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Performance evaluation and cost estimation as compared for different paddy threshers

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Abstract

The experiment was conducted on four different tractor operated paddy threshers at lohar Khera, Sanga and Baguwalli in Fatehabad (Haryana). The main purpose of this research work was to estimate the operational cost, evaluate their performance and select the best one by comparing their performance. In this study, four paddy threshers model such as Manku Agro., New Agri. Work, Delux Manku and Manku Agri. Rattan were tested at different threshing cylinder rpm 12, 15, 20, 25, 30 and 35 m/sec and corresponding these speed their performance were evaluated. The variation in speed was achieved by using stepped pulley system. The operational cost of each paddy thresher was estimated by the straight line method of depreciation and it was found that the Manku Delux paddy thresher had minimum operational cost about 380 Rs/hr and minimum fuel consumption about 2.75 lt/hr. The maximum threshing efficiency (96, 96.6, 98.80 and 95.60%) and cleaning efficiency (96.4, 97, 98.2 and 96.5) was achieved of Manku Agro., New Agri. Work, Delux Manku and Manku Agri. Rattan respectively. The fuel consumption rate was found 3.026, 3.023, 2.75, 3.40 lt/hour of these thresher such as Manku Agro., New Agri. Work, Delux Manku and Manku Agri. Rattan respectively. The total loss was found 2.33, 2.82, 2.20 and 2.74 percent in Manku Agro., New Agri. Work, Delux Manku and Manku Agri. Rattan thresher respectively. From this study, it was concluded that Delux Manku thresher is best one, since it is more economical due to less fuel consumption rate and it has more threshing efficiency, cleaning efficiency and minimum total loss.

Keywords: Cleaning efficiency, operational cost, paddy threshers, threshing efficiency etc.

Introduction

In the ancient time, It was observed that more than 80% of the rice crop on farms was threshed manually (Pathak & Bining, 1985) ^[4] but manual threshing of rice crop was very cumbersome, time consuming and less efficient process. There was also chance of spoilage of crop due to the climate change, so the mechanization is needed essentially. Nowadays, for most of the crop; thresher has been developed and available in market. Many experiments have been conducted to optimize thresher performance. Behery *et al.*, (2000) ^[1] had performed threshing tests on El-Shams rice thresher and done using a range of drum speeds, feed crop rates and length of conveyor chain tension at four different levels of capsule moisture content. The optimum performance was found at threshing cylinder speed, feed rate and length of conveyor at about 31.43 m/s, 20kg/min and 48mm respectively at 18.45% moisture content of crop. Chandrakanthappa *et al.*, (2001) ^[2] had conducted a test using a rasp bar type multi-crop thresher to thresh finger millet and found threshing efficiency of 79.61% and total damage of 2.95% were obtained at 4mm concave clearance, 1000 rpm threshing cylinder speed and grain moisture content of 10% wet basis. Desta and Mishra (1990) ^[3] had developed and conducted the study to evaluate the performance of a sorghum thresher and tried to find out its performance at three different feed rate (6, 8, 10kg/min), at two levels of concave clearance (7 and 11mm) and three different levels of threshing cylinder speed (300rpm, 400rpm & 500rpm). The results of their study showed that the threshing efficiency was increased with an increase in cylinder speed for all feed rate and concave clearance. The threshing efficiency was found in the range of 98.3% to 99.9%. Radwan *et al.*, (2009) ^[6] also performed a study on developed El-Shams type tangential axial flow cereal thresher and it was found that threshing efficiency increases with increase in rotor speed. When rotor speed was increased from 500 to 700rpm at air speed (4.8m/s) and moisture content (10.36%) and then the threshing efficiency was also increased from 70.2 to 73.7%.

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Most of these researchers had performed their study to evaluate the performance of the thresher and effect of different parameters on its performance, but the aim of present research work was to estimate the operational cost, evaluate and comparing the performance of four different tractor operated paddy thresher. On the basis of their performance, the best thresher was selected.

