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## Development and testing of solar operated paddy winnower

**Bhupendra Ghritalahre, Kunal Kolhe, Uma Chandra and Shweta Yadav**

**Abstract**

Winnowing is the process of removing foreign material, chaff, from the paddy by the use of air application. The annual production of rice in Chhattisgarh is 6608.83 thousand tonnes. Large number of farmers thresh paddy crop manually or by trampling it under feet of animals thus the cleaning is more difficult. For cleaning, traditional methods such as natural draft of air and small fans are used. The output obtained in this process is 40-45 kg/hr, which is very low and also the process is time consuming. In power operated paddy winnower the energy consumption is high. Keeping this fact in mind this project was undertaken to develop a solar operated paddy winnower. This machine can be used in those areas where electricity is not available or cost of electricity is too high. The size of the developed winnower is 70cm in length, 65 cm in width and 137.5cm in height (including hopper). The performance of the winnower was evaluated in field. The average cleaning efficiency of the winnower was found to be 94-97%. The capacity of the machine 320-367 kg/hr. The cost of developed solar operated paddy winnower is Rs.6280/- and operating cost of the machine was found to be 53.071 Rs/hr.

**Keywords:** Paddy, winnower, solar, performance, development

**Introduction**

Rice (*Oryza sativa* L.) is the world's most important wetland food crop. Rice is staple food for billions of people around the world. Rice is an integral part of creation myth and remains today as leading crop and most preferred food (Huke and Huke, 1997) [1]. Possibly the oldest domesticated grain (~1000years), rice is the staple food for 3billions people (60% of the world's population) and growing rice is the largest single use of land for producing food, covering 9% of the earth's arable land. Rice accounts around 23% of the global calorie intake (Kush, 2003). The annual production of rice in various State of India is shown in table (Table 1). Chhattisgarh state is popularly known as "Rice Bowl of India" because maximum area is covered under Rice during kharif and contribute major share in national rice production. The state is completely dependent on monsoon with an annual Rainfall 1200-1300 mm. it has geographical area of 13.51 million hectare of which 5.9 million hectare area is under cultivation Rice occupies an area around 3.61 million hectares with the production of 5.48 million tonnes an productivity 1.52 tonnes/ha.

Winnowing is the separation of the grains from chaff or straw. It is traditionally carried out by lifting and tossing the threshed material so that the lighter chaff and straw get blown to one side while the heavier seed fall down vertically. Hand- held winnowing basket is used to shake the seeds to separate out the dirt and chaff. They are very effective, but slow. The machine is easily operated and very useful for women farm workers. There is a range of winnowing machines that use a fan to create artificial wind. This speeds up the winnowing process. Some of these contain sieves and screens that grade the grains as well. The winnowing of paddy is done in following ways:

**Traditional winnowing:** Total 5-6 labour are required to start traditionally paddy cleaning where rice crop is beaten by two or three person on wooden logs. After collecting the rice in big basket, these are raised above the head by a person standing on a self-made bamboo-frame platform to clean husk and impurities from rice. Anon (1997) [3], studied that in many part of India, paddy threshing is still done either with animal treading or manually by beating on wooden plank or stone.

**Hand operated winnower:** The hand operated winnower is a machine that uses fan blades, chain and sprocket arrangement to enable fan operation faster with little effort. The traditional method is very labour intensive, time consuming and has less capacity of 40-45kg/hr (Anon, 1997) [3].

Central Institute of Agricultural Engineering (2005), developed the hand operated paddy winnower machine is easily operated and very useful for women farm workers. It consists of main frame, handle, gear mechanism, volute case, fan, hopper, outlets for clean grain and chaff.

**Power operated paddy winnower:** It consisted of a feed hopper to hold the grain for cleaning. It discharges the grain over the scalper and removes bigger size impurities. A blower provided at the bottom, passes air against the grain falling through the chaff and other impurities. The capacity of the machine is very high as compared to manually operated winnower. The motorized paddy winnowing machine was developed at TNAU coimbtore (Patil, R.T, 2013) [5]. It consists of a feed hopper to hold the grain for cleaning. It discharges the grain over a scalper and removes bigger size impurities. Thomachan, K. and Srinivasan, K. (1996) [6], have designed, investigated and developed photovoltaic power which has been utilized in low to medium power applications such as in telecommunication stations, water pumping, refrigeration etc. In this research in this area considered solar power as the sole power source. The first part of this paper deals about how to acquire the power from the sun, and there on to recharge the battery. The second part deals with using the power from battery in running and controlling the motor and recharging the battery simultaneously.

## Material and Method

**Physical properties of paddy:** To determine the effect of paddy and machine parameter, it was necessary to study the physical properties of paddy. The property of seed used in this experiment is bulk density, terminal velocity and angle of repose and various instrument used for testing physical property of seed is anemometer, seed blower, weighing machine etc.

