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Performance Evaluation of Locally Manufactured Rice Threshers in Niger State

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Abstract: A survey involving type-tests, the use of questionnaires and personal communication during field trips was carried out in Niger State. It was aimed at the performance evaluation of locally manufactured rice threshers in use in Niger State. Details of the performance evaluation and summary report are presented. The performance indices evaluated include threshing intensity, capacity utilization, power requirement, threshing efficiency, cleaning efficiency, grain recovery range, percent total losses, number of adjustments and portability. The threshing intensity, capacity utilization, power requirement, threshing efficiency, cleaning efficiency, grain recovery range and percent total losses are 0.0098 kw kg^{-1}, 65.7%, 7.5 kW, 95, 92.43, 81.1 and 18.9%, respectively for FATE-RF-450 threshers. They are 0.0103 kw kg^{-1}, 74.5%, 9 kw, 96, 93.45, 84.1 and 15.9% in that order for FATE-5TS-50J threshers.

Key words: Performance evaluation, rice threshers, threshing index, Nigerian agriculture

INTRODUCTION

The use of engine-powered machine and equipment in Nigerian Agriculture dates back to the early 1960s following the establishment of farm settlements in the Eastern and Western Regions of Nigeria. Also, there is now a general awareness in Nigeria and other developing countries that the rapid development of agriculture depends to a large extent on the successful introduction of modern agricultural machinery. But most of the farm equipment currently in use in Nigeria are imported from several countries.

This has resulted in assortment of different machines with inherent problems ranging from mismatching within the machine combinations and with the local farming systems to non-availability of spare parts, bogus claims in relation to applicability to handle diverse crops, inadequate provision of power and drive units. More so, reliable information and performance evaluation of these machines and equipment which we have in the country are limited.

The above problems in combination with many others had led to one of the mandates of the Agricultural Mechanization Research Programme of the Institute for Agricultural Research Samaru, Zaria, which is to carry out performance evaluation of agricultural machinery and equipment and present reports on such machines and equipment (Chukwu, 1994). One of the major highlights from such reports points to the fallacy of importing any machine without an evaluation of the local farming systems. Even though there are, as of now only few manufacturers and only some research institutions currently producing rice threshers in Nigeria, the demand for these threshers is slowly spreading all over the country.

Performance evaluation is a scientific method of ascertaining the working conditions of the main components of a system with a view to establishing how the components contribute to the overall efficiency of the system. Evaluation of FATE-RF-450 and FATE-5TS-50J threshers was carried out in this study. It is envisaged that information presented will be useful in attempting to eliminate the importation of unsuitable rice threshers into Nigeria. It is also hoped that this will highlight the need for farm equipment evaluation in the local situation, especially now that concerted efforts are being directed towards Agriculture and its mechanization. FATE-RF-450 and FATE-5TS-50J threshers are manufactured by Farmland Agricultural Technical Equipment (Nig.) Ltd., 40, Oba Akran Avenue, P.O. Box 9646, Ikeja, Nigeria.

A rice thresher is a machine that separates paddy rice kernels from the spikelets on the panicle. Mechanical threshers could be manually operated or motorized. Generally, mechanical rice threshers have threshing cylinders or drums with different arrangements and configurations of the threshing tooth. The drum could be partially covered by a concave which will filter the materials that pass through it. Winnowers for cleaning the grains are often an integral part of threshers. Commonly available threshing cylinders are the spike-tooth, the syndicator and the beater types.

Beater type threshers were the first to be introduced in Nigeria (Policarpio and Mannamy, 1978). According to Saxena *et al.* (1971), the beater type threshers lost their popularity mainly due to their high power requirements. Both spike-tooth and syndicator types of threshers are very popular in Niger State (mainly used in the farms surveyed; Umma Farm, Sanbel Farms Ltd and Bako Farm). Although, the spike-tooth type thresher has advantages of simple and compact design with low grain breakage, it can handle only very dry crops with grain moisture content (m.c.) below 10% (Saxena *et al*., 1971). Whenever there is rain, much time is lost in drying the crop to the desired level of moisture content for threshing.

