ASSESSMENT OF PEDAL OPERATED MAIZE THRESHER FOR RURAL DWELLERS

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ABSTRACT

The most important aspect of post-harvest operation of maize is threshing, which involves detaching of the maize grain from its cobs (Kama 1992). The traditional method of grain threshing is by heating with stick which is laborious, time consuming, loss of grains and low output. The performance of an improved pedal maize threshing machine consisting of the threshing unit, chain and sprocket drive system, bearing, handles, seat and machine stand in other to meet the demand of rural farmers. When the machine is turned manually, the threshing spike disc rotate inside the threshing unit as the cobs of maize passes through a spring controlled space between the rotating disc and a stationary plate. The grain spreads through the grain outlet. The result shows that the machine can shell about 81.03kg/hour of maize while using the traditional method (hand) only 25.00kg/hour of the maize could be shelled. The threshing efficiency of the machine obtained is 86.6%.

Keywords: cost, efficiency, heating, machine, maize, threshing

1.0 INTRODUCTION

Maize is one the most important cereal crop production in Africa, most especially in Nigeria. About 70% of the total population of the country produces maize. The production as well as the processing is done to a large extend by hand tools and implements. This is as a result of high cost, hard labor and non – availability of threshing machines in the market Furthermore, with the improvement of modern technology, some high technological threshing machine like combined harvesters were imported into the country those are expensive and beyond the reach of the small and rural farmers.

Maize production is on the high increase as a result of new improved varieties, fertilizers and better modern practices primarily processing continues to be problem. Traditionally, after harvesting, threshing is accomplished by hand beating in a mortar with pestle or beating the cobs with stick in sags until the grain are separated from the cobs. There are problems associated with

these methods. It limits the scale of production, time consuming, reduces reliability of the grain, break the maize in to pieces some times.

Effects have been made to overcome the limitation observed in the traditional method of threshing. The common feature of this method of threshing mentioned above is that the diameter between the threshing prongs is fixed which limit the size of the maize that the threshing can accommodate. This modification process of threshing which

Operate pedally, is developed so that it can thresh different cobs of the maize at the same time. This is accomplished by producing a thresher with an adjustable threshing unit (Adams J.M. 1982).

In Nigeria, the northern region is the highest producer of maize. Farmers in this region normally use the local threshing tools, which are time consuming and requires hard labor.

In Nassarawa state most mechanical threshers were designed for multi-grain threshing which caused great damage to the maize seeds besides breaking the cobs to pieces. The available local threshers, were equipped with rotating threshing drums, rollers etc. which causes damages to the seed. Also the cost of purchasing such threshers were too high for the poor rural farmers and therefore necessitated the improved design of low – cost system that will be affordable and also increase threshing efficiency but reduce the damage done on the seed (Adams J.M 1982).

The American Indian word for corn means literally that which sustain life. It is after wheat and rice, the most important cereal grain in the world, providing nutrients for humans and animals and serving as a basic raw material for the production of starch, oil and protein, alcohol beverages, food sweetener and more recently fuel. In Africa, maize has become a staple food crop that is known to the poorest family. It is used in various forms to alleviate hunger and such form includes pap, maize four etc. Because of the importance of maize, it's processing and preservation must be done to an optimum condition. The major steps involved in the processing of maize are harvesting, drying and dehiscing (Sahay .L. 1992).

The process of maize threshing involves the removal of grain from their cobs. The process can be traced as far back as the discovery of the crop as a source of nutrition. Maize is passed in cob or instantly threshed mainly by machines. The need for more efficient methods of maize threshing has over the years resulted in studies carried out on the threshers. (Kaul R.N 1985)

1.1 Threshing Equipment

There are various types of threshing equipment, each type catering to differing scales of production and conditions (e.g. domestic use, co-ownership by small farmers, use by independent farmer on a daily hire bases, ownership by custom or merchant mills) farmers often used small hand craft rotary sellers which are usually simple, effective, inexpensive and fairly durable. They are available from many manufacturers from both developing and industrialized countries this type. Any developing country should be able to manufacture this type of thresher. The latter are of various designs and are made from a small number of iron castings. They utilize a spiked disk to prize out the grain while the cob is held by an adjustable spring – loaded pressure plate. While the capacities of different machines vary, these will at least double the rate of the most productive hand – held devices (e.g. 100kg grain per hour).

