

REDESIGN OF COCONUT DEHUSKING MACHINE

PRODUCT DESIGN PROJECT III

BY

S.SUNDARA MOHAN
Roll No : 00613010

Guide : Prof. B. K. Chakravarthy

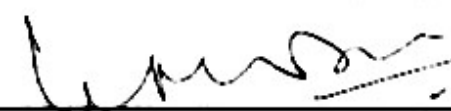
CO-Guide: Prof. K. Munshi

INDUSTRIAL DESIGN CENTRE
INDIAN INSTITUTE OF TECHNOLOGY
BOMBAY


Approval Sheet

The project titled 'Redesign Of Coconut Dehusking Machine' by S. Sundara Mohan is approved for the partial fulfillment of the requirement for the degree of Master of Design in Industrial Design.

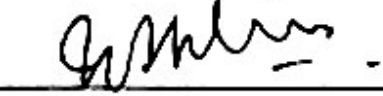
Guide:



Co-guide :



Chairperson:




Internal Examiner:



External Examiner :



Dated :



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I am sincerely thankful to my guide Prof. B. K. Chakravarthy who helped me in all stages in my project and gave moral support throughout the project. I am also thankful to my co-guide Prof k. Munshi for his invaluable guidance and encouragement.

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Last but not the least, thanks to all my friends, Sandy, Jitu, Sumit, Amey who helped me throughout the project.

Thanks to my family members, my anna and amma, appa, and all who helped me to come to this stage in my life.

S. Sundara Mohan

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1. Introduction:

The project, redesign of coconut dehusker was taken up to improve the innovation developed by the innovator Mr.R.Jayaseelan, from a small village in TN. The objective of this project is to develop the machine to the level of a complete product with all the inputs from a product design perspective.

1.1 SPONSOR of the Project:

The Department of Science and Technology helped establish the National Innovation Foundation (NIF) of India, in March 1st 2000, with the main goal of providing institutional support in scouting, spawning, sustaining and scaling up grassroots innovations and helping their transition to self supporting activities.

The foundation has a Governing Body chaired by Dr. R. A. Mashelkar, Secretary, CSIR and Director General CSIR. Professor Anil K. Gupta, President SRISTI and Professor, Indian Institute of Management Ahmedabad, is the Executive Vice Chairperson of NIF.

For the last ten years the Honeybee Network and Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) have been scouting innovations by farmers, artisans, women, etc. at the grassroots level.



fig 1. First machine by jayaseelan

1.2 Introduction to the Innovator and his Innovation:

The Innovator

Mr. R. Jayaseelan has studied up to SSLC and owns a coconut garden and mango orchard in Koomapatti. He also manages few coconut gardens on lease. He performs dehusking of coconuts and packs them in gunny bags and sends lorry load of nuts through agents in Madurai and from there to northern states.

The Innovation

Dehusking coconut is a strenuous and time taking activity performed to separate the outer husk of the green coconut to get the inner nut.

This act of removing the husk requires high muscle power and strength and all this had inspired Mr. R. Jayaseelan to develop the coconut dehusking machine.

The details of the innovation as registered at National Innovation foundation as follows.

Project No : NIF/RD/MECH/14

Innovation Number :726

Title of the Innovation : Coconut Dehusking

Innovators Name : MR. R. Jayaseelan



fig 4, LAKSHADWEEP NORMAL COCONUT.

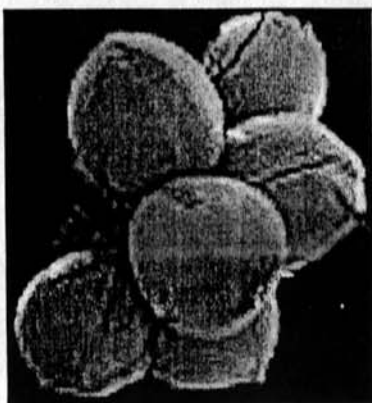


fig 5. PONAVALI GREEN ROUND COCONUT.



fig 6.

2. DATA COLLECTION

2.1 ABOUT THE COCONUT CROP

Different Types of Coconut Grown in India:

In some parts of South India, coconuts were grown as cash crop, beside other cash crops. Coconut has many applications: Coconut is used in food, in oil industry, in ayurvedic cosmetic industry, and coconut milk production. So different kinds were grown according to the purpose.

1. Lakswadeep Normal Coconut:

This coconut is round in shape has good water and pulp inside, size of the coconut is bigger than normal country coconut.

2. PonaVali Green Round Coconut:

This is round, is for water, coconut pulp is less .

3. Philippine Normal Coconut:

This coconut has good amount of water and coconut pulp inside size of the coconut is bigger than Indian country coconut.

4. Western Long Run Coconut:

This coconut grown in coastal region of western India and kerala, and some parts of Tamil Nadu. This coconut has reasonable size with more pulp.



STATES	TOTAL PRODUCTION OF COCONUT ('000)
1. ANDHRA PRADESH	12.88
2. KARNATAKA	10.02
3. KERALA	44.70
4. MAHARASHTRA	1.50
5. ORISSA	5.33
6. TAMIL NADU	20.75
7. WEST BENGAL	2.13
8. OTHER STATES	4.19

fig 6. Coconut growth in India.

2.2. THE INDIAN COCONUT INDUSTRY :

- One of the leading producer of coconuts in the world producing 13 billion nuts per annum.
- Coconut area is distributed in 18 states and three Union Territories under different agro-climatic conditions.
- 3000 years' tradition in coconut cultivation.
- Premier coir manufacturing country in the world.
- Producer of best grade milling copra in the world yielding high grade coconut oil known for its aroma and flavour.
- Large number of farmer's co-operative societies in primary processing and marketing.
- Government agencies such as Kerafed, State Trading Corporation, Kerala State Marketing Federation and Karnataka State Marketing Federation in manufacturing and marketing of branded coconut oil in small packs.
- Hundreds of reputed and established private firms in manufacturing and marketing of various coconut products including branded coconut oil in small packs.
- Wide range of coconut products both edible and non-edible available for export.
- Technical know-how and trained manpower for the manufacture of various coconut based products.
- Availability of research support by reputed research organizations such as CSIR, ICAR and DRDO.
- Good number of cultivators/varieties having specific nut characteristics.



fig 7. Coconut growth in tamil nadu.

All India Final Estimate Of Coconut -2000-2001 :

This is the data collected form the coconut board of India which show the growth of coconut through out the India. And the amount of coconut production in resen years.

STATE / UNION TERRITORIES A R E A	(Thousand Ha.) PRODUCTION	(Million Nuts) PRODUCTIVITY	(Nuts / ha) 1999-2000	(Revised) 2000- 2001 1999-2000	(Revised) 2000- 2001 1999-2000	(Revised) 2000- 2001 1999-2000
Andhra Pradesh'	101.7	102.5	1051.8	1092.7	10342	10660
Assam*	20.2	20.9	150.0	135.9	7426	6502
Goa	25.0	25.0	121.6	125.1	4864	5004
Karnataka	321.2	33.8	1671.8	1754.2	5205	5255
Kerala	899.1	936.3	5167.0	5496.0	5747	5870
Maharashtra	15.8	16.8	218.2	244.4 1	3810 1	4548
Orissa	17.8	17.7	50.5	109.9	2837	6209
Tamil Nadu	304.0	323.5	3222.0	3158.4	10599	9763
Tripura*	9.1	9.1	7.5	7.0	824	769
West Bengal	24.2	24.5	324.3	330.5	3401	13490
A & N Islands*	25.0	24.7	88.2	87.2	3528	3530
Lakshadweep*	2.8	2.8	28.3	28.0	10107	10000
Pondicherry	2.2	2.2	27.8	28.0	12636	12727
ALL INDIA	1768.1	1839.8	12129.0	12597.3	6860	— 6847
(Source from Journal for the Coconut Board of India, Sept,2001						

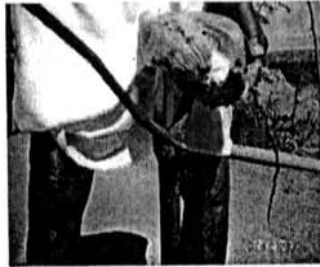


fig 9 . LEVER SYSTEM COCONUT DEHUSKER.

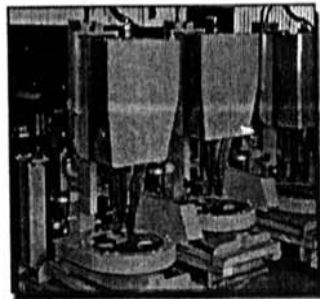


fig 10 FLETCHER DEHUSKER



fig 11. JAYASELEEN DEHUSKER.



fig 8 . MANUAL INSERTING OF COCONUT
IN VERTICAL ROD.

3. Existing Techniques Used For Coconut Dehusking:

Here are some of the tools and machine use for dehusking coconut.

3.1. MANUAL INSERTING OF COCONUT IN VERTICAL ROD (traditional).

3.2. LEVER SYSTEM COCONUT DEHUSKER.

3.3. FLETCHER DEHUSKING MACHINE.

3.4. JAYASELEEN DEHUSKING MACHINE.



fig 12. Traditional method of fiber removing

3.1 MANUAL INSERTING OF COCONUT ON A VERTICAL ROD (TRADITIONAL METHOD).

Traditionally in most parts of India (kerala ,Tamil Nadu, karnataka)and other part of world this tool is been used. This is the traditional method is used for removing coconut fiber.

This tool is used for removing total/partial fibers from coconut. In this, single person is engaged in doing the operation. It can be male/female operated. Normally a skilled person is engaged in this operation.

The person who works on this tool normally will be standing and the tool is mounted on a wooden block (or) in the ground, so that the tool doesn't shake or get inclined while coconut is inserted.

Using this tool an experienced person can dehusk 180 coconut (4 sided ones) in one hour.

3.1.2 PROCESS ANALYSIS

- The person has to stand all the time while removing fibres.
- While lifting the coconut the person has to bend sideways and in front which results in back pain in the operator.
- While inserting the coconut into the sharp rod it is difficult to judge in which direction the sharp rod comes out which may cause injury to hands.
- Weight of the tool depends on the length of the rod.

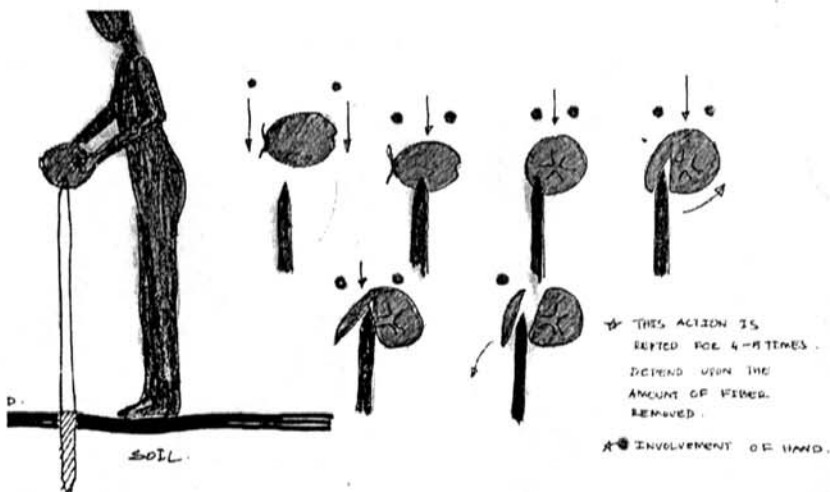


fig 13. Traditional method and its sequence in operation.

3.1.3 Structural Analysis of the Tool:

The tool is basically a vertical rod of mild steel, 4 cm diameter. The end of the rod is sharpened by forging, so that the sharp end goes deep into the coconut fibre.

The sequence of operation is as follows. Coconuts are gathered around the machine and the person who is sitting in front of the machine bends and lifts the coconuts with one hand and while inserting the nut he use both hands and presses it with force into the rod. After inserting he/she twists the coconut and the fibers come out completely from the shell.

