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DEVELOPMENT OF SINGLE PHASE ONE HORSE POWER OPERATED GROUNDNUT STRIPPER

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ABSTRACT

Stripping is an important post-harvest activity in which there are involved as the major labour force. It is laborious and time-consuming operation mostly facing many health problems *viz*., body pain and blackening of palms. The primary objective of developing a powered operated groundnut stripper is to alleviate the physical efforts required by farmers and minimize the time needed for separating groundnuts. The single phase one horse power groundnut stripper has been developed by ICAR AICRP on FIM, MPKV, Rahuri and its field performance trials were conducted. The minimum unstripped pod percentage was obtained of 1.44 per cent at 420 kg hr^{-1} and speed 350 rpm. The minimum damaged pod percentage was obtained 0.98 per cent at 420 kg hr^{-1} and speed 350 rpm. The average stripping capacity of the machine was obtained 178.73 kg hr^{-1}. The highest cleaning efficiency was obtained at feed rate 360 kg hr^{-1} at 350 rpm which was 94.26 per cent. The highest stripping efficiency of machine was obtained at feed rate 420 kg hr^{-1} at 350 rpm which was 97.61 per cent. This machine is suitable for small and medium farmers. The developed machine achieved a cost savings of 82.24 per cent and a time savings of 96.64 per cent.

Key words : Groundnut stripper, Stripping capacity, Stripping efficiency, Cleaning efficiency, Groundnut pods.

Introduction

Groundnuts belong to the legume or “bean,” family. It is likely that the Paraguay valleys are where the groundnut originated and became domesticated. Growing to a height of 25 to 50 cm, it is a perennial herbaceous plant (Raut *et al*., 2021). It arrived in India in the first part of the sixteenth century from one of China’s Pacific islands, where it had previously arrived without having travelled through Central or South America. Currently, China and India produce half of the world’s groundnuts (Ghatge *et al*., 2014). The most important oilseed crop and a major source of meal oil in India is groundnuts, or Arachis hypogaea Linn. It is used for food, peanut butter, peanut oil, peanut flour, cooked nuts, and other things (Tarekegn *et al*., 2007). Groundnut seeds comprise about 48- 50 % oil, 25.33% protein, 10.2% carbohydrates, a calorific value of 500-600 kilojoules per kilogram and 40.5% fat (Andhale *et al*., 2017).

India is the country with the largest groundnut cultivation area in the world and the second-highest production, with year-round output. 6.6 million tonnes of groundnuts were produced in India in 2020–21, with an average yield of 1703 kg-ha^{-1}. This production total reached 6.6 milliontonnes annually (Anonymous, 2022b). Interestingly, Gujarat, Tamil Nadu, Maharashtra, Andhra Pradesh and Karnataka are the main regions in India where groundnuts are grown. Gujarat is the largest producer, supplying 40% of the total output of groundnut, followed by Rajasthan (18%), Tamil Nadu (10%), Andhra Pradesh (8%), Karnataka (5%) and Maharashtra (3%). In 2020–2021, groundnuts contributed 21.3% of India’s total oil seed production and 19.1 % of the nation’s oilseed acerage (Anonymous, 2021a). The two growing seasons for the crop are usually summer and kharif. Eighty percent

of India's groundnut crop is grown in the kharif season, when rainfall is dependent. In rainfed cultivation, prompt action is essential to achieving higher yields. The majority of groundnut growers in India's semiarid regions are small-scale, marginal farmers (Govindraj and Mishra, 2011).

Stripping is an extremely labour intensive and exhausting process. The constant knee bending and handpicking is extremely painful. The conventional stripping techniques harm nuts, which can only be used for oil expelling, and injure farm women's fingers. Additionally, the work requires constant attention, which greatly unnerves the workers. Many farmers reported numerous insect and scorpion attacks while handpicking.

The primary objective of developing a powered groundnut stripper is to alleviate the physical efforts required by farmers and minimize the time needed for separating groundnuts. The overarching goal is to enhance overall profitability, efficiency, and performance in the agricultural sector. By incorporating modern machinery and technology, the project aims to address the longstanding challenges associated with labour-intensive tasks, ultimately contributing to a more sustainable and productive farming process.

Materials and Methods

Development of Power Operated Groundnut stripper

This machine was specially developed for small, marginaland medium farmers for the harvesting operation of groundnut, specifically for stripping groundnut pods. The methodology and procedure adopted for the development of this poweroperated groundnut stripper were presented in this section under the following subsections.

Design calculation

According to the motor specification: voltage: 220-230V, RPM: 1425, single phase, induction motor, 750 watt, 1 HP.

Calculation of torque required for stripper

According to Raut *et al.* (2021), to separate the pod from the plant 23 N tensile force is required. Considering the weight of the shaft and additional mountings, the maximum force required to remove the groundnut pod in this instance is 207 N, here we are using eight to nine groundnut plants. When a groundnut is stripped, power is stated as (Bhalavignesh *et al.*, 2019).

Force, F = 207 N

Torque, T = Force × Perpendicular distance (1)

Perpendicular distance is the distance between the shaft axis and the rod of the rotor and it is 95 mm.

