BUSITEMA UNIVERSITY
Pursuing Excellence

FACULTY OF ENGINEERING

AGRO-PROCESSING ENGINEERING DEPARTMENT

DESIGN AND CONSTRUCTION OF A COCOA BEAN SOLAR DRYER FOR SMALLHOLDER FARMERS

BY

NALUBEGA JANE FRANCES
BU/UG/2011/220
Tel: +256788164124/+256701659654, Email: jeannatfrancie@yahoo.com

Main Supervisor: Mr. Kilama George
Co-supervisor: Eng. Odogola Richard Wilfred

A final year project report submitted to the department of Chemical and Process Engineering in partial fulfilment of the requirements of award for a Bachelors of Science degree in Agro-Processing Engineering

May 2015

ABSTRACT

Cocoa beans are the seeds from fruit pods of a tropical tree botanically known as *Theobroma cacao L. (Family Sterculiaceae)*. Each pod contains at least 30–40 "cocoa beans" embedded in a mass of mucilaginous pulp within the pod. It is a perennial crop that responds well in rainy tropical areas, with a maximum annual average of 30-32^{0}C. The crop supports about 10,000 households. Organic cocoa is grown mostly in Bundibugyo, Mukono, Jinja, Kamuli, Buikwe, Masindi, Mayuge, Iganga and Kayunga districts on a small scale.

The challenge is that Ugandan cocoa farmers realize over 30% loss of harvested cocoa. The main cause is that cocoa is mainly harvested during rainy season where so many mature cocoa pods are realized. The main aim of the study is to design, construct and evaluate the performance of a locally constructed cocoa bean solar dryer for smallholder farmers. Specifically, it will be designed, fabricated and assembled in model-form to determine its suitability for the target users. The purpose of this project will address the problem of smallholder farmers drying of cocoa beans during bad weather period, by ensuring timely and precision drying of the crop using efficient and sustainable solar drying technology affordable by small scale farmers and processors. The technology shall target cocoa farmers in Jinja district where large volumes of cocoa are produced but most of them employ the traditional method of drying. This machine will also facilitate effective drying of the crop which will result in good quality of the final product with no discoloration and loss of nutritional value.

A solar dryer with thermal energy storage is suitable for drying of cocoa beans. The prototype will be constructed using readily available local materials. The drying mechanism will be based on a combination of convective heating and direct radiation, with a provision for controlling the rate of airflow through the beans. Quality assessment of the dried beans will be shown at the end of the construction. The work, thus will provide a viable system for producing cocoa beans of good quality attributes, comparable with using the traditional sun-drying, but without the associated drudgery. All the data generated will be analyzed and economically evaluated.

DECLARATION

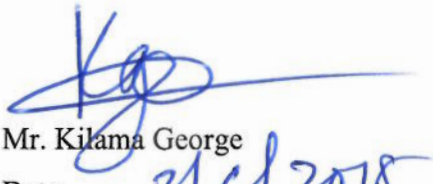
I, Nalubega Jane Frances, hereby declare to the best of my knowledge that this project report is an outcome of my own original work and has not been presented for any academic award in any college or higher institution of learning.

Nalubega Jane Frances

Date.....

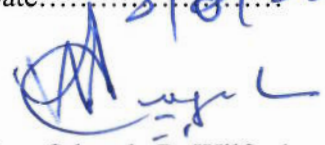
APPROVAL

This final year report has been submitted to the Faculty of Engineering Busitema University for examination with approval of my Supervisors:



Mr. Kilama George

Date.....31/6/2018



Eng. Odogola R. Wilfred

Date...4th June 2015

DEDICATION

I dedicate this report to my parents, my Dad Mr. Joseph Herman Byuma, Mrs. Mary Nakayiwa and my dearest Aunt Margaret Nakibuuka for their selfless care towards my Education since childhood. May the Almighty God bless and reward you abundantly.

ACKNOWLEDGEMENT

My sincere thanks go to the Almighty God for the wisdom, knowledge, grace, mercy, and protection He has given me , to my parents, brothers, sisters, relatives, classmates and friends who have assisted me through guidance and support.

Special thanks also go to my supervisors Mr. Kilama George and Eng. Odogola Richard Wilfred for all the help and advice rendered during the writing of this proposal report.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

1 INTRODUCTION

Under this chapter, we get to know about cocoa growing areas in Uganda, the existing drying methods and its uses.

1.1Background

According to (Ndukwu, 2009), cocoa (*Theobroma cacao* L.) is a perennial cash crop and its natural habitat is the humid tropics In most tropical countries, agricultural products like cocoa are harvested all the year round and the beans must be dried immediately after fermentation to reduce mass losses and prevent spoilage. The end products from cocoa bean especially chocolate and beverages are considered among the basic food in many countries of the world; however the quality of these end products is a function of how they are processed. The fermentation and drying of this crop are the major critical steps in the sequence of its processing. Drying can be achieved naturally by making use of solar energy or artificially by using heated cocoa bean dryers. Cocoa beans are dried by either spreading the beans to form a thin layer so that much of their body is exposed to ambient air or forming a deep bed, therefore models try to imitate any of this. Cocoa trees thrive under shades in areas with annual rainfall between 1,500mm to 2,000mm. T. S. Guehi *et al.* (2010). Cocoa plants grow in countries lying between 10 degrees North and 10 degrees South of the equator. The bean pulp is rich in fermentable sugars, such as glucose, fructose and sucrose, and has a low pH of 3.0–3.5, mainly because of the presence of citric acid. It with stands water logging for a short time and since it is sensitive to inadequate water, it can easily dry up. (Ardhana and Fleet, 2003).

Cocoa beans are dried after fermentation in order to reduce the moisture content from about 60% to about 7.5%. Drying must be carried out carefully to ensure that off-flavours are not developed. It should take place slowly. If the beans are dried too quickly some of the chemical reactions started in the fermentation process are not allowed to complete their work. The results produce acidic cocoa beans with a bitter flavour. However, if the drying is too slow, moulds and off-flavours can develop. Various research studies indicate that bean temperatures during drying should not exceed 65^0C. (ICCO, 2015)

REFERENCES

Anon, Renewable energy, four volume set, edited by Bent Sorensen.

Deutsche F.S., 2010. Planning and installing solar thermal systems, second edition,.A guide for installers, architects and engineers.

Duffie J.A.*et al.*, 2006. Solar Engineering of Thermal Processes, Third edition. Wiley Interscience Publications.

Duffie J. A , William A Beckman, 2006. Solar Engineering of Thermal Processes, Third edition. AwileyInterscience Publications.

D. S. Trim, L. Kennedy., 1985. Solar dryers- their role in post harvest processing.

Hill J. E., Jenkins J. P. and Jones D. E., 1979, NBS Building Science Series 117, U. S. Dept. of

http://www.ats.uni-hohenheim.de/_deutsche_site/projekte/_pdf/Guidance.pdf.

http://www.ukpandi.com/fileadmin/uploads/ukpi/LP%20Documents/Carefully_to_Carry/Cocoa.pdf

ICCO (February 1996) ha1 Report 1994/95 IGADD, (1990). Food Security Strategy Study Vol. 3 Country Reports.

ICCO., 2012. Harvesting and Post-harvest Processing. Londo W51YY.

plubega., 2013. Uganda Agricultural News and Research Digest. Kampala: Daily Monitor.

Wetala, D. P. (2014). Cocoa growing in Uganda.