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DESIGN FABRICATION AND PERFORMANCE ANALYSIS OF GROUNDNUT THRESHER

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ABSTRACT

Groundnuts have been used since the origin of humanity. It is rich in oil and protein and has a high energy value. Oil extraction from groundnut is more common at village in most of the developing countries. Groundnut is very common and eatable item and its oil is used as a cooking medium. Also the by-product groundnut cake after oil extraction also contain 43 to 65 percent protein and 6 to 20 percent fat which is mostly used as food for cows and goats. At present there is a lack of workers in the field of agriculture and due to more cost in harvesting. Due to the above factors, farmers are not involved in groundnut cultivation. The removing of groundnut pods is a time consuming process and cost expensive. Temperature is very high at harvesting time so people finds difficult to work. To overcome these difficulties groundnut thresher is used in groundnut pod removing process which minimize the time and cost.

Key words: Groundnut Pods, Strip, Thresher, Performance Analyse

1. INTRODUCTION

1.1 GROUNDNUT

Groundnut or peanuts is a species in the legume or "bean" family. The peanut was probably first domesticated and cultivated in the valleys of Paraguay. It is an annual herbaceous plant growing 30 to 50 cm tall. The leaves are opposite, pinnate with four leaflets two opposite pairs; no terminal leaflet, each leaflet 1 to 7 cm long and 1 to 3 cm broad. Peanuts are known by many other local names such as earthnuts, ground nuts, goober peas, monkey nuts, pygmy nuts and pig nuts. Despite its name and appearance, the peanut is not a nut, but rather a legume. India is the second largest producer of groundnuts in the world in the order shown in the table 1. Indian groundnuts are available in different varieties as bold or Runner, Java or Spanish and Red Natal.

Table 1. Production of groundnuts in different countries

RANK	COUNTRY	PRODUCTION (MILLION TONNES)
1	China	17
2	India	9.5
3	Nigeria	3
4	United states	1.9
5	Myanmar	1.4

They have a rich nutty flavour, sweet taste, crunchy texture and above a relatively longer shelf life. Soil conditions in some producing regions are ideally suited for dry, clean and spotless Groundnuts in Shell. Groundnut is the major oil seed crop in India and it plays a major role in bridging the Vegetable oil deficit in the country. Groundnuts in India are available throughout the year due to a two-crop cycle harvested in March and October. Groundnuts are important protein crops in India grown mostly under rain-fed conditions. The awareness and concern for quality amongst the Indian groundnut sellers and processors are growing steadily. Multiple sorting and grading are fast becoming a norm. Indian manufacturer have the capability to prepare and supply edible peanuts conforming to highest standards. The groundnut legume is shown in the figure 1.

Figure 1.Groundnut Legume

Figure 2. Groundnut

Apart from raw edible peanuts, India is also in a position to supply Blanched Peanuts, Roasted Salted Peanuts and Dry Roasted Peanuts and a variety of peanut based products. The photographic view of groundnut is shown in the figure 2.The major growing state for groundnut is Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra Rajasthan, Madhya Pradesh, Orissa, and Uttar Pradesh.

1.2 CULTIVATION AND HARVESTING

Peanuts grow best in light, sandy loam soil with a pH of 5.9–7. Their capacity to fix nitrogen and they improve soil fertility. The crop cultivation land view is shown in the figure 3. Therefore, they are valuable in crop rotations. Also, the yield of the peanut crop itself is increased in rotations, through reduced diseases, pests and weeds. Adequate levels of phosphorus, potassium, calcium, magnesium, and micronutrients are also necessary for good yields.

Figure 3. Groundnut Farm

If it is too early, too many pods will be unripe. If too late, the pods will snap off at the stalk, and will remain in the soil. For harvesting, the entire plant, including most of the roots, is removed from the soil. The fruits have wrinkled shells that are constricted between pairs of the one to four seeds per pod. Harvesting occurs in two stages: In mechanized systems, a machine is used to cut off the main root of the peanut plant by cutting through the soil just below the level of the peanut pods. The machine lifts the "bush" from the ground and shakes it, then inverts the bush, leaving the plant upside down on the ground to keep the peanuts out of the soil. This allows the peanuts to dry slowly to a little less than a third of their original moisture level over a period of three to four days. Traditionally, peanuts were pulled and inverted by hand.

Harvesting usually consists of a series of operations comprising digging, lifting, windrowing, stocking and threshing. Some of these tasks can be combined or eliminated depending on the system applied. Among the field operations concerned with groundnut cultivation, harvesting is the most laborious and costly endeavor. The actual method of harvest employed depends upon the type of groundnut grown. In bunch types, pod development is confined to the base of the plant and the pegs carrying the pods into the soil are thick and strong. Almost all the pods are recovered with the plants when they are pulled out of the soil.