Amount of fibre to be removed from the coconut can be adjusted by varying the depth of insertion of coconut into the rod. The person repeats this action 3 to 4 times for every coconut. After the fibres are removed he throws the fiber in left or right direction and the coconut is thrown in a basket on the ground. After the fibres are removed all the coconuts are gathered and put in the sunlight for drying. In some cases the coconuts may have to be transported from village to town so the well dried coconuts last longer.

The operator used to bend to lift the coconut throughout the operation of one cycle of coconut fiber removing. He has to stand and bend forward, each time by this action he gets back pain and he also gets tired fast thus the speed decreases and the amount of dehusked coconut reduces. Hence more labourers were employed for this operation.

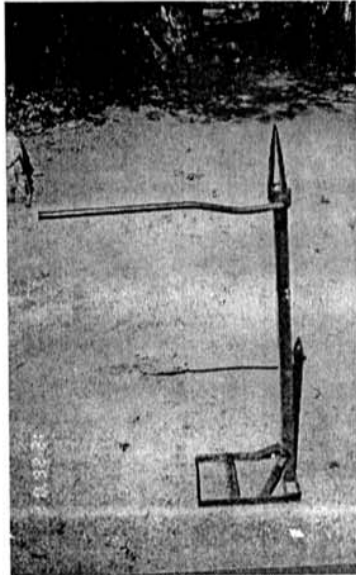


fig 14. Alternative tool for fiber removing.

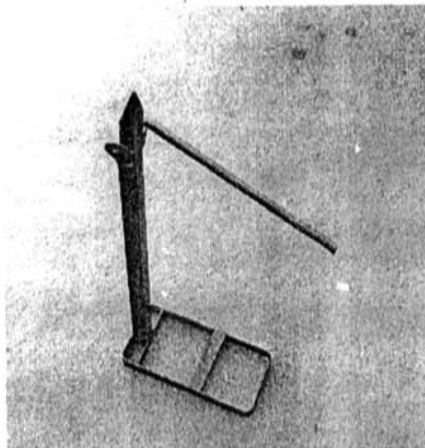


fig 15.

3.2 Lever Type Fiber Remover:

3.2.1. Description:

This tool is further developed from the traditional method of fibre removing. It is fabricated using mild steel rods and strips.

This tool is used for removing full fiber from the coconut. In this tool single person is engaged in operating the tool which is easier than the traditional way of fiber removing.

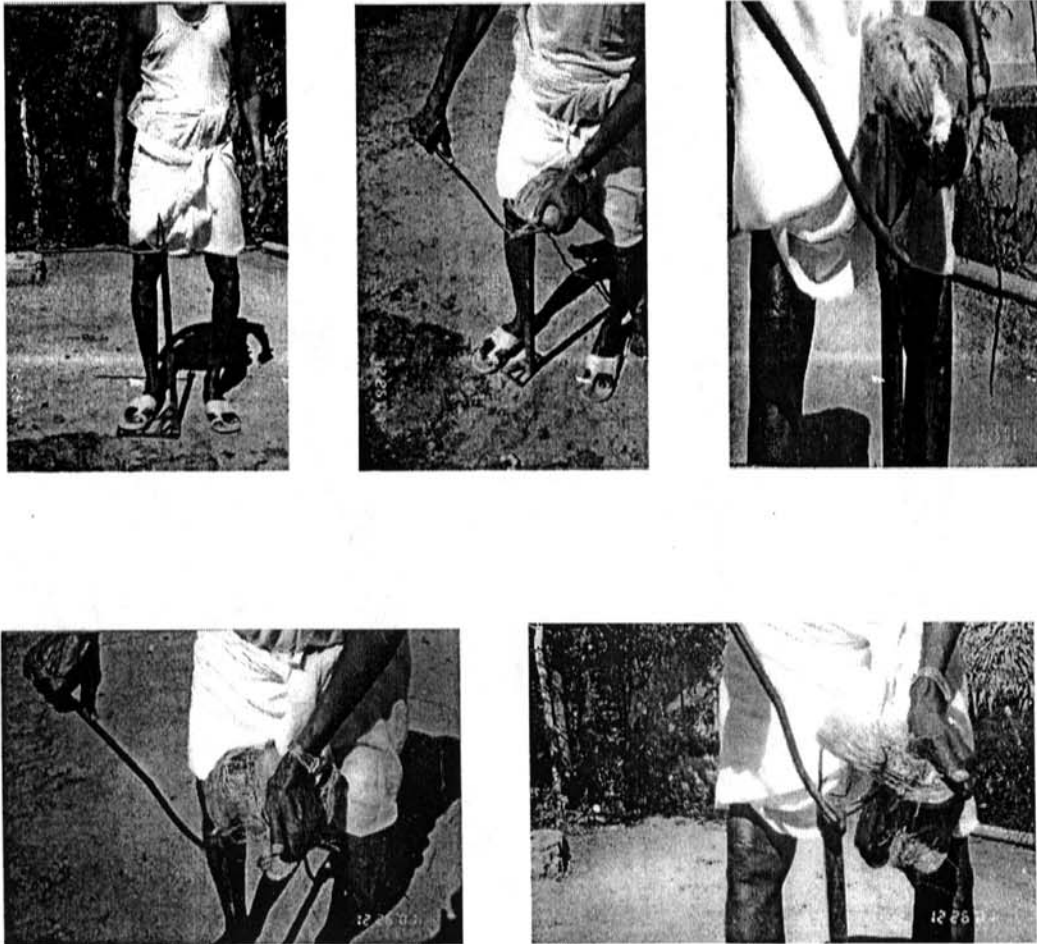
This tool is mostly used in houses for dehusking less numbs of coconut for domestic use.

3.2.2. Functional Consideration:

This tool is operated in the standing posture. For complete stability one foot is used to press the tool towards the ground to give stability and the coconut is lifted in the left hand and inserted into the sharp twin plates. This is the special feature of this tool. There are two sharp plates, one of which is fixed to the structure and the other to the extended lever.

When the coconut is inserted, both the plates are close to each other lever is at lower position. When the lever is lifted, the two sharp plates open wide so the fibres are removed from the coconut shell. After the fibre is removed, further separation of fibers is done by hand. The coconut is turned to the other side to remove fibres and the same action is repeated again.

fig 16. Operation sequence of lever based tool.



3.2.3. Sequence Of Operation for Lever Based Dehusking Tool:

1. Placing the tool on a flat surface to get proper balance while working.
2. After the tool is firmly fixed, with the help of the left or right foot the coconut is lifted from the ground and inserted on the sharp twin plates.
3. Then the lever which is at lower position is lifted up. By this action the twin plates open wide and the fiber splits and gets tossed. Splitting action takes place in this hand operated tool.
4. After the fibres are split they are removed by hand and the coconut is turned for other side.
5. The same action of inserting, lifting of lever, splitting, and removing is repeated to complete the full removal of fibres.

fig 17.



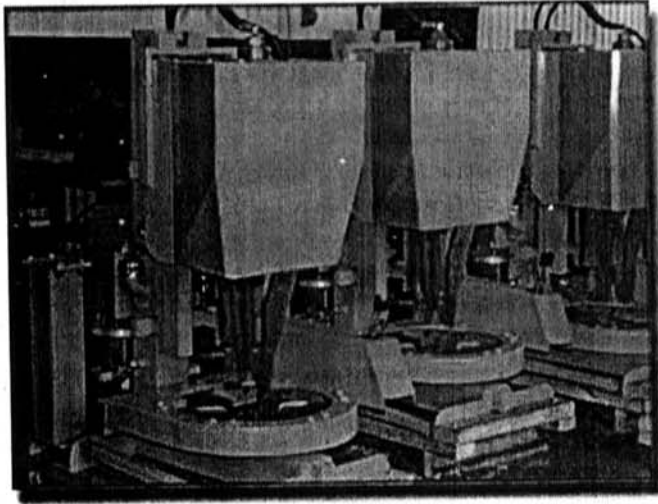
3.2.4. User Interaction with the Tool :

This tool is kept on the ground and the operator has to stand and perform the dehusking operation. While lifting the the coconut and operating the lever he has to bend forward every time. This action causes back pain, shoulder pain and constant stretching of the hands. The tool is used to remove all the fibres from the coconut. It is easy to dehusk dry coconut than green coconut with this tool.

The person has to use his hands to remove all the fibres from the coconut . After the fiber is removed the coconut is thrown in sunlight for drying. Actions such as lifting, bending, inserting, applying force, lifting of lever, bending of the back, hand removal of fibres are involved in the task.



fig 18. Fletcher machine.



3.3. Fletcher Dehusking Machine:

This machine is developed in Australia and is used for dehusking dry coconuts in oil manufacturing industry. The machine works with hydraulic control cutting tools. A motor is connected to the cutting arms. When the motor is engaged the cutting arms come down to the coconut. Before this the coconut is kept in vertical position and then the cutting action takes place in vertical direction.

When the cutting edges are pressed fully they go through the coconut and during the reverse action the arms complete the fiber removal as shown in the illustration. The arms then go back to the normal position. The fibres are thus removed and coconut is taken out from the cutting slot. This machine is used for mass dehusking of coconuts in the oil manufacturing industry.

By using this machine , 6 coconuts can be dehusked per minute and 2500 nuts per day.

fig 19. Operation sequence of fletcher machine.

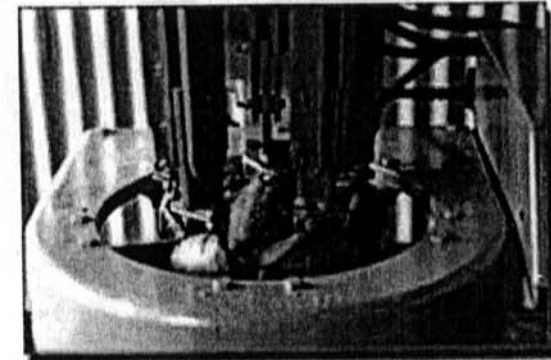
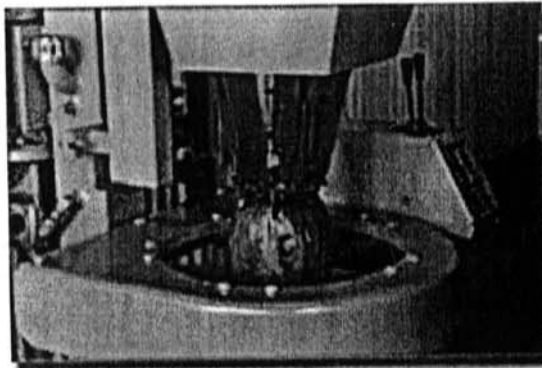
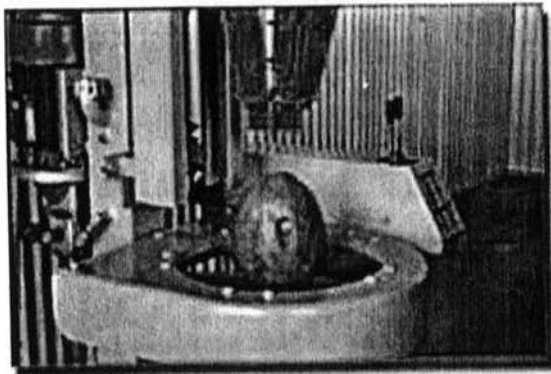
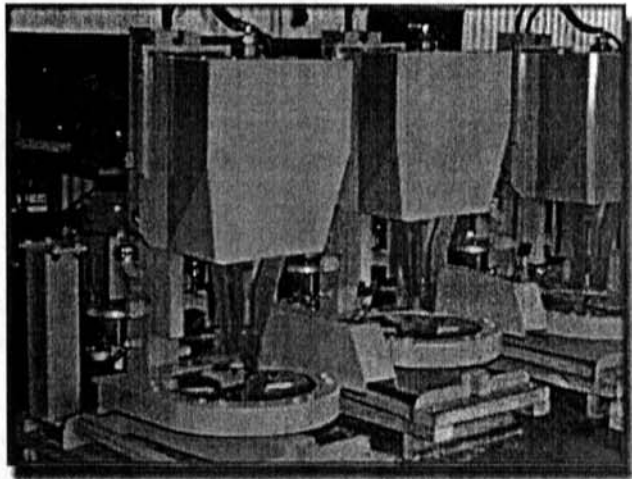
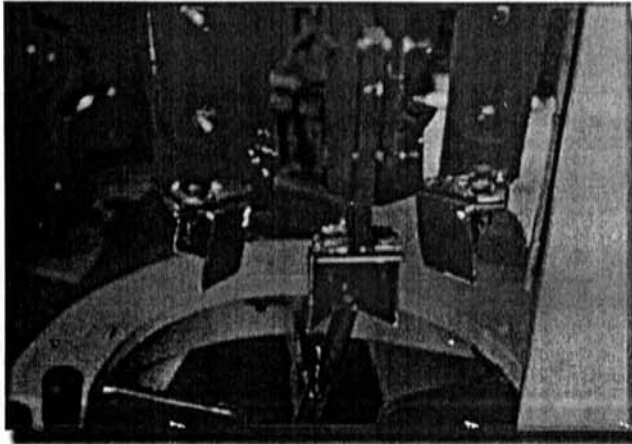


fig 20. Cutting blade



3.3.1 User Interaction with the Machine:

In this machine an operator is required even though the machine can be automatically operated without human help.

