Design, Construction and Commercialization of Rice Threshing Machine

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Submitted

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ABSTRACT

The rice thresher is a machine used to separate rice grain from dried paddy in the farm which will be ready for further process known as milling or parboiling. The higher cost and low output associated with the traditional method of rice threshing and also the high cost of existing large imported threshers that cannot be afforded by our local farmers, calls for the design of an efficient and affordable threshing machine that will encourage higher rice production. A performance evaluation was carried out on the fabricated machine and a threshing rate of 550kg/hr was achieved with a threshing efficiency of 93%.

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Project

A rice threshing machine is a machine used to bring out rice grain from rice straw in the farm prior to further processing such as parboiling and milling. It has been observed that one of the most important cereals across the sub Saharan Africa and even the entire Asia is rice products. Rice is cultivated in almost all parts of the globe including Nigeria. By 2015, it has been estimated that over three-fifth of the world population will depend on rice as their staple food (Echiegu 2009).

Rice in Nigeria is primarily an urban middleclass product. The total market is an estimated 5 million tons in 2007, approximately two-third of which is urban and the rest rural. Estimated annual production is 3.4 million tons and rest is imported. Again approximately two-third of urban demand is met by imports. Rice in Nigeria is distributed through five channels - rural household consumptions (8%), small scale processing for rural and semi urban markets (33%), medium commercial processing for urban markets (16%) and large scale industrial processing (10%) and the fifth channel is the imported rice market (33%).

Half of local rice is channeled through the small-scale processors and medium commercial processors, which have direct connection with poor parboilers and farmers. National rice production growth is 15% per annum (FAO) and growth of national demand is 20% per annum. Imported rice sets the standard in the market in terms of price and quality (in terms of cleanliness, whiteness, consistency, breakage and being free of stones). In principle locally produced and processed rice can compete with imports at an estimated sales price of NGN 300/measure (vs.

NGN 450/measure for imports) by improving the quality of local rice.(DFID, 2010).

However, rice threshers developed are not affordable or easily accessible and varies from the manually operated to the more advanced machines used in large government and commercial installations. In rural areas, only some organized personnel involve in the manual threshing with sticks and drum. This is because the local rice farmers have no means of getting the mechanized threshing method, even if there is, it is not affordable by common farmers.

1.2 Statement of the Problem

The higher cost and low output associated with the traditional method of rice threshing and also the high cost of existing large imported threshers that cannot be afforded by our local farmers, calls for the design of an efficient and affordable threshing machine that will encourage higher rice production.

1.3 Justification of the Project

Improving rice production is considered one of our government policies in creating jobs and providing quality home grown food supply to the nation, this project is aiding in the realisation of a viable economy of our country Nigeria through the attainment of food sufficiency status.

1.4 Objectives of the Project

The specific objectives of this project are to:

i. make available low cost and affordable machine to our local farmers;
ii. reduce human effort in rice production;
iii. promote local industrialization;
iv. improve local production of rice and wheat;
v. encourage mechanized system of food production to our local farmers; and
vi. reduce losses associated with the local method of rice threshing.

CHAPTER TWO

2. MATERIALS AND METHODS

2.1 Materials

The materials required are sourced locally and are readily available; these include mainly:

- ❖ Mild steel sheets
- ❖ Angle iron(Mild steel)
- ❖ Iron rod(Mild steel)

2.2 Methods

The construction mostly involved the following operations i.e measurement, cutting, folding, drilling, machining and welding. Also the construction was carried out in the following phases.

- ✓ Construction of threshing chamber
- ✓ Construction of hopper
- ✓ Construction of separation systems (blowers)

Mechanisms will be incorporated to thresh rice plant into a fine finished crop ready for milling.

