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Performance evaluation of power operated paddy winnower

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■ **ABSTRACT :** Large number of farmers thresh paddy crop manually or by trampling it under feet of animals. Now-a- day's number of progressive farmers are using pedal operated or hold on type threshers which does not have cleaning facility. For cleaning traditional methods such as natural draft of air or small fans are used but it involves drudgery, hence, performance of power operated paddy winnower was evaluated at three different feed rates which was 112, 127 and 138 kg/hr which was developed at CAET Dapoli. The highest cleaning efficiency of 99.3 per cent was found at feed rate of 127 kg/hr for main outlet. The highest output capacity of 117.02 kg/hr was found at feed rate of 138 kg/hr. The percentages of blown grain were 0.21, 0.22 and 0.27 for respective feed rates. The corrected output capacity was 94.64, 109.49 and 114.6 kg/hr for main outlet. The power consumption was in the range of 0.194-0.200 kWh. The cost of operation of power operated paddy winnower was Rs. 30.81/ hr.

■ **KEY WORDS :** Power operated paddy winnower, Cleaning efficiency, Output capacity, Energy consumption, Cost of operation

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Paddy is very important crop amongst all food grains. Among three forth of population of world consumes rice as staple food as major constituent of their daily diet. India is world's second largest producer and consumer next to china. In India rice occupies an an area of 42.56 million hectares with production of 95.33 million tones and productivity is 2.2 tons per hectare (Anonymous, 2011). In Maharashtra, Konkan region contribution is higher in case of production. Large number of farmers in India follows age old practice of threshing such as trampling of paddy with hail, treading a layer of 15-20 cm thick harvested crop by team of animals followed by cleaning and winnowing. Threshers with cleaning facility are area of 42.56 million hectares with production of 95.33 million tones and productivity is 2.2 tons per hectare (Anonymous, 2011). In Maharashtra, Konkan region contribution is higher in case of production. Large number of farmers in India follows age old practice of threshing such as trampling of paddy under feet of animals, hand beating of sheaves of paddy on hard available but small farmers or stakeholders of Konkan region can't afford costly machinery due to small land holding. Now days hold on type paddy threshers are used in some areas of konkan but such threshers do not have cleaning facility. After manual or by using hold on type threshers for threshing paddy crop winnowing operation is necessary. Winnowing operation is carried out to separate dust, straw from clean paddy grains. The winnowing operation is carried out by separation of straw or bhusa from paddy by creating air draft or natural wind. In villages winnowing is done by pouring grains from higher elevation to ground in the prevailing wind direction so that draft of air will blow away straw from clean grains and clean grains can be collected at ground. But

this method is time consuming, uncomfortable and laborious and totally depends on wind conditions. Labour is required to stand at higher platform and pour grains from higher to lower elevation with unsuitable body conditions which increases drudgery of labour. Considering these limitations now day's small fans are used but it also involves same drudgery as said above, labour has to stand in front of fan and pour grains in prevailing direction of wind. This method has also one limitation that percentage of blown grain was high due to improper position of operator. Also these operations are carried out in open yard and subjected to inclement weather conditions. Considering these limitations small power operated paddy winnower was developed in Department of Farm Machinery and Power, CAET Dapoli. The threshed paddy crop will be fed through hopper, the blower will separate the mixture into grains at main and subsidiary outlet (two outlets) and straw can be collected at straw outlet.

METHODOLOGY

The power operated paddy winnower (Fig. A) consists of baffles, blower unit, grain outlet, frame and electric motor. The blower is operated by belt and pulley. The machine is operated by 1 hp single phase electric motor. The detail specifications of power operated paddy winnower are shown in Table A.

Table A : Specification of power operated paddy winnower

Particular	Description
Type of machine	Power operated paddy winnower
Length, cm	100
Width, cm	55
Height, cm	115
Blower width, cm	38
Blower opening, cm	50 x 20
Hopper size, cm	38x30x18
Prime mower	1 hp single phase electric motor ,1440 rpm

Performance evaluation of winnower :

Testing was carried out as per RNAM test code. The Ratnagiri-1 paddy variety was used for testing. Three replications are taken for power operated paddy winnower. During the test, the sample of grain from main outlet, straw from straw outlet were taken to determine various parameters during 30 minute test. The samples were taken from each outlet at three intervals *i.e.* at 5th, 15th and 25th minute of test. The samples were analysed and following parameters were determined (Ahuja and Sharma,1989).

