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Development of threshing cylinder for small millets

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ABSTRACT

India is the largest producer of many kinds of millets and most important minor millets in India are finger millet, proso millet, barnyard millet, kodo millet and little millet. Threshing is based on the principle that, some impact is given on crops, the grains are separated from panicles, cobs and pods. The performance of the threshing unit with development of five different shapes of pegs for threshing *Kutki* (little millet). *Kukti* millet was evaluated with an average moisture content of 13.4% wet basis and pegs was tested at two different speeds 712 rpm and 1068 rpm. The use of disc shape peg at 1068 rpm in plot size thresher for little millet at 13% moisture content (wb) with highest threshing efficiency 99.67 % highest cleaning efficiency 98.64 %, moderate output capacity 20 kg/ha, unthreshed grain percentage and seed damage was found 0 %. is recommended in view of minimum cost requirement, timeliness of operation, low cost of operation was achieved.

Key words: Cleaning efficiency, Output capacity, Pegs, Threshing efficiency.

INTRODUCTION

Small millets are small sized cereal grains belonging to the family poaceae (Gramineae) are grown mainly in America, Japan, China and India. In India minor millet grown are *kodo* millet (*Paspalum scrobiculatum*), *kutki* (*Panicum sumtrense*), *ragi* (*finger millet*), *kakun* (*foxtail millet*), sawan (*barnyard millet*) and *cheena* (*proso millet*). Small millets are grown in almost every state of India under rain-fed condition. Main small millets growing states are Rajasthan, Maharashtra, Karnataka, Uttar Pradesh and Madhya Pradesh. In Madhya Pradesh small millets are mainly grown in Mandla, Dindori, Rewa, satna and Jabalpur districts. Madhaya Pradesh contributes approximately 45 per cent of total production of small millet in India (Anonymous 2011-12). Small millets are sown in June- July and harvested in September- December. The ideal moisture content at the time of harvesting is approximately 11-15% (Ajay and Adejumo 2005). Threshing is the process of separating grains from heads accomplished by impact of fast moving element, rubbing, squeezing or a combination of these methods. The pegs to be design for small millets must incorporated with a moving elements that may provide the impact on the feeding material for detachment of grain from earheads, rubbing/ shearing action to remove husk, outer coating from the grain (Ramakumar *et al*. 1988). Framers particularly the tribals are not able to affort the different thresher for different crops. This leads to the design and development of small, low cost thresher which may be greatly helpful and affordable to the poor farmers particular to the tribals as these crops are commonly grown in tribal areas.

Physical properties of crop are very important for the design and development of machine. The physical property of millet shown in Table 1. Singh (2010) studied different physical properties of barnyard millet. Baryeh (2002) evaluated different physical properties of millets and expressed as function of moisture content between 5-22.5%. Singh *et al*.(2015) reported that for minor millets, the optimized parameters were 7.79% (d.b) moisture content, 105 kgh^{-1} feed rate, 625 rpm cylinder speed, 5 mm threshing sieve size which gave maximum threshing efficiency of 95.13% and cleaning efficiency of 94.12%. Ukatu (2006) The performance of the modified pegs was compared with that of the conventional pegs.

Naveen Kunel *et al*,.(2013) moisture content 10-13% of the ear head plays a key role in threshing operation and seed quality. Abo-EL-Naga *et al*,.(2015) reported that threshing efficiency proportional to the feed rate. Pandey and slevans . (2016) evaluated that the operational cylinder speed for threshing gram crop was found 600 rpm at feed rate 21q/hr. threshing efficiency 98.99% and cleaning efficiency 97.30% The aim of these study were to developed different shape of pegs and evaluate best for *kutki* millet with appropriate clearance, threshing efficiency, output capacity and minimum seed damage.

MATERIALS AND METHODS

The millet threshing machine was designed to be made up of the following major parts as shown in Fig 1. The thresher mainly consists of a threshing unit, separating unit and the frame. The specification of thresher shown in Table 2.

