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PERFORMANCE EVALUTION OF PEANUT HARVESTING MACHINE

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Abstract - *The peanut harvesting machine was designed and fabricated. The machine was designed in CATIA software and optimum cutter design was taken from three different designs. The machine was tested in the sandy soiled grown peanuts and found that the machine outputs at two different speeds and the time for the outputs also noted. The machine output was compared to the manual method output and it was tabulated. The machine output was optimized by using the Taguchi method in Minitab. Our main aim is to construct the peanut harvesting machine that will be useful to the small scale farmers and this machine will be useful for harvesting the peanut process and reduce the time and labour cost for farmers.*

Key Words: *Peanut, Sandy soil, CATIA, Taguchi method, Minitab*

1. INTRODUCTION

Groundnuts, sometimes known as peanuts, are members of the legume or "bean" family. The peanut was most likely domesticated and farmed in Paraguay's lowlands. It is an annual herbaceous plant that grows to a height of 30 to 50 cm. The leaves are opposite and pinnate, with four leaflets in two opposing pairs; there is no terminal leaflet, and each leaflet is 1 to 7 cm long and 1 to 3 cm wide. Peanuts are also known as earthnuts, ground nuts, goober peas, monkey nuts, pygmy nuts, and pig nuts. Despite its name and look, the peanut is a legume, not a nut. According to table 1, India is the world's second largest producer of peanuts.

Table-1: Peanut production ratio (Source: (8) pg.no:1)

RANK	COUNTRY	PRODUCTION (MILLION)
1	China	17
2	India	9.5
2.1	Tamilnadu	0.35
3	Nigeria	3
4	United states	1.9

The peanut has a deep nutty flavour, a sweet flavour, a crunchy texture, and a significantly longer shelf life. Some producing locations' soil conditions are suitable for dry, clean, and immaculate Peanuts in Shell. Peanut is India's main oil seed crop, and it contributes significantly to the country's vegetable oil shortfall. Peanuts are accessible all year in India due to a two-crop cycle gathered in March and October. Peanuts are an important protein crop in India, where they are farmed mostly under rain-fed circumstances. The knowledge and concern for quality among Indian peanut vendors and processors is constantly increasing. Multiple sorting and grading is quickly becoming the standard. Indian manufacturers are capable of preparing and supplying edible peanuts that meet the highest requirements. Aside from raw edible peanuts, India can also offer Blanched Peanuts, Roasted Salted Peanuts, Dry Roasted Peanuts, and a range of peanut-based goods. Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Madhya Pradesh, Orissa, and Uttar Pradesh are the major peanut-growing states.

1.1 Cultivation and Harvesting

Peanuts thrive on light, sandy loam soil with a pH range of 5.9–7. They have the ability to fix nitrogen and increase soil fertility. Figure 3 depicts a crop farming land perspective. As a result, they are useful in crop rotations. Rotations also boost the output of the peanut crop by reducing diseases, pests, and weeds. Phosphorus, potassium, calcium, magnesium, and micronutrient levels must also be adequate for excellent harvests.

By cutting through the dirt slightly below the level of the peanut pods, you may reach the root of the peanut plant. The machine raises and shakes the "bush," then inverts it, leaving the plant upside down on the ground to keep the peanuts out of the soil. This permits the peanuts to dry slowly over three to four days to a little less than a third of their original moisture content. Peanuts were traditionally plucked and inverted by hand.

Harvesting often entails a sequence of processes such as digging, lifting, windrowing, stocking, and threshing. Depending on the system used, some of these jobs can be merged or omitted. Harvesting is the most time-consuming and expensive field operation associated with peanut growing. The manner of harvesting used is determined on the type of peanut cultivated. Pod growth is limited to the plant's base in bunch kinds, and the pegs carrying the pods into the soil are thick and robust. When the plants are removed out of the soil, almost all of the pods are retrieved.

In India, the bunch form of peanut is generally harvested by plucking the plants out by hand. The type of labour used to harvest the crop is determined by the locality. In Tamil Nadu, for example, male labourers are engaged, but in Gujarat, both

male and female labourers are employed. A one-hectare peanut crop may typically be harvested in one day by 12 to 14 labourers. Harvesting can be difficult at times, especially when the crop has reached full maturity and the earth has hardened. In this instance, it is normal to elevate the plants by loosening the soil along the plant rows using a hand hoe, a plough, or a blade harrow. If, after physically lifting the crop, it is discovered that a significant percentage of the pods have been left in the soil, the same equipment can be used to pick the remaining pods. Additional labour will be necessary in the latter situation. In the case of the spreading kind, uprooting the crop from the soil is a challenging procedure since pod development occurs all along the creeping branches of the plant. The pegs are thinner and more delicate in comparison.

