OBAFEMI AWOLOWO UNIVERSITY

# PERFORMANCE EVALUATION OF A KENAF DECORTICATOR

**BY**

**THOMAS ADEDAYO AYORINDE**
**B.Eng. (Akure), 2009**

**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 AND ENVIRONMENTAL ENGINEERING**

**2015**

OBAFEMI AWOLOWO UNIVERSITY

## CERTIFICATION

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

……. Date
……..
**Prof. O.B. Aluko**
Supervisor

…… Date
……..
**Prof. O.K. Owolarafe**
Co-supervisor

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

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## DEDICATION

This work

is

dedicated to

the Almighty God of Israel,

who has been my help since I was born.

## ACKNOWLEDGEMENTS

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## ABSTRACT

The study determined the effect of operation parameters of a kenaf decorticator on the quantity and quality of fibre produced. This was with a view to establishing the optimal operating condition and its appropriateness for small and medium scale processing of kenaf.

A field was planted with kenaf at the Teaching and Research Farm (T&RF) of the Obafemi Awolowo University, Ile Ife. The field was maintained and monitored until the kenaf was 10 weeks old when the evaluation of the machine commenced. The kenaf decorticator was evaluated using different operation parameters, which include plant age (10, 11 and 12 weeks after planting), kenaf stem size (small, medium and large) and decorticator speeds (520, 600 and 680 rpm). The experiment is a 3 by 3 factorial experiment in three replicates. The indices used to determine the performance of the machine were: the weight (kg) of quantity of fibre generated in kg, weight (kg) of quantity of waste collected from the machine and time taken to complete each of the experiments. Data collected were subjected to 3-way ANOVA using Statistical Analysis System (SAS) System software to determine the effect of the processing condition on the throughput capacity, percentage of fibre decorticated and machine extraction efficiency.

This results obtained showed that the highest mean of throughput value generated was 614.70 kg/h. This was obtained when the machine was operated at 600 rpm using large kenaf size harvested at 12 weeks after planting. The percentage of kenaf fibre trapped in the machine decreased from 24 to 13% as the speed decreases from 600 to 520 rpm and percentage waste collected decreased from 54 to 32%. These show that the best fibre was obtained when large kenaf stem was decorticated, and the speed of the machine was between 520 to 600 rpm. The percentage decorticated also increased from 31 to 49% as the speed decreases to 520 rpm. This shows that the

best fibre was obtained when the kenaf stem was large, speed of decorticator was 520 rpm and age of kenaf was 12 weeks old. The kenaf extraction efficiency increased from 74 to 91% as the speed deceased to 520 rpm, kenaf size was large and at 12 weeks after planting.

The study concluded that the optimal operational parameters of the machine was 520 rpm with large kenaf size and 12 week of kenaf maturity. The machine has the capacity to decorticate 0.4 ton of kenaf per hour.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Study

There is a continuous increase in the use of low-cost sacks for handling and storing agricultural product like cocoa, coffee, rice, bean, maize, and groundnut and so on. The textile industries also demand these sacks for packaging their products and textile industries are facing great pressure to reduce pollutant emissions. This drives textile manufacturers to seek new approaches to producing environmentally friendly products, such as recyclable and biodegradable textile materials. More and more attention has been drawn to agricultural products, wastes, and derivatives because of their renewability. In Nigeria, environmental degradation is increasing due to increase in oil production (Energy Information Administration Nigeria, 2003) and felling of trees in forests. The need to develop a renewable resource that will provide raw materials in a sustainable manner has therefore led to the recent acceptance of kenaf as an industrial crop.

The kenaf plant is composed of multiple useful components (e.g. stalks, leaves, and seeds) and within each of these plant components there are various usable portions (e.g. fibres and fibre strands, proteins, oils, and allelopathic chemicals). The combined attributes of these components provide ample potential product diversity to continue use and development of this crop (Webber *et al*., 2002).

Kenaf yields a soft fibre from the stem that is very similar to jute. Along with a closely related species called roselle (*Hibiscus sabdariffa L*.), the two species account for one-third of

the world production of soft fibre used for packaging. Kenaf is rapidly replacing jute, because the crop has less intensive labour requirements, is cheaper to produce, may be grown on a wide range of soils under varied climatic conditions, and is not necessarily competitive with food crops. While kenaf is somewhat coarser than jute, it has greater tensile strength, is lighter in colour, and has greater resistance to moisture (Dempsey, 1975).

The traditional use of kenaf focuses on its fibre production, such as making ropes, sacs canvases, and carpets (Li, 1980). However, new applications of kenaf have recently been developed such as pulping and papermaking, board making, absorbents and potting media, filtration, textiles, and livestock feed.

The commercial success of kenaf has important potential economic and environmental benefits in the areas of soil remediation, toxic waste cleanup, removal of oil spills on water, reduced chemical and energy use for paper production, greater recycled paper quality, reduced soil erosion due to wind and water, replacement or reduced use of fibre glass in industrial products, and the increased use of recycled plastics (Webber and Bledsoe, 2002). The automotive industry uses the so-called biocomposites (made from kenaf bast fibre and resins) as replacement material for glass-reinforced plastic materials in the manufacture of car seats, door panels, boot trim, wheel arches and parcel shelves (Anonymous, 2005). Kenaf seed yield edible oil that is used for first class cooking oil and margarine production. The seeds can also be used for cooking (flour) and lubrication, soap manufacture, linoleum, paints, and varnishes (LeMahieu *et al*., 2003).

Kenaf is a plant that contains fibre useful for the production of low cost sacks (jute bags) for packaging agricultural products and for industrial uses such as pulp and paper for

newsprint, writing paper and tissue paper, burlap cancass for making shoes and bags, camouflage cloth, linoleum backing, fibre board, cement/fibre roofing sheets, ceiling sheets and tiles, and carpet underlay most of which are imported in Nigeria.

## 1.2 Problem Definition

Kenaf Decortication to extract the fibre is a major challenging unit operation in the production of fibre from the plant. A kenaf decorticator was designed several years ago in the Department of Agricultural Engineering of the then University of Ife. The existing design was modified to get the machine to a commercial status. The machine is however yet to be evaluated for its performance. The main target of this research is to evaluate the machine in terms of throughput capacity, decortication efficiency and time taken to decorticate.

## 1.4 Objective

The specific objectives of this research are to

a. determine the effect of machine operation parameters on the yield of fibre;
b. evaluate the effect of the operation parameters on the quality of fibre; and
c. establish optimal operating condition for the machine based on (a) and (b) above.

## 1.3 Justification

Kenaf fibre is an important raw material in the production of low cost sack for packaging agricultural product (jute bags) and for industrial uses such as pulp and paper for newsprint, writing paper and tissue paper, burlap cancass for making shoes and bags, camouflage cloth, linoleum backing, fibre board, cement/fibre roofing sheets, ceiling sheets and tiles, and carpet underlay most of which are imported in Nigeria. With the purpose of reducing import of these

bag and save some foreign exchange, there is need to produce low cost bags from jute substitute plants grown in Nigeria. Kenaf and other similar substitute for jute were grown in commercial quantities in different parts of Nigeria. The fibre required for manufacturing these bags is obtained from the bark of kenaf and similar plants. This fibre can be extracted using three