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Introducing an appropriate mechanical way for Coconut dehusking

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Abstract

Coconut (*Cocos nucifera* L.) is a perennial tree crop, which has a *percapita* consumption of 120 nuts/ year/ head in Sri Lanka. Nut is the most important economical part in a coconut palm. Fruit has to be de-husked before any production process and there is no any mechanical mean, available in Sri Lanka other than manual coconut de-husking with an iron spike. This has become a major problem in coconut industry, as it is laborious, dangerous and expensive. This study was aimed to introduce an efficient and affordable mechanical method for coconut de-husking. Main components of the de-husking machine are; set of blades and blade spreading system, operating lever system and adjustable fruit holder. The most salient feature of this machine is detaching the husk into four pieces while retaining the soft eye covering part. Machine weighs 65 kg and the total cost of production was LKR 13,200. The performance of the de-husking machine was evaluated separately using a single operator (T_1) and an operator with a helper (T_2) and compared it with most practicing manual de-husking method (de-husking with iron spike). According to the analyzed results by one way analysis of variance (ANOVA), there is a significant difference ($p<0.05$) between T_2 and the manual method but no significant difference was observed between T_1 and the manual method. Actual capacities of T_1, T_2 and the manual method were 69, 135 and 78 nuts/ hr, respectively. Theoretical machine capacities of T_1, T_2 and manual method were 107, 164, 105 nuts/ hr, respectively. Efficiency of the machine with T_1, T_2 and the manual method were 64.5%, 82% and 74%, respectively. Therefore, the coconut de-husking machine could be effectively utilized using operator with a helper for a higher capacity and machine efficiency.

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Keywords: Coconut production; dehusking; machine capacity

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1. Introduction

Coconut (*Cocos nucifera* L.) is a versatile palm tree in which most of the parts can be used for different purposes. Coconut oil, copra, vinegar, jaggery, coconut oil cake, shell products and coir products are few of industries, which are based only on nut and inflorescence of the coconut tree[1]. An individual coconut fruit is made up of an outer exocarp, a thick fibrous fruit coat known as husk, underneath is the hard protective endocarp or shell which protects the edible flesh. The size of nut varies from 147 to196 mm in diameter and 245 to 294 mm long[2]. The coconut fruit should be dehusked prior to any postharvest application on flesh. Prevailing de-husking techniques in Sri Lanka are risky and laborious. Semi and fully automated machines used in developed countries are not affordable for small and medium scale farmers in Sri Lanka. Although, lots of studies on coconut de-husking machines have been carried out, those are not popular among coconut producers due to their complexity in operation and low efficiency. This research was conducted to develop a manually operated coconut de-husking machine for medium scale farm holders which make their coconut de-husking operation efficient, safe and cheaper in order to increase profits in this particular aspect of the coconut industry in Sri Lanka.

2. Methodology

The study was conducted at the Faculty of Agriculture, Rajarata University of Sri Lanka. A preliminary experiment was carried out with hundred coconuts selected from a properly maintained coconut plantation in order to find out the average measurements such as height and width of the fruit, thickness of the husk at stalk end, height and width of the nut, for the determination of the dimensions of the machine components.

