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Design, Development and Testing of an Areca nut Dehusking Agri-machine

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Abstract
Areca nut has to be processed in dry condition by peeling the outer shell completely. Peeling of Areca nut is very difficult by hand. However it is being done manually by using a sharp knife with a production rate of 3kg/hr. So it is essential to develop an agri-machine which will increase the production rate and safety to labourers. Presently there are few machines available but these machines are not suitable for variety of sizes of Areca nut which leads into the insufficient removal of outer shell of Areca nut. Therefore there is enough scope to develop a agri-machine suitable for variety of sizes of Areca nut which will overcome these problems.

The present reserch work emphasizes on developing an Areca nut Dehusking agri-machine for three different sizes of Areca nut. The concept is to shear-off the husk of the dry Areca nut by shearing force. The features a Dehusking mechanism, and a power drive. The experiments were conducted by changing the blades, and selecting the best method. The first experiment were conducted by mounting set of two cutters separated by spacers for each size of Areca nut, then the set of two cutters were replaced by single cutters and the results of both the experiments were compared and concluded that the single cutters were more efficient than the set of two cutters in Dehusking the Areca nut.

Key Words: Arecanut, Peeling, Dehusking, Agri-machine, cutters.

I. INTRODUCTION

Areca nut is an important commercial crop in India. An Areca nut is the seed of the Areca nut palm. It plays a prominent role in the social, cultural functions, religious and and economic life of people in India. The income produce is the fruit called "betel nut" and is used mainly for masticatory purposes. These Areca nut has uses in ayurvedic and veterinary medicines. And it is estimated that nearly ten million people depend on Areca nut industry for their livelihood in India. The quality, variety and types of Areca nut vary from one place to another. The Areca nut palms grow under a variety of climatic and soil conditions. This Areca nut palm grows well from almost sea level up to an altitude of 1000 m in areas of abundant and well-distributed rainfall or under irrigated conditions. While fresh, the husk is green and the nut inside is so soft that it can easily be cut with an average knife. During the ripening of fruit the husk becomes yellow or orange and, as it dries, the fruit inside hardens to a wood-like consistency.[1-2]

1.1. GENERAL CHARACTERISTICS

There are two varieties of Areca nut, called White Supari and Red Supari. White variety supari is prepared by harvesting fully ripe Areca nut and by sun drying for 40 to 50 days. After drying the nut, the shell of the nut has to be removed by hand/machine. The nut derived from this dried fruit is called Areca nut/Supari/Betel nut. The white variety of Areca is mainly grown in Dakshina Kannada and North Canara of Karnataka state and northern parts of Kerala. Red variety supari is prepared by harvesting the tender (green) Areca nut, boiling it and peeling off the husk. 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. The red variety of Areca nut is mainly produced in Shimoga, Chickmangalur, Chitradurga, and Tumkur Districts of Karnataka. The white variety accounts for 60 percent of the production with the rest going for red.[3-4]

1.2. 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.[5-6]

Fig.1 Photo of a ripened Areca nut

1.3. STATUS IN KARNATAKA

Karnataka is the major producing state in India. In Karnataka, Areca nut is cultivated as a garden crop. Areca nut is mainly produced in Shimoga, North Canara, Dakshina Kannada, Udupi, and Chikmagalore districts. In four decades area under Areca nut was tremendously increased that is nearly 400 times. More than 2 lakh farmer families are involved in the Areca nut cultivation. Areca nut could provide an assured employment to the extent of one crore man days annually.[7-8]

Fig.2 Photo showing Areca nut trees

1.4. AGRI-MACHINE

An agri-machine or Decorticator (from Latin: cortex, bark) is a machine for stripping the skin, bark, or rind off nuts, wood, plant stalks, grain, etc., in preparation for further processing. It is nothing but de-shelling process for several seed (groundnut seeds, Jatropha seeds and Pongamia seed) varieties. The word decorticator is also referred to a device which helps to separate the seeds from the Pods, the structure of device varies from crop to crop based on seed type.

In the present research, a protocol has been proposed to design the agri-machine. The principle behind this fabrication is that, the mechanical separation of seeds from Pongamaia pods by developing appropriate technology i.e, Machine operated Agri- Machine which requires less human energy to achieve sustainable development of rural farmers.[9-10]

Fig.3 Photo showing Dehusked Areca nut

II. RELATED WORKS:

There are few Areca nut peeling machines are available in the market. These machines are further classified into:

- ***Manually operated machines:*** These machines are either hand operated or pedal operated.
- ***Fully automated machines:*** These machines are operated by electric motor and other source of energies.

