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Design and development of manually operated coconut splitting device

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After coconut is de-husked, the hard but brittle shell is exposed and can be split open into two halves using a machete. The nut water is drained off leaving the cups ready for drying. In India, coconut is broken transversely into two cups using a traditional knife having a long handle and a sharp edge. This operation is carried out in the bending posture, which is a tedious and tiresome work. In other countries, the coconut is split open into halves using a machete (Punchihewa and Arancon, 2001). Some farmers split nuts using a heavy machete even without de-husking. After splitting the nut water is allowed to drain off. This is a labour intensive, semi-skilled job and time consuming. Hammonds *et al.* (1991) reported that each coconut was broken into halves by a sharp blow with a file along the less sharply curved portion of the equatorial circumference. Sankat and Rolle (1990) reported that whole de-husked nuts are usually split into halves using a wooden mallet and dried with kernel, in the Caribbean Island. Friend (1991) reported that in the Solomon Islands nut splitting is performed with an axe and copra is scooped out with a knife. There are reports of severe hand injury in case the knife slips. Attempt to develop an improved device for splitting coconut has not been reported so far. The water of matured nut is wasted as there are no gadgets to collect the same hygienically during the splitting operation. Thus, there is a pertinent need to develop a coconut splitting device for the benefit of small and large scale processing units and Co-Operative Societies engaged in copra processing. With this in mind an attempt is made to develop a coconut splitting device.

Thampan (1981) stated that in India, coconut is broken transversely into two cups using a traditional knife having a long handle and a sharp edge and is then generally sun-dried. Sankat and Rolle (1990) reported that whole de-husked nuts were usually split into halves using a wooden mallet and dried with kernel in the Caribbean island. Friend (1991) reported that splitting was performed with an axe and the copra scooped out with knife. Hammonds *et al*. (1991) reported that each coconut was broken into half cups by a sharp blow with a file along the less sharply curved portion of the equatorial circumference in the Solomon Islands.

Thampan (1999) reported that splitting of coconuts by the farmers is commonly done using knives in Kerala state. Punchihewa and Arancon (2001) reported that in many countries, coconut was de-husked and the hard but brittle shell were split open in to halves using a machete. The coconut water was drained off leaving the cups ready for the drying stage. Some farmers also practiced nut splitting using a heavy machete even without de-husking the coconut. After nut splitting, the water was allowed to drain off. Splitting nuts is a labour intensive and semi skilled job and required lot of time and energy. Arulraj *et al*. (2002) reported that in the traditional method of nut splitting using a knife, the impact force was applied opposite to the larger eye (germinating eye) which helped to split the nuts with less force.

The fabrication of the device was done as shown in the Fig. 1. In order to make the supporting stand of the splitting platform angle iron bars of 50 x 50 x 6 mm size were welded to get the rectangular base frame of 50 x 40 cm. The 50 mm I D “B” class pipe of 95 cm length was welded vertically to the base frame at one end. Above the M.S.pipe two pieces of 40 x 40 x 6 mm angle iron of 30 cm length were welded vertically with 12 mm holes to fix the splitting tool frame. Additional holes were provided for adjustment of the cutting tool. A support box frame made of 25 x 25 x 3 mm, M.S. angle and 16 guage, M.S. sheet was welded to the vertical pipe at one end and the other and was supported with 15 mm ϕ M.S. rod with the base platform. Above the support box frame M.S. nut holder was provided to hold the split nut. The nut support box frame was given an inclination of 45º towards the bottom base, so that the coconut water will