2. MATERIALS AND METHODS

2.1 Materials

The peanut harvesting machine consists of a motor, stepped cone pulley, belt drive, cam, shaft, cutter and tray. The motor and pulley were connected. The belt drive is attached to the pulley. The tray was connected to the cam mechanism. The cam connected to the shaft and the shaft attached to the pulley. The cutter is rotated by the use of a belt drive. And the tray to and fro movement was controlled by the cam mechanism. By using the pulley, we controlled the speed of the cutter and changed the output of the machine. The pulley diameters are 150 mm, 120 mm and 100 mm and it was made up of cast iron. The cutter, cam, frame and the trays are made up of mild steel. The 3 cutter plates are welded to circular plates. The each cutting plate angle in circular plates was 120° and it was shown in figure 1. The nylon V-belt was used in drive and the thickness of 20 mm. The wooden plate was used to support the hand during feeding the peanut. The ¼ hp motor was used in the harvesting machine. The final design of the machine was shown in figure 1.

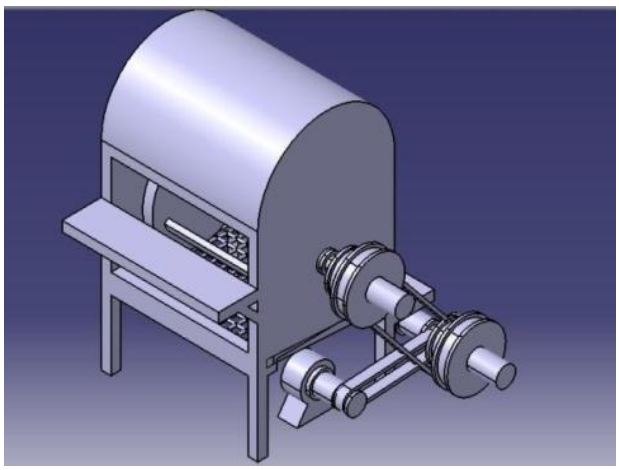


Fig-1: Design model

Table-2: Specification of machine

A. General	
Name	Peanut harvester
Type	Tangential flow
Year of manufacture	2021
B. Power unit	
Type	Motor operated
Recommended power	¼ hp
Type of drive	Electric drive
C. Main drive	
Type	Belt drive
Length of belt, mm	3000
Width of pulley, mm	25
D. Shaking Mechanism	
1. Shaft	
Material	MS rod
Size, mm	700x50ϕ
2. CAM	
Numbers	1
Material	Mild steel
Diameter of CAM, mm	300
Thickness of CAM, mm	5
E. Crop feeding	
Method of feeding	Manual
F. Overall Dimensions	
Length, mm	800
Width, mm	500
Height, mm	1000
Ground clearance, mm	100
Total mass, kg	35

2.2 Working principle

The peanut harvesting machine working principle is that the peanut was picked manually from the land. After that the peanut was manually fed through the cutter of the harvesting machine. The cutter is rotating with the help of a motor and belt drive, because of that the peanut was separated from the plant. The peanut dropped to the vibrating tray. Vibrating the tray was done by cam mechanism and the cam was attached to the shaft and pulley. The tray removed the excess element of the peanut like soil and leaves. The output of the machine was noted for one hour every five minutes. After that, the speed of the cutter was reduced by changing the belt from small cone to big cone of the pulley. And again the peanut was fed through the cutter manually. The same process was repeated. The speed 2 output is also noted for one hour in every five minutes. The speed 1 and speed 2 outputs were tabulated. Then, the peanut was separated in a traditional method of manual harvesting. The quantity of the peanut was measured in one hour time in every five minutes intervals and the values are

tabulated. Finally, the peanut harvesting machine output and the traditional method output were compared and the highest output was taken to improve the performance of the peanut harvesting machine. The working of the peanut harvesting machine was shown in figure 2.1 and 2.2.

Fig-2.1

Fig-2.2: Working model

3. RESULT AND DISCUSSION

The Taguchi method is applied for optimizing the peanut harvesting machine. The two outputs of the peanut harvesting machine speed 1 and speed 2 and the traditional method manual output were taken for the input parameters for Taguchi method optimization. The 3 levels of design and the L9 array of Taguchi method were selected for the optimization of the peanut harvesting machine. The input parameters for 3 levels of design were shown in table 3. The input parameters are in kilogram and speed 1 and speed 2 inputs are machine output and the manual is traditional method output.