The larger, free – standing threshers are more productive and convenient, but more expensive. They are often with cleaning and separation device for the removal of unwanted material. The relatively large size of maize grain facilitates the use of both cleaning fans for the blowing away of the dust and light particles, and of simple reciprocating sieves for the removal of sand, stripped cob centers and broken or undersized grain. Depending on the type of thresher

and on the number of operators employed, the capacity of these machines can be four times larger than that of the smaller rotary threshers. This may be explained by the use of low – friction bearings and of simple gearing which result in steady and operating speeds. The threshing principles are similar to those of the smaller thresher. One main difference is the replacement of the spring loaded pressure plate by a relatively low speed feed roller which forces cob into the threshing element. The design and sizing of large threshers allow the use of alternative drive methods such as small electric or petrol motors. These threshers are suitable for small – scale merchant mills.

The full –sized, diesel or electrically – powered threshing machines, with capacities of several times per hour, represent the normal equipment used in large number or scale, fully mechanized situations. A large number of firms produce their own designs for sale through normal agricultural equipment suppliers. No standardized design exists, but most thresher use broadly similar operating principle. These threshing machines are available in a variety of installations use within a mill requires a fixed installations, with associated handling and feeding facilities fitted close by. Mobile installations are also available; they are either wheeled or mounted on tractors. The high rates of throughput require the use of cob loading elevators and bagging equipment. Most threshers utilize a pegged drum, mounted on a horizontal shaft, which rotates at about 700,000 rpm. A concave metal screen, with holes approximating to the size of the grain is located around the drum.
It contains the cobs while shelling takes place. A baffle plate restricts the flow of the cobs, and maintains the required shelling pressure. A strong fan discharges the stripped cobs centers and other large debris. A second, smaller fan is often used at the grain discharge point for the removal of the remaining dust and finer particles. Available information indicates that an average threshed grain output of 900kg/hr/ installed kw/h may be obtained from these threshers.

Dehusking of the cob may be carried out with a special device installed within the threshing machine. The usual method of dehusking is to provide sets of contra-rotating rollers whose projections pull the husk away from the cob. It is possible to shell and husk maize, despite some loss of capacity, within the threshing sections itself. However, it is recommended to obtain the advice of individual manufacturers on the practicability of this approach.

The working lifetime of the various components of these machines should be relatively high since no wearing or rubbing parts are employed. Thus, the need for spare parts such as bearings, drum part and screws should be relatively low. However, difference in materials of construction does occur and not typical replacement rates can be quated. No skilled labor is required to run these machines sine it is only necessary to manually feed the cobs and dispose of the grain and cob centers. The number of laborers employed has a pronounced influence on the work rate of the machines particularly that of the smaller units with unmechanized loading (Ebegbod, M. 1988)

1.2 Measurement of Efficiency

The efficiency of threshing in maize threshers can be defined as the ratio of the weight of threshed maize to the weight of maize. The total weight of maize is obtained by adding the weight of the threshed maize to the weight of maize remaining on the cobs after threshing.

$$\text{Threshing efficiency (\%)} = \frac{X}{x+y} \times 100$$

Where

X = weight of machine threshed grains

Y = weight of corn remaining of the cobs after threshing.

1.3 Chain Drive

A chain drive is another form of a flexible connector device which can vary much like a belt drive, transmit power between shafts spaced quite a distance (up to 8pm) apart. It consists essentially of a driving and driven toothed sprocket. Set on parallel shafts and connected by an endless chain. Most types of the chain drives used in the practice also have various tightness, lubricators, and castings.

