

## Performance Evaluation of an Okra Thresher

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### ABSTRACT

Based on the design and operational parameters for an okra thresher (Bolaji 2000), a prototype thresher was modified, developed and evaluated. The thresher was evaluated at three different levels each of cylinder concave clearance (10, 20, 30mm), seed moisture content (12.5, 14.0, 17.0%), two levels of cylinder speed (580,600 rpm peripheral speed 4.2m/s and 4.4m/s), and feed rate 10kg/hr of dried okra pods. Performance parameters for the study were threshing efficiency, cleaning efficiency, total loss of seed and germination.

The test results indicated a maximum of 97% threshing efficiency and 97.7% cleaning efficiency, a minimum of 3.3% total seed loss and a maximum germination of 85%. The average output capacity of machine was 6.3kg/hr of seed. The performance was found to be influenced by all the study variables. The machine is dismantlable for easy transportation.

**Key Words:** thresher, performance, okra, threshing efficiency, cleaning efficiency, germination

### 1. INTRODUCTION

Okra (*abelmoschus esculentus L. moench*) of the family malvaceae is commonly called okra. It is an oblong edible pod, which is large at one end and slender at the other. Okra can be eaten grated raw or cooked. It possesses high nutritive value, which is higher than tomatoes, eggplant and most cur bit except bitter gourds (Nonneck 1989). The dried Okra pods are also consumed directly and it is also used as flavoring in preparing other food products. The fresh stem of okra serves as robes, while the dried ones serves as source of paper pulp or fuel (Kalra and Pruthi 1984).

The seeds of okra have been used as coffee substitutes and edible oil also has been extracted from dried okra seeds. Vegetable curds prepared from the dried seed have been used as substitutes for cheese in recipes. The amino acid profile of the seed indicates that it could be used to complement other partially complete protein sources such as soybean (Bryant et. al.,1988).

The economic value of the fresh okra pods, fresh stems, dry okra stem, pods and seed cannot be over emphasized, hence there is the need to produce large quantities of dried okra seeds for seedlings and for use in other processed forms. The traditional methods of threshing dry okra pods involve manual rupturing of the pods and the separation of the seed from the chaff. The

process is tedious and time consuming; it also results in losses as well as low quality product. An okra thresher was designed and constructed to solve this problem. The machine had a threshing efficiency, cleaning efficiency and a percentage total loss of 88.1%, 46% and 15.3% respectively (Bolaji 2000). Design modifications were carried out on the initial design to further improve its performance. This paper reports the effect of machine and crop variables on the performance of the modified machine.

## 2. MATERIALS AND METHODS

### 2.1 Modified Machine

The thresher is consisted of a threshing unit, separating unit and the frame (Fig.1).

