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Design, Development and Testing of Green Betel Nut Husking Machine

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***Abstract* – The primary processing of green betel nut is, peeling the outer shell completely. This process is called husking of green betel nut. However it is being done manually by using a sharp knife with a production rate of 3kg/hr. The husking is difficult with Knife and hand. Presently there are no devices available for green betel nut husking. The nut is very soft that a higher pressure on it will break in to pieces. So it is essential to develop a hand-operated machine as a primary stage which will increase the production rate and safety to laborers, later with the same techniques we can move to a mass production machine. Under these circumstances, there is enough scope to develop a suitable device to peel the green betel nuts of different sizes and conditions. This device would find its major application in husking green betel nuts. The device is simple in design, portable, weightless, low cost and easy to operate by unskilled person. The proposed device is tested and it is found that the production rate is increased to 5 Kg/hr. There is also a scope for automated processing which would enable processing of bulk quantities at a higher production rate.**

***Keywords* – Green betel nut, Husking, Machine, Peeling.**

I. INTRODUCTION

The green betel nut is the seed of the Areca palm (Areca catechu), which grows in much of the tropical Pacific, Asia, and parts of east Africa. It takes approximately five years for an areca nut palm to mature and bear fruit. Once mature, the palm can provide nuts annually for up to fifty years. Each areca palm is harvested once a year. It is commercially available in dried, cured, and fresh forms. While fresh, the husk is green and the nut inside is so soft. Green betel nut is widely used mainly in the Asian and South East Asian population. It is normal that after having food in India people use betel nut along with the betel leaves as a digester in small quantities. Though usage of green betel nut and its implications on the health is debatable it is still not a good habit to use it on a continuous basis [1]-[2]

Green betel nut has to be primarily processed in by peeling the outer shell completely. Peeling of Green betel nut is difficult by hand and more over operations are not safer. However it is being done manually by using a sharp knife with a production rate of 3kg/hr [2]. So it is essential to develop an agri-machine which will increase the production rate and safety to laborers. In the present research a proposal is made to design the husking machine. The principle behind this fabrication is that, the mechanical separation of seeds from green betel nut husk by developing appropriate technology i.e, hand operated green betel nut husking machine which require less human energy to achieve sustainable development of rural farmers.

A green betel nut husking device is a device used for peeling the husk of areca nut. It is nothing but deshelling process for areca nut. The word husking is also referred to a device which helps to separate the seed from the husk. The device is designed for green betel nuts only [3]-[4].

A. General Characteristics

There are two varieties of Areca nut, called White Supari and Red Supari. Red variety supari is prepared by harvesting the tender (green) Areca nut, peeling off the husk by hand. The nut derived by peeling the tender nut, are processed as per the variety required (i.e., whole nut, two pieces, 8pieces, etc) boiled in water and then Sun dried. India accounts 1184 Kg/ Ha in 2001 and 1222 Kg/Ha in 2009 [5]

B. Indian Scenario

The current world productivity of Areca nut is 1.287 tonnes/ha. India is the largest producer of Areca nut in the world. India ranks first in both area (58%) and production (53%) of Areca nut. Besides India, China, Bangladesh, Indonesia, Myanmar, Thailand are the other important Areca nut producers. It is estimated that more than 10 million people depending on this crop for their livelihood. The main pockets of production of Areca nut in India are distributed in the states of Karnataka (42% of area and 45% of production), Kerala (28% of area and 24% of production), and Assam (20% of area and 16% of production). Tamil Nadu, Maharashtra, Andhra Pradesh, West Bengal and Orissa are the other important producing states. Mumbai, Ahmadabad, Indore, Jaipur, Delhi, Nagpur, Patna, Calcutta, Cuttack, Mangalore, Bangalore, Rajkot, and Chennai are the important marketing centers of Areca nut in India. Total consumption in India is estimated to be 330,000 ton per year. India also exports limited quantity mainly in the form of pan masala, scented supari and gutkha [6]

