



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

**BUSITEMA UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF AGRO PROCESSING ENGINEERING**

FINAL YEAR PROJECT REPORT



DESIGN AND CONSTRUCTION OF A MULTI GRAIN CLEANER

BY

SSENGABI ALEX

BU/UG/2010/107

ssengabialex@gmail.com, +256 784429193

**SUPERVISORS: Dr. Catherine Wandera
Mr. Andama Otubo**

A final year project report submitted to the Faculty of Engineering as a partial fulfillment of the requirements for the award of a Bachelor of Science degree in Agro-Processing Engineering

JUNE 2014

ABSTRACT

Rice and maize, contribute an important element in food industry and food security in Uganda. Grains are consumed in homes, schools, hospitals, among the armed forces, rehabilitation centers, refugee camps institutions, health centers due to the large quantity of carbohydrates, proteins, vitamins and fats contained in the kernels. According to FAO, 1994 , 10% grain losses occur due to poor post-harvest handling .Harvested grains have straw, chaff, sand, rocks, dust, damaged seed , stones ,cobs husks and many others. The foreign matter in grains adversely affects subsequent storage and processing conditions affecting the nutritional and market value. Cleaning by traditional winnowing technology leaves the grain contaminated with foreign matter posing a reduction in farmer's income

Smallholder farmers in Uganda use traditional post-harvest handling methods that expose grain to contamination by foreign matter. Manually grain cleaning methods are inefficient, labor intensive and depend on natural wind which leaves the grain contaminated.

To overcome this problem, this study chose as its main objective to design and construct a multi grain cleaner as well as testing of the constructed machine and the economic evaluation of the multi grain cleaner. It is aimed to enable the small holder farmers to enhance the quality and quantity of their consumable grain and enhancing the nutritional and market value, with significant reduction in the quantitative post-harvest losses thus enhancing the country's food security status. The grains considered in this study were rice and maize

Various components of multi grain cleaner were designed using basic engineering principles and some physical properties of grains such as size, density, (760kg/m^3), moisture content, (7.6% dry basis), angle of repose, (28) and weight of the grain. The trays, sieves perforations were obtained to be 11mm and 6.0mm for first and second sieves respectively.

The performance of multi grain cleaner was evaluated in terms of machine output, cleaning efficiency, cleaning loss and mechanical damage for machine output and found as 748.44kg/hr, 74%, 7.54% and 2.275% respectively.

Key words: multi grain, cleaning, stratifying efficiency, cleaning output, density, size, chaff, contaminants

ACKNOWLEDGEMENTS

I thank the almighty Lord for His loving kindness and providing me exceedingly abundantly more than I can ever ask or imagine. To Him be the glory power, worship, honor and praise.

My gratitude and deep appreciation to my supervisors Dr. Catherine Wandera and Mr. Andama Otubo for their invaluable guidance , comments , suggestions ,criticisms and friendship throughout my research

Deserving no less gratitude are the different lecturers of Department of APE, for their technical assistance during the project.

I also acknowledge the APE students for the help rendered unto me during my study period

Special mention, deep appreciation and thanks to my mother Miss Nanfuka Magret without her toil, devotion, sacrifice and encouragement, I would not be whom I am

DECLARATION

I **SSENGABI ALEX** hereby declare that the information presented and submitted in this final year report to the department of Agro Processing Engineering Busitema University is entirely original, was done and researched by myself and has never been submitted to any other institute for any award.

NAME: **SSENGABI ALEX.**

REGNO: **BU/UG/2010/107**

SIGNATURE: 



APPROVAL

This final year project report writing has been under my supervision. I have read and checked the report. I therefore approve it for submission.

Name: Dr. Catherine Wandera


Designation: Main supervisor

Signature 

Date 20/06/2014

Name: Mr. Andama Otubo

Designation: Co. Supervisor

Signature 

Date 20/06/2014

LIST OF ACRONYMS

MAAIF Ministry of agriculture animal industry and fisheries

FAO Food and Agriculture Organization

KCCA Kampala Capital City Authority

USD United States Dollar

CAD Computer Aided Drawing

HP Horse Power

UNBS Uganda National Bureau of Standards

LIST OF FIGURES

- Figure 2.1..... Cleaning by aspiration
- Figure 2.2..... Cyclone separation
- Figure 2.3.....cleaning grains with the help of wind
- Figure 2.4 winnowing fan
- Figure 2.5..... Silver line AS10T Grain cleaner
- Figure 3.1..... ..Conceptual illustration of the multi grain cleaner.
- Figure 3.2..... Layout of the conceptual design of the multi grain cleaner
- Figure 3.3..... An experimental setup for determination of the angle of repose
- Figure 3.4..... ..The shape of a hopper.
- Figure 3.5..... Schematic diagram of a blower system.
- Figure 3.6..... Belt tensions.
- Figure 3.7..... ..Motion of a cam
- Figure 3.8.....Shaft layout and forces acting on it.
- Figure 3.9Schematic diagram of a key
- Figure 3.10.....Dimensions of a frame
- Figure 3.11..... The frame
- Figure 3.12..... ..The hopper.
- Figure 3.13..... Cleaning chamber and perforated sieve.
- Figure 3.14 blower system.

