DEVELOPMENT AND TESTING OF A TENDER COCONUT PUNCH AND SPLITTER

By

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PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree

Bachelor of Technology in Agricultural Engineering

Faculty of Agricultural Engineering
KERALA AGRICULTURAL UNIVERSITY

Department of Farm Power Machinery and Energy
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
TAVANUR - 679573, MALAPPURAM.

1997

DECLARATION

We hereby declare that this project report entitled **"DEVELOPMENT AND TESTING OF A TENDER COCONUT PUNCH AND SPLITTER"** is a bonafide record of project work done by us during the course and that the report has not previously formed the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

ANITHA JOHN

SHAMSUDEEN. K. P

Tavanur
31st May 1997

CERTIFICATE

Certified that this project report entitled **"DEVELOPMENT AND TESTING OF A TENDER COCONUT PUNCH AND SPLITTER"** is a record of project work done jointly by ANITHA JOHN and SHAMSUDEEN. K. P. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to them.

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Tavanur
31st May, 1997

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Above all, we bow our head before God Almighty for enabling us to complete this work and for His blessings.

Anitha John

Shamsudeen. K.P.

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SYMBOLS AND ABBREVIATIONS

cm	-	Centimetre(s)
Co.	-	Corporation
Dept.	-	Department
Fig.	-	Figure(s)
FPME	-	Farm Power Machinery and Energy
g	-	Gram(s)
G I	-	Galvanised Iron
KAU	-	Kerala Agricultural University
KCAET	-	Kelappaji College of Agricultural Engineering and Technology
kg	-	Kilogram(s)
m	-	Metre(s)
mg	-	Milligram(s)
ml	-	Millilitre(s)
M S	-	Mild Steel
No.	-	Number
SAC	-	Supportive and Allied Courses of Study
&	-	And
<	-	Less than
/	-	Per
%	-	Percentage

INTRODUCTION

From time immemorial, agriculture has been the mainstay of a majority of human population. India is not any exception to this and agriculture still remains the back bone of our country. In the development of agriculture, advances in science and technology have played an important role. Whenever people have failed in managing and combining the resources and technology in a manner to get maximum output,the agricultural development has also sufffered. At present our villages are in need of cheaper and reliable technology in order to promote the yield and reduce the excessive labour requirement particularly in respect of the major crops like rice, coconut, spices and vegetables. As far as Kerala is concerned this is more relevant in the case of coconut.

The coconut palm, botanically known as *Cocos nucifera* is the most important of all cultivable palms. It's uses are plenty and it provides drink, food, oil, fibre, fuel, thatch and domestic utensils. Thus, each and every part of coconut palm is useful to man and hence there is no harm in calling it as the *tree of life.*

Tender coconut water is a common beverage through out the tropics. It is very sweet and makes a refreshing drink. At seven months old, that is just before the kernels begins to harden, the nuts are plucked. By this time, the the coconuts have the best quantity of liquid and the highest amount of sugar content of 6 g/100 ml. (Thampan,1975). During summer, the liquid endosperm of the tender coconut provides an agreeable drink.

Thampan (1975) has also stated of the use of tender coconut water in treating gastroenteritis and also as a useful substitute for saline glucose in

intravenous infusions. The tender coconut water is of utmost importance in serious cases of diarrhoea and vomiting. It is having a calorific value of 17.4/100 g of water (Thampan,1975). The jelly like endosperm of the tender coconut may be eaten.

Though this is the age of artificial drinks, the use of tender coconut water which is in use from pre-histroric times, is also being popularised . For the coconut farmers, selling of the tender coconut is more profitable than selling coconut. It is said that the plucking of tender coconut increases the yield of the tree.

The conventional method of extraction of tender coconut water from the nut is by removing the top portion of the nut with a knife(Plate 1). In order to remove the top portion it has to be cut with a sharp knife after holding the coconut in the other hand. This is tedious, time consuming and also dangerous. Since, husk pieces remain spread around the premises, it makes the surroundings dirty and unhygenic. Similarly, the splitting of the coconut is also tedious and dangerous.

These drawbacks have been discouraging people from adopting or popularising tender coconut as a common drink. One solution to overcome these problems is to develop simple tools suitable for punching open and ripping apart the tender coconut in a short time. At present, tools suitable for extracting the liquid endosperm of tender coconut is not available . Accordingly, a project was undertaken at the Kelappaji College of Agricultural Engineering and Technology, Tavanur with the following objectives.

i) To develop a tender coconut punch.

ii) To develop a tender coconut splitter.

iii) To test both the equipments.

CHAPTER II

REVIEW OF LITERATURE

A brief review of the past studies carried out on tender coconuts and the equipments suitable for extracting the liquid and solid endosperm is presented in this chapter.

2.1 Composition of tender coconut water

According to Thampan (1975) , the following is the composition of water of the tender coconut.

Component	Percentage Content
Water	95.50%
Protein	0.10%
Fat	<0.10%
Mineral matter	0.40%
Carbohydrates	4.00%
Calcium	0.02%
Phosphorus	<0.01%
Iron	0.50mg/100mg.

The percentage of sugar is maximum in the tender stage of the coconut. The tender coconut water has a pH varying from 4.8 to 5.3 and contains Vitamin C and Vitamin B. The concentration of ascorbic acid (Vitamin C) ranges from 2.2 to 3.7mg/100ml, which gradually reduces as the kernel begins to harden(Thampan, 1975). The tender coconut also contains various minerals.

According to Thampan (1975), the following is the mineral composition of tender nut.

Mineral	Content (mg/100ml)
Sodium	105.00
Potassium	312.00
Calcium	29.00
Magnesium	30.00
Iron	0.10
Copper	0.04
Phosphorus	37.00
Sulphur	24.00
Chlorine	183.00

From these, the importance of tender coconut water as a good soft drink is evident .