II. PROBLEM DEFINITION

Cost of processing of Areca nut to remove the nuts has revealed that about 35-40 per cent of the total cost of processing is spent for husking Areca nut alone. Peeling of Areca nut is one of the labour intensive processes. This task is mainly carried out by ladies and children in the village. Peeling of Areca nut is difficult by hand. Presently it is being done manually by using a sharp knife with a production rate of 3kg/hr . and normally one will do about 24 kg in a day. This work is done by skilled labours only. Shortage of labour is a major problem which almost every village and farmer faces, especially during the harvest season. Therefore it is essential to develop a machine which will enhance the ease of production & eliminate the risk of labour injury involved in the traditional manual

peeling process. Under these circumstances, there is enough scope to develop a suitable machine to peel the Areca nut of different sizes completely and efficiently. The machine should be simple in design, easy to operate, portable, low cost and easy to operate by unskilled person [7]-[8]

III. OBJECTIVE

The objective of the project is to develop a machine for husking of green betel nuts. These problems can be overcome by developing a machine which can efficiently and economically husking the Areca nuts. The machine should be able to accommodate different sizes of Areca nut and it must also be easy to operate, eliminating the need of skilled labour [9]-[10].

IV. DEVELOPMENT OF GREEN ARICANUT HUSKING MACHINE

Fig.1 provides a 3D model of a green betel nut husking machine. The machine comprised 4 parts: blade, blade holder, rotating ring, base holder. The base holder will hold the areca nut correctly in position. The upper portion contains rest of the parts which include the blade, blade holder and rotating ring.

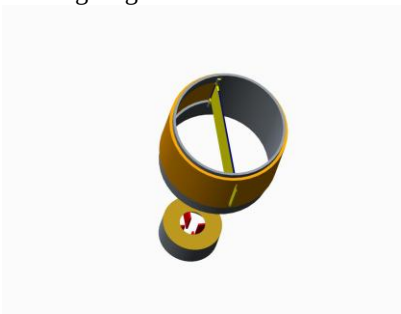

Fig.3D Model

V. DESIGN

The machine comprised 4 parts:

1. Blade
2. Blade holder
3. Rotating ring
4. Base holder

A. Blade

The blade is an important part of our mechanism with a sharp edge to cut the areca husk. There will be two symmetrical blades (Fig.2). When we keep both blades joined together one side of the blade is sharp enough to cut the areca nut up to one by third of the height. The material used is tempered steel for withstanding bending load. The one end of blade is inserted to a hinge on the blade holder (Fig.4) and the other ends have a sliding contact to the rotating ring (Fig.6) of our mechanism. Blades have the freedom to rotate about 70 degree to 80 degree inside the blade holder (Fig.4). Initially the two blades are kept together which is act as one sharp blade. When we apply tangential force the blades will moves apart. And the husk will separate from the nut. Blade's freedom is calculated separately i.e; through the rotation of blades inside the mechanism. According to the case study on areca nut the mean diameter ranges between this to this. Therefore the rotation of the blades should be provided between 70° to 80° but the required angle of freedom for the blade range between 30° to 40°. If the expansion of the blade is lower than the required value the husk will not be removed perfectly.Fig.3 represents the part drawing of blade.

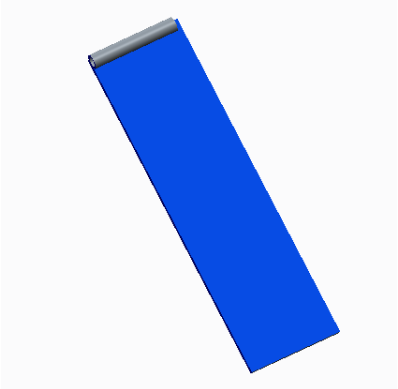

Fig.2 Cutting Blade

Specification

1. Length: 86mm
2. Wedge: 2mm (together: 4mm)
3. Thickness: 1mm (together: 2mm)
4. Width: 30mm
5. Hinge diameter: 8mm
6. Length of hinge: 23mm
7. Material: HSS (high speed steel)

