Original Research Article

DEVLOPMENT AND EVALUATION OF MODIFIED SOLAR PHOTOVOLTAIC POWERED PADDY WINNOWER

ABSTRACT

A solar photovoltaic powered paddy winnower was developed and evaluated at CAET, BSKKV, Dapoli. The developed winnower was tested for single variety of paddy (Ratnagiri-1) and operational difficulties were reported. In order to eliminate the operational problems and difficulties, it was proposed to modify and evaluate the existing photovoltaic power operated paddy winnower, for better and improved performance. The existing SPV operated paddy winnower was tested for finding the operational difficulties, the physical properties of different paddy verities i.e., Ratnagiri-1, Ratnagiri-6, karjat-3. The terminal velocity, angle of repose, bulk density was determined for testing and modification. It was found that there were various parameters for improving the performance by eliminating the operational difficulties from the existing SPV operated paddy winnower. The necessary modifications were incorporated in modified SPV operate paddy winnower. The modified SPV operated paddy winnower was tested for Ratnagari-1 Variety of paddy.

Keywords: Paddy Winnower, Blower, Solar Photovoltaic, Cleaning Efficiency, SPV operated Paddy winnower.

Introduction:

Paddy (*Oryza sativa*) is an important crop amongst all food grains. As one of the three most important grain crops that helps to fulfil food needs all across the world. Three fourth of total world population consumes rice as staple food. Rice is the staple food for 65 % of the population in India. Global rice production more than tripled between 1961 and 2010 with compound growth rate of 2.24 % per year (2.21% in Rice Producing Asia). India is the world's second largest producer and consumer next to China. In India, rice cover area was 42949.80 thousand hectares against total geographical area of 163.46 million hectares with production of 112905.50 thousand tones and productivity was 2585 kg/ha (India agristat). Maharashtra has 1446.60 lakh ha land under rice cultivation with rice production of about 2660.50 lakh tons and productivity was 1839 kg/ha for the year 2017-18 (Dept. of agriculture Gov. of Maharashtra). In Konkan region, it is grown on 0.50 million hectares with the production of 1.14 million tons per year and productivity is 2768 kg/ha.

There are several post-harvest operations carried out on paddy. The most important goals of post-harvest handling are keeping the product fresh, to avoid

losses and slow down undesirable chemical changes, and avoiding physical damage such as bruising and to delay spoilage. It has been reported that about 9 per cent of paddy is lost due to use of old and outdated methods of drying and milling, improper and unscientific methods of storage, transport and handling. It has been estimated that total post-harvest losses of paddy at producers level was about 2.71 per cent of total production. To minimise post-harvest losses, precautions should be taken to follow proper post-harvest practises. It includes timely harvest at optimum moisture percentage, use of proper method of harvesting; avoid excessive drying, fast drying and rewetting of grains. Ensure drying of wet grain after harvest, The losses in threshing and winnowing can be avoided using better mechanical methods.

In the post-harvesting process of the paddy threshing contributes 12 % cost of production. Presently hold on type paddy thresher in some areas of Konkan region are widely use which do not have cleaning facility. Hence, winnowing operation is necessary after manual or hold on type threshing. Cleaning and winnowing is one of the important post-harvest processes for preparing paddy as food. It involves the removal of unwanted material like chaff, straws, weeds soil particle and other debris from the grain. Winnowing helps to improve grain storability, reduces dockage during milling, gives good quality milled rice and improves the milling output. It also reduces insects, pests and disease infestation.

Winnowing is an agriculture method developed by ancient cultures for separating grain from foreign material like chaff, straw, husk. It involve simple process like throwing the mixture into the air so that the wind blows away the lighter chaff, while the heavier grains fall back down for recovery. There are different techniques used which include a shaped basket shaken to raise the chaff, a winnowing fan, winnowing fork or shovel. This methods are time consuming, uncomfortable and laborious. Labours get tired within a short period of time and this operation completely depends on wind conditions.

The winnower may be hand operated or power operated. Hand operated winnower require two persons for operation, one for operating the fan and another one for feeding the grain to winnower. Effectiveness of separation of winnower may be very less in case of hand operated winnowing due to non-uniform speed of the blower as it was operated manually. Power operated winnower has the high effectiveness of separation due to uniform blower speed, but requires electrical power to run the blower. In many rural locations of developing countries, grid-connected electricity and supplies of other non-renewable sources of energy are either unavailable and unreliable or too expensive.

The available solar energy in tropical countries like India can be efficiently utilize to provide the source power supply for the post-harvest operations like paddy winnowing. In such conditions, solar photovoltaic powered paddy winnower is useful in areas with no utility lines. Photovoltaic systems are often less expensive and require less

maintenance and operating cost than conventional electrical powers.

