

Design of Semi-Automatic Coconut Dehusker for Small Scale Farmers



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Abstract: The removal of shells of coconut and nut has been a problem for lots of years. Foot-operated and hand-operated systems are very in-efficient and in countries like India where large coconut farms are available, it is difficult to employ manpower alone. Efficient methods are necessary for the de-husking of coconut. This paper proposes Double spiked roller arrangement over traditional Dehusking tools and the modern dehuskers. This method employs the use of Single-phase motors instead of conventional three-phase motors. It helps in the reduction of price. The Machine dimensions are designed after various Averages of Coconut dimensions and torque calculations of the Single Phase Induction motor. The machine makes use of the Gear shaft-Pulley powered Single Phase motor which powers the spiked rollers. The rollers dehusk the coconut which when placed on it. It also possesses an adjustable base frame which helps in changing the speed and adjustment of the position of the motor in case Electrical speed varying methods are not available. This machine is extremely useful for small scale farmers because it's a very low cost, high operating efficiency.

Keywords: Adjustable Base Frame, Dehusker, Gear, Pulley, Torque, Spiked rollers.

I. INTRODUCTION

India is an agricultural country. It is the primary occupation for about 58% of the Indian Population. Agriculture, Fishery, and Forestry together contribute a gross value of Rs 18.55 Lakh Crore. Agriculture contributes 13% of India's exports and 6% of total industrial investment. Among the agricultural crops, Coconut is one of the crops that plays an important role in India's National Economy. India stands as a leading producer of the coconut. As of 2019, the country is the 3rd

largest coconut producing country in the world with an annual production of more than 21,500 million tons of nuts behind Indonesia and the Philippines respectively

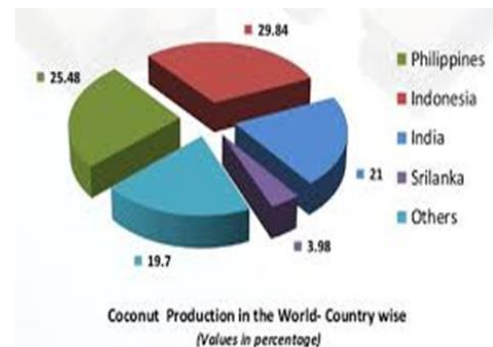


Fig.1.Coconut Production in the World

Coconut cultivation is predominant in states such as Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and some parts of Goa and Union territories. Coconut has a wide variety of applications such as rope manufacturing, oil preparation, crafts, food processing, fertilizers, etc.. Different processing methods are done depending on the application. One of the Processing methods which is important and yet difficult is the Husk removal process from the Exocarp, the outer part of the Coconut for preparing charcoal fuel, mattress, etc...This process is essential before retrieving the edible inner endocarp. Coconut farms are facing a huge problem regarding the Coconut Dehusking process owing to the huge labor effort required. This decreases efficiency and increases time consumption. So several machines have been designed to help the Dehusking process of the coconut. But Statistics reports that only 8% of the farmers in India employ advanced mechanization tools for agriculture. It is due to the high cost of the agriculture machinery which is true for the Dehusking process of the coconut. Small scale or smallholder farmers contribute about 60% of the total agricultural production of India and they can't afford the high cost foreign imported machineries. Hence a simple and effective Dehusking method employing spiked rollers and motors is required.

II. LITERATURE

Abi Varghesel and Jippu Jacob[1] made a research on several traditional coconut dehuskers such as Coconut husk removing tool,KAU,Keramithra and several other Manual Coconut Dehusking tools.

