

**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

**DEPARTMENT OF AGRICULTURAL MECHANISATION AND
IRRIGATION ENGINEERING**

**DESIGN AND CONSTRUCTION OF AN IMPROVED FORAGE
CHOPPER**

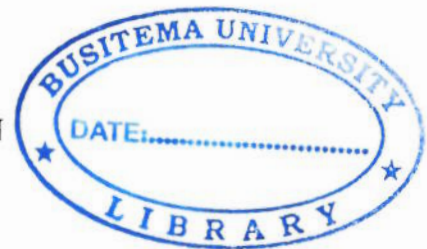
BY

MULINDWA STEVEN

BU/UP/2012/282

+256-706826608

mulindwasteven82@gmail.com



SUPERVISORS: 1. Mr. SALANJAYE WILBERFORCE

2. Mr. MUGISHA MOSES

3. Eng.ODOGOLA WILFRED

*A final year project report submitted in partial fulfillment for the award of a
Bachelor's Degree in Agricultural Mechanization and Irrigation Engineering of
Busitema University*

May 2016

ACKNOWLEDGEMENT

First of all I would like to thank the almighty GOD for the gift of life, guidance and vision.

As always, I wish to dispatch my sincere gratitude towards my supervisors; Mr. Salanjaye Wilberforce, Mr. Mugisha Moses and Eng. Odogola Wilfred plus all departmental lecturers for the professional guidance and monitor ship they have always given me.

Finally, I would like to express my deep appreciation and gratitude to Opio, Zirabamuzale, Sadick, Waiswa, Erion, Joash, Maguku, Sekatawa, Onet, Brendah, Prossy, Abal, Jordan, Solomon, Kakumba Ezra and all individuals that have in one way or the other contributed to my academic, spiritual and personal growth.

GOD BLESS YOU ABUNDANTLY

DEDICATION

I would like to dedicate this report to my parents Mr. Mayanja Godfrey and Mrs. Nasuna Proscovia for their outstanding support and guidance through my education carrier, my beloved brothers, sisters, relatives and my colleagues who have supported me in one way or the other.

DECLARATION

I MULINDWA STEVEN, declare that this project report is my original work and has never been published or submitted before to any University or Institution of high learning for the award of Bachelors in Science of Agricultural Mechanization and Irrigation Engineering.

Signature *Sam*

Date *26th May 2016.*



APPROVAL

This report has been submitted for examination with approval from the following supervisors:

Main Supervisor

Mr. Salanjaye Wilberforce

Sign

Date

Mr. Mugisha Moses

Sign

Date

Co-Supervisor

Eng. Odogola Wilfred

Sign.....

Date

ABSTRACT

Forage has been the main source of feed for livestock. A forage chopper is a machine that is meant to chop forage into the required uniform size. Forage grows well in areas of Mpigi district because of the fertile soils and favorable climate. Despite the involvement of many farmers in livestock farming, many people have underutilized forage consumption by livestock.

The problem of unequal size of forage has been due to traditional methods of chopping forage i.e using machete. More still, the existing forage choppers are expensive to be afforded in developing countries like Uganda. Also hand machete increase the level of exposure to injuries.

The purpose of this study was to design and construct a low cost improved motorized forage chopper machine that creates a quick, safe and easy way to chop forage with increased productivity and equal size. The chopper consists of feed hopper, chopping blades, power transmission unit, base support and frame and it was designed and developed basing on the mechanical, physical and chemical properties of common forage. The chopper was made using the cheap available materials in Uganda.

The chopper uses a motor of 4 hp with two blades operating at 850 rpm speed in order overcome drawbacks of existing hand or power operated choppers and to meet the demand of livestock farmers. This chopper has a chopping efficiency of 90% with effective capacity of 252 kg/hr. The mean length of cut is about 4 ± 0.5 cm. The cost of the prototype was 500,000UGX excluding the cost of the electric motor. It is recommended that the forage chopper be integrated into any livestock farm because of its low cost and both a high capacity and chopping efficiency

TABLE OF CONTENTS

ACKNOWLEDGEMENT.....	i
DEDICATION.....	ii
DECLARATION.....	iii
APPROVAL.....	iv
ABSTRACT.....	v
LIST OF TABLES.....	xi
LIST OF FIGURES.....	xii
LIST OF ACRONYMS.....	xiii
CHAPTER ONE: INTRODUCTION.....	1
1.1 Background.....	1
1.2 Problem statement.....	2
1.3 Purpose of the study.....	2
1.4 Justification of the project.....	2
1.5 Objectives of the project.....	2
1.5.1 Main objectives.....	2
1.5.2 Specific objectives.....	3
1.6 Scope of the project.....	3
CHAPTER TWO: LITERATURE REVIEW.....	4
Preamble.....	4
2.1 Forage production in Uganda.....	4
2.2 Evaluation of forage species.....	4
2.3 Forage, protein and energy intake.....	5
2.4 Description of elephant grass.....	5
2.5 Elephant grass habitats.....	6

