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Comperative Performance of a Locally Developed Groundnut Decorticator with an Imported Kirlosker Decorticator

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ABSTRACT

The performance of a locally developed groundnut decorticator was compared with the imported kirlosker decorticator to ascertain and probably make optimal and effective use of locally developed decorticator as substitute for imported groundnut decorticator from India. The comparison was based on the following parameters; 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 better than imported decorticator. The local decorticator had threshing and cleaning efficiencies of 97.52% and 97.88% respectively with minimal total seed losses of 4.13% while the imported kirlosker decorticator recorded a threshing efficiency of 96.58% and cleaning efficiency of 97.66 with total seed losses of 7.94%. More so, the local decorticator recorded 97.26%, 63.84% and 0.038kw/kg for the grain recovery range, capacity utilization and threshing intensity respectively while the imported decorticator in that order recorded 93.92%, 61.24% and 0.013km/kg respectively. Therefore the locally developed decorticator could be substituted for the imported decorticator thereby conserving foreign exchange in Nigeria in addition to its low cost, easy maintenance and simple operation.

Keywords.*Local and Imported Decorticator, Performance Evaluation, Decorticating Efficiency, Cleaning Efficiency, Groundnut, Threshing Intensity and Capacity Utilization.*

1. INTRODUCTION

Groundnut use to be the major farm crops in India. It is the number one oil seed crop in India (Ojha and Michael, 2012). It was introduced to West Africa by the Portuguese in the 16th century; from where it spreaded quickly though faster in the interior part of the Africa than along the coast. Groundnut 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 industries and individuals in the form of groundnut oil for human food, soap making, manufacturing of cosmetics and lubricants. 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). The calorific value of groundnut oil is 349 per 100 grams. Its oil lake is an important supplement in cattle and poultry rations and can be used in manufacturing artificial fibre.

Research shows that groundnut has an inherent poor storage life, if not threshed after harvesting unlike some other crops, but in threshed forms, it can be stored for a very long period of time (Onuoha, 2010). Therefore to overcome the problem associated with manual threshing and quick rate of insect infestation after harvesting, the development of groundnut decorticating machine is of paramount.

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 machinery have not made appreciable impact on increased food production due to several problems chief among them is 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%.

Kirlosker groundnut decorticator (plate 1) is an imported groundnut thresher. It was developed and built by a firm of Maharashtra state of India. Intensive testing in countries like Mali, Sierra Leone, Vietnam, Nigeria, Indonesia and Philippines recorded high threshing and cleaning efficiencies with low damage/loss of the seeds (Ojha and Michael, 2012).

The objectives of this work is to compare the performance of a locally developed groundnut decorticator with the imported Kirlosker groundnut decorticator in a drive to discover and make optional and effective use of locally developed groundnut decorticator as substitute for imported groundnut thresher.