2.3 Design Analysis of Major Components

The major components of the rice thresher are:

1. Prime mover
2. Shaft
3. Separation System (Blower)
4. Threshing Chamber

Determination of power requirement (P)

Power is delivered to the shaft from the prime mover through a belt drive mechanism which in turn perform the desired threshing by the action of an arranged bitters housed inside the threshing chamber

Input Parameters

d = distance covered by paddy during threshing (m) =

t = time taken (s) =

m = mass of threshing material = 15 kg

g = acceleration due to gravity = 9.8 ms^{-2}

Design Formulae

$$F = m \times g \tag{1}$$

$$W_R = F \times d \tag{2}$$

$$P = \frac{W_R}{t} \tag{3}$$

However, the coefficient of friction between the belt and pulley is 0.3 (Khurmi and Gupta, 2011). For the purpose of this design, 3pulleys were adopted.

Calculated Parameters

F = force (N)

W_R = work required (J)

P = power (W)

F= ; WR = ; P = 3578.8 W

By this analysis, a 4.0 kW diesel engine was selected as the prime mover due to its availability in the market and ease of use in the farm areas, where there is no electricity.

Design of Shaft

When power is delivered to the shaft, torque is set up within shaft and permits power to be transmitted (Khurmi and Guptar, 2011).
Threshing speed can be achieved by the choice of the pulley sizes on the prime mover and the shaft. Also the size of a shaft is a function of the required work to be performed.

Input Parameters

N_1 = speed of engine =1440 rpm

N_2 = speed of shaft = 480 rpm

D_1 = diameter of pulley in engine = 90 mm

P = power = 3578.8 W

$\tau = 40 \times 10^6$

Design Formulae

According to Khurmi and Gupta (2011), the diameter of the driven pulley, power requirement and torque can be calculated from the equations (4), (5) and (6) as follow:

$$N_2 = \frac{N_1 D_1}{D_2} \tag{4}$$

$$P = \frac{2\pi NT}{60 \times 1000} \tag{5}$$

$$T = \tau \times \frac{\pi}{16} \times D^3 \quad (6)$$

Also

$$T = \frac{P \times 60 \times 1000}{2 \times \pi \times N} \quad (7)$$

Calculated Parameters

D_2 = diameter of pulley in shaft = 270 mm

D = diameter of shaft = 0.0256 m = 26 mm

Therefore, for this design, the minimum shaft diameter required is 26mm. however, for the sake of reducing risk of failure; a 30mm shaft diameter will be adopted.

Actual shaft diameter used = 30 mm.

2.3.3 Design of Blower

The blower serves as the separation mechanism of the machine

Input Parameters

Width of blade (b) = 150 mm

Diameter of blade tip (d) = 500 mm

Speed of rotation (N) =1800 rpm

Air density (ρ) = 1.2 kg/m^3

Chaff density (ρ_c) = 83 kg/m^3

Ratio by mass of air to flush amount of chaff is taken to be 10:1

Design Formulae

$$V_b = \frac{\pi dN}{60} \tag{8}$$

$$Q = \frac{\pi D_e^2 V}{4} \tag{9}$$

Calculated Parameters

Air flow rate (Q) = 1 kg/sec?

Air velocity at tip of blade (V_b) = 470m/sec

Blower eye (D_e) = D_e = 200 mm

2.3.2 Design of Threshing Chamber

As soon as the paddy passes the hopper, it enters the threshing chamber. A set of arranged bitters in rotary motion separates the grains from the chaff. The grains fall out through a sieve and the chaff is blown away by a blower attached to the end of the threshing chamber.

Input Parameters

Number of bitters (N) =60

Diameter of bitters (D_b)=0.4m

Chaff flow path = A_1 is required for smooth passage of chaff to the blower.