Inspite of these advantages, the use of tender coconut has not become popular. One of the reasons is the lack of suitable tools for making the extraction of the liquid endosperm(water) and solid endosperm (meat) easier and safer.

2.2 Extraction of liquid endosperm (water)

In the present method, the water is extracted by cutting open one end of the coconut with a sharp knife. Holding the tender coconut in one hand the top portion of the husk is chopped off in three or four pieces with a sharp knife. It requires considerable practice and skill to cut open the tender coconut in this manner. As the knife is to be heaved to remove the slices, this may become dangerous in the hands of unskilled people. After the top portion of the husk is removed in this manner, the shell is opened with another stroke of the knife to extract the water.

Though some attempts were made here in the college and elsewhere to develop a tool to punch open or drill open a hole in the tender coconut to extract the water, none of them became popular because of the inherent drawbacks of such tools particularly the difficulty caused in withdrawing the tool from the coconut.

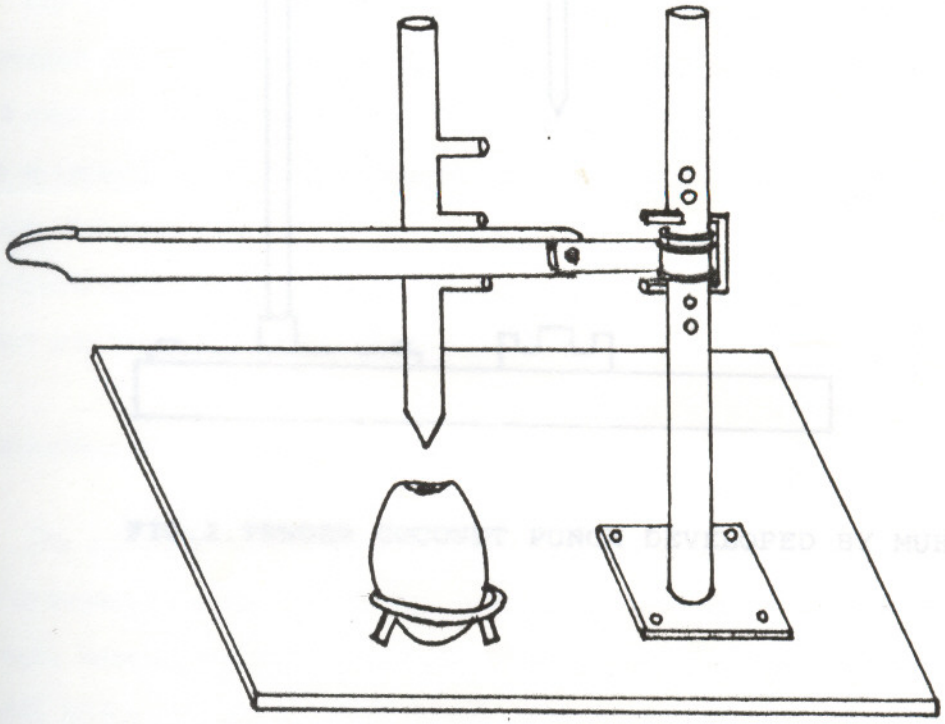


FIG.1. TENDER COCONUT PUNCH DEVELOPED BY JIPPU & MUHAMMED

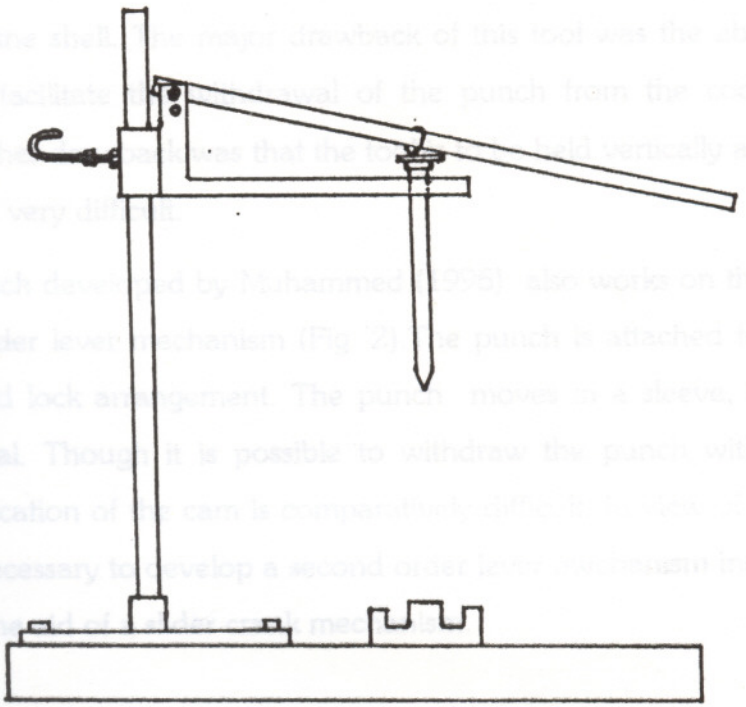


FIG.2.TENDER COCONUT PUNCH DEVELOPED BY MUHAMMED

The punching system developed by Jippu and Muhammed (1995) consists of a second order lever mechanism to drive the punch into the coconut. The equipment is shown in Fig. 1. The punch is held in one hand and placed at the pedicel end of the coconut placed upward on a suitable stand placed below the punch. The lever is lowered by the other hand and placed on the projection on the punch. As the lever is further pushed down, the punch penetrates the husk and then the shell. The major drawback of this tool was the absence of a mechanism to facilitate the withdrawal of the punch from the coconut after punching. Another drawback was that the tool is to be held vertically and pushed down. This was very difficult.

The punch developed by Muhammed (1996) also works on the principle of a second order lever mechanism (Fig. 2).The punch is attached to the lever with a cam and lock arrangement. The punch moves in a sleeve, the axis of which is vertical. Though it is possible to withdraw the punch without much difficulty, fabrication of the cam is comparatively difficult. In view of the above, it was found necessary to develop a second order lever mechanism incorporating a punch with the aid of a slider crank mechanism.