Table 1: Some technical specification of different paddy thresher

Name of thresher	Manku Agro. tech	New Manu	Delux Manku	Manku Agri. Rattan
Length of cylinder (mm)	1770	1780	1775	1790
Diameter of cylinder (mm)	745	535	803	832
Concave clearance (mm)	23	24	26	25
No. of sieves	2	2	2	2
Type of cylinder	Spike tooth	Spike tooth	Spike tooth	Spike tooth
Working height of spike (mm)	142	135	130	148
Length of feed chute (mm)	930	980	940	900
Thresher length (m)	4.2	4.1	4.2	4.1
Thresher Height (m)	1.97	1.86	2.63	1.92
Thresher Width (m)	1.99	1.97	1.99	2.00

In the present study, for the measurement of threshing cylinder speed, Magnetic Tachometer and Digital Tachometer were used according to exposed suitable location of the shaft of threshing cylinder. The small strip of reflective mark was pasted at the periphery of shaft and then switch on the Non – Contact type digital tachometer as shown in Fig. 1. When laser beam struck with this pasted strip, it gives pulse and then the pulse analyzed and processed in the software to be incorporated in the digital tachometer. The data presentation system of the tachometer displays the measured value of the threshing cylinder speed.

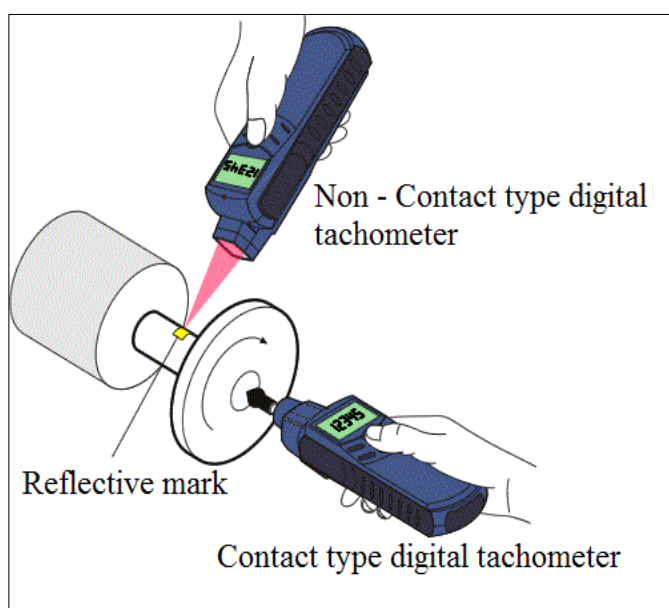


Fig 1: Measurement of threshing cylinder speed by using Magnetic and Digital Tachometer

The weighing Machine was used to weigh the sample to be taken for threshing efficiency, cleaning efficiency, cylinder loss and broken loss. Four samples were taken with sample size about 1kg of grain for threshing efficiency, cleaning efficiency, cylinder loss and broken loss at different threshing cylinder speed and feed rate for each parameter. The variation in threshing cylinder speed was obtained using stepped pulley system and feed rate on the basis of applying the varied quantity of threshed material. The 1 litre and 2 liters beakers were used to measure fuel consumed per hour for each

Materials and Methods

The experiment was conducted on four different paddy threshers at lohar Khera, Sanga and Baguwali village in Fatehabad (Haryana). Before conducting the experiment, some technical observations were taken which shown in the Table 1.

thresher with varied threshing cylinder speed and feed rate. The fuel consumed per hour for each thresher was estimated by filling the fuel tank of the tractor and care of time taken was done by the stop watch. The each thresher was propelled with Mahindra & Mahindra tractor DI 275.

The evaluation of performance parameters of paddy thresher

The performance parameters of paddy thresher were calculated like threshing efficiency, cleaning efficiency, cylinder loss, broken loss, fuel consumption rate and operational cost. The grain sample size about 1kg was taken from the main out of the thresher and weigh the cleaned paddy grain after removal of unwanted material from the sample. The equation 1st was used to estimate cleaning efficiency.

$$\text{Cleaning efficiency} = \frac{\text{weight of clean grains in sample (gm)} \times 100}{1000 \text{ (gm)}} \dots 1$$

For the measurement of threshing efficiency, 1 kg sample was taken from the bhusa out of the thresher and collected the unthreshed grain from the sample. The equation 2nd was used to calculate threshing efficiency.

$$\text{Threshing efficiency \%} = [100 - \text{percentage of unthreshed paddy grain}] \dots 2$$

For the estimation of broken loss, the grain sample size about 1kg was taken from the main out of the thresher and then broken grains were drawn out from the sample by manually on the basis of visibility. The broken, sieve and total grain loss were calculated by using 3rd, 4th and 5th equation respectively.

$$\text{Broken grain \%} = \frac{\text{weight of broken grain found in 1kg sample} \times 100}{1 \text{ kg sample}} \dots 3$$

$$\text{Sieve loss} = \frac{\text{weight of grain collected from over flow and under of the sieve} \times 100}{\text{Total grain input}} \dots 4$$

$$\text{total grain loss \%} = \text{blown loss\%} + \text{damaged grain\%} \dots 5$$

The estimation of operational cost for each paddy thresher

The straight line method was used to estimate the operational cost for tractor operated each paddy thresher. In the straight line method, two types of cost involved like fixed cost and variable cost.

