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Performance Evaluation of Motorized Maize Sheller

By

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Abstract

Maize (*Zea mays*), also known as corn, is the third largest crop after wheat and rice in the world.The traditional method of shelling maize is by hand or by beating sacks filled with maize cobs with woods or even by putting the dry maize into the mortar and apestle is then used to hit the maize with force. These traditional methods of shelling maize are time consuming because a small quantity of shelling is achieved per time with high amount of seeddamage. To improve the market value of maize, the machine must work efficiently with minimum seed damage. Shelling isone of the most important processing operations done to bring out the quality of maize.

This report present the performance evaluation of maize shelling machine and from the result obtained, it showed that the average capacity of the machine is 1655 kg/hr with shelling efficiency of 81.84% and minimal seed damage

Keyword: Performance, evaluation, sheller, motorized, maize.

1.0 Introduction

Maize (*Zea mays*), also knowsn a corn, is the third largest crop after wheat and rice in the world, it is believed to have originated in central Mexico seven thousand years ago from a wild grass,and an indigenous Americans transformed it into a better source of food. It contains approximately 72% starch, 10%protein, and4%fat, with an energy density of 365 Kcal/100 g, it is also grown throughout the world, with the UnitedStates, China, and Brazil being the top three maize-producing countries in the world, producing approximately 31%, 24%, and 8% respectively of world production. (Ranum et al.,2014).

In Nigeria, cultivation of maize is spread across all states and to all theagro-ecological zones in the country (NBS, 2007).

Maize produced in Nigeria is harvested either as greenmaize or maize grain (i.e. dried maize). Theprocessing and consumption of maizevaries greatly from country to country, in Nigeria the green maize is consumed inseason as a snack either in boiled or roasted formand it act as a substitute for regular food (Adene and Oguntade, 2005).The maize grains are eaten as breakfast: hot pap called "ogi or akamu "Eko" the cold pap,the dehusked maize meal called "Eegbo" and the milled grains "Tuwo". Almost 60 percent of maize production in Nigeria isused for animal feed (Oriaku et al, 2014). Maize is also beingused for ethanol fuel (ethyl alcohol) production. Shelling is the process of removing the edible part of the crop. The traditional method of shelling maize is by hand or by beating sacks filled with maize cobs with woods. These traditional methods of shelling maize are time consuming, hazardous and associated with lots of drudgery (Kaul and Egbo, 1985). Akubuo(2003), described the use of pestle and mortar as a process by which dry maize is put into the mortar and pestle which is then used to hit the maize with impact force. A considerable quantity of shelling is achieved per time but the amount of seed damage is high with low cleaning efficiency (Oriaku et al., 2014).

The processing of agricultural products like maize into quality prolongs the useful shelf life and also increases the profit farmers make from mechanization technologies of such products. Shelling is an important processing operation done to bring out the quality of maize.

2.0 Objectives

i. To carryout performance evaluation of motorized maize sheller

ii. To determine the capacity of motorized maize sheller

3.0 Materials and Methods

3.1 Machine description

The machine comprises of the following parts:

1. **Rectangular feed hopper:** That is framed in both horizontal and tangential position to the threshing unit.
2. **Top cover:** It is a 3mm thick semi circular structure made from mild steel iron.
3. **Threshing unit:** It is a 10mm thick cylindrical structure with 12mm bore perforation all that its cross section. The central shaft carrying the threshing bar is located in the threshing drum. It has a bull wheel that helps to provide for torque and higher mechanical advantage during the threshing operation.
4. **Horizontal conveyor:** This is a right – hand helical worm of regular flight which helps to convey the threshed maize seed into a reservoir from where they are conveyed to the outlet.
5. **Vertical conveyor:** This is the component which has its base positioned in the maize seed reservoir. From here, the threshed maize seed are conveyed upward into a delta spout for final delivery to the bagger.
6. **Delta spout:** This is the component of the machine that provide for selective discharge of the threshed maize which help to make a return of unclean seed back into the threshing unit.
7. **Cart:** This is a component of the machine that bears the overall weight of the thresher. It has a two number pneumatic rear wheels that helps to absorb the weight of the thresher and also provide traction for movement of the machine from one place to another. The

cart is also provided with a one point linkage circular hinge which provides for articulation to a prime moving engine.