2.3 Extraction of solid endosperm (Meat)

The solid endosperm of the tender coconut is sweet and palatable. In order to extract the meat, the coconut is split into two halves, with the help of a knife and heaving it a couple of times. This also requires considerable practice and skill, in the absence of which it may become difficult and dangerous. The entire literature surveyed does not give indications of any study conducted in the past. However, existance of the nut cracker, the sugarcane set cutter and fodder cutting tools working on the principle of a second order lever is well known. Based on this principle, a tender coconut splitter was perceived to be developed in this study.

CHAPTER III

MATERIALS AND METHODS

This chapter describes the design and the procedures adopted in the fabrication and testing of the tender coconut punch and splitter. The punch and splitter are mounted on a common base to make it a compact unit.

3.1 Tender Coconut Punch

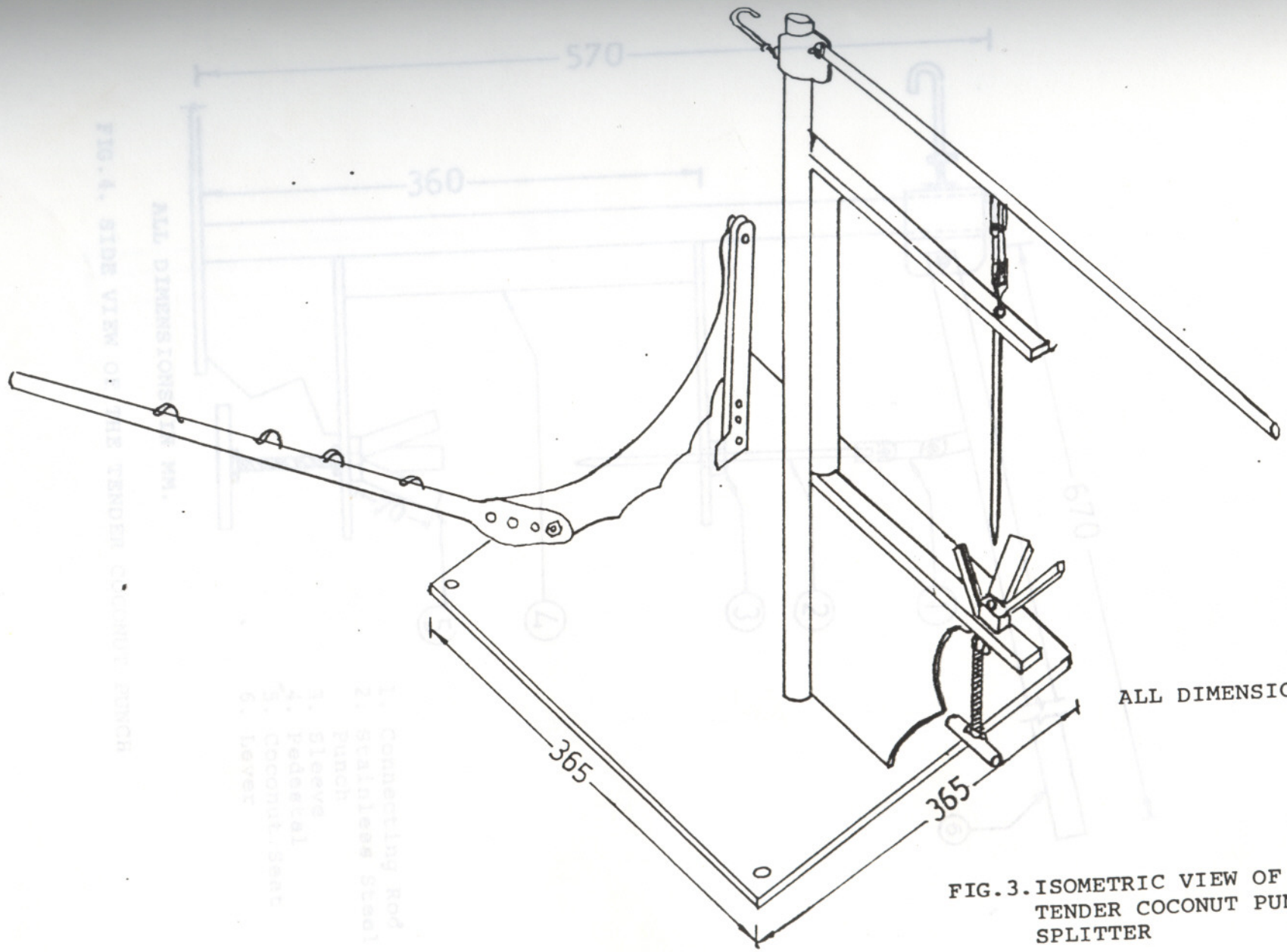
This consists of the following. (Fig. 3 & 4 , Plate 2)

1. Coconut punch assembly.
2. Coconut seat assembly.

3.1.1 Coconut Punch Assembly

It is used for punching holes in the tender coconut so that coconut water can be extracted through a straw.

It consists of a stainless steel punch of diameter 10mm and length 215mm. For easier penetration, the tool is sharpened at it's lower end (Fig. 5, Plate 4). The punch works like a slider crank mechanism. The guide in which the punch is sliding is fixed at one end of an extended arm having a length of 200 mm and fixed on a pedestal at a height of 360mm from the base. The length of sleeve is 12 mm and the diameter of rod is 100mm. The punch is connected to the lever through a connecting rod of length 50 mm. The connecting rod is connected to the lever at a distance of 155mm from it's fulcrum point and 45mm from the other end. The total length of the lever is 670 mm and it's diameter is 12.5 mm. This arrangement provides a mechanical advantage of 4.47. The fulcrum point is arranged on the pedestal as a sliding pair so that the height of the fulcrum point can be varied and fixed at any required height depending upon the length of the coconut. The lever is made of G I pipe.