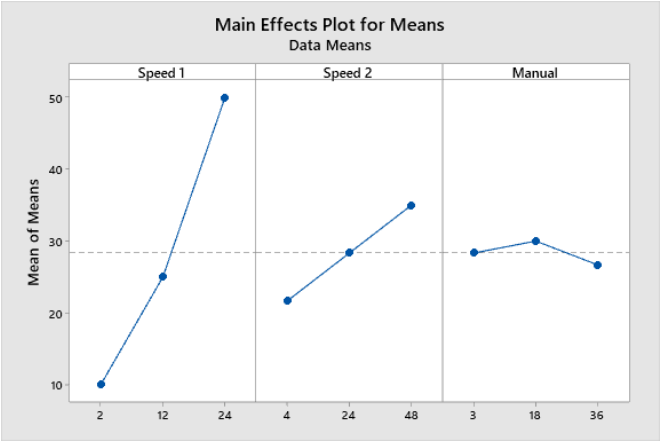
Table-3: Input parameters

S.NO	SPEED 1	SPEED 2	MANUAL
1	2	4	3
2	12	24	18
3	24	48	36

The three different outputs for each method of speed 1, speed 2 and traditional method are taken three times in between 5 minute, 30 minute and 1 hour. The Taguchi L9 array was created by the Minitab software. The time column was added in the Minitab final L9 array table for each five minutes interval of time. The final Taguchi L9 orthogonal array table was shown in table 4. This L9 array table was used to draw the graph for main effect plot for means and main effect plot for SN ratio. It was show in graph 1 and graph 2 respectively.

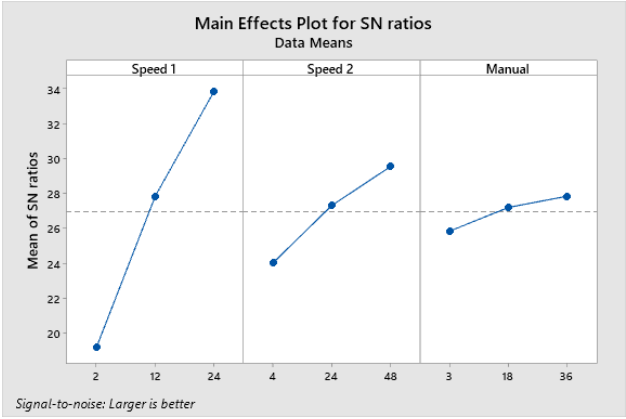
SPEED 1	SPEED 2	MANUAL	TIME (MIN)
2	4	3	5
2	24	18	10
2	48	36	15
12	4	18	20
12	24	36	25
12	48	3	30
24	4	36	40
24	24	3	50
24	48	18	60

Table-4: Taguchi L9 Orthogonal array



Graph-1: Main effects plot for means

The graph 1 refers, the all three parameters, speed 1, speed 2 and manual output of the peanut harvesting machine means and the main effect when the means of a factor is affected by the response. The graph 2 refers; the signal to noise ratio of each parameter of input must be assessed for each output function. The highest S/N ratio of considered input parameters indicates an optimal level. The x-axis indicates the outputs and the y-axis indicates the time taken for the output.



Graph-2: Main effects plot for SN ratio

By concluding the results of Taguchi method graphs of main effects plot for means and SN ratio, the top speed of peanut harvesting machine (speed 2) output was better than manual method and the low speed of machine (speed 1) outputs. But considering the manual efforts, the low speed (speed 1) of the machine also resulted in better results.

Practically, when the time increases human efforts slow down and it is affecting the output and the time for harvesting is also increased. So considering those parameters, the machine was never slowed down and feeding manually was done rotating the people in some time intervals. Therefore, the output of the peanut harvesting machine was increased and the time also reduced. By considering these two practical and theoretical methods, the machine output was better at these two methods and the optimizing the peanut harvesting machine was done successfully.

4. CONCLUSION

The peanut harvesting machine was designed, fabricated and tested in sandy soil and also the machine output was compared to manual methods and the results were optimized using Taguchi method. This technology is beneficial for farmers in removing peanut pods in the most convenient and cost-effective manner. Today's weather conditions are also a factor in the unavailability of labor in certain areas. Farmers may utilize a peanut harvesting machine to execute their harvesting operations and work at the correct time, preventing peanut damage due to late harvesting or labor unavailability at the proper time.

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