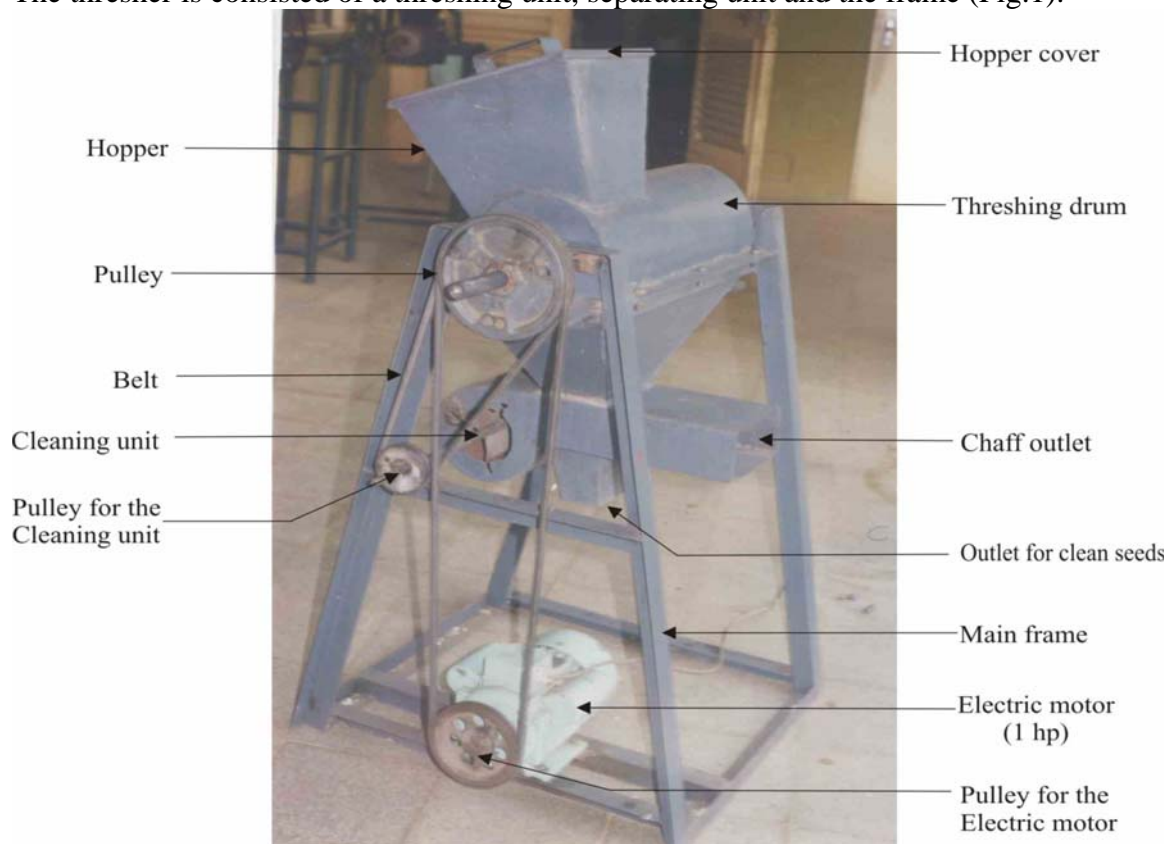


Figure 1. The okra thresher



Figure 2. The threshing unit

The threshing unit is consisted of a threshing head and concave (Fig.2). Threshing head is made up of a hollow pipe of 67mm diameter and 640mm long with ends closed. Spikes (20mm diameter) made of mild steel are welded alternatively in rows on the cylindrical pipe. This arrangement is to allow easy movement of crop in the concave. Also, a stretch of rod curled round the whole length of the main shaft is welded to form an auger (screw) to convey the materials out. The cylinder shaft is mounted on a bearing, which is attached to the frame by a set of bolts and nuts. The concave is made of steel sheets rolled into a cylinder of 330mm diameter and 640mm length. The lower part is punched with round holes of 10mm diameter which performs the function of a screen. The upper end consists of a 360mm by 140mm hopper from where the crop is fed into the concave. The concave sits on the frame with the aid of two flat steel bars joined on each side by bolts and nuts. The sprout of 100mm is located directly below the concave. The straw comes out of the concave at the other end of it, opposite to the position

of the hopper. A cup shaped sheet is welded to channel the straw not to obstruct or come in contact with the end bearing. This is in such a way that the straw comes out after passing through the length of the concave. The separating unit comprises of a housing and a blower. The blower is made of mild steel sheet and enclosed in spiral shaped housing. An inlet for the sprout is provided at the top of the Housing along its length and attached directly to the sprout. The blower is made of 3 vanes of 140mm by 60mm and is attached to a 10mm diameter blower shaft mounted on two bearings on each side to allow free rotation. It is connected to the threshing pulley by a belt to its own pulley. The spiral section of 80mm diameter and 160mm long is provided to allow outflow of the chaff. The collector opening below the blower is tapered to convey the seed into the container or bag below. The machine is mounted on a 200 x 650 x 1000mm frame. The machine has a rigid platform attached to base of its main frame to seat the source of power.

The following modifications were made on the initial design to further improve its performance.