ALL DIMENSIONS IN MM.

FIG.3. ISOMETRIC VIEW OF THE TENDER COCONUT PUNCH & SPLITTER

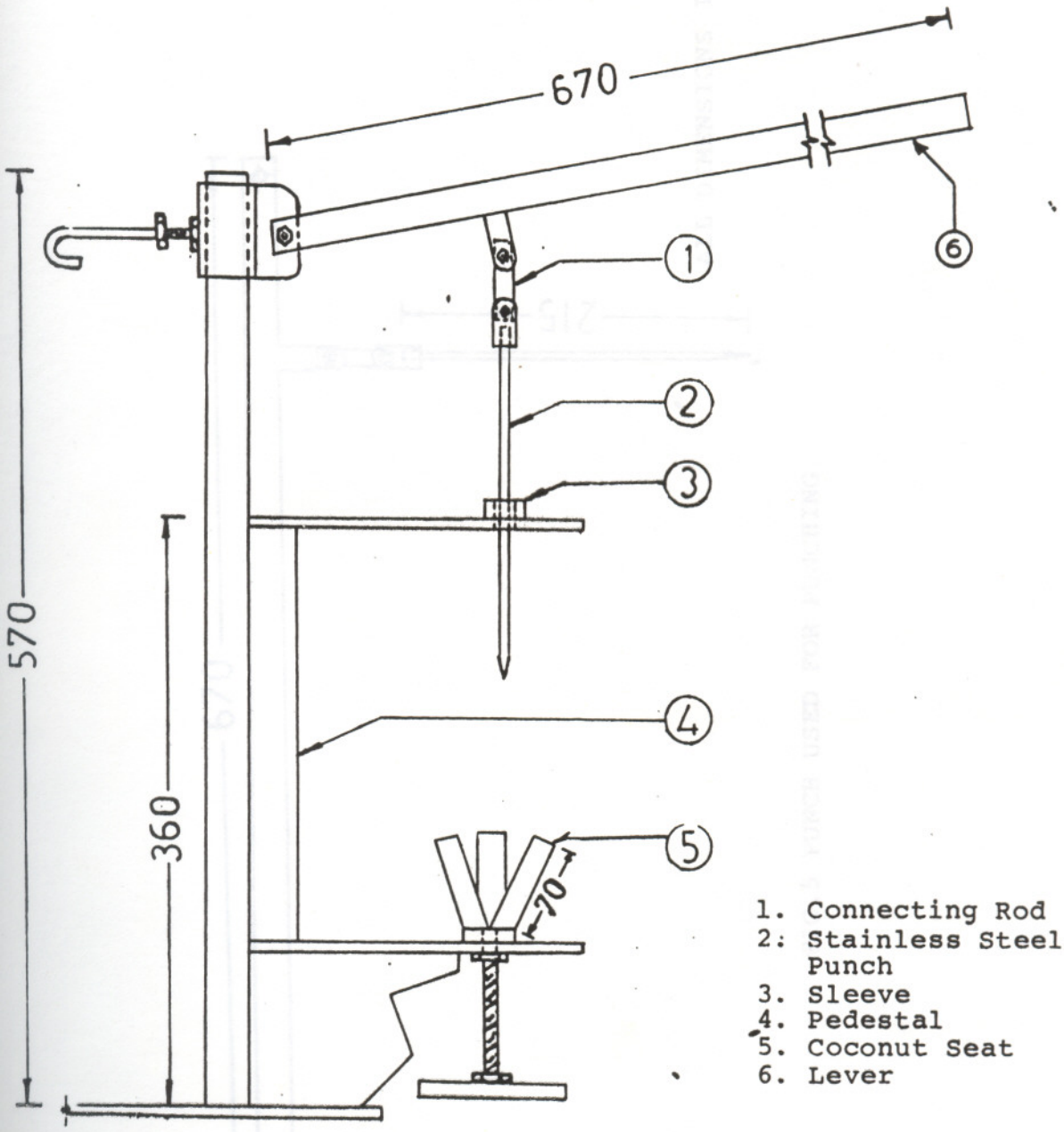


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FIG.4. SIDE VIEW OF THE TENDER COCONUT PUNCH