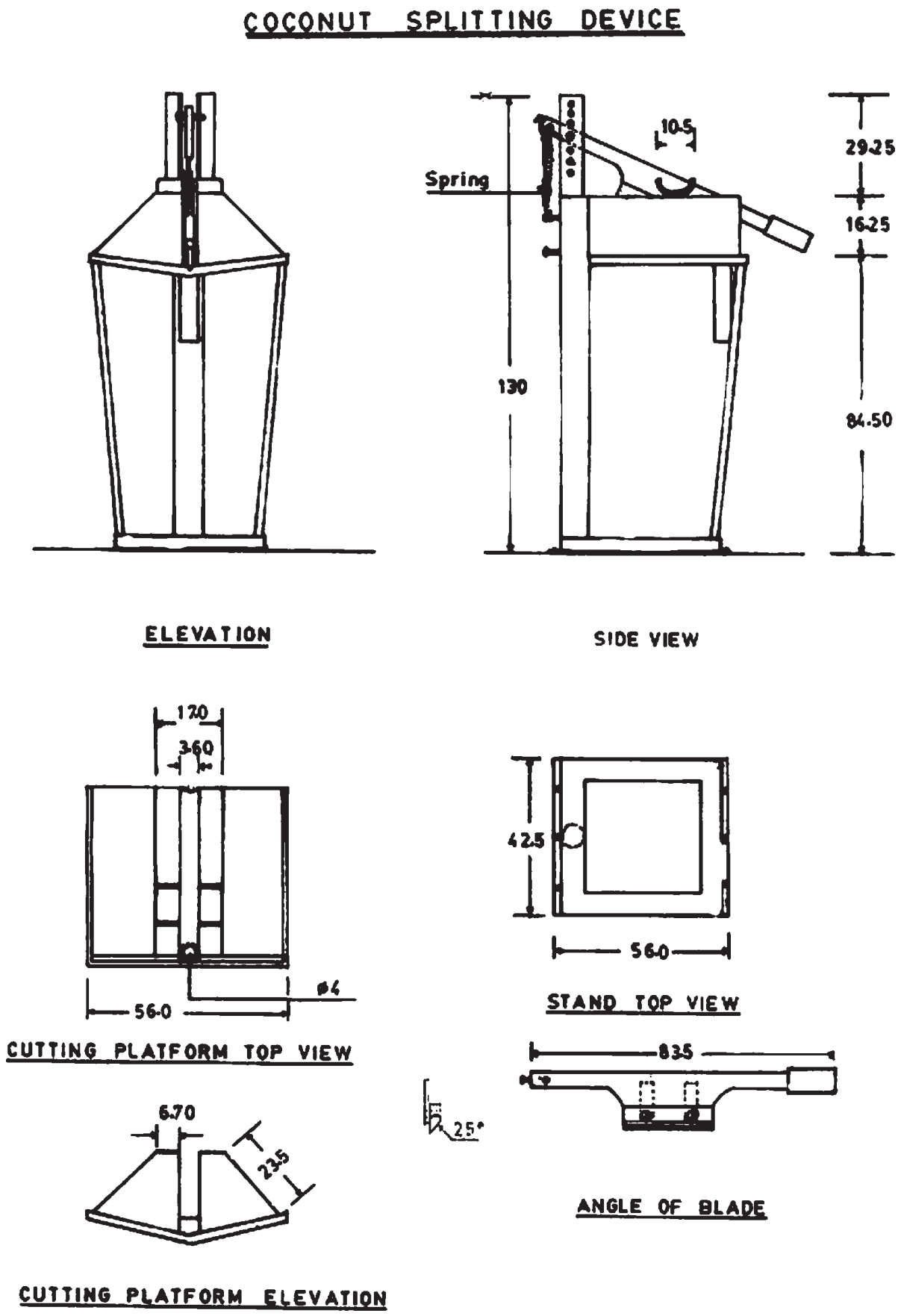

Fig. 1. Design drawing of splitting device

flow through the inclined surface into the channels provided all along the base of the box. HSS splitting tool was fixed on the handle provided as shown in Fig. 2. The round frames to hold the basket was made of 12 mm M.S. rod, welded on both sides of the main frame for holding split nuts. Provision was also made to drain the coconut water and to collect at the bottom using pipe.

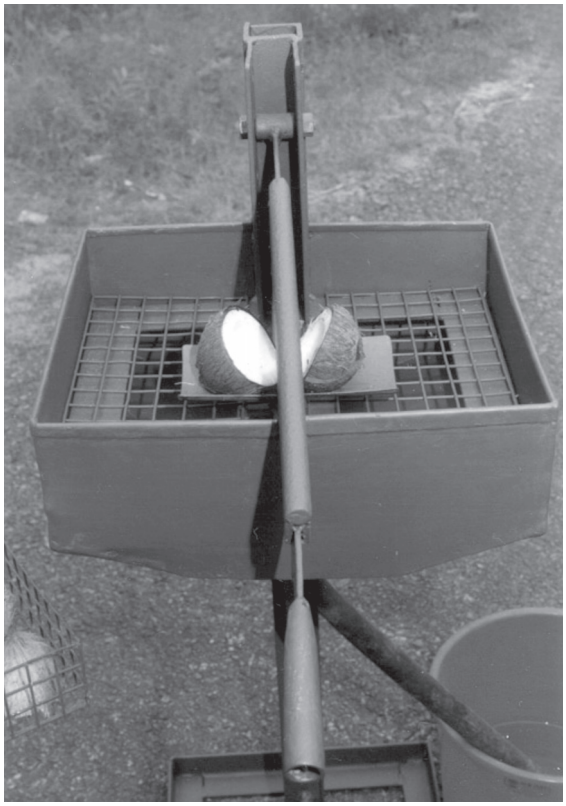

Fig. 2. View of splitting device

Nut holder of the splitting device was fixed based on the average diameter of 200 coconuts. The length and diameter was recorded and was analyzed to get the mean values. The mean diameter was 9.41 cm. Thus the nut holder's diameter was fixed at upper level of 9.5 cm to accommodate all sizes of nuts. This was made using hard but flexible rubber which was pasted on a mild steel disc of 9.5 cm using araldite (an adhesive). At the center of the nut holder a sharp and curved knife was welded. The splitting knife and the knife of the nut holder lie in the same vertical plane.

