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Research Paper :

Performance evaluation of square beater bar type threshing drum on groundnut threshing

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ABSTRACT

A square beater bar drum type groundnut thresher was fabricated which mainly consists of a feed hopper, threshing unit, cleaning unit and power transmission unit. During the trials, the effect of 50 mm concave clearance for developed square beater threshing drum and existing flat plate beater threshing drums on performance was evaluated for three plant moisture contents *viz,* 21.30, 18.40 and 16.10% (w.b.) for SB XI variety of groundnut. The average feed rate of thresher was 660 kg/hr. Average sieve loss of 7.4% was observed at 16.10% (w.b.) plant moisture content. The average highest value of blown pod percentage of 4.89 was observed at 16.10% (w.b.) plant moisture content. The average pod damage by flat plate beater threshing drum was 3.12% which was 36% more than the average pod breakage of 1.97% by developed square beater bar threshing drum. The average highest threshing efficiency of 97.23%, in case of developed square beater bar thresher was observed to be 3% more than the existing flat plate beater threshing drum for plant moisture content of 16.10% (w.b.). Average power consumption of 1.54 Kw-hr was observed for developed square beater bar thresher. Cost of groundnut threshing with developed power operated groundnut thresher was Rs. 22.71 /quintal which saves 86.40% cost and 99.3% time as compared to the manual striping.

Key words : Performance evaluation, Evaluation, Square beater bar, Threshing drum, Groundnut threshing

Groundnut (*Arachis hypogaea* Linn.) also known as peanut, is commonly called the poor man's nut. The plant is native to South America. In India, groundnut was introduced in 16th century. It is the worlds 4th most important source of edible oil (50%) and 3rd important source of vegetable protein (25%). (Handbook of Agriculture (2001) Gujarat, Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra accounts for about 86% of the total area (23.44 million ha) under cultivation of oil seeds, with share, approximately 25% in the India's total oil seed production (25.14 million tons) (www.icrisat.org). In statewise scenario, Gujarat with productivity 1.09 million tons, ranks Ist, while Maharashtra occupies Vth place in productivity (0.44 million ton) of groundnut. Maharashtra occupies IInd place followed by Tamil Nadu in terms of average yield, their, respectively average yields are 1041 kg/ha and 1784 kg/ha. Maharashtra's area under cultivation of this crops is observed to be nearly 0.42 million ha which is 7.06 per cent of the total area (5.95 m ha) of the India under groundnut cultivation.

The groundnut crop is grown in two seasons, *viz.*, *kharif* (rainy season) and summer (post rainy season). There are three types of varieties in groundnut, bunch types (with erect plant habit), spreading and semi spreading types. TG-1, TG-17, TGS-24, TKG-19, TG26, SB XI are some recommended varieties of groundnut for cultivation in Maharashtra. These varieties are seen to be cultivated largely in Marathwada region of Maharashtra. Manually pod separation is labour consuming operation, and drudgery prone activity which involves separating the pods from the plants by hand (manually). A fully mature pod is difficult to split easily with fingered press.

In some regions of the country after harvesting of crop, a heap is made which is left 2-3 days for curing, later crop is collected at one place and pods are detached either by hand or using groundnut striper/plucker for separating the pods from the plants (Abedeal Moneium *et al.,* 1992). Considering area, production and average yield of groundnut, an attempt was taken for minimization of the labour cost in post harvesting of groundnut (Wasley *et al.*, 2004).

METHODOLOGY

After studying the previous research studies of crop parameters and machine parameters required for groundnut threshing, a groundnut thresher (Fig. 1 and 2) was fabricated at the Department of Farm Machinery and Power, MAU, Parbhani, for required capacity. Testing was carried out for groundnut variety SB XI (bunch type

erect variety.

Main frame:

Main frame was fabricated by using 50x50x5 mm and 40x40x5 mm M.S. angles to accommodate all the other functional parts like feed hopper, cylinder and concave, separation and cleaning unit, motor etc. The overall dimension of main frame was 2130 x 1440 x 780mm. The frame was provided with four ground wheels of 240 mm diameter for easy transportation.