If the coconut is fed by conveyor belt the whole process of transportation of coconut is reduced. All the actions starting from collection to cutting and separation of fibre and the dehusked coconut can be done automatically. In this case there is no human involvement in the process other than supervising the machine.

This machine has high spring steel cutting blades and hydraulic cutting arms.

- The machine is used for removing dried coconut fibers.

- This machine removes all the fibres from the coconut.

- This machine is used for the oil manufacturing industry.

- Cost of this machine would be high and may not be affordable by Indian farmers.

- This machine cannot be transported to the farm. It has to be mounted at one place and requires proper facilities for the running of the machine.



fig 21. Complete machine.

3.4. Coconut Dehusking Machine Developed by Mr. R. JAYASEELAN :

3.4.1 THE PRESENT SCENARIO

- The machine runs on a 1.5 hp motor.
- The device has two sharp blades, attached to a cylindrical metal rod, which is useful in dehusking more coconuts compared to manual effort

Apart from the traditional method of dehusking coconuts this machine's working is similar to the traditional vertical rod dehusking tool (with splitting action). The action of removing fibres is achieved by the motor as a prime mover which provides the force by which the coconut fiber is removed. The special feature of the machine is the cutting spikes of the machine which is the invention of the innovator. It has two sharp rods connected in the middle by the same diameter rod. These cutting spikes are connected to the motor. The sequence of operations is as follows. Lifting of coconut from ground which is collected on the left hand side of the machine. After lifting, the coconut is inserted in the spikes and the coconut is held in one hand then the motor is engaged. The cutting spikes start rotating in the clockwise direction while one of the spikes goes through the coconut and tends to come out and at this instant the fibre is removed from the coconut shell.

By using this machine one can dehusk 150- 200 (4 side dehusked) coconuts per hour.

3.4.2 Description of the Device:

1.5 HP Electric motor is coupled through a belt to a long cylindrical metal rod. At the tip of the rod two sharp blades are fixed. The blades are at 3/4 feet length and at 1" apart from each other.

These blades on rotation help to dehusk the coconut easily to the desired level. At the innovators place there are 6 such machine. Each set is coupled to a 1.5 hp Electric motor.



fig 22. Jayaseelan machine.

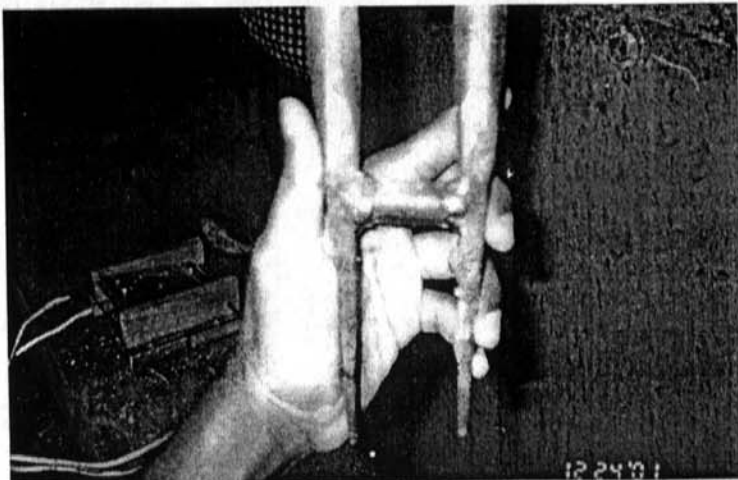


fig 23. Cutting tool

As described above with the use of this device the coconut can be dehusked from four sides, still leaving some fibre on it. An about 150 nuts can be dehusked per hour. In a shift of 8 hours about 7200 nuts (6x150x8) could be dehusked. For feeding the nuts 6 labourers are needed. The cost of dehusking 7200 nuts with this mechanical device will be only Rs 336 (wages for 6 laborers in a shift @ Rs 50/- per labourer, Rs.300/- electricity charges for 12 units @ Rs 3 per unit Rs.36/- (total Rs.336/-). Where as if exclusively labourers are to be employed for the operation it will cost Rs 720/- at the rate of Rs 10/- for dehusking 100 coconuts.

3.4.3 Advantages:

1. In a shift of 8 hours with 6 sets of threshers 7200 coconuts could be dehusked. In two shifts by employing 12 labourers about 14,500 nuts could be dehusked which is sufficient for a lorry load. In the conventional system 18 labourers are needed for 2 days to fill load of nuts. Hence it is labour saving.

2. 100 machine dehusked nuts will fetch an increase of price Rs 70/- than hand dehusked nuts.

3.4.4 Special Features:

If we employ labourers for dehusking and fill a gunny bag it will hold 100 nuts. But when mechanically dehusked nuts are filled in a bag it will only 80 nuts.

The cost of nuts dehusked mechanically will fetch a price of Rs 260/- as compared to Rs 230 /- for a bag of 100 nuts husked by human labour.

3.4.5 Existing Action of Coconut the Machine:

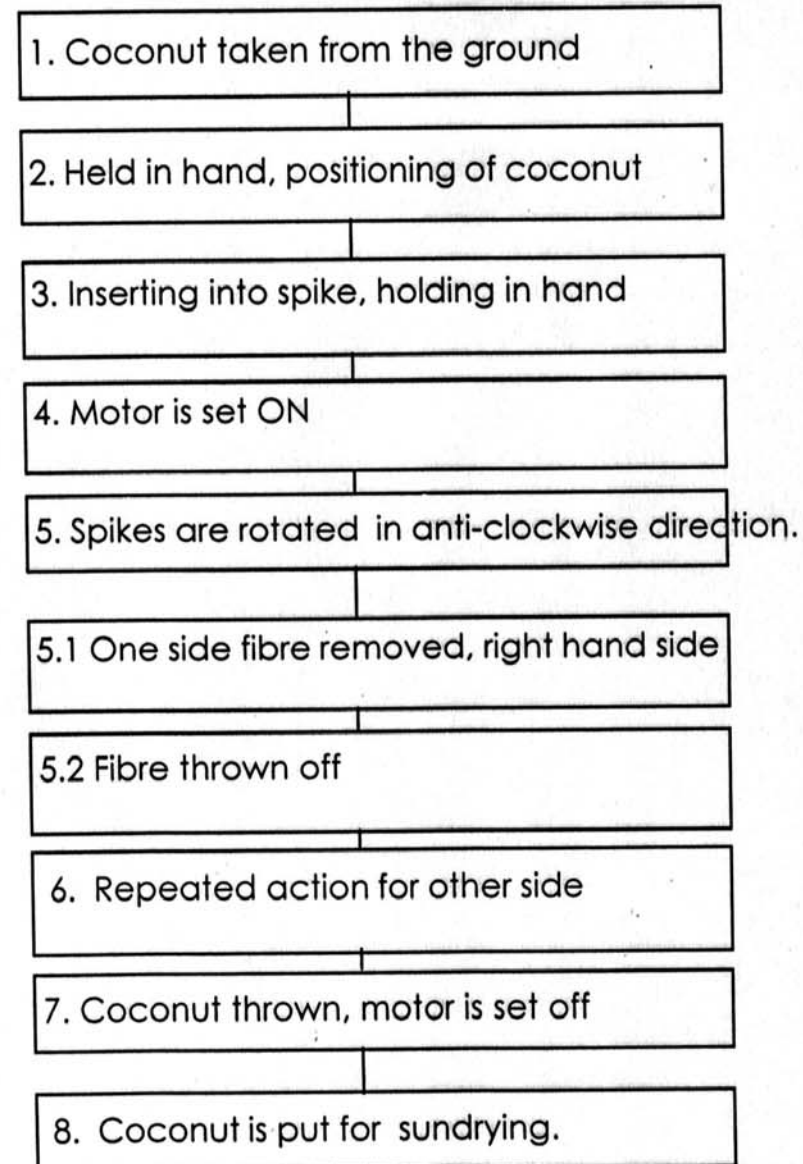


Table 8.1



fig 24 .

3.4.6 Analysis of various aspects related to the present dehusking activity and the problems identified therein.

STRUCTURE :

Whole body of the machine is made of sheet metal with internal mild steel 'L' channel support.

- Motor of 1.5 HP is used to generate the force which is the prime mover of the machine
- Power transmission takes place from motor to the cutting spike by 'V' belt.
- Motor is operated by a fuse box and starter switch.
- Motor is connected by 'V' belt to the cutting spikes. The 1.5 hp motor runs at 1440 rpm.

1. Body Posture:

In this machine the person is sitting in front of the cutting machine and each time he has to bend forward and take a coconut. He/she comes to the normal sitting position and inserts the coconut into the spikes. It is dangerous to insert the coconut into the spike since you can not judge at what point the spike comes out on the upper side of coconut.

When the motor is engaged, the person has to hold the coconut in hand and if he fails to do so, with the cutting speed of the spikes the coconut is also thrown away. So the person has to hold the coconut tightly in the hand. Holding the coconut in hand, every time he has to switch ON/OFF the motor. Reaching switch every time is a time consuming operation. The motor in the machine is activated by a foot operated switch.

No proper protective cover or safety precaution is provided for the cutting spikes of the machine. Motor belts are exposed without any cover which may cause an accident when the motor is running.

2. HOLDING COCONUT IN HAND (motor off condition):

- Direct feeding of coconut into machine by inserting it into lower spike.
- Holding coconut in hand when the motor is engaged.
- only one hand is used when the size of coconut is small.
- Both hand when the size of coconut is big.
- No reverse rotation is possible
- Switch ON the motor forw starting and when the fiber is removed, again switch off the motor.



fig 27. Holding of coconut in hand.

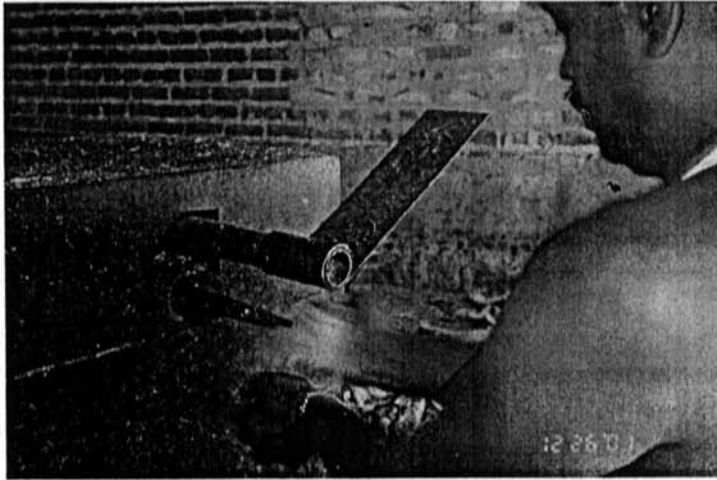


fig 28 . Holding coconut
in both hand ,tool is running

3. Holding Coconut while dehusking :

This is the first operation which takes place after lifting the coconut. The person inserts the coconut into the lower spike with the help of both hands.

