DEVELOPMENT OF A LOCUST BEAN PROCESSING PLANT

(DESIGN OF LOCUST BEAN THRESHER AND CONSTRUCTION OF LOCUST BEAN DECORTICATOR)

BY

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

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DECLARATION

I hereby declare that this project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree, diploma or certificate at any university or institution. Information derived from personal communications, published and published works of others were duly referenced in the text

Ojo, Temitope Olawale

14/11/2006

Date

CERTIFICATION

This project entitled "Design of a locust bean thresher and construction of a locust bean decorticator" by Ojo, Temitope Olawale meets the regulations governing the award of the degree of Bachelor of engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project work is dedicated to my parents Mr. A. H. Ojo and Mrs. C. B.Ojo and my grandmother Mrs. M. Y. Fatosa

ACKNOWLEDGEMENTS

My sincere thanks go to God Almighty for his support which I enjoyed throughout the successful completion of this programme.

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I also wish to appreciate the staff of Agricultural Engineering Department, Federal University of Technology, Minna; The Head of Department; Dr (Mrs.) Z. D. Osunde, Prof. E. S. A. Ajisegiri, Dr D. Adgidzi, Dr A. N. Egharevba and others who have imparted knowledge on me during the course of my programme.

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ABSTRACT

This project work presents the design of a locust bean thresher and the construction of a locust bean decorticator. The necessary parameters of the thresher designed include the shaft diameter, power requirement which are 20mm, 2.2kW respectively. The operating principle involves beaters which beats the crop against a stationary plate, this beater achieves threshing by beating (impact).The decorticator was constructed from locally sourced materials, which are cheap and the working principle of the decorticator is simple with an efficiency of 68%.

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CHAPTER ONE

1.0 INTRODUCTION

The African locust bean tree which belongs to the family of *mimesacease* is of leguminosae group and has different varieties namely; *parkia bicolour*, *parkia clappertuniana, parkia fillicoida* and *parkia biglobosa*. Locust bean seed is an important protein based fermented food produced from African locsust bean (Ajayi, 1991). It is consumed substantially throughout Nigeria and West Africa. Its production is essentially at the cottage industry level. It is called different names in various Nigeria languages, namely "iru" (Yoruba); "dawadawa" (Hausa) and "ogiri" (Ibo). Locust bean seed is of high quality and nutritional value both for human and animal feed (Ajayi, 1991).

The locust bean fruit consists of bunches of pods which form the edible part of the plant. Each pod contains a yellow pulp which is enveloped by a thin membrane that covers the brownish black seed coat to be removed. The removal of the seed and pulp from the locust bean pod is the most laborious and tedious of all the processing steps in the local production of "iru" at the moment. This is an aspect of the processing of locust bean which has not been fully mechanized.

1.1 Aim and objectives

The overall aim of this work is to industrlize the production of process of fermented locust bean seed, reduce the drudgery associated with remover of pulp which contains the seed from the pod of locust bean and improve the efficiency of the process through mechanization.

Specifically, the objectives are:

(i) To design a locust bean thresher

(ii) To construct a locust decorticator

(iii) To do {ii} above using locally available materials

(iv) To evaluate the constructed decorticator in terms of efficiency

1.2 Justification

Since, there is a need to reduce drudgery, save time and encourage the industrial production of this food condiment, it is important to work on this , since according to (Ajayi, 1991) an existing cowpea thresher was used to carry out threshing trials on locust bean. It was found to be inadequate for threshing locust bean. This is because locust bean has peculiar physical characteristics which are different from those of cowpea. Therefore, it is important to design a thresher for locust bean .

1.3 Scope

The work involves the design of a machine that will remove the locust bean pulp from the pod and also the construction of a decorticator

1.4 Limitations

The challenges faced in the course of the research work were finances and time for proper investigation into the work, though various were made to actualize the aim.

CHAPTER TWO

2.0 LITERATURE REVIEW

Threshing is the process of detaching grain from the earhead in the case of sorghum, millet, wheat and so on. While the removal of the pulp and seed from the pod of locust bean is also threshing.

Tremendous research work has been done on threshers the test report of some of these gives a broad idea about the design of a locust bean thresher.

Delony and Schwantes (1942), studied the effect of cylinder speed and clearance on mechanical injury of barley for three types of cylinder. A small, power take off driven combine harvester which could be equipped with a rasp bar cylinder or a rubber faced bar cylinder was used. A stationary thresher was used for spike- tooth cylinder for the test. The best clearance for rasp bar cylinder was found to be 0.95 to 1.27 cm as measured to the tips of the bar serrations. The rubber faced bar did the best work at a clearance of1.27 to 1.59 cm, whereas a 0.40 cm lateral clearance was best for spike- toothed cylinder. The cylinder peripheral speed of 1,524 to 1,828 m/min was the best of all three cylinders. Slower speeds left un-threshed head and higher speeds resulted in much cracking and skinning of barley

Klein and Harmond (1966), studied the effect of varying cylinder speed and clearance on three different threshing cylinders. They tried to determine cylinder type and its setting for efficient threshing without increasing the broken and damaged grains. The cylinders tested were (1) spike-toothed (2) rubber covered angle bar (3) rubber covered flat bar and their optimum peripheral speed and clearance were 25.75m/s and 0.40cm, 20.9m/s and 24.53m/s and 0.80 to 0.32cm respectively. The rubber covered flat bar cylinder recovered

about 10% more crimson clover seed than the two cylinders and the unthreshed seed were reduced to about 5% in the process.

IRRI (1967, 1968), designed and developed a drum type powered thresher for freshly harvested paddy. The machine was powered by a 4hp air cooled engine and utilized the u-shaped wire loop type threshing drum, which was mounted with sheet metal housing. Rubber flaps were placed in spiral arrangement on the drum to suit the housing bottom and to deliver the threshed material to the rare mounted rotary screen separator. An axially mounted fan was used to blow air through the drum and the separator. The threshing drum therefore was not used only for threshing but also as an auger for moving the material to the separating unit of the machine. The machine was capable of threshing both dry (14% moisture contents) and wet (over 30% moisture contents) paddy.

