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Sourabh Kumar DewanganPh.D Scholar (FMPE),
SVCAET&RS, IGKV, Raipur,
Chhattisgarh, India**Dr. RK Naik**Professor (FMPE), PI-AICRP-
FIM, SVCAET&RS, IGKV,
Raipur, Chhattisgarh, India**Shankar Lal**YP (Young Professional)
(FMPE), SVCAET&RS,
IGKV, Raipur, Chhattisgarh,
India**Geeta Patel**Guest Teacher (FMPE),
College of Agriculture
COA&RS, IGKV, Raigarh,
Chhattisgarh, India**Gajendra Singh**Ph.D Scholar (FMPE),
SVCAET&RS, IGKV, Raipur,
Chhattisgarh, India**Corresponding Author:****Sourabh Kumar Dewangan**Ph.D Scholar (FMPE),
SVCAET&RS, IGKV, Raipur,
Chhattisgarh, India

Performance evaluation of developed power operated thresher

Sourabh Kumar Dewangan, RK Naik, Shankar Lal, Geeta Patel and Gajendra Singh

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Abstract

Groundnut is a common legume that is grown in several states of India. One of the most crucial steps in groundnut cultivation is threshing. Due to labor shortages during peak seasons, farmers suffer significant losses when threshing is delayed. An effort was made to create a groundnut thresher in order to solve labor issues during busy times and to ensure timely operation. The following parts should enable the groundnut thresher to carry out the intended tasks. Groundnut crop pods are separated from the vines using a thresher cylinder, concave and shifter unit. After threshing, a blower is used to remove the dust and chaff particles. Use a sieve to separate the pods from any foreign objects, like as vines. The prototype tractor-operated groundnut thresher achieved a maximum harvesting efficiency of 99.30 percent, a cleaning efficiency of 98.20 percent, and a minimum blown and broken pod percentage of 1.2%.

Keywords: Groundnut, threshing, labor shortages, prototype, efficiency

Introduction

India is the second largest producer of groundnut after China. Groundnut (*Arachis hypogaea* L.) is the major oilseed in India in terms of production. On an average it accounts for 31.81% of the oilseeds. The annual production of seed and oil are 5.8 and 1.5 million tonnes, respectively. About 80% of the total groundnut produced in India undergoes processing so that it can be utilized as oil and cake. Around 75% of the crop is produced during *kharif* season in June-September) and remaining 25 percent during *rabi* season in November-March (Senthilkumar *et al.*, 2017) ^[9]. Groundnut serves as edible oil in a large part of India, and edible oil constitutes 72.1% of the total agricultural imports. Though machines for planting and digging groundnut crops have been developed, threshing in India is still performed manually, requiring approximately 160-200 man-hours per hectare (Kalkat and Verma, 1972 ^[5]; Singh *et al.*, 2009 ^[10]; Reddy *et al.*, 2013) ^[8]. It is recognized that threshing is an extremely labor-intensive process that requires a great deal of human drudgery (Naik *et al.*, 2010) ^[6]. Due to a number of causes, Chhattisgarh farmers have historically placed a higher priority on paddy agriculture, which has resulted in a decreased interest in groundnut growing. Although recent data show that groundnut production is becoming more popular in different districts. Growing groundnuts can be more costly and time-consuming than growing paddy, especially for small-scale farmers. One of the most important aspects of post-harvest activities that influence the caliber and volume of crop production is threshing. Groundnut threshing can be labor-intensive, but it is also made more challenging by the absence of widespread and affordable mechanization these regions need power operated groundnut thresher. Singh *et al.*, 2009 ^[10] studied effect of 3 levels of operational parameters, i.e. feed rate (600, 800 and 1,000 kg/hr), cylinder peripheral speed (5.8, 6.4, 7.1 m/s) and concave clearance (30, 36, 42 mm) was studied on various performance parameters of thresher to find best combination of operational parameters. These parameters were selected based on preliminary trials conducted on the thresher. Samples were collected from all outlet of the machine for 30 sec. to compute threshing efficiency, cleaning efficiency, output capacity and pod loss of the machine.

