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Evaluation of Performance of an Indigenous Bambaranut Decorticating Machine

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ABSTRACT: *The performance of an indigenous Bambara groundnut decorticating machine was tested to make optimal use of locally developed decorticators as substitute for imported bambaranut decorticators. The test was based on the threshing/decorticating efficiency, cleaning efficiency, total grain losses, grain recovery range, capacity utilization and threshing intensity. Results obtained showed that the locally developed decorticator performed credibly well. The local decorticator had threshing and cleaning efficiencies of 97.52% and 97.88% respectively with minimal total seed losses of 4.13%. More so, the decorticator recorded 97.26%, 63.84% and 0.038kw/kg for the grain recovery range, capacity utilization and threshing intensity respectively. Therefore the locally developed decorticator could be substituted for imported decorticators thereby reducing foreign exchange in Nigeria in addition to its low cost, easy maintenance and simple operation.*

Keywords*: Indigenous, performance, evaluation, decorticating efficiency, cleaning efficiency, bambaranut, and threshing intensity*

I. INTRODUCTION

Bambara Groundnut use to be the major farm crops in Nigeria. It was introduced to West Africa by the Portuguese in the 16th century; from where it spreaded quickly in every part of Africa. Bambara has been identified by the food and agricultural organization (FAO) as one of the main species of crops that constitute the principal root crops and is widely utilized in different quantities by human beings and animals. The kernels are eaten raw, roasted or sweetened. They are reach in protein and vitamin A, B and some members of B_2 group (Jasaini 2009). Its cake is an important supplement in cattle and poultry rations and can be used in manufacturing artificial fibre.

Despite the high nutrient content of bambaranut, mechanization of its production in Nigeria has not received much attention especially in the area of processing. The processing of Bambaranut is handled traditionally; seeds are removed out mature pods manually by hand, stones or sticks which according to Oduma et al, (2015) release the seeds from the pods by shattering and the seeds are separated from the chaff by winnowing. This method cause damage of the seeds and it is difficult and takes much time.

According to Danda and Dzivama (2000), Nigeria as a country is very rich in indigenous technology. It is in recognition of this that Andeh (1992) reported that long before colonial period; technology in Nigeria had attained measure of technological development. Agriculture is one of the fields where Nigeria heavily relied on importing technology especially in areas of machinery and equipment (Bashir and Danda 2003). These machines have not made appreciable impact on increased food production due to several problems such as the regular breakdown of these machinery. Yisa (1997) stipulated that these machinery and equipment breakdown as early as few days after commissioning due to ignorance, abuse or misuse.

Imported equipment can be sophisticated to justify better output but more maintenance will be required. Priel (1994) reported that, the more sophisticated the equipment, the better it is expected to perform and with the confirmation of this trend it becomes more dependent on maintenance. But it becomes counterproductive if such sophisticated equipment is imported into an underdeveloped country with inadequate maintenance capability, technology or lack of knowledge of the vital equipment characteristics maintainability and reliability (Imonigie 2003).

Danda and Dzivama (2000), however, maintained that in contrast with the locally manufactured machines, the imported machines are usually more prone to maintenance problems since they are designed and manufactured with the components under different environmental and operating conditions. They strongly believe that the progressive technological change in the equipment exporting countries (usually developed countries) inevitably leads to rapid equipment obsolescence in developing countries; and poses problems to the maintenance personal who always battle to adapt or adjust to the change. More so, imported machines are cost intensive, exorbitant and spare parts are not always readily available as compared to locally developed machine which are always easy to maintain, affordable and very simple to operate.

Kudabo and Olawepo – Olayiwole (2001) developed a local yam bean thresher the result of the performance evaluation revealed a high threshing and cleaning efficiencies of 95% and 95.3% respectively with a low percentage loss of 1.45%. Adewumi (2000) developed a local maize Sheller, the shelling efficiency varied from 92.90% - 9.3%. Danda and Dziama (2000) compered a locally developed rice thresher with a Vortex rice fan, result revealed that, the local thresher performed credibly well in comparison to the imported one with threshing efficiencies of 98.01% and 98% respectively; and they recommended that local threshers can be substituted for the imported thresher thereby conserving Nigeria's foreign exchange. Oduma et at (2014) appraised the performance of a locally developed pigeon pea thresher and recorded a threshing efficiency range of 97.01% – 99.97% with minimal seed loss/damage of 0.2%.

The objectives of this work is to test the performance of an indigenous Bambara groundnut decorticator make optional and effective use of locally developed groundnut decorticator as substitute for imported Bambara thresher which is costlier.