--While inserting the coconut into the sharp spikes, it is difficult to judge the direction in which it comes out on other side which may cause injury to the hands.

--When the spikes are not in use they are left uncovered which may cause accidents.

--When three sides are dehusked the size of the coconut is reduced and it may tend to slip from the hand.



fig 29 . Removing of fiber from coconut.

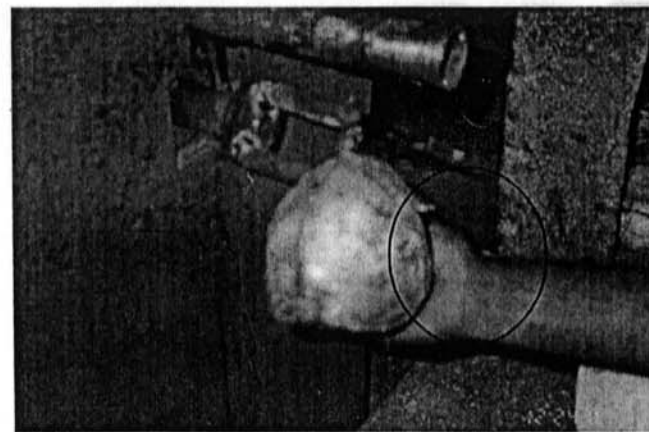


fig 32. Inserting of coconut in to spikes .



fig 30. Foot operated switch .



fig 31 . Switch box is placed in ground.

4. Peeling operation force :

- When the coconut is inserted in the spike, the person has to hold the coconut in position till the fibres are totally removed.
- A stopper, 4 mm thick metal sheet is provided, which is dangerous because some time the hands and fingers get hurt.
- When the coconut grip is loosened, it may fall on the next person who is working beside the operator.

5. Operation Switch:

- A foot operated switch is provided for switching OFF/ON the motor.
- The foot operated switch a crude one, without proper concealment of the live electric wires.
- When the coconut is dumped near the machine they get collected near the machine. This makes it difficult to see and locate the switch .
- No earthing is provided .
- Proper position for the switch is not provided on the floor to locate it by foot.
- When the switch is operated by foot, only the toe is in contact.

6 Projection of Motor Belt:

- Motor pulley and motor belt are exposed.
- Speed of the motor is 1440 rpm. The plley also rotates at this speed and it is exposed which is dangerous.

4 Scope of the Project:

With the use of 1.5 hp electric motor coupled through a belt to the machine, the coconut dehusker is capable of processing 150 nuts per hour.

To make the job of dehusking cheaper and more efficient the transmission system and the machine performance have to be studied and improvement can be done.

The innovator himself is of the opinion that the speed and efficiency can be increased tremendously. Also, there is a chance of devising a two side peeling system rather than the single peeling system. After the study of existing machines in the market the following can be listed as possibilities which can be achieved.

- There is a need for a compact machine which is easy to operate.
- Safety and ergonomic factors need to be considered.
- Machine should be energy efficient.
- Machine should be easy to transport from one place to another.
- Cost of the machine should be low enough to be affordable by the community of people involved in the trade.
- Proper fixture or a coconut holder can be provided while cutting takes place.
- Segregation of coconut and removed fibres needs to be addressed.
- Man, machine and the environment have to be well related and integrated.

5 Product Brief:

- Product must be at least 25%(as a general target) cheaper than existing price.
- The machine must be designed for light M.S. fabrication with no special tooling needed.
- Safety of the operator must be taken care of.
- Improve the speed of dehusking of coconut.
- Arrangement must be made so that dehusked fibers can be collected easily
- All moving parts must be guarded.
- Should be designed for ease of maintenance.

6 Ergonomic considerations Recommended data for occupational activities.

6.1 Posture Sitting / Standing:

Seating has many advantages. Grandjean (1973) describes sitting as being '**a natural human posture**'. Allowing the operator to sit relieves him of the need to maintain an upright posture, which reduces the overall static muscular workload required to lock the joints of the foot, knee, hip and spine, and reduces his energy consumption.

Also, sitting is better than standing for the circulation. When a person is standing the blood and tissue fluids tend to accumulate in the legs --a tendency which is reduced when seated since the relaxed musculature and lowered hydrostatic pressure in the veins of the legs offer less resistance to the return of the blood to the heart. Seating also helps the operator to adopt a more stable posture, which might help him to carry out tasks requiring fine or precise movements, and it produces a better posture for the operation of foot controls.

6.2 Normal line of sight

The direction of sight is determined firstly by the movement of the eyeballs and secondly by the posture of neck and head. Eye movement within 15° above and below the normal line of sight is still comfortable. This means that the regular viewing tasks should be within a 30° cone around this principal plane of sight. If a target lies outside this cone it is assumed that the neck-head movement is involved.

Most authors today agree that the normal line of sight lies 10° - 15° below the horizontal plane. Thus any object to be viewed should be placed within a viewing angle of 5° and 30° below the horizontal plane.

The location of visual information can be specified in terms of distance from the eyes and directing of gaze (information can only be acquired within a solid angle of approximately of 50°) The greatest distance at which a display can be placed is

determined by visual acuity (the capacity to resolve small details), which in turn is determined by many factors including figure-ground contrast and the overall illumination of the visual field.

The least distance of distinct vision being 8 cm, the accommodation capacity of the lense of the eye is on average 12 at the age of 25 years, receding to 18 by the age of 40 years and changes very rapidly thereafter.

6.3 The Normal and Maximum Working Areas:

The normal working area is enclosed by arcs of the forearm with the upper arm hanging freely in the natural position at the side. This area can be reached with a sweep of the forearm.

The maximum working area is enclosed by arcs of the full arm pivoted at the shoulder.

This area can be reached by extending the arm from the shoulder.

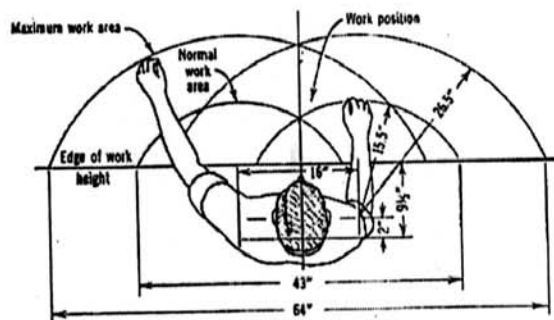


fig 34 . Human working area.

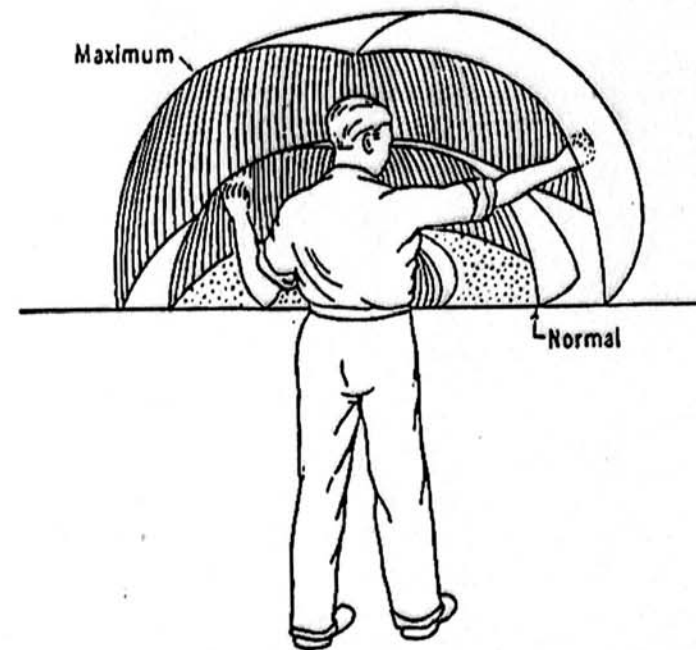


fig 35. Working area of arm.

6.4 Foot pedals

Foot pedals can be useful as alternatives to hand controls. One of their major benefits is when both hands are busy. The use of foot controls can also free space in a workstation. Foot controls, however, often require keeping a special posture and thus restrict the operator's movement. This is particularly critical for standing operators.

Foot pedals that are operated repetitively by one foot cause one-sided leaning which may lead to back pain.

Foot pedals cannot be easily seen from the normal working position. Special care must be taken to prevent stumbling or inadvertent activation.

- Locate a foot pedal at floor level in order to avoid uncomfortable foot positions.
- Make it possible to move the location of a foot pedal on the floor.
- Consider using a foot-rest at the side of the pedal.
- The best direction of movement of foot controls is down and away from body.
- Foot controls should be employed to reduce overburdening of hands.
- Foot pedals needing a large force should be such that the pressure is applied by the whole leg. For moderate force, the pressure can be applied by the ankle. Foot push buttons should be employed only when minimal force is needed.
- For effective operation, the pedal should be spring loaded.

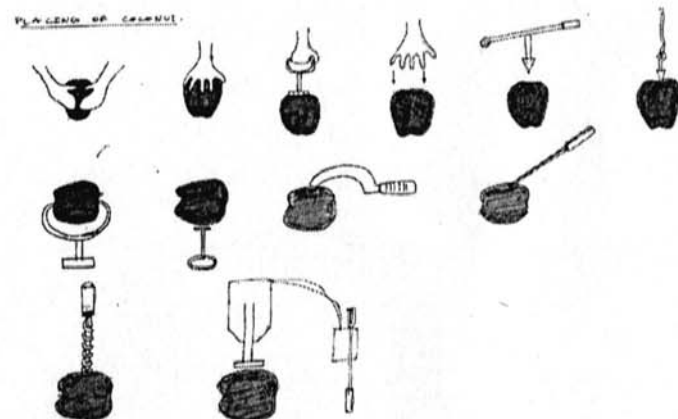


fig 37 . Different ways of holding coconut.

7 Exploration on different aspects of dehusking

To set a good perspective of the problem creative idea generation was undertaken and new methods were tried.

Using hydraulic force

1. Removal of the fibre by hydraulic force

This is a good method and trial were conducted and it was found that such a thing can be done as micro-common facility in the region where the number of coconut traders can get their dehusking done as a productive process.

7.1 Methods for holding Coconuts:

Different alternative options for holding coconut in hand or any part which will be extension of hand that can be used in the first operation of holding of coconut to insert in the machine. Different options are as follows.

- Holding in hand single hand/both hands.
- Sharp spike with extended handle.
- Lever handle with spike.
- Flexible grippers.
- Inserting by spring mounted spike.
- Hydraulic inserting arms.
- Holding coconut by two metal arms which have sharp spikes which will hold coconut in position while removing the fibres.

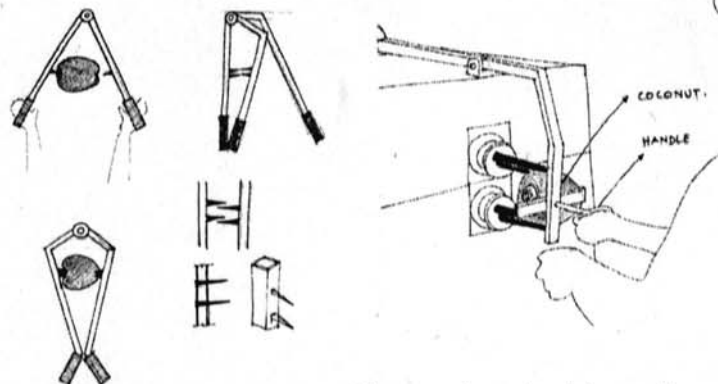


fig 38 . Holding coconut by extended handles.