Materials and Methods

A prototype thresher had been developed and constructed in order to investigate its main working properties.

SV College of Agricultural Engineering, IGKV, Raipur, manufactured the machine, which included a concave, feeder, cleaning unit, shifter unit, and threshing drum. Field tests using the Rabi season output of the groundnut variety *Jyoti* were conducted in the farmer's field at Parsada village, New Raipur (CG) during the growing season of 2023-2024. A threshing cylinder with pegs, concave, and sieves is provided with the groundnut thresher. The threshing cylinder measured 810 mm in diameter and 1705 mm in length. For significance, pod separation was provided by a shifter unit, and the groundnut crop was fed from the hopper to the thresher via a stationary concave where it was threshed and then passed through various sieve sizes. At several locations, the cleaned groundnut pods were gathered. To achieve the ideal feed rates of 7700, 7800, and 7900 kg/h, respectively, a known quantity of crop (12 kg) was manually fed for a predetermined amount of time to maintain different levels of feed rate. Different-sized pulleys were used to change the cylinder's peripheral speed.

Properties of groundnut

Key physical properties were measured, with the following average values: a length of 28.18 mm, a width of 13.05 mm, and a thickness of 12.07 mm. The average arithmetic mean diameter was 17.77 mm, and the geometric mean diameter was 16.39 mm. Other properties included a sphericity of 0.58, a bulk density of 246.45 kg/m³, a true density of 438.79 kg/m³, and an angle of repose of 26.73°. The rupture forces were 31.24 N when applied longitudinally and 245.41 N when applied vertically. These values are crucial for designing efficient post-harvest systems for threshing and helps reduce losses. (Dewangan, *et al.* 2025) ^[2].

Testing parameters for groundnut thresher

A standard procedure as outlined in IS: 11234-1985 were used to test the groundnut power thresher. IS: 6284-1985 also served as the basis for the nomenclature used in threshing operations. The dependent parameters of the thresher's performance were computed using these criteria. The following sections provide specifics on the analysis's findings, including each parameter's values and relevance.

- Percentage of blown and spilled pods = $G_s/A_i \times 100$
- Percentage of damage pod = $D_p/A_i \times 100$
- Percentage of unthreshed pod = $U_p/A_i \times 100$
- Threshing efficiency = $100 - \text{percentage of unthreshed pod}$
- Cleaning efficiency = Q_t/T_s

Where;

G_s = quantity of threshed pod obtained at sieve overflow, sieve underflow and vine outlet per unit time; and

A_i = total pod input per unit time

D_p = quantity of damage pods from all outlets

U_p = quantity of unthreshed pod obtained from all outlets per unit time

Q_t = quantity of threshed pod obtained from sample taken at main pod outlet

T_s = total quantity of the sample taken at main pod outlet

Result and discussion

The testing of groundnut thresher was done as explained in above and the results were presented in Table: 1 including threshing efficiency, cleaning efficiency, damage pod and blown pod percentage and output capacity of thresher

machine. The outcomes show how well the thresher performs, especially when it comes to output capacity and threshing efficiency. This is a crucial component in optimizing yield. The variations in the thresher's operating parameters peripheral speed and concave clearance can be traced back to the variation in the outcomes, especially for production capacity, cleaning effectiveness, and pod losses. The exceptional average threshing efficiency of 99% suggested a high rate of grain separation. R-1 had the highest cleaning efficiency (98.2%), while R-3 had the lowest (96.3%). The cleaning efficiency, on the other hand, varied somewhat between runs, average 97.4%. The thresher's average output capacity was 1970.99 kg/h. R-3 produced the most, at 2008.49 kg/h, while R-1 produced the least, at 1904.17 kg/h. While the average percentage of blown pods was 1.1%, the average percentage of damaged pods was 1.5%. At an average of 1%, the proportion of unthreshed pods was negligible. R-3 showed the fewest blown and damaged pods. The output capacity increased as the peripheral speed increased from 23.5 m/s to 31.5 m/s and the concave clearance increased from 15 mm to 25 mm. This makes sense because more material can be processed through the machine in a given amount of time with a greater speed. Similar results reported by Sinha *et al.* 2009 ^[11]. Cleaning efficiency, however, suffered as a result of the feed rate increases, falling from 98.2% (R-1) to 96.3% (R-3). This suggests that even though the machine processed more material, the cleaning mechanism's effectiveness may have been diminished. Similar result found by Afify *et al.* (2007) ^[1], Singh *et al.* (2009) ^[10] and Patel, *et al.* (2024) ^[7].

