



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

DEPARTMENT OF AGRO-PROCESSING ENGINEERING

**DESIGN AND CONSTRUCTION OF AN ON-FARM WASHINGMACHINE FOR
MANGOES AND CARROTS**

BY

Nagudi Asha Twaha

BU/UG/2010/452

nagudiasha@gmail.com

+256 787773809 or +256 717773809



SUPERVISOR: DR. WANDERA CATHERINE

CO-SUPERVISOR: MR. MUYINGO EMMANUEL

**A research report presented in partial fulfillment of the requirements for the Award of
Bachelors of Science in Agro-Processing engineering of Busitema University**

MAY 2014

Declaration

Nagudi Asha Twaha confirm and declare that this project report is my own original work and has not been presented for any academic award in any collage, university or higher institution of learning. Throughout the work I have acknowledged all sources in it's compilation.

Date

Nagudi Asha Twaha

Signature

BUSITEMA UNIVERSITY LIBRARY
CLASS No.:.....
ACCESS NO.:.....

Approval

This final year project report has been submitted to the faculty of engineering for examination with approval from the following supervisors.

Dr. Wandera Catherine

Main supervisor

Date:

Mr. Muyingo Emmanuel

Co-supervisor

Date:

Dedication

I dedicate this report to my uncle Mr. Mufuma Wilson, my beloved mother, Aunt Sarah and the new generation interested in food processing technology; let us join hands to overcome the consequences of low incomes from agricultural produce by adding value to our produce.

Acknowledgement

I am so grateful to God Almighty who has seen me throughout this far and by whose mercy I am still alive

I am indebted to my dear relatives to whom I extend my sincere appreciation for their guidance and support.

I extend my gratitude to all my lecturers at the faculty of Engineering, Department of agro-processing engineering who have equipped me with academic knowledge that has guided me to reach this far.

I wish to acknowledge the valuable assistance given to me at various stages in the preparation of this report by my supervisors; Dr. Wandera Catherine and Mr. Musingo Emmanuel whose directions and guidance have enabled me to complete this thesis.

To my beloved friends Rhoda, Lydia and Lematia thanks for always helping me out please let us continue working together.

Acronyms

<i>N</i>	<i>newtons</i>
<i>m</i>	<i>metres</i>
<i>Kg</i>	<i>kilograms</i>
<i>mm</i>	<i>milimetres</i>

Table of contents

Declaration	i
Approval.....	ii
Dedication	iii
Acknowledgement.....	iv
Acronyms	v
Table of contents	vi
List of figures	viii
List of tables	ix
Abstract	x
CHAPTER I: INTRODUCTION	1
1.1 Background.....	1
1.2 Problem statement	3
1.3 Justification.....	3
1.4 Purpose of the study	3
1.5 Objectives of the study	4
1.5.1 Main objectives	4
1.5.2 Specific objectives	4
1.6 Scope of the study	4
CHAPTER II: LITERATURE REVIEW	5
2.1 Fruit and vegetable resource in Uganda	5
2.1.1 Characteristics of the fruits and vegetables considered under this section	5
2.2 Types of fruit and vegetable washing methods	7
2.2.1 Households washing methods	7
2.2.2 River flow washing methods.....	7
2.2.3 Modern household washing machines	8
2.2.4 Industrial fruit and vegetable washing machines	9
CHAPTER III: METHODOLOGY	15
3.1 Description of the fruit and vegetable washing machine	15
3.1.2 Components of the fruit and vegetable washing machine.....	15

3.2.2 The mechanism of operation of the washing machine.....	16
3.3 Design of the machine components	17
3.3.1 Design of the washing drum.....	17
The minimum acceptable diameter, d , of the shaft is 21 mm	24
3.3.3 Selection of the bearings	24
3.3.4 Design of a handle for manual operation of the machine	25
3.3.5 Design of the machine frame.....	26
3.4 Specifications of the washing machine components.....	27
3.5 Fabrication methods used.....	28
3.6 Construction of the Machine	29
3.6.1 The construction of the washing unit.....	30
3.6.2 The Construction of the Frame.....	30
3.2.3 Construction of Power Unit.....	30
3.2.5 Assembly of the Various Parts	31
3.3 Testing process and the equipment used	31
CHAPTER IV: RESULTS AND DISCUSSION.....	32
4.1 Performance evaluation of the fabricated washing machine.....	32
4.1.1 Comparing the hand and machine options the table below was generated.....	33
4.1.2 Relationship between rpm and washing efficiency.....	33
4.2 The economic evaluation of the machine.....	34
4.2.1 Cost of materials.....	34
4.3 Discussion of results.....	35
CONCLUSIONS AND RECOMMENDATIONS.....	36
5.1 CONCLUSIONS.....	36
5.2 RECOMMENDATIONS	36
References	37
APPENDIX	38
PROJECT SCHEDULE	42

List of figures

- Figure 2.1Ozone fruit washer.
- Figure 2.2Cuisine-Clean Fruit and Vegetable ozone Food Sanitizer
- Figure 2.3.....Horizontal mixed-flow spray washing machine
- Figure 2.4Low pressure washing machine
- Figure 2.5The multi-functional fruit and vegetable washing machine
- Figure 2.6Brush type Vegetable and fruit cleaning machine
- Figure 2.7Surf Type Fruit Cleaning Machine
- Figure 2.8Roller with brush cleaning machine
- Figure 2.9Rolling drum washing machine
- Figure 3.1The conceptual design of the fruit and vegetable washer
- Figure 3.2 a) Outer drum and b) Inner drum
- Figure 3.3The power unit; the shaft, the handle and the bearings
- Figure 3.4The machine frame
- Figure 3.5 a)Outer drum
- Figure 3.5 b)Inner drum
- Figure 3.6bearing

List of tables

Table 3.1	specifications of the washing machine components
Table 3.2	material selection criteria for different components of the washing machine
Table 3.3.....	summary of the possible fabrication methods for each machine component
Table 4.1.....	testing results
Table 4.3.....	proposed project schedule
Table 4.2	Expected cost of the proposed machine

Abstract

The demand for food worldwide is steadily increasing due to the increasing world population. Fruits and vegetables play an important role in providing essential vitamins, minerals, and dietary fiber to the diets of populations in the world. And they are sighted to being food alternatives to increase food security in the world, (<http://www.fao.org>). The Ongoing consumer demand for fruits and vegetables has contributed to an increase in trade volume of fresh produce. The increased trade in fresh produce has promoted the growth of small farms and the addition of new value added products there creating more rural and urban jobs.