MATERIAL AND METHODS

The development and evaluation was conducted at Energy park, College of Agricultural Engineering and Technology, Dapoli., with the three varieties of paddy i.e Ratnagiri-1, Ratnagiri-6, Karjat-3.

Analysis of existing SPV powered paddy winnower for operational difficulties

During no load and field-testing operational difficulties were found as follows:

- Irregular inflow of feed from hopper.
- Irregular outflow from outlet 1 and outlet 2.
- Absence of hooks on outlet for hanging of gunny bag.
- Variable blower speed and air velocity with solar intensity.
- Absence of auxiliary power in case of low solar intensity.

Modifications in existing SPV powered paddy winnower for improved performance

- **For regulating inflow of feed from hopper:**

The Paint was removed from inside of hopper and then polished the surface. The existing two side central feed control plate was replaced with single sliding type feed control plate with inclination angle equal to hoppers slant angle. Four no. of springs was provided at four corners of hopper and two vibration motors fixed for vibrations to the hopper for smooth and continuous flow of paddy grains.

- **For regulating outflow from outlet 1 and outlet 2:**

The painted outlet 1 and outlet 2 were creating hurdle in smooth outflow, to facilitate smooth outflow, the paint was scrapped off from the outlet surface.

- **For hanging of gunny bag at outlet:**

A three number of hooks were attached to outlet 1 and outlet 2 for hanging of gunny bags at outlet or collection of grains.

- **To regulate blower speed and air velocity with solar intensity:**

To keep the blower speed constant there was need to supply constant voltage to the blower motor, to achieve this a 12 V 7.2 Ah battery was provided with maximum power point (MPP) tracking charge controller. DC to DC step up booster was incorporated to increase the voltage supply to the blower, A DC motor speed regulator was provided to control the blower speed and air velocity suitable for different varieties of paddy.

- **To provide uninterrupted power in case of low solar intensity:**

Battery backup of 12 V 7.2 Ah was provided to facilitate uninterrupted winnowing operations in case of low solar intensity

The necessary modification required for smooth working and making trouble free operations of winnower was incorporated in existing solar photovoltaic paddy winnower.

Working of modified solar photovoltaic powered paddy winnower:

The modified SPV operated paddy winnower was equipped with 7.2Ah maintenance free sealed lead acid battery. The battery was charged by the solar photovoltaic panel with the help of the MTTP charge controller. The charge controller gives the load output voltage of 12.6 V. In order to increase the blower, speed the voltage needs to step up, hence step-up booster module was used. To regulate the speed of fan blower in accommodate winnowing of different varieties of paddy, DC motor speed controller module was provided. Two vibration DC motors were connected parallel to the 12 V load output of charge controller.

Technical specifications of modified solar photovoltaic powered paddy winnower:

- Solar Photovoltaic Panel: Power – 80 W, Voltage – 12V, Size – 83 cm×45 cm
- D.C Motor Power – 18 W Voltage – 12 Volt
- Centrifugal Blower RPM - 2800
- Hopper Capacity – 10 Kg Size = 40×40×20 (G. I. Sheet)
- DC Motor Speed controller 12Volt 4 amp.
- Battery 7.2 Ah, 12 V
- Solar Charge Controller 12 V/24 V
- Vibrating D.C motors Voltage 12 V
- DC to DC voltage booster 150 W, 6 A, 10-32 V to 12-35 V
- Switch 1 no. On/Off
- Caster wheel 4 nos.
- Frame (Height = 100 cm Breath = 70 cm Width = 40 cm) Mild steel.

