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Design Modification, Development and Performance Evaluation of a Cereal crop Thresher

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ABSTRACT: *The design and development then performance evaluationof a suitable Threshing Machine to cope with the limitations of the existing small-scale thresher with a view to modifying it, test and evaluate its performance and making same available to farmers in the hinterland by way of mitigating the post-harvest challenges of threshing the two major cereals, corn cum sorghum was undertaken: hence a comprehensive performance evaluation was conducted on the old machine to identify its capabilities or otherwise any limitations on maize and sorghum threshing. In the threshing unit of the existing machine, it was identified to have some defects in the form of inadequate number of beaters, as well as the result showed that its performance parameters were low generally. The throughput capacity, threshing efficiency, cleaning efficiency, grain damages and scatter losses of maize were found to be 422 kg/hr., 89.87%, 60.95%, 5.17% and 8.30%; and, that of sorghum were 408kg/hr., 86.54%, 61.79%, 5.28% and 7.81% respectively for the modified thresher. The multi- crop thresher was however modified to achieve increased threshing effectiveness; thus, the number of beaters around the threshing cylinder were increased by mounting three rows of beaters on the cylinder. The redesigned thresher was fabricated using locally available materials. Its performance was evaluated under three phases. Test result of the modified thresher indicate an average throughput capacity, threshing efficiency, cleaning efficiency and grain damages values for maize to be 534 kg/hr., 92.00%, 73.33 %, 10.43% while for sorghum the corresponding values were obtained as follows; 531.43kg/hr., 89.10%, 74% and 1.596% respectively affirming an improvement over the modified thresher.*

KEYWORDS*: Design Modification, cereal crop, throughput capacity, cleaning efficiency, scatter losses, performance evaluation.*

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I. INTRODUCTION

A threshing machine is device used to undertake threshing. [1] define threshing as removal of grains from its cobs either by stripping, impacting by rubbing. It can also be defined as the process of detaching grains from the heads or from the plants, threshing separates grains from panicles, crops and pods. Threshing or detaching the kernels from the ears or pods is accomplished by combination of impact and rubbing action.

Threshing and cleaning operation are necessary steps after which grains are further processed into flour for domestic or industrial uses. In addition, annual yield evaluations by farmers are only possible after threshing operations. The by-products of threshing such as straws and chaff could be accumulated in stack, and be saved for future use as animal feed.

Nigeria heavily relies on imported technology in areas of machinery and equipment, [2]. These machineries have only made limited impact on increased food production due to several problems such as regular break down. Experience has shown that, a number of these machinery and equipment break down as early as few days after commissioning due to improper usage, [3] Seed losses were of unacceptable levels and cleaning efficiency was unsatisfactory.

The predominant farming of maize, sorghum and millet production in Nigeria, especially in northern part is based on manual labor provided by the family members. Each family operates a small farm, producing enough grains for family consumption until next season's harvest.

With the migration of rural youths to cities for better employment opportunities, there is shortage of labor during peak crops harvesting and threshing period. This causes delay in crops harvesting and threshing.

Hence, it increases both quantitative/qualitative post-harvest losses and production has become too laborious for many farmers.

The traditional threshing methods of human or animal foot trampling and manually beaten against hard element are less efficient, require high labor capacity and may cause crop seed crack or scatter around. A lot of small-scale farmers use this kind of traditional threshing method as they cannot afford to buy conventional large threshing machines which are more expensive. This is because the conventional machine only suitable for big scale farmer.

Furthermore, different types of threshers are needed for different crop which is economically unwise and space consuming.

In design, modification and fabrication of any threshing agricultural machine, Design parameters such as cylinder speed, cylinder diameter, shape, size,spike, shelling length,clearance between the spikes and the concave, diameter holes in the concave aand arrangement on the shelling drum and the blower type should be considered so as to determine the efficiency of the theperformance of thresher in terms of threshing efficiency, damage percentage, output capacity, cleaning efficiency, and power requirement[4].

There is a growing need to provide small scale farmers with an appropriate multi-crop thresher with higher throughput capacity, low processing losses and mechanical grain damage. That will reduce the processing losses by threshing thereby increasing the economic return to the farmers. Similarly, efficient power operated multi-crop thresher will also eliminate the large drudgery involved in manual method of threshing. This will certainly encourage more farmers including the youth to engage in crop production thereby reducing unemployment.