Singh and Joshi (1977), reported that the Japanese type thresher of 40cm drum diameter and 90cm width rotating at 400rpm powered by a 3hp electric motor gave an output of 145kg/hr. A rasp bar thresher of 28.5cm drum diameter and 32cm width gave an output of 139kg/hr of clean paddy. The energy needed per quintal of threshing and cleaning was 0.36hp/hr of manual and 1.64hp/hr of electrical energy. For through feed rasp bar thresher it was 0.44hp/hr of manual and 0.72hp/hr of electrical energy.

Desta and Mishra (1990), developed and evaluated the performance of a sorghum thresher. The capacity of the thresher is 188kg /hr. It was designed on the basis of physical properties of sorghum grain. The thresher was evaluated for its performance in terms of threshing efficiency, cleaning efficiency, visible damage, germination percentage and sieve loss. From the results, the threshing efficiency was found to be in the range of 98.3% to 99.9%. Visible damage decreases with increase in cylinder speed

and with decrease in feed rate and cylinder concave clearance. It was observed in the range 1.12% to 4.22%. The results of the test indicate that for optimum performance the thresher should be operated at a cylinder speed of 400rpm (10.05m/s) with cylinder concave clearance of 7mm and feed rate of 6kg/min. The power required for operating the thresher at this combination was 5kW and the maximum output was 162.57kg/hrs.

Ndirika (1993), designed, developed and evaluated the performance of a millet thresher. The throughput capacity of the thresher is 47.5kg/hr and was designed for local varieties of millet (ex Borno and maiwa). The physical properties of millet crop and grain such as bulk density, grain/straw moisture content, size and angle of repose were studied. The thresher was fabricated and evaluated for its performance in term of threshing efficiency and sieve loss. The result revealed that for optimum performance the thresher should be operated at a cylinder speed of 800rpm respectively with ex-Borno and maiwa varieties at federate of 20kg/hr. The power requirement for operating the thresher at this combination 2.24kW and the maximum output was 38.5kg/hr.

Yisa and Idah (1997), designed and fabricated a mobile thresher to thresh sorghum (kaura and long varieties). Preliminary tests were carried out on the thresher to ascertain its performance and hence facilitate necessary modifications that will lead to perfection. The reciprocating assembly also provides the necessary cleaning operation required. The cost, safety, durability and efficiency were critically taken into consideration in the design. The results of the preliminary tests carried out on the machine showed a very remarkable and promising success.

2.1 Locust Bean Processing Generally

From fig. 1, we find the unit operations involved in the processing of locust bean

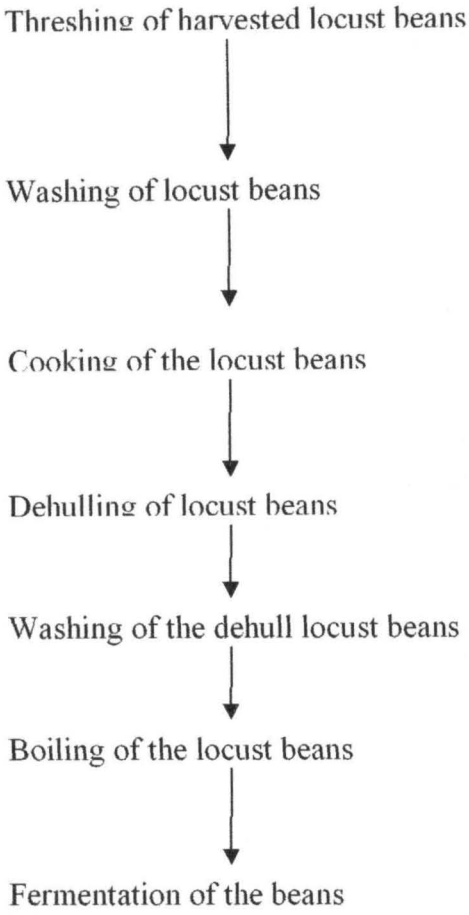


Fig. 1 flow chart of locust bean processing

After harvesting the locust bean, the first post harvest activity is its threshing (removal of the pulp containing seed from the pod). This is followed by washing away the pulp in water, and then the washed locust bean is cooked for very long hours after which it is cooled and sent to the duhuller to remove the coat of the locust bean. After dehulling the removed coat of the locust bean is then washed out with water. After which the washed locust bean is boiled for short period to make the locust beans ready for fermentation.

2.2 Locust beans threshing

Threshing of locust beans is the removal of the pulp containing the seed from the pod and as well separating the locust beans seed from the pulp, this could be done by

(1) Traditional method i.e. manual

(2) mechanical method

2.2.1 Threshing by traditional method

The manual threshing of locust beans could be by hand or by using stick. Hand is used to split the individual pods to reveal the pulp containing the locust beans seed. This is tedious and time consuming. It also requires large labour. Using stick to beat the locust beans also removes the pulp containing the locust bean seeds. This also requires large labour and also a very arduous task. In addition the pulp and seed becomes contaminated with debris from contact with the ground where the beating takes place.

2.2.2 Mechanical threshing of locust bean

The basic unit of a threshing machine is the beater which beats or rubs the crop against a stationary plate. The beater achieves removal of the pulp containing the seed from the pod either by impact (beating) or by the rubbing action or by a combination of the two.

The main components of a threshing machine are:

(1) A beater, usually revolving, which may have different types of beater heads or pegs on its circumference. It is usually called a threshing cylinder, and depending on whether the threshing action is achieved by beating or rubbing, the cylinder is denoted a spike type or a rasp bar type respectively.

(2) A stationary plate, usually with slots or spaces in it, against which the threshing cylinder beats. The part is called the concave.

(3) A feeding hopper to feed the crop.