Feed hopper:

The feed hoper was made of M.S. sheet of one mm thick riveted in M.S. angles of 30 x 30 x 5 mm and 20 x 20 x 3 mm size. The overall dimension of the feed hopper was 855 x 600 x 527 mm. A deflector was made of one mm thick M.S. sheet of size 640 x 350mm fitted at 25^0 at the mouth (for deflecting the crop material to the clearance space). A throw-in type feeding was used on this thresher.

Threshing unit:

Threshing unit consisted of a cylinder and a concave.

Cylinder:

The threshing cylinder (Fig.3) was of spike tooth type with a cylinder diameter of 500 mm. The length of cylinder was 680 mm. The threshing cylinder consists of,

- beater sections and
- main shaft.

Beater section:

There were two types of beater sections; square beater type and flat plate beater type from which drums were made.

Square beater bar type (developed) section was made of beaters and beater mounting plate. The beaters (with spikes of 5mm diameter and 40mm length) were of 12mm sq bar (length 240 mm) were fitted in beater mounting plate (150x150x5 mm size) with the help of a housing (15x15mm c/s and length 70mm) in which the beater can slide for adjusting the concave clearance. The four beater sections were fitted on main shaft of 1300 mm length, 180 mm apart, with the help of 50mm boss (10mm thick, with 40mm i.d. and 48mm o.d.) such that alternate sets of beater were parallel while adjacent sets of beater were displaced at 45^0. The details of beater section is shown in Fig. 2.

Flat beater bar type (existing) drum (Fig. 3) was made of 30x5 mm M.S. flat of length 210mm the other mounting on main shaft was similar to square beater

Fig. 1 : Power operated groundnut thresher

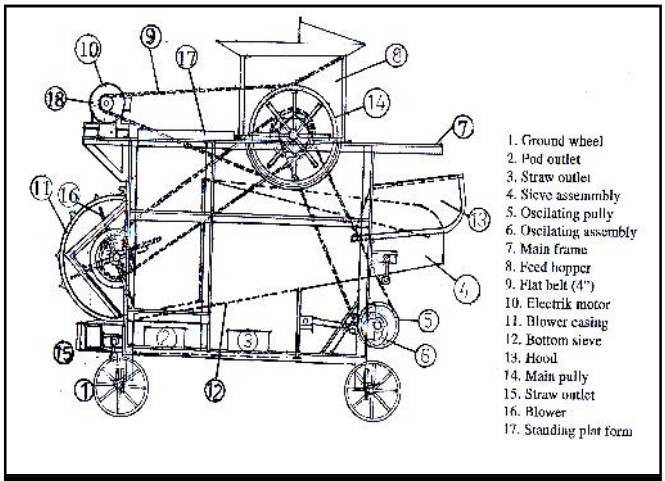

Fig. 2 : Power operated groundnut thresher

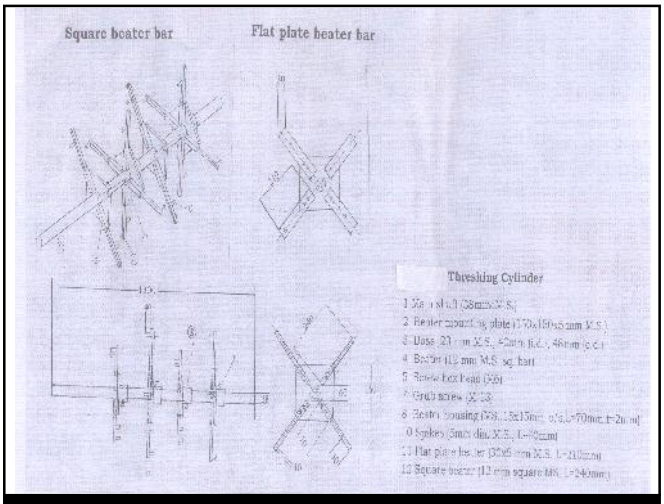

Fig. 3 : Power operated groundnut thresher

section.