Furthermore, it will assist the farmers to thresh large quantities of maize and millet, per unit time and reduce the heavy postharvest losses increasing food availability and security in the nation. The use of available local materials will help to reduce cost of producing a multi-crop thresher, so that small scale and average income farmers can afford.

In this paper, multi-crop threshers which are used to handle a number of crops are highly successful for threshing cereal crops and pulses. The advantage of multicrop threshers is that with minor adjustments it can be used to thresh different crops, whereas other threshers can thresh a particular crop only, efficient threshing does not only require substantial time but also cause considerable threshing losses of grain. The main objective of this is the desgn modification and performance evaluation of a cereal multi-crop thresher.

II. MATERIALS AND METHODS

*The Description of the multi crop thresher:*The development of modified design of a thresher generally made use of local materials including metals, iron rod, angle iron, metal sheets and 6.5kw power generating machine purchased from the Jalingo building materials market: the crops used for performance evaluation were grown by the researchers and used in November, 2022. The fabrication was done at the Taraba State Polyethnic workshop while performance evaluation was carried out at the farm.

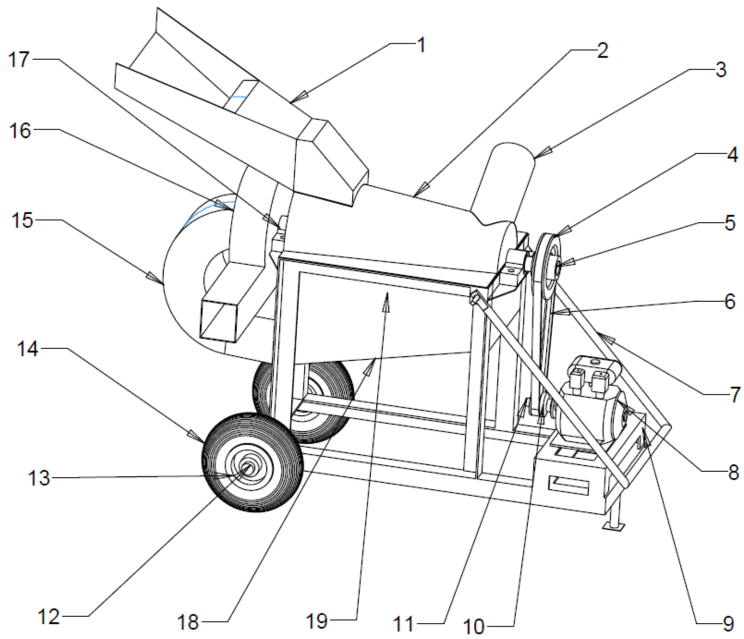
The machine comprises of a hopper, frame, threshing unit, cleaning unit and sieve. The hopper serves as the feeding chute to the threshing chamber where the grains are threshed and separated. It was constructed using a 2mm thick metal sheet. The crop fed into the hopper go down to the threshing chamber where the panicles are threshed by the action of rotating drum against the stationary concave. After the panicles are threshed, some of the threshed seeds, unthreshed crop and some impurities pass down through the perforated concave unto a stream of air blown by the drum through the perforated concave which also removes some portion of the impurities. The rest are passed together with impurities onto a set of aspirators and sieves. The air blown by the drum takes away chaffs and impurities, while the cleaned grains pass through the sieves down to the grain delivery outlet by the action of vibration produced by power source of the thresher.

*Limitations of the ExistingCereal Crop Thresher:*The primary purpose of a crop thresher is to perform the postharvest duty of separating grains of cereal crops (such as maize, sorghum, millet and so on) from the chaff and deliver clean grains to the farmer or consumer. The existing thresher though functionable had obvious gaps among which are the following that necessitated the modification of the thresher:

- The existing machine did not have suction chamber, thereby allowing dirt to enter the threshed grain.
- The handle is stationary and requires heavy machine to pull.
- The sieveswere welded to the frame which madetheir replacement difficult.
- Introduction of blower for effective achievement of threshed grain cleaning quality.

