

Design and Fabrication of Pedal Operated Groundnut Sheller Cum Cleaner Machine

Megha Meshram¹ Er. C.L. Sahu² and Ankit Kumar*³

¹Student ²Assistant Professor

Department of Farm Machinery and Power Engineering
Chhattisgarh Agricultural Engineering College, Chhattisgarh, India

²Department of Food Technology and Nutrition, School of Agriculture, Lovely Professional University, Phagwara, Punjab,

ABSTRACT

The aim of this work is to remove the shell in groundnut with better efficiency. In traditional method, decortication of groundnut is pressed between the thumb and first finger. On the present manual process by beating with stick time taken for groundnut shell removal is more. A better process is to be evolved. This shell removal operation is done without using any electrical power. This machine is eco-friendly. Shelling of groundnut is tedious and time-consuming process. Commercially available hand operated shell removal process requires more energy with less output. An attempt was made to develop and evaluate pedal operated groundnut shell removal. The difference in unit cost of operation for the unit was appreciable less than that of hand operated decorticator. By considering less fatigue to the operator and higher output, the pedal operated sheller could be advantageously used for decortication of groundnut. It has been observed that the efficiency and productivity with hand operated groundnut decorticator and the traditional method is less. Due to this tire some working operation, commercially available hand operated decorticators require more energy with less output. By considering this pedal operated groundnut decorticator is beneficial for decortications of groundnut pods. The new and small farmer or business man can start their business by investing for less capital. So, working on the above points, we design and fabricate a new medium production capacity machine. Feedrate of developed continuous feeding type groundnut sheller is 25 kg of groundnut per hour, at moisture content of 6.8% (d.b.) gave shelling efficiency 75-85% and broken loss found to be 20-30%. For efficient of groundnut sheller, should be 55-60 rpm. Overall dimension of developed sheller is 79 × 60 × 146 cm. The cost of developed groundnut sheller is Rs.5945 and cost of operation is 28 Rs/hr.

Keywords: Decortication, Traditional method, Sheller Machine, Efficiency, Design, Fabrication etc.

1. INTRODUCTION

Agriculture is the backbone of India. In country India, groundnut is grown on a small scale by farmer. Initially the groundnuts were separated from its shell by the labours. The output from this method is very less and could not satisfy the market demand. It is very time-consuming process. Peanuts grow best in light, sandy loam soil with a pH of 5.9–7. Their capacity to fix nitrogen means that, providing they modulate properly, peanuts benefit little or not at all from nitrogen-containing fertilizer and they improve soil fertility. 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. Groundnut is very important as per as the oil seed is concerned. Groundnut is the sixth most important oilseed crop in the world. It contains 48-50% oil and 26-28% protein, and is a rich source of dietary fibre, of this crop.

The production of ground nut is concentrated in Asia and Africa (56% and 40% of the global area and 68% and 25% of the global production, respectively). India is the second largest producer of groundnuts in the world. Indian groundnuts are available in different varieties: Bold or Runner, Java or Spanish and Red Natal. The main Groundnut varieties produced in India are Kadiri-2, Kadiri-3, BG-1, BG-2, Kuber , GAUG-1, GAUG-10, PG-1 , T-28, T-64, Chandra, Chitra, Kaushal, Parkash, Amber etc.

They have a rich nutty flavour, sweet taste, crunchy texture and over and above a relatively longer shelf life. Soil conditions in some producing regions are ideally suited for dry, clean and spotless Groundnuts in Shell. Today, groundnut has a share of approximately 25% in the total Indian oilseed production. But this share is persistently reducing since India got independent, as it was around 70% in 1950s. It is also known as peanut, is one of the world's principal oilseed crops, widely grown in areas ranging from latitude 40°N to 40°S. The nuts are eaten in a variety of forms, or crushed to provide vegetable oil for human consumption and protein-rich meal for livestock.

In the beginning the peanuts were separated from its shells by the workers. They simply decoct the groundnut by their hands and separate the peanuts from its shell. The output got from this method, was very low and it does not fulfil the market demand because it was very time-consuming process. It was also a boring work for the worker. Traditional method of separation nuts from groundnuts by putting the peanuts in a cloth bag and rolling over it with a rolling pin. This technique did a good job of cracking the shells (deleting the painful fingers problem), but we still had to pick the peanuts out since they didn't come all the way loose. This is not a reliable method for shell a groundnut due to this crack the groundnut and nuts mixed with shell. Due to this manual process, identify some major problem & to overcome this problem some idea or concepts generates. According to general idea deciding objective of project. Farmer and small businessman are facing many problems.