Concave:

A semi circular concave of radius 300 mm was constructed by welding the 15 No. M.S. flats of 670x25x5 mm size separated 50 mm along the periphery supported by semi circular concave angle of 25x25x3mm size. Four concave rods, of 15 mm diameter at 150 mm apart, were passing through center of concave flats across the length were provided to with stand the concave flats at the time of working, giving the passage of 150x50mm to the threshed material.

Three sets of fingers of 100 x 25 x 5 mm M.S. flats were provided on the concave. Each finger comes between beater sections for the effective holding of vines passing through the clearance between two beaters. Thus finger holds material while material was passing through the concave clearance and beater section gives impact to material. The combine actions results in cutting the vine in pieces and also separating the pods.

Separation unit:

This mechanism was provided for separating the groundnut pods from the total material threshed. The groundnut pods were separated from the threshed material, mechanically with the help of oscillating sieve, aerodynamically by blower and combination of mechanically and aerodynamically. Thus unit consisted of a set of oscillating sieves and a blower.

Oscillating sieve set:

Oscillating sieve set consisted of two sieves and bottom sieve.

Upper sieve of 1250 mm length was made of G.I. Sheet of 1mm thickness and placed 11^0 to the horizontal plane supported by 25x25x3 mm M.S. angle of length 1250. This sieve was divided in two parts the first part was 620 mm long which was just providing platform to the coming threshed material for the purpose of separation. The remaining length (630 mm) has slots of 20x50 mm (Fig. 4). The slots were punched alternately along and across the length which allows threshed material to pass to bottom sieve.

The bottom sieve was supported by 25x25x3mm M.S. angle of length 1930mm, made similar to the upper sieve, fitted below 80 mm starting from end of the second portion of the upper sieve with 11^0 angle of inclination with horizontal towards the rearward. The first part of length 850mm was without slots which receive threshed material of upper sieve and convey it for separation of pod and straw. The perforations start from 850mm in two section. The first section of 450mm has slot opening of 65x7mm allowing heavy mud stone/particle and straw to straw (mud) outlet and the remaining length 630mm carries the slot opening of 20x50mm for screening the pod and lead it to the pod outlet.