Design Formulae

$$A_1 = \frac{\pi(D_d^2 - D_b^2)}{4} \tag{10}$$

Calculated Parameter

Outer drum diameter = D_d = 0.5 m

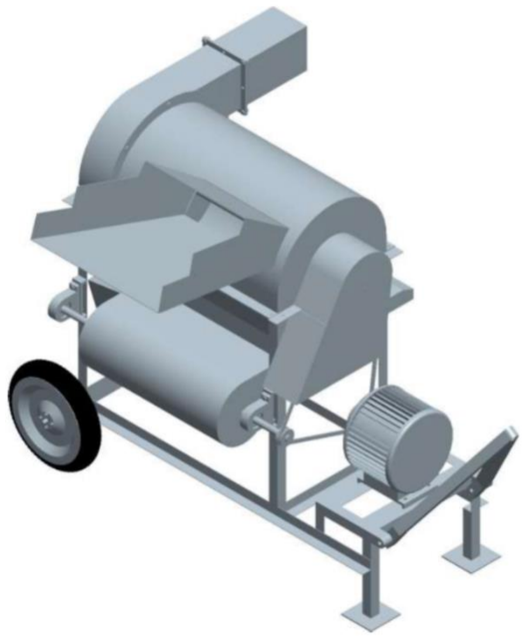

Figure 1: Isometric view of the rice thresher, preliminary design assembly

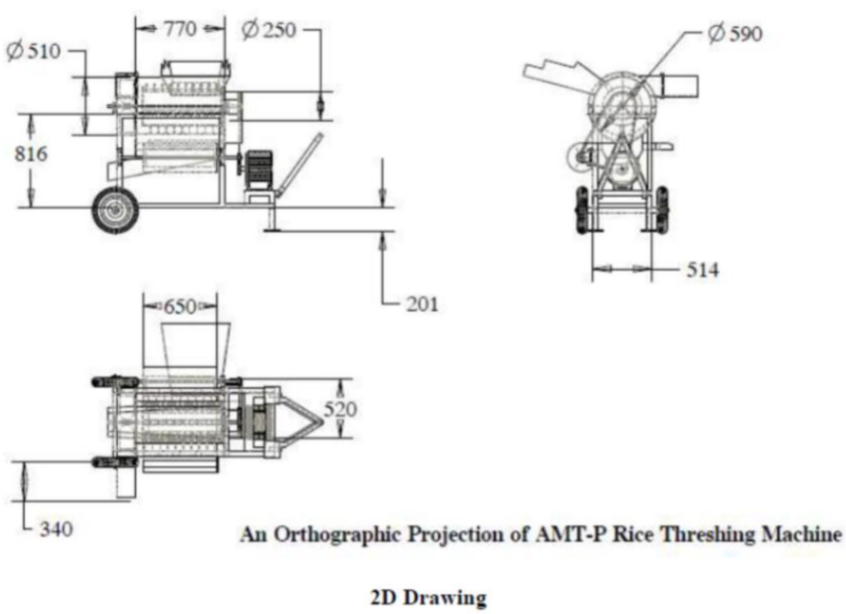

Figure 2: First angle orthographic projection

CHAPTER THREE

3. RESULT AND DISCUSSION

3.1 Results

The following results were obtained after construction and performance evaluation of machine.

1. Threshing rate = 550 kg/hr.

4. Threshing efficiency = 93 %.

Three persons are required to efficiently work with machine on the field.

Pictorial view of the machine is presented in Figure 3.

Figure 3: Pictorial view of the rice thresher

3.2 Discussions

The design and construction of the machine was carefully carried out considering all major factors including economy, locally available materials and technical capacity. The machine can be easily adopted by Small and Medium Scale Farmers.

Performance evaluation was carried out and a threshing efficiency of 93% was recorded resulting in being the first machine to be patented by the Advance Manufacturing Technology programme (AMT-P) Jalingo. The machine also attracted the interest of the Taraba State Government whom purchased10 units of the machine. The machine was valued at = ₦1,061312.50 excluding the Prime mover.

