

**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING
DEPARTMENT OF AGRO-PROCESSING ENGINEERING
FINAL YEAR PROJECT REPORT

DESIGN AND CONSTRUCTION OF A SOLAR POWERED WINNOWING MACHINE FOR
SORGHUM

BY

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ABSTRACT

Sorghum is a very important food crop around the world because of its nutritional values, it also serves as a dietary staple food for humans, and is rich in vitamin B-complex. About 217000 Metric tons of sorghum are produced in Uganda annually. A solar powered winnowing machine for sorghum was designed, constructed with locally available materials and tested for sorghum winnowing. The machine consists of the frame, hopper, solar panel, solar charge controller, centrifugal blower, motor and battery. It was powered by 36W direct current motor, 2800rpm blower speed, 100W solar panel, 75Ah battery, 30Ah solar charge controller that were suitable to operate the machine. The newly developed solar powered sorghum winnower is technoeconomically suitable for winnowing of sorghum at feed rate of 110.2 kg/h and gives a throughput capacity of 85.8kg/hr. The machine comes with a production cost of 1.35 million UGX. The sorghum winnower recommended to be used by the rural farmers who grow sorghum.

DECLARATION

I **Auma Emmily, BU/UP/2014/182** declare to the best of my knowledge that the work presented in this final year project report is my own and has never been presented to any University or higher institution of learning for any academic award.

Signature..... .....

Date..... 23rd / 05 / 2018.....



APPROVAL

This final year project report has been submitted to the Department of Agro-Processing Engineering for examination with approval from the following supervisors:

Mrs. Kabasa Mary Sally

Signature.....

Date.....

Mr. Muyingo Emmanuel

Signature.....

Date.....

DEDICATION

This report is dedicated to my beloved parents **Mr. Munji Fredrick** and **Mrs. Ajambo Rosemary** for the good support provided unto me since childhood, and for the spirit of hard work, courage and determination instilled into me, which attributes I have cherished with firmness and which have indeed made me what I am today, May the Almighty God reward you abundantly for such good work.

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May the Almighty God reward you abundantly.

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Abbreviations

D.C Direct current

UBOS Uganda Bureau of Standards

Ha Hectare

Kg kilogram

RPM Revolution per minute

APE Agro processing Engineering

Ah Ampere hour

NPV Net present value

WE winnowing efficiency

WL Winnowing loss

CHAPTER ONE

1.0 Introduction

This chapter presents the general information about the research design giving its background, problem statement, significance, objectives, justification and scope of the study.

1.1 Background to the Study

Sorghum (*Sorghum bicolor*) is the fifth most important grain after wheat, maize, rice and barley in Africa (Olembo *et al*, 2010). In the year 2008, Uganda produced 217000 Metric tons of sorghum from an area of 399000ha. Soroti district(46000 Metric tons) being the highest producer and is followed by Tororo (35000Metric tons), Ntungamo (23,000 Metric tons) and then Pader (20,000 Metric tons) respectively(UBOS, 2010).Sorghum acts as a dietary staple food, potential food security crop and is drought tolerant. It is grown on both small and large scales as food and commercial crop. Sorghum is an excellent source of iron, zinc and it is rich in vitamin B-complex which play a role in metabolism(Lindsay, 2010).Sorghum is harvested at moisture content of 20% so as to avoid loss of grains(Talbot, 2003). Then the crop is dried, threshed and winnowed respectively. Winnowing is a technology for particle size separation which separates on the principle of gravity and air movement. It is applied to most cereals and legumes which are already dry. Sorghum is a light grain with an average weight of 202.88g and requires minimal air forces because of its lightness. Traditionally, sorghum is winnowed using baskets and circular trays by lifting and tossing the threshed material so that the lighter chaff and straw get blown to one side while the heavier ones fall down vertically (Muhammad *et al.*, 2013). It is not effective because people carrying out the work have to wait for the wind current. This results in some clean grains and others with chaff remaining in them, this spoils their quality. Existing machines that do winnowing like power operated and engine driven machines require electricity and fuel for their operation and thus making them expensive. (Lasseter *et al*, 2004). There was need to use renewable energy source to winnow sorghum. This study aimed at designing and constructing a solar powered winnowing machine that reduced the drudgery of the work. The machine was able to generate electricity from the sunlight which was appropriate solution for winnowing work. A study aimed at conserving the environment since it uses solar energy.

REFERENCES

Henley, E. C. (1996) 'The Sorghum Story An Ancient, Healthy and Nutritious Old World Cereal', *Office of International Affairs National Research Council*, 8(5), pp. 1060–1065.

Available at: <http://www.nap.edu/openbook.php?isbn=0309049903&page=127>.

Jang, C. and Montanaro, G. (2014) 'Design Report : Design of a Winnowing Machine for West African Rice Farmers'.

Kadam, R. G. and Dhande, K. G. (2016) 'Performance evaluation of power operated paddy winnower', *International Journal of Agricultural Engineering*, 9(1), pp. 47–52. doi: 10.15740/HAS/IJAE/9.1/47-52.

Olembo, K., M'mboyi, F. and Kiplagat, S. (2010) 'Sorghum breeding in sub-saharan africa: the success stories', *African Biotechnology Stakeholders Forum*, p. 37 pages. Available at: <http://absfafrica.org/downloads/Sorghum Book Series.pdf>.

Olugboji, O. A. (2004) 'Development of a Rice Threshing Machine', 8(2), pp. 75–80.

Sorghum, U., Program, C. and Lindsay, J. (2010) 'Sorghum: An Ancient, Healthy and Nutritious Old World Cereal'.

Talbot, M. (2003) 'Grain sorghum : Harvesting , Drying and Storage 1', (June), pp. 1–8.

UBOS (2010) *Uganda census of agriculture Crop Area and Production Report*. Available at: www.ubos.org.