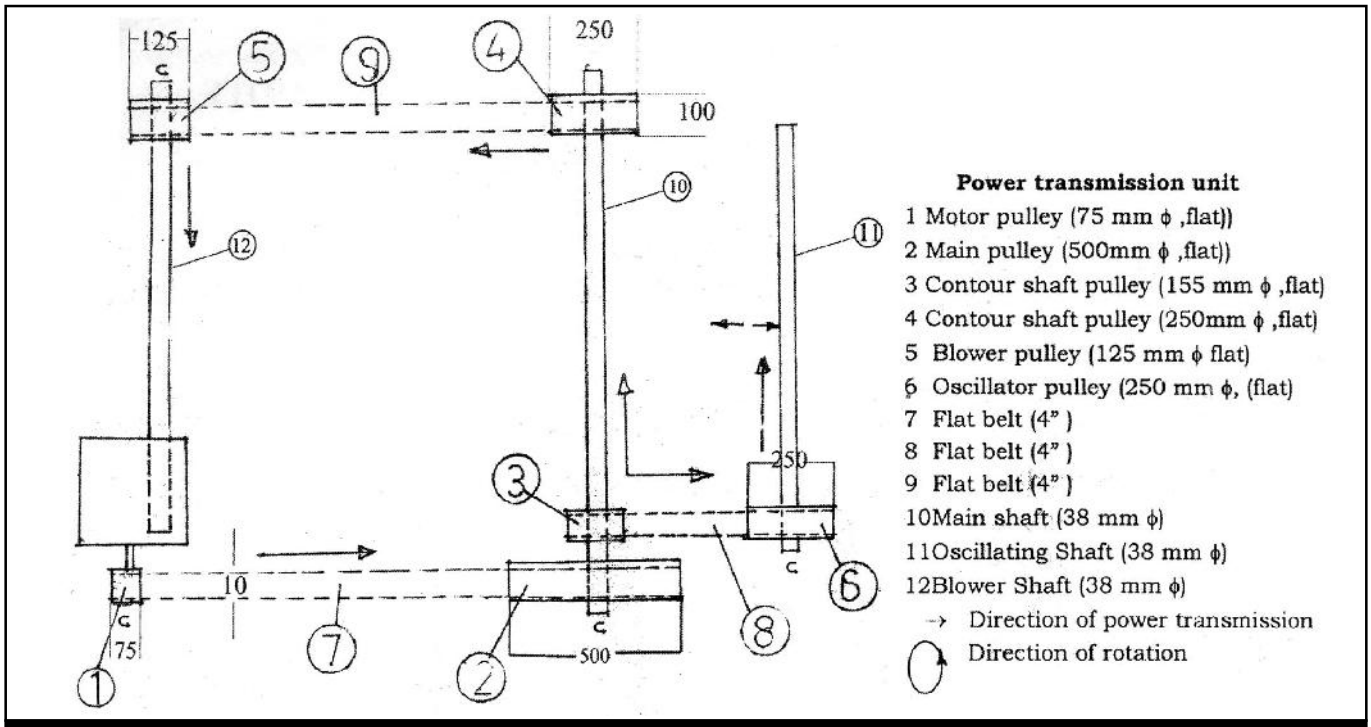

Fig. 4 : Power transmittance unit

The sieve set was connected to the main frame by the two sets of parallel links, one set was connected two rear side of frame at 230mm height from the rear wheel axle with the help of rear link hanger and other sets of links was connected to the front side of frame at 400mm below the top angle of frame with the help of front link hanger which was actuated by eccentric drive provided below the sieve set. Which consist of oscillating shaft, eccentric bearing and sieve connecting flat. The drive taken from the main shaft was transmitted to the oscillating shaft (1050 mm length and 38mmϕ) on which eccentric bearing (eccentricity 28mm) was mounted, which oscillate the sieve to and fro direction with the help of M.S. flat of 280 x 50 x 4mm attached with bush (100 mmϕ, 20mm thick) and pin of 100mm length and 30mmϕ arrangement.

Blower:

Aerodynamic separation was carried out by the blower consisting blower casing and blower fan. The blower casing (760mm diameter) accommodates the blower fan which directs the air towards the bottom sieve from where the screened light material gets flow off. The blower casing was fitted in angles 5 no. of 25 x 25 x 3mm M.S. of length 680 mm and M.S. curved flats of (10 x 3mm size), spaced 215 mm. The fitting angles (25 x 25 x 3mm M.S.) of length 680mm provide the plat form for fitting the housing on main frame. The blower fan (710mm diameter) consist of four blades (1mm GI sheet) mounted, right angle on shaft of 100mm length, on blower plate of size 150 x 150 x 5 mm. The blower plate was welded with a bush which was fitted on blower shaft (100 mm length) with the help of 25 x 25 x 3 mm M.S. angle.

Power transmission unit:

The power was transmitted from electric motor (1440 rpm) by 75mm motor pulley to the main shaft (214 rpm), 500 mm main shaft pulley through flat belt of 4 inches. On main shaft, 155mm diameter pulley and 250 mm dia. pulley were mounted at both ends. 155 mm dia. pulley was connected to 250 mm dia. pulley mounted on oscillating shaft. A 250 mm dia. pulley on main shaft was connected to 125 mm dia. pulley mounted on blower shaft. Thus rotary power was transmitted from main shaft to all the functional parts like oscillating assembly giving 132 oscillation/min and blower (432 rpm). The detail distribution of power from electric motor is indicated by arrows in Fig. 4.

Linear speed of the threshing cylinder can be calculated by the following formula by knowing the motor rpm.

