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COMPARATIVE PERFORMANCE OF A LOCALLY DEVELOPED VOTEX RICE FAN THRESHER

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Abstract

The efforts to discover and make optimal and effective use of locally developed rice thresher as substitute for imported rice threshers form the focus of this paper. A locally developed rice thresher was compared with an imported Votex rice fan from Holland. The study was based on threshing efficiency, cleaning efficiency, total grain losses, grain recovery range, capacity utilization and threshing intensity. Three popular rice varieties, Faro 51, Faro 29 and Faro 21 were used to evaluate the performances of the threshers. The results showed that, the local thresher had 98.01%, 99.32%, 4.78%, 95.22%, 54.67% and 0.029 kWkg-1, as: threshing efficiency, cleaning efficiency, total grain loss, grain recovery range, and capacity utilization and threshing intensity respectively. Whereas the imported votex rice fan thresher had 98%, 95.77%, 8.72%, 91.28%, 76.97% and0.0037 kWkg-1 as threshing efficiency, cleaning efficiency, total grain loss, grain recovery range, capacity utilization and threshing intensity respectively. Thus the local thresher compared favorably with the imported thresher and can be used as substituted thereby conserving Nigeria's foreign exchange.

1. Introduction

Rice is one of the most important crops grown in Nigeria (Dauda *et al*, 1999). It is the sixth major crop in terms of cultivable area after sorghum, maize, cowpea, cassava and yam. It is the only crop which is grown nationwide and in all agro-ecological zones from Sahel to the coastal swamps. It is estimated that 4.1 million hectares of land could be put into cultivation. In 1999, the rice area harvested in Nigeria was 2.1 million hectares a ten-fold increase compared to the average for the 1960s (210,000 ha). Compared with the other food crops, the recent increase in rice area is unrivalled, implying a structural shift towards rice production in the Nigerian (Misari et al, 2001).

The current emphasis on energy conservation and utilization in many countries prompted agricultural policy makers to reset priorities in agriculture. Consequently, policy makers in Nigeria focus interest on the production and processing of rice.

Agriculture is one of the fields where Nigeria heavily relied on imported technology especially in areas of machinery and equipment (Bashir and Daudu, 2003). These machinery have not made any appreciable impact on increased food production due to several problems, among which is the regular breakdown of these machinery. Experience has shown that a number of these machinery and equipment breakdown as early as few days after commissioning due to lack of adaptability, ignorance, abuse or misuse (Yisa, 1997).

Imported equipment can be sophisticated to justify better output but more maintenance will be required (Priel; 1974). The more sophisticated the equipment, the better it is expected to perform, but it becomes counter productive if such sophisticated equipment is imported into an underdeveloped country with inadequate maintenance capability, technology or lack of

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knowledge of the vital equipment characteristics-maintainability and reliability (Imonigie, 2003).

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 parts/components under different environmental and operating conditions. The progressive technological change in the equipment-exporting countries (usually developed countries) inevitably leads to rapid equipment obsolescence in developing countries. This further poses problems to the maintenance personnel who always battle to adapt or adjust to the change (Imonigie, 2003).

Dauda and Adgidzi (2002) and (Dauda and Adgidzi (2003), reported on the development of an indigenous rice thresher in Nigeria, and also their performances. The locally developed rice thresher has a hopper, transmission unit, cleaning unit, straw and grain outlets and a supporting frame. The method of feeding is the throw-in type, in which, rice heads are feed into the hopper and fall in by gravity. The inventory of imported rice threshers by make in Niger State, Nigeria was reported by Chukwu (2002), which shows that the most common is Votex rice fan thresher (representing 62.79% of total number available). The performance evaluation of the Votex rice fan thresher has been reported (Chukwu, 2001).

Votex rice fan thresher is an imported rice thresher (Plate 1). It was developed and built at the University of Wageningen-Holland and had undergone intensive evaluation in countries like Indonesia, Nigeria, Mali, Philippines, Sierra Leone and Vietnam, during which the thresher was perfected (Volgelenzang, 1982). The votex rice fan thresher is a portable thresher for small farms and easily carried by four people to the field. The design of the threshing drum, which also have a cleaning function and a long concave arrangement covering about 1500 of the drum circumference make it possible for the votex rice fan thresher to handle very long (up to 100cm straw length). It also has only one moving part which is the cross flow threshing drum.

The objective of this work was to evaluate the performances of the National Cereals Research Institute, Badeggi, Nigeria locally developed rice thresher (Plate 2) compared with an imported Votex rice fan from Holland.

Plate 1 – Votex Rice Fan thresher


Plate 2 – Locally Developed Rice Thresher

2. Materials and method

Three popular rice varieties, Faro 51, Faro 29 and Faro 21 were harvested from National Cereals Research Institute, Badeggi research field; they represent the conventionally known grain sizes (long, medium and short) grown by farmers in Nigeria. Tests were carried out on both the locally developed and the imported votex ricefan threshers at 556 rpm cylinder speed, 14% rice moisture content and 1:1.22 grain/straw ratio to obtain the total losses, threshing efficiency, cleaning efficiency, input and output capacities, grain recovering range (GRR), capacity utilization (CU), threshing index (TIX) and threshing intensity (TIN) in accordance with the draft Nigeria standard test code for grain threshers (NCAM, 1990). The threshed materials were collected at the grain outlet, cleaned and weighed. The unthreshed materials were separated from straw and weighed after hand threshing and cleaning. The tex was carried in replicates and the average were calculated and recorded as the values of the parameters determined The results for both threshers were presented and compared.