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Fig 1

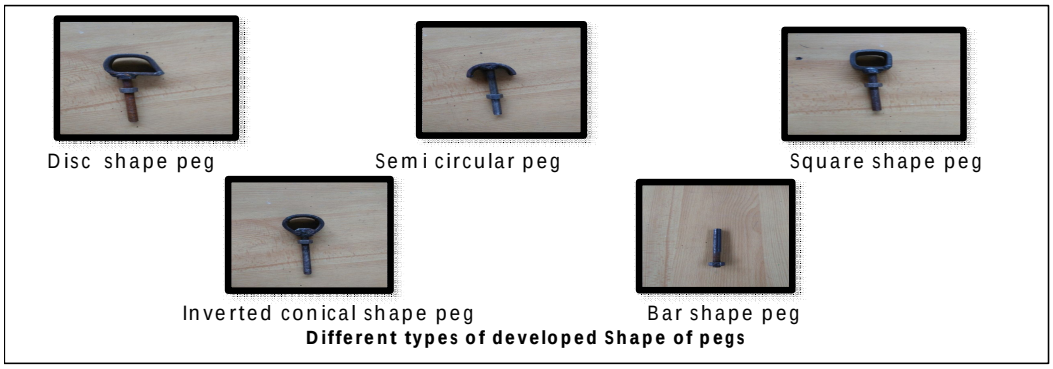

Fig 2: Different types of developed pegs.

Hopper: It is introductory section of millet pods into the threshing chamber. It is made of mild steel and it is identified by a trapezoidal shape. It is the part where millet pods are being fed into the threshing drum.

Threshing unit: It is part where the millet seeds are beaten out of the panicle and separated first. It is made of mild sheet. The threshing chamber consists of threshing drum ,pegs and concave together makes the threshing unit. It separates the grain from the crop and removes grain from straw. Concave is provided in the thresher to hold the fed crop inside the threshing chamber and allow only grain and small amount of chaff to pass through it. The threshing takes place only in this chamber.

Selection of pegs: Material required for the fabrication of different pegs such as mild steel sheet, nut bolts, welding machine etc. On the basis of previous work done by different researchers the five different shape were selected for study. The five shape which we developed during research are disc, semi circular, square, inverted conical and bar type. In which disc, semi circular and inverted conical have curved shape. The principal of selection of these three shape is that the area of contact of these shape is more than conventional pegs which are used for threshing other crop and the force of impact of these three pegs are directly to the crop, where bar type pegs strike crop better at less rpm, square shape peg has plan horizontal surface so the force of impact direct to the centre of crop. (Fig 2) Shows different type of develo ped pegs.

Separating unit: Millet thresher was equipped with two screens. Top screen is provided so as to pass the grain to second screen and chaff etc is taken out from it. Other screen below the first screen sieves out the smaller grain or weed seeds and delivers the cleaned grain towards outlet. The size of screen hole is selected on the basis of the grain size. These screens are effective when kept under oscillation.

Frame: A very strong frame is provided in the thresher on which all the functional parts are attached. The frame is made usually of heavy angle iron sections. It should be strong enough to sustain vibrations of machines, during its operation in the field.

Performance parameters: The performance of threshing cylinder was computed by the formula such as threshing efficiency, cleaning efficiency, output capacity.

Threshing efficiency: The threshing efficiency was estimated by using the formula and expressed in percentage (Anonymous, 1983):