Determination of grain ratio :

The weight of sample of paddy crop was measured and noted. Then weight of grains and straw was measured. The grain ratio was calculated by dividing

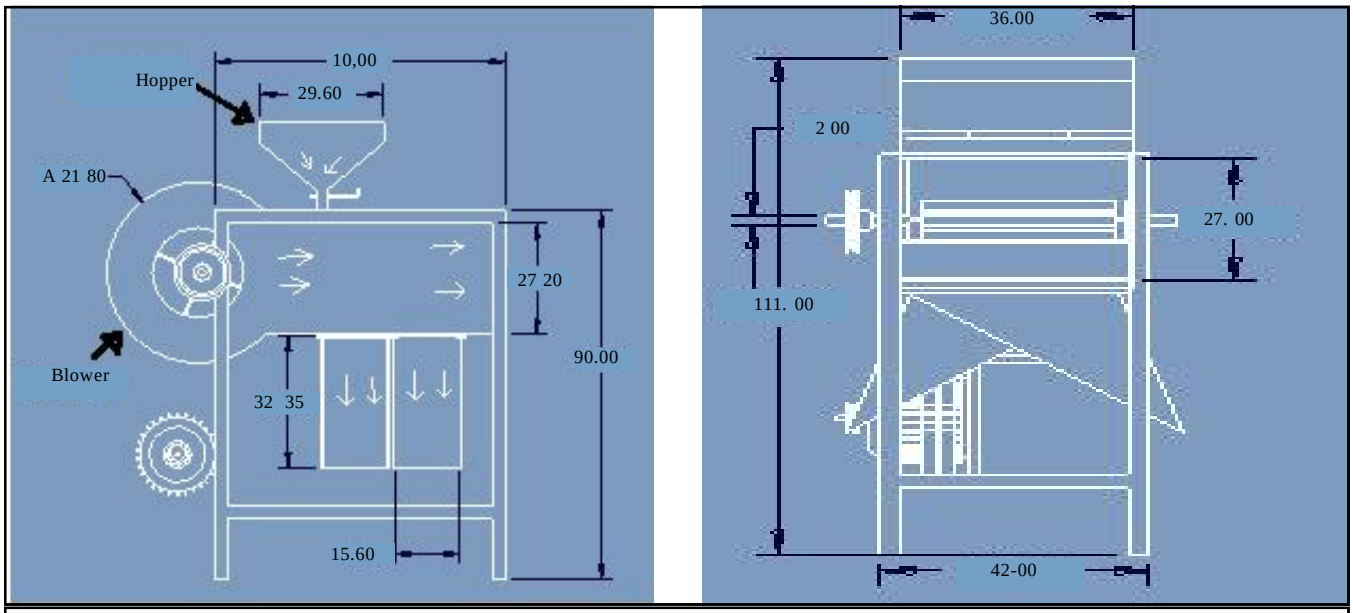

Fig. A : Power operated paddy winnower

weight of grains by weight of the straw.

$$\text{Grain ratio} = \frac{\text{Weight of grain in sample}}{\text{Total weight of sample}} \times 100$$

Determination of moisture content :

Moisture content of grain and straw was determined by taking sample during each test. 100 g grains were taken and 10 g sample of straw was collected and filled in the moisture boxes. Then boxes were kept in hot oven for drying. After drying, the dried weight was noted. The moisture content (db) was found out by formula :

$$\text{Moisture content (\%)} = \frac{\text{Initial weight - dried weight}}{\text{Dried weight}} \times 100$$

Feed rate :

The power operated paddy winnower and power operated fan type winnower were evaluated for performance at three different feed rate. The feed rate can change by adjusting the plate of hopper.

Percentage of blown grain :

$$\text{Percentage of blown grain} = \frac{F}{A} \times 100$$

where,

F= Quantity of whole grain collected at chaff outlet per unit time, kg.

A= Total grain input per unit time by weight, kg.

Cleaning efficiency :

$$\text{Cleaning efficiency} = \frac{I}{J} \times 100$$

where,

I =Weight of whole grain per unit time at main grain outlet, kg.

J= Weight of whole material per unit time at the main outlet, kg.

Corrected output capacity :

$$Wc = \frac{(100 - M) \times R_s \times W}{100 - M_s}$$

where,

Wc = Corrected output capacity, kg/hr.

W = Output capacity obtained, kg/hr

M = Observed moisture content of grain, per cent.

M_s = Standard moisture content of grain (13%).

R = Observed grain ratio.

R_s = Standard grain ratio = 0.6.

Determination of output capacity :

The clean grains were collected at main and subsidiary outlet. The output capacity was determined by measuring weight of clean grains converted into hour basis.

Measurement of energy requirement :

Energy requirement for winnowing was measured by analog type energy meter.

Cost economics of winnowing :

In cost economics, fixed and variable cost were determined.

Fixed cost :

Cost of machine.