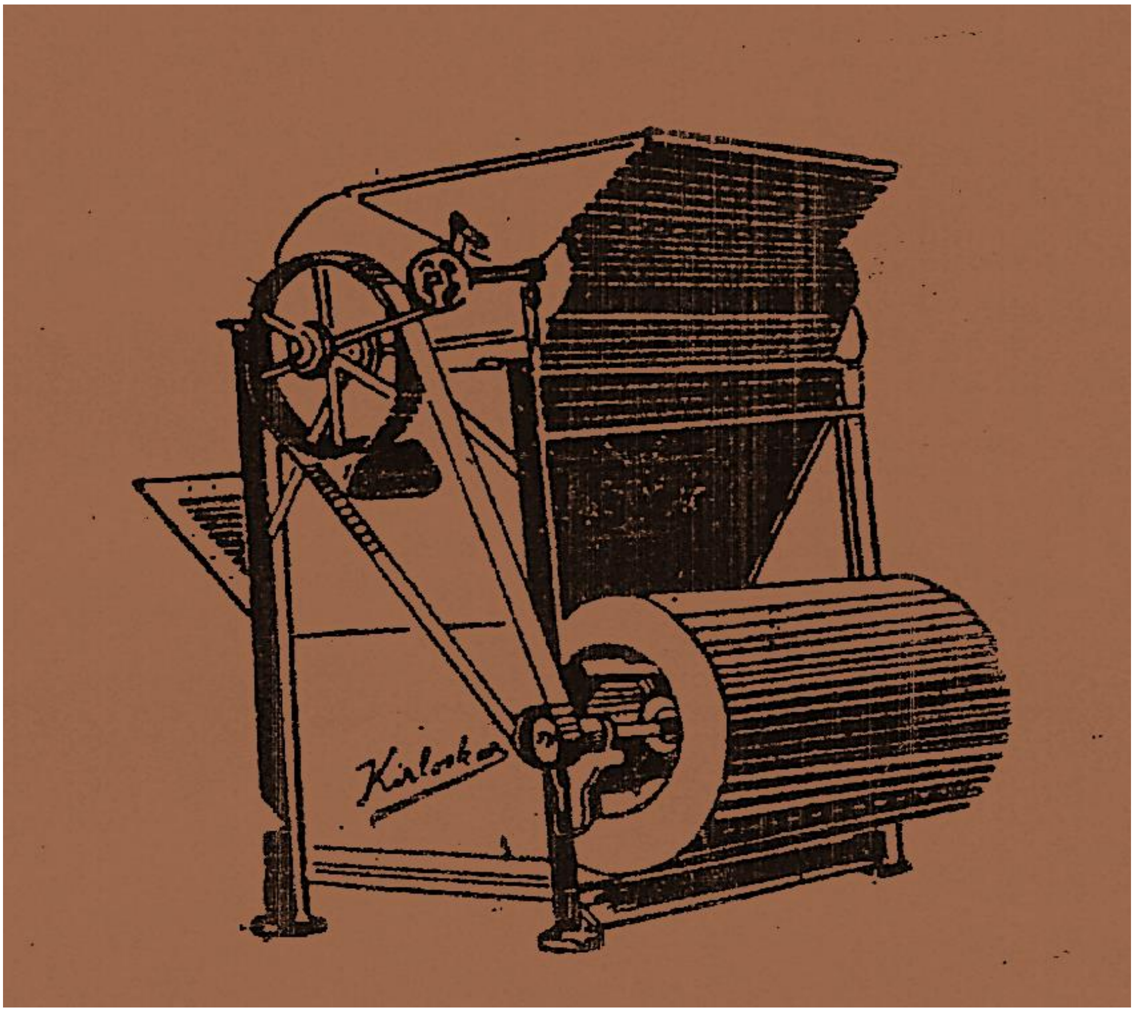


Plate 1: Imported Kirlosker Decorticator.

2. 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;

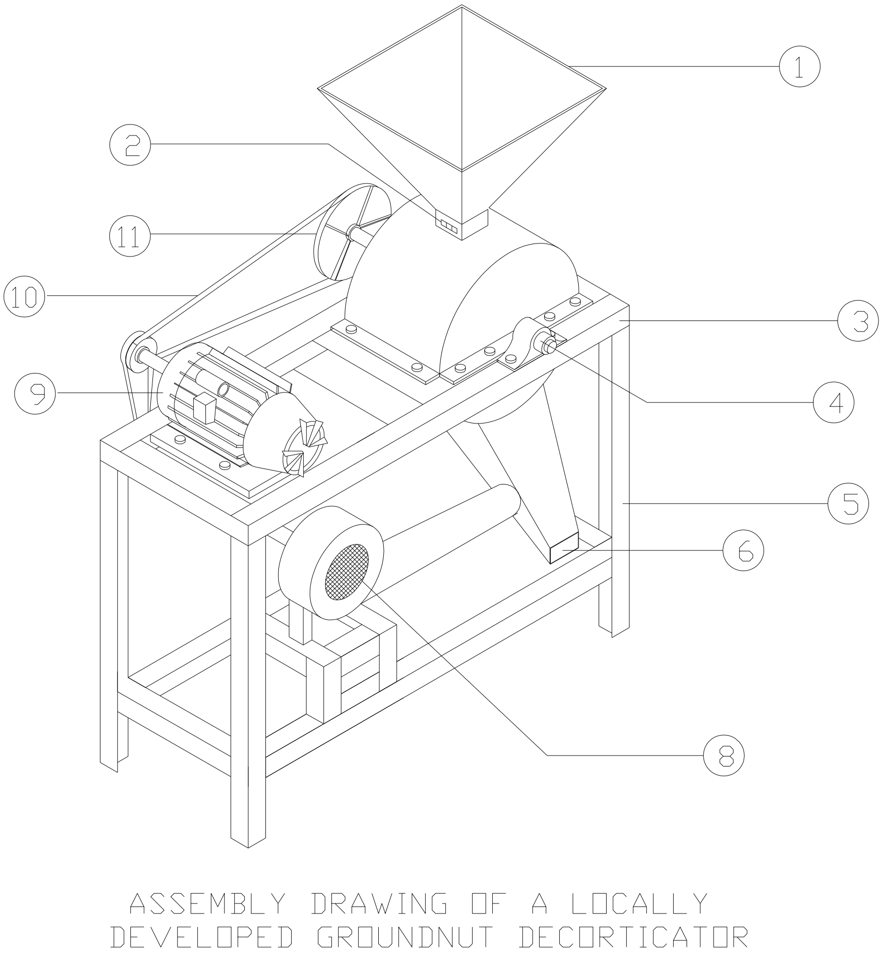
the hopper, stopper, perforated cover serein, V-belt, pulley drive, frame, centrifugal blower, electric motor, shaft with spike tooth, shaft casing, bearing, bolt and nut, seed outlet and chaff outlet.