Fixed cost

$$a) \text{ Depreciation} = \frac{(C - S)}{L \times P}, \text{Rs/hr} \quad \dots 6$$

Where,

C is capital cost, Rs.

S is salvage value, Rs.

L is life of machine, yrs

P is annual use of machine, hrs

$$b) \text{ Interest cost, } I_c = \frac{(C + S) \times I}{2P}, \text{Rs/hr} \quad \dots 7$$

Where, I is rate of interest, %

$$c) \text{ Insurance, taxes \& shelter chargers} = \frac{3\% \text{ of total of cost of machine}}{\text{Annual hours use}}, \text{Rs/hr} \quad \dots 8$$

$$\text{Total fixed cost} = [\text{depreciation} + \text{interest} + \text{insurance} + \text{taxes} + \text{shelter}], \text{Rs/hr} \quad \dots 9$$

Variable cost

$$I) \text{ Repair and maintenance} = \frac{7\% \text{ total cost of machine}}{\text{Annual hours use}}, \text{Rs/hr} \quad \dots 10$$

$$II) \text{ Labour cost, Rs/hr} = \text{Wage rate per person} \times \text{No. of persons involved} \quad \dots 11$$

$$III) \text{ Fuel cost, Rs/hr} = \text{Fuel consumed per hour} \times \text{cost of fuel 1litre} \quad \dots 12$$

$$\text{Total variable cost, Rs/hr} = [\text{Repair and maintenance} + \text{Labour cost} + \text{Fuel cost}] \quad \dots 13$$

$$\text{Total operational cost, Rs/hr} = \text{Total fixed cost} + \text{Total operating cost} \quad \dots 14$$

Results and Discussion

The main purpose of this research work was to estimate the operational cost, evaluate performance and select the best one by comparing their performance. In this study, four paddy threshers model such as Manku Agro., New Agri. Work, Delux Manku and Manku Agri. Rattan were tested at different threshing cylinder rpm 12, 15, 20, 25, 30 and 35 m/sec and corresponding these speed their performance were evaluated. The variation in speed was achieved by using stepped pulley

system. The operational cost of each paddy thresher was estimated by the straight line method of depreciation and it was found that the Delux Manku thresher had operational cost about 380 Rs/hr. which was less than as compare to others. The maximum performance parameters was achieved in the experiment for each paddy thresher like threshing efficiency, cleaning efficiency, fuel consumption, total loss and operational cost was shown in Table 2.

Table 2: The maximum performance of each paddy thresher

Name of thresher	Manku Agro tech	New Manku	Deluxe Manku	Manku Agri. Rattan
Fuel consumption rate l/h	3.026	3.023	2.750	3.400
Cleaning efficiency, %	96.4	97.00	98.2	96.5
Threshing efficiency, %	96.00	96.5	98.80	95.60
Total loss, %	3.6	3.0	1.8	3.5
Operational cost, Rs/hr	401	418	380	433

The experiment was conducted at six different threshing cylinder speeds 12, 15, 20, 25, 30 and 35 m/sec and corresponding these speeds their performance were evaluated. After the evaluation of their performance, graph was plotted for each thresher by keeping threshing cylinder speed at X

abscissa and total loss, threshing efficiency and cleaning efficiency at Y abscissa but the graph of Manku Delux thresher was presented in this paper due to its better performance than others which is shown in Fig. 2.