BILL OF ENGINEERING MEASUREMENT AND EVALUATIONS FOR THE CONSTRUCTION OF RICE THRESHING MACHINE

S/N	DESCRIPTION	QUANTITY	UNIT PRICE (₦)	AMOUNT(₦)
1	6mm mild steelsheet	**1/10**	200,000.00	20,000.00
2	2mm mild steel sheet	2,1/2	90,000.00	225,000.00
3	Angle iron 4mm x45mm x 45mm	3	15,000.00	45,000.00
4	Ø40mm mild steel shaft	1	30,000.00	30,000.00
5	Ø25mm mild steel shaft	1	20,000.00	20,000.00
6	Sieve	1	10,000.00	10,000.00
7	Ø35mm bearing	2	10,000.00	20000.00
8	Ø20mm bearing	2	10,000.00	20,000.00
9	16 mm mild steel square rod	1	8,000.00	8,000.00
10	V Belt	1	3000.00	3,000.00
11	Ø210mm Pulley	1	20,000.00	20,000.00
12	Ø70mm pulley	1	5.000.00	5,000.00

13	Bolt And Nut	50	500.00	25,000.00
14	Electrode (gauge 10)	2	10,000.00	20,000.00
15	Filing and cutting disk	7	3,500.00	24,500.00
16	40mm bushing	2	5,000.00	10,000.00
S/N	DESCRIPTION	QUANTITY	UNIT PRICE (₦)	AMOUNT(₦)
17	30mm metal bushing	2	5,000.00	10,000.00
18	500 mm rubber wheels	2	20,000.00	40,000.00
19	Paints	-	15,000.00	15,000.00
20	R175A Diesel engine	1	-	-
26	**TOTAL**	**-**	**-**	**570,500.00**

<u>OTHER COST RELATED EXPENSES AND SELLING PRICE</u>

Material cost (MC) =₦570,500.00

Contingency (CON) = (15%MC) = ₦85,575.00

Direct labour Cost, DLC = (30%MC) = ₦171,150.00

Intellectual Input, II = (6%MC) = ₦34,230.00

Production Cost, (PC) = (MC+CON +DLC+II) = ₦861,455.00

Actual Production cost (APC) = (PC+12.5%PC) = ₦964,829.60

Value Added Tax (VAT) =5%APC =₦48,241.45

Withholding Tax (WHT) =5%APC =₦48,241.45

TOTAL TAX (TT) =₦96,482.90

Selling Price (SP) = APC +TT = ₦1,061,312.50

Table 1:Table of manufacturing layout of Mechanical Rice Thresher

S/No.	Component	Manufacturing Methods
1	Frame	➢ With 50.8X50.8mm angle iron of low carbon steel, cut to sizes with the aid of a cutting machine to sizes and weld them together with an arc welding apparatus as shown. ➢ Weld the engine seat onto the frame with the specified dimensions using arc welding apparatus
2	Hopper	➢ With 2mm stainless metal sheet ,measure cut and bend as shown
3	Fan protector	➢ With 2mm stainless sheet, cut and develop the protector unit. ➢ Weld the parts and drill as shown ➢ The control panel is mounted on the top central of the protector to allow for easy control in the production process. ➢ At the center of the protector, cut the 200mm by 200mm on the stainless steel and replace with air screen by welding. ➢ This allow suction of air by fan system.
4	Roller	➢ With 25mm shaft, cut to the length, appropriately cut 2mm sheet with length of 450mm roll to obtain 110mm diameter.
Specified	Belt guard	➢ Using 2mm stainless sheet, cut, drill, roll, bend and weld the profile
15	External chut	➢ Use 2mm stainless metal sheet , measure, cut and fold the metal sheet. Take the profile of the isolator as shown in fig 8. ➢ Welt the metal sheet on the frame.
16	Final assembly	➢ Arranged, fix and bolt all the parts together, mount the tricycle wheels at rear as shown in fig: 10 ➢ Check all bolt and nuts for proper tension ➢ Grind all rough edges and smooth dent with body filler. Clean and apply primer and final spraying ➢ Mount the prime mover ➢ Run belt from prime mover to thresher assembly

CHAPTER FOUR

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

After a successful performance evaluation, we arrive at the following conclusions. A selling price of **= <u>₦1,061312.50</u>** is affordable among medium scale farmers and farmers cooperative groups.The machine can thresh 4.4 tons of rice grains a day taking 8 hours working period. Locally available materials used in the construction of machine.The fabricated machine has a threshig efficiency of 93%, which can hardly be achieved with the traditional method; losses were significantly reduced.

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