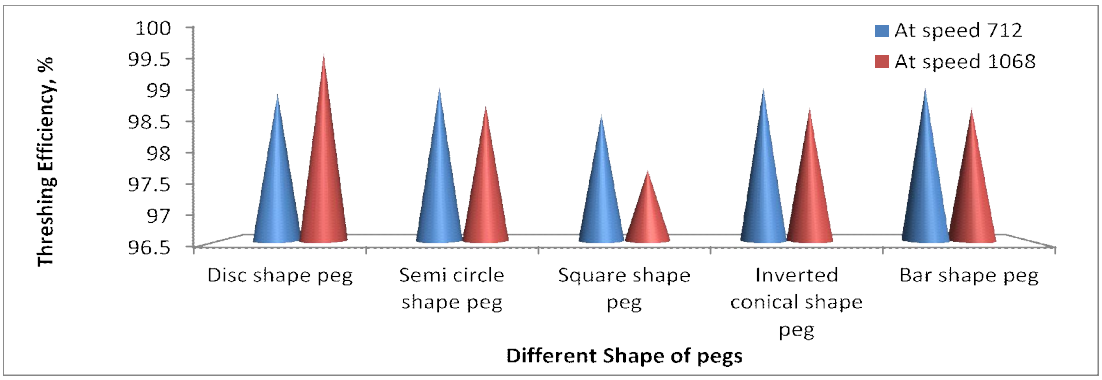

Fig 3: Threshing efficiency of different pegs.

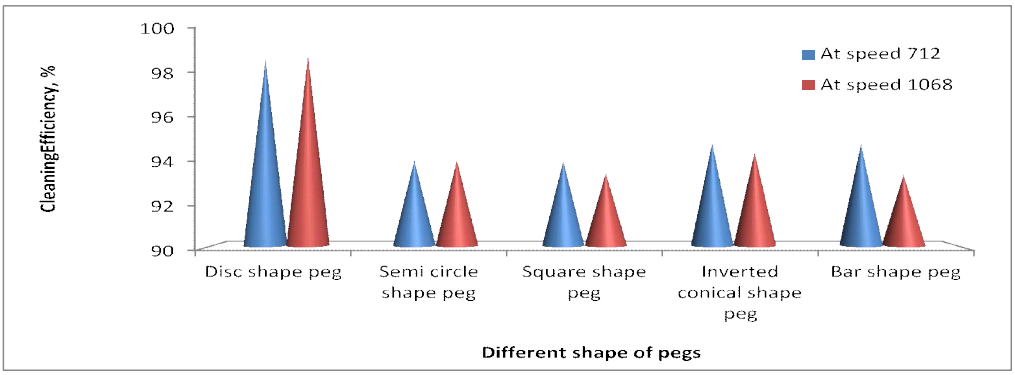

Fig 4: Cleaning efficiency of different pegs.

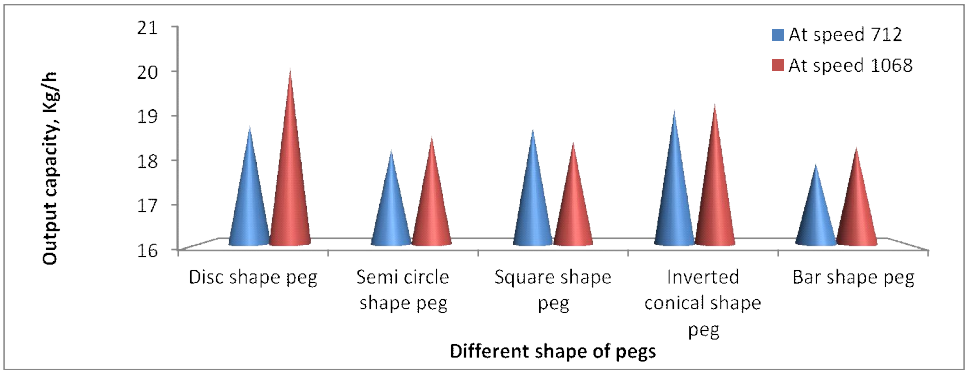

Fig 5: Output Capacity.

Threshing efficiency (%) = 100-percentage of unthreshed grain.

Cleaning efficiency: The cleaning efficiency was calculated by using formula and expressed in percentage (Anonymous., 1983):

$$\text{Cleaning efficiency (\%)} = \frac{\text{Weight of whole grain per unit time at the main grain out let}}{\text{Weight of whole meterial per unit time at the main outlet}} \times 100$$

Output capacity : The output capacity was estimated by weighing the total grain (whole and damaged) received per hour at main grain output of the thresher (Anonymous., 1983):

$$\text{Output capacity (kg/h)} = \frac{\text{Weight of grain threshed (kg)}}{\text{Time taken (hr)}}$$

RESULTS AND DISCUSSION

Threshing efficiency: The threshing efficiency with different pegs are presented in Fig 3 threshing millet at 13% moisture content with a speed of 1068 rpm and with the shape of disc peg produced the highest efficiency of 99.67% (Table 3 and 4) and threshing millet with 13% moisture content with

Table 1: Physical property of little millets.