Torque, T = 207 × 95 = 19665 N mm.

Torque, T = 19.66 Nm.

Power calculation

Power, $P = 2\pi NT/60$ (2)

Speed required N = 356 rpm

$P = (2\times\pi\times356\times19.66)/60$

P = 732.55 watt

Hence a single phase 1 hp motor was selected for stripping.

Peripheral velocity

$Vp = \pi D1N1/60$ (3)

Where,

D1 = diameter of drive pulley (50.8 mm)

N1 = rpm of motor (1425 rpm)

$Vp = (\pi\times50.8\times1425)/ (60\times1000)$

Vp = 3.79 m/sec

Vp = 227.4 m/min

Peripheral velocity required for stripping groundnut = 3.79 m. sec^{-1} = 227.4 m. min^{-1}

Cylinder Peripheral speed

Cylinder peripheral speed (m/s) = $(\pi D\_2\ N\_2)/60$ (4)

$3.79 = (\pi\times0.203\times N\_2)/60$

$N2 = (60\times3.79)/(3.14\times0.203)$

N2 = 356 rpm …. (speed of rotor shaft)

The functional components of machine

Main frame

Stripping rotor

Separator Unit

Stripping unit safety cover

Main frame

The main frame functioned to carry the entire load of the stripping rotor, separator, electric motor, stripping unit safety cover etc. The frame provided the necessary support and strength to all the components of the machine. The main frame was fabricated by using 40 × 40× 5mm M.S. angles. The overall dimensions of rectangular main frame were 920 × 650 × 700 mm. Others details of main frame shown in Fig. 3.2

Stripping Rotor

Rotor was the active or rotating portion of the machine

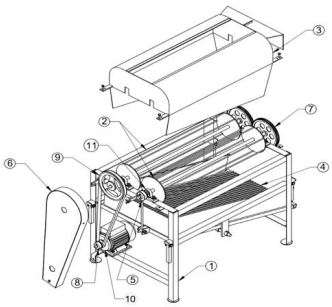
810 mm in length and 190 mm in diameter. Two rotors were mounted at the top of the main frame so that the operators could perform their work. The rotors were rotating in opposite directions to each other. It consisted of flanges made of compressed mild steel rods, which helped to separate the pods from the groundnut vines. When a bunch of groundnut vines was fed to the rotor, it created a shearing action, causing the pods to separate from the groundnut vines. This was the unit that actually stripped the pod from the groundnut vines when rotated by the electric motor. Stripping was done by manually holding the pod portion of vines over the horizontal rotary rotor. It was suitable for stripping groundnut pods from the harvested crop. The stripper was run with the help of a 1 hp single phase electric motor. It was designed to be operated by four persons simultaneously.

Main shaft

The main shaft was a rotating member, 1010 mm length and 20 mm diameter on which stripping rotors were fitted, was made from mild steel. Bearing supporting main shaft, was fitted in a housing pedestal, which assists for fitting shaft on main frame.

Determination of stripping rotor diameter

The diameter of stripping rotor was kept 190 mm to achieve designed peripheral speed of cylinder.



S. no.	Name of part
1	Main frame
2	Srtipping unit / rotor
3	Safety cover
4	Sieve assembly
5	Cam shaft mechanisam
6	Safety cover gurd
7	Spur Gear
8	Drive Pulley
9	Driven Pulley
10	Single Phase 1 HP Electric Motor
11	Padastal bearing

Fig. 1 : Isometric view of power operated groundnut stripper.

Performance evaluation of Power Operated Groundnut Stripper

The performance evaluation of the developed power operated groundnut stripper was evaluated at three different feed rates and three different rotor peripheral speed, for Phule Unnati groundnut variety. Different machine parameters i.e., percentage of unstripped pod (%), percentage of damaged pod (%), cleaning efficiency (%), stripping capacity (kg-h^{-1}), stripping efficiency (%) were evaluated during performance evaluation. The performance evaluation of the developed power operated groundnut stripper was carried out at AICRP on FIM, Dr. Annasaheb Shinde College of Agricultural Engineering and Technology, MPKV, Rahuri and AICRP on

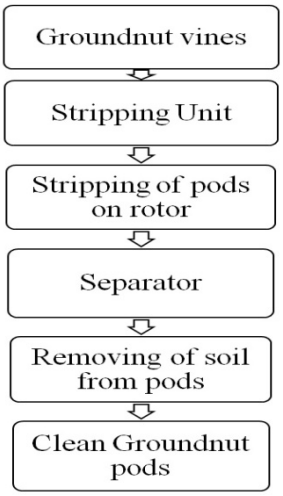


Fig. 2 : Flow diagram of working process of power operated groundnut stripper.

Groundnut, MPKV, Rahuri. This performance evaluation was conducted according to the procedure and guidelines prescribed by IS: 11234, 1985. Field trials of the power operated groundnut stripper were shown in the plate 3.5, along with a flow diagram of the working process.

Results and Discussion

The power operated groundnut stripper was developed and its overall dimension are 920 mm × 650 mm × 700 mm. The fabrication of different components of groundnut stripper, Test code IS11234, 1985 was followed for selecting materials.