Washing of fruits and vegetables is required for direct consumption (packaging) or processing into products like juice extracts, dried fruits and vegetables among others. Many rural small scale farmers in Uganda harvest and take produce to the market unwashed. The unclean produce fetches for these farmers fewer incomes as dirty produce is less acceptable to customers and it contains pathogens that brings in health and hygiene concerns from consumers and responsible law making bodies. . Similarly, the washing machines available on the market are expensive and not fit for small scale washing operations. .

Yet the farmers who try to wash this produce to improve on acceptance and fetch higher incomes, use rudimentary washing methods which encourage losses , mechanical damage to the produce are time consuming and tedious.

The main objective of this project is to design and fabricate an on farm washing machine for mangoes and carrots and other related produce. This machine consists of the power unit, the washing unit and the frame. Design and selection of the various components was done by analyzing forces acting on the components, sizing the components to appropriate capacity and selection of proper materials to be used to fabricate the components. The materials of construction were chosen according to their chemical properties, mechanical properties, physical properties, availability and cost. The designed and fabricated components of the washing machine were assembled together to make a prototype. The rate of washing efficiency was determined as the amount of fruits or vegetables the machine can wash clean with in a specific period of time. The cost evaluation of the designed and fabricated washing machine was carried out. It had a cost-benefit ratio of 1.93 and therefore was viable and beneficial to small scale fruit and vegetable farmers

CHAPTER I: INTRODUCTION

1.1 Background

The demand for food worldwide is steadily increasing due to the increasing world population (<http://www.fao.org>). Fruits and vegetables play an important role in providing essential vitamins, minerals, and dietary fiber to the diets of populations in both developed and developing countries and they are sighted to be an alternative to food to increase food security of rural and urban communities. Ongoing consumer demand for fruits and vegetables in developed countries has contributed to an increase in trade volume of fresh produce in developing countries; (<http://www.fao.org>). The increased trade in fresh produce has promoted the growth of small farms and the addition of new value added products creating more rural and urban jobs. In Uganda, the common fruits on the market include citrus, pawpaws, mangoes, pineapples, tomatoes, okra, carrots, pepper, cabbages, bananas, and a variety of other indigenous vegetables. The estimates worldwide production of mangoes was estimated at more than 23 million tons in 2001(<http://www.fao.org>). Similarly Carrots are among the top-ten most economically important vegetable crops in the world, in terms of both area of production and market value. In 2005, world carrot production approached 24 Mt on 1.1 million hectares and the total global market value of the more widely traded carrot seed crop has been estimated to be in the range of \$100 million.(Carrot Museum,2013)

In Uganda, the production of mangoes is improving steadily especially as a result of the improvement in the export market and growth of the food processing subsector. For instance Britannia allied company requires more than 4,000 tonnes of mangoes annually (<http://mangoproduction.tamu.edu>). This demand for mangoes and carrots has become a government strategy in poverty alleviation in rural farmers of fruits and vegetables. Therefore rural farmers are urged to practice horticulture in order to raise more produce for export and processing within Uganda, to ensure increase of house hold incomes to meet the goal of poverty eradication.

In 2000, the Government adopted the Medium Term Competitiveness Strategy (MTCS) for the private sector and Plan for Modernisation of Agriculture (PMA) in order to achieve rapid economic growth and structural transformation. These documents spell out the actions government will undertake order to remove bottlenecks to the private sector business (in Agriculture, industrial and services sectors) growth and development. The

References

FAO report, "Agriculture: Towards 2015/30" chapter 1. Fruits and vegetables: an overview on socio-economical and technical issues, available at <http://www.fao.org>, 14th October, 2013.

Production of mangoes in the tropics available at <http://mangoproduction.tamu.edu>, 3rd October 2013

Shandong Refine Fruit & Vegetable Machinery Technology Co., Ltd available at <http://www.21food.com>, 2nd November 2013

Pesticides-fruits-vegetables-healthy available at <http://abcnews.go.com>, 14th October 2013

World carrot museum; discover the power of carrots available at <http://carrotmuseum.co.uk>

Ambrose Agona and H. Muyinza, An overview of horticulture in Uganda Postharvest Programme

NARO Uganda, available at <http://www.egfar.org> 14th October 2013

Commercial production and management of carrots available at <http://www.caes.uga.edu> 14th October 2013

Barbara R. Rowe professor and Extension specialist, 2007, Washing fruits and vegetables, Utah State University

United Nations industrial development Organisation, 2007, food processing pilot plants, Vienna, Dr. A. Quaouich.

WHO fruits and vegetable report on Surface decontamination of fruits and vegetables eaten raw, 2013

Peggy Van Laann and Amanda Scott, 2103, safe handling of fresh fruits and vegetables, agricultural communications; the Texas A&M University system. Available at <http://fruitandvegetablesafety.tamu.edu>

Jenny Lynd James and Tipvanna Ngarmsak, 2011, processing of fresh cut tropical fruits and vegetables, Food and Agriculture Organisation of the United Nations