- i) Increase in the number of spikes in the threshing head from 27 to 36 in order to increase the force of impact by the spikes on the material; thus increasing the threshing efficiency.
- ii) The length of the threshing head and the concave were increased from 620mm to 640mm so as to increase the dwell time; thus enhancing the threshing and cleaning efficiency.
- iii) The diameter of concave was increased from 200mm to 220mm to increase capacity.
- iv) The fan blades are under the concave and curved to about 65° to allow for more volume of air, which will increase the cleaning efficiency.
- v) A cover is made for the hopper to prevent splashing of seeds during threshing. The thresher is dismantlable for easy transportation.

## 2.2 Performance Evaluation

The modified machine was installed on level and hard surface. Sufficient quantity of dried okra pods of the same variety was taken. The thresher was evaluated at three different levels of moisture content, three concave clearances, three level of cylinder speed and a feed rate. The thresher was powered by an electric motor (1hp) at a maximum speed of 1410rpm. The prototype thresher was evaluated as per test procedure of IS:6284 (1986). The codes prescribe method of testing power threshers to evaluate their performance and durability. The threshing efficiency, cleaning efficiency, percentage total loss and germination were evaluated at each combination of variables.

During the test period, the speed of the main shaft was recorded using a tachometer while three sets of primary samples were taken from the seeds, pods and chaff outlets. The levels of the variables for testing the thresher are included in Table 1.

Table 1. Experimental plan for evaluation of modified Okra thresher

S/No	Variables	Levels
1.	Crop Moisture Content (%)	12.5, 14.0, 17 .
2.	Concave Clearance (mm)	10, 20, 30.
3.	Cylinder Speed (rpm) (m/s)	580, 600.(4.2m/s,4.4m/s)
4.	Feed rate (Kg/hr)	10

The final samples obtained at the seeds, pods and chaff outlets were analyzed by hand picking separately the seeds, pods and chaff in each outlet and weighing each separately. All data were recorded.

### 2.3 Determination of Total Losses

The following relationships were used to calculate the total losses of the thresher.

- a. Total seed input = feed rate x seed content
- b. Percentage of unthreshed seeds =

$$\frac{100 \text{ (quantity of unthreshed seeds obtained from all outlet in kg)}}{\text{Total grain input (kg)}} \quad (1)$$

- c. Percentage of cracked and broken seed =
- $$\frac{100 \text{ (cracked and broken seeds from specified seed outlet(s) in kg)}}{\text{Total seeds received at seed outlet in (kg)}} \quad (2)$$

- d. Percentage of blown seeds =

$$\frac{100 \text{ (quantity of clean seed obtained at chaff outlet in kg)}}{\text{Total grain input in (kg)}} \quad (3)$$

Total Loss (%) = sum of losses obtained at (b), (c) and (d)

### 2.4 Determination of efficiencies

- i. Threshing efficiency = 100 - Percentage of unthreshed seeds
- ii. Cleaning efficiency =

$$\frac{100 \text{ (clean grain received at grain outlet(s) in (kg)}}{\text{Total seeds received at seed outlets in (kg)}} \quad (4)$$

### 2.5 Germination Test

Equal samples of seeds were taken from each set of experiment. The seeds were planted and subject to equal conditions for germination. The number of germinated seeds for each sample was noted. Percentage germination was calculated as;

$$\text{Percentage germination} = \frac{\text{number of germinated seeds}}{\text{Total number of seeds planted}} \times 100$$

### 3. RESULTS AND DISCUSSION

The performance of the thresher was evaluated at the various concave clearances, threshing cylinder speed and moisture content in terms of threshing efficiency, cleaning efficiency, percentage total loss and germination. Table 2 gives the results of the performance tests.

Table 2. Performance of thresher at different moisture, cylinder speed and concave clearance.