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 systems 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 groundnut 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.



2.2 Comparative Performance Test.

Test were carried out on both the locally developed and the imported Kirlosker groundnut decorticator in Ebonyi state Agricultural Development Programme (EBADEP), using a local groundnut species popularly called Nkara which was obtained from Eke Market in Ebonyi state, Nigeria, at average moisture content of 14.8% (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). 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

Total seed losses are the sum of all the losses incurred during decorticating process which were described as percentage unthreshed seeds, P_u; percentage of cracked/broken seeds, P_c ;

percentage of clean seeds obtained at chaff outlet, P_l and percentage of sieve loss, P_s. The total losses (L_t) were evaluated as follows:

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

In which

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)

In which

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)

In which

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)

In which

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. %): The threshing efficiency is the ratio of total weight of grain/seed threshed to the total weight of seed feed into the thresher expressed as a percentage (Ndirika 1994). It is also the difference between 100% and the percentage of unthreshed seed. This is expressed as

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

Or 100 – q_u ……………………………………………(7)

b) Cleaning efficiency (C.E, %):- The cleaning/separation efficiency is the ratio of the weight of clean grain/seed that pass through the cleaning unit to the total weight of grain at the outlet of the grain retainer expressed as a percentage (eqn.8)

$C_E = {G_c}/{G_t}\ X\ 100\%$ …………………………………………… (8)

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

2.2.3 Determination of Input and Output Capacities:

a. Input capacity:- To determine the input capacity for each test, a known weight of groundnut basin as 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).

$I_c = {W_u}/{t}$ ………………………………………… (9)

In which

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:- To determine the 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;

$O_c = {W_t}/{t}$ ……………………………… (10)

In which O_c = output capacity (kg/hr.)

W_t = weight of threshed groundnut (kg)

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

2.2.4 Grain Recovery Range (%):

This is different between 100% and percentage total seeds/grains losses. It can be expressed as

G.R.R.=100-P_t ……………………………………………… (11)

In which P_t = percentage total seed/grain losses (%)

2.2.5 Capacity Utilization (C_u):

The product of input and output capacities expressed as percentage. It is given by

$C_u = O_c\ X\ 100 I_c$ ………………………………….. (12)

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2.2.6 Threshing Index T_i:- Is the product of grain recovery range, capacity utilization and threshing efficiency expressed in decimal (10)

T_i= GRR x C_u x T.E ……………………………………………………………(13)

Which

C_u = capacity utilization (%)

O_c = output capacity (kg/hr.)

I_c = input capacity (kg/hr.)

2.2.7 Threshing Intensity T_{in}:

This is the ratio of the power consumed by the decorticator to the output capacity. It is given by

T_{in} (Kw/kg) = P_c/O_c ……………………………………………………… (14)

In which

P_c = power consumed by (kw)

O_c = output capacity (kg)

3. RESULTS AND DISCUSSION

Table 1 presents the result of the threshing/decorticating efficiency of the locally developed groundnut decorticator and the imported Kirlosker decorticating machine. From the table it is observed that the locally developed decorticator had 97.52% threshing efficiency while the imported Kirlosker decorticator recorded 96.58%. Obviously the local decorticator efficiently performed well in comparison to the imported Kirlosker decorticator although the discrepancy is very infinitesimal.

Table 2 shows the cleaning efficiency of the local decorticator and imported Kirlosker groundnut decorticator. From the evaluation the local decorticator recorded 97.88% while the imported decorticator had 97.66% cleaning efficiency. This indicates that the locally developed decorticator is more efficiency in winnowing the decorticated groundnut than the imported one, probably, the cleaning mechanism used in the fabrication of the local machine is better than the foreign type used in the Kirlosker decorticator.