In contrast to belt drive which function owing to friction between the belts and pulleys, chain drives depends on their operation on the mesh between the sprocket teeth and the chain links. Because of this, they can maintain the desired speed ratio at the same level throughout the operation, need no initial tension (thereby receiving the shafts and bearings), and show an increased efficiency (up to 0.98).The chain contract angle is for less critical for a chain drive than the belt contract angle for a belt drive. As a consequence, chain drives can quite safely be used at high speed ratio with their shafts installed rather close together or where power is to be transmitted to several shafts at the same time, with some shafts rotating in opposite directions.

Chain drives are smaller in size, loss less power in friction, and are much cheaper in maintenance than belt drives. Also chain being inherently stronger than belts, they can handle heavier loads than their belt counterparts. Chain drive are especially effective where not more than 100kw of power is to be transmitted at a peripheral speed of up to 15ms^{-1} and a speed ratio of up to 8. Chain drives may be used as both step-down and step-up transmission (the latter been employed in bicycles). Used by man from time immemorial, chains have nevertheless lost none of their importance. Today, chain drives can be found practically everywhere from a modest household to a major industrial plant.

Of course, chain drives are not entirely free from disadvantages. Basically, these can be attributed to the chordal action of the chain. The chain links pass around the sprocket as a series of chords rather than as a continuous arc. As a result, the speed of the chain is pulsating, as it were, instead of being uniform which is especially pronounced at higher speeds and with fewer teeth. This builds up the rear of the linking pins and in consequence, stretches the chain pitch, thereby spoiling the mesh. So, chain drives are sometimes too noisy in operation and have to withstand additional dynamic loads.

2.0 MATERIALS AND METHODS

The manually threshing machine is made up of threshing unit, pedal, handle seat, chain and sprocket drive system and machine stand. The threshing unit is made up of zinc alloy (stand casting) which involves the following parts; mainframe, press, chamber, shelling spike-disc and cobs outlet member mounted at one side of machine stand.

The machine is operated by a set of chain and sprocket drive system, the length of the chain is 174cm while the pitch circle diameter of sprocket is 7cm and 20 teeth.

2.1 Sand Casting

The sand casting process is the oldest method of making and often providing to be the cheapest method of production. Stand casting can be defined as a process of process of pouring molten metal into a non – permanent sand mould prepared with the aid of a suitable pattern.

The basic stages in sand casting are:-

(I). Making the pattern of the threshing machine.

(ii).Making the sand mould.
(iii).Preparation of the molten metal, taking it to the mould and pouring it into the mould.
(iv).Felting the casting
(v).Inspection.

2.2 Making the Pattern of the Threshing Machine

Casting production starts with the manufacturing of the pattern. The pattern is a replica of the required casting but all its dimensions was made slightly larger than those of the casting allow for the construction which took when the hot metal solidified in the mould.

2.3 Types of Sand used (green sand)

Green sand mould is the name given to a mould which was made from sand that contains clay in its natural state.

2.4 Sand Mould of the Components

The equipment required for this operation were; all the pattern of threshing machine, Drag and cope boxes, rammer, bellow, trowel and two wooden conical plugs. After pattern was ready the methods of operations were as follows:-

1. The pattern was placed on a turnover board and the drag box placed over it. A quantity of molding sand was added and the rammed lightly around the pattern. Additional molding sand was added and the remaining repeated until the drag was full. The surface of the sand was then trimmed off with a trowel and leveled with the edges of the box.

2. The drag was inverted and joint surface sprinkled with parting sand. The cope box was placed in position above the drag and the two boxes are registered by locating pins. The cope was rammed with molding sand. Two conical wooden plugs were inserted in the cope mould to form the down gate and riser channels.

3. After ramming the cope, the two boxes were separated and the pattern loosens in the impression by rapping and carefully withdrawing from the mould.

The two conical wooden plugs were removed from the cope. The cope was returned in position on the drag and firmly secured by the locating pins. The mould was ready to receive the molten metal.

2.5 Preparation of Molten Metal

The equipment required for this operation were crucible pot lift out tong skimming spoon, pouring tong charge (zinc ingot) flux (Ammonium chloride). The metal zinc alloy are sourced locally from scrap seller and refined into ingot in the foundry workshop before casting to meet metallurgical standard.