Figure 3.15.....Complete constructed multi grain cleaner prototype.

Figure 4.1.....A graph of machine output against time for rice grain.

Figure 4.2.....A graph of machine output against time for maize grain.

Figure 4.3Machine output against tray angle of inclination.

Figure 4.4A graph of efficiency against feed rate.

LIST OF TABLES

- Table 3-1.....Results for determination of the angle of repose.
- Table 3-2a.....Sample diameters of maize grain.
- Table 3-2b.....Sample diameters of rice grain.
- Table 3-3..... Material selection
- Table 3-4..... Tools used for fabrication.
- Table 4-1.....Results for determining the output for rice grain.
- Table 4-2..... Results for determining the output for maize grain.
- Table 4-3..... Results for damaged rice grains.
- Table 4-4..... Results for damaged maize grains
- Table 4-5.....Different angles of tilt for tray
- Table 4-6..... The effect of feed ate against efficiency of machine
- Table 4-7..... Costing of materials
- Table 4-8..... Labour costs
- Table 4-9..... Overhead costs

TABLE OF CONTENTS

Contents

ABSTRACT.....	i
ACKNOWLEDGEMENTS.....	ii
DECLARATION.....	iii
APPROVAL.....	iv
LIST OF ACRONYMS.....	v
LIST OF FIGURES.....	vi
LIST OF TABLES.....	viii
TABLE OF CONTENTS.....	ix
CHAPTER ONE.....	1
1.0 INTRODUCTION.....	1
1.1 Background of the Study.....	1
1.2 Problem Statement.....	3
1.3 Justification.....	3
1.4 Purpose of the Study.....	5
1.5 OBJECTIVES.....	5
1.5.1 Main objective.....	5
1.5.2 Specific Objectives.....	5
1.6 Scope of the study.....	5
CHAPTER TWO.....	6
2.0 LITERATURE REVIEW.....	6
2.1 Varieties and Physical Properties of Rice and Maize Grains.....	6
2.2 Utilization of Rice and Maize Grains.....	8

2.2.1 Utilization of Rice	8
2.2.2 Utilization of Maize.....	8
2.3.2 Rice and Maize Threshing.....	9
2.4.2 Cleaning by aspiration.....	12
2.4.3. Cyclone Separation.....	13
2.5.1 Grain Cleaning Methods.....	14
2.4.2 Grain Cleaning Machinery	16
CHAPTER THREE	18
3.0 METHODOLOGY	18
3.1 Desired Characteristics of the Multi-grain Cleaner.....	18
3.2 Conceptualization of the Design of a Multi-Grain Cleaner.....	18
3.2.1 Functions and Components of the Multi-Grain cleaner	18
3.2.2 Operation Principle of the Multi-Grain Cleaner.....	20
3.3 Design of the Components of the Multi-Grain Cleaner.....	20
3.3.1 Seed Hopper	20
3.3.2 Design of a cleaning chamber	23
3.3.3 Design of screen size	24
3.3.4 Design of power unit.....	25
3.3.5 Determination of force required for reciprocating a sieve for cleaning grains	31
3.3.6 Design of Belt.....	32
3.3.7 Design of a cam	36
3.3.8 Designing of a shaft using ASME code.....	37
3.3.9 Design of machine frame and supports	39
3.3.11 Designing of the key.....	41
3.4 Fabrication of the Prototype.....	43

3.4.1 Selection of materials	43
3.4.2. The fabrication of the multi grain cleaner	46
3.4.3. Tools used using fabrication.....	46
3.4.4. The fabrication of the multi grain components.....	47
3.4.5Assembling of the different parts of the multi grain cleaner machine	51
CHAPTER FOUR: RESULTS AND DISCUSSION	53
4.0 Testing of the multi grain cleaner	53
4.1 Testing Procedure Used	53
4.2 Machine Capacity.....	54
4.3 Efficiency of the machine.....	57
4.3.1 Efficiency of the blower to remove chaff was calculated using equation 4.2;.....	57
4.3.2 Efficiency of the sieves to remove undersize and oversize particles;	57
4.4 Machine grain damage	57
4.5 Cleaning Loss:.....	59
4.6 Effect of the angle of inclination of the cleaning tray	59
4.6 Effect of feed rate.....	60
4. 7 Discussion of results.....	61
4. 7.1 Machine output and efficiency	61
4.7.2 Tray angle of inclination.....	62
4.7.3 Effect of grain feed rate	62
4.8 Economic Analysis of the Project.....	63
5.0 CONCLUSION AND RECOMMENDATION.....	66
5.1. CONCLUSION	66
5.2. RECOMMENDATIONS	66