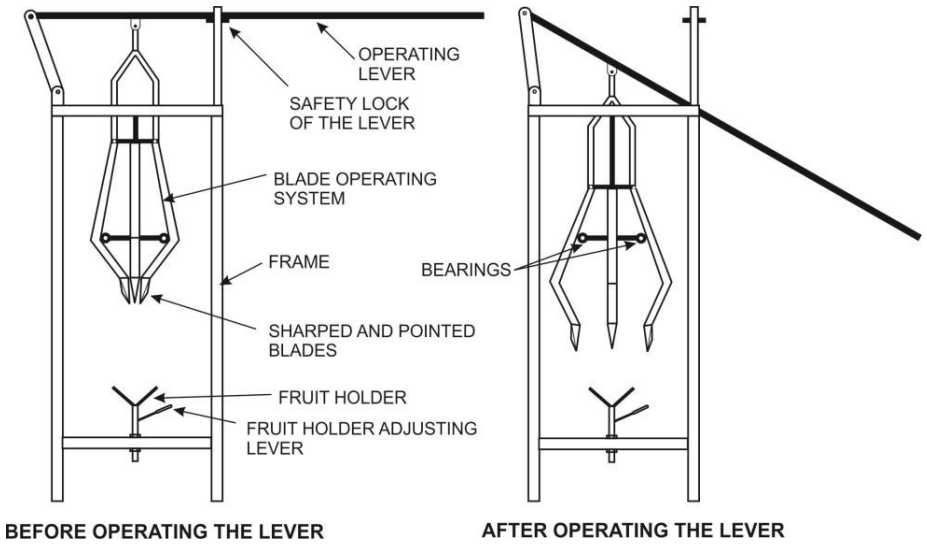

Fig. 1. Side views of the machine after and before operating the lever

Specially designed lever system which has two fulcrums was used to give a straight downward motion to the set of blades. Blades set consisted of four sharp, pointed blades, made of steel and connected to the system of bended blade hands. Shape of the blades was designed considering the fibre arrangement inside the coconut husk. The blade hands were designed to a special shape to operate the blades set in such a way to penetrate into the husk without damaging the nut and then spreading them to detach the husk while retaining the soft eye covering part.

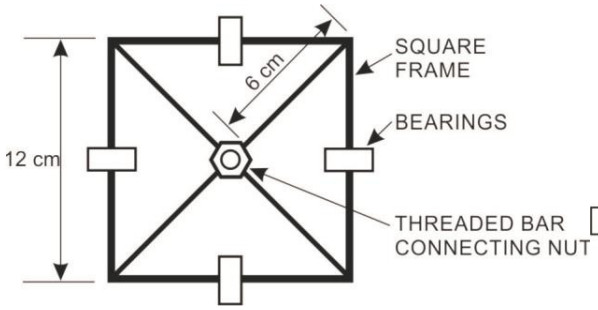

Fig. 2. Blade Operating System

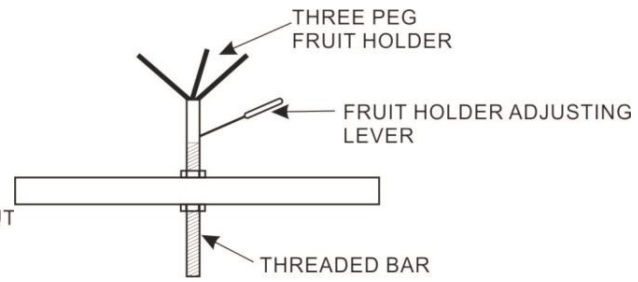

Fig. 3. Fruit Holder

Blade operating system consisted of four bearings arranged in a square frame, which is connected to the machine frame using a threaded bar. These four bearings roll over the flat iron pieces in the blade hands, while spreading the blade system. Fruit holder was designed to hold the fruit during the pealing operation. It was designed in an adjustable manner by attaching to a threaded bar and a lever, as fruit sizes are variable with a wide range. It was designed as three angled rods because of the special shape of the coconut fruit at the blossom end and to reduce the resistance, while detaching the husk. Unskilled male workers were used in machine method using only one operator (T_1) and operator with a helper (T_2) along with the manual method for the performance evaluation of the machine. According to the average time taken to de-husk a single fruit, theoretical capacities (No. of fruits/ hr) of both machine and manual method were calculated. Actual number of fruits de-husked within an hour, after taking all the time wastages into account was calculated to determine the actual capacities of both methods.

3. Results, Discussion, Conclusion and Recommendations

According to the data collected in the preliminary test, the average dimensions of coconut fruits were calculated and they are shown in the table 1.

Table 1. Required dimensions of the coconut fruit for the design

Parameter	Dimension (cm)
Width of the fruit (maximum recorded diameter)	18
Height of the fruit (maximum recorded height)	28
Thickness of the husk at stalk end (recorded average thickness)	2.5
Diameter of the nut (maximum recorded diameter)	13