Various knife bevel angles like 15, 20, 25, 30, and 35º were fabricated and used for splitting the nuts. The material used for the fabrication of knife was high speed steel. Knife bevel angles were made by grinding the material on a power operated grinding machine. Provision was made on the knife holder for easy replacement of knife with different bevel angles using bolts and nuts.

The performance was evaluated based on splitting trials conducted with optimized knife angle and was compared with traditional method of splitting followed by farmers and processing units.

Based on the materials used and the fabrication charges of the splitting device, the cost of the unit was calculated. The cost of splitting of coconut was worked out using the standard procedure.

The design and fabrication of the nut splitting device and the results obtained for splitting of coconut are discussed in the following sections. The nut holder's diameter was fixed at the upper level of 9.5 cm based on the average diameter for all the 200 observations. The average diameter of the nut was 9.47 cm (Table 1). During tests conducted it was found that the nut holder was effective in holding all sizes of nuts.

Table. 1. Length and diameter of WCT coconuts (n = 200)

Character	Length	Diameter
Mean	10.1095	9.4730
SD	0.6939	0.7751

The ANOVA (Table 2) of observations on number of nuts broken in single stroke and number of round-shaped split nuts showed significant difference among the knife bevel angles studied. The Duncan's Multiple Range Tests (Table 3) revealed that the bevel angle of 25° was the best which was significantly different form others with regard to the characteristics studied. Next best bevel angle was 30°.

Table. 2. Summary ANOVA on number of nuts broken in single stroke and round-shape

Source	DF	Mean Square	
		Single stroke	Round shape
Between Bevel angles	4	382.16**	194.06**
Error	20	5.72	14.70

**Significant at 1% level

Table. 3. Duncan's Multiple Range Tests on effect of knife angle on effort required and shape of nuts split in the splitting device

Knife bevel angle, degree	Single-stroke*	Round-shape*
15	22.4[a]	32.4[a]
20	32.4[b]	33.8[a]
35	33.6[b]	34.0[a]
30	39.2[c]	39.8[b]
25	46.0[d]	47.4[c]

*Treatments means with the same letters are not significantly different at DMRT 1% level

Individual de-husked nuts were placed on the nut holder. Impact force was applied through the knife

attached to a handle. By a small impact force (1.155 N) the nut was split. The split nut automatically rolled side ways where in it got collected in a basket. The nut water drained into a collecting chamber from where it moved in to a bucket though a pipe. The advantage of this device is that any unskilled person can operate with less strain and chances for hand injury are almost eliminated. Thus, one of the constraints faced by farmers has been solved by this new, simple, low cost device. The splitting device fitted with 25° knife bevel angle was tested for its performance. The average time taken to split one nut was seven seconds. The coconut water collected could be used for preparing Nata-de-coco or vinegar as it was collected hygienically. The splitting device developed was compared with the traditional method of splitting. The relative advantages and disadvantages are given in Table 4.

Table. 4. Comparison of performance of splitting device with traditional method

Device	Type	Capacity, nuts / h	Risk for injury	Water	Force required, N	Shape	Labour
MOSD*	manual	514	Low	used	1.55 to 4. 56	round	Un-skilled
TK**	manual	508***	high	wasted	NA	irregular	Semi-skilled

*MOSD-manually operated splitting device, **TK-traditional knife, ***From Table 4.10

The output of splitting device was slightly more than manual method using traditional knife, easy to operate and chances of injury are very less. Physical strength and drudgery required is comparatively less as compared to the manual splitting. One of the major constraint reported in splitting of nuts using a traditional knife was bending posture as nuts are to be picked from the ground where as in the splitting device developed the posture is straight and the nuts were taken from the basket kept near the operator. From the Table 4 it is evident that the splitting device could remove the requirement of skilled labour which was also one of the major constraints faced by the coconut farming community in Kerala. The cost of nut splitting device was Rs 2000.00. The cost involved to split 1000 nuts in the newly developed splitting device was worked out using standard procedures and found to be Rs. 5 / 1000 nuts if the labour is common for splitting and drying, other wise the cost will be Rs. 36.25 / 1000 nuts. The cost of splitting using semi skilled labour will be Rs. 31.25 / 1000 nuts. The cost of splitting can be reduced if automatic feeding device is provided. As the shape of the split nut through the splitting device was round, copra will fetch higher price in the market.

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