(4) A winnowing device, which is usually a fan to blow the chaff away from the threshed material or an aspirator to suck up the unwanted chaff.

(5) A set of sieves, to sort grain or seed from the chaff and other materials.

The crop is fed from the hopper into the threshing area and the pulp containing seed and chaff fall down onto the sieve area. Simultaneously air from the blower passes through and the grain, being heavier, falls down to the screen; the chaff and other debris are blown out, being lighter than the grain or seeds.

CHAPTER THREE

3.0 DESIGN CALCULATIONS

3.1 Design assumptions

From the experiment carried out at National centre of Agricultural Mechanization, using the Universal testing machine, the force required to break open the pod is 35N and the length of the pod of locust been is used to select the hopper size which is 280 at average length. The tests carried out to know the amount of force required to break open the locust bean pod and locust bean seed were obtained and results are shown in Table1, Table 2, Fig. 2, and Fig. 3. Using the multipurpose thresher in the department which threshed the locust bean but not effectively and did not separate it. The assumed weight of locust bean acting on the shaft at a point is 30kg based on the hopper size.

Table 1 Results of compressive test carried out on the locust bean pod

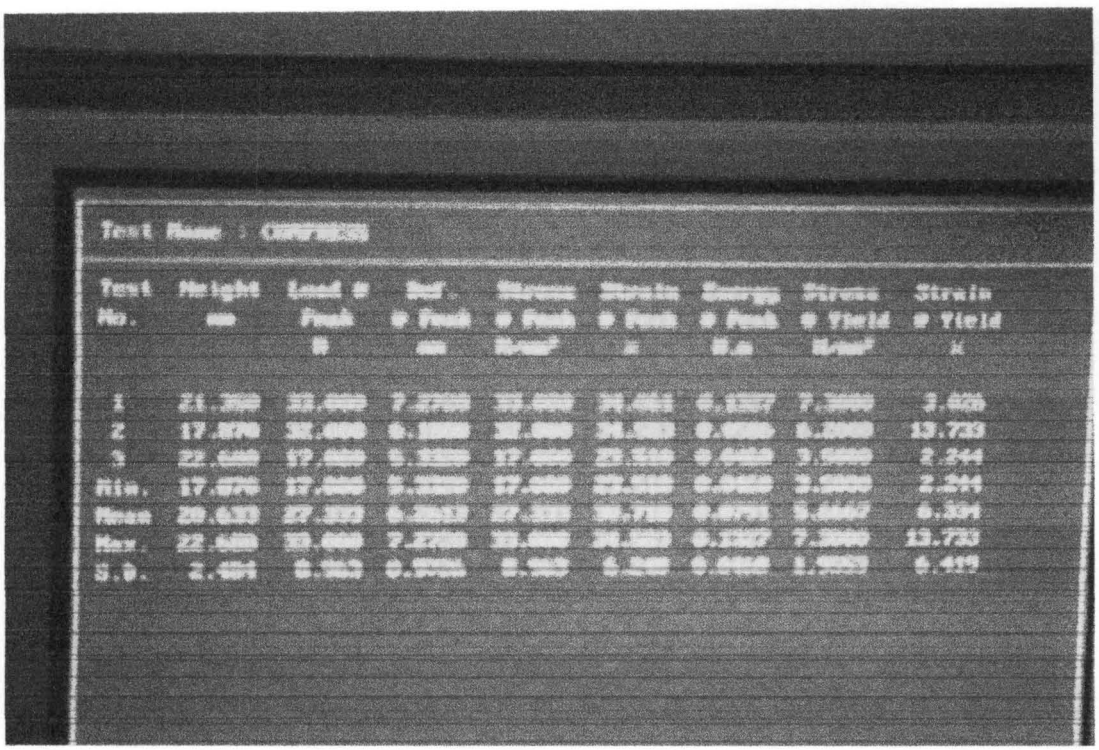


Fig 2 Graph of the compressive test carried out on the locust bean pod

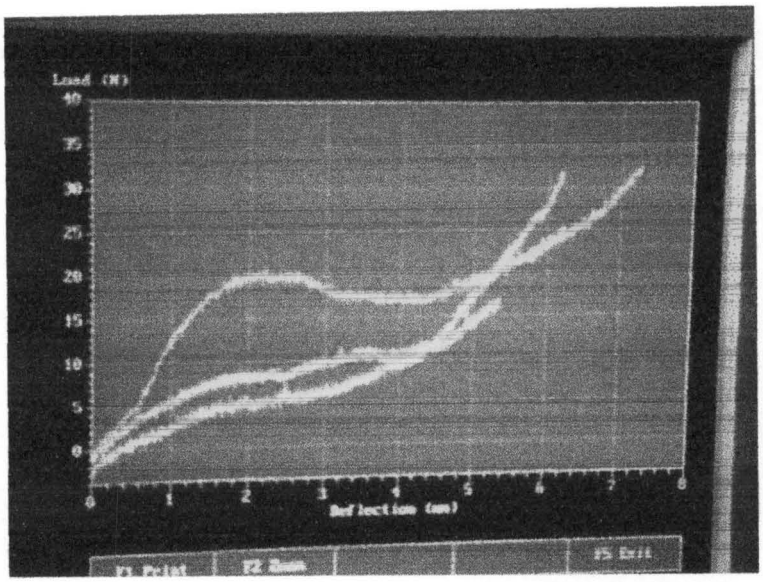


Table 2 Result of compressive test carried out on the locust bean seed