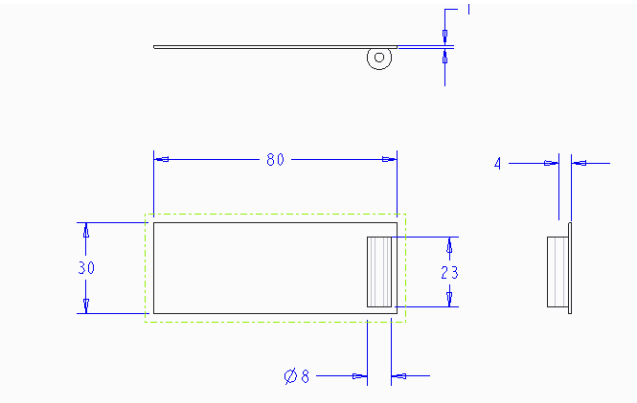

Fig.3. Part Drawing of Blade

B. Blade Holder

Blade holder is the part in which we are fixing the blade to a hinge. This arrangement will make the blade to dismantle easily from the body. It is a cylindrical ring having inner diameter of 85mm. One end of the blade is hinged on the ring. The hinge is provided inside the blade holder and there is a slot given to the holder for the rotation of the blades (Fig.4). There is a provision is made in such a manner that it allows the blade to rotate about the hinge at an angle of 70° to 80°.The part drawing of rotating ring is shown in Fig.5.

Fig.4. Blade holder

Specification

1. *Diameter: 85mm*
2. Thickness: 2mm
3. Axial length: 65mm
4. Provision length (arc length): 50mm
5. Material: HD plastic

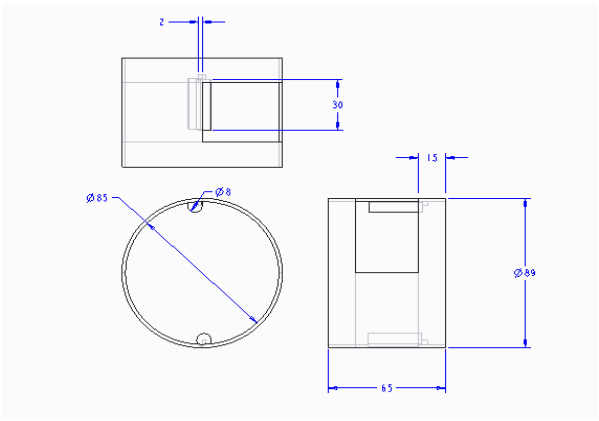

Fig.5. Part drawing of blade holder

C. *Rotating Ring*

Rotating ring is the part through which we are transferring clockwise torque couple to the blades (Fig.6).This is a ring like structure with two offset slots. While inserting the ring over blade holder (Fig.4) slot space will be occupied by blade. The rotation of rotating ring with a sliding action it will transfer torque to both the blade as a clockwise couple. The ring is provided inner diameter 1mm more (Fig.7) than outer diameter of the blade holder (Fig.5). The relative torque applied to the ring will transfer to the blade and the hold stationary with the other hand. The part drawing of the rotating ring is shown in Fig.7.

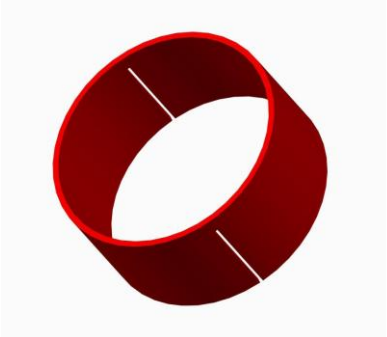

Fig.6. Rotating ring

Specification

1. Inner diameter: 91mm
2. Axial length: 56mm
3. Thickness: 2.5mm
4. Provision length: 33mm
5. Provision thickness: 5mm
6. Material: HD Plastic