2.6 Livestock feeding practices	6
2.7 Harvesting	7
2.8 Effects of age on dry matter composition of Uganda hairless Napier grass	8
2.9 Review of the existing methods of forage chopping.....	9
2.10 Design analysis of components suited to a motorized forage chopper	13
2.10.1 The hopper.....	13
2.10.2 Design Analysis of a Shaft and its Attachments.....	13
2.10.3 Design of support strut (frame).....	14
2.10.4 Cutting force for direct cutting.....	14
2.10.5 Analysis of the bearings	15
2.10.6 Design of the Retort stand	16
2.10.7 Forage considered.....	16
2.10.8 Design of the chopping clearance.....	16
2.11 Fabrication processes applicable to the chopper.....	16
2.11.1 Requirements for Cutting of Sheet Metal.....	16
2.11.2 Requirements for Welding of Sheet Metal.....	17
2.11.3 Requirements for Machining of Components	17
2.11.4 Requirements for Casting of Components.....	17
2.12 Testing methods of the prototype.....	18
2.12.1 The capacity of the chopper.....	18
2.12.2 The chopping efficiency	18
2.13 Determining the cost benefit analysis	18
CHAPTER THREE: METHODOLOGY	19
Preamble	19
3.1 Design Considerations.....	19

3.2 Machine description and working mode	19
3.3 Design of the various machine components.....	20
3.3.1 Design of a hopper.....	20
3.3.2 Cutting force	21
3.3.3 Determination of power requirement of machine.....	22
3.3.4 Design Horse Power, P.....	23
3.3.5 Pulley design.....	23
3.3.6 Belt Drive Design (Belt Selection).....	23
3.3.7 Belt Speed, V.....	24
3.3.8 Arc of contact of smaller pulley	24
3.3.9 Ratio of Belt tensions	24
3.3.10 Power transmitted per belt.....	24
3.3.11 Design of the shaft.....	24
3.3.12 Bearing selection	25
3.4 Construction and fabrication of the machine	25
3.4.1 Selection of materials	26
3.4.2 Fabrication of the different parts of the forage chopper machine	27
3.5 Assembly of various component parts	28
CHAPTER FOUR: RESULTS AND DISCUSION	30
Preamble	30
4.1 Determination of the dimensions of the hopper	30
4.2 Determination approximate frontal area of the knife edge	31
4.2.1 Determination of the force on the blade	33
4.2.2 Determination of the cutting force.....	33
4.3 Determining the feeding rate.....	34

4.4 Power required for chopping forage.....	34
4.5 Design power.....	34
4.6 Dimensions of the pulleys.....	35
4.7 Determination of the speed of the belt.....	35
4.8 Determination of the length of the belt.....	35
4.9 Determination of arc of contact of small pulley.....	36
4.10 Ratio of Belt tensions.....	37
4.11 Determination of the number of belts required.....	37
4.12 Determination of the minimum diameter of the shaft.....	38
4.12.1 Determination of the forces acting on the shaft.....	38
4.13 Design of the machine frame.....	42
4.14 Design of the chopping clearance.....	44
4.15 Construction of the chopper.....	44
4.15.1 Hopper.....	46
4.15.2 Shaft.....	46
4.15.3 Blade holder (circular discs).....	47
4.15.4 Chopping blades.....	47
4.15.5 Semi-circular housing.....	47
4.15.6 Supports.....	48
4.15.7 Assembly of the prototype machine.....	49
4.16 Testing the performance of the chopper.....	50
4.16.1 Results for analysis.....	51
4.16.2 Cutting efficiency.....	51
4.17 Economic analysis.....	51
4.17.1 Estimation of the cost associated with the chopper.....	51

4.17.2 Using the straight line method of depreciation.....	53
4.17.3 Payback Period	53
4.17.4 Monthly operating cost.....	54
CHAPTER FIVE: CHALLENGES, CONCLUSION AND RECOMMENDATIONS.....	55
5.1 Challenges	55
5.2 Conclusion.....	55
5.3 Recommendation.....	55
REFERENCES	56
APPENDICES	A
APPENDIX ONE: Forage chopper	A
APPENDIX TWO: Hopper.....	B
APPENDIX THREE: Shaft and attachments	C
APPENDIX FOUR: Shaft and attachments.....	D
APPENDIX FIVE: Stands supports.....	E
APPENDIX SIX: Stand supports.....	F
APPENDIX SEVEN: Marking and measuring.....	G
APPENDIX EIGHT: Testing the chopper	G

LIST OF TABLES

Table2.1: Table showing the effects of age on dry matter composition	8
Table2.2: Change in dry matter composition of Uganda grass with age	9
Table3.1: Showing components parts of the prototype and possible materials selected	26
Table3.2: Mechanical properties of steels used for shafts	27
Table3.3: Tools used in the fabrication of the component parts of the prototype	29
Table4.1: A table of the actual material specifications for the prototype	45
Table4.2: Test results for three experimental replications	51
Table 4.3: Total costs involved.....	52