The aim is to design and developed a low-cost ground nut shelling machine which will help farmer to sell finished (shelled groundnut) instead of unshelled groundnut. Considering the above problems, we are going to design and fabricate such a machine that will eliminate most of the problems from previously available manually shelling machine, so human effort is reduced and getting more productivity, earn more profit to farmer. This is a simple mechanism machine, which can be made easily, and we have tried to reduce the cost on less as possible.

2. MATERIAL AND METHODS

This chapter describe methodology adopted in this project which includes study of existing designs of shellers, development, description of various functional units of sheller and its testing for groundnut. The sampling procedure is described, followed by means of data collection. The various factors govern the design of sheller for groundnut are availability of human power and buying capacity of the processor, farmers, operational safety, and power requirement per unit of output, efficiency of operation, cost of production and ease of operation. The operations and adjustments were kept simple and easy so that processor/farmers can use it without much knowledge.

Samples of Groundnut

Samples from different communities were collected and measured, using the vernier calliper, to determine the length and thickness of an unshelled nut. This procedure was carried out, to determine the average clearance to be used in the sheller, for an average size of a shelled nut to minimize breakage.

Methodology

In this project the pedal power is used. Pedal power is used to make the rolling operation in roller. Dried groundnut is used to the shell removal operation.

A) Ergonomic consideration

1. Development within the capability of human worker.
2. Seed losses, micro and macro breakages of kernels should be minimum.
3. Suitability of the machine for worker of varying age and body dimensions.

B) Physical properties

Size, density, sphericity and pods weight, moisture content, aspect ratio, terminal velocity of shells and crushing force were measured.

C) Description of Machine

The machine consists of the feeding hopper, rotating wooden rollers, mounted rigidly on a shaft with bearing supported on an angle iron steel machine frame, with a pedal fitted behind the frame. The gap or clearance provided is depends upon the size of the groundnut which is to be deocoted and can be adjusted by means of a bolt connecting the shaft to the frame.

D) Testing objectives

The objectives under which the testing of the groundnut sheller for groundnut was carried out are as under:

1. Functional testing of the developed sheller.
2. To determine the optimum feed rate of sheller.
3. To determine the output capacity of sheller.
4. To determine the optimum speed for shelling groundnut.

Testing of groundnut sheller cum cleaner

Testing parameters of the sheller are as follows:

1. Sphericity of groundnut.
2. Performance evaluation of pedal operated groundnut sheller cum cleaner.

E) Modelling and Fabrication of following components

1. Frame
2. Roller
3. Hopper
4. Bearing
5. Pedal Drive
6. Power transmission unit
 - i) Roller shaft
 - ii) Pedal shaft
 - iii) Fan shaft
 - iv) Chain and sprocket
7. Fan
8. Handle
9. Seat