2.6 Melting Procedure (zinc scrap)

The crucible pot was put inside the furnace on the crucible stand. The crucible furnace was closed and pre – heated for 110–120min, the firing stopped and the furnace opened. The ingot (zinc alloy) was charged into crucible pot and the furnace closed. The furnace then fired and allowed to heat up until the ingot has melted completely in the pot.

The flux (ammonium chloride) was added into molten metal. As the temperature of the furnace rises above the melting point of the metal, dirt and dross called slag was removed by using skimming spoon was heat up to ($700\,^0$C) or cherry red color the firing was stopped and the furnace opened.

The crucible pot containing the molten metal was removed from the furnace by lifting device (tong). Then crucible pot was put inside the pouring tong and transported to the prepared mould. The pouring was done steadily until the riser was filled with the molten metal, then allowed to cool and solidified. When it was satisfied cool, the two boxes are separated and the casting removed from the sand.

2.7 Casting Fettling

This is the process of cleaning and dressing the cast after it is removed from the mould. After removing the casting from the mould, the casting then placed on the foundry floor and allowed to cool. The riser growing horns, profusions and all the unwanted attachments were removed by hark – sanding, grinding and filing.

2.8 Inspection

This is the process of visual examination checking and subjecting to vigorous inspection procedure to ensure that they are making logical and uniform quality of surface finish and dimensional accuracy.

2.9 Welding Method

Electric arc welding was used in constructing the frame of the machine and the pedal system. The frame of machine consists of:

(i). Base
(ii). Machine stand
(iii). Coupler and the machine stand
(iv). Pedal support
(v). Sit support.
(I). Base of the frame:- The base of the frame was constructed with angular iron of rectangular from of length (20 x 3inch and 90 x 2inch) try square was used to make sure that the construction was square.
(ii). Machine stand:- the machine stand formed with angle iron of length (30 x 10inch) each welded in form of the frame to support weld the machined and bearing coupler and fillet was used for welding to the frame.
(iii). Coupler and machine stand:- these are two angle iron of length (20incch) welded on top of the machine stand to support the coupler bearing and the maize threshing machine fillet welding was used for welding the stand.
(iv). Pedal support:- Angle iron of length (12inch) was welded to the base of the frame to support the pedal system and fillet welds used for welding the system.
(v). Seat support:- The seat support was angular iron of length (33inch) welded to the frame at the ends fillet welding was used for welding the support.

This involved tightening the parts of threshing unit. These parts include, main frame, press member, threshing spike disc and the cobs outlet member. All the tightening was done with bolts and nuts.
The main frame was assembled starting from pedal system, shaft, sprocket system, chain drive system, and seat and lastly the machine was mounted on the mainframe, tightening it with bolts and nuts.

2.10 Finishing Operation

Finishing is the final work or products carried out on the threshing machine in-order to make it perfect. Some of the finishing works carried out on the machine include:-
(i). filling: This is the process of smoothing rough surface, including the length and size of the excess metal by using hand file.
(ii). Sand papering: This is also smoothing process carried out with the aid of emery cloth in order to have even surface.

(iii). Painting: At the finishing process the machine was painted to prevent it against rusting and also for aesthetic purpose.

2.11 Working Principle of the Machine

The machine is operated by rotating the pedal; when the pedal is rotating it provide the Rotary motion of the spike disc, the cobs will pass out through the cobs outlet opening, and then grain will spread through the grain outlet.

2.12 Bill of Engineering Measurement and evaluation

Table 1

S/N	ITEM	DESCRIPTION	COST (NAIRA)
1.	Angle Iron	3 lengths	5100
2.	Big/small sprocket	2pcs	400
3.	Chain	2pcs	600
4.	Pedals	2pcs	900
5.	Coupling Bearing	2pcs	600
6.	Bicycle coupler Bearing	1pcs	400
7.	Shaft	1pcs	500
8.	Seat	1pcs	450
9.	Bolt and Nuts	10 pcs	200
10.	Sheet metal	¼ sheet	1000
11.	Sheller	1pcs	3500
12.	Paint	1/2tin	500
13.	Electrode	1/2pack	500
14.	Blade	1pcs	200
15.	Chain cover	2pcs	700
16.	Handle	2pcs	600
	TOTAL		**₦ 15,500**