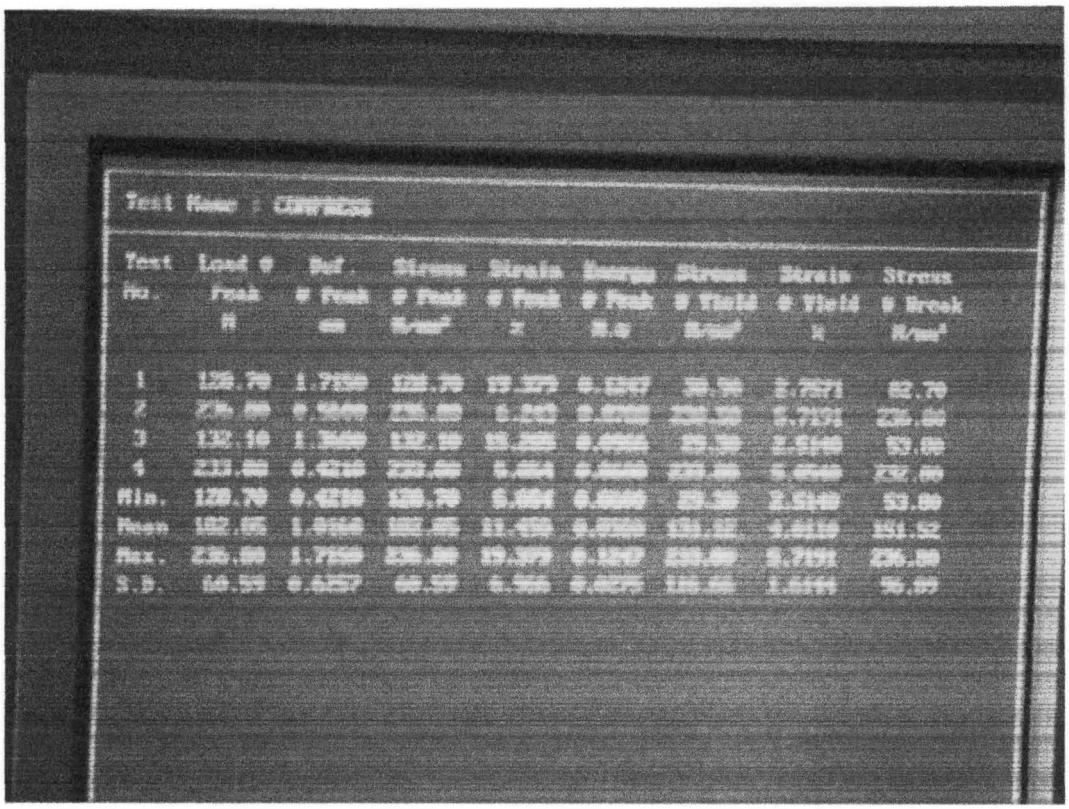
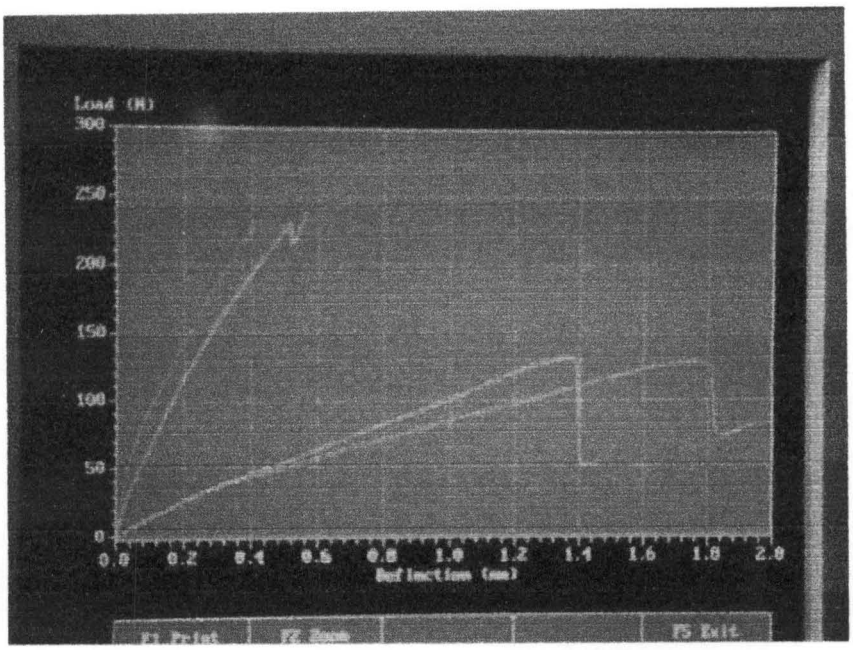


Fig 3 Graph of the compressive test carried out on the locust bean seed



3.2 Determination of the diameter of shaft

We consider the weight of the cylinder, pulley, cylinder end plates and spike tooth on cylinder

Diameter of cylinder = 150mm

Length of cylinder = 400mm

Thickness of cylinder material = 4mm

The volume of cylinder = circumference x length x thickness (2π rlt) (1)

$= 2\ \pi\ (75) \times 400 \times 4$

$= 7.54 \times 10^5\ mm^3$

Since density of mild steel is $7840 kg/m^3$

Mass = $7840 \times 7.54 \times 10^5 \times 10^{-9}$

=5.90kg

Cylinder end plates

Two end plate made of mild steel were used

Diameter = 150

Thickness = 5mm

Volume = $\pi\ r^2\ (t)$ (2)

$= \pi\ (75^2) \times 5$

$= 8.8 \times 10^4\ mm^3$

But a hole of diameter 30mm was opened at the center of each plate. This hole is where the shaft passed before being welded to the plate

Therefore, the volume of each of these plates is the volume less the bore

Volume of hole = $\pi r^2 t$

$= \pi\ (152) \times 5$

$= 3.5 \times 10^3\ mm^3$

Therefore volume V of each cylinder end plate is

Volume of plate - volume of bore

$V = 8.8 \times 10^4 - 3.5 \times 10^3$

$V = 84500mm^3$

Mass of the cylinder plate, M

$M = V \times \rho$ (3)

$M = 84500 \times 9840 \times 10^{-9}$

$M = 0.831kg$

For two plates the mass is;

$M = 2 \times 0.831$

$M = 1.66kg$

Spike tooth on the cylinder

The spike is made of mild steel with height, h = 50mm diameter, D = 8mm

Therefore volume of each spike (Vs)