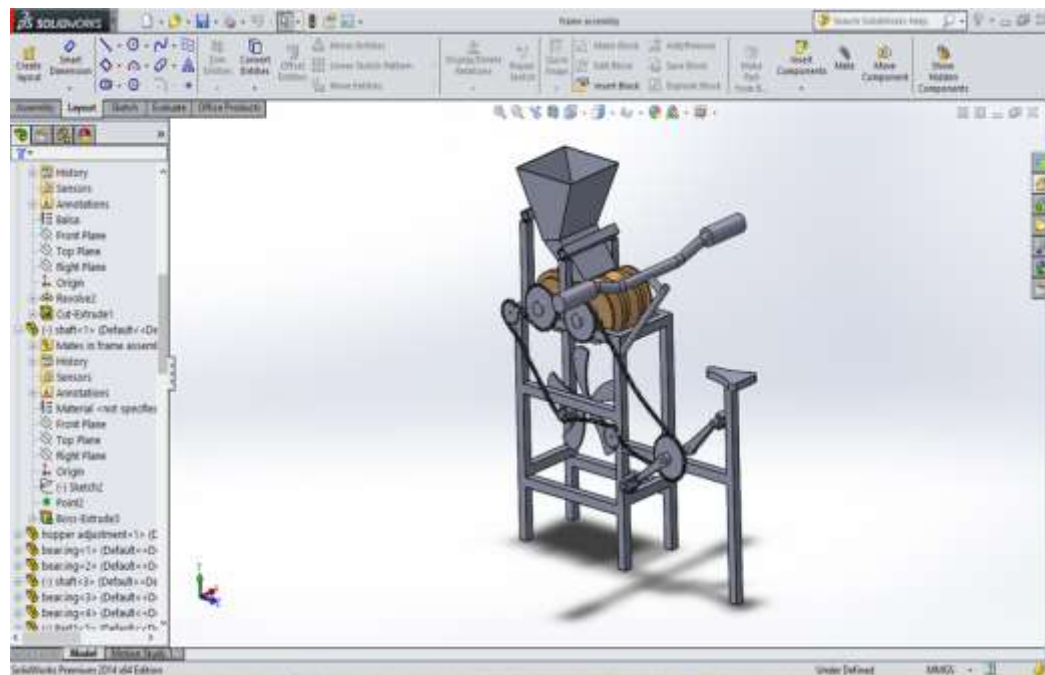


Fig 1: Modelling of Sheller machine in Solid works Software



Fig 2: Design and Fabrication of Pedal Operated Groundnut Sheller Cum Cleaner Machine

3. RESULT AND DISCUSSION

I. Shelling Action

The clearance between the rollers is about 1.3 mm. The groundnut is trapped between the grooves in roller, as rotated in opposite direction a shearing force is set up thereby shelling the groundnut since the force from these two members opposes each other. After shelling the groundnut the kernels and the shells of the groundnut gets dropped in downward direction then a centrifugal force is applied by a fan on the kernels and shell of the groundnut. Due to more weight, the kernels gets moved downward and collected in the tray. But due to light lighter weight the shell of the groundnuts is thrown outside the machine.

II) Design Procedure

Dimensions of existing groundnut decorticator oscillating type (CIAE model) were considered for length of roller.

Length of roller = 28cm

(CIAE Bhopal, 2007)

Diameter of roller = 24cm

Clearance between roller = 1.3cm

III) Bulk density of pods

Diameter of container (d_c) = 13.5 cm

Height of container (h_c) = 9.5 cm

Mass of pods = 250 g

$$\text{Volume of container} = \frac{1}{4} \times \pi \times (d_c)^2 \times (h_c) \quad (1)$$

$$= \frac{1}{4} \times \pi \times (13.5)^2 \times 9.5$$

$$= 1359.818 \text{ cm}^3$$

$$\text{Density of pods} = \frac{\text{Mass}}{\text{Volume}} \quad (2)$$

$$= \frac{250}{1359.818}$$

$$= 0.184 \text{ g/cc}$$

IV) Power Required to Shelling Groundnut

Time taken for 1kg of groundnut shell removal process = 122 sec.

$$\text{Power required (P)} = T \times \omega \quad (\text{Shanmugam, A et al, 2016}) \quad (3)$$

$$T = F \times r \quad (4)$$

where,

T = Torque

F = force applied in the pedal.

r = radius of the counter shaft

Speed of the cycle pedal (N_1) = 55 rpm

$$\omega = \frac{2\pi N}{60} \quad (5)$$

where,

ω = angular acceleration.

$$\omega = \frac{2\pi \times 55}{60} = 5.76 \text{ rad/sec}$$

$$F = 47.21 \text{ N}$$

$$r = 0.182 \text{ m}$$

$$T = 47.21 \times 0.182$$

$$= 8.6 \text{ N-m}$$

$$P = 8.6 \times 5.76$$

$$= 49.5 \text{ Watt}$$

$$= 0.066 \text{ hp}$$

V) Counter shaft

A machine drive shaft that transmits motion and power from the main shaft to where it is required. Speed on counter shaft,

$$T_1 = T_2 = T_3 = 44$$

$$N_1 = 55 \text{ rpm}$$

$$\text{Then, } N_2 = 55 \text{ rpm}$$

Similarly, speed of N_3 also have 55 rpm since all three gears are of same dimension mounted on pedal and rollers drive respectively.