A: Moisture Content: 12.5%						
	Cylinder Speed: 580rpm(4.2m/s)			Cylinder Speed: 600rpm (4.4m/s)		
Concave clearance	10	20	30	10	20	30
Threshing efficiency (%)	93.7	94.1	94.5	95.1	95.6	95.6
Cleaning efficiency (%)	94.6	97.2	97.4	95.7	96.9	96.5
Total loss (%)	13.3	10.1	8.4	7.8	8.4	8.4
B: Moisture Content: 14.0%						
	Cylinder Speed: 580rpm(4.2m/s)			Cylinder Speed: 600rpm (4.4m/s)		
Concave clearance	10	20	30	10	20	30
Threshing efficiency (%)	93.9	93.7	96.1	95.2	94.7	94.9
Cleaning efficiency (%)	94.4	96.5	97.9	95.7	95.3	97.0
Total loss (%)	8.7	8.7	6.3	8.1	9.9	6.9
C: Moisture Content 17.0%						
	Cylinder Speed: 580rpm(4.2m/s)			Cylinder Speed: 600rpm (4.4m/s)		
Concave clearance	10	20	30	10	20	30
Threshing efficiency (%)	94.3	95.0	96.8	97.9	97.5	96.3
Cleaning efficiency (%)	96.5	97.2	97.4	96.1	97.1	96.1
Total loss (%)	8.6	10.2	5.5	3.7	6.6	5.3

#### 3.1 Threshing Efficiency

The threshing efficiency ranged from 90.8% to 97.9% for the concave clearance of 10mm to 30mm and 12.5 to 17.0% moisture content. The threshing efficiency for a given level of concave clearance and moisture content increases with increase in cylinder speed. At a given moisture content and cylinder speed, the threshing efficiency increases with increase in concave clearance. This is however not the case with increase in cylinder speed for a given moisture content where the threshing efficiency reduces. This is due to the increased impact on the product resulting in a low ability of the thresher to efficiently thresh the crops thereby resulting in low threshing efficiency. This finding agrees with that of Kamble et. al. (1997) who reported the same trend for a Pearl-millet thresher.

### 3.2 Cleaning Efficiency

The cleaning efficiency of the machine ranged from 91.1% to 97.7% for the concave clearance of 10mm to 30mm and the seed moisture content of 12.5% to 17.0%. The cleaning efficiency increases with increase in threshing cylinder speed. The cleaning efficiency is significantly high at 17.0% moisture content, 580rpm (4.2m/s) cylinder speed and 30mm concave clearance. These findings compare well with those reported by Mehta et.al (1995) and Ajav and Igbeka (1995).

### 3.3 Total Loss (%)

The total loss as spilled over and blown-up seeds ranged from a minimum of 3.3% to maximum of 13.1% for the concave clearance of 10mm to 30mm and moisture content of 12.5% to 17.0% respectively. The total losses were influenced significantly by the cylinder speed, concave clearance and moisture content. The total loss was the least at the lowest cylinder speed of 580rpm (4.2m/s) and increased with increase in speed. Generally, the concave clearance of 30mm caused the minimum total loss at a given moisture and speed. The losses increased with reduction in concave clearance. No cracked or broken seeds were observed.

### 3.4 Germination

The percentage germination of threshed seed was influenced significantly by moisture content, cylinder speed and concave clearance. The germination of the threshed seed ranged from 45% to 85% over the range of concave clearance 10mm to 30mm and 12.5% to 17.0% moisture content. The percentage germination of threshed seed reduced with increase in cylinder speed and vice versa at all the levels of combination of the study variables. This was due to the increased damage to seed at higher levels of cylinder speed. The germination of threshed seed at 17.0% moisture content was significantly less at the corresponding levels of speed and concave clearance compared to germination of seed threshed at 12.5% moisture content. Also, the minimum concave clearance of 10mm caused the maximum reduction in percentage germination, which increases with increase in the level of concave clearance. Increase in cylinder speed causes higher damage while higher concave clearance reduces the damage. Also the higher the moisture content the more susceptible the seed is to deformation without breakage resulting in injury or viability of seed. Therefore, the observation of reduction in germination with increase in cylinder speed, moisture content and reduction of concave clearance could be expected.

## 4. CONCLUSIONS

The following conclusions could be drawn from this study.

1. The performance of the modified okra Sheller was high and was affected by the moisture content, the cylinder speed of the threshing drum as well as the concave clearance.
2. The optimum threshing efficiency of 93.4% was obtained using the cylinder speed of 580rpm (4.2m/s) at the moisture content of 12.5%

3. The germination of the threshed seeds was high implying that the sheller did not cause internal damage of the seeds.

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