The bunch type of groundnut is mostly harvested by pulling out the plants with manual labour in India. The diversity of the labour employed to harvest the crop depends on the location. For instance male labourers are used in Tamil Nadu and in Gujarat both male and female labourers are employed. Usually 12 to 14 labourers can harvest one-hectare area of groundnut crop in one day. Harvesting may sometimes become a problem especially when the crop has passed the stage of full maturity and the soil has hardened. In this case, it is customary to lift the plants by loosening the soil either by working a hand hoe, a plough or a blade harrow along the plant rows. If after lifting the crop manually it is observed that a good percentage of the pods have been left in the soil, the same implements may be used to pick the leftover pods. In the latter case, additional labour will be required. In the case of the spreading type, the process of uprooting the crop from the soil is a rather difficult operation as pod formation takes place all along the creeping branches of the plant. The pegs are comparatively thinner and more delicate.

2. LITERATURE REVIEW

2.1 DRUM TYPE POD STRIPPER

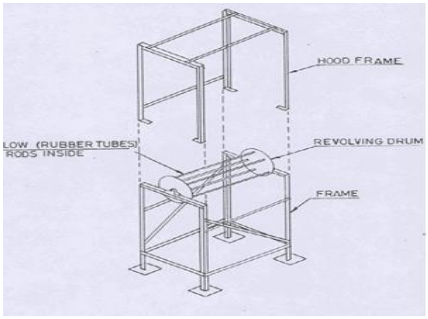

Figure 4. Drum Type Pod Stripper

The description of the drum type stripper as shown in the figure 4. developed at Zonal Research Centre, Tamil Nadu Agricultural University, Coimbatore. Drum type strippers consist of a hollow drum formed by two metal discs at the ends, connected on the periphery of 5 1/2 inch M.S. rods inserted inside and covered by thick and soft rubber tubes. This drum is mounted on pedestal bearings and is free to rotate. It is fixed on a framework at a conventional height so that the operator can stand and beat the root portion of handful of plants over the rubber-covered roads of the revolving drum. To avoid scattering of pods, a hood frame is also provided. The roof as well as the three sides, i.e. other than the operator's side is covered with a canvas or gunny bag. One man can carry the unit.

2.2 COMB TYPE POD STRIPPER

A comb type groundnut stripper as shown in the figure. 5 is used for stripping the pods from the wet groundnut vines. This has been developed at Zonal Research Centre, Tamil Nadu Agricultural University, Coimbatore. The unit consists of a square frame of four vertical standards with a strip of expanded metal fixed on to each of its side in the form of a comb. The stripping of the pod is accomplished by drawing a handful of vines across the comb with slight force. The structure facilitates use by four persons simultaneously.

Stripping of pods from the vines is done by several methods. In bunch type the plants are stacked in heaps with the pod end exposed. The pegs become brittle within a week and pods are stripped by hand. In some areas in India the pods are first lifted out of the soil, dried in the field and then the pod ends of the plant are knocked against a crossbar to dislodge the pods. In this process some pods become damaged. This method of stripping is cheaper. A simple comb-type stripper and peddle-operated stripper are available and can be used for bunch types of groundnut.

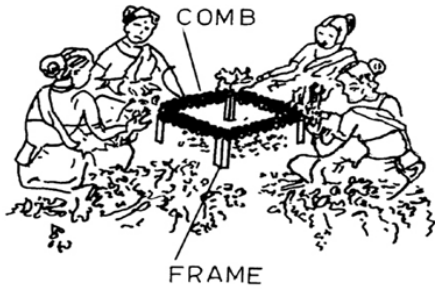

Figure 5. Comb Type Stripper

Groundnut threshers are generally designed as axial flow where the plant moves in a direction parallel to the beater axis. The pods are separated from the remainder of the plant in the threshing chamber the latter is expelled at the other end of the thresher. The impurities fall onto the sieve, where the leaves and light material are removed by air from the blower. The clean pods than fall through the sieve and are discharged through the pod outlet.

The clearance between the bar and the screen is too small to admit the pods with the shell. The machine can be trickle-fed automatically or fed by handfuls. The JYOTI Ltd, Vadhodhra, has developed a decorticator, which performs simultaneously decorticating and cleaning operations. The blower separates the hull and clean kernels are discharged through the grain outlet. Ball or bush bearings with oil cups are standard fittings.