CHAPTER ONE

1.0 INTRODUCTION

This chapter provides a background of the study, problem statement, justification, objectives and scope of the study.

1.1 Background of the Study

The grains that are commonly produced and consumed in Uganda include: rice, maize sorghum, millet. Particularly production, processing and trade in these grains largely contribute an important element in the food industry and the food security situation in the country. Rice and maize are largely consumed in homes, schools, hospitals, among the armed forces, rehabilitation centers, refugee camps institutions, health centers and they are the focus grains in this study.

In Uganda, rice farming in lowland areas using traditional or improved gravity irrigation facilities is established in various rice growing areas, namely: Doho rice scheme in Butelejadistrict, Olweny rice scheme in Lira district and the Kitgum rice scheme in Agoro Sub County (MAAIF, 2006). Kibimba (Tilda) rice scheme (MAAIF, 2007) was established in 1966 by the then government of Uganda with the objective of reducing expenses on food imports (Bigirwa *et al*, 2005). Today rice has become a major food security crop as well as a cash crop in a number of Uganda's districts and its adoption is increasing. The traditional rice growing districts of Uganda include: Bugiri, Tororo, Iganga, Palisa, Lira, Amuru, Gulu, Kitgum and Pader in Eastern and Northern Uganda and Hoima, Kibaale, Masindi, Bundibugyo, Kabarole, Rukungiri, Kanugu and Kamwenge in Western Uganda, and Luweero, Nakaseke, and Wakiso in Central Uganda; (MAAIF, 2006). Rice is particularly being promoted across the country by the government as a rural poverty alleviation crop. Total rice consumption is estimated at 225,000 metric tons yet population growth rate is 3.2% thus the demand for rice is expected to rise (UBOS, 2009). Oryokot *et al* (2004), reports that by 2004, Uganda's rice imports stood at about 45,000 metric tons. The rice production levels in terms of both area and quantity of paddy is rising steadily.

REFERENCES

- Adewumi, B. A., O. C. Ademosun and A. S. Ogunlowo. 2006. Preliminary investigation on the distribution and spread pattern of cowpea in a cross flow grain separator. *Agricultural Engineering International: the CIGR E journal*. Manuscript FP 06 020. Vol III.
- Agricultural Engineers Year Book (1978-80). Published by the American Society of Agricultural Engineers, Twenty-sixth edition. Pp 352-355.
- Aguirre, R. and A. E. Garray. 1999. Continuous flowing portable separator for cleaning and upgrading beans seeds and grains. *Agricultural Mechanization in Asia, Latin America and Africa* 30 (1): 59-63
- Joseph Edward Shigley, (1986), Mechanical Engineering Design. First Metric Edition, McGraw-Hill
- Beck, F and H. D. Kutzbach. 1996. Computer simulation of grain/chaff separation on grain pan and cleaning shoe of the combine harvester. ASAE paper 961051. St Joseph, M.I.USA
- Elfverson, C. and S. Regner. 2000. Comparative precision of grain sieve and pneumatic classification on a kernel level. *Applied Engineering in Agriculture* 16 (5): 537-541.
- Feller, R. and A. Foux. 1975. Oscillating screen motion effect on the particle passage through perforations. *Transactions of the ASAE* 18 (5): 926-931..
- Harrison, H. P. and A. Blecha. 1983. Screen oscillation and aperture size- sliding only. *Transactions of the ASAE* 26 (2): 343-348.
- Henderson, S. M., R. L. Perry, and J. H. Young. 1997. *Principles of Process Engineering*. 4th Edition. ASAE. Michigan, USA. pp 280-283.
- Conference on Crop Harvesting and Processing*. Kentucky USA. ASAE Publication Number 701P1103e. St Joseph, Mich. ASAE. 22 Pp .
- Hopfen, H. J. 1969. Farm implement for arid and tropical regions. Agricultural Development Paper No 91. FAO Rome.
- Lee, J. H. A. and R. G. Winfield. 1969. Influence of oscillating frequency on separation of wheat on a sieve in an air stream. *Transactions of the ASAE* 12(3): 886-888.