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**BUSITEMA UNIVERSITY  
FACULTY OF ENGINEERING  
DEPARTMENT OF CHEMICAL & PROCESSING ENGINEERING**



**AGRO PROCESSING ENGINEERING PROGRAMME**

**A FINAL YEAR PROJECT**

**Design and Construction of a Manually Operated Cassava Grinder for Production of  
Industrial Starch**

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**BU/UG/2011/167**

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## **ABSTRACT**


The nutritive reserves of cassava is made up of starch which is one of the most important products synthesized by plants that is consumed as food and used in industrial processes. The currently increasing cassava production will lead of higher amount of starch available making it cheaper for industrial processes and opening up of new markets. The design of a cassava grinding machine was made and powered manually to take care of power failure problems to be used in rural settlements where electricity supply is presently erratic and not available at all. The cassava was fed into the machine through the hopper to the grinding drum for grinding cassava tubers into pulp which was discharged out through the discharging unit to the storage vessel. After grinding, cassava pulp was mixed with water and filtered to obtain starch solution where the starch was separated from water by sedimentation and decantation then set on the sun to dry.

## DEDICATION

To my beloved Aunt Magret Kyatuhairé thanks for the discipline of your collective love; to my friend Aidah Nkwanzi: thanks for watching my back while I took all the chances may the Almighty God bless and reward abundantly.

**DECLARATION**

I **GLORIA BAKWATIRENDA** declare that the work presented in this report is my own and has never been presented to any University or higher institute of learning for any academic award.

Signature.....

Date..... 20/05/2015

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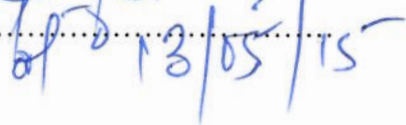
## APPROVAL

This project report has been submitted to the Department of Chemical and Process Engineering for examination with approval from the following supervisors:

### MAIN SUPERVISOR

**Mr. Edward Lubega Ssemukasa**

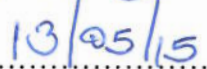
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## LIST OF ACRONYMS/ABBREVIATIONS

### Acronym/Abbreviation

- 1) FAO – Food and Agricultural Organization.
- 2) g – Grams.
- 3) Kg – Kilogram.
- 4) MAAIF – Ministry of Agriculture Animal Industry and Fisheries.
- 5) Mg – milligrams.
- 6) NAADS- National Agricultural Advisory Services
- 7) SBA-Small business administration



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## CHAPTER ONE: INTRODUCTION

### 1.0 Introduction

#### 1.1 Background of the Study

Cassava is a root crop native to Central America, but is now widely grown throughout Africa and some parts of Southeast Asia (Jeff *et al.*, 2005). It is resistant to drought and grows well in poor soils; making the crop ideal for both wet and dry climates (Kalimo, 2012).

The government of Uganda through the National Agricultural Advisory Services (NAADS) under MAAIF initially spearheaded the production of cassava and high quality tubers that led to increase in the cassava yields. Uganda is among the world largest producers of cassava in the world, producing about 34 million tons of the world's 174.0 tones (FAO, 2012). Moreover, Uganda has emerged to be a tuber surplus area. Cassava is one of the main tubers grown in most districts of Uganda including: Masaka, Bugerere, Kamuli, Kayunga, Mubende, Mukono, Iganga, Masindi, and Bushenyi (Wandia, 2011).

Cassava is a good source of food for humans (Nwokoro *et al.*, 2002). Moreover, it is also used as a source of starch in industries where starch forms one of the dominant raw materials for the various industrial processes and applications. In Uganda, cassava is a staple food for both rural and urban areas. Starch was originally used as a source of biological energy in a living cell. Industries use starch or its derivatives in various forms. In food and pharmaceutical industries, starch is used to influence or control such characteristics as texture, moisture, and consistency. Moreover, starch is used in the paper industry to bind, expand and enhance texture. It can be used to stabilize emulsions or to form oil resistant films (Miyazaki *et al.*, 2006).

Oyesola (1981) reported that the traditional method of grinding involves placing of the local grinder, which is made of perforated metal sheet on the table where it is convenient for effective use and brushes sheet metal. The cassava turns into pulp and drops into the container that is being used to collect the grinded pulp cassava. Adejumo (1995) in his design used a wooden grater in which the cassava forced into a hopper is rubbed against the grater which is being electrically powered. Enhanced quantity of cassava can be grinded using this method. However

## REFERENCES

1. A. Nasir, Development and Testing of a Hammer Mill
2. Adejumo S.O., construction and evaluation of an engine operated Bur. 1994.
3. Adzimah S.K. (2009), modification of the design of cassava grater and cassava Dough processing machine into a single automated unit. European journal of scientific Research, accessed at <http>
4. Ajao K.R, Mustapha K., Mohammed M.R., and Lyanda M.O., (2010), Design and Development of a pedal powered soap mixer, New York science journal, Vol.3(1)pp.6-9
5. B. Ndaliman, Development of Cassava grating Machine
6. Bhandari V.B., Design of machine Elements, Second Edition, ISBN 0-07-061141-6,978-0-07-061141-2, Published by McGraw-Hill Companies
7. Budynas-Nisbett, (2006), Shigley's Mechanical Engineering Design, Eighth Edition, ISBN: 0-390-76487-6, published by McGraw - Hill.
8. Electronic Journal of Biotechnology ISSN: 0717-3458.
9. FAO.2005.FAOSTAT, statistical Data Base of food and Agricultural organization(FAO) of the united Nations; Rome, Italy
10. Hearn E. J., (1997), Mechanics of materials I: An Introduction to the Mechanics of Elastic and Plastic deformation of solids and Structural Materials
11. K. N. Nwaigwe et al ,Design, Construction and Performance Evaluation of a Modified Cassava milling Machine
12. Khurmi, K. S. and J. K. Gupta. "A Text Book of Machine Design." Eurasia Publishing House (Pvt) Ltd., RAM Nagar, New Delhi, 2004.
13. Kolawole, O.P., L.A.S. Agbetoye, and A.S. Ogunlowo, 2007, cassava mash Dewatering parameters international journal of food.
14. Ministry of Agriculture, Animal Industry and Fisheries, 1992. Report on Uganda National Census of agriculture and livestock (1990-1991). Vol.III crop area, yield and production. Entebbe, Uganda.
15. Ndaliman M.B., Design and construction of a pedal operated cassava grinder, unpublished manuscript, 2006.
16. Oyesola G.O., technology processing cassava and utilization, Advisory leaflet No.3 cassava and Garri storage, NCAM, kwara stale, Nigeria, 1981.