2.3 TRADITIONAL METHOD

Threshing operation varies from the age-old procedure of using sticks and racks to the modern power threshers. In India the smallholder and marginal farmers do manual threshing using sticks and rakes. Variations also exist in stripping pods from the plant. After harvest bunch type plants are stacked in heaps with the pod-end exposed. After the crop has remained in this state for a week or so the pegs become brittle and the pods are plucked from the plants with labour. This operation is comparatively difficult as the attachment of peg to pod is stronger in bunch type, but drying the plants for a few days facilitates this operation. Sometimes the stripping of the pods is also performed side by side with the harvest when the crop area is small and labourers are available. In this case, the pods are dried immediately after stripping. The usual practice is to separate pods by beating the pod-end of the plants against a rough stone or a thick iron rod. This process damages a small percentage of the pods. The photographic view of traditional method is shown in figure 6.

Figure 6. Traditional Method

2.4 GROUNDNUT POD THRESHER

Mr. Mohanasundaram, a small groundnut farmer from Nasiyanur village, Erode district has developed a portable groundnut pod stripper. The machine is powered with a help of a 0.25 HP electrical motor. Stripping is done by holding the pod portion of a bunch manually over the spiked cylinder. The vines along with the groundnuts are held over the spiked cylinder and the pods get removed. The vines are not fed into the machine. After pod removal, the bunch is dried and used as fodder for animals.

Based on the result from the literature review, threshing is the important process in cultivation process. Also temperature level is very high during these days and the labor finds hard to undergo the removal of pods from plant under these climate condition. Hence it is required to find the easy method to perform the operation. The farm may be located at far distance from the power source hence the usage of motor is not used in most places. Hence it is essential to find the alternate power source like engine to serve the purpose of power source.

3. COMPONENTS OF GROUNDNUT THRESHER

3.1 ENGINE

An engine is a machine designed to convert one form of energy into mechanical energy. Heat engines, including internal combustion engines and external combustion engines, burn a fuel to create heat, which then creates a force.

3.2 PULLEY

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt along its circumference. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power.

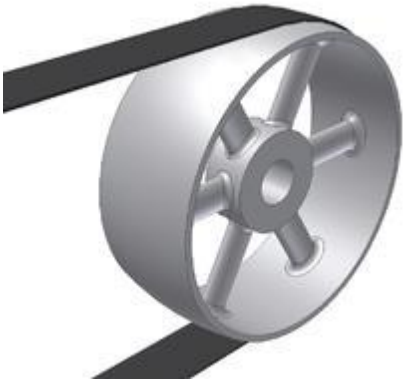

Figure 7. Belt and Pulley Arrangement

3.3 BELT

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel. In a two pulley system, the belt can either drive the pulleys normally in one direction, or the belt may be crossed, so that the direction of the driven shaft is reversed. The belt and pulley arrangements is shown in the figure 7.

Figure 8. Ball Bearing

3.4 BEARING

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Many bearings also facilitate the desired motion as much as possible, such as

by minimizing friction. The ball bearing is shown in the figure 8.

3.5 SHAFT

A shaft is a rotating member, usually of circular cross section used to transmit power or motion. It provides axis of rotation, or oscillation, of element such as gears, pulley, flywheel, crank, sprockets. In order to transmit power various member such as pulley and gears are mounted.

3.6 FUEL TANK

Fuel tank serves the function of storing the petrol at high position such the fuel drops under the action of gravity.

3.7 CUTTING PLATE

A Cutting plate consists of V shape teeth for separating the groundnut pods from the plant. Plate contains two holes at the ends. Plate are attached with the shaft using nut and bolts for any replacement if necessary. A shaft contains two plate, they are fitted with angle 180°. A plate are continuously rotated with the help of shaft. Groundnut plants are feed perpendicular to the rotation of plates. The photographic view of cutting plate is shown in the figure 9.

Figure 9. Cutting Plate

4. DESIGN CALCULATION

4.1 GROUNDNUT SPECIFICATION

A single groundnut plant contains 20 to 30 groundnuts. On average,

Length of groundnut root = 30 mm
Length of groundnut = 20 mm
Width of groundnut = 10 mm

4.2 SPECIFICATION OF CUTTING PLATE

Length of the blade = 500 mm
Thickness of the blade = 5 mm
Gap between tooth = 15 mm
Length of the teeth = 15 mm

4.3 CALCULATION OF TORQUE

A research paper by J.M.Troeger, E.J.William and J.L.Butler the peg attachment force or the tensile force required to separate peg from pod is 22.26 N. Here we use up to ten ground nut plants so the maximum force that is required to remove groundnut pod is up to 300 N with considering the weight of shaft and other mountings.

Torque, T = Force x Perpendicular distance
Force, F = 300 N
Perpendicular distance is the distance between the shaft axis and the plate edge is 115 mm
Torque, T = 300 x 115 = 34500 Nmm.
Torque, T = 34.5 Nm

4.4 POWER CALCULATION

Power, $P = 2 \pi N T / 60$
Speed required N = 200 rpm
$P = (2 \times \pi \times 200 \times 34.5) / 60$
P = 722.2 W
P = 0.968HP
Power required is 1 HP but for application we choose 1.5 HP.