Depreciation (Rs./hr) = **(C - S) x (L x H)**

$$\text{Interest (Rs./hr)} = \frac{C + S}{2} \times \frac{I}{H}$$

Insurance and taxes (Rs./hr) = 2 per cent of initial cost.

Housing (Rs./hr).= 1.5 per cent of initial cost.

Total fixed cost = 2+3+4+5.

Variable cost :

Electricity cost

= Electricity consumed (kWh) X Electricity charge (Rs. /kWh).

Operators cost

= Wage of operator/ working hours

Repair and maintenance = 10 per cent of initial cost.

Total variable cost = 1+2+3

Operating cost :

= Fixed cost + Variable cost

where,

C = Initial cost of machine, Rs.

H = Annual use of machine, hr.

I = Interest rate, per cent.

L = Total life of machine, yr.

S = Salvage value, Rs.

Test conditions :

Measurement of performance is primary importance and will be carried under controlled conditions

to obtain reliable data on machine, such that work capacity, quality of work, adaptability to different kinds of crop in comparison with local methods.

Testing will be carried out at the specified speed of the winnower at three different feed rates including optimum feed rate for each paddy variety. Each test shall last for at least half an hour. Each test should be replicated thrice.

A 1 hp single phase motor will be used to run the winnower. An energy meter will be used to measure power requirement of prime mower.

During half hour run period, the appropriate volume of samples will be collected three times at equal interval of clean grain outlet and straw outlet.

From the analysis of samples and sampling time feed rate, cleaning efficiency of winnower calculated.

The effect of three feed rates on different parameters like cleaning efficiency, output capacity of winnower also determined.

RESULTS AND DISCUSSION

The testing of power operated paddy winnower was carried out with Ratnagiri-1 paddy variety with grain ratio of 0.60. The blower speed was measured and found to be 380 rpm and air flow rate was 5.81 m/s. Three moisture content levels of paddy were 14.80 per cent, 15.13 per cent and 15.11 per cent, respectively (Chiplunkar and Patil, 2003).

The performance was carried out at three feed rates 112 kg/hr, 127 kg/hr and 138 kg/hr, respectively and the details are shown in Table 1. Cleaning efficiency at main outlet was found to be 99.1 per cent, 99.3 per cent and 98.9 per cent for first, second and third feed rate, respectively. Cleaning efficiency at subsidiary outlet was found to be 91.2 per cent, 89.3 per cent and 88.6 per cent for respective feed rates. As far as output capacity is concerned it was found to be 96.4 kg/hr, 111.8kg/hr and 117.02 kg/hr at main outlet and at subsidiary outlet it was 6.7 kg/hr, 7.6 kg/hr and 11.8 kg/hr for respective feed rates. The corrected output capacity at main outlet was 94.64 kg/hr, 109.49 kg/hr and 114.6 kg/hr and at subsidiary outlet it was 6.56 kg/hr, 7.45 kg/hr and 11.56 kg/hr, respectively (Dhanchezian *et al.*, 2013).

For first feed rate *i.e.* 111.44 kg/hr, cleaning

Table 1 : Performance of power operated paddy winnower (Avg. of three replications)

Sr. No.	Particulars	Level 1	Level 2	Level 3
1.	Operating time, minutes	30	30	30
2.	Crop/Grain input, kg	55.72	63.54	68.69
3.	Total weight of grain at main outlet, kg	48.318	55.900	58.51
4.	Total weight of grain at subsidiary outlet, kg	3.550	3.803	5.900
5.	Total weight of chaffed paddy straw, kg	3.940	3.750	4.100
6.	Grain to straw ratio	0.60	0.60	0.60
7.	Feed rate of grain, kg/hr	111.44	127.08	137.38
8.	Weight of representative material collected at main outlet, kg (D_1)	1	1	1
9.	Weight of representative material collected at subsidiary outlet, kg (D_2)	1	1	1
10.	Weight of clean grain from above representative material collected at main outlet, kg (E_1)	0.991	0.993	0.989
11.	Weight of clean grain from above representative material collected at subsidiary outlet, kg (E_2)	0.912	0.893	0.886
12.	Cleaning efficiency at main outlet, % (E_1/D_1 x 100)	99.1	99.3	98.9
13.	Cleaning efficiency at subsidiary outlet, % (E_2/D_2 x 100)	91.2	89.3	88.6
14.	Output capacity at main outlet, kg/hr	96.64	111.8	117.02
15.	Output capacity at subsidiary outlet, kg/hr	6.7	7.606	11.8
16.	Quantity of whole grain collected at chaff outlet, (F) kg	0.115	0.140	0.188
17.	Percentage of blown grain (F/A x 100)	0.21	0.22	0.27
18.	Corrected output capacity at main outlet, kg/hr	94.64	109.49	114.6
19.	Corrected output capacity at subsidiary outlet, kg/hr	6.56	7.45	11.56
20.	Power consumption, kWh	0.200	0.192	0.194