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M.K.Ghoshal and S.K.Mohanty [2] made an ergonomically study on the traditional Pedal operated and Hand operated dehuskers and concluded that the Dehusking efficiency of motorized system is more than 90% based on the calculations made on the total weight of the husk removed from the coconut and stated that the Electrical operating systems are faster and more efficient than traditional Dehusking tools. The first Electrical system for Dehusking was invented and patented by Chandra Dinanath[3] in 1986. He analyzed the traditional tools and proposed a spiked roller powered by an electric motor to dehusk the coconut. Further several advancements were made in this design. P.A.Wadilel and K.P.Kohle[4] provided a graphical relationship between Time of Processing and number of coconut harvested for different methods of Coconut dehuskers. It helps in understanding the efficiency and performance of the dehuskers. Modern Dehusking machines used in large scale farms are Dehuskers powered by three-phase machines. Its performance and economy are discussed by Krishnal et.al [5]. A.V.Gajokos et.al[6] proposed the Power Dehusker employing a three phase Dehusker operating on 5 HP Electric motor. Even though the machines give a very good efficiency and faster Dehusking process, the cost of the machine is very high of the order of 2 lakhs. The machine is heavy and transportation is too difficult. Also in the rural side, it is difficult to obtain a three-phase supply. COM11 [7] is a Diesel-powered Coconut Dehusking employing hydraulic mechanism. It employs a metal arm separation model. It can dehusk up to 200-300 coconuts per hour. But the rising cost of Diesel and its environmental impact is needed to take into account. The machine weighs about 200Kg which makes the transportation very difficult and since it operates on three-phase motor, a separate three-phase supply is required. Mr.Vinod Sahare et.al[8] proposed Hydraulic cylinder which operates through Four way three position control valve and dehusk the coconut through fruit gripping mechanism and hydraulic operated knives. But the rate of Dehusking is slow in the process. Roopashree C R[9], Dany Thomas et.al[10], Jibin Jacob et.al[11] proposed system making use of double spiked rollers employing Single phase Induction motors. This system proved to have good efficiency. G.Sujaykumar et.al[12] in his paper proposed the torque calculation required for Dehusking the coconut, the torque obtained from the motor based on its speed and the design of dimensions of the machine. Another similar method of Dehusking is proposed by Amal PV et.al[13]. The machine designed by them had spike array on a single roller and the other was left smooth. This method also gives as good efficiency as the double spiked roller method. The machine dimensions needed to be designed should also depend on the dimensions of the coconut. Dr.Sabale and Kohle[14] proposed machine dimension design after several measurements and the parameters necessary to be considered before making the design. They also concluded that the cutting tyne system attached to the cylinders can be replaced at a faster rate in case of damage to the tynes. Nwankwojike BN et.al [15] proposed average of several parameters of the coconut such as shape, diameter, husk thickness, Shell diameter etc...which is required to design the machine dimensions.

III. CONVENTIONAL SYSTEM

There are numerous methods of Dehusking with coconut through traditional systems. The most popular traditional method is the cutlass method. But it is dangerous and causes injury to the personnel such as cutting their hands and their face as the cutlass usually bounces back. So tools involving spikes were developed to minimize the risk. Coconut spanner is a hand operated method. The sharpened tongs need to be impaled and to be bent by the user. But one need to operate multiple times to separate the husk which is tiresome.

One of the most commonly used Dehusking technique is the Pedal-operated tool for split opening the Coconut husk. It consists of two blades one is fixed at the upright column and the other blade is attached to the handle. When the handle is operated, the two jaws of the blades split open the coconut and this result in separation of husk. The Traditional bar or machete is highly in-efficient and skilled manpower is required. It makes use of a cantilever pedal attached to the bottom of the Plate. When the Pedal is pressed, the Coconut pressed in the spike which connects the two jaws gets split open and the husk is removed. These methods of de-husking either through manpower or through machines like crowbars can sustain sometimes lead to injury to the hands when these sharp points make contact with human skin..

IV. PROPOSED SYSTEM

To improve the efficiency more and for design simplification, instead of using the conical tynes, we propose using triangular tynes for Dehusking. Even though the conical tynes can pierce the husk, for internally cut through the husk, the triangular tynes are of good option because of the shear tangential force and the extreme sharp smoothness along the edges. The proposed system consists of double spiked roller shafts with triangular tynes coupled with a Single Phase Induction motor through a gear shaft and belt mechanism. This method is safe, faster in operation than manual methods, less cost, and simple maintenance. Also, the Coconut of any shape and size can be used for Dehusking. Single Phase Induction motor has a low cost and so it is affordable for small scale farmers.