$V_s = \pi r^2 h$ (4)

$V_s = \pi \times \left(4^2\right) \times 50$

$V_s = 2513mm^3$

Mass of each spike (Ms)

M_s = volume× density

$M_s = 2513 \times 7840 \times 10^{-9}$

$M_s = 19 \times 10^{-3} kg$

But there are 50 spikes therefore,

$M_s = 50 \times 19 \times 10^{-3}$

$M_s = 0.95kg$

Therefore the weight of the cylinder, the cylinder end plates and the spikes on the shaft are;

$M_t = 5.90 + 1.666 + 0.95$

$M_t = 8.51kg$

now, $M_t = 8.51 \times 9.81 = 83.48$ N

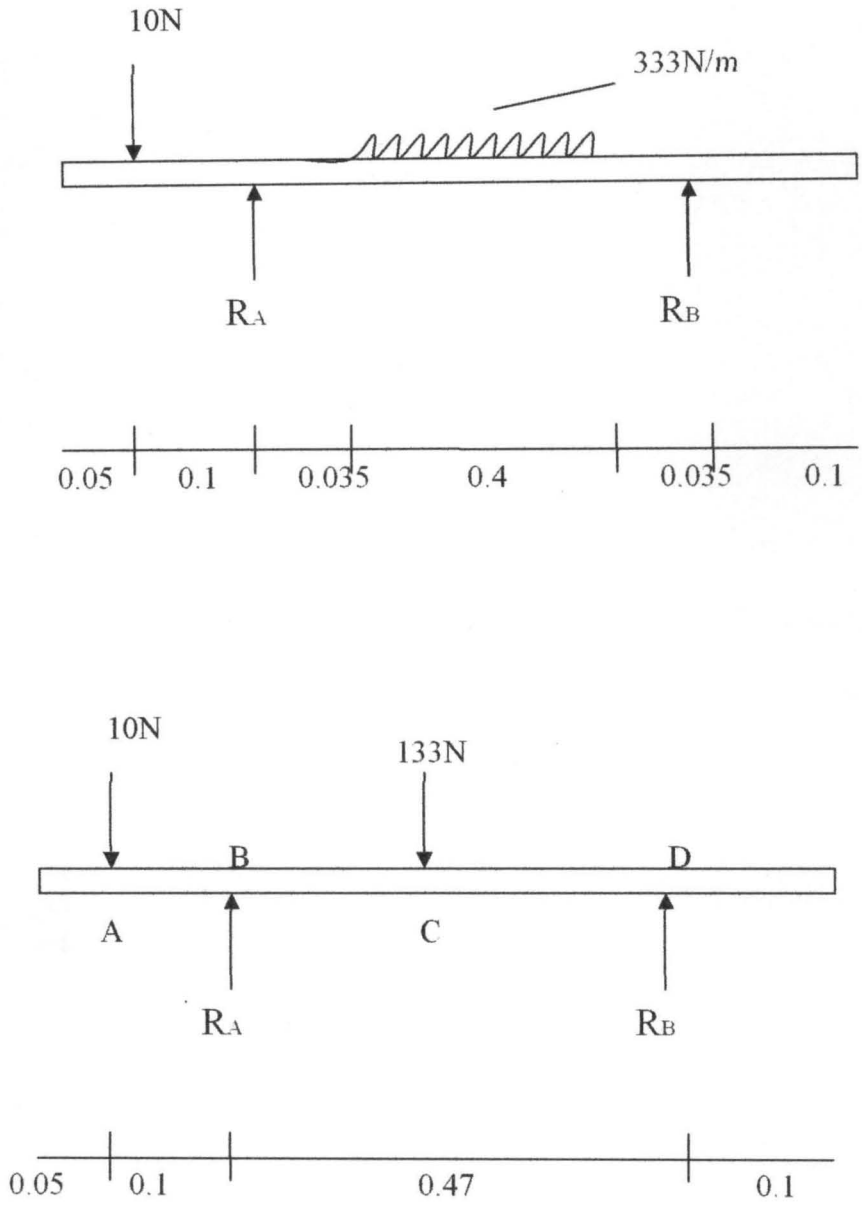


Fig. 4 force loading on the shaft

$$\sum F = 10 - R_A + 133 - R_B = 0$$

$R_a + R_B = 143N$

$$\sum M_A = (-10 \times 1) + (133 \times 0.235) + \left(-0.47 \times R_B\right) = 0$$

