ADAPTATION OF MALAYSIAN PALM FRUIT BUNCH HARVESTER TO NIGERIAN PALMS

BY

BASIRU PHILIP ARAMIDE
(TP11/12/H/1466)
B.Sc. (Agricultural Engineering), 2008.

A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND ENVIRONMENTAL ENGINEERING, OBAFEMI AWOLOWO UNIVERSITY ILE-IFE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc.) DEGREE IN AGRICULTURAL ENGINEERING.

2015

CERTIFICATION

This is to certify that this research project carried out by Mr B.P. Aramide has been read, approved and adjudged adequate to satisfy in part, the requirements for the award of the degree of M.Sc. in Agricultural and Environmental Engineering of the Obafemi Awolowo University, Ile-Ife.

…………………………. Date
………………………..
Prof. O.K. Owolarafe
Supervisor

………………………… Date
………………………
Prof. O.B. Aluko
Head of Department

OBAFEMI AWOLOWO UNIVERSITY, ILE IFE
HEZEKIAH OLUWASAMI LIBRARY

POSTGRADUATE THESIS

AUTHORISATION TO COPY

AUTHOR: BASIRU PHILIP ARAMIDE

TITLE: ADAPTATION OF MALAYSIAN PALM FRUIT BUNCH HARVESTER TO NIGERIAN PALMS.

DEGREE: M.SC. (AGRICULTURAL AND ENVIRONMENTAL ENGINEERING)

YEAR: 2015

I, Basiru Philip Aramide, hereby authorize the Hezekiah Oluwasanmi Library to copy my thesis, in whole or in part in response to requests from individual researchers and organisation for the purpose of private study or research.

Date; ……………………….. Signature: ………………….

DEDICATION

This work

is

dedicated to

the God of Heaven,

Who has been my help since I was born.

ACKNOWLEDGEMENT

I appreciate everybody that has contributed to the success of this academic pursuit, for their immense assistance and contribution during the course of this study. I wish to acknowledge the immense contribution of Prof. O.K. Owolarafe, in his capacity as my supervisor and mentor. This work was greatly impacted by his critique, helpful guidance, devoted review and meticulous corrections of this thesis. I appreciate him for his unrelenting contribution in seeing that this work is concluded and perfectly presented. I owe him much more for his understanding during my trying times. Your training has added more value to me which I will cherish for the rest of my life.

The academic staff of the Department of Agricultural and Environmental Engineering did show genuine empathy which really encouraged me. I wish to specifically thank Dr. L.A.O. Ogunjimi, Engr. D.A. Okunade and Dr. G.A. Ogunwande for their encouragement. It would have been impossible to execute this project without the technical assistance of Mr. O. Ogunseeyin, Mr. R.O. Ibrahim, Mr. A.A. Salami, and Mr. D. Arigbede. I want to recognise the effort of Dr. A.O. Ajayi during my work at the research farm. The effort of Mr S.O. Abayomi is also highly appreciated.

I will not do without appreciating Dr. O.A. Oyeleke, the founder of the Seedot farm, and Mr A.S. Adetunji the Agriculture Officer at the State of Osun Ministry of Agriculture who was of help to me when I was collecting data on the height of palms. I appreciate Tola Odewale, Olalekan Oni, Akindipe Segun, Kehinde Olalekan, Adekanmi Sukurat, Adekele Kehinde and Wasiu who helped me on the farm during the testing of the machine at the farm. May you also find help in the time of need.

My classmates are not just friends, they are brothers. They include Tunde, Olashebikan Yemi, Ogundahunsi Femi, Ayorinde Adedayo, Ademiju Teslim, Tope. Thanks for the contribution you made to my life during our first session together. My wife and

special friend, Adebola was always encouraging and praying for me during the course of the program. She is the source of my strength and courage. I love you so much. Above all, I say thank you to the King of Kings and Lord of Lords Who has been my all in all throughout this program. God is really good to me even when I am unfaithful and weak. Without God I am nothing.

TABLE OF CONTENTS

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Plate No. **Plate Title**

Page No.

ABSTRACT

In this study, a motorized oil palm fruit bunch harvester (MT) was first tested on some plantations. The palm trees and climbers on some of the plantations were characterized. A support mechanism for the harvester was designed, fabricated and tested on a plantation. This was with a view to assessing the suitability of the harvester for harvesting the average Nigerian palms.

The MT was tested on Nigerian plantations for the palm trees it could reach, the average time taken to harvest a bunch and the time taken per hectare of plantation were determined. The best orientation and the cutting angle for the harvester were also determined. The exact height which the harvester could reach was also determined on each of the plantations. The harvester was later used in comparison with bamboo pole and knife (BK) method on palms of moderate height. Time study (TS) of the two methods was also carried out. The height of some randomly selected palm trees were measured and recorded. Also the weights of some climbers on the plantations were determined. The data on the characteristic features of palm trees and climbers were used to design the components of a support mechanism. The support mechanism (SP) was designed to make the harvester suitable for the taller trees. The design concept for the support mechanism is a pyramid structure. It comprises of three different segments namely: the wheels which facilitate easy movement within the plantation; the lower segment which comprises the stands and the platform upon which the operator (climber) stands; and the upper segment which comprises the chamber in which the operator stands. The support mechanism was fabricated and tested with the harvester on some plantations in comparison with existing method, namely the rope-and-knife (RK) method. The study determined the effect of some harvesting parameters on the harvesting methods. The harvesting parameters used are time to climb up the palm (TU); time to cut (TC); time to come down from the palm (TD); number of bunches harvested (NB) and total time of harvest (T). The data collected were analyzed using Statistical Analysis Software (SAS) package.