(a) Determination of total losses (Lt)

$$Pu\,(\%)=\frac{qu}{Gt}x100.....1$$

$$Pc\,(\%)=\frac{gc}{Gt}x100.....2$$

$$Pl\,(\%)=\frac{gl}{Gt}x100.....3$$

$$Ps\,(\%)=\frac{gs}{Gt}x100.....4$$

$$Lt\,(\%)=Pu+Pl+Pc+Ps.....5$$

Where,

Pu	=	Percentage of unthreshed grain, %
Qu	=	Quantity of unthreshed grain obtainable from straws, kg
Gt	=	Total grain received at grain outlet, kg
Pc	=	Percentage of cracked and broken grain, %
qc	=	Quantity of cracked and broken grain from grain outlet, kg
Pl	=	Percentage of clean grain, %
Ql	=	Quantity of clean grain obtained at straw outlet, kg
Ps	=	Percentage of sieve loss, %
Qa	=	Clean grain at sieve overflow + sieve underflow + stuck grain, kg

(b) Determination of efficiencies

Threshing efficiency (TE): A bundle each weighing 10kg of unthreshed rice was fed into each of the machines and timed using a stop watch. This is the ratio of total weight of grain threshed to the total weight of grains fed into the thresher expressed as a percentage. It is also the difference between 100% and the percentage of unthreshed grain as (equation 6).

$$TE\,(\%)=100-Pu.....6$$

Cleaning Efficiency (CE): the clean grain that pass through the cleaning unit was collected at the grain outlet and weighed and also the unclean grain was as well weighed and the ratio as percentage taken. The ratio of the weight of clean grain that pass through the cleaning unit to the total weight of grains at the outlet of the grain retainer expressed as a percentage (equation 7).

$$CE(\%)\frac{GC}{GT}x100.....7$$

Where, Gc = clean grain received at grain outlet, kg

(c) Determination of input and output capacities.
To determine the input capacity for each test, a known weight of rice bundle was fed at a time. The threshing time for each test was recorded by a stop watch.
Similarly, to determine the output capacity, the weight of threshed grain received at specified grain outlet per unit time was taken and recorded.

(d) Grain Recovery Range (GRR)

$$GRR = 100 - Pt.....8$$

(e) Capacity Utilization (CU)

$$CU = \frac{QC}{Ic}x100.....9$$

(f) Threshing Index (TIX)

$$TIX = GRR\,x\,CU\,x\,TE(decimal).....10$$

(g) Threshing Intensity (TIN)

$$TIN = \frac{Fc}{Oc}.....11$$

Where
Pt = Percentage total losses, %
Oc = Output Capacity, kg
Ic = Input Capacity, kg
Fc = Power consumed by thresher, Kw

3. Results and discussion

The results presented in Table 1 show the overall mean performances for both locally developed and imported votex rice fan threshers under the same treatment. The mean values for threshing efficiencies for both threshers were obtained to be 98%. As shown in the table, the cleaning efficiency for the local rice thresher was higher (99.32%) as compared to the imported votex rice fan which was obtained to be 95.77%. The trend reversed for the capacity utilization with a 54.67% for the local thresher compared to 76.97% for the imported votex fan thresher. The lower capacity utilization may be attributed to the local thresher still being in its prototype stage. Similarly, the local thresher recorded a lower threshing index of 51.00% compared to the imported votex fan thresher with 65.00%. This also may be attributed to lack of perfection of the local thresher when compared to the imported thresher, which took many years to perfect

The mean value of cumulative total losses was lower for the local rice thresher at 4.7% compared to 8.72% for the imported votex rice fan. This is possible with the local thresher having a good sieve arrangement design.

Table 1: Result of Performance Evaluation of Locally Developed Rice Thresher and Imported Votex Ricefan

	Locally developed rice thresher				Imported votex ricefan			
	FARO 51	FARO 29	FARO 21	Mean	FARO 51	FARO 29	FARO 21	Mean
Unthreshed grain (%)	1.99	1.98	2.00	1.99	1.99	2.01	2.00	2
Cracked & broken grain (%)	0	0	0	0	2.95	3.08	3.23	3.1
Sieve loss (%)	2.77	2.78	2.82	2.79	1.43	1.51	1.54	1.49
Blown loss (%)	0	0	0	0	2.12	2.13	2.15	2.13
Total loss (%)	4.76	4.76	4.82	4.78	8.71	8.71	8.74	8.72
Threshing efficiency (%)	98.10	98.00	97.98	98.01	98	98	98	98
Cleaning efficiency (%)	99.40	99.32	99.22	99.32	95.79	95.76	95.76	95.77
Input capacity ($Kghr^{-1}$)	490	490	490	490	1300	1300	1300	1300
Output capacity ($Kghr^{-1}$)	267.9	267.9	267.9	267.9	1026.44	1026.44	1026.44	1026.44
Grain recovery range (%)	95.43	95.27	94.97	95.22	91.60	91.25	91	91.28
Capacity utilization (%)	54.68	54.67	54.66	54.67	76.99	76.97	76.96	76.97
Threshing index (%)	51.00	51.00	51.0	51.0	65	65	65	65
Threshing intensity ($KwKg^{-1}$)	0.029	0.029	0.029	0.029	0.0037	0.0037	0.0037	0.0037

4. Conclusions

Based on the results of the performance indices of both local and imported votex rice fan, the local performs credibly as the foreign with a tendency of performing better with little further modification. This measure is bound to reduce the foreign exchange expenditure on the importation of rice threshers and to encourage local manufacturers and research Institution in the adoption and production of this locally developed rice thresher, this will help in improving the production and processing of rice locally in Nigeria.

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