8. **Main frame:** This is a 75 by 75 by 5mm mild steel angle iron which provides for the rigidity and balance of the machine in operation and its height of fabrication was selected from ergonomics with respect to the optimum height desired for human operation.
9. **Engine seat:** This is a 75 by 75 by 5mm mild steel angle iron fabricated to provide an appropriate base and fixture for the prime mover to the thresher. It has adjustable feature to allow for optimum tensioning of the driving belt connected to the prime mover connected on it.
10. **Aspirator fan:** This helps to provide for suctional force which moves out the turbulent air mixed with particles in the inside of the threshing unit.

3.2 Operation of the machine

The maize cobs are fed into the machine through the feed hopper into the threshing unit. The threshing action is achievable by the rotary motion of the central shaft which bears the threshing bar. The threshing bar agitates the maize cobs against the perforated circular sieve of the threshing unit which eventually delivers the clean threshed maize seeds into a lower chamber underneath the threshing unit. In this lower chamber, lies the horizontal conveyor which sweeps the threshed seeds into a receiving pot that has the vertical conveyor positioned right into its centre.

The top cover houses a central shaft which carries the suctional fan that helps to provide for the cleaning of the threshed seeds by moving out dust and particles filled aerosol out of the machine. Meanwhile, the clean seeds that are deposited into the receiving pot at the end of it, horizontal conveyor are conveyed out of the machine through the vertical conveyor into the bagger.

4.0 Test Procedure and Evaluation

4.1 Performance Test

A performance test of the shelling machine was carried out at the Engineering and Scientific Services (ESS) department of the National Center for Agricultural Mechanization (NCAM). Dry maize of 50kg was loaded into the shelling machine in four replicate. At each loading, the time taken; the weight of the shelled grain and weight of damaged seeds were noted.

The results of the performance test are shown in Table 5.1, 5.2 and 5.3.

4.2 Performance parameters

The performance indices that were used include; Shelling efficiency (%), Percentage damaged (%) and shelling rate.

i. Shelling efficiency - $S_{E(\%)}$

$$S_E = \frac{W_S}{Wi} \times 100 \quad (1)$$

Where,
S_E=Shelling efficiency
W_s = Weight of shelled
W_i = Input weight

ii. Percentage damaged -$P_{d(\%)}$.

$$P_d = \frac{W_d}{Ws} \times 100 \quad (2)$$

Where,
P_d =Percentage damaged
W_d = Weight of damaged seed
W_s = Weight of shelled

iii. Shelling rate (S_r)

$$S_r = \frac{W_s}{T} \times 3600 \quad (3)$$

Where,
S_r =Shelling rate
W_s = Weight of shelled
T = Time taken

5.0 Results and Discussion

The result represented in Tables 5.1, 5.2 and 5.3 showed that the machine has a shelling efficiency of 96.26% with 1655kg/hr shelling capacity and a minimal grain damage.

Table 5.1: The mean data obtained from the evaluation of maize sheller

Input weight (kg)	Weight of shelled grain (kg)	Time (sec)	Threshing speed(rpm)	Conveyor speed(rpm)	Machine speed (rpm)
50	40.92	107	1472	396	1596
50	40.67	109	1472	396	1596
50	40.88	108	1472	396	1596
50	40.56	111	1472	396	1596

Table 5.2: The mean data obtained from the evaluation of maize sheller

Input weight (kg)	Weight of shelled (kg)	Time (sec)	Shelling rate(kg/hr)	Shelling efficiency(%)
50	40.92	107	1376.75	81.84
50	40.67	109	1343.23	81.34
50	40.88	108	1362.67	81.76
50	40.56	111	1315.46	81.12

Table 5.3: The mean data obtained from the evaluation of maize sheller

Input weight (kg)	Weight of shelled (kg)	Weight of damaged (kg)	Percentage damaged(%)
50	40.92	0.51	1.25
50	40.67	0.62	1.52
50	40.88	0.54	1.32
50	40.56	0.65	1.60

6.0 Conclusion

In this study performance evaluation of maize shelling machine was evaluated and from the above presented results and discussion, it was discovered that the average capacity of the machine is 1655kg/hr and the shelling efficiency is 81.84% at the minimum grain damage.

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