

First and foremost, I thank the Almighty God for his grace, mercy, wisdom and protection. In a special way, I would like to extend my sincere thanks to Aunt NABASA Janepher and her husband Uncle KUMBUGA Richard (Advocate) for the great love they have shown me through this journey; financially, spiritually, and all their tireless efforts to see me have a purposeful education. May the good lord reward them abundantly.

I would also want to thank my brothers who did a lot of my facilitation while at college; Mr. NAHAMYA Owen (URA – MALABA), Mr. AGABA Moses (Nakasongola), Mr. KAIJUKA Kenneth (National Housing & Construction company).

The following people Mr. NUWAMANYA Goden (Ministry of Water and Environment – Water for production department), Mr. MANIRAKIZA Moses (Adritex-Ug) did a great job through providing with me a lot of guidance in the course of my project implementation.

I also thank the people at HIP for the conducive environment while I was doing my project. Thanks a lot.

I am greatly indebted to Mr. Eriau Emmanuel and Ms. Nakabuye Hope Njuki for the incredible help, knowledge and encouragement they gave me throughout the accomplishment of this final project report.

I congratulate and appreciate all my fellow Classmates for the mutual support I received from them during the project proposal preparation and during the implementation phases.

May the Almighty God bless you all.

TABLE OF CONTENTS

LIST OF ACRONYMS/ ABBREVIATIONS

AMI	Agricultural Mechanization and Irrigation Engineering
FAO	Food Agricultural Organization
GPS	Global Positioning System
ha	hectare
kg	kilogram
km	kilometer
m	meter
NEMA	National Environment Management Authority
NWDR	National Water Development Report
%	Percentage
UBOS	Uganda National Bureau of Statistics
Q	Inflow rate
R	Cut off ratio
T_{co}	Cut off time
TL	Advance time to end of the field
D(x)	Function describing the infiltrated depth along the length of the field
D_{app}	Average depth of applied water
D_{dp}	Average depth deep percolation
D_{inf}	Average depth of infiltrated water
D_{lq}	Lower quarter average infiltrated depth
D_{min}	Minimum infiltrated depth
D_{ro}	Average depth of Run off
D_z	Infiltrated depth contributing to the irrigation target

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

1.0: INTRODUCTION

This chapter includes the following; Background of the study, Statement of the problem, Purpose of the study, and Justification of the study, Objectives and finally the Scope of the study.

1.1: BACKGROUND

Uganda's agriculture subsidizes almost 37% of the Gross Domestic Product (GDP) and has always been considered as the backbone of Uganda's economy(Han, 2017). Produce from agriculture contribute almost all of Uganda's foreign revenue, for example coffee being the leading export contributes the largest percentage of 19% of the country's exports. The sector employs 81% of the labor force, and total export earnings amount to 31% from the agricultural sector. A total of 6,810,000 ha (16,828,000 acres), or one-third of the land area, is under cultivation(Summary, no date).

Agriculture in Uganda depends only on rain where farms wait for the rains to cultivate land with an average holding capacity of 1.1 ha(Uganda Bureau of Statisitcs, 2016). The production in agriculture is low because of limited application of irrigation as well as other improved agricultural practices and inputs like fertilizers, pesticides, improved varieties and poor mechanization(FAO, 2013).

Globally, 69% of water available for home use is used in Agriculture through Irrigation which end up not being used efficiently (30-40%) (Tran, Koncagul and Connor, 2016). With the increasing demand for daily food and the day today struggle to attain sustainable food security, it calls for an increased demand to maximize and improve both water and land productivity. 'Inputs' to land may improve land productivity whereas 'inputs' to water may not change the productive potential of water. Improving 'water security' and 'water efficiency' can, however, result in high productivity(Mintesinot *et al.*, 2004).

Water security, in this context, is used to bring out the all year round availability of water for production purposes.

In Uganda, the issue of 'water security' is being tackled through the setting up and implementation of water harvesting projects like valley dams, valley tanks, ponds and so on. The

REFERENCES

Allen, R. G. (2006) 'FAO Irrigation and Drainage Paper Crop by', (56).