More to these, the cylinder drum, the shaft and shaft speed, blower volume, beater capacity required to be improved to enhance the efficiencies of operations and the general throughput capacity of the cereal thresher.

*Design Considerations:*A cylinder-concave clearance of 10 mm was used for the thresher. This is in accordance with the recommendations of [5]. To keep the mechanical grain damage low, 9.21 m/s (800 rpm) was chosen as the threshing cylinder peripheral speed. This is within the range of values recommended by [6] for sorghum threshing. Sieve hole size of 6 mm was used, this is based on [7] recommendation. The shaking frequency and amplitude of oscillation were 360 rpm and 7 mm respectively. A threshing drawing of the thresher is shown below in Figure 1.cylinder diameter of 220 mm and length of 230 mm was maintained from the previous machine. To increase threshing capacity, the number of pegs around the cylinder was increased from 4 to 5 and cutting knives were mounted on the cylinder cover. The assembly



S/N	COMPONENT	QTY
1	Hopper	1
2	Upper Drum	1
3	Cobs Exit	1
4	Thresher Pulley	1
5	Thresher Shaft	1
6	Belt	1
7	Handle	1
8	Prime Mover	1
9	Frame	1
10	Prime Mover Pulley	1
11	Prime Mover Shaft	1
12	Wheel Shaft	1
13	Wheel	2
14	Tyre	2
15	Suction Chamber	1
16	Blower	1
17	Bearing	2
18	Collection Chamber	1
19	Seive	1

Figure 1: Assembly Drawing of the Thresher

The Major Considerations in Modification of the Machine

Belt Selection:

Length of Belt was calculated as:

$$L = 2c + 1.5(D - d) + (D - d)/4C \quad (3.1)$$

L= Effective length of belt (m),
C= Centre distance from drive to driven pulley (m)
D= Diameter of driven pulley (m),
d= Diameter of driving pulley (m) [8]
The equation above will be used to estimate the following lengths
L1= Belt length from engine to thresher pulley (m), and L2= Belt length from thresher to fan pulley (m)

Belt speed: The belt speeds was calculated using [9] equation:

$$N = \frac{V}{\pi d} \quad (3.2)$$

V= belt speed (m/s),
N= drive speed (rpm),
D= diameter of drive pulley (m)

Calculation of Belt Tension

The formula for the torque producing power, T is given byθ

$$T = \frac{60P}{2\pi N} \quad (3.3)$$

P = Power of engine (kW),
T = Torque (Nm) and N = Speed of thresher pulley (rpm)
The tension in the tight side, T1 and slack side, T 2 of belt was calculated using the formula given below;

$$T = (T1 - T2)r \ [9] \quad (3.4)$$

Fan Design:
Fan case design: The radius of the fan case was calculated from:
$R = \frac{1+\theta}{360}$ (3.5)

r=radius of fan case
R=Distance from shaft to tip of blades
θ = Angle
Fan Blade Selection: A 20-gauge mild steel sheet blade was used.
Determination of air velocity of fan
$Q = AxV$ (3.6)
Q = Volumetric flow rate (m/s), A = Cross sectional area (m), V = Air velocity (m/s) [8].
Determination of fan speed:
$V = \frac{\pi DN}{60}$ (3.7)
N = Speed of fan (rpm), D = Diameter of fan (mm) and V = Velocity of fan (m/s)[9].
Components of the machine:.

- Petrol Engine: this is the power source for thresher providing mechanical energy to the threshing drum in a form of rotation through belt. This engine is of 6.5 kW petrol engine with a speed rating of 3500 rpm.
- Threshing drum/ blower: this is a component that revolves and rubs the grain panicles against a stationary plate thereby detaching the grains from the Plate cob, it blows away or separates the unwanted chaffs from the threshed grain and other impurities.
- Grain plate: it contains holes and against which the panicle is rubbed by the threshing drum. It is where threshed grain passes through after been detached by the threshing drum.
- Feeding hopper: it is where the panicle is fed.
- Set of sieves: it sorts grain from the chaff and other unwanted materials through the action of vibration of the machine.
- Grain delivery outlet: where the threshed grain is delivered.
- Frame: it serves as the body of the thresher