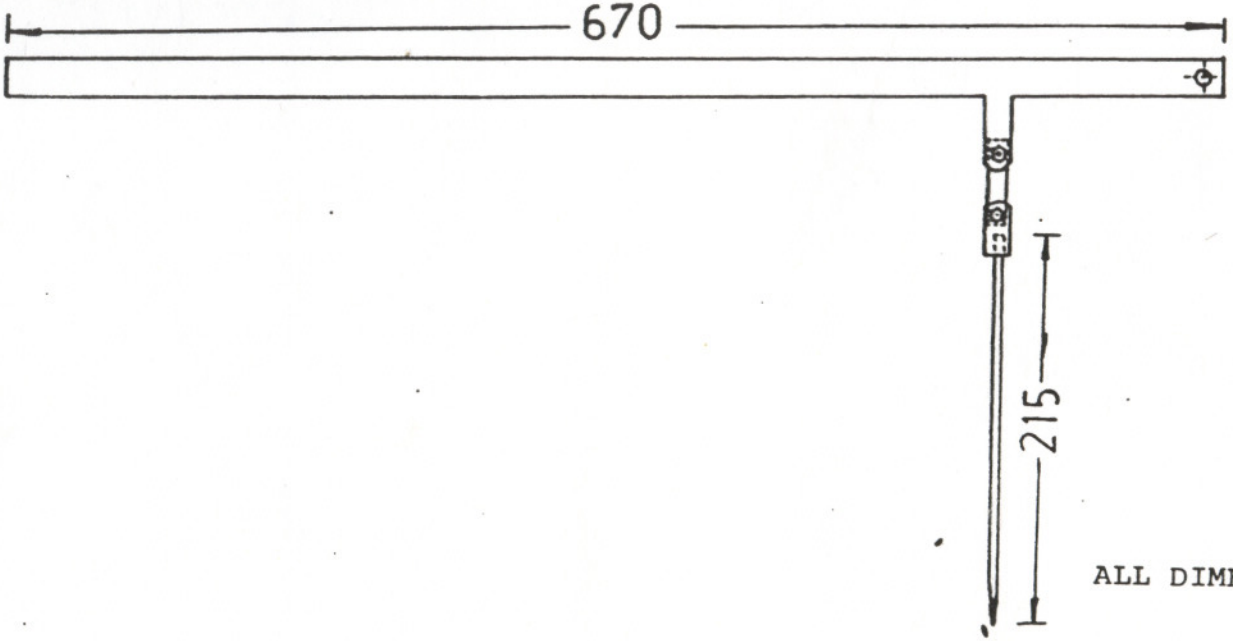


FIG.5 PUNCH USED FOR PUNCHING

3.1.2 Coconut Seat Assembly

The arrangement of the punch is such that it operates up and down in the sleeve in the vertical direction. It has been observed that the most vulnerable region on the coconut is it's pedicel end. In order to expose the pedicel end to the punch the coconut is to be placed on a stand in such a manner that the pedicel end is vertically below the punch.

A coconut seat is provided on an extended arm of length 200mm. The extended arm is fixed to the pedestal at a height of 100 mm. The coconut seat consists of an inverted tripod attached to a screw rod of length 70 mm and pitch 1. 2mm. The lower end of the screw rod is attached to a handle to facilitate the rotation of the screw rod. The legs of tripod are apart by an angle of 120^{0}. Each leg is of length 70mm. The nut in which the screw rod rotates is fixed on the extended arm and vertically below the sleeve.

The rotation of the screw rod helps to raise the coconut towards or lower it away from the sleeve. This arrangement helps in holding the coconut firmly between the sleeve and the coconut seat at the time of punching, and also while withdrawing the punch. The pedestal along with the punch assembly and the coconut seat assembly is firmly fixed on a MS base of size 365 x 365 x 6mm.

3.1.3. Punching

In operation, the coconut is placed on the coconut seat with it's pedestal end upward and the screw rod is rotated to move the coconut towards the sleeve till it is tight between the sleeve and the rest. The punch is lowered by pulling the lever down. The punch pierces the pedicel end through the husk and the shell. The punch is then withdrawn and the screw rod is rotated in the anticlockwise direction and the coconut is taken out. By inserting a straw into the shell through the hole punched, the liquid endosperm can be taken out. The water can also be taken out by inverting the tender coconut. The opertaion of punching is shown in Plate 3.

3.1.4 Testing of a Coconut Punch

After placing a platform weighing balance below the coconut, the maximum force exerted on the coconut at the time of punching was noted and recorded. The force exerted at the handle was then determined from the mechanical advantage.

3.2 Tender Coconut Splitter

It consists of mainly the knife assembly. (Fig. 6).

3.2.1 Knife Assembly

In order to extract the solid endosperm for consumption, after the liquid is drawn out, the coconut is to be split into two halves. A second order lever assembly consisting of a pedestal, a fulcrum, a knife and a pivoted long handle was fabricated and mounted on the same base on which the coconut punch was also mounted. The pedestal consists of two M.S flats mounted vertically upward on the base. The height of the pedestal is 250 mm. The opposing faces of the flats are separated by a distance of 6 mm. Holes were drilled on these flats at different heights in order to insert a bolt to form the pivot. The diameter of the hole is 10mm. A high carbon steel knife of the shape and dimensions as shown in Fig. 7 (Plate 4) was fabricated and mounted on the pedestal at a convenient height with the help of a bolt and nut. Serrations were provided on the knife to concentrate the applied force at one point. A G I pipe of length 630mm and outer diameter 19mm was pivoted to the other end of the knife facilitating the swinging of the handle through an angle of 30^0. The total length of the effort arm was 720mm. The length of the load arm varied from 9 to 35 mm; the average being 17.5mm. Based on this the mechanical advantage varies from 6.31 to 6.33 with the average at 6.32.