II. MATERIALS AND METHOD

2.1 Description of the Locally Developed Groundnut Decorticator

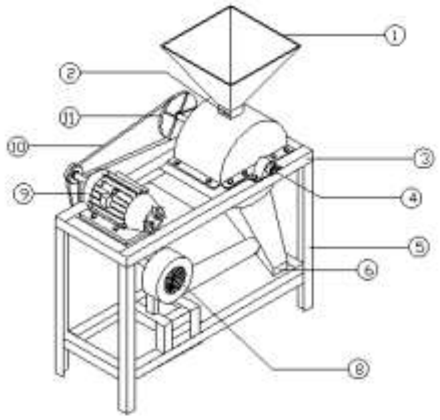
The assembly drawing of the groundnut drawing decorticating machine is as shown in figure 1. The component parts include; the hopper, stopper, perforated cover serein, V-belt, pulley drive, frame, centrifugal blower, electric motor, shaft with spike tooth, shaft casing, bearing, bolt and nut, seed outlet and chaff outlet.

2.1.1 Principle of Operation.

The groundnut decorticator is designed to be powered by either an electric motor or a petrol engine of 6kw with a too-way pulley system driven through V-belt pulley drive at speed range of 500rpm to 900rpm. The machine is manually feed through the hopper with two or three capable people to ensure continuous operation (Oduma et at, 2014). The separated/cleaned seeds are collected via the seed outlet and the chaff through the chaff outlet.

2.1.2 Design Considerations.

The design was based on the engineering properties of the Bambara shells and kernels. The blower was incorporated for cleaning of the threshed groundnut seeds; cost, availability and suitability of the construction materials for the working condition, strength, vibration, stability, rigidity, durability and portability of the decorticator were also paramount in the design of the machine.



ASSEMBLY DRAWING OF A LOCALLY DEVELOPED GROUNDNUT DECORTICATOR

Component Description

1. Hopper
2. Stopper
3. Frame
4. Bearing
5. Frame stand
6. Grain outlet
7. Chaff outlet
8. Blower
9. Electric motor
10. V-belt
11. Pulley system

2.2 Performance Test.

Test were carried out on both the locally developed bambaranut decorticator in Imo state Agricultural Development Programme (IMADEP), using a local bambaranut species popularly called okpa which was obtained from the local market in Imo state, Nigeria, at average moisture content of 12.9% (w.b). Data were obtained on the performances of both machines by exploring some useful parameters of the machines in accordance with the draft Nigeria standard test code for grain thresher 1999 as used by Dauda and Dzivama (2000) as adopted by Oduma et al, (2015). The parameters evaluated include: threshing efficiency, cleaning efficiency, total seed losses, input and output capacities, grain recovery range, capacity utilization, threshing index and threshing intensity. The results obtained were thereafter compared for both decorticators.

2.2.1 Determination of Total Seed Losses

The total losses (L_t) were evaluated as follows:

(a) $p_u = {}^{q_u}/_{G_t}\ X\ 100\%$ (1)

where p_u = percentage unthreshed seed (%)

q_u = quantity of unthreshed seed obtained from chaff (%)

G_t = Total grain/seed received at seed outlet (kg)

(b) $P_c = {}^{q_c}/_{G_t}\ X\ 100\%$ (2)

where P_c = percentage of cracked/broken seeds (%)

q_c = and G_t are as defined in equation (1)

(c) $P_L = {}^{q_L}/_{G_t}\ X\ 100\%$ (3)

where P_L = percentage of clean grain seeds obtained at chaff outlet, (%)

q_L = quantity of clean grain/seeds obtained at chaff outlet (kg)

G_t = as defined above.

(d) $P_s = {}^{q_a}/_{G_t}\ X\ 100\%$ (4)

where P_s = percentage of sieve loss (%)

q_a = clean grain/seed at sieve over flow + sieve under flow + stuck grain/seed (kg)

G_t = as earlier defined.

(e) Total losses, T_L (%) = $p_u + P_c + P_L + P_s$ (5)

2.2.2 Determination of Efficiencies

a) Threshing efficiency (T. E. %) was obtained from the expression

T.E, % = 100 - ${}^{q_c}/_{G_t}\ X\ 100\%$ (6)

b) Cleaning efficiency (C.E, %) was evaluated from the formula

$C_E = {}^{G_c}/_{G_t}\ X\ 100\%$ (7)

Where G_c = clear grain/seeds received at seed outlet (kg)

2.2.3 Determination of Input and Output Capacities:

a. The Input capacity was determined as follows: A known mass of bambaranut, measured using weighing balance was fed into the decorticator at a time. The decorticating time for each test was recorded using stop watch.

The input capacity was evaluated from equation (9). (Oduma, (2015)

$$I_c = {}^{W_u}/_{t} \quad (8)$$

Where I_c = input capacity (kg/hr.)

W_u = weight of unthreshed groundnut fed into the machine (kg)

t = time taken to thresh the groundnut (hr.)

b. Output capacity:- The weight of threshed seeds received at seed outlet per unit time was taken and recorded. Then the output capacity was determined mathematically from the expression;

$$Q_c = {}^{W_t}/_{t} \quad (9)$$

Where Q_c = output capacity (kg/hr.)