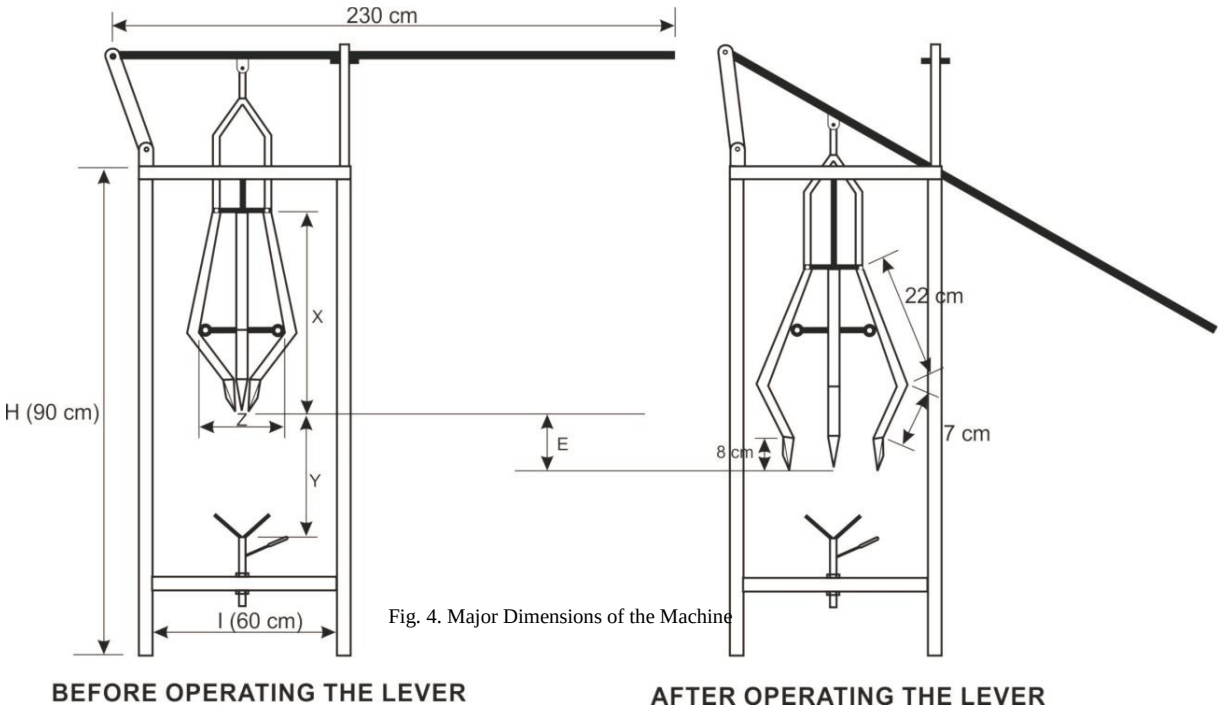

Fig. 4. Major Dimensions of the Machine

Height of the blade set (X) and maximum height of the space between the lowest point of the blade set and fruit holder (Y) were determined as 30cm by using the maximum height of the coconut fruit. Space represented by *Y* is the place where coconut fruit is placed, so that it requires an enough height to suit for any size of coconut. Maximum inside space of the blade set (Z) was determined as 15cm by considering the maximum diameter of a nut in order to avoid damages to the nut. Height of the machine frame (H) was designed as X + Y + height of the adjustment of the fruit holder. Width of the machine frame (I) was determined as 60cm, by considering the distance blades spreaded. Interior angle of the blade hand was determined as 120^0 to facilitate the application of force to the blades set. The blades were connected vertically to the hand in order to ease the penetration in to the husk. The non spreading distance of the blade sets (E) is very important, because it initiates the dehusking by penetrating into the husk. This was determined as 2 cm, in order to avoid the damages to the nut by possible blade penetration, because the average thickness of the husk at stalk end of the fruit was 2.5 cm. Final specifications of the machine were as in table 2.

Table 2. Specifications of the coconut dehusking machine

Machine Part	Dimension
Total height	120 cm
Total width	60 cm
Total length (without operating lever)	60 cm
Total weight	65 kg
Weight without operating lever	50 kg
Height of the blade	8 cm
Length of the operating lever	230 cm
Height of the frame	90 cm

Table 3. Comparison of the machine performance with manual method

Results	Machine with one operator	Machine with Two operators	Manual method
Theoretical capacity (nuts/hr)	107	164	105
Actual capacity (nuts/hr)	69	135	78
Machine efficiency (%)	64.5	82	74
Dehusking percentage (%)	88.3	93.3	100
Damage percentage (%)	18.6	6	0

By one way analysis of variance (ANOVA), there is a significant difference ($p<0.05$) between T_2 and manual method, while no significant difference was observed between T_1 and the manual method. The results of the evaluation (Table 3) show that, this machine could be effectively utilized with operator and a helper, with a higher machine efficiency (82%). In this method, operator's only responsibility is to operate the lever and there should be an extra person to adjust the fruit and remove the nut after de-husking. Operators do not need to have any special skill to operate the machine and even a women operator can operate the machine as it requires minimal effort (50kg). Safety of the operators could be assured at 100%, as no casualties were recorded during the evaluation procedure. Retaining of the soft eye covering upper husk part is a special advantage for the shelf life of a coconut. This mechanism may be further developed to modify the lever to couple with the three point linkage of a four-wheeled tractor, to facilitate operation with hydraulic power.

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