Performance evaluation of Developed Power Operated Groundnut Stripper

The performance of developed power operated groundnut stripper was evaluated as per the experimental plan of study. The performance of the developed power operated groundnut stripper was carried out for different levels of independent parameters i.e., feed rate (Kg-h^{-1}) and rotor speed (rpm). The three levels of feed rate were 360 kg-h^{-1}, 420 kg-h^{-1}, 480 kg-h^{-1} also the three different levels of rotor speed 300 rpm, 350 rpm, 400 rpm for Phule Unnati groundnut variety. Three replications were taken for all the experiments. Different machine parameters i.e., percentage of unstripped pod (%), percentage of damaged pod (%), cleaning efficiency (%), stripping capacity (kg-hr^{-1}), stripping efficiency (%) were evaluated during performance evaluation.

In present study, feed rate and rotor peripheral speed was selected as independent parameters. The three levels for feed rate taken as 360 kg-h^{-1}, 420 kg-h^{-1} and 480 kg-h^{-1} and rotor peripheral speed were taken as 300 rpm, 350 rpm and 400 rpm. The dependent parameters are *viz.*, Percentage of unstripped pod, Percentage of

Table 1 : Fieldperformance data of power operated groundnut stripper.

S. no.	Particulars	Feed rate (F)								
		F1 = 360 kg-h^{-1}			F2 = 420 kg-h^{-1}			F3 = 480 kg-h^{-1}		
		300 rpm	350 rpm	400 rpm	300 rpm	350 rpm	400 rpm	300 rpm	350 rpm	400 rpm
1	**Unstripped pod percentage, (%)**	2.12	1.83	1.73	2.43	1.44	1.48	2.57	1.59	1.54
2	**Damaged pod percentage, (%)**	1.12	1.16	1.39	1.02	0.98	1.17	1.15	1.25	1.33
3	**Cleaning efficiency, (%)**	94.04	94.26	94.06	94.03	94.25	94.01	94.05	94.14	94.11
4	**Stripping capacity, (kg-h^{-1})**	128.77	132.97	136.63	158.13	163.77	166.20	173.13	180.47	182.60
5	**Stripping efficiency, (%)**	97.50	97.55	96.93	97.31	97.61	97.39	97.11	97.20	97.18

damaged pod, cleaning efficiency, stripping capacity and Stripping efficiency. At feed rate 360 kg-h^{-1} and at rotor speed 300 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 2.12%, 1.12%, 94.04%, 128.77 kg-hr^{-1}, 97.50% respectively. At feed rate 360 kg-h^{-1} and at rotor speed 350 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 1.83%, 1.16%, 94.26%, 132.97 kg-h^{-1}, 97.55%, respectively. At feed rate 360 kg-h^{-1} and at rotor speed 400 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 1.73%, 1.39%, 94.06%, 136.63 kg-h^{-1}, 96.93% respectively.

At feed rate 420kg-h^{-1} and at rotor speed 300 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 2.43%, 1.02%, 94.03%, 158.13 kg-h^{-1}, 97.31%, respectively. At feed rate 420kg-h^{-1}and at rotor speed 350 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 1.44%, 0.98%, 94.25%, 163.77 kg-h^{-1}, 97.61% respectively. At feed rate 420 kg-h^{-1} and at rotor speed 400 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 1.48%, 1.17%, 94.01%,166.20 kg-h^{-1}, 97.39% respectively.

At feed rate 480kg-h^{-1} and at rotor speed 300 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 2.57%, 1.15%, 94.05%, 173.13 kg-h^{-1}, 97.11%, respectively. At feed rate 480 kg-h^{-1}and at rotor speed 350 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 1.59%, 1.25%, 94.14%, 180.47 kg-h^{-1}, 97.20% respectively. At feed rate 480 kg-h^{-1} and at rotor speed 400 rpm unstripped pod percentage, damaged pod percentage, cleaning efficiency, stripping capacity, stripping efficiency were obtained 1.54%, 1.33%, 94.11%, 182.60 kg-h^{-1}, 97.18%, respectively.

At feed rate 420 kg-h^{-1} and at rotor speed 350 rpm maximum stripping efficiency 97.61%, maximum cleaning efficiency 94.25%, minimum unstripped pod percentage 1.44% and minimum damaged pod percentage 0.98% were observed.

Conclusion

The minimum unstripped pod percentage was obtained as 1.44%, at feed rate of 420 kg-h^{-1} and for rotor speed at 350 rpm. The minimum damaged pod percentage was obtained as 0.98 % at feed rate of 420 kg-h^{-1} and for rotor speed of 350 rpm. The maximum stripping efficiency was obtained as 97.61% at feed rate 420 kg-h^{-1} and for rotor speed 350 rpm. The average stripping capacity of the machine was obtained as 178.73 kg-h^{-1}. This machine is suitable for small and medium farmers, for groundnut stripping with an operating cost of Rs 1.11 per kilogram of groundnut pods. The saving in operating cost and time was 82.24% and 96.64% by using developed power operated groundnut stripper compared with conventional method of groundnut pod stripping. This machine saves time, reduces operational costs, and minimize drudgery

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