MATERIALS AND METHODS

This study was designed on the basis of the Investigative Survey Research Approach (ISRA) as developed by Anazodo (1975, 1983). The investigative survey research approach for obtaining data entails the schedule of a series of visits to establishments of interest. The tasks accomplished during the visits for this study include the following:

- Physical inspection or examination of threshers name plate.
- Carrying out type-tests and routine tests on threshers.
- Completion of questionnaires from available records kept by the establishments and also inventories and interviews held with relevant and competent staff of the establishments.
- Measurements of output capacity of a thresher to compare with the manufacturer's specification in the operation manual or available from literature.
- Computation of a single Performance Index (PI) based on the Grain Recovery Range (GRR), Capacity Utilization (CU) and Threshing Efficiency (TE).

Two kinds of data (quantitative and qualitative) were sought for in each establishment visited and were based on measurements, observations and existing records. For performance evaluation of threshers, type-tests and routine tests were carried out. Type-tests are tests carried out on a machine (thresher) to prove the conformity with the requirements of relevant standard (or design specifications). Type-tests usually carried out include general tests, test at no load and test at load. The general tests include checking of materials and visual observations and provision for adjustments.

Test at no load is running the thresher at no load for at least 30 min at the specified revolutions of threshing unit using an electric motor of appropriate power and recording the readings of an energy meter at intervals of 5 min (Chukwu, 1994). The difference between two consecutive readings gives power consumption for 5 min. This is used to calculate the power consumption at no load for 1 h. During and after completing power consumption test the following observations are made and recorded:

- Presence of any marked oscillation during operation.
- Presence of undue knocking or rattling sound.
- Frequent slippage of belts.
- Smooth running of shafts in their, respective bearings.
- Other observations (if any).

Tests at no load are of 2 types-short-run tests and long-run tests. Short-run tests enable the tester to get the following: total losses, threshing efficiency, cleaning efficiency, power consumption, input capacity, output capacity and corrected output capacity. The final sample obtained is analyzed for cracked and broken grains, refractions, unthreshed grains and clean grains. Analysis for cracked and broken grains is made only from the samples taken at specified grain outlets. Grain losses, threshing and cleaning efficiencies are also determined.

Long-run tests entail operating the machine for at least 20 h and up to 50 h. Long-run tests enable the tester to determine the major breakdowns, defects developed and repairs to be made. In this study, long-run tests were not carried out due to the unwillingness of the threshers' owner (s) to release their thresher for such tests. As a result information on major breakdowns and repairs presented are based on the questionnaires completed by competent staff of the establishments surveyed.

Routine tests are tests carried out on a machine to check the requirements, which are likely to vary during production or use. These are grouped into essential and optional tests. The essential routine tests are visual observations and provisions for adjustments and test at no-load. The optional tests are checking of specifications and checking of material. The pre-test observations carried out include the determination of grain-straw ratio and the moisture content (wet basis) of grains.

RESULTS AND DISCUSSION

The inventory of rice threshers by make (Table 1) shows that the most common is Votex Ricefan (representing 62.79% of the total number). The performance evaluation of Votex Ricefan thresher has been reported (Chukwu, 2001). Votex Ricefan is an

Table 1: Inventory of rice threshers by establishment and by make in Niger State in 1993

	Numbers available by make								
Establishment	Votex	FATE	Vicon	Akshat	Embee	Cecoco	Kubot	Alvan blanch	TNA*
NSADP (Minna)	-	-	1	-	-	-	-	-	1
NSADP (Bida)	9	2	1	2	1	1	-	-	16
NRBDA (Minna)	-	-	-	-	-	-	3	-	3
NSADP (Kuta)	2	-	-	-	-	-	-	-	2
FMANR (Minna)	2	-	1	-	-	-	-	-	3
Sanbel Farm (K gora^{-1})	6	-	-	-	-	-	-	-	6
Bako Farm (K gora^{-1})	3	-	-	-	-	-	-	-	3
Umma Farm (K gora^{-1})	2	-	2	-	-	-	-	-	4
Farm Institute tegina	1	-	-	-	-	-	-	-	1
NCRI (Badeggi)	2	-	-	-	-	-	-	2	4
Total	27	2	5	2	1	1	3	2	43