4.5 DESIGN OF SHAFT

Torque , $T = \pi \tau d3 / 16$
Allowable shear stress, τ = 42 N/mm2
Torque, T = (3.14 x 42 x d3) / 16
34.5 = (3.14 x 42 x d3) / 16
Diameter, d = 16.11 mm
The obtained shaft diameter is 16.11 mm. In order to do weld attachment on the shaft, diameter of the shaft is chosen to 30 mm.
Diameter of shaft, d = 30 mm.
Shaft length used, L = 770 mm

4.6 SELECTION OF BEARING

Bore diameter = 30 mm
Bearing number = 205
Outer diameter = 52 mm
Width = 15 mm
Pillow block radial ball bearing is selected.

4.7 SPECIFICATION OF PULLY

For the load calculated the value range from 0.7 to 3.5kW,
The type of belt to be used is A series.
Pitch diameter of pulley, D = 75 mm
Pitch width, w = 11 mm
Face width, B = 95 mm
Edge of pulley to first groove center, f = 10 mm
Groove angle, $2\beta = 32°$
Minimum distance down to pitch line, a = 3.3 mm
Minimum depth below the pitch line, c = 8.7 mm

4.8 SPECIFICATION OF BELT

For usual load, P = 0.722KW
Type of belt = A
Nominal top width, W = 13 mm
Nominal thickness, T = 8 mm
Weight per meter = 1.06 N
Nominal pitch length, Lp = 1331 mm

4.9 SPECIFICATION OF ENGINE

Power P = 1.5 HP
Starting method = Pulley and Rope
Weight of engine = 3.6 kg

Number of stroke, n = 2
Fuel type = Petrol

4.10 TABLE SPECIFICATION

Length of table, l = 910 mm
Breadth of table, b = 780 mm
Height of table, h = 1160 mm
Floor space required (Area), A = 0.716 m2
The proposed model design is shown in the figure 10.

Figure 10. Model Design

5. FABRICATION OF GROUNDNUT THRESHER

5.1 FABRICATION PROCESS

The first step in our fabrication is machining the shaft of 30 mm diameter to 25.4 mm at both end in order to attach the bearing. The next step is to provide holes to weld the cutting plate with the shaft. For that we have to do milling operation in the shaft using 6 mm milling slot. After this process cutting plate attachment is inserted in the hole and welding operation is carried out. The cutting blade is cut in to teeth according to the average width of the groundnuts and the cutting operation is carried out using gas welding. Hollow section pipes are used in the body construction.

Figure 11. Frame Construction

The pillow block radial ball bearing used here which is assembled by using screw and nuts. Pulley is connected at one end of the shaft. The engine shaft and the working shaft using belt drive. In order to cover the shaft so as to prevent the groundnut pods to scatter away randomly casing has to be done. Casing is done using sheet metal and fitting operation is done using screws. Sieve is fitted below the shaft to collect the removed groundnut pod and delivered to the collector. The table construction for the groundnut thresher is shown in the figure 11.

The figure 12 shows the portion where groundnut plants have to be inserted. The figure 13. Shows the complete view of groundnut thresher and its part. The groundnut plant is taken and inserted in the input portion and hold it near the plate until the pods are removed.

Figure 12. Feed Portion of Groundnut Thresher

Figure 13. Groundnut Thresher

5.2 PERFORMANCE ANALYSIS

Based on the working of the groundnut thresher the following performance analysis were made. According to the analysis,

Number of workers required = 2
Collection of groundnuts per hour= 48 kg
Total working time period = 7 hours
Collection of groundnuts per day= 336 kg
Cost per labour = ₹ 170
Fuel required = 0.42 litres per hour
Total fuel required = 3 litres
Cost of fuel with oil = ₹80 per litre
Total fuel cost = ₹ 240
Total cost = Labour cost + Fuel cost
= 340 + 240
Total cost = ₹ 560
Picking cost per kg = ₹ 560/360=₹1.66
Manual cost = ₹ 1500

By using groundnut thresher we can save more money and less manual work. Now-a-days the climate is very hot and the labours find difficult to work in the farm. And also it is difficult to get workers in more areas. It will help the farmers to harvest with minimum time and money.

6. CONCLUSION

The groundnut thresher is useful for farmer in stripping of groundnuts pods in most convenient methods with time and cost efficient. Now-a-days climatic condition also a reason for unavailability of workers in these fields. With the use of groundnut thresher, farmers can do their harvesting operations and do their work at right time which helps in prevention of damage of groundnuts due to late harvesting or unavailability of workers at needed time.

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