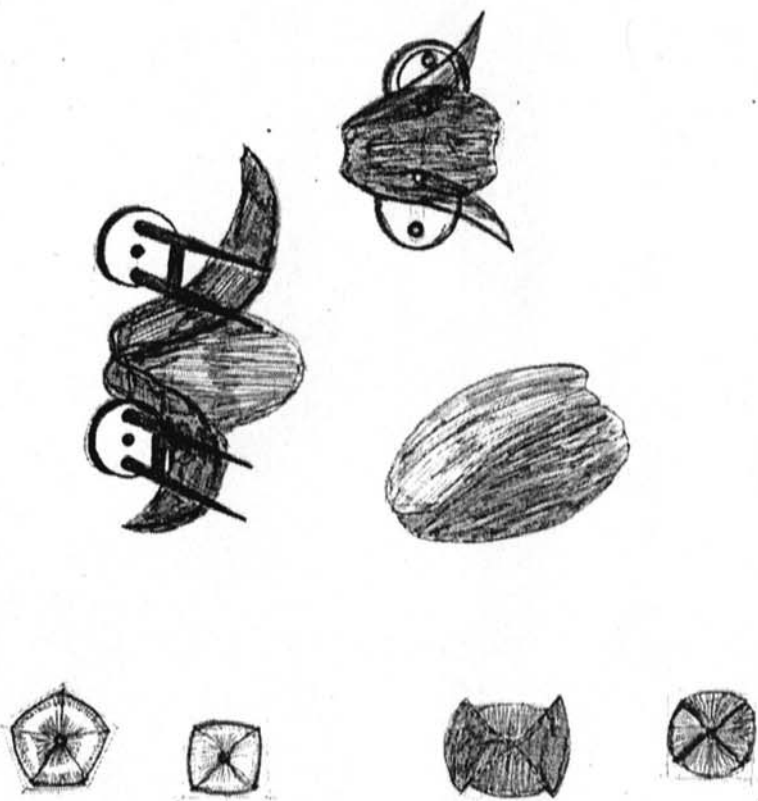


fig 36 . Different shapes of fiber removed on coconut.

7.2 Different shapes of dehusked Coconuts:

Coconut fibers were removed according to the different uses and purpose. Coconut fibre from mature coconut is removed according to the regional standards.

Coconuts fibers were removed in different shapes. when the full fiber is removed coconut is left with the shell, which is not recommended by the vendors, because the coconut which doesn't have fiber will not last for long time.

Different shapes are four side, five side, eight side. Among these three shapes in Tamil Nadu, the four sided ones are preferred because the coconuts have more fibres. In a normal sack 100 coconuts(manually dehusked) can be packed.

But if the coconut fibre is removed in four side using the dehusker in same sack bag 80 coconut can be packed which is beneficial for the vendor or farmer in making money.

8. Ideation

8.1 Introduction

In Idea generation stage, it was decided to use the innovators ideas as the best solution as it was a tried innovation and was successful. It was simple and using a very efficient method of peeling.

one

This machine is different from the existing machine in volume and internal mechanisms.

--This machine has front controlling switch.

--Front side is inclined and easy to keep leg while working.

--This machine has two pairs of spikes by which number of dehusked coconuts dehusked coconuts can be increased.

--The person who works on this machine will be in standing posture

--Closing the opening after inserting the coconut so that the coconut wont come out in cutting process.

--In this machine two pairs of cutting spikes have been added so that two sides of coconut can be dehusked at one time.

--After two sides are removed lift the coconut and turn the coconut for other two sides.

--All four sides are removed. Lift the coconut and put it in a basket provided for collecting dehusked coconuts.

--Lower part of the machine has mesh which allows ventilation in the machine to cool the running motor.

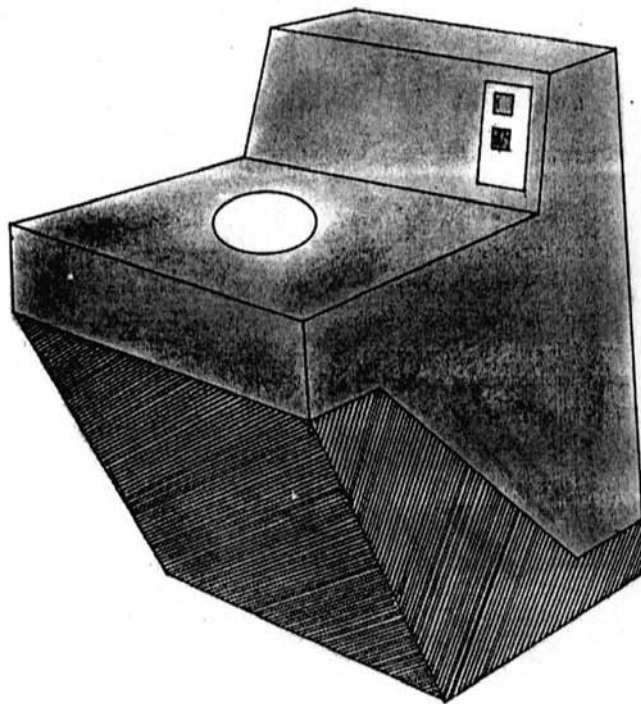


fig 39 .

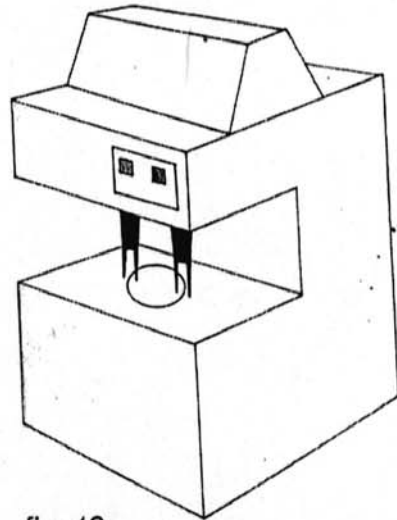


fig 40 .

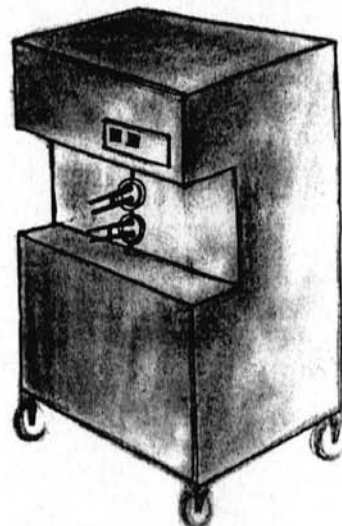


fig 41 .

two

-- SIMPLE ENCLOSED BODY STRUCTURE.

- Two cutting spikes are used, cutting spikes are oriented in 'Y'- axis.
- Control panel is in front side of the machine.
- Cutting tool is controlled by main switch.
- Body of the machine is of sheet metal with simple bending.
- Fibres are removed in front side.
- Person will be operating the machine by sitting.

three

-- SIMPLE RECTANGULAR ENCLOSED METAL BODY.

- Two cutting spikes oriented in 'X'- axis.
- Control panel is in front on the right hand side.
- Cutting tool is controlled by main switch on right side.
- Body of the machine is of sheet metal.
- Person will be operating the machine by sitting.
- Metal wheels are provided to the machine for easy shifting.

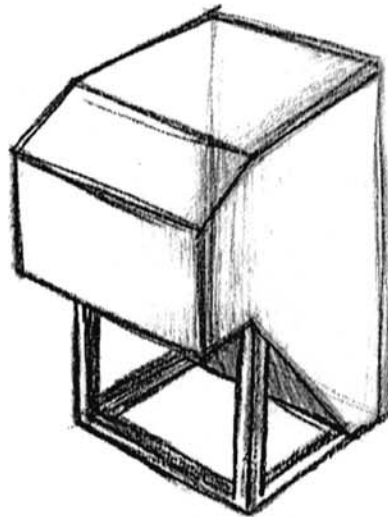


fig 44 .

FOUR

- Simple rectangular form ,with front face inclined.
- Control panel is on inclined surface for easy visibility of the switch.
- Bottom space is open without external envelope.
- Removed fiber after cutting will be collected in front bottom side of the machine.
- Sheet metal is used for external encloser.

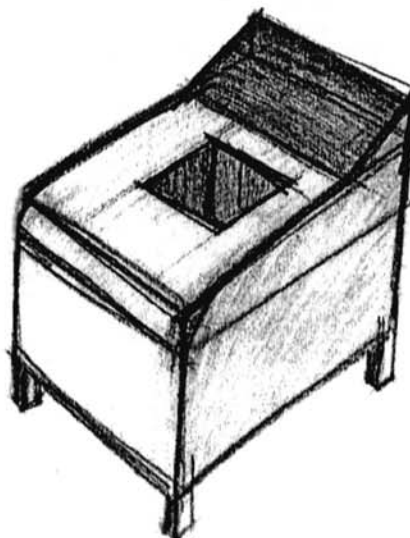


fig 45 .

FIVE

- Coconut is fed on the top surface. cutting slot is provided on the top of the machine.
- Control panel is provided across the cutting slot.
- Person will be standing while cutting operation takes place.
- Two cutting spikes will be used for cutting the coconut.
- Coconut fiber will be collected in the back side of the machine.

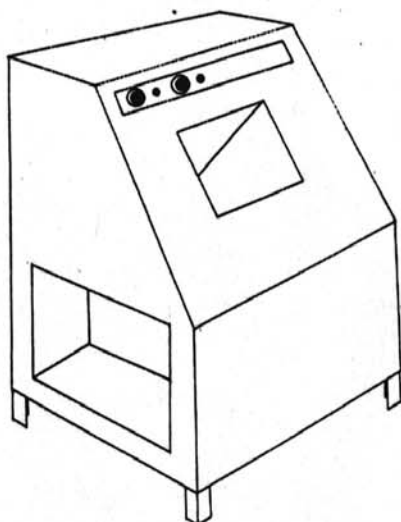


fig 46 .

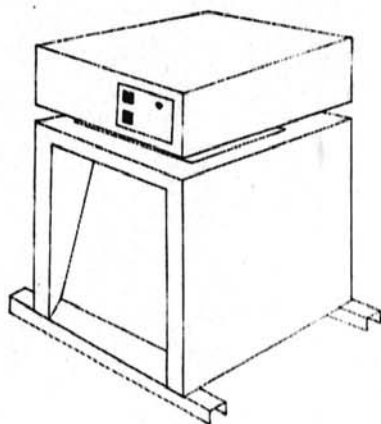


fig 47 .

SIX

- Coconut is fed into machine from the front side, which is inclined for easy visibility for dropping of coconut into machine.
- Control panel is on top left hand side of the machine.
- Coconut fiber after cutting will be separated at the side of the machine.
- Sheet metal for external enclosing of machine.

SEVEN

- Coconut is fed on the top surface of the machine.
- Control panel is on front side right hand corner.
- Coconut fiber is separated in front side.
- Two cutting spikes are used in this machine.
- There is a air gap provided in between the top body and the bottom.

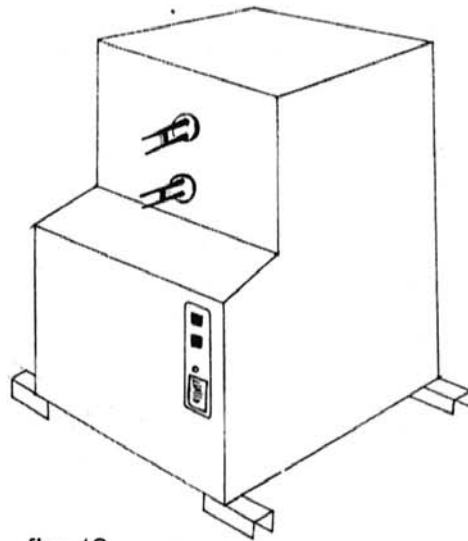


fig 48 .