Table 1 : Experimental detail of Groundnut threshing

Sr. No.	Particulars	Details
1.	No. of treatment	Two, T1 = square beater bar drum T2 = flat plate beater bar drum
2.	Parameters	i) Plant (pod) moisture content (%) M1= 21.30 (21.59) w.b. M2 = 18.40 (19.60) w.b. M3 = 16.10 (15.90) w.b. ii) Concave clearance C1 = 50mm
3.	Replication	Three, (R1, R2, R3)
4.	Parameters for comparison	Pod – straw ratio Blown pod Sieve loss Broken /shelled Unthreshed pod Cleaning efficiency Threshing efficiency Power consumption Cost of operation

$$\text{Linear speed (m/sec)} = \frac{\text{®DN}}{60} = \frac{\text{3.14 x Dia. (m) of cylinder x rpm of cylinder}}{60}$$

(IS 9016-1979)

RESULTS AND DISCUSSION

The results obtained from the present investigation are presented below :

Selection of treatments:

For the performance evaluation of developed thresher, comparative study was done by replacing the developed square beater drum (T_1) with existing flat plate beater drum (T_2).

Selection of parameters for the study:

Plant (pod) moisture content obtained after 3, 4 and 5 days sun drying, *viz.*, 21.30 (21.59), 18.40 (19.60) and 16.10 (15.90) % (w.b.) were selected for evaluating the performance of two concave clearances, *viz*. 50 mm and 25 mm for both threshing drum. Three replications were taken. Other experimental details are shown in Table 1.

Comparative performance for developed square beater threshing drum (T_1) and existing flat plate beater threshing drum (T_2) for 50 mm (C_1) concave clearance for three moisture contents

Blown pod:

There was no much effect of type of threshing drum on blown pod, but blown pods percentage increased with decrease in plant moisture content. Highest average blown pod of 4.89% was observed at 16.10% plant moisture content (Table 2).

Broken or shelled pod:

Broken (shelled) pod for two threshing drums (T_1 and T_2) are tabulated in Table 2. Minimum pod breakage *i.e.* 1.57% was observed for developed square beater threshing drum as against 2.5% pod breakage/damaged by flat plate beater drum. The average pod breakage by flat plate beater drum was 3.12 % which is 36% more than the average pod broken of 1.97% by square beater bar drum.

Some vines were observed to be wounded around the beaters and shaft of flat plate beater type. This might be due to configuration of spikes provided on flat beater section. In square beater drum, spikes were situated at 50mm and at extreme position from both end giving 50 mm clearances between spikes during rotation. Where as position of spikes on flat beater drum is 20 and 40 mm from both ends giving 20mm clearance during rotation. Thus due to less clearance between spikes of flat plate beater drum material gets wounded around the shaft.

Cleaning efficiency:

Cleaning efficiency indicates the presence of foreign matter with pod in pod outlet. It was seen that the cleaning efficiency decreased with increase in plant moisture. It was also observed that cleaning efficiency was the function of two parameters *i.e.* cohesion, between soil and pod, and densities of attached soil and pod, for that moisture content. Because when the moisture maintaining the bond of cohesion decreased as the densities of the pod as well as soil also decreased, hence, detachment of soils from the shell was observed to be more at lower moisture and hence sliding velocity of pods reduced and hence cleaning efficiency observed was more in case of lower moisture content.

As we compare the cleaning efficiency of two threshing drums obviously cleaning efficiency observed was more incase of developed square beater bar drum as compared to the flat plate beater drum because more contact area got by the material for threshing.

For the three plant moisture contents *viz.*, 21.30, 18.40 and cleaning efficiency were 16.10 per cent. 96.5, 97.2 and 97.9% incase of threshing with square beater threshing drum (T_1) and 97.5, 97.0 and 95.6%, respectively for the threshing with flat plate beater threshing drum (T_2).