Design analysis and calculation:
Belt speed: The belt speeds will be calculated using [9] equation:
$N=V/\pi D$
V= belt speed (m/s),
N= drive speed (rpm),
D= diameter of drive pulley (m)
$V=N\pi D$ (3.8)
Calculation of Belt Tension
The formula for the torque producing power, T is given by
$T = 60P/2\pi N$ [9] (3.9)
P = Power of engine (kW),
T = Torque (Nm) and N = Speed of thresher pulley (rpm)
The tension in the tight side, T1 and slack side, T 2 of belt will be calculated using the formula given below;
$T = (T_1 - T_2)\, r$ Nm [9]
Pulley Selection: The drive speed is the criteria for which the pulley sizes are based.
$N_1 D_2 = N_2 D_2$

Where;
N_1 = Speed of driving pulley (rpm)
D_1= Diameter of driving pulley (m)
N_2= Speed of driven pulley (rpm)
D_2= Diameter of driven pulley (m) The selection of the following pulley sizes is based on [10]: Prime mover pulley, Threshing drum pulley and Fan pulley.
Estimation of pulley dimensions: Pulleys dimensions were determined by using expression given by [11];
$N_1 D_1=N_2 D_2$
Where:
N_1= Speed of drive pulley;
D_1 = Diameter of drive pulley;
N_2= Speed of driven pulley;
D_2=Diameter of driven pulley
For cylinder and prime mover:

N_1 = Speed of the prime mover (3500 rpm);
D_1 = Diameter of the prime mover pulley (60 mm);
N_2 = Speed of the threshing cylinder (1312.5 rpm);
D_2 = Diameter of the threshing cylinder pulley. Therefore,
D = 160 mm

Determination of concave sieve radius:
The radius of curvature of concave sieve rc, was determined by the following expression as used by [12]:
R_c = rd + hp+ Cc
Where:
R_c = Radius of concave sieve (mm); r
d = Radius of cylinder drum (110 mm); h
p= Height of peg above the drum (78 mm);
C_c= Cylinder concave clearance (10 mm);
R_c= 198 mm

Determination of the volume of cylinder and spike tooth:
Determination of the volume of cylinder and spike tooth: This was obtained by summing up the volume of the threshing cylinder which is hollow and peg teeth volume which is solid

$$V_C = \pi(\mathrm{r}_1 - \mathrm{r}_2)\mathrm{L} + (\pi \mathrm{r}_3 \mathrm{h})\mathrm{n} \quad (3.13)$$

Where:
V_c = Cylinder and peg tooth Volume (m3);
R_1 = Outer radius of the cylinder (110 mm);
R_2 = Inner radius of the cylinder (105 mm);
R_3 = Radius of the peg tooth (10 mm);
L = Length of the cylinder (230 mm);
H = Height of the peg tooth (78 mm);
N = Number of peg tooth (40);

$$V_c = \pi(110 - 105)\ X\ 230 + (\pi\ X\ 10\ X\ 78) * 40$$

$$vc\ = 3.142(5)230 + (3.142\ X\ 3.142\ X\ 78)40$$

Vc = 3613.3 + 98030.4
Vc = 101643.7
Vc = 101 X 10^3

Fan Design:
2.6.6 Actual discharge
: Is the actual flow rate of fan can be estimated as

$$Q_a = V_t DW \quad (3.14)$$

Where:
Q_a = Actual flow rate (m3/s);
V_t = Terminal velocity of air (m/s);
D = Depth of air stream over the screen (400 mm);
W = Width over which air is required (450 mm).

$$V_t = \frac{Q_a}{D \times W}$$

$$V_t = \frac{3}{400 \times 450}$$

$$V_t = 0.0166$$

An air stream terminal velocity V_t is selected such that it is greater than the terminal velocity of the light contaminants and smaller than that of the principal grain materials. At 10–20% moisture content, the terminal velocity of sorghum seeds ranges from 3.73 – 5.13 m/s [13]. Therefore 3.70m/s was chosen as the terminal velocity of air; Q_a=0.670 m3/s.