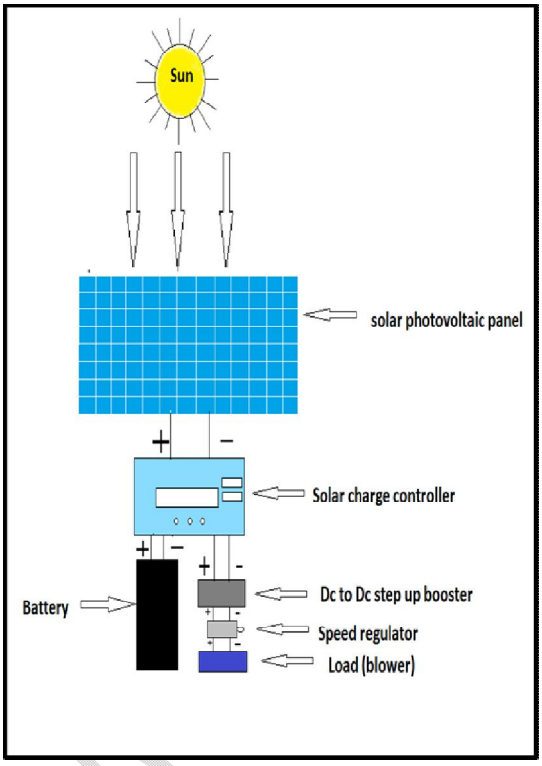

Fig. 1 Block diagram of electrical system of modified SPV powered winnower

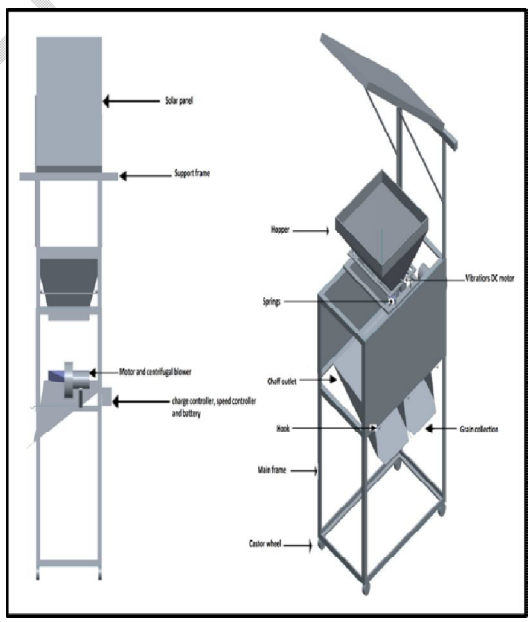

Fig. 2 Diagram of modified SPV powered winnower

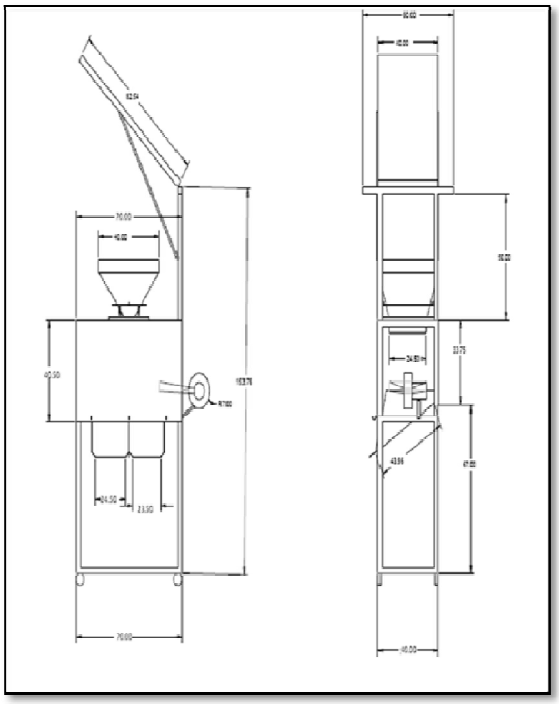

Fig. 3 Sketch of modified SPV powered winnower

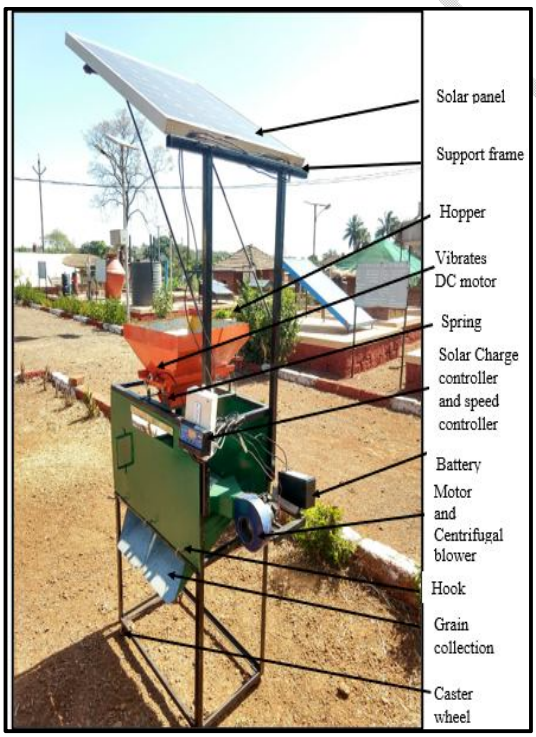

Fig. 4 Modified SPV powered winnower

RESULT AND DISCUSSION

The field testing of modified SPV operated paddy winnower was conducted at Energy Park, Department of Electrical and other Energy sources, CAET, DBSKKV, Dapoli. The different operating parameters were recorded as per RNAM test code for field testing of winnower. The results obtained are described on the basis of cleaning efficiency, output capacity, percentage of blown grain and power consumption.

The SPV operated paddy winnower was evaluated and details its parameter given as follow.