Ampas, V. and Baltas, E. (2009) 'OPTIMIZATION OF THE FURROW IRRIGATION EFFICIENCY', 11(4), pp. 566–574.

Bautista, E. *et al.* (2009) 'Analysis of surface irrigation systems with WinSRFR — Example application', 96, pp. 1162–1169. doi: 10.1016/j.agwat.2009.03.009.

Eldeiry, A. *et al.* (2004) 'Furrow Irrigation System Design for Clay Soils in Arid Regions'.

English, M. J. (1995) 'Redacted for Privacy'.

FAO (2013) *The State of Food Insecurity in the World The multiple dimensions of food security 2013, Web report*. doi: E-ISBN 978-92-5-107917-1.

Gillies, M. and Koech, R. (no date) 'No Title', pp. 15–26.

Han, J. (2017) 'Korea Outlook 2017', (November 2016).

Holzapfel, E. A. *et al.* (2010) 'FURROW IRRIGATION MANAGEMENT AND DESIGN CRITERIA USING EFFICIENCY PARAMETERS AND SIMULATION MODELS', 70(June), pp. 287–296.

Ingrith, V. *et al.* (2014) 'Optimization of furrow irrigation systems with continuous flow using the software applied to surface irrigation simulations - SASI', 9(42), pp. 3115–3125. doi: 10.5897/AJAR2014.8983.

Irrigation, F. (2017) 'Bachelor of Biosystems Technology Faculty of Technology South Eastern University of Sri Lanka', pp. 1–8.

K-, F. (no date) 'Managing furrow irrigation', pp. 88–96.

Kannan, N. and Abate, B. (2015) 'Studies on hydraulic performance of furrow irrigation to optimise design parameters suitable to onion field in Hawassa , Ethiopia', (Earo 2002), pp. 17–30.

Maheshwari, M. E. B. L. (1997) 'Field values of the shape factor for estimating surface storage in furrows on a clay soil', pp. 157–158.

Mcclymont, D. (2007) 'Development of a Decision Support System for Furrow and Border Irrigation .'

Mintesinot, B. *et al.* (2004) 'Examining traditional irrigation methods , irrigation scheduling and alternate furrows irrigation on vertisols in northern Ethiopia', 64, pp. 17–27. doi: 10.1016/S0378-3774(03)00194-X.

Mode, S. (no date) 'Furrow Irrigation', pp. 125–134.

Nicol, A. *et al.* (2015) *Water-smart agriculture in East Africa*. doi: 10.5337/2015.203.

'No Title' (2010), pp. 9–19.

Odhiambo, L. O., Kranz, W. L. and Eisenhauer, D. E. (2011) 'Irrigation Efficiency and Uniformity, and Crop Water Use Efficiency', *University of Nebraska*, p. 8. doi: 10.13031/trans.59.11331.

Pressure, L. *et al.* (2004) 'Low cost / Low Pressure Drip Irrigation Techniques in Irrigated Agricultural Sector in Syria : Towards Technical and Economic Feasibility', (April).

Rahman, A. and Shafi, H. A. (2017) 'Effect of wide-bed and alternate furrow irrigation on water use and yield of cotton In the Graduate College'.

Scow, K. (no date) 'Participatory Research on Irrigation Technologies for Horticultural Production with Smallholder Farmers in Uganda'.

Stengel, R. (2013) 'Introduction to Typical Optimization Problems Optimization Implies Choice Criteria for Optimization'.

Summary, E. (no date) 'Uganda outreach "', 23236(804).

Systems, S. I. (no date) 'Chapter 6 Irrigation System Design'.

Tran, M., Koncagul, E. and Connor, R. (2016) 'Water and jobs: facts and figures', *The United Nations World Water Development Report*, pp. 1–12. doi: ISBN 978-92-3-100146-8.

Uganda Bureau of Statisitcs (2016) '2016 Statistical Abstract', p. 349.

Walker, W. R. (2003) 'Surface Irrigation Simulation , Evaluation and Design', *Sirmod Iii*, p. 146.

Zayton, A. M., Eng, A. and Inst, R. (2015) 'PREDICTING OF INFILTRATION PARAMETERS UNDER DIFFERENT INFLOW RATES', 93(1), pp. 163–184.