$0.47R_B = -1 + 31.26$

$0.47R_B = 30.26$

$R_B = 64.38N$

$R_A = 143 - 64.38$

$R_A = 78.62N$

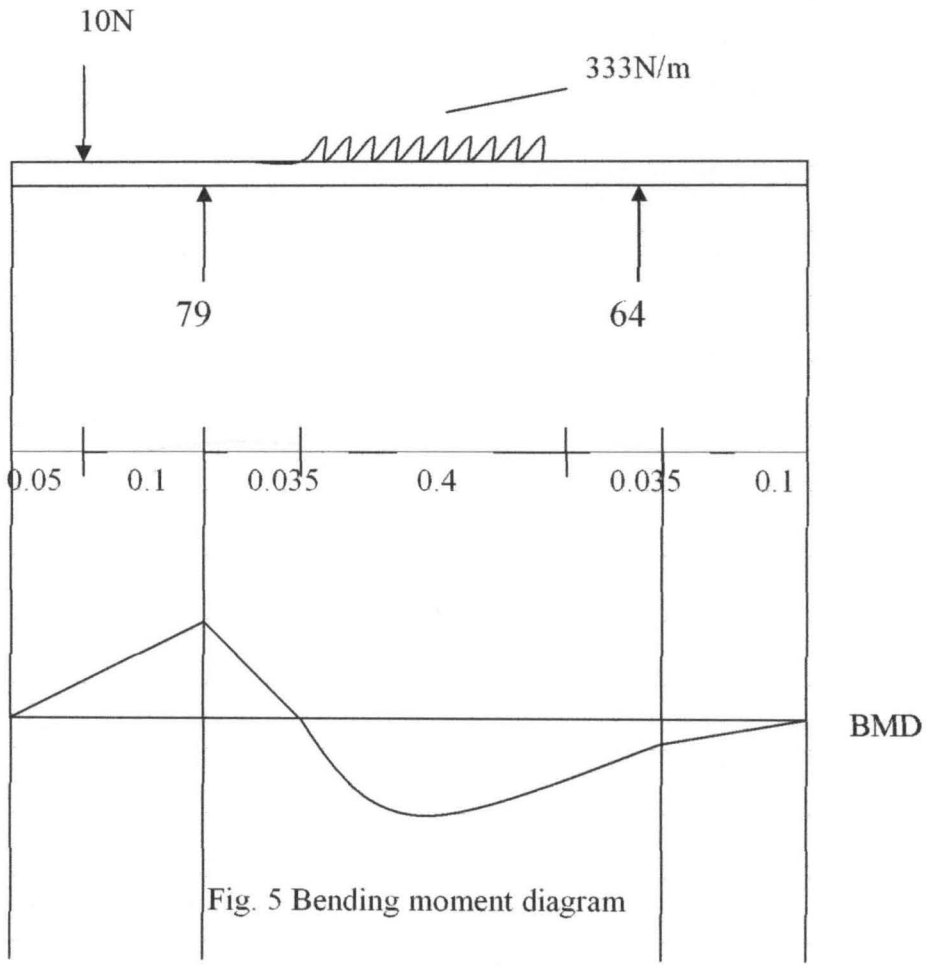


Fig. 5 Bending moment diagram

$$M + 10x - 79(x - 0.1) + 133(x - 0.335) - 64(x - 0.57) = 0$$

$$M = -10x + 79(x - 0.1) - 133(x - 0.335) + 64(x - 0.57)$$

For point A

When $x = 0$, $M = 0$

$$M_A = -10 \times 0$$

$$M_A = 0$$

For point B,

When $x = 0.1$

$$M_B = -10x + 79(x - 0.1)$$

$$M_B = -10 \times 0.1 + 79(0.1 - 0.1)$$

$$M_B = -1\text{Nm}$$

For point C,

When $x = 0.335$

$$M_C = -10(0.335) + 79(0.335 - 0.1) - 133(0.335 - 0.335)$$

$$M_C = 15.215\text{Nm}$$

For point D,

When $x = 0.57$

$$M_D = -10(0.57) + 79(0.57 - 0.1) - 133(0.57 - 0.335) + 64(0.57 - 0.335)$$

$$M_D = 0.175\text{Nm}$$

The maximum bending moment is 15.215Nm and is obtained at point C.

Torsional moment $Mt = (T_1 - T_2) \times r$ (5)

$M_t = (233.7 - 9.29) \times 0.1$

$M_t = 22.44\text{Nm}$

Therefore the formula for diameter of shaft

$$d^3 = \frac{16}{\pi \tau} \times \sqrt{(K_m \times M_b)^2 + (K_t \times M_t)^2} \qquad (6)$$

Where:

τ = maximum permissible shear stress for shaft with allowance for keyways = 42MPa

K_m = combined shock and fatigue factor for bending

K_t = combined shock and fatigue factor for torsion

M_b = maximum bending moment

M_t = maximum torsional moment

Thus;

$$d^3 = \frac{16}{\pi \times 42 \times 10^6} \times \sqrt{(1.5 \times 15.22)^2 + (1 \times 22.44)^2}$$

$$d^3 = 1.21 \times 10^{-7} \times \sqrt{1024.76}$$

$d^3 = 0.0157\text{m}$

d = 16mm (used 20mm diameter)

3.3 Power requirement

Power requirement of the cylinder

The power supplied to the cylinder Ns, is used to overcome idling resistance Nj and threshing process Ns. The idling resistance Nj is caused by friction in bearing of the

cylinder shaft. This resistance depends mainly on the speed of the cylinder and according to Goriaczkin:

$$N_j = A\omega + B\omega^3 \qquad (7)\ \text{(Yisa, et al)}$$

Where:

A = moment from friction force in the bearing

B = coefficient characterizing the fan effect of the cylinder

ω = angular speed

Where

$$\omega = \frac{V_B}{R_B} \qquad (8)$$

VB = speed of threshing cylinder = 1230 rev/min

RB = diameter of the threshing cylinder

$$\omega = \frac{20.5}{0.02}$$

$$\omega = 1025\,\frac{\text{rad}}{\text{s}}$$

Therefore

$$A\omega := 0.4 \times 10^{-3} \times 1025$$

$$A\omega = 0.41 \quad \text{W}$$

Therefore:

$$B\omega^3 = \frac{M_p V_p}{2} = \gamma_p \times F_1 E^2 (V_c)^2 \qquad (9)\ \text{(Yisa, et al)}$$

$B = 0.91 \times 10^{-3}$ Nm (According to Russian data, 1982)

$B\omega^3 = 0.91 \times 10^{-3} \times 1025$

$B\omega^3 = 0.933$ W

also

$N_j = 0.41 + 0.93$

$N_j = 1.34$ W

The above relationship shows that fanning resistance with increase in angular velocity takes a substantial portion of the power supplied. In the threshing process, the major resistance is caused by;

(1) Acceleration of the material

(2) Interaction between the pods and the rubbing by the pods on the concave.