2.13 The Velocity Ratio of the Chain Drive

The velocity ratio of a chain drive is given by

$$V.R = \frac{N1}{N2} = \frac{T2}{T1}$$ ……………………………………………………….(3.1)

Where;

N_1 = Speed of rotation of smaller sprocket in r.p.m

N_2 = Speed of rotation of Larger sprocket in r.p.m

T_1 = No of teeth on smaller sprocket

T_2 = No of teeth on larger sprocket

The average velocity of one chain is given by

$$V = \frac{\pi DN}{60} = \frac{TpN}{60}$$ ……………………………………………………….. (3.2)

Where;

D = pitch circle diameter of the sprocket in meters

P = pitch of the chain in meters

2.14 Teeth of Sprocket (small)

Consider an arrangement of a chain drive in which the smaller or driving sprocket has only four teeth, Let the sprocket rotates anticlockwise at a constant speed of N. r.p.m. The chain of link AB is at distance d/2 from the center of the sprocket its linear speed is given by

$$Vmax = \frac{\pi dN}{60} \ m/s$$ …………………………………………………..(3.3)

Where;

d = pitch circle diameters of the smaller or driving sprocket in meters.

When sprocket rotates through an angle Q/2 the link AB occupies the position from the center of the sprocket and its linear velocity is given by

$$Vm = \frac{\pi dN \cos Q/2}{60} \quad m/s \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.4)$$

In order to have smooth operation, the minimum number of teeth on the smaller sprocket or pinion may be taken as it moderate speed and 21 for high speed.

3. Parameter of the chain (Note them down)

(a).Pitch

(b).Roller diameter

(c).Minimum width of the roller.

P = 2 AD sin (θ/2)

$$P = D \sin (\theta/2) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (3.5)$$

4. Pitch circle diameter of the sprocket

$$= p \csc \left(\frac{180}{t1}\right) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (3.6)$$

Where;

P = pitch of the chain

T = no of teeth of smaller sprocket

Pitch line velocity

$$= \frac{\pi dN1}{60} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (3.7)$$

Where;

d = diameter of the sprocket in meters.

N = rotational speed of the sprocket r.p.m.

5.   Load on the chain

$$W = \frac{Rated\ power}{pitch\ line\ velocity} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.8)$$

2.15 Center Distance between the Sprockets.

The minimum center distance between the smaller and center distance between 30 to 50 times the pitch, let us take it as 30 time s the pitch.

Center distance between the sprockets

$$30P \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..(3.9)$$

Where;

P = Pitch length of the chain.

The length of the chain (l) must be equal to the product of the number of chain links (k) and the pitch (p) mathematically,

L = K.P

The number of chain links may be obtained from the following expression i.e

$$K = \frac{T1+T2}{2} + \frac{2\times}{P} + \left(\frac{T2-T1}{2\pi}\right)P/x \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.(3.10)$$

The value of K as obtained from the above expression must be appropriate to the nearest even number.

The center distance is given by

$$X = \frac{P}{4}(k - \frac{T1+T2}{2} + \sqrt{(k - \frac{T2-T1}{2\pi})^2 \frac{P}{x}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.(3.11)$$

In order to accommodate initial sag in the chain the value of the center distance obtained from the above equation should be decreased by 2 to 5mm.

Note. The minimum centers distance for the velocity transmitted ratio of 3, may be taken as

$$x_{min.} = \frac{d1+d2}{2} + 30 \text{ to } 50mm$$

2.16 Design Calculations

1. To get the velocity ratio of the chain drive from equation (3.1)

$$V.R = \frac{N1}{N2} = \frac{T2}{T1}$$

$T_2 = 44$

$T_1 = 20$

$$V.R = \frac{T2}{T1} = \frac{44}{20} = 2.2 \text{ say } 3.$$

2. The number teeth on the smaller sprocket from table (3.1) the number of teeth on the smaller Sprocket for velocity ratio of 3 is $T1 = 25$.

