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**DEPARTMENT OF AGRICULTURAL MECHANIZATION AND
IRRIGATION ENGINEERING**

**DESIGN AND CONSTRUCTION OF
A COFFEE PULPING MACHINE**

BY

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DECLARATION

I, Muhire Nelson declare that this research report is my own original work and has not been published and/or submitted for any academic award to any higher institution of learning. All the work contained in this report is as a result of my research effort except where cited.

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APPROVAL

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DEDICATION

I dedicate this project report to my dear parents Mr. Munyarugari Benon and Mrs. Kabami Oliver for the care and financial support they have given me up to this level.

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LIST OF ACRONYMS

DCPT	-	Dry Coffee Processing Technology
WCPT	-	Wet Coffee Processing Technology
FAO	-	Food and Agricultural Organization
MAAIF	-	Ministry of Agriculture, Animal Industry and Fisheries
ICC	-	International Coffee Council
UCTF	-	Uganda Coffee Trade Federation
CQIP	-	Coffee Quality Improvement Program
PAES	-	Philippine Agricultural Engineering Standard
FAQ	-	Fair Average Quality
UCDA	-	Uganda Coffee Development Authority
ITC	-	International Trade Council
NARC	-	Nepal Agricultural Research Council
GI wire	-	Galvanised Iron wire

ABSTRACT

Coffee is primarily produced by smallholders and is the main source of income for more than 500,000 Ugandan smallholders. In spite of high export earnings from coffee globally, coffee produced in most African countries fetch low prices compared to coffee from other continents due to poor quality coffee (Bibangamba, 1989). This is as a result of relying heavily on conventional processing which is cumbersome, expensive both to install and maintain and is prone to quality degradation if stringent processing standards are not followed. Additionally, lack of information on the performance of such equipments in respect to quality was cited as the main reason for the production of poor quality coffee that fetches low prices in the international markets. As a result most coffee farmers particularly individual local farmers who cannot afford to buy expensive imported coffee pulping machines, get low incomes from coffee sales which make very little difference in helping them out of poverty.

This demanded an extensive research in the area of coffee processing in which the researcher came up with the design and construction of a manually operated coffee pulping machine that will effectively address the above mentioned problems that are currently faced by individual local coffee farmers and coffee processors.

The prototype which is powered manually comprises of a hopper which contains fresh coffee cherries to be pulped and is welded on the outer drum. The frame of the prototype is made of mild steel angle bar of thickness 2mm. The frame is of size 320mm x 200mm x 800mm. The pulping chamber comprises of rotating pulping drum of length 300mm and a diameter of 60mm with spikes like projections on its outer surface, a shaft of 450mm long and diameter of 25mm passing through its centers and a fixed cylindrical drum of length 340mm and diameter 120mm. The pulping drum with a rotational speed of 60rpm is attached to the handle which drives it in an anticlockwise direction to pulp coffee cherries.

The machine was fabricated from locally sourced materials and it can be used in rural areas where there is no electric power supply. The output capacity of the fabricated prototype is 60kg/hr and its efficiency is 73% which is greater than that of already existing manually operated coffee pulping machine.

CHAPTER ONE

1.0 INTRODUCTION

This chapter briefly discusses the historical background of coffee as a crop, its production and spread worldwide and in Uganda, details the problems related to post harvest handling of the crop and provides justification of the study to develop a manually operated coffee pulping machine that is to address local farmers and processors needs.

1.1. Background

Coffee is still currently one of the most important export commodity in Uganda, contributing around 20% of total export earnings (Richard Roberts and Robert Ocaya, 2009). It is second to crude oil as the most important internationally traded commodity in monetary value (FAO, 2004).

In spite of high export earnings from coffee globally, coffee produced from African countries fetch low prices compared to coffee from other continents due to poor quality coffee (Babingamba, 1989). This is as a result of relying heavily on conventional processing which is cumbersome, expensive both to install and maintain and is prone to quality degradation if stringent processing standards are not followed. As a result most coffee farmers in Uganda get low income from coffee sales which make very little difference in helping them out of poverty.