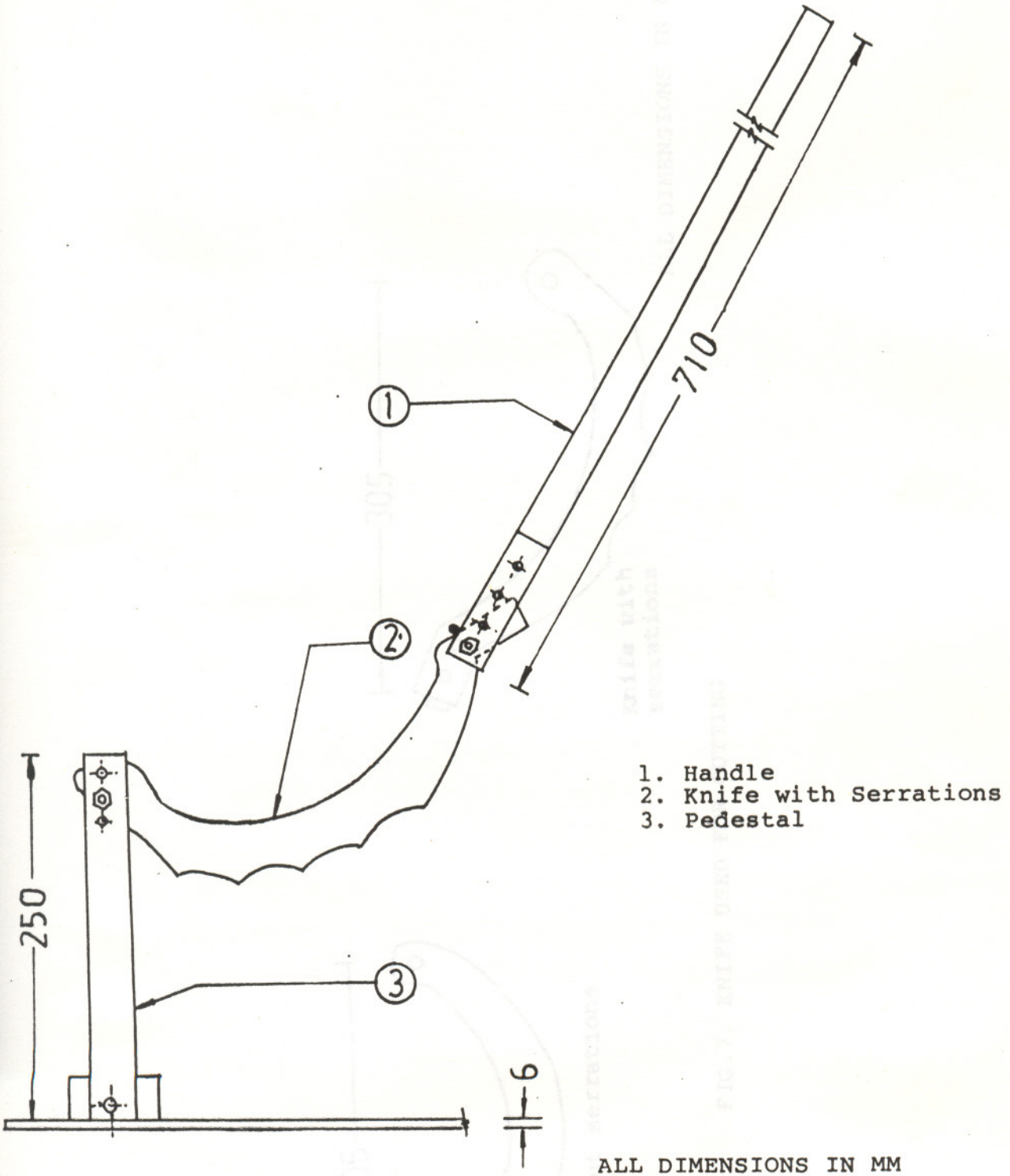
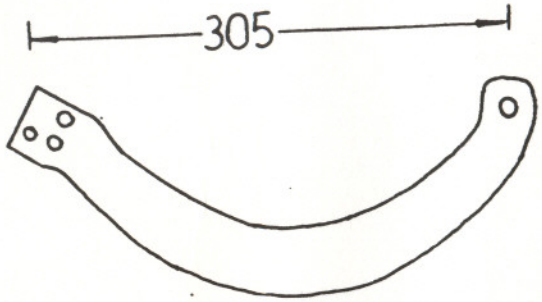
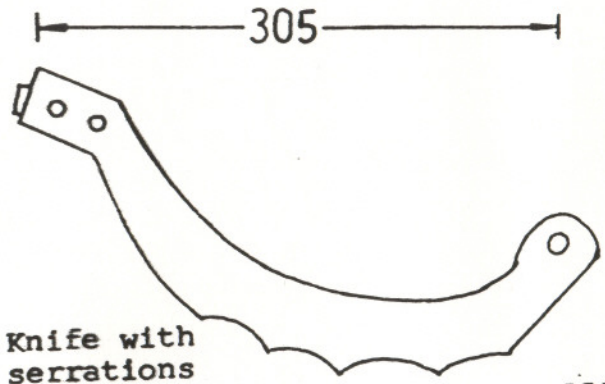