3. The maximum number of teeth on larger sprocket $T2 = T_1 \times \frac{N1}{N2}$

$$= 2.2 \times 25 = 55.$$

Let $N_1 = 220rpm$

$N_2 = 100rpm$

Our $N = \frac{N1+N2}{2} = \frac{220+100}{2}$

$N = 160$

4. Average velocity of the chain from (3.2)

$$V = \frac{\pi DN}{60} = \frac{3.142 \times 12 \times 160}{60} = 2.92m/s$$

$$V_{max} = \frac{\pi dN}{60} m/s \text{ Maximum velocity from (3.3)}$$

$$= \frac{3.142 \times 24 \times 160}{60}$$

$V_{max} = 201m/s$

5. Pitch circle diameter of the smaller sprocket from (3.6)

$$= P \text{ cosec } \left(\frac{180}{T_1}\right)$$

$$d_1 = 12.70 \text{ } cosec \left[\frac{180}{T_1}\right] \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots$$

$$= 12.70 \times 6.3794 = 810mm = 0.081m$$

$pitch \text{ } circle \text{ } diameter \text{ } of \text{ } the \text{ } bigger \text{ } sprocket$

$$d_2 = p \text{ } cosec \left[\frac{180}{T_2}\right]$$

$$= 12.70 \text{ cosec } \left[\frac{180}{44}\right] = 12.70 \times 14.149$$

$$= 179.69mm = 0.179m$$

6. Pitch line velocity from (3.7)

$$= \frac{T_1 d_1 N_1}{60} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots.$$

$$= \frac{3.142 \times 0.08 \times 220}{60}$$

$$= 0.9332mls$$

7. Load on the chain from (3.8)

$$W = \frac{Rated \text{ } power}{Pitch \text{ } line \text{ } veloicty}$$

$$= \frac{1.18}{0.9332}$$
$$= 1.2645KN = 1264N$$

8.   Centre distance between the sprockets from (3.9)
        $= 30p = 30 \times 12.70 = 381mm.$

In order to accommodate initial sag in the chain, the value of centre distance is reduced by 2 to 5mm: Correct centre distance.
$x = 381 - 4 = 377mm$

9.   We know that the no of chain links
        $K = \frac{T_1 + T_s}{2} + \frac{2x}{P} + \left[\frac{T_2 - T_1}{2T_1}\right]^2 \frac{P}{x}$
        $K = \frac{20 + 44}{2} + \frac{2 \times 377}{12.70} + \left[\frac{44 - 26}{2 \times 3.142}\right]^2 \frac{P}{x}$
        $K = 32 + 59.37 + [14.586] \times 0.03369$
        :. K = 91.86
        Length of chain from the relation
        L = K.P
        $= 91.86 \times 12.70 = 1166.64mm$
                        $= 1.167m$

2.17 Performance Evaluation
        Twenty five cobs of maize were selected and divided into five groups of five cobs each were threshed by the machine. And also another twenty five cobs of maize were also selected and divided into five groups which were also threshed by hand.

2.18 Parameters
        The following parameters were determined from the data collected:
i)   Output (rate of threshing) = $\frac{mass\ of\ threshed\ grains\ (kg \times 3600\ kg/hr}{Time\ taken\ (s)}$

ii).   Threshing efficiency =
$$\frac{mass\ of\ threshed\ grains}{Mass\ of\ threshed\ \ grains + Mass\ of\ unthreshed\ grain} \times 100(\%)$$

iii).   Grain damage = $\frac{Mass\ of\ damaged\ grain \times 100(\%)}{Mass\ of\ threshed\ grains}$

2.19 For Machine Threshing
Out (rate of shelling) = $\frac{mass\ of\ shelled\ grains\ (kg) \times 3600kg/hr}{Time\ taken\ (s)}$

Trial No.1
Output (rate of shelling) = $\frac{0.50 \times 3600\ kg/hr}{26}$ = 69.23 kg/hr