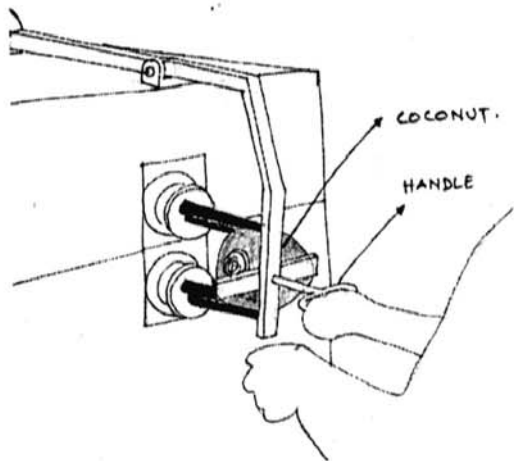


fig 49 .

EIGHT

- Coconut is fed in front side of the machine.
- Two cutting spikes is used for removing coconut fibers.
- Cutting spikes are oriented in 'X'-axis.
- Control panel is located in front right bottom side.
- Two cutting spikes are exposed outside the machine.
- Coconuts are located by external handle provided on the top of the machine which hold the coconuts while cutting.
- One hand will be engaged in holding the coconut while cutting the coconut.
- Inserting of coconut will be done by the person, putting coconut in between the two cutting spikes by both hands.
- Extended handle with coconut locators which has fine teeth which hold the coconut while cutting.
- After two sides have been dehusked handle is to be lifted and the coconut has to be turned for other two sides.

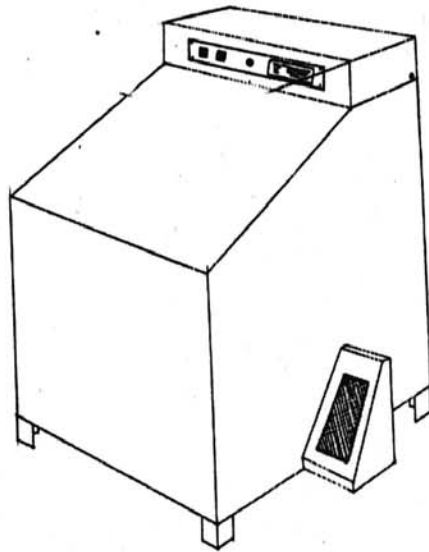


fig 50 .

NINE

- Coconut is fed in the front side where the surface is inclined towards the person for easy visibility and movement of hand is less when we have inclined face.
- Cutting tool is engaged with motor by foot operation.
- Foot peddle is placed on right hand side.
- Main control panel is placed on front side over the cutting slot.
- All controlling systems are grouped in one side for making user to locate the system easily.
- All the moving parts are placed inside the sheet metal body.
- Person will be sitting while he carries out the operation of dehusking coconut.

9 Concepts

9.1 Concept 1

- _ Two cutting spikes were added in the machine to increase the number of sides been cut in one time.
- _ Foot peddle is added to engage the motor and cutting tools.
- _ Motor is vertically fixed.
- _ Control panel is placed across the cutting slot.
- _ Cutting slot with coconut locator is kept on the top surface.
- _ Person will be sitting while operating the machine.

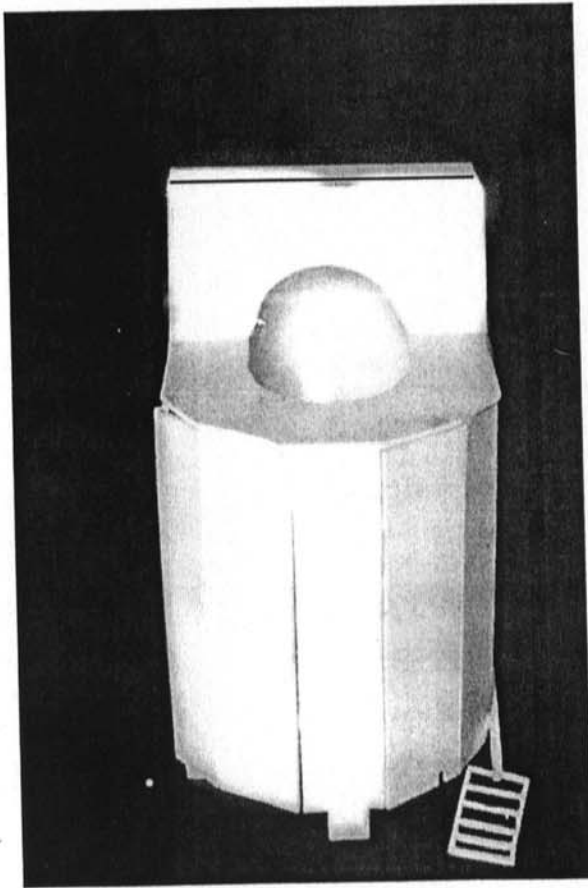


fig 52. Concept model .



fig 53 . Operating control panel



fig 54 . Inserting coconut in to machine

In this concept the user will be sitting in front of the machine and will be doing the operation.

_ The image shows the person while sitting how he will reach the control panel for switching ON/OFF the motor.

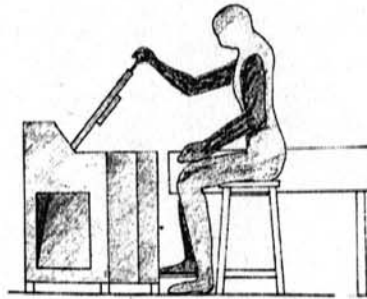
_ In this concept person stretches his arms across the cutting slot. He has to bend for this action.

Coconut is fed on the top. The coconut is taken over the top of the cutting slot, and dropped into it by gravity which forces it to get into the spikes.

_ After the fibres are removed from coconut , they are thrown on right/left side of the machine. These fibers can be collected by placing a basket below the outlet.

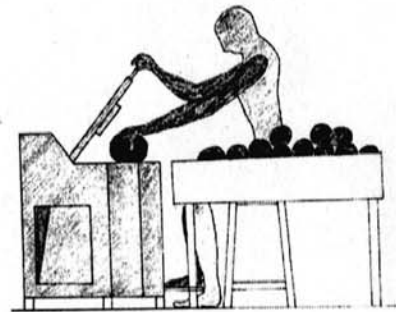
_ No internal moving parts of the machine is exposed out side.

_ Coconut can be gathered near the machine on an elevated platform.



The sequential operation of coconut fiber removing in concept 1.

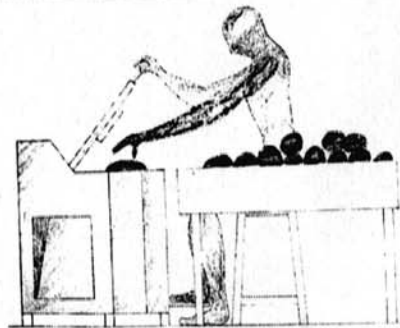
_ First the handle is lifted above the cutting slot.



_ Coconut is lifted and dropped into the cutting slot of the machine.

_ Coconut is properly placed in between the cutting spikes.

_ Handle is brought in contact with the coconut and pressure is given on the coconut to make the coconut go deep into the spike.



_ Motor is engaged with spike, in first action two sides of coconut is removed.

_ Same action is repeated again for removing fiber on other two side of the coconut.

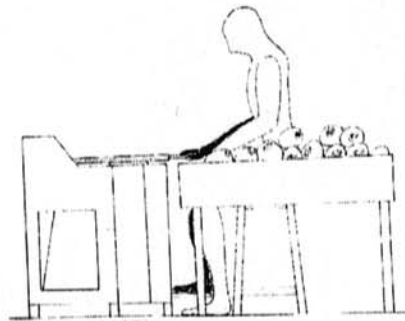
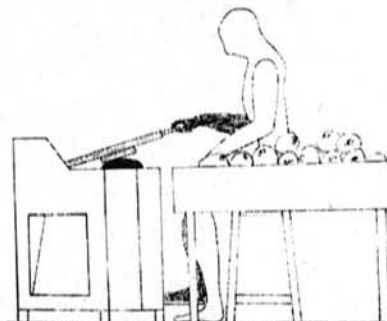
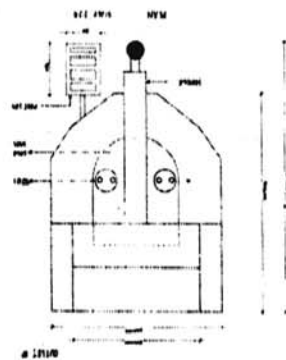


fig 55 . Sequential operation concept 1.



The figure shows the top view and side view and internal arrangement of the motor and spikes fixing.

_ Figure 1, Shows the handle is over the cutting slot, which is spring mounted. When the coconut is to be pressed the handle is taken down. When the operation is over the handle is released and it goes back to its original position.

_ Removed fibres are separated on the side of the machine.

_ Motor and cutting spikes are connected separately. When it want to engage, two clutch plates connect to the central shaft. when these clutch plates engage the spikes start rotating and cutting takes place.

_ Motor is fixed horizontally and the main shaft is perpendicular to the motor.

_ Air ventilation is provided at back side of the body at bottom level to let the heated air out and keep the motor cool.

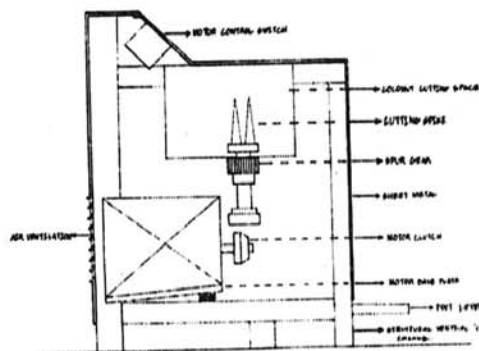
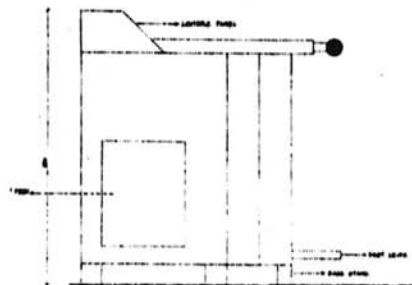


fig 56 . Drawing show top, side internal section of concept 1.

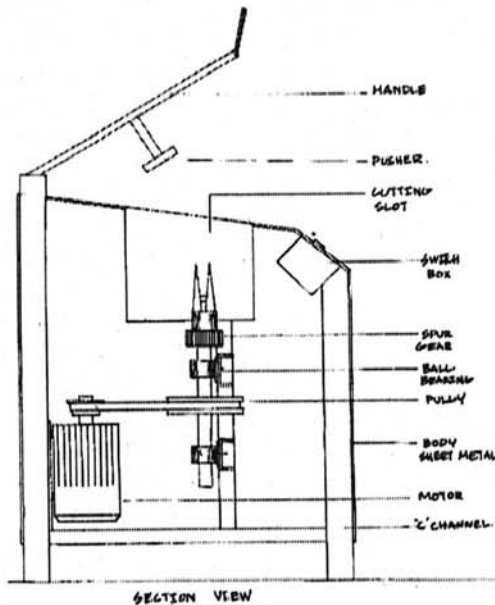


fig 57 . Internal configuration.

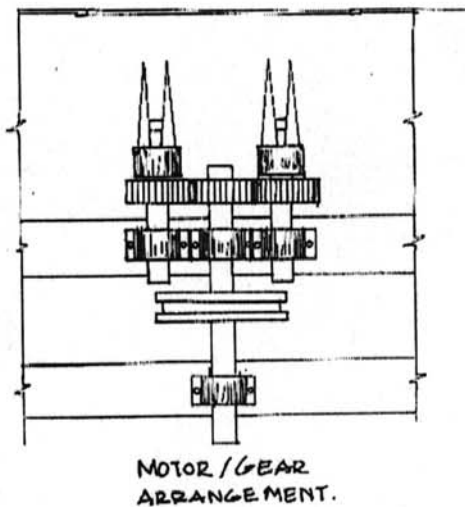


fig 58 . Gear arrangement.