FIG.6. SIDE VIEW OF THE TENDER COCONUT SPLITTER



Knife without serrations



Knife with serrations

ALL DIMENSIONS IN MM

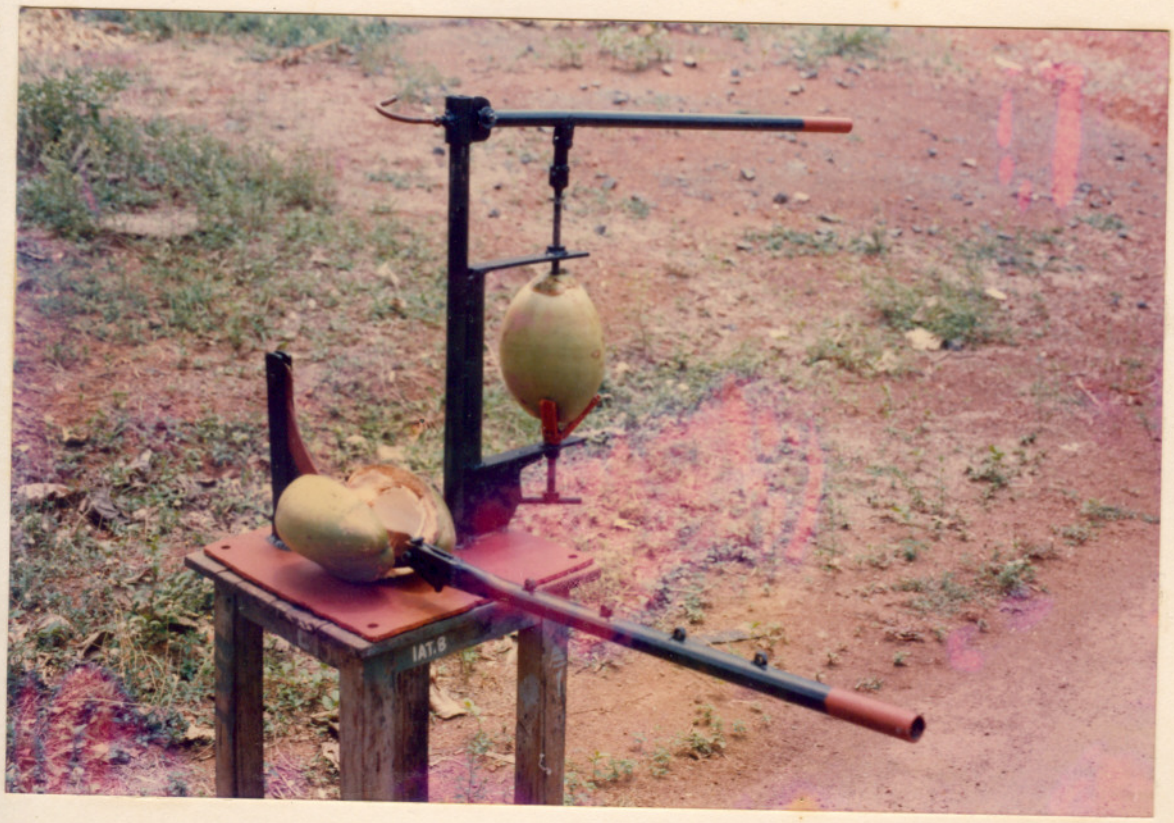
FIG.7. KNIFE USED FOR CUTTING

3.2.2 Tender Coconut Splitting

After raising a knife by lifting the handle, the coconut is placed in the base on it's natural rest position, such that the longitudinal axis is below the longitudinal axis of the knife assembly. Then, the knife is lowered and forced through the husk till it reaches the shell. The handle is then given a sudden jerk to apply an impact load on the shell. This cuts open the shell and the coconut is split into two halves. Plate 5 shows the splitting operation. The punched and split tender coconuts are shown in Plate 6.

3.2.3 Testing of Tender Coconut Splitter

A platform balance was placed below the coconut and the maximum force required to cut the coconut was noted and recorded. The effort required at the handle to cut open the coconut was then determined from the mechanical advantage. The mechanical advantage was determined based in the average length of the load arm.



CHAPTER IV

RESULTS AND DISCUSSION

The performances of the tender coconut punch and splitter were evaluated and the results are presented and discussed below.

4.1 Effect of tenderness of coconut on punching force

Experiments were done using different coconuts varying in their tenderness and the load applied at the handle was calculated and are tabulated in Table 1. It was found that as the age of coconut increased (resulting in decrease in its tenderness) the punching force required also increased. This is represented graphically in Fig 8 and 9. As the age of coconut increases, the hardness of the shell also increases making punching more difficult. Hence, more force is required to punch open a coconut of more maturity. The maximum force recorded was 70 kg in punching of a coconut of 6 months maturity whereas it was 109 kg when its maturity was 8 months. Accordingly, the effort to be applied at the handle varies from 17.4 to 24.4 kg. It can be seen that the force to be applied at the handle is within the normal capability of an average person.

4.2 Effect of tenderness of coconut on the force required for splitting

Different coconuts varying in their tenderness were selected for experiments and the load applied at the handle was calculated and are tabulated in Table 2 . It was found that as the age of coconut increased the splitting force also increased . This is represented graphically in Fig.10 and 11. Since the hardness of shell increases more splitting force is required. The maximum force recorded was 132 kg in a coconut of 6 months maturity whereas it was 152 kg when it's

maturity was 8 months. Similarly the effort to be applied at the handle varies from 21 to 24 kg.

Table 1 : Magnitude of effort and load in punching open tender coconuts of various maturity.

Length of load arm of punch with extension = 15 cm

Length of effort arm of punch with extension = 67 cm

Mechanical advantage = 4.47

Age of Coconut (Month)	Load (Kg)	Effort (Kg)
6	63	14.112
6	63	14.112
6	78	17.472
7	78	17.472
7	94	21.056
7	94	21.056
8	94	21.056
8	109	24.416
8	94	21.056
Mean	85.22	19.089
Standard Deviation	14.78	3.310

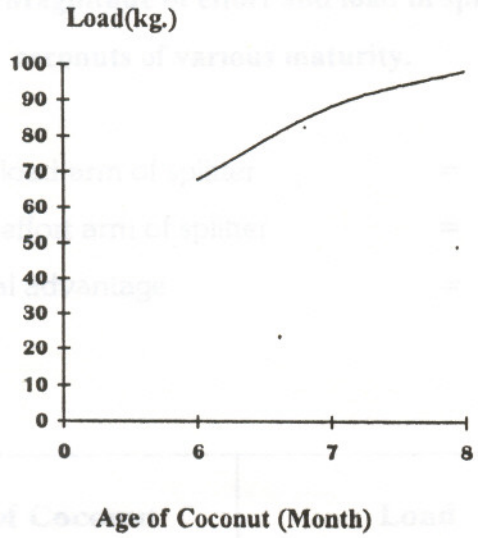


Fig. 8. Relationship between Age of Coconut and Force (load) in punching Open Tender Coconuts.

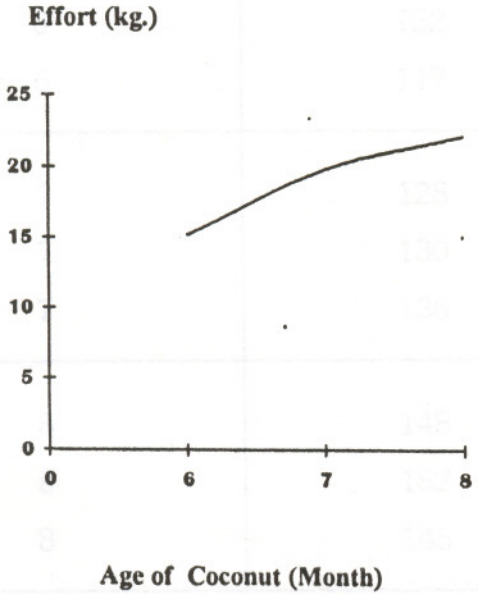


Fig.9. Relationship between Age of Coconut and Effort in punching Open Tender Coconuts.

Table. 2 : Magnitude of effort and load in splitting open tender coconuts of various maturity.