*Determination of the shaft diameter:*Design of a shaft involves determination of the minimum diameter of the shaft material that can withstand certain loading conditions; it is a ductile material base on strength which is controlled by maximum shear theory. It is subjected to torsion, to bending, to axial tension or compression or to a combination of any or all of these actions. Therefore, there is the need to take all of the above into consideration to avoid shaft failure. To get the shaft diameter (d), the following relationship would be used, [14].

$$d=16/\pi S_S(\sqrt{(K_bM_b)^2+(K_tM_t)^2}(m) \quad (3.15)$$

Where;
S_s= Allowable shear stress (42N/mm2for shafts with keyways), according to ASME Code
K_b=1.5 (constant)
M_b= Maximum bending moment (kNm)

K_t= 1.0 (constant)
M_t= Maximum torsional moment (kNm)
2.6.8 Power required for uploaded cylinder
Power required turning the unloaded threshing cylinder: This was calculated by the formula used by [15];

$$P_1=2\pi\ N tr Mc/60x75(g+\frac{Vt2p}{r}) \quad (3.16)$$

Where:
N_t = Speed of the threshing cylinder (800 rpm);
M_C = Mass of threshing cylinder (13.79 kg);
r = Radius of cylinder (110 mm);
V_{tp} = Peripheral velocity of the threshing mechanism (9.21 m/s); P1=1.32 kW
Torque transmitted by shaft

$$T=P/W \quad (3.17)$$

Where
W=Angular Velocity

$$T=Px60/2\pi N \quad (3.18)$$

$$T=\frac{1.32\times 60}{2\times\pi\times 800}$$

$T=0.01575N$
N=No of revolution of shaft per minute
From equation (3.4) torque transmitted
r = radius of the shaft
$Px60/2\pi N - (T_1-T_2)\ x\ r$
Power required of the prime mover on the multi crop thresher

1. Threshing power = P_{tr}
2. Winnowing power = P_w
3. Feeding power = P_{fm}
4. Transmitting power of the cob = P_{trc}

Total power = $P_{tr} + P_w + P_{fm} + P_{trc}$ (3.19)

III. RESULTS AND DISCUSSIONS

Design calculation results were obtained for all the components as shown below.

Diameter of threshing cylinder pulley = 160 mm; Radius of curvature of concave sieve = 198 mm; Speed of the prime mover = 3,500 rpm; Diameter of prime mover = 60 mm; Speed of the threshing cylinder = 1312.5 rpm; Outer radius of cylinder = 105 mm; Radius of peg tooth = 10 mm; Length of cylinder = 230 mm; Height of the peg tooth = 78 mm; Number of peg tooth = 40; Radius of cylinder = 110 mm; Speed of the threshing cylinder = 800 rpm; Mass of the threshing cylinder = 13.79 kg; Peripheral velocity of the threshing mechanism = 9.21 m/s; Length of beater = 90 mm; Threshing chamber diameter = 300 mm; Length of the threshing chamber = 520 mm

Volume of the drum = 12.37 x 10^3m^3 ;Volume of the threshing chamber with the beaters = 6.363 x 10^3m^3 ;Volume of beaters = 3.7115 x 10^3m^3 ;Volume of the threshing chamber = 2.2985 x 10^3m^3 ;Threshing power = 295.74 W; Volume of the blower shaft and the blade = 6.72706 x 10^3m^3;Angular velocity = 314.2 rad/sec; Threshing force = 3524.30 N; Threshing torque = 126.46 N ;Tortional moment = 78.79 Nm.

These values certify to the fact the machine performance was optimal within the range of these basic design values. The volumes of the threshing chamber,that of the beaters, the volume of the chamber as well as the power rating of the thresher as specified in the design results below enhanced the quantity of material fed into the machines well as the quantity and quality of grain exited. The blowers design capacity of 6.72706 x 10^3m^3 raise the quality and quantity of the material giving rise to an improved material throughput Capacity. The assembly diagram in (figure1) above is a product of these various parameters which served as the data used in coupling the new machine. (Also, see appendices for component drawings using pro e):

The machine was designed to thresh grains by impact and it derives its power from a petrol engine prime mover. The thresher with a new design modification has a reasonable configuration as seen in figure 1comprises of a moderate energy consumption and a relatively high output as contained in Tables 1and 2.