Torque on counter shaft

$$T_c = 8.6 \text{ N-m}$$

Speed on the idler shaft

$$N_3 = 55 \text{ rpm}$$

$$T_4 = 18$$

Speed ratio;

$$\frac{N_3}{N_4} = \frac{T_4}{T_3}$$

$$\frac{55}{N_4} = \frac{18}{44}$$

$$N_4 = 134.44 \text{ rpm}$$

(6)

Speed on Fan shaft

$$T_5 = 11$$

Speed ratio;

$$\frac{N_4}{N_5} = \frac{T_5}{T_4}$$

$$\frac{134.44}{N_5} = \frac{11}{18}$$

$$N_5 = 219.99 \text{ rpm}$$

(7)

The rotational speed of the fan required for cleaning = 1635 rpm. (G. Kibi, 2014)

Chain Design

The chain in use on machine has a $\frac{1}{2}$ inch (12.7 mm) pitch. (Sanjeev Reddy K Hudgikar, 2017)

Total central distance between sprockets = 1336 mm

Number of chain link = 97

Length of chain = 97×12.7

$$= 1.23 \text{ m}$$

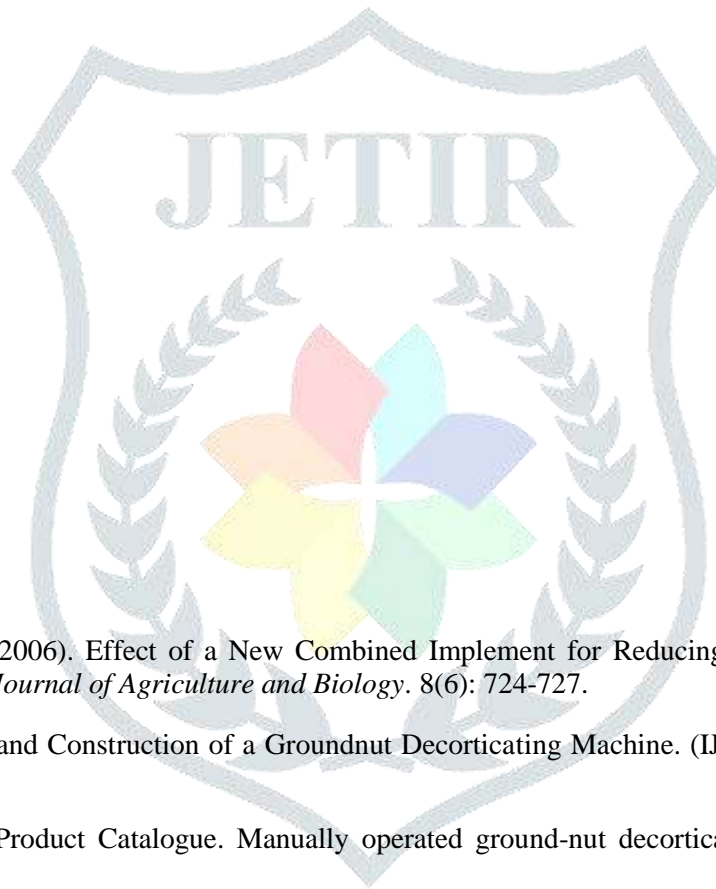
4. CONCLUSION

The Groundnut sheller machine is developed for shelling groundnut. Groundnut shelled through rubbing action in the space between two wooden rollers. Based on it is concluded that, the pedal operated groundnut sheller machine is better option for farmer instead of hand operated. The machine is pedal operated so that there is no energy consumption which

will helps to reduce the cost of production. This machine also saves time and manpower. If we go on continuous work we get a higher output in very short time. The operating procedure of this system is very simple, so there is no skill labour required to operate a machine.

The manually operated groundnut sheller was tested for groundnut at CAEC Dhanora and on the basis of the results obtained, following conclusion drawn. Design parameters and their application in manufacturing sheller for groundnut were to be established.

1. Groundnut-sheller is designed of overall dimension 79×60×146 cm.
2. The shelling efficiency lies between 75-85%, feed rate is 25kg/hr, rpm is from 55-60, broken loss varies from 20-30%, and clearance between roller is 1.3 cm.
3. Hopper capacity – 4.5 kg.
4. The total cost of groundnut sheller machine is Rs. 5945 and cost of operation is 28 Rs/hr.



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