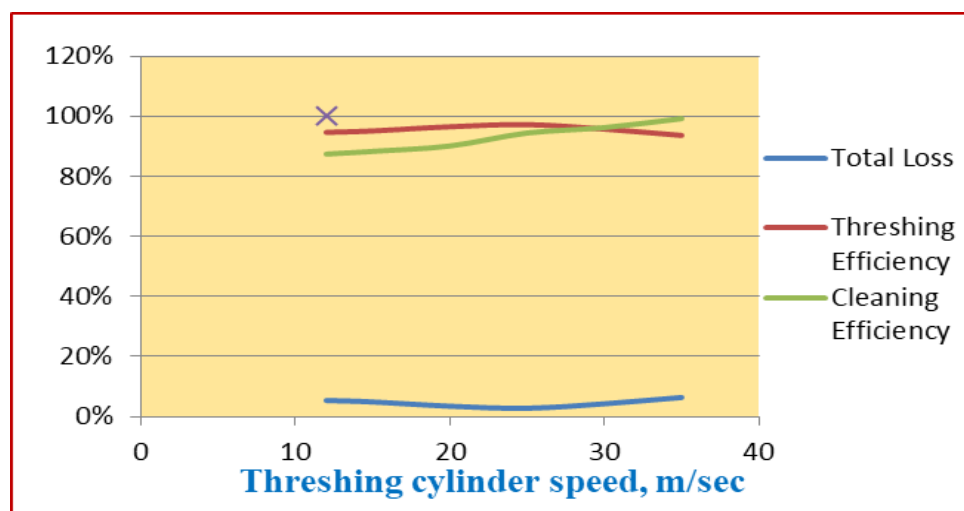


Fig 2: The performance of Manku Delux paddy thresher

Fig. 2 illustrates the performance of Manku Delux paddy thresher at different threshing cylinder speeds 12, 15, 20, 25, 30 and 35 m/sec. It was observed that the threshing efficiency of the thresher was increasing with cylinder speed up to 25m/sec, because at this speed, spikes will give more beating action to panicles of paddy crop, to do so cylinder loss will reduce. After 25 m/sec. cylinder speed, the threshing efficiency decreases with increase in speed because damage loss increases. The cleaning efficiency was increasing continuously with threshing cylinder speed, because at higher speed blower delivered the more volume of air which will help to clean the output of the thresher.

The graphs were plotted for each thresher by keeping feed rate constant at X abscissa and total loss, threshing efficiency and cleaning efficiency at Y abscissa but the graph of Manku Delux thresher was presented in this paper because its better performance than others which is shown in Fig. 3.

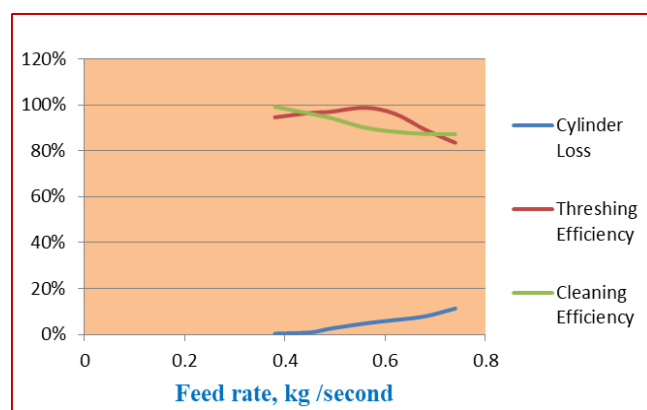


Fig 3: The performance of Manku Delux thresher

Fig. 3 illustrates the performance of Manku Delux paddy thresher at different feeding rate 0.38, 0.45, 0.49, 0.56, 0.62, 0.68 and 0.74 kg/sec. It was observed that threshing efficiency and cleaning efficiency was decreasing continuously with increasing feeding rate up to 0.56kg/sec because machine had ability to thresh the material and after 0.56kg/sec feed rate it decreases with feed rate because excess feeding lead to more damage loss, that's why threshing efficiency decreases. Total loss also increases with feeding rate because of more shearing force developed between grains and periphery of threshing cylinder and damage the rice grains.

Conclusions

In this study, four tractor operated paddy threshers such as Manku Agro., New Agri. Work, Delux Manku and Manku Agri. Rattan were tested at six different threshing cylinder 12, 15, 20, 25, 30 and 35 m/sec and corresponding these speed their performance were evaluated. From the observed data, the following conclusions can be drawn.

1. The maximum threshing efficiency (96, 96.6, 98.80 and 95.60%) and cleaning efficiency (96.4, 97, 98.2 and 96.5) was achieved for the Manku Agro., New Agri. Work, Delux Manku and Manku Agri. Rattan respectively.
2. The threshing efficiency of the thresher was increasing with cylinder speed up to 25m/sec and then decreases with increase in speed.
3. The cleaning efficiency was increasing continuously with threshing cylinder speed, because at higher speed blower delivered the more volume of air which will to clean the output of the thresher.
4. The performance of Manku Delux paddy thresher at different feeding rate 0.38, 0.45, 0.49, 0.56, 0.62, 0.68 and 0.74 kg/sec was evaluated and it was observed that threshing efficiency and cleaning efficiency was decreasing continuously with increasing feeding rate up to 0.56kg/sec and then decreases with feed rate.
5. Total loss also increases with feeding rate because of more shearing force developed between grains and periphery of threshing cylinder and break the grains.
6. The Manku Delux paddy thresher had found minimum operational cost about 380 Rs/hr as well as fuel consumption 2.75 litre/hr.

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