The below machine in **Fig.4** consists of a mainframe on which a rotary shelling drum having 8 numbers of solid rubbers on its periphery is mounted. Below this, a concave is placed to aid shelling and to pass the Dehusked material down. After Dehusking kernels and husk flow to the duct and reach the air stream, produced by a blower. The husk is thrown out and the kernels/nuts are collected at the bottom. Depending upon the size of fruits, the concave has to be changed for higher efficiency and minimum breakage. Grading the dried fruits before Dehusking will also help to increase the Dehusking efficiency and reduce the breakage. 1 hp electric motor is required to run this machine. Its production capacity is 30 kg per hour. The cost of this unit is Rs. 25 000.

But this machine is suitable only for dried Areca nuts.

Fig.4

The below machine (**Fig.5**) was developed by Mr. M J Francis, Kerala. This machine is priced at Rs 850 and can Dehusk 14 nuts in one minute. But it requires skilled labours. Since this machine is pedal operated and not suitable for continuous peeling process.

Fig.5

The below machine (**Fig.6**) was developed by Post Harvest Technology Centre, University of Agricultural Sciences (UAS), Gandhi Krishi Vigyan Kendra (GKVK), Bangalore. Machine assembly consists of two sharp edged flaps, one being stationary and the other movable, operated by the pedal through a linkage mechanism. The unit has a hopper to hold about 20 kg of Areca nuts. Assembly is made of mild steel, the entire unit is mounted on an angle iron stand and the Dehusking mechanism is made of spring steel. This is suitable only for Dehusking freshly harvested mature green Areca nuts of all varieties under cultivation. The machine can be operated by four persons to Dehusk Areca nuts simultaneously. The Dehusking capacity of the unit is 160 kg per day with a running time of eight hours per day. The unit is priced at Rs. 3500. This semi-mechanized Dehusker operates at reasonably high output causing less drudgery compared to the traditional method of Dehusking which requires a lot of manpower. But it requires skilled labours. Also only half portion of the husk can be removed by using this machine and the rest should be removed by hand.

Fig.6

III. 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 Dehusking 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 very 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 rate of production & eliminate the risk of labour injury involved in the traditional manual peeling process.

Presently there are few machines available in the market, but these machines are not suitable to peel variety of sizes of dry Areca nut and also which are not fully efficient in the view of complete removal of outer shell. These existing machines are more costly and are complex in design. The main problem is that they are heavy in weight and not portable. Some machines may cause damage to the Areca nut and not easy to operate. 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.

IV. OBJECTIVE:

The objective of the project is to develop a machine for Dehusking of Areca nuts and to address the drawbacks of the existing machines such as incomplete removal of husk, expensive, not suitable for different sizes of Areca nut etc. These problems can be overcome by developing a machine which can efficiently and economically Dehusk 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.