**Design consideration:** The drawing of solar operated paddy winnower is done with the help of solid modelling software. The main components of solar operated paddy winnower are Frame, Speed controller, Battery, Fan, D.C. motor, Solar panel, Plywood, Hopper. The 3-D solid and orthographic view of machine is shown in fig 1 and fig 2 respectively.

**Frame design:** Ergonomically The machine is developed according to average height of women (142.7– 159.7 cm) (CIAE, 2005) and the other dimension of the solar operated paddy winnower is consider as per the power requirement of the machine (Table 2)

**Hopper design:** The volume of the hopper is calculated using following formula and design is taken. The dimension is given on the Table 3

$$V = \frac{1}{6} H(2L_1B_1 + L_1B_2 + L_2B_1 + 2L_2B_2)$$

## Result and Discussion

The study was undertaken to determine technical and economic performance of solar operated paddy winnower in the field. Cleaning efficiency, machine capacity, and performance of the solar operated paddy winnower were calculated. In the field, the performance and efficiency of the solar operated paddy winnower was evaluated on the basis of parameters, Development of solar operated paddy winnower

and Testing of solar operated paddy winnower. The developed solar operated paddy winnower is shown in fig 3. Bulk density of paddy is calculated at laboratory. The average bulk density of paddy was found to be 0.505 g/cm<sup>3</sup> and the average of Angle of repose of paddy was found to be 29.48°. The observation are shown in (Table 4)

The capacity of the developed paddy winnower was determined by testing the machine at the field. The winnower was used continuously half an hour and results were noted. The capacity of the winnower was ranges between 320-367 kg/hr. The observation Table pertaining to the capacity is shown in Table 5

Cleaning efficiency of the developed paddy winnower is shown on Table 6 The cleaning efficiency increase with increase in the velocity of air. The maximum velocity of air which can be supplied by motor is 5.2 m/s. It is obtained by connecting the battery and solar panel simultaneously. Solar panel and battery allow air velocity 3.8 m/s (depends on sun intensity) and 4.6 m/s respectively. The cleaning efficiency is found to be 94 – 97%.

**Table 1:** Production of rice in India

S.no.	State	2015 Production (thousand tonnes)
1.	West Bengal	15023.68
2.	Uttar Pradesh	14416
3	Andhra Pradesh & Telangana	11510
4.	Punjab	11374
5.	Bihar	7529.3
6.	Orissa	7295.45
7.	Chhattisgarh	6608.83
8.	Assam	5128.51
9.	Tamil Nadu	4049.9
10.	Haryana	3976

**Sources:** Directorate of Economics and statistics, Ministry of Agriculture

**Table 2:** Frame Dimension

Height of machine (CIAE, Bhopal)	Width of machine	Length of machine	Thickness of plywood
140 cm	60 cm	75 cm	6 mm

**Table 3:** Dimension of hopper

Top length of hopper (L <sub>1</sub> )	Bottom length of hopper (L <sub>2</sub> )	Top width of hopper (B <sub>1</sub> )	Bottom width of hopper (B <sub>2</sub> )	Height of the hopper (H)
45 cm	30 cm	30cm	15cm	27 cm