(3) Crushing of pods, the reaction of the spike on the material

The reaction of the spikes on the material is given by

$$P = Ae^{cd} \frac{N}{m^2} \quad (10)$$

where

d = relative crushing of material

A & c = are coefficients (A = 0.001N/m2 and c = 12)

$$d = \frac{a - a'}{a} \quad (11)$$

a = thickness of the uncrushed pods

a' = thickness of the crushed pods

$$d = \frac{0.14 - 0.1}{0.14} = 0.2857$$

$$d = 0.3$$

$$P = 0.001e^{12\times 0.3}$$

$$P = 0.001 \times 36.6$$

$$P = 0.037\ W$$

When the spikes move on the concave the total reaction on the material is given by

$$P = b\rho\lambda L \qquad (12)$$

Where;

ρ = unit pressure of the spike (N/m2) = 0.037

b = thickness of the concave (m) = 0.02

L = length of concave (m) = 0.4

λ = coefficient of utilization of the length of the concave = 0.6

$$P = 0.025 \times 0.037 \times 0.6 \times 0.4$$

$$P = 1.776 \times 10^{-4}\ W$$

$$P = 1.8 \times 10^{-4}\ W$$

Total power required

$$N = \frac{J\omega\delta\omega}{dt} \qquad (13)$$

This implies;

$$N = \frac{M'V^2}{(1-\mu)} \qquad (14)$$

M' = mass of material send into the system within one second

V = velocity of material

μ = coefficient of friction of the material within the threshing unit.

Now;

M' = 0.8

V = 20.5

μ = 0.85

Thus;

$$N_V = \frac{0.8 \times 20.5^2}{(1 - 0.85)}$$

$N_V = 2241.33$ W

Therefore, the total power required by cylinder is,

$$N_S = N_j + N_V \quad (15)$$

$N_S = 1.34 + 1.8 \times 10^{-4} + 2241.33$

$N_S = 2242.67$W

$N_S = 2.2$kW

3.4 Bearing selection

Determination of the radial load on bearing

$$P = 2\pi NT \quad (16)$$

Where;

P = power

N = number of revolution per minute

T = torque

$$T = \frac{P}{2\pi N}$$

But,

$$T = F \times R$$

$$F = \frac{P}{2\pi NR}$$

$$F = \frac{P}{\pi ND}$$

$$F = \frac{5.5 \times 10^2}{\pi\left(\frac{1230}{60}\right) \times 0.02}$$

$$F = 427N$$

Considering the loading and summing the force vertically

$$F = 0$$

$$RA + RB = F = 427N \qquad (17)$$

Taking moment about B

$$M_B = 1 \times F - 0.335RA = 0$$

$$427 - 0.335RA = 0$$

$$RA = 1275N$$

Therefore;

$$R_A + R_B = 427$$

$1275 + R_A = 427$

$R_B = -848N$

The load on the bearing A would be used to select the appropriate size bearing because its greater than the load at bearing B

Therefore, the radial force F x R = 1275N for shaft with axial load.

From table c/p = 4.23 at 1230 rpm and 8000 hours (PSG design data, 1982)

The axial load,

$F_a = 562.73$

This implies that the ratio

$$\frac{F_a}{F_r} = \frac{562.73}{1275} = 0.4414 \quad (18)$$

Self aligning ball bearing

For

$$\frac{F_a}{F_r} = 0$$

X = 0.65 Y = 2.3 (PSG design data, 1982)

Determination of the equivalent load, P

The equivalent load, P acting on the bearing is

$$P = \left(XF_r + YF_a\right) \quad (19)$$

where

X = radial factor

Y = thrust factor

Fa = axial load

Fr = radial load

$P = (0.65 \times 1275 + 2.3 \times 562.73)$

$P = (828.75 + 1294.28)$

$P = 2123.03N$

Determination of the required life of bearing

The required bearing life for hand tools, lifting tackle, Agricultural machines, domestic appliance, 8000hours. (PSG design data, 1982).

L = number of revolution of shaft / hour x bearing life / 1million (20)

$$L = \frac{1230 \times 60 \times 8000hours}{1 \times 10^6}$$

L = 590millionrevolutior

Determination of the dynamic capacity of bearing

The basic dynamic capacity is the constant radial load that any bearing in 90% of the bearing population will carry for 500 hour at 331/3 rpm (1 million revolutions) without evidence of fatigue.

Determination of radial load bearing

$C = 4.23 \times 2123.03$

$C = 8980.4N$

Therefore, for self aligning ball bearing (PSG design data, 1982.)

Bearing with cylinder bore 2204

Basic dynamic capacity, C = 9650N

Basic static capacity, Co = 3800N

Maximum permissible speed rpm = 14000

The dimension of the bearing is:

Bore diameter, d = 20mm

Outer diameter, D = 47mm

Width, B = 18mm

3.5 Frame Design

For axially and laterally loaded frame

$$\frac{F_c}{P_c} + \frac{F_{bc}}{P_{bc}} < 1 \qquad (21)$$

Where;

Fc = actual direct axial stress

Fbc = actual direct bending stress

Pbc = allowable bending stress

Pc = allowable axial stress

$$P_{bc} = 165 \frac{N}{mm^2}$$

For steel

$$P_c = 128 \frac{N}{mm^2}$$

For steel

But

$$F_c = \frac{F}{A} \qquad (22)$$

F = axial load

A = cross - sectional area of the section

$$F_{bc} = \frac{M}{Z} \tag{23}$$

M = moment

Z = sectional modulus

Section chosen = 50mm thickness

Cross sectional area = $a^2 - a^2$

Sectional modulus = $a^4 - b^4/6a$

$$Z = 50^4 - \left(\frac{40^4}{6 \times 50}\right)$$

$$Z = 6250000 - \left(\frac{2560000}{300}\right)$$

$$Z = 6241466.667mm^4$$

$$\text{area}, A = a^2 - b^2$$

$$A = 50^2 - 40^2$$

$$A = 900mm$$

$$\text{force}, F = 2052N$$

The four legs of the frame share a load of

$$\frac{2052}{4} = 513N$$

Thus each leg carried a load of 513N

$$F_c = \frac{513}{900} = 0.57mm^2$$

$$F_{bc} = \frac{M}{Z}$$

$$M = 513 \times 450$$

$$M = 230850$$

$$F_{bc} = \frac{M}{Z} = \frac{230850}{6241466.667}$$

$$F_{bc} = 0.037m^2$$

Design is safe if

$$\frac{F_c}{P_c} + \frac{F_{bc}}{P_{bc}} \leq 1$$

$$\frac{0.57}{128} + \frac{0.037}{165} \leq 1$$

$$0.0045 + 0.00024 \leq 1$$

$$0.00474 \leq 1$$

CHAPTER FOUR

4.0 CONSTRUCTION OF A LOCUST BEAN DECORTICATOR

4.1 Material Selection

Material selection is the process of choosing the right type of material in the construction of engineering structures and components. When selecting the materials used for relevant parts relating to the functions coupled with the stress condition and service life, considerations were made. Below are the properties considered in selecting the materials for the fabrication of the decorticator