9.1.1 Configuration 1 of Concept 1

With the basic idea of first concept, different configurations have been tried in placing the motor and how the cutting tool will be connected to the main shaft.

- _ Motor is fixed vertically to the structural frame. The main shaft is driven by the pulley and belt which is connected the motor pulley.
- _ Power from the motor is transferred to the cutting spike using two standard gear's connected to the cutting tool.
- _ Two cutting spikes have been used to increase the cutting action.

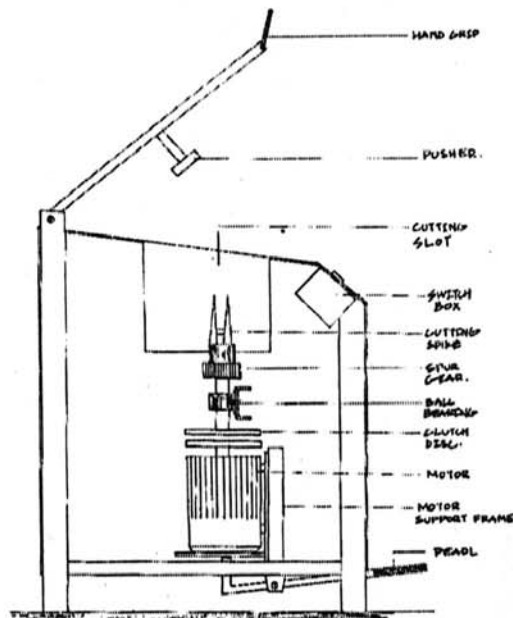


fig 59 . Internal configuration.

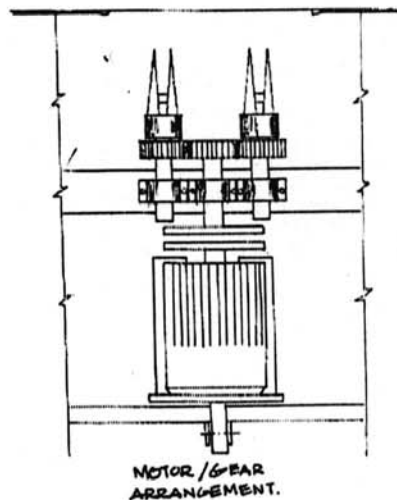


fig 60 . Gear arrangement .

9.1.2 Configuration 2 of Concept 1

- _ Motor is fixed vertically with the shaft below two clutch plates.
- _ Motor is fixed centrally so the machine is stable when it runs.
- _ Motor is connected to the foot operated peddle. This lifts up the motor so that the two clutch plates get engaged and the cutting takes place.
- _ Above the clutch plates standard gears have been used to engaged the cutting spikes.
- _ By this arrangement space occupied by the internal component is reduced and the whole machine looks compact.
- _ Advantage of the this method is that life of the motor is more, because motor is continuously running, only when the cutting is to happen the running motor is engaged by clutch mechanism.

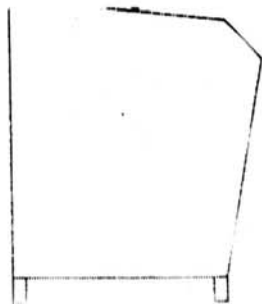
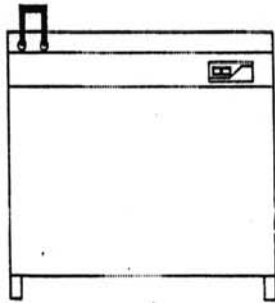
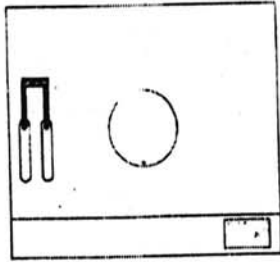


fig 61. Top ,front, side view
concept 2 standing position.

9.2 Concept 2

This concept is developed by adding four cutting spikes.

- _ The body posture of the person will be standing while he/she is cutting.
- _ Coconut is lifted from the basket and dropped vertically into the cutting slot.
- _ In the cutting slot the cutting spikes rotate around the coconut. The four spikes are arranged in such a way that in one slot four sides are removed.
- _ Cutting spikes are engaged and controlled by hand.
- _ Main control panel is kept at front right hand side which is tilted in an angle for easy visibility.
- _ Coconut fibre is thrown at back side of the machine, which can be collected in a basket.
- _ Body of the machine is proposed to be sheet metal.

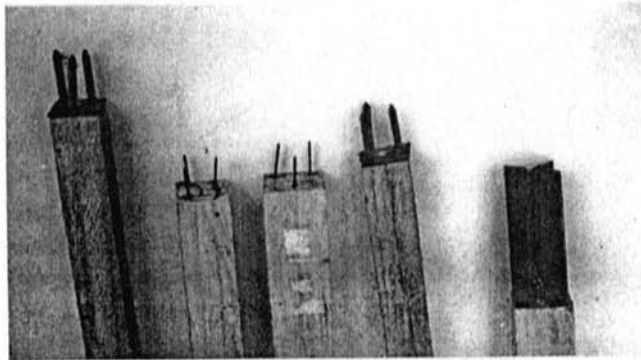
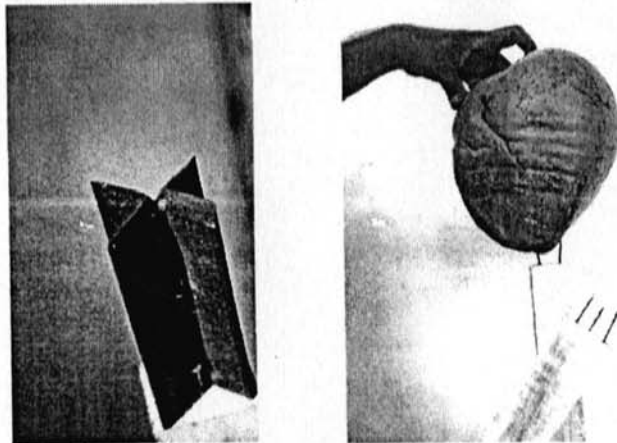


fig 62 . Alternative fixtures to hold coconut.

In the concept 2 coconut is dropped at the side of the cutting slot. After this the coconut has to be fixed and located in the cutting position. To locate the coconut in cutting position locator arms have been provided inside the machine. These arms hold the coconut and when the motor is engaged, these handles move towards the coconut and hold the coconut. These arms move in 'y' -axis and the coconut is dropped inside the machine. Head of the coconut is on top so the cutting spike moves around the surface of coconut.

The figure shows the position how the coconut will be placed inside the cutting slot.



The figure shows the sequential operation as the coconut is dropped in to the machine and holding of coconut and the movement of cutting tool around the coconut.

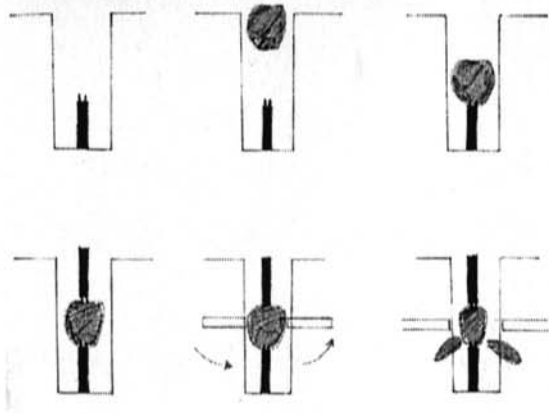


fig 63 . Sequence of peeling.



fig 64 . Standing posture and the machine

The figure shows the structural frame and volume of the machine. The person stands in front of the machine.

_First action will be lifting the coconut which will be placed on an elevated platform so it will be easy to lift the coconut.

_After the coconut is lifted it is dropped inside the machine. The cutting head of the coconut has to be facing top. In this machine, in one shot all the four side are removed.

_After dehusking, the coconut comes out separately. The fibres and coconut can be collected in basket or in sacks.

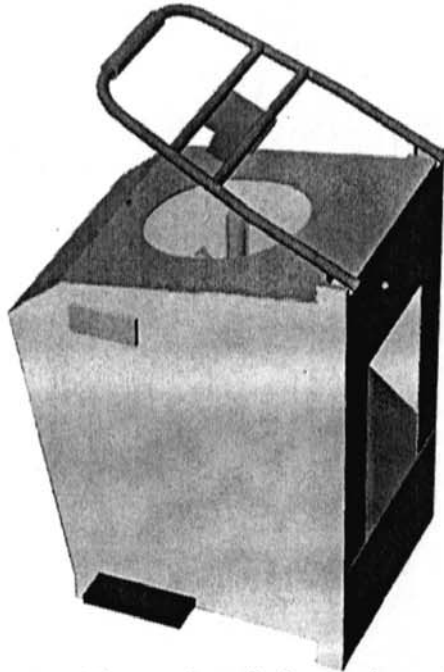


fig 65. Position of switch and padle

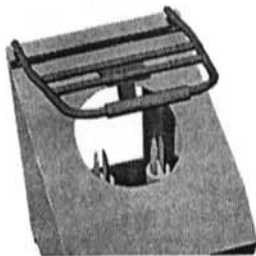


fig 66. Handle detail

9.3 Concept 3

The person will be sitting with his body facing the machine

-The cutting slot is provided on the top inclined surface to have the clear visibility of the cutting tool

-Two cutting tools are used in this concept which rotate in opposite directions

-The body of the machine formed by the sheet metal enclosure

-The switch is provided on the right side for the easy and also inadvertent activation.

-The cutting tool is engaged with the motor by pressing the peddle kept at the bottom right side and required foot clearance is kept.

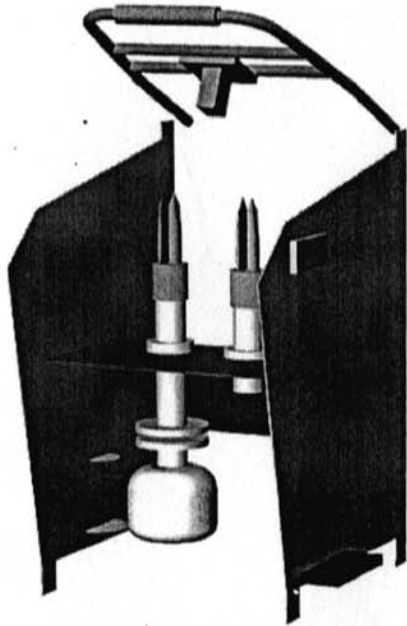


fig 67. Internal arrangement of motor.

- Extended handle is provided for pressing the coconut against the cutting tool and also to locate the coconut in the right position.
- The removed fibre is thrown at the back side of the machine.
- A rubber covering over the handle is provided to have a good grip.
- Foot paddle is fixed on the right hand side of the machine making the controlling activities grouped on one side.
- Speed of the motor is reduced from 1440 rpm to 30 rpm to have a safe rotation. This also facilitates low speed and high torque.

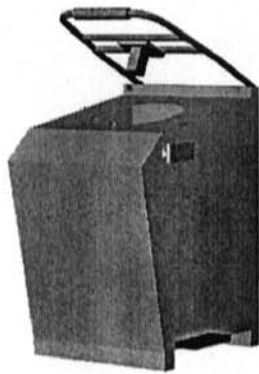


fig 68.



fig 69. Concept 'A'

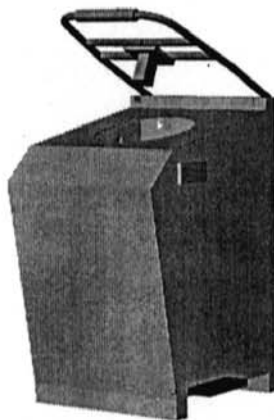


fig 70. Concept 'B'

10. Concept Evaluation

-After evaluation of the various concepts two concepts were studied in detail.