V. DEVELOPMENT OF AN ARECA NUT DEHUSKING MACHINE:

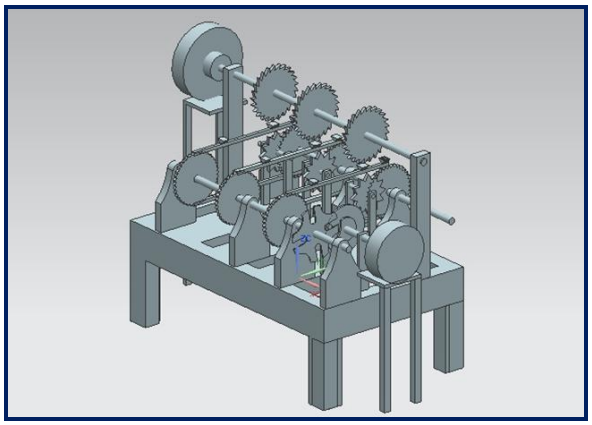

Fig.7 3D MODEL

Fig.8 Frame

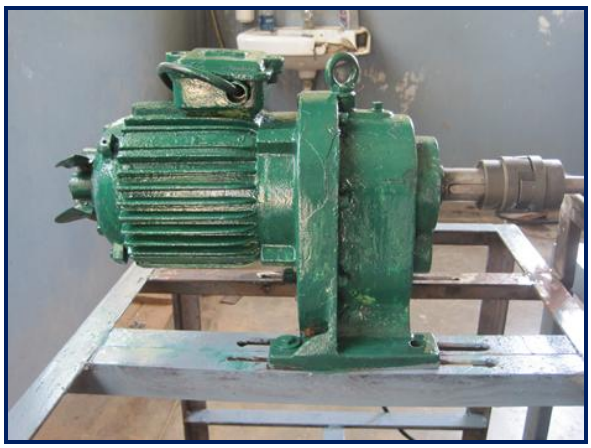

Fig.9 Motor

Fig.10 Cutter Shaft

Fig.11 Sleeves and spacers

Fig.12 Cutter

Fig.13 Cutters held on shaft by the sleeves

Fig.14 Photo showing Plummer Block

Fig.15 Complete assembly

VI. TECHNICAL SPECIFICATIONS OF AN ARECA DEHUSKING MACHINE:

Sl. no	Feature	Description
1	Total weight	80kg
2	Maximum height	900mm
3	Maximum width	600mm
4	Maximum length	1800mm
5	Working speed	125rpm
6	Capacity	18 kg/hr
7	Cutter diameter	110mm
8	Electric Gear Motor	1.5hp,3 Phase,125rpm
9	Shaft	Length= 900 mm, Dia =20 mm

VII. EXPERIMENTS PERFORMED:

Three experiments were conducted by altering the blades and varying the speed and selecting the best one. The details of experiments are as given below.

7.1. EXPERIMENT 1:

In this experiments a set of two cutters with spacers inbetween for each grade of Areca nut were used. The speed of the cutter shaft was at 125 rpm. The Areca nut was fed below the cutters. As it can be seen from the images below, the outer shell of most of the Areca nuts fed was not being removed completely. Due to these problems the experiment was not satisfactory.

Fig.16 Setup showing experiment-1

Fig.17 Showing the result of experiment-1

7.2. EXPERIMENT 2:

In this experiment only one cutter was used as compared to set of two cutters used in the previous experiment for each grade of Areca nut. The speed of the cutters were also reduced to 62 rpm using double grooved pulleys and "V" belts. The Areca nuts were fed below the cutters. Again in this case most of the nuts were not Dehusked.

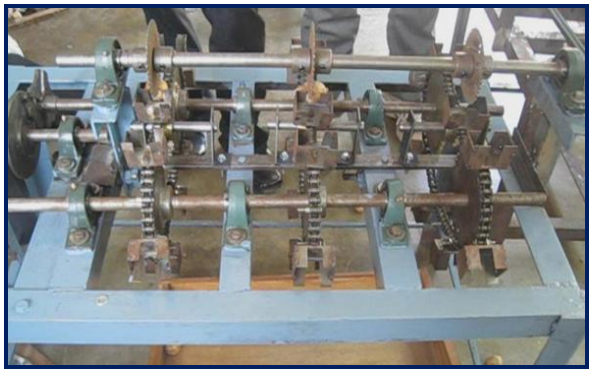

Fig.18 Setup showing experiment-2

Fig.19 Showing the result of experiment-2

7.3. EXPERIMENT 3:

In this experiment, the speed was speed was changed back to 125 rpm. Single cutter was cutter was used for each grade of Areca nut. It could be seen that most of the Areca nuts were being Dehusked completely in this experiment. The results of this experiment was satisfactory.

Fig.20 Setup showing experiment-3

Fig.21 Showing the result of experiment-3

VIII. RESULT AND DISCUSSION:

Three experiments were conducted by changing the speed and the number of cutters used. blades. At the end of each experiment, observations were made with respect to the removal of outer shell of Areca nut. Dry Areca nuts can be categorized into three types depending on their sizes. They are small sized, medium sized and large sized. These three types of Areca nuts were used in all the experiments.

After completing these experiments, the results were compared and found that the third experiment was the best method. This set up consists of a single cutter for each grade of areac nut rotating at a speed of 125rpm. Thirty Areca nuts fed to the machine, 10 of each grade and it was seen that 22 Areca nuts were Dehusked completely. This suggests that on an average around 7 Areca nuts of each grade is Dehusked completely by this machine. Hence the calculated efficiency of the machine is around 74%.

IX. CONCLUSION

The Areca nut Dehusking machine is developed and tested successfully. This machine is compact in design, making it portable. This machine is economical compared to the other existing machines. It can be operated by semiskilled personnel also. This machine has

three cutters making it suitable for Dehusking of three grades of Areca nut. Hence this machine has overcome the problems associated with the existing machines. After performing three experiments with different speeds and changing the number of cutters used, it can be concluded that the machine has an efficiency of 74% with single cutter at 125rpm.

Fig.22 Photo showing peeled dry Areca nuts

Fig.22 Photo showing final result

X. SCOPE FOR FUTURE WORK

- The Dehusked peel gets stuck to the cutter blades and hence it is necessary to make arrangements to remove the stuck peel from the cutter.
- Provision for keeping the chains free from dust.
- Suitable covering for the machine and arrangement for collection of Dehusked Areca nuts.

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