**Table 4:** Angle of repose of paddy

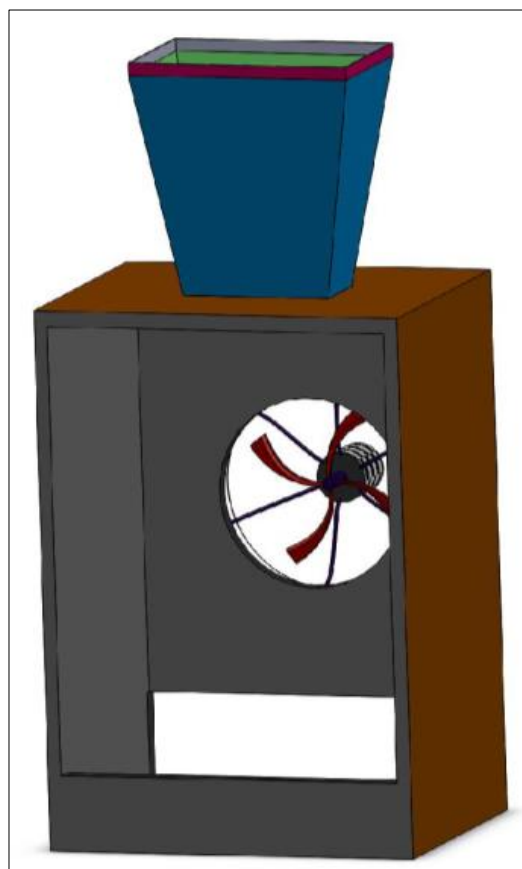
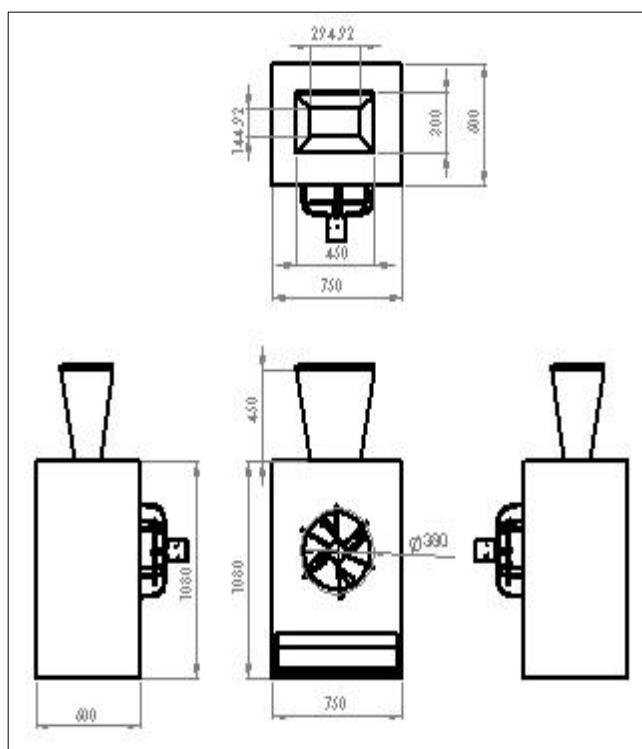
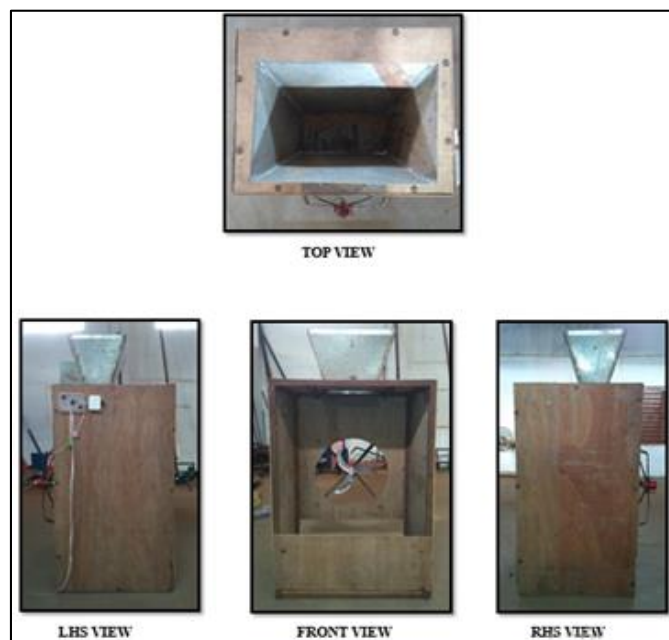
S. No.	Circumference (cm)	Radius, r (cm)	Height, h (cm)	$\theta = \tan^{-1} \left( \frac{h}{r} \right)$
1	78.5	12.5	7	29.25
2	79	12.6	6.5	27.28
3	80	12.7	6.9	28.51
4	82.5	13.1	6.5	26.38
5	83	13.2	6.5	26.21
Average				29.48

**Table 5:** Capacity of machine

S. no.	Weight of clean Grain (kg)	Time taken (s)	Capacity (kg/s)	Capacity (kg/hr)
1	178.6	1800	0.099	357.2
2	183.6	1800	0.102	367.2
3	170.3	1800	0.094	338.4

**Table 6:** Cleaning efficiency of paddy

S. no.	Unclean grain (kg)	Clean grain (kg)	Efficiency (%)
1	11.860	11.200	94.4
2	6.785	6.430	94.76
3	11.790	11.320	96.01
4	11.570	11.185	96.67
5	7.005	6.794	96.98

**Fig 1:** 3-D Solid view of paddy winnower**Fig 2:** Orthographic view of paddy winnower**Fig 3:** Developed solar operated paddy winnower

### Conclusion

The machine is developed for cleaning the unclean grain (mixture of paddy and chaff). Paddy is cleaned by the application of air stream. The advantage of our designed winnower is reduction of drudgery, use of renewable energy, moderate capacity, and high cleaning efficiency. The solar operated paddy winnower was tested for paddy at CAEC Dhanora and on the basis of the results obtained, following main conclusions drawn are:

1. Solar operated paddy winnower is designed of overall dimension 750×600×1375mm.
2. The cleaning efficiency and Capacity of winnower were found to be 94-97% and 320 to 367 kg/hr respectively.

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