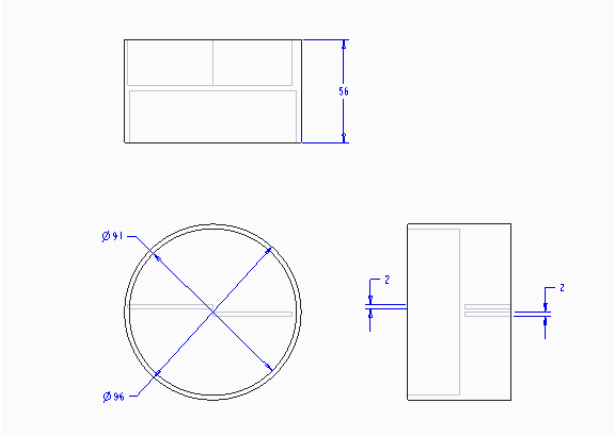

Fig.7. Part drawing of rotating ring

D. *Base Holder*

It is used to hold the areca husk from the bottom side with other hand. It is a hollow cylinder about 59mm in outer-diameter, depth of 38mm and thickness 1mm (Fig.9). Inner portion of the hollow cylinder is welded with 4 sharp cornered plate to get a seating for areca nut husk. Top portion is covered by a steel plate which is having a inner opening of 26mm (Fig.8).

Fig.8. Base holder

Specification

1. Length: 38mm
2. Diameter: 58mm
3. Opening diameter: 25mm
4. Thickness: 1mm
5. Distance between two holding plates: 15mm
6. Material: mild steel

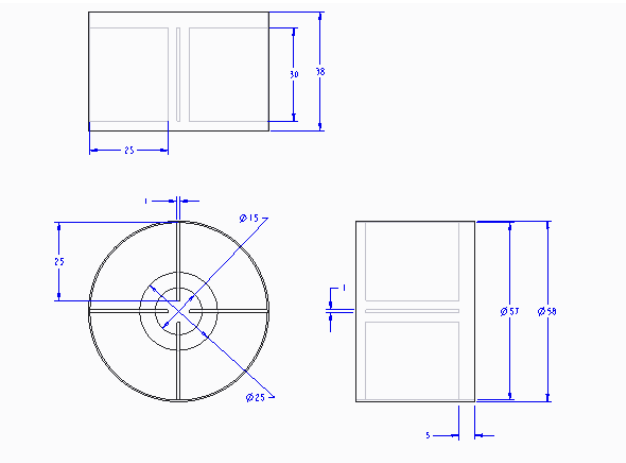

Fig.9. Part drawing of base holder

V. WORKING

Figure shown below is a complete working unit of areca nut husking machine (Fig.9). The top portion consist of cutting bade, blade holder and rotating ring as one mechanical unit called cutting unit. Fig.10 shows the cutting state of the unit. When we rotated the ring in counter clockwise direction both blades will move apart as shown in Fig.11. On our right hand side we are going to hold the cutting unit and on the left hand we will hold the base holder.

Operation steps:

Step1: Take the green areca nut with the base holder (Fig.8). That is the lower pointed side of areca nut should go inside the hole. Now the 4 pointed plates inside the base ring will grip the areca nut.

Step 2: Take the cutting unit (Fig.10 top portion) on our right hand side. Now bring the lower unit with areca nut close to the cutting side of the cutter unit. By applying pressure try to cut the areca nut to one third of its total height.

Step 3: Using our left-hand finger try to hold the lower portion of blade holder (Fig.4). Now try to rotate the rotating ring on our right-hand side to counter clockwise direction till the shell breaks and nut comes out.

Step 4: After step 3 we will get the nut in right-hand palm. Remove the husk from the base holder. Now the system is ready for next green areca nut.

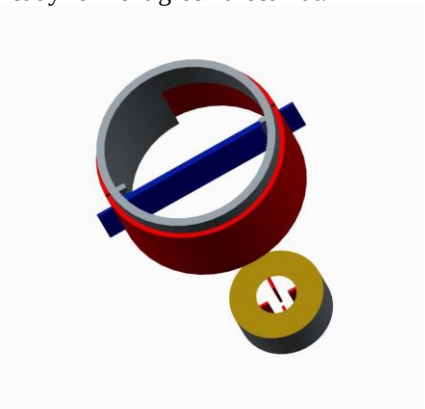

Fig.10. isometric view

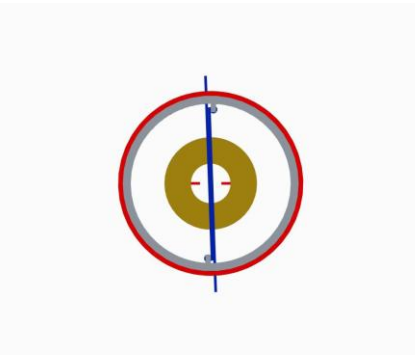

Fig.11. Top view (Blades are closed)