The result showed that MT could harvest between the height of 2.5 m and 4.5 m of palm conveniently. The average time of harvest per tree and speed of harvest for MT and BK were 98.86 sec. and 66 bunches/h; and 166.93 sec. and 40 bunches/h, respectively. This shows that time of harvest for motorized harvester is over 60% lower, and the speed of harvest is over 50% higher than bamboo pole and knife. The time of harvest per hectare for both MT and BK are approximately 4 h/ha and 7h/ha, respectively. Statistical analysis of the effect of time of harvest on methods indicated that the effect was significant ($p < 0.05$). Using the support mechanism for the MT it was much easier than rope and knife. The average time of harvest, TU, TD, and TC per tree, for both SP and RK are 189.64 and 391.20; 21.28 and 151.82; 21.08 and 103.42; and 147.28 and 134, respectively. The total time of harvest for RK is over 100% more than the time of harvest for SP. The time of harvest per hectare for both SP and RK are approximately 9 h/ha and 20 h/ha, respectively. The comparison of SP and RK shows that there is a significant difference in TU, TD, NB, T, but there was no difference in TC, ($p < 0.05$). The study concluded that the support mechanism shows promise in enhancing the use of the motorized harvester for tall palms and hence should be adopted.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The oil palm (*Elaeis guineensis* Jacq.), a tree without branches but with many wide leaves (or fronds) at the top (or crown) is a native of tropical Africa growing wild and cultivated in many parts of West Africa and Congo Basin for its economic, food and renewable bio-energy applications. The other tree crops apart from oil palm are rubber, coconut, citrus, coffee and kola (Geoffrey, 2006). Oil palm takes a prominent place among the family of tree crops because of its ability to thrive under severe climatic and ecological conditions. The oil palm gives the highest yield of oil per unit area compared to any other crop and produces two distinct oils viz palm oil and palm kernel oil; both of which are important in world trade (FAO, 2002). The oil is considered as being healthier for human consumption than the hydrogenated vegetable oil. Indeed, there is a growing awareness of the danger associated with the consumption of trans fats (hydrogenated vegetable oil), and this has made the palm oil much more popular as an alternative ingredient in packaged grocery products. It has also gained credence as cooking oil (Whole Food Market, 2006).

The production of palm oil and palm kernel oil in 2005 reached 36 million tons, and palm derived oil has become the most abundant and consistently supplied oil among vegetable oils of the world (Kanoh *et al*., 2008). The oil palm tree produces fruits that are compactly packed in bunches which are hidden in leaf axils in crowns that may be over 12 m above the ground. Each of the bunches contains over a thousand fruits, which are held in the axils of the leaves and are arranged in a rosette around the crown. It is simply the most productive oil plant in the world (Butler, 2006).

Oil palm is one of the focus area where there is still less contribution from the researchers and manufactures. There are few problems arising, such as how to maximize the profit, increase productivity and reduce the cost. One of the important activities in oil palm plantation is harvesting. However, oil palm harvesting still defies the best attempt of mechanization (Russ, 1998). There had been previous work on development and modification of the existing methods of harvesting oil palm.

Efficient harvesting of fresh fruit bunches (FFB) plays a vital role towards improving the quality of the harvested fruits. Harvesting of FFB from short palms (<3 m high) is relatively a simple operation. A chisel attached to a short steel pole is normally used. The tool is usually aimed at the target point (frond base or bunch stalk) at a very high speed to effect the cutting. The weight of tool coupled with the very high speed of chopping creates high momentum, which provides enough energy to cut through the frond or the bunch stalk (Abdul Razak, 1997).

However, harvesting FFB from palms of more than 3 m height requires a different method and technique. In this situation, a long pole with a sickle at the end is used. Two activities have to be carried out: lifting the pole upright, and cutting the frond or / and fruit bunch. This operation demands that the operator be highly skilled in handling the tool and having enough energy to carry out cutting operation (Abdul Razak *et al*., 2003).

1.2 Statement of Research Problem

In the early days, bamboo was the most popular pole used for harvesting FFB from the tall palms (Abdul Razak *et al*., 1998). With bamboo pole and knife method, the greater mass and length of poles made harvesting uncomfortable. When trees are beyond 6.5 m in height, pole bending becomes very pronounced. Transportation of long and heavy harvesting poles to, from, and on the field was an onerous task. There is also the accompanying risk of injuring other field workers with the Malaysian knife on a long pole (Adetan and Adekoya, 1995).

Realizing the problem, Malaysian Palm Oil Board (MPOB) developed a motorized cutter for palms of middle height. It has been tested on some plantations and observed to be effective on some palms. According to Abdul Razak *et al*. (2008), this cutter can only harvest palms below 5 m, which is the major shortcoming of the cutter. However, a healthy oil palm produces fruit for over 50 years which would be above 9 m in height. It is to this end that the research was set up to design and develop a support mechanism that would help adapt the motorized cutter developed by MPOB to Nigerian palms.

1.3 Objectives

The main objective of this work is to adapt the Malaysian motorized palm fruit bunch harvester to the plantations in Nigeria.

The specific objectives of the research are to:

a) test the motorized oil palm bunch harvester on some plantations;
b) characterize oil palm trees and climbers on the plantations;
c) design the support mechanism for an existing oil palm fruit bunch harvester that would be adapted to harvesting Nigerian palms; and
d) test the support mechanism with the oil palm bunch harvester.

1.4 Justification

Timeliness of harvesting is very crucial to reduce loss in terms of the quality and quantity of oil palm FFB. At present, a sickle attached to a pole is the normal tool