Table 3 revealed the total losses obtained from both local and imported machines. According to the results of this table the total losses obtained from the local and the imported Kirlosker decorticating machine are 4.13% and 7.94% respectively. The result shows that the local decorticating machine had lower seed losses as compared to the imported Kirlosker machine.

Table 4 presents the result of the input and output capacities of the locally developed and imported Kirlosker decorticating machine. Form the table it can be observed that the local decorticator recorded an output capacity of 436.8kg/hr while the imported Kirlosker decorticator had 422.8kg/hr, output capacity; indicating that the local decorticator has higher output capacity than the imported one for the 500gk/hr input of seed.

Table 5 revealed that the local decorticator had a better grain/seed recovery range of 97.26% than 93.92% obtained from the imported Kirlosker decorticator.

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 imported Kirlosker decorticator performed better with the value of 63.84% as compared to the locally developed decorticator with the capacity utilization of 61.24% the lower value obtained from the local decorticator may be attributed to the machine being in its prototype state as suggested by Danda and Dzivama (2000).

Table 1. Threshing efficiency of the locally developed and imported groundnut decorticating machine.

Replication	Locally Developed Decorticator/T.E (%)	Imported Kirlosker Decorticator/T.E (%)
1	96.3	94.5
2	98.1	97.6
3	94.8	98.9
4	98.7	96.1
5	99.7	95.8
Mean	**97.52%**	**96.58**

Table 2. Cleaning efficiency of the locally developed and imported groundnut decorticating machine.

Replication	Locally Developed Decorticator/T.E (%)	Imported Kirlosker Decorticator/T.E (%)
1	98.4	97.9
2	96.9	96.8
3	98.0	97.4
4	98.2	97.9
5	97.9	98.3
Mean	**97.88%**	**97.66%**

Table 3. Percentage losses of the locally developed and impored decorticating machine.

Parameter	Rep1	Rep2	Rep3	Rep4	Rep5	Mean
Locally Developed Decorticator						
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**
Imported Kirlosker Decorticating Machine						
Unthreshed seed (%)	2.21	1.83	2.30	2.12	1.96	2.08
Cracked/broken seed (%)	2.45	2.30	3.01	3.00	3.11	2.77
Sieved loss (%)	1.12	0.08	2.11	0.11	1.18	0.94
Blown loss (%)	2.31	1.99	2.18	1.93	2.33	2.15
Total	**8.09**	**6.20**	**2.18**	**7.16**	**8.58**	**7.94**

Table 4. Input and output capacities of the locally developed and imported decorticating machine.

	Locally Developed Decorticator		**Imported Kirlosker Decorticator**	
Replication	Input capacity (kg/hr.)	Output capacity (kg/hr.)	Input capacity (kg/hr.)	Output capacity (kg/hr.)
1	500	385	500	374
2	500	400	500	398
3	500	481	500	472
4	500	420	500	460
5	500	498	500	410
Mean	**500**	**436.8**	**500**	**422.8**

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

	Locally Developed Decorticator		**Imported Kirlosker Decorticator**	
Replication	Grain recovery range (GRR), %	Capacity utilization (C_u), %	Grain recovery range (GRR), %	Capacity utilization (C_u), %
1	96.6	63.8	90.8	68.3
2	98.7	65.9	93.6	71.4
3	96.6	71.7	95.3	69.6
4	99.3	68.6	93.8	68.3
5	95.1	59.6	96.1	78.2
Mean	**97.26**	**59.9**	**93.92**	**71.16**

Table 6. Threshing index and threshing intensity of the locally developed and imported decorticating machine.

	Locally Developed Decorticator		**Imported Kirlosker Decorticator**	
Replication	Threshing index (%)	Threshing intensity (kw/kg)	Threshing index (%)	Threshing intensity (kw/kg)
1	63.2	0.038	66.7	0.012
2	58.8	0.048	65.3	0.023
3	61.4	0.040	59.8	0.008
4	63.3	0.031	67.1	0.012
5	59.3	0.034	60.3	0.011
Mean	**61.24**	**0.038**	**63.84**	**0.013**

4. CONCLUSION/RECOMMENDATIONS.

The locally developed groundnut decorticator credibly performed better than the Kirlosker decorticator 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 groundnut 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 groundnut locally in Nigeria because the machine is affordable, easy to maintain and simple to operate; more so, it was fabricated with locally available materials making the spare parts easily/readily available for repair and /or replacement of parts if broken down.

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