Mechanical properties such as strength, toughness, stiffness, fatigue, hardness and wear resistance. Chemical properties such as resistance to oxidation and all forms of corrosion. Since the machine in question is a food processing machine.

The material selection for the construction of the decorticator was based mainly on the

1. Material availability
2. Suitability of the material for the design
3. Cost of the material

4.2 Material Costing and Analysis

The material costs listed in the table below are the costs of the materials as at October, 2006. These values may change depending on the market situation.

Table 1: Material Costing and analysis

S/no	Materials	Specification	Quantity	Unit cost ₦	Cost ₦
1	Galvanized metal sheet	Mild steel gauge 20	2 sheets	6800	13600
2	Angle bar	Mild steel	2 lengths 2''	2000	4000
3	Disc plates	Mild steel	2 plates	1000	2000
4	Shaft	Steel	1	1500	1500
5	4'' pipe	Galvanized 2 ft	1	800	800
6	Thin rods	12mm dia.	2	200	400
7	Exit valve	Plastic	2	1500	3000
8	Bearings/housing	ID 20mm, OD 47mm	2	1000	2000
9	Pulley	250mm dia. A type	1	500	500
10	Paint	Enamel	1	860	860
11	Thinner	Enamel	1	640	640
12	Roller Cylinder	29mm dia Galvanized	4	600	2400
	Total				31,700

The total material cost is ₦ 31,700

Labour Cost

The cost of the various jobs performed on the machine is as shown below. Labour cost involves the cost of machining, cutting, welding, turning and painting. It is taken as 25% of the material cost.

Therefore,

Labour cost = (25/100) × 31,700

= ₦ 7,925

Overhead Cost

This cost includes cost incurred during production such as transportation, Lubrication as well as other consumables. The overhead cost is taken as 20% of the labour cost.

Therefore,

Overhead cost = (20/100) × 7,925

Overhead cost = ₦1,585

Total Cost

The total cost of the decorticator is the sum of the material cost, labour cost and overhead cost

Total cost = material cost + labour cost + overhead cost

Total cost = 31,700 +7,925 +1,585

Total cost = ₦ 41,210

4.3 Construction Procedure

After the design has been accomplished, the following steps were followed for construction of the decorticator.

1) Marking out the dimension required for the tank from the galvanized metal sheet of gauge 20:- the equipments used are scriber, try square, meter rule and divider.
2) Cutting of the marked out galvanized metal sheet:- the equipment used is the metal sheet cutter.
3) Rolling of cut galvanized metal sheet to the desired shape:- the equipment is the metal sheet rolling machine
4) Bending of the rolled galvanized metal sheet:- the equipment is the metal sheet bending machine.
5) Welding of the both rolled and bent galvanized sheet into the cylindrical tanks the equipment used is the welding machine
6) Cutting of the internal cylindrical decorticating rollers:- the equipment used is the hack saw
7) Welding of the rod to the roller for coupling: - the equipment used is the welding machine.
8) Cutting and machining of the shaft to the required size:- the equipment used is the lathe machine.
9) Coupling of the disc plates on the shaft
10) Grinding of weld joint to a smooth finish and filling the rough surface:- the equipment used are the handing grinding machine and auto body filler
11) Cutting of angle iron of required dimension for the frame: - the equipment used is the hack saw.
12) Welding the angle iron to form the frame:- the equipment used is the welding machine

13) Assembly of all component to a unit using bolts and nuts

4.4 Operating Principle of the Locust Bean Decorticator

The boiled or cooked locust bean was loaded through the hopper into the decorticating chamber, and then the boiled locust bean was spread on the wall of the decorticating drum, then the rotating rollers rub the locust bean against the decorticating drum which gives a clearance between the decorticating drum and rotating rollers for the bean to pass through. The shearing force between the decorticating drum and rotating rollers cause the locust bean to peel while the seeds fall into the base tank in which separation takes place.

4.5 Performance Evaluation of the Locust Bean Decorticator

The test performed to evaluate the performance of the machine was basically the decorticating efficiency and it is done on weight basis.

The decorticating efficiency was assessed by loading 5kg of boiled locust bean into the machine while it was running, then after the operation, the decorticated locust bean were separated from the undecorticated locust bean and they were weight as follows

Decorticated locust bean =3.4kg

Undecorticated locust bean =1.6kg

Therefore, the efficiency of the decorticator is

$$\% \text{ efficiency} = \frac{\text{weight of decorticated locust bean}}{\text{Weight of total locust bean}} \times 100$$

$$\% \text{ efficiency} = \frac{3.4}{5} \times 100$$

$$\% \text{ efficiency} = 68\%$$

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The design of a locust bean thresher and the construction of a locust bean decorticator have been completed.

The locust bean decorticator has an efficiency of 68%. The project work although, faced with time and financial challenges, however the machine was constructed and tested given a positive result.

5.2 Recommendations

The result obtained after testing the decorticator necessitates the following recommendations for a more efficient model

(1) The results obtained from the design calculation of the thresher can be used to constructs the locust bean thresher.

(2) More improvement can be made to increase the efficiency of the decorticator

(3) Aluminum can be used instead of galvanized metal steel to reduce rusting because the machine is a food processing machinery.

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