There are two types of coffee which are predominantly grown in Uganda namely; Robusta coffee and Arabica coffee. Robusta coffee is grown in lower altitude areas for example along the shores of Lake Victoria while Arabica coffee is grown in higher altitude areas for example along the slopes of Mount Elgon in eastern Uganda and Mount Rwenzori in western Uganda. According to Geoff Sayer (2002), Uganda Coffee Development Authority estimates that there are 500,000 Coffee small holdings in Uganda, producing 97% of the country's crop, with almost 5 million Ugandans (almost a quarter of the country's population), depending on coffee earnings. Coffee occupies 290,485 ha in total, of which 265,000 ha is under Robusta and 33,985ha under Arabica coffee.

In Uganda, Arabica coffee and Robusta coffee are processed differently. Arabica is mostly pulped and washed while Robusta is dry processed (Roy Parizat et al, 2011). The main

REFERENCES

- Babingamba, J.R. (1989). Managing rural development in Uganda: Uganda co-operative alliance development papers. Kampala – Uganda. Pp30-32.
- Bandari.V.B. (2007). Design of machine elements: Second edition, Pub. Tata McGraw-hill publishing company limited ISBN 0-07-061141-6, ISBN 978-0-07-061141-2.
- Budynas Nisbett., (2006). Shigley's Mechanical Engineering Design, Eighth Edition, Pub. McGraw-Hill, ISBN: 0-390-76487-6.
- Food and Agricultural Organisation (2004). Post harvest handling and processing of coffee in African countries: Nairobi Kenya. Pp 4 – 8
- Geoff Sayer, (2002). Coffee Futures: The impact of falling world prices on livelihoods in Uganda. Uganda coffee project.
- Haarer, A.E. (1962). Modern coffee production, second edition, Ebenezer Baylisand sons Ltd. Landon, UK. Pp 2 – 6
- <http://mrdecsagada.blogspot.com/2008/02/mrdeproducts.html>; visited on 15/11/2012.
- <http://practicalaction.org/coffee-processing-1>; visited on 18/11/2012.
- <http://practicalaction.org/coffee-processing-1>; visited on 18/11/2012, 10:23 am.
- <http://www.mixph.com/2009/02/small-scale-processing-of-coffee.html>, visited on 15/11/2012, 10:14am.
- <http://www.ugandainvest.go.ug/index.php/agriculture/coffee?tmpl=component&print=1> accessed on 17/11/2012, 7:34pm.
- <https://law.resource.org/pub/ph/ibr/pns.252.2011.pdf> *Philippine agricultural engineering standard 252:2011* visited on 12/3/2013 at 2:46pm
- International Trade Council (1992). Coffee. An Exporter's Guide. Community Hand Book: UNCTAD/GATT Geneva. Pp 39 – 46
- Kennedy T K Gitonga, 2004. OTA Project Socio- economic component; *An assessment of the primary coffee processing practices in the North Rift Valley region of Kenya.*
- Kule Enos Katya, (2010), *Influence of technology of gender division of labour in households; Case study of wet coffee post harvest handling in Kasese District.*

Liangzhi You and Simon Bolwig, (2003), *Alternative growth scenarios for Ugandan coffee to 2020*.

MAAIF (1993). Clonal- Robusta Coffee Hand Book part III. Farming systems support program. Ministry of Agriculture, Animal Industry and Fisheries. Entebbe Uganda.

Mohammed. B. Ndaliman (2006). Development of cassava grating machine. A dual – operational mode.

Richard Roberts and Robert Ocaya, (2009), Agricultural finance year book.

Roy parizat, et al (2011). Uganda Coffee Supply Chain Links.

Shreemat Shrestha, et al (2008). A Quarterly Newsletter of Nepal Agricultural Research Council (NARC)

Uganda Coffee Trade Federation (2003). Uganda's special quality. The coffee year book 2002-2003. Pp50 and 54.

Virginia Easton Smith, Shawn Steiman, and Craig Elevitch, nd, Farm and Forestry Production and Marketing profile for coffee. Vol 15 No. 1

www.ico.org/ecology.asp; accessed on 12/2/2013 at 10:23am.

www.renewable-world.org › *East Africa Programme*; accessed on 11/12/2012 at 2:23pm