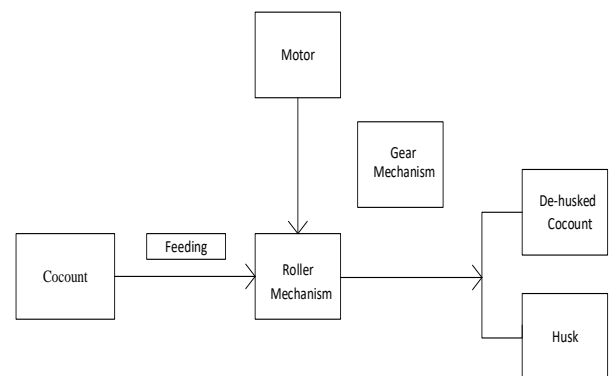


Fig.2.Block Diagram

A. OPERATION:

The piercing method of the traditional system is employed in this method. The coconut is fed into the machine and using the pressing the mechanism, it is pressed. One roller acts as Dehusker and the other acts as a guide.

One rotates in a clockwise direction while the other rotates in anticlockwise direction. The direction of rotation of the rollers is from top to bottom to the center. The speed can be adjusted through varying the speed of the motor or by adjusting the pulley and gear mechanism. The rotating motor couples the Pulley and gear shafts through which energy transmission takes place. The Kinetic energy is transferred to the rollers and the sharp tynes in the rollers tear open the Coconut husk.

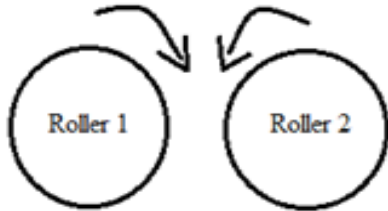


Fig.3.Anti Directional Rotation of rollers

B.TORQUE CALCULATION:

Based on Averages, a coconut of a Diameter of 200 mm average length of 200 mm, Shell diameter 100 mm, Weight of 2 kg, Husk thickness 55mm is taken as an average for calculation.

The system makes use of Single Phase 230V/50Hz, 1HP motor rotating at a steady 1440 rpm. The torque obtained from the motor is calculated as follows

Speed of the Motor (N) = 1440 rpm
Power of the Motor (P) = 1 HP or 0.75KW
We know that, Torque = $60P/2\pi N$

By substituting the values, we get the torque value of 4.97 Nm.

For effective Dehusking of the coconut, the torque should be maximum but it should not be too maximum which will crush the Coconut. For Dehusking, an approximate torque of 50N is required. Since torque is inversely proportional to speed, the speed from the machine has to be decreased to obtain high torque. So speed varying mechanisms such as Voltage control or by mechanical adjustment of gear systems can be used.

C.COMPONENTS:

Single phase systems can be used widely than three-phase systems because of economic advantage. Also, most of the power requirement in domestic applications is met by Single Phase Induction motor. Their construction is simple and they are reliable for small power rating than three-phase rated. They are available up to 1 KW rating. Since it is not self-starting owing to their exact opposite revolving field, we use a capacitor for making them self-starting.



Fig.4. Gear

The gear is essential for providing a coupling path for the pulley. It acts as a speed reduction medium for the motor. By employing a suitable gear ratio through calculation, the roller speed can be varied. It also acts as a coupling path between the roller and the pulley.



Fig.5. Pulley and Belt Mechanism

A belt and pulley system is a common form of power transmission in Mechanical systems which can transmit power, torque, and speed transmitted across axles along with different systems in the desired manner through appropriate Mechanical constructions. By changing the diameter of the Pulley, different speed and torque according to the requirements can be obtained. An alternate method of speed variation are simply changing the Pulley having a suitable diameter and connecting to the gear shaft since the belts offer an excellent solution to transmission systems. Changing the gears for speed variation is tiresome and involves large cost. So in case where electrical speed varying mechanisms are not available, this offers a good option.



Fig.6. Adjustable Base Frame with Motor

But the belt running over a motor shaft and Pulley won't develop the Pulling torque owing to slippage of belts. So a mechanical setup having an adjustable frame is provided at the bottom of the machine which helps in adjusting the base frame to the desired height. An adjustable bottom frame is designed as shown in Fig.6. By adjusting the screws of the base rods attached to the motor which rests on the motor, the shaft can be leveled to the desired level. This will prevent the slippage of the belt and thus helps in effective Dehusking of the coconut.