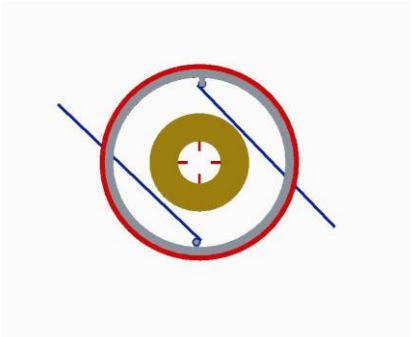

Fig.12. Top View Blades are open state

VI. FORCE ANALYSIS

By using the new proposed system we have double the mechanical advantage (Fig.13).

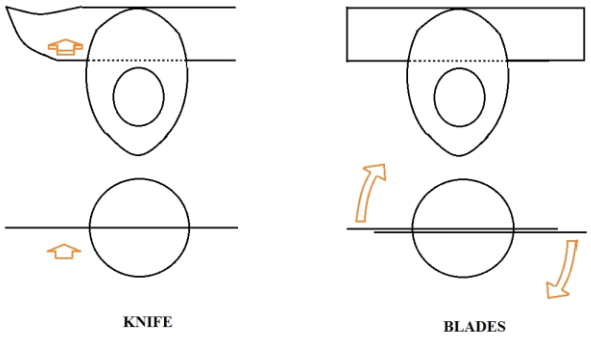

Fig.13. cutting with knife on left and with new system right

F_h is the force given by the hand for husking process F_a is the force needed at the husk part for husking.

In case of a traditional husking of areca nut using a knife:

The husking process is based on moment action of force. When we twist the knife inside the husk half width of knife will be the moment point. Let *l* be the width of the knife. Moment occurs at *l*/2.

i.e $F_h \times l/2 = F_a \times l/2$ (1)

$$F_h = F_a \quad (2)$$

But in case of the blades (of same length *l*) of green areca nut husking machine as shown in Fig.14.

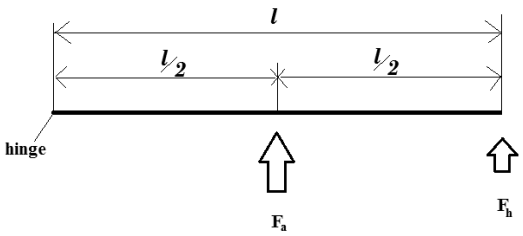

Fig.14. Force diagram of proposed model

Taking moment about the hinge

$F_h \times l = F_a \times l/2$ (3)

$F_h = F_a / 2$ (4)

Since two such blades are coupled action the force effect will be doubled

$Fh = Fa / 4$ (5)

Thus the mechanical advantage of the mechanism is 1:4 or the applied force is magnified four times. Considering the width of the knife is equal to the length of the blade.

VII. TESTING

Table 1: Testing and comparison of machine

Person	Husking time with new machine (Kg/ Hr)	Husking time with Knife (Kg/hr)
1	5.2	2.9
2	5.4	2.8
3	5	3
4	4.8	3.2
5	4.6	3.1

Table 1 shows the test report of the machine where five persons are provided the machine for the work. They feel more convenient for work with new technology. The most important point to be noted are the effort is reduced and the average production rate is increased for 3 Kg/ hr with knife to 5 Kg/hr.

VIII. CONCLUSION

The green areca nut machine is developed and tested successfully. As per the test result it is found that the production rate of the laborers increased from 3Kg/hr to 5 Kg/hr. By this mechanism the extracted nut will have the least damage. The rate of damage is decreased considerably and can be neglected. Also the safety of the operator is enhanced. By this project we have designed a mechanism to extract the areca nut from areca husk. It is found that the effort require to husk the nut with this mechanism is one fourth that with traditional husking using knife. The light weight of the machine is very much helpful for consistent working and portability.

SCOPE FOR FUTURE WORK

By the proper incorporation of modern technology to the system can be converted to stand alone machine which will produce a large quantity of pealing.

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