*TNA = Total Number Available; NSADP = Niger State Agricultural Development Project; NRBDA = Niger River Basin Development Authority; FMANR = Federal Ministry of Agriculture and Natural Resources; NCRI = National Cereals Research Institute; K gora^{-1} = Kontagora (a town in Niger State)

Table 2: Performance evaluation of FATE-RF-450 threshers

Item	Remarks
Manufacturer	Farmland Agricultural Technical Equipment (Nig) Ltd, 40 Oba Akran Avenue, P. O. Box 9646, Ikeja, Nigeria.
Make	FATE
Model	RF-450
Establishment where used	NSADP, Bida
Variety of rice handled	Long and short grains
Grain-straw ratio	1:1.5 (average)
Moisture content of rice handled	16.25% (wb) (average)
Adjustments	Adjust (i) The speed of threshing pan (ii) The wind Deflector (iii) Concave clearance (iv) Air flow passage
Power requirement	About 7.5 kW (10 hp) electric motor or 9 kW (12 hp) internal combustion engine or 18.75 kW (25 hp) tractor
Losses	Total loss was 18.9% made up of unthreshed loss (5%), dehusked loss (4%), blown loss (2.4%) and sieve loss (7.5%).
Grain Recovery Range (GRR)	81.1%
Threshing efficiency	95%
Cleaning efficiency	92.43%
Input capacity	1200.31 kg h^{-1}
Output capacity	788.63 kg h^{-1} (depending on grain-straw ration)
Capacity Utilization (CU)	65.7%
Threshing index	0.51 (or 51%)
Threshing intensity	0.0098 kW kg^{-1} or 0.013 hp kg^{-1}
Any observation affecting performance	Moisture content of rice crop and straw; stem length of rice should not exceed 400 mm; requires continuous feeding of crop and number of workers required is between 10-15 persons
Other observations (if any)	The RF-450 thresher is a machine of the hand feeding type developed mainly for threshing wheat, but has been adapted to thresh rice and other grains in Niger State by altering the machine, but with time and relevant modifications it could be a good machine for Nigerian farms. Its weight of 450 kg makes it not easily transported from place to place like the Votex Ricefan, hence, it is a trailed machine. Its variable power is a plus as a farmer has a choice of power to run the thresher.

imported thresher, while FATE-RF-450 and FATE-5TS-50J threshers are manufactured here in Nigeria. The summary reports of the performance evaluation on FATE Threshers are presented in Table 2 and 3. Table 1 shows that there is high proliferation of Makes of rice threshers in Niger State, though most establishments use Votex Ricefan threshers. The portability, simplicity, outstanding results, low maintenance costs and minimal adjustments could have contributed to the popularity of Votex threshers.

The results presented in Table 2 represent the average performance evaluation of FATE-RF-450. The grain and environmental conditions were essentially uniform since, threshing in Niger Sate is mainly carried out in January and when grain conditions are averagely the same.

The threshing intensity for RF-450 thresher is 0.0098 kW kg^{-1}. Threshing intensity is the horsepower or kilowatt consumed by a thresher divided by the output capacity of the thresher. It is expressed in kW kg^{-1} or hp kg^{-1}. Any value of threshing intensity much higher than 0.075 kW kg^{-1} (0.1 hp kg^{-1}) is unattractive as threshing could be more economically carried out manually. Since, the threshing intensity of 0.0098 kW kg^{-1} was computed for FATE-RF-450, it is considered efficient in power utilization.