W_t = weight of threshed Bambara groundnut (kg)

t = time taken to thresh the Bambara groundnut (hr.)

2.2.4 Grain Recovery Range (%):

The grain recovery range was determined from the expression

G. R. R. = 100 - P_t (10)

Where P_t = percentage total seed/grain losses (%)

2.2.5 Capacity Utilization (C_u):

Capacity Utilization was obtained from the expression

$$C_u = Q_c\ X\ 100 I_c \quad (11)$$

2.2.6 Threshing Index T_i:-

Is the product of grain recovery range, capacity utilization and threshing efficiency expressed in decimal

T_i = GRR x C_u x T.E (12)

Where C_u = capacity utilization (%)

Q = output capacity (kg/hr.)

I_c = input capacity (kg/hr.)

2.2.7 Threshing Intensity T_{in}:

The threshing intensity was obtained using the relationship

T_{in} (Kw/kg) = P_c/Q_c (13)

Where P_c = power consumed by (kw)

Q_c = output capacity (kg)

III. RESULTS AND DISCUSSION

3.1 Results

The results of these research work are recorded in table 1-6

Table 1. Threshing efficiency of the local decorticator.

Replication	Locally Developed Decorticator/T.E (%)
1	96.3
2	98.1
3	94.8
4	98.7
5	99.7
Mean	**97.52%**

Table 2. Cleaning efficiency of the local decorticating machine.

Replication	Locally Developed Decorticator/T.E (%)
1	98.4
2	96.9
3	98.0
4	98.2
5	97.9
Mean	**97.88%**

Table 3. Percentage losses of the local decorticating machine.

	Locally Developed Decorticator					
Parameter	**Rep1**	**Rep2**	**Rep3**	**Rep4**	**Rep5**	**Mean**
Unthreshed seed (%)	1.19	0.98	0.93	1.04	1.01	1.03
Cracked/broken seed (%)	1.03	0.11	1.31	1.00	1.14	0.92
Sieve loss (%)	2.11	1.83	0.96	2.00	1.34	1.65
Blown loss (%)	0.10	1.00	0.13	0.12	1.19	0.53
Total (%)	**4.43**	**3.92**	**3.33**	**4.25**	**4.68**	**4.13**
Total	**8.09**	**6.20**	**2.18**	**7.16**	**8.58**	**7.94**

Table 4. Input and output capacities of the local decorticating machine.

	Locally Developed Decorticator	
Replication	Input capacity (kg/hr.)	Output capacity (kg/hr.)
1	500	385
2	500	400
3	500	481
4	500	420
5	500	498
Mean	**500**	**436.8**

Table 5. Grain/seed recovery range and capacity utilization of the local decorticator.

	Locally Developed Decorticator	
Replication	Grain recovery range (GRR), %	Capacity utilization (C_u), %
1	96.6	63.8
2	98.7	65.9
3	96.6	71.7
4	99.3	68.6
5	95.1	59.6

Mean	97.26	59.9

Table 6. Threshing index and threshing intensity of the local decorticating machine.

	Locally Developed Decorticator	
Replication	Threshing index (%)	Threshing intensity (kw/kg)
1	63.2	0.038
2	58.8	0.048
3	61.4	0.040
4	63.3	0.031
5	59.3	0.034
Mean	**61.24**	**0.038**

3.2 Discussion

Table 1 presents the result of the threshing/decorticating efficiency of the local bambaranut decorticating machine. From the table it is observed that the decorticator had 97.52% threshing efficiency. This showed that the decorticator performed performed well.

Table 2 shows the cleaning efficiency of the local decorticator and imported Kirlosker groundnut decorticator. From the evaluation the local decorticator recorded 97.88%

Table 3 revealed the total losses obtained from both local and imported machines. According to the results of this table the total loss obtained from the local decorticator is 4.13% .

Table 4 presents the result of the input and output capacities of the locally developed. Form the table it can be observed that the local decorticator recorded an output capacity of 436.8kg/hr indicating that the local decorticator has high output capacity.

Table 5 revealed that the local decorticator had a good grain/seed recovery range of 97.26%.

Finally, table 6 presents the results of the capacity utilization for both the local and imported decorticating machines. From this table it is observable that the locally developed decorticator had the capacity utilization of 61.24%.

IV. CONCLUSION/RECOMMENDATIONS

The locally developed groundnut decorticator credibly performed well and has the tendency of giving optimum performances if modified further. The adoption of this machine will drastically decline the foreign exchange expenditure on the importation of bambaranut decorticators and will encourage the indigenous manufacturers and research institutions in the adoption and production of locally developed groundnut decorticators. It will also improve the production and processing of Bambara groundnut locally in Nigeria because the machine is affordable, easy to maintain and simple to operate.

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