Name of crop - Paddy

Variety of crop – Ratnagiri-1

Grain ratio - 0.896

Operating time - 15 min

Moisture content (w.b) -11.76 %

Grain input – 30 kg

The filler trials of SPV operated winnower were conducted at different positions of feed plate. It was observed that if the 100% feed plate was opened, the feed rate was found to be very high, which is beyond capacity of blower. Hence, the modified SPV operated winnower evaluated at constant feed rate of 120 kg/h.

No load test of modified SPV paddy winnower

Effect of solar intensity on blower speed.

It was observed that, the solar intensity does not affect the blower speed, the blower speed in modified winnower remains steady around 2800 rpm because battery provided steady voltage supply to

the blower. The maximum solar intensity (542.3 W/m^2) was achieved at 13:00 h of the day.

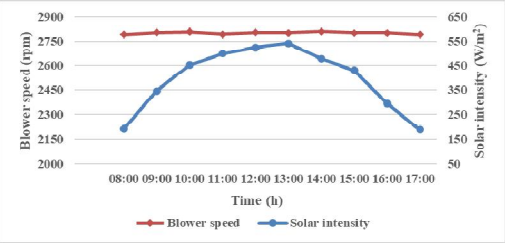

Fig. 5 Variation of blower speed with respect to time and solar intensity

Effect solar intensity on air velocity

variation of solar intensity and air velocity with respect to time at different distances from blower. It was observed that the air velocity also remains steady with respect to time, the solar radiation varied with the time of the day. The maximum velocity of air through at 10 cm, 20 cm, 30 cm from blower was found to be 8.73 m/s, 7.43m/s, 5.40m/s, respectively.

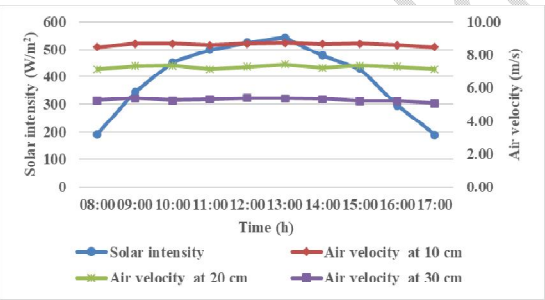

Fig.6 Effect of solar intensity on air velocity

Field testing of modified SPV operated paddy winnower

cleaning efficiency and output capacity of outlet 1 with respect to time which reveals that the cleaning efficiency during the day was found to be constant. The maximum cleaning efficiency found to be 95.5 per cent and minimum cleaning efficiency found to be 92 per cent. Maximum output capacity of outlet-1 found to be 40.82 kg/h. and minimum found to be 40.6 kg/h.

cleaning efficiency and output capacity of outlet 2 with respect to time which reveals that the cleaning efficiency during the day was found to be constant. The maximum cleaning efficiency found to be 94 per cent and minimum cleaning efficiency found to be 90 per cent. Maximum output capacity of outlet-2 found to be 78.6 kg/h. and minimum found to be 78.1 kg/h.

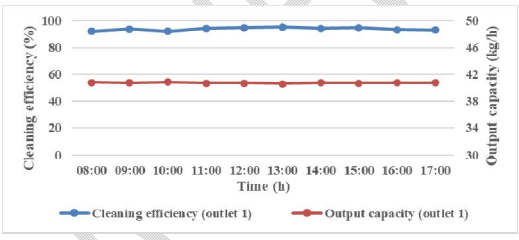

Fig.7 Cleaning efficiency and output capacity at outlet 1

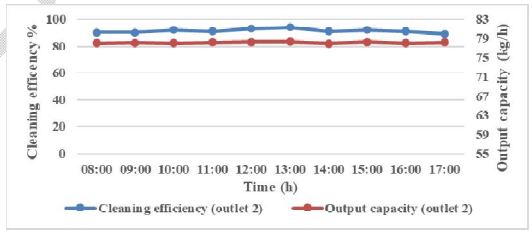

Fig.8 Cleaning efficiency and output capacity at outlet 2

Variation of percentage of blown grain with respect to time at 20 cm distance from blower

It was observed that, the percentage of blown grain from blower was found nearly constant. The percentage of blown grain was ranged from 0.1 % to 0.12 %. The variation power consumption with respect time of operation was studied.

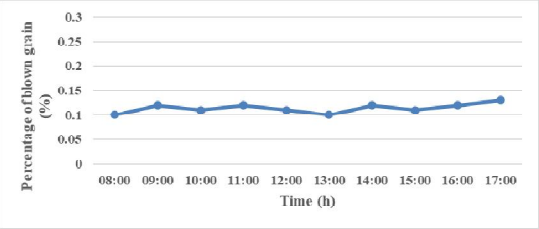

Fig.9 Variation of percentage of blown grain with time.

CONCLUSION

It can be concluded the modified SPV operated paddy winnower found suitable for winnowing of various paddy varieties by controlling blower speed and distance of hopper.

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