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Table 1: Performance evaluation of wet pod thresher

Parameters	Testing values			
	R-1	R-2	R-3	Mean
Feed rate, kg/h	7700	7800	7900	7800
Peripheral speed, m/s	23.5	27.5	31.5	27.5
Concave clearance, mm	15	20	25	20
No. of labour required	8	8	8	8
Output capacity, kg/h	1904.17	2000.31	2008.49	1970.99
Threshing efficiency, %	98.70	99.30	99.00	99
Cleaning efficiency, %	98.20	97.70	96.30	97.4
Percentage of damaged pod, %	1.7	1.5	1.2	1.5
Blown percentage, %	1.5	1.2	0.7	1.1
Unthreshed pod percentage, %	1.3	0.7	1.0	1

Conclusion

The results from testing the groundnut thresher demonstrate its high effectiveness, with an exceptional average threshing efficiency of 99%. It was discovered to be the most variable characteristic, indicating its sensitivity to operational parameters, even if the average cleaning efficiency was likewise high. The concave clearance and peripheral speed might be adjusted to boost the thresher's robust average output capacity of 2000 kg/h. There was a cost associated with this output boost, too, as cleaning effectiveness decreased as input rates increased. Overall, the thresher was a very effective machine for post-harvest processing, with low losses and little pod damage.

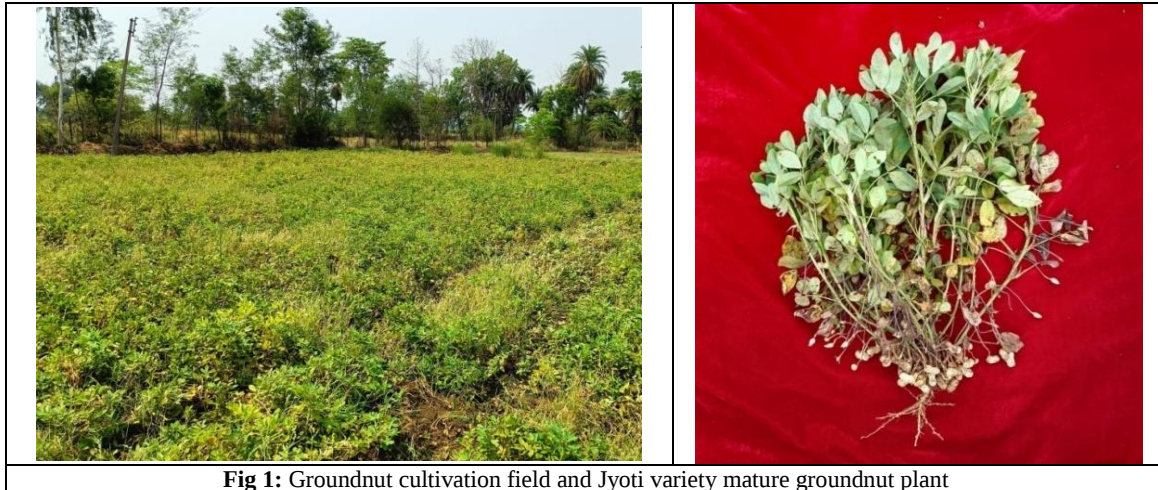


Fig 1: Groundnut cultivation field and Jyoti variety mature groundnut plant



Fig 2: Testing of power operated groundnut thresher

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