Threshing efficiency:

Effect of three plant moisture content on two cylinders was studied for the threshing efficiencies for the cylinder speed of 215 rpm. Average threshing efficiencies were 93.63, 95.10 and 97.23 %. For square beater threshing drum and 92.83, 93.40, 94.30 % for the flat plate beater threshing drum for the three plant moisture contents *viz.*, 21.30, 18.40 and 16.10% (w.b.), respectively. The threshing efficiency incase of square beater threshing drum is observed to be 0.9, 1.8 and 3.0 per cent more than the flat plate threshing drum. Also, it was observed that threshing efficiency increases with decrease in plant moisture content. Thus unthreshed pod

Table 2 : Comparative analysis of threshing at different moisture content for developed square beater drum (T1) and flat plate beater drum (T2) for concave clearance C1= 50mm (average values of three replications)

Sr. No.	Particulars	M1=21.30% (w.b.)		M2=18.40% (w.b.)		M3= 16.10% (w.b.)	
		T1	T2	T1	T2	T1	T2
1.	Pod-straw ratio	0.38	0.36	0.41	0.41	0.44	0.45
2.	Feed rate (kg/h)	653	666	642	675	647	648
3.	Blown pod (%)	3.57	3.5	4.22	4.2	4.89	4.85
4.	Sieve loss (%)	6.37	6.0	7.38	7.3	7.4	7.47
5.	Broken/shelled pod (%)	1.57	2.5	2.04	3.3	2.3	3.57
6.	Unthreshed pod (%)	6.4	7.17	4.87	6.6	2.78	5.7
7.	Cleaning efficiency (%)	96.5	95.60	97.2	97.0	97.9	97.5
8.	Threshing efficiency (%)	93.63	92.83	95.10	93.40	97.23	94.30
9.	Output (pod) capacity (kg/h)	250	242	265	279	287	278.66
10.	Power consumption (Kw-hr)	1.7	1.7	1.45	1.6	1.3	1.48
11.	Cost of operation(Rs/h)	60.31	60.37	59.50	60.08	58.82	59.50
	(Rs/qtl)	24.78	25.00	22.50	21.58	20.53	21.35

percentage was more incase of flat plate beater threshing drum. The unthreshed pods incase of flat plate threshing drum were observed to be 77, 26 and 52 per cent more as compared to the square beater threshing drum. The unthreshed pods were observed to be generally immature pod.

Power consumption:

The power consumption at no load condition was 0.93 Kw-hr.

An average actual power consumption of 1.54 Kw-hr was observed for an average feed rate of 660 kg/h (average 240 kg pod/hr) for the three days of trial.

Cost economics of threshing of groundnut:

The cost of thresher including cost of electrical motor was Rs.25,236/-. The total cost of threshing with power operated groundnut thresher for 660 kg per hour feed rate was estimated to be Rs.59.74/-. Output by power operated groundnut thresher was 660 kg/hr as against 4.4 kg/hr by manual threshing. Cost of threshing with power operated thresher was Rs.22.71/ quintal where as by manually it is Rs.167 /quintal. Thus cost saving of 86.40% and time saving 99.3% was observed by power operated threshing as against manual threshing. Eswarappa *et al*. (1995) compared the performance of different methods of thrashing in groundnut.

Conclusion:

– The average feed rate of thresher was 660 kg/hr.

– Average sieve loss of 7.4% was observed at 16.10% (w.b.) plant moisture content.

– The average highest value of blown pod percentage of 4.89% was observed at 16.10% (w.b.) plant moisture content.

– The average pod damage by flat plate beater threshing drum was 3.12% which was 36% more than the average pod breakage of 1.97% by developed square beater bar threshing drum.

– The threshing efficiency, in case of developed square beater bar thresher was observed to be 3% more than the existing flat plate beater threshing drum for plant moisture content of 21.30% (w.b.).

– An average power consumption of 1.54 Kw-hr was observed for developed square beater bar thresher.

Cost of groundnut threshing with developed power operated groundnut thresher was Rs. 22.71 /quintal which saves 86.40% cost and 99.3% time as compared to the manual striping.

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