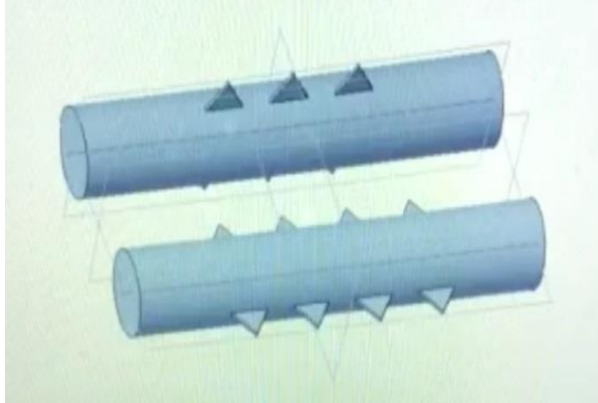


Fig.7. Roller with Cutting tynes

The rollers are cylindrical in shape. The rollers rotating in the anti-parallel direction develop the shear force which helps the tynes in Dehusking of the coconut. The tynes are displaced at 90 degree to that of the tynes at the other roller. The spike array is at 180 degree to each other array of the same roller. By adding more number of tynes to the spike array, we can dehusk the coconut at a faster rate without damaging the coconut. The design of the roller made through the CREO Software is shown in Fig.5. The rollers are coupled to the gear which in turn is attached to the Pulley.

D.DIMENSIONS:

The design and rating of the parts of the machine is given below in the Table 1.1.

Table I: Specifications

No	Parts	Dimensions	Measurements
1	Motor	Supply	AC
		Phase	Single
		Frequency(Hz)	50
		Voltage(V)	230
		Poles	4
		Speed(rpm)	1440
		Power	0.75KW/1 HP
2	Gear	Type	Induction
		Number of teeth	80
		Diameter	6 inch
		Outer Pitch	1.5 mm
3	Pulley	Diameter	30 cm
		Belt Width	1.5 cm
4	Rollers	Shape	Cylinder
		Diameter	7.5 cm
		Length	45 cm
		Distance	10 cm
5	Cutting Tynes	Shape	Triangle
		Width	4 cm
		Height	3 cm

E.HARDWARE SETUP:

The final designed hardware setup is shown in Fig.8. The long double rod like structure fitted with screws acts a downwards force on the rotating coconut and prevents the coconut from bouncing from the machine.

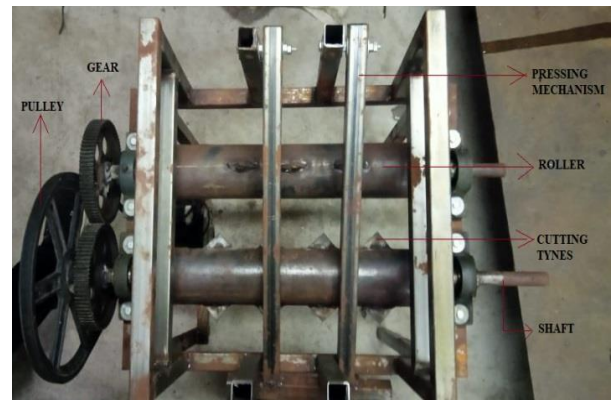


Fig.8. Semi-Automatic Dehusking Machine

V. RESULT

The machine is tested by comparing with the manual Pedal mounted Dehusker which is being commonly used and the results are tabulated as follows. The below readings are based on a average of three trials

Table II: Experimental Results

Time	No of Coconuts Dehusked by Manual	No of Coconuts Dehusked by the Proposed System
30 min	100	170
1 hour	210	320

VI.CONCLUSION:

The Proposed Coconut Dehusker is very helpful for the small scale farmers because of its low cost and high efficiency. Because of the tynes splicing system which proves very effective, a large number of coconuts can be dehusked at a minimal amount of time. This reduces labor effort, increases operating efficiency and eliminates injury to the Dehusking labor. The system also proves to be very safe. The system can be modified to have a Coconut Collector from which the coconut can be dehusked automatically through timer programmed circuits. This can eliminate the need for manual feeding process and thus completely Automate the project.

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