Crop	Little Millets
Moisture content (%)	13.4
Size of Grain (mm)	3.4
Wt of 1000 seeds (gm.)	4.2
Bulk density (kg/m^3)	747
True density (kg/m^3)	1289
Porosity (%)	42.1

Table 2: Specification of thresher.

Particulars	Specifications
Overall dimension (l×w×h), mm	(900×500×840)
Threshing cylinder drum	Length 250mm, diameter of cylinder 135 mm
Concave clearance	5 mm concave clearance.
Pegs	5 different shape of pegs (disc, semi circular, square inverted conical and bar type) 36 pegs fitted in threshing cylinder
Feeding device	Chute type as per Indian standard
Sieves	2 different size of sieves fitted, upper sieve diameter 8mm and lower sieve diameter 2mm.
Power source	1 hp electric motor
Blower	Aspirator type and Blower speed is constant during operation

Table 3: Performance and evaluation of different types of pegs at 712 rpm.

Shape of pegs	Threshing Efficiency	Cleaning efficiency	Output Capacity
Disc	99	98.7	18.8
Semi circle	99.1	94.0	18.2
Square	98.6	93.9	18.7
Inverted conical	99.1	94.8	19.2
Bar	99.1	94.7	17.9

Table 4: Performance and evaluation of different types of pegs at 1068 rpm.

Shape of pegs	Threshing Efficiency	Cleaning efficiency	Output Capacity
Disc	99.6	98.9	20.2
Semi circle	98.8	94.0	18.5
Square	97.7	93.4	18.4
Inverted conical	98.7	94.3	19.3
Bar	98.7	93.3	18.3

712 rpm and bar shape peg produced threshing efficiency 99.1% . This could be as a result that the shape of peg with different speed also effect the threshing efficiency high speed of rotation of threshing drum that resulted in more impact of beaters on the millet stalks. This agreed with the result of an earlier study by Simonyan and Oni (2001). It was also reported by Helmy *et al*. (2000), that threshing effectiveness was also found to be affected by the cylinder speed.

Cleaning efficiency: The results of cleaning efficiency of the machine are presented in Fig 4. From the results, the highest values of cleaning efficiency is recorded 98.94% with the disc type of peg and the moisture content was 13% and the speed 1068 rpm . at speed 712 rpm the cleaning efficiency was highest with bar shape peg at the same moisture content 13% Table 3 and 4. Thus, at highest rpm produces highest cleaning efficiency received. This is in lined with the result of an earlier study Afify *et al*. (2007) where cleaning efficiency was found to be increased by increasing speed. The cleaning efficiency is increased with disc shape peg at higher speed and decreased with lower speed thus, it could be a result that disc shape peg gives highest cleaning efficiency at higher speed.

Output capacity: The output capacity of the machine are presented in Fig 5. The highest output capacity recorded 20.2 kg/h with disc shape of peg at 1068 rpm and the moisture content was constant 13% . the output capacity at the same moisture content 13% at 712 rpm was highest with disc shape peg 18.08 kg/hr means that the performance of disc shape peg at both speed was highest as compared to other shape of peg. The results is that the output capacity is not increased with increasing speed and shape it could increased by increasing the volume of the feed. From the earlier study Ukatu (2006) the output capacity is not increased with operational speed and causing more damage the essential things are to maintain the peg shape and the clearances.

CONCLUSION

The performance of five type of pegs was evaluated on millet thresher. The result shows that the use of disc shape peg at 1068 rpm in plot size thresher for little millet at 13% moisture content (wb) is recommended in view of minimum cost requirement, timeless of operation, cost of operation, highest threshing efficiency (99.67%), highest cleaning efficiency (98.64%), moderate output capacity minimum (20 kg/h) unthreshed grain percentage and zero seed damage.

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