The capacity utilization of RF-450 was calculated as 65.7%. Capacity Utilization (CU) is the ratio of output capacity to input capacity of a thresher, expressed in percent. Grain Recovery Range (GRR) is the difference between 100% and percent total losses. For the RF-450 (GRR = 81.1%). The threshing index for RF-450 is 0.51 (or 51%). Threshing index is the product of Grain Recovery Range (GRR), Capacity Utilization (CU) and Threshing Efficiency (TE).

Table 3: Performance evaluation of FATE-5TS-50J thresher

Item	Remarks
Manufacturer	Farmland Agricultural Technical Equipments (Nig.) Limited, 40 Oba Akran Avenue, P. O. Box 9646, Ikeja, Nigeria.
Make	FATE (Farmland and Technical Equipment)
Model	5TS-50J
Establishment where used	Niger State Agricultural Development Project (Bida)
Variety of rice handled	Long and Short grains
Grain-straw ratio	1:1.5 (average)
Moisture content of rice handled	16.25% (wet basis) (average)
Adjustments	Adjust: Cylinder Speed, Concaves, Threshing gap, Belts, Rear guard of finishing sieve and Air flow-rate for fan
Power requirement	9KW (12hp) diesel engine
Losses	Un-threshed grain 4.0%, de-husked grain 3.0%, blown loss 2.1%, sieve loss 6.8%; giving a total loss of 15.9%
Grain Recovery Range (GRR)	84.1%
Threshing efficiency	96%
Cleaning efficiency	93.45%
Input capacity	1200.29 kg h^{-1}
Output capacity	894.25 kg h^{-1}
Capacity Utilization (CU)	74.50%
Threshing index	0.60 (or 60%)
Threshing intensity	0.0103 KE kg^{-1} or 0/014 hp kg^{-1}
Any observation affecting performance	Inclination of the machine to the direction of feeding. It should lean slightly to the direction of feeding.
Other observations (if any)	The machine requires 8 workers. The 5TS-50J thresher is a bulky machine (weight 720 kg) but efficient in threshing rice. It however, requires many adjustments but more efficient than its counterpart the RF-450. Since, the RF-450 and 5TS-50J threshers are manufactured here in Nigeria, they could be recommended to Nigerian farms especially as the problem of spare parts may not exist.

Threshing efficiency for FATE-RF-450 is 95%. It is 100% min percentage of unthreshed grains. The cleaning efficiency is 92.43%. It is the ratio of clean grains received to total grains expressed in percent. The percent total losses is the sum of percent unthreshed grains, cracked (%) and broken grains, blown grains (%) and sieve loss (%).

Tandon *et al*. (1988) reported that grain moisture content (m.c.) has a significant effect on threshing efficiency and grain damage at 1% level. The effect of concave clearance and cylinder speed was significant at 5% level. Threshing efficiency increased with cylinder speed. As concave clearance increased the grain damage decreased. Grain damage increased also with an increase in the cylinder speed and the grain m.c.

The length of a grain and the size of sieve aperture affected the sieve loss as some of the grains were stuck ore passed as sieve overflow. The grain number (which gives a measure of grain-straw ratio) also affects the output capacity of the rice threshers evaluated.

The results presented in Table 3 represent the average performance evaluation of FATE-RF-5TS-50J. Threshing intensity of 0.0103 kW kg^{-1} was computed for it. Therefore, the 5TS-50J thresher is efficient in power utilization. The capacity utilization of the 5TS-50J was calculated as 74.5%, the grain recovery range is 84.1% while the threshing index is 0.60 or 60%.

CONCLUSION

Based on the results of this study, the following conclusions have been made:

- Grain moisture content, grain number, grain length, cylinder speed, concave clearance and size of sieve aperture are some of the machine-crop parameters that influence the performance of a rice thresher.
- The task of matching power source with the size of a thresher, farm size, operating cost as well as timeliness cost are some of the management factors that must be considered in the selection and introduction of rice threshers.
- Based on overall performance indices discussed in this study, FATE-RF-450 and 5TS-50J threshers perform well in Niger State.

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