LIST OF FIGURES

Figure2.1: Elephant grass grown on a piece of land.....	6
Figure2.2: Hand chopping of forage.....	10
Figure2.3: Simple forage chopper.....	11
Figure2.4: Fly wheel type forage chopper.....	12
Figure2.5: Motorized forage Chopper.....	12
Figure2.6: Shows relationship between rake, bevel and clearance angle.....	15

LIST OF ACRONYMS

Se-Selenium

DM- Dry Matter

Kg- Kilo gram

GDP-Gross Domestic Product

T-Ton

Hp- Horse power

Ha-Hectare

CHAPTER ONE: INTRODUCTION

1.1 Background

Forage is plant material (mainly plant leaves and stems) eaten by grazing livestock (Drew, 2015). Almost all the forages have sufficient levels of Potassium (K), Calcium (Ca), Magnesium (Mg), Manganese (Mn), and Zinc (Zn) to meet requirements of ruminant animals (Ababa, 2013).

According to the 2004 Population Census, the livestock population in Uganda comprised of 6,100,000 cattle, 1,150,000 sheep, 6,852,000 goats, 1,719,000 million pigs, 33,000,000 chickens and all these feed on forage.(Kabirizi et al. 2007.)

Varieties of forage grown in Uganda include; *Chloris gayana* (Rhodes grass), *setaria*, *Cynodon plectostachyus*, guinea grass, *Pennisetum purpureum* (elephant grass), coach grass among others(Kabirizi et al. 2007.). *Pennisetum purpureum* (elephant grass) is the most desired by livestock because of its palatability and high nutrient values.(Dorozvnski 2013.)

Animal agriculture is one of the most important economic sub-sectors of Uganda's agriculture and is currently among the most rapidly developing countries. The livestock sub-sector in Uganda contributes about 30% of the national Agriculture Gross Domestic Product(GDP) in the form of milk and meat(Kabirizi et al. 2007.). In order to improve household nutrition, income and food security among resource-poor households in Uganda, a number of livestock development projects have introduced intensive or stall feeding for cattle production based on improved breeds.

Chopping forage is the fundamental step in forage processing and it is divided into hand chopping (using machete) and machine chopping. Most of all these early choppers were turned with a hand crank aided by a heavy flywheel to maintain motion while the blade bit through the forage. The forage chopper is particularly designed for livestock keepers to facilitate in chopping the huge volumes of forage delivered to the farm to feed the zero grazed animals.(Agricultural 2011)

The new livestock farming methods adopted in Uganda like zero grazing gives no room for animals to graze in the fields. However, chopping is still done rudimentarily which is associated with un-equal size of the forage hence digestion problems to the animals.

This calls upon the need to design and construct an improved forage chopper that will achieve equal size of forage and at a lowest cost.

REFERENCES

- Agricultural, N., 2011. National Agricultural Research Organisation Study in Support of Transfer , Adoption and Dissemination of Labour Saving Technologies in Masaka & Wakiso Districts of Uganda. , p.50.
- Anon, 2014. ASSESSMENT OF FORAGE DYNAMICS UNDER VARIABLE CLIMATE IN KARAMOJA SUB-REGION OF UGANDA Egeru Anthony Thesis Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of Doctor of Philosophy in Dryland Resources Management of the University of Nairobi.
- Anon, grass 4.pdf.
- Bamberg, E., 2000. Principles of Rapid Machine Design by.
- Dorozvnski, A., Elephant grass is good for cows 0 0 0. , pp.6-7.
- Jacob, A.L. et al., 2014. Author ' s personal copy Topographic and spectral data resolve land cover misclassification to distinguish and monitor wetlands in western Uganda Author ' s personal copy. , 94, pp.114-126.
- Kabirizi, J., Agricultural, N. & Ejobi, F., INDIGENOUS FODDER TREES AND SHRUBS AS FEED RESOURCES FOR INTENSIVE GOAT PRODUCTION IN UGANDA FARMERS ' HANDBOOK. , pp.1-27.
- Kabirizi, J., Mpairwe, D. & Mutetikka, D., 2007. Tropentag 2007 University of Kassel-Witzenhausen and University of Göttingen , October 9-11 , 2007. , pp.1-7.
- Mechanization, A., No Title.
- Mhere, O., 2002. Forage Production and Conservation Manual Growing and ensiling annual and perennial forage crops suited to marginal and semi-arid areas of Southern Africa. , (April).
- Omolo, O.P., 2010. EFFECTS OF AGE ON NUTRIENT COMPOSITION OF NAPIER GRASS (UGANDA HAIRLESS AND HAIRY NAPIER GRASS) VARIETIES .

Units, S.I., 2005. A textbook of , (I).

Zhang, M. et al., 2003. D e c s h u s f c . , 46(6), pp.1503–1511.