The un-threshed grain, when fed into the hopper, falls down to the threshing chamber which rotates against the concave by the threshing drum. The impact of the drum results in the grain being threshed. The seeds and chaff are separated through the concave sieve. The broken cobs are ejected through the drum outlet. Cleaning of the seeds is done through the airstream produced by the fan, by suction process and then the threshed clean seeds pass down to the discharge outlet.

Tables 1 and 2 below represent the performance evaluation carried out on the new thresher using two major cereals (maize and sorghum). Various parameters such as threshing efficiency, percentage of unthreshed grain, percentage of mechanical damage, percentage of blown grain,Percentage of sieve loss, throughput Capacity,threshing performance index,total grain loss etc. determined which displays adequate superiority over the existing thresher.

TABLE 1: QUANTITY OF GRAIN (MAIZE) THRESHED IN (Kg) PER TIME

S/N	Qty of unthreshed grain (x) Kg	Time taken to thresh (T) min	Qty of threshed grain (x_1) Kg	Qty of grain cobs (y_b) Kg	Qty of damage grain (y_2)	Qty of unthreshed seed (y_1)	Qty of grain stuck in sieve (y_c)
1	63	10	48	8.80	2.70	0.90	2.00
2	240	20	218	17.10	3.00	1.90	4.00
3	320	40	300	13.10	4.80	2.10	5.00
TOTAL	623	70	566	39	10.50	4.90	11.00

TABLE2: QUANTITY OF GRAIN (SORGHUM) THRESHED IN (Kg) PER TIME

S/N	Qty of unthreshed grain (x) Kg	Time taken to thresh (T) min	Qty of threshed grain (x_1) Kg	Qty of grain cobs (y_b) Kg	Qty of damage grain (y_2)	Qty of unthreshed seed (y_1)	Qty of grain stuck in sieve (y_c)
1	70	10	41	9.1	2.30	0.70	1.80
2	250	20	211	18.5	2.90	1.60	3.70
3	300	40	291	14.1	4.20	1.80	4.40
TOTAL	620	70	543	41.7	9.41	4.10	9.9

These results demonstrate a high efficiency of the machine. This actually shows a great improvement on the existing which is virtually below 65%.

IV. CONCLUSIONS

The purpose of this research was the design modification, development and performance evaluation of a thresher. This effort seeks to respond to the need to provide local farmers with appropriate multi-crop threshers with high throughput and mechanical grain damage that will reduce processing losses which invariably increases economic returns to the farmers. In the same vane, efficient poweroperated multi-crop threshers would also eliminate large drudgery involved in the manual method of threshing.

The threshing machine has been developed which offers the potentials of a number of basic design advantages which implies from the performance test its ability to be used for minimizing energy, high productivity, affordability and ease of operation by local farmers. The adoption a petrol engine as a power source is a featurealso makes it available right down to the grassroot. The cylinder and concave sievesare easilyreplaced for different cereal crops it's been portable ease of movementfrom farm to farm.

The performance of the modified thresher was carried out using maize and sorghum. The threshing efficiency of the modified thresher was determined as 92.54% for maize and 89.096% for sorghum as against the 58.72% for maize, and 56.49% for sorghum respectively.

REFERENCES

[1]. Keepner, R. A., Bainer, R. and Barger, E. L. 1978. Principles of Farm Machinery, CBS Publishers and Distributors, New Delhi.

[2]. Basher, I.M and J.O. Dauda (2003) problem associated with the maintenance of fully imported technologies. A case study of agricultural machinery and equipment in Kaduna state, Nigeria. Nigeria journal of engineering and appropriate technology 1 (1) Pp. 59-62.

[3]. Yisa M.G. (1999) Agricultural Mechanization, how far? And what is next? Paper presented at NSE quarterly dinner in Minna, Niger state Nigeria.