Trial No. 2
Output = $\frac{0.50 \times 3600\ kg/hr}{22}$ = 81.82 kg/hr

Trial No. 3

$$\text{Output} = \frac{0.50 \times 3600 \ kg/hr}{25} = 79.2 \ \text{kg/hr}$$

Trial No. 4

$$\text{Output} = \frac{0.50 \times 3600 \ kg/hr}{23} = 89.22 \ \text{kg/hr}$$

Trial No. 5

$$\text{Output} = \frac{0.50 \times 3600 \ kg/hr}{21} = 85.71 \ \text{kg/hr}$$

2.20 For Hand Threshing

Trial No. 1

$$\text{Output (rate of shelling)} = \frac{0.50 \times 3600 \ kg/hr}{73} = 24.67 \ \text{kg/hr}$$

Trial No. 2

$$\text{Output} = \frac{0.50 \times 3600 \ kg/hr}{75} = 24.00$$

Trial No. 3

$$\text{Output} = \frac{0.50 \times 3600 \ kg/hr}{78} = 25.38$$

Trial No. 4

$$\text{Output} = \frac{0.50 \times 3600 \ kg/hr}{77} = 26.65$$

Trial No.5

$$\text{Output} = \frac{0.50 \times 3600 \ kg/hr}{74} = 24.32$$

2.21 Shelling Efficiency

Trial No. 1

$$\text{Efficiency} = \frac{0.50}{0.5+0.08} \times 100 = 68.5\%$$

Trial No. 2

$$\text{Efficiency} = \frac{0.50}{0.5+0.09} \times 100 = 84.7\%$$

Trial No. 3

$$\text{Efficiency} = \frac{0.50}{0.55+0.07} \times 100 = 88.71\%$$

Trial No. 4

$$\text{Efficiency} = \frac{0.50}{0.57+0.08} \times 100 = 87.7\%$$

Trial No. 5

$$\text{Efficiency} = \frac{0.50}{0.50 + 0.07} \times 100 = 87.72\%$$

3.0 RESULTS

Table 4.1 output obtained with machine and hand threshing.

Trials No	Machine threshing				Hand Threshing		
	Time (s)	Mass of threshed grains (kg)	Output (kg/hr)		Time (s)	Mass of threshed grains (kg)	Output (kg/hr)
1	26	0.50	69.23		73	0.50	24.66
2	22	0.50	81.81		75	0.50	24.00
3	25	0.55	79.20		78	0.55	25.38
4	23	0.57	89.22		77	0.57	26.65
5	21	0.50	85.71		74	0.50	24.32
Mean			81.03				25.00

The thresher threshed three times as fast as hand threshing. This translates in to about 68% savings in time which the farmers who uses this machine can utilize for other productive activities.

The output shown in table 4.1indicated that there is decrease in hand threshing which increases in machine threshing has an advantage over the hand threshing in terms of output. The mean threshing efficiency obtained as 86.6%

3.1 Grain Damage

Table 4.2 Grain damage in the manual thresher.

Trial No.	Mass of threshed grain (kg)	Mass Damage Grain (kg)	Percentage of Grain damage
1	0.50	0.07	0.00
2	0.50	0.04	0.00
3	0.55	0.05	0.00
4	0.57	0.00	0.00
5	0.50	0.00	0.00

The mean grain damage obtained was 0.06%.

4.0 CONCLUSION

The pedal maize thresher was constructed to thresh maize. The materials used in constructing the machine are the chain and sprocket drive system, bearing, seat and ample iron which were joined by welding. The machine is easy to construct and costs ₦15, 500 only. Result of performance test conducted showed that an average output of the machine was 81.03 kg/hr, while the average output of the hand thresher is 25.00 kg/hr.This shows the machine output is significantly higher than the hand threshing output. The shelling efficiency is 86.6% and 0.08% grain damage.

The machine operates smoothly and efficiently when in operation and the threshed grains flow freely through the grain outlet.

The thresher helps to reduce substantially the human labor involved in threshing at an affordable cost and also reduces the time used for threshing operation on small farms

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