Length of load arm of splitter = 15 cm

Length of effort arm of splitter = 95 cm

Mechanical advantage = 6.32

Age of Coconut (Month)	Load (Kg)	Effort (Kg)
6	125	20
6	132	21
6	117	18
7	128	20
7	130	21
7	136	22
8	148	23
8	152	24
8	145	23
Mean	134.78	21.33
Standard Deviation	10.88	1.76

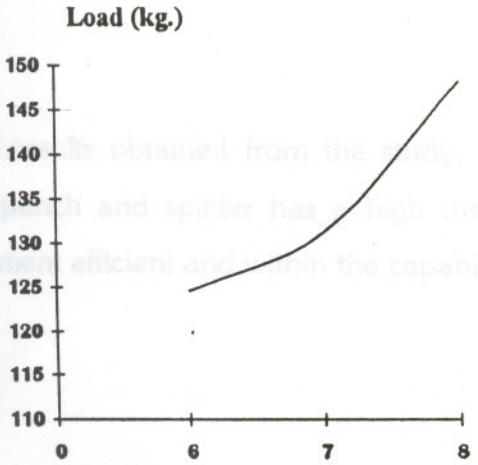


Fig.10. Relationship between Age of coconut and Force (Load) in Splitting Open Tender Coconuts

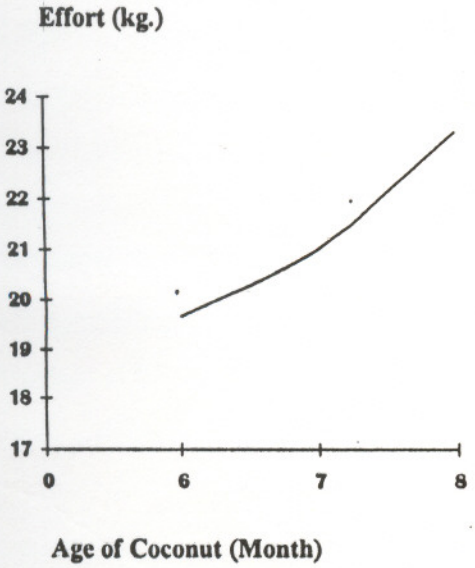


Fig. 11. Relationship between Age of coconut and Effort in Splitting Open Tender Coconuts

From the results obtained from the study, it is quite evident that the tender coconut punch and splitter has a high mechanical advantage thereby makes the equipment efficient and within the capability of an average operator.

SUMMARY AND CONCLUSION

Kerala, truely termed as *"God's own country"* is a heaven for agriculture and related process. Paddy and coconut are the major crops grown in abundance here, and majority of farmers depend on these for their livelihood. Due to the subtropical climate with high percentage of humidity prevalent in Kerala, consumption of water is of utmost importance to the human and animal population. Coconut water is rightly called as *"God's substitute to potable water"*. The nutrient value and other natural minerals present cannot be substituted by any of the modern day artificial cool drinks. The demand for coconut water has been increasing year after year and so many Government agencies like the Coconut Development Board, Kochi has set up retail outlets for selling tender coconut water. However, one of the constraints in setting up large number of these retail outlets is the absence of efficient tools for punching and splitting open the tender coconut. Therefore, a project was undertaken in the Dept. of Farm Power Machinery and Energy of KCAET, Tavanur to develop a tender coconut punch and splitter and to evaluate it's performance.

The coconut punch and splitter developed is apt for retailers, due to low cost and high efficiency . It mainly consists of a punching assembly to punch open the coconut and a splitter to split the coconut into two halves.

The punch assembly consists of a vertical stainless steel punch sliding in a sleeve and operated by a second order lever. The set up provided a mechanical advantage of 4.47. The punch operates like a slider crank mechanism. A coconut seat is provided to hold the coconut . It is also possible to hold coconut firmly in that position vertically by adjusting the height of the seat. The punch is then lowered and a hole is punched in the coconut through which the water is taken out.

The maximum force required to be applied at the handle is 78 kg for a coconut of 6 months maturity and 109 kg for a coconut of 8 months maturity.

The splitter assembly consists of a pedastal, a curved serrated knife and a swinging handle . The mechanical advantage provided by the set up varies from 6.31 to 6.33. The coconut is placed on the base and the knife is lowered splitting the coconut husk till the knife reaches the shell. After that, the handle is given a sudden jerk to rip open the shell. This cuts the coconut into two halves. The serration provided on the knife helps to concentrate the cutting force at one point to facilitate the initiation of cut.

The maximum force required to be exerted at the handle during this operation was found to be 132 and 152 kg for a coconut of 6 and 8 months maturity respectively.

Based on this study it is concluded that the coconut punch and splitter developed is effective in punching and splitting open the tender coconuts in the age range of 6 to 8 months.

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ABSTRACT OF THE PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree

Bachelor of Technology in Agricultural Engineering

Faculty of Agricultural Engineering
KERALA AGRICULTURAL UNIVERSITY

Department of Farm Power Machinery and Energy
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1997

ABSTRACT

A tender coconut punch and splitter for extracting liquid and solid endosperm was developed at Kelappaji College of Agricultural Engineering and Technology, Tavanur. It consisted of a stainless steel punch connected to a lever in the form of a slider crank mechanism. The coconut seat provided with the help of a screw rod aided to hold nuts of varying sizes at the time of punching. After the coconut is placed in the seat, the screw rod is rotated to hold it in position. The lever is lowered and the punch is made to penetrate the tender coconut. The water is taken out through this hole by inversion with the help of a straw. The splitter assembly consisted of a knife pivoted at a convenient height. A second order lever of length 630 mm is attached to the other end of the knife to another pivot point. After placing the coconut below the knife, the lever is lowered and the knife is made to split open the coconut into two halves. The maximum force required to punch open a coconut of 6 months and 8 months maturity were 78 and 109 kg, where as that required for splitting were 132 and 152 kg.