[4]. Denis Nsubuga, Isa Kabenge, Ahamada Zziwa,Nicholas Kiggundu, Joshua Wanyama and Noble Banadd (2021):Improving Maize ShellingOperation Using MotorizedMobile Shellers: A Step towardsReducing Postharvest Losses in LowDeveloping Countries: intechopen doi :http://dx.doi.org/10.5772/intechopen.101039

[5]. Saeidirad, M. H., Esaghzade, M., Arabhosseini, A. and S. Zarifneshat, S. (2013). Influence of Machine-Crop Parameters on the Threshability of Sorghum. *Agric Eng Int: CIGR Journal*, 15(3): 55—59.

[6]. Joshi, H.C (1981) design and selection of thresher parameters and component. Journal of Agricultural mechanization in Asia, Latin America and Africa (AMA). 12(2): 61-68

[7]. IRRI (1978). "The Rice Plant and How it Grow." International Rice Research Institute.(www.fao.org/inpho/content/compend/text/ch10-05htm)

[8]. Khurmi, R.S, and Gupta, J.K. (2005). A textbook of machine design. 14 Edition, Eurasian Ltd. Ran Nagar New Delhi, pp.1230

[9]. Hannah, J. and Stephens, R.C. (1984). Mechanics of machines, Edward Arnold, London.

[10]. Gupta, P. K., Singh, Singh, S. and Sharma, V. K. 1985. Performance Studies on tractor operated combine for maize threshing. Agricultural Engineering Today 9(4):40

[11]. Mohammed, J. (2009). Development of a maize dehusker thresher. An unpublished master degree thesis, department of agricultural engineering, Ahmadu Bello University, Zaria.

[12]. Dangora, N.D Suleiman M.L and Yusuf D.D (2006): Modification of IAR Maize Dehusker Sheller for sorghum Threshing. 'Proceedings of the seven international conference of institute of Agricultural Engineers', 28: 106-109.

[13]. Dauda, A. and Aviara, A. N. 2001. Effect of threshing methods on maize grain damage viability. AMA 32(4):43-46.

[14]. ASME. 1995. Design of Transmission Shafting. American Society of Mechanical Engineering, New York, NY, USA
[15]. Olaoye, J.O., Oni, K.C and, M.O. (2011) computer applications for selecting operating parameter in a stationary grain crop thresher. Journal of Agricultural Technology, 7(1): 39-56
[16]. Gbabo. A., Gana, I and Amoto, M, (2015). Design, fabrication and testing of a millet thresher. Net journal of agricultural science, 1(6): 100-106.

APPENCICES

Cleaning Efficiency Ce (%)

This is defined as the ratio of the weight of grain collected at the grain outlet to the weight of the total mixture of grain and chaff received at the main outlet expresses as percentage. It can be determined according to [16] as stated below.

Ce = (Wt – Wc)/Wt x 100%

Where:

Ce = cleaning efficiency (%)

Wt = Total mixture of grain and chaff received at the main outlet (kg) =63 kg

Wc = Weight of chaff at the main outlet of the thresher (kg) =16.8 kg

Therefore

Ce = (Wt – Wc)/Wt x 100%

= 63 – 16.8/6.3 x 100

= 46.2/63 x 100

= 73.33%

Percentage of Unthreshed Grain

Partially threshed material coming out of the thresher was collected on analysis approach tarpaulin. All the unthreshed and partially threshed ear heads were sorted out from the straw. The unthreshed heads were re-threshed manually and the grain recovered was weighed. Percentage of th unthreshed loss was calculated by the following formula:

Percentage of unthreshed grain, p = Y_1/X x100

P = 4.9/623 x 100%

= 0.78%

Cracked Grain

Five samples of clean grain weighing approximately 1 kg each were taken at random from the clean grain and divided into smaller fraction of about 200 gm. Cracked grain was sorted out manually from each of these samples and weighed. Percentage of cracked grain was calculated by using following formula:

Y_C =w/W x100

Where;

Y_C = Percentage cracked grain w = weight of cracked grain in (g)

W = weight of sample in gm

Throughput Capacity

The throughput capacity is the rate at which T_1 is down linking data at a particular point in time, it is expressed in megabits per second

Throughput Capacity (kg/min), T_s = (X/T) x 100%

T_s = 623/70

= 8.9 kg/min

Converting to hour;

= 8.9 x 60

= 543 kg/hr

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