APPENDIX

Cost economics of power operated paddy winnower

Fixed cost = cost of machine Rs. 10000/-

Depreciation $= \frac{C - S}{L \times H}$

=10000-1000/ 10×250

= Rs 3.6/hr

Interest/h@10% $= \frac{C + S}{2} \times \frac{i}{100 \times H}$

= (10000+ 1000 / 2) ×10 / 250

= Rs. 2.20/hr

Insurance and taxes= 2 % of initial cost / 250

= (2 X 10000/ 100)/ 250

= Rs. 0.8 /hr

Housing = 1.5 % of initial cost

= (1.5 X 10000)/ 250

= Rs. 0.6 /hr

Total fixed cost= Rs. 7.2/hr

Variable cost :

Electricity cost= Electricity consumed (kWh)X electricity charge

= 0.200X4.5

= Rs. 0.91/hr

Operating cost= Wages of operator / working hours x no. of labours (1)

= 150/8

= Rs. 18.70/hr

Repair and maintenance= 10 % initial cost

= (10 / 100) X10000

= Rs. 4/hr

Total variable cost = Rs. 23.61 /hr

Operating cost of winnower= Rs. 30.81 /hr.

efficiency at main outlet and subsidiary outlet was found to be 99.1 per cent and 91.2 per cent, respectively and the output capacity was found to be 96.64 kg/hr and 6.7 kg/hr. For second feed rate *i.e.* 127.08 kg/hr, cleaning efficiency at main outlet and subsidiary outlet was found to be 99.3 per cent and 89.3 per cent, respectively and the output capacity was found to be 111.8 kg/hr and 7.606 kg/hr. For third feed rate *i.e*. 137.38 kg/hr, cleaning efficiency at main outlet and subsidiary outlet was found to be 98.9 per cent and 88.6 per cent, respectively and the output capacity was found to be 117.02 kg/hr and 11.8 kg/hr. As the feed rate increases, cleaning efficiency decreases, as same draft of air employed for cleaning more quantity of grains.

The performance of paddy winnower was found satisfactory as far as cleaning efficiency output capacity and power consumption is concerned. The percentages of blown grain were 0.21, 0.22 and 0.27, respectively. As cleaning efficiency at subsidiary outlet is low, grains collected at subsidiary outlet are again fed into winnower for cleaning. After repeating for several times the quantity of grains collected at subsidiary outlet decreases. The power consumption was found to be 0.200, 0.192 and 0.194 kWh, respectively.

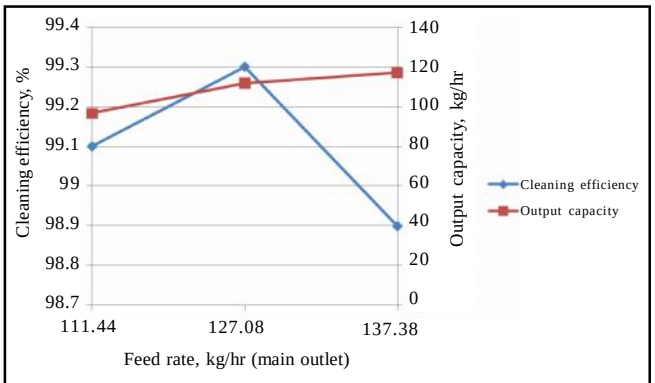

Fig. 1 : Effect of feed rate on cleaning efficiency and output capacity for main outlet

From the Fig. 1 it was found that as feed rate increases the cleaning efficiency decreases and output capacity decreases. The percentages of blown grain also increases as feed rate increases but the quantity of blown grain is negligible, hence, power operated paddy winnower can be used for winnowing operation.

Conclusion :

The power operated paddy winnower was tested at three feed rates 112 kg/hr, 127 kg/hr and 138 kg/hr, respectively. The highest cleaning efficiency of 99.3 per cent was found at feed rate of 127 kg/hr and highest output capacity was found at feed rate of 138 kg/hr. The percentages of blown grain were less than 1 per cent in case of all three feed rates. The output capacity at three feed rates ranges from 96-120 kg/hr which was efficient. The power consumption also near bout same for all three feed rates *i.e.* 0.192-0.200 kWh. The cost of operation for power operated paddy winnower calculated as Rs. 30.81/hr Appendix. Considering all these factors and limitations of traditional methods which is time consuming, drudgeries and also non comfortable, hence power operated paddy winnower can be used for winnowing operation.

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