1. Concept 'A'

- Sitting posture.
- Fibers are removed on right/left sides.
- Control panels are above the cutting slot.
- Top surface is below elbow height.
- Paddle controlled.
- External cover of the machine in sheet metal.
- All the internal components are covered.

1. Concept 'B'

- sitting posture.
- Fibre is removed and thrown in opposite direction of feeding.
- Control panel is placed on right hand side of the machine.
- Handle is provided to press the coconut and to locate the coconut in cutting slot.
- Motor and cutting tool is engaged by paddle.
- speed of the cutting tool is reduced from 1440 rpm to 30 rpm.
- Body of the machine is covered by sheet metal.

11. Final Concept

After detailed study and evaluation of both concept 'A' and concept 'B', concept 'B' is finalized for prototyping. The scoring points were given for the following features.

- Feeding of coconut was better and safer.
- Construction of machine was better.
- speed of the motor is reduced from 1440 rpm to 30 rpm.
- Location of switch
- User sitting poster.
- Separation of fibre, after cutting.
- Location of paddle .
- Joining of body cover.
- Maintenance of motor and servicing is easier.
- User is comfortable when he work on this machine.



fig71,



fig72,

Final concept for prototyping:

In the final concept following problems were taken in to consideration

- Feeding of coconut
- Construction / fabrication / cost of machine
- Speed of the motor / cutting tools
- Location of switch
- Human-Machine interaction
- Separation of coconut and removed fibers
- Joining details of the machine body covers
- Maintenance, service of machine
- Transportation
- Safety.

After finalization of concept prototype is made for testing.

Clear instruction is given to the operator how to work on the machine.

Sequence of operation is as follows,

Step 1- Lifting of coconut

Step 2- Placing of coconut over cutting spikes

Step 3- Pressing the coconut over the spikes by the help of handle attached to the machine

Step 4- Pressing the pedal switch

Step 5- Cutting operation starts

Step 6- Removing the coconut and placing again over the spikes on other remaining two sides of coconut

Step7- Pressing the pedal switch.

Step8- Placing the dehusked coconut on left-side.



fig 73,



fig 74,

In the old machine 12 actions had to be done for dehusking one coconut. Which is improved in this new machine by which same work can be completed in just 8 actions, by reducing 4 action number of coconut dehusked is increased.

In old machine number of coconut dehusked in 1minutes- 4 / 5 coconuts

In new developed machine 1minute- 10 / 12 coconuts

One coconut takes 6 seconds that is 4 sided fiber removed coconut,

1 minute -10 coconuts

60 minutes – Approx 600 coconuts, can be dehusked in the new developed machines

Specification of the machines :

1. Two spike cutter machines
2. 30 rpm output motor with single phase
3. Peddle operated switch
4. L-angle structural frames
5. Stainless / sheet metal body cover
6. Total weight of the machine is 110 Kg
7. Price of the one machine is Rs, 10,000 /-

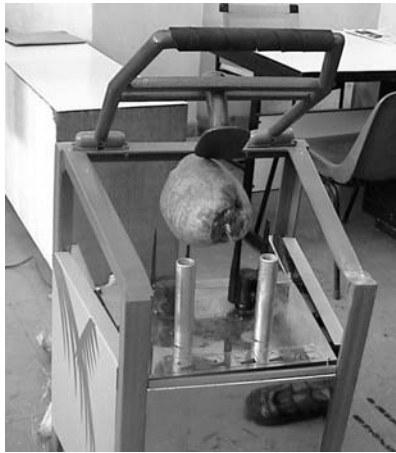


fig 75,



fig 76,



fig 77,



fig 78,



fig 79,

User tests have been conducted on the prototype.

Mr. Jayaseelan, innovator himself tested and operated the machine, coconuts which will be used in the real situation is used during the test.

Figure 75, Showing Mr Jayaseelan placing the coconut above the cutting spike. Coconut is kept in position by the handle pressing on the coconut. Important thing is that coconut has to be kept in proper position otherwise during cutting, coconut may move before cutting or it may cut at any one side of the coconut.

Figure 76, Showing pressing operation of handle over the coconut, during this operation sharp spike get in to the coconut fibers.

Figure 77, After pressing the coconut, Motor is switch ON by pedal switch. Pressing constantly on the coconut till the coconut passes through the cutting spikes.

Figure 78, Showing removal of fiber on two sides.

Figure 79, Showing back side view of the machine, where removed fiber from coconut will be falling on opposite direction of cutting which can be collected by attaching jute bag to the machine.



fig 80,



fig 81,

Figure 80, Showing the different stages of fibers been removed from the full coconut. The main aim is to get that squarish form over the coconut so that it can be packed in the bags. If the coconut fiber is not removed in this manner is not economical for the vendors. In normal jute bag 60 coconuts can be stored, and if the fiber is removed about 100-110 coconuts can be stored in the same jute bag. Another advantage of retains the fiber on coconut is that it acts like natural packaging for coconut and coconut lasts longer without any damage while transportation.

Figure 81, Showing vertical stackability of the coconut.



fig 82,

Figure 82, Showing horizontal stack ability of the coconut.



fig 83 ,

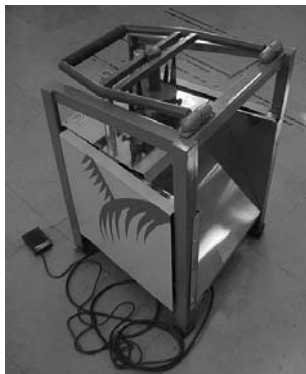


fig 84,



fig 85,



fig 86,

The whole machine has been fabricated with simple 'L' section MS channels. The operations involved include basic channel cutting, welding, sheet metal bending etc. machines for which are widely available in rural areas. Manufacturability in the rural areas has been an essential consideration while designing the whole machine.

All the 'L' sections have a welded joint between them, and the sheet metal work is basically done by bending and spot welding.

Fig. 85 shows the location of the single phase motor inside the machine which has been vertically mounted to avoid incorporating a pulley and wheel assembly for speed reduction which instead is achieved by using a additional gear reduction assembly. This is directly coupled with two small ms gears on to which the cutting tools are fixed.

The speed reduction assembly gives an output of 30 rpm while being directly coupled with the motor shaft rotating at 1440 rpm, thus the reduction ratio being 48.

The motor can be easily accessed by only removing the side panels for regular maintenance and repairs.

The motor has been mounted about 10 cm above the ground level to improve the stability of the machine by keeping its centre of gravity low.

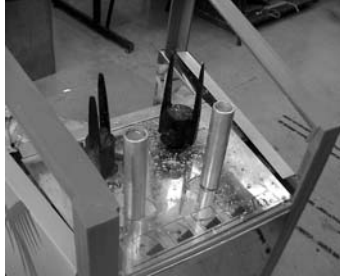


fig 87,



fig 88,



fig 89,

Removal of coconut fibre:

After the coconut is placed on the cutting tools and pressed, it tends to be carried towards one side due to the force of the cutting tools. To address this problem a stopper had been provided so that the coconut is guided in the proper direction without any damage. The removed fibres will then fall into a basket or jute bag attached to the back side of the machine. The fibres are free to fall into the sack over a slope of about 20 degrees.

The top surface panel is made of stainless steel, as the liquid content in the fibres reacts with mild steel. Rust formation is very quick when ms sheet is used. The figures illustrate the dehusking of the fibres and their collection in one place.



fig 90,



fig 91,



fig 92,

The movable handle is pivoted on the top of the structure. This is used to apply positive pressure on the coconut once it is placed on the cutting tool and holding the coconut in position while the fibres are being removed. This avoids using the hands to do the same operations, which is not safe. The spring capsule incorporated in the handle assembly helps in getting the handle back to normal vertical position once the pressing operation is over. A soft rubber tube is used to cover the handle at the point where it is held. This provides for better grip for the hands and also acts as a cushion between the hands and the handle while applying pressure onto the coconut.



fig 93,



fig 94,

The main controlling switch to the motor is connected to the foot operated pedal switch.

This can be extended as per the users need in terms anthropometric requirements.

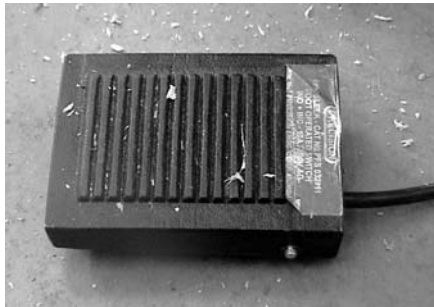


fig 95,

The stainless steel surface at the top has graphical illustrations for easy communication of the processes involved in operating the machine. The stainless steel sheet is treated with matt finish to avoid reflection of the surrounding to the user.

The whole machine has been treated with shades of green to lend to it a feeling of naturalness in keeping with the environment in which it will be used. The main structural frames are in foliage green, the side panels being pastel green.

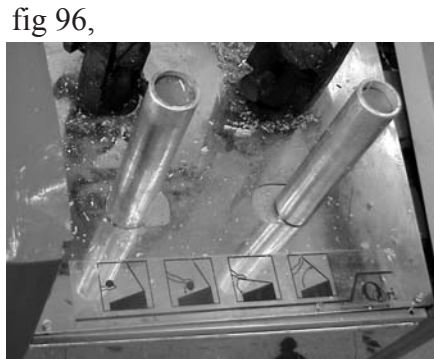


fig 96,



The handle is bush green in colour.

The side panels have graphics of coconut leaves which semantically imply the machines association with the coconut.

fig 97

SALIENT FEATURES

The salient features of the dehusking machine are as follows.

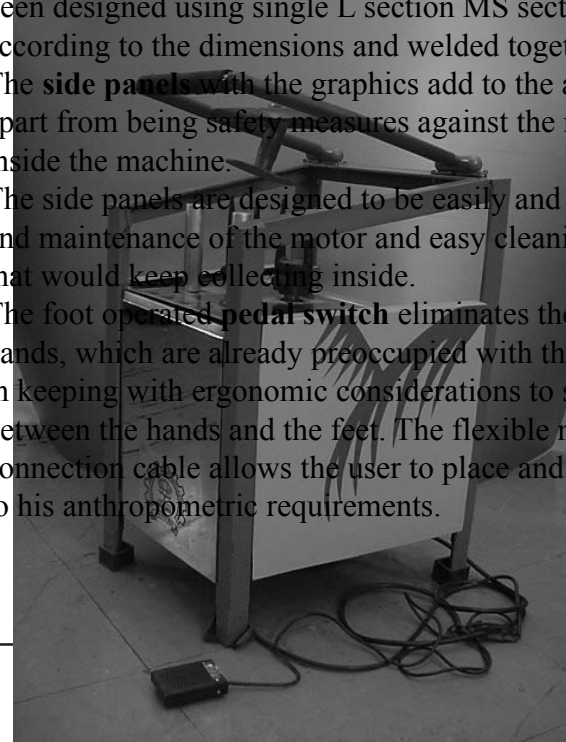
1. The machine is ergonomically designed to offer a good degree of comfort to the user. The user can sit and operate the machine for long durations of time.
2. The safety of the user is greatly enhanced in the machine in the sense that direct hand contact with the coconut while dehusking has been avoided. One only has to press the coconut on the spikes and then press further by using the **handle** provided on the top of the machine.
3. The shock and vibrations which come on the hands are reduced by using **cushioned sleeve** on the handle.
4. In terms of manufacturability the **structural frame** for the machine has been designed using single L section MS sections. These can be cut according to the dimensions and welded together in an easy manner.
5. The **side panels** with the graphics add to the aesthetics of the machine apart from being safety measures against the motor and electrical parts inside the machine.
The side panels are designed to be easily and quickly removed for repair and maintenance of the motor and easy cleaning of grit and husk particles that would keep collecting inside.
6. The foot operated **pedal switch** eliminates the strain developed in the hands, which are already preoccupied with the dehusking activity. This is in keeping with ergonomic considerations to share the work activity between the hands and the feet. The flexible nature and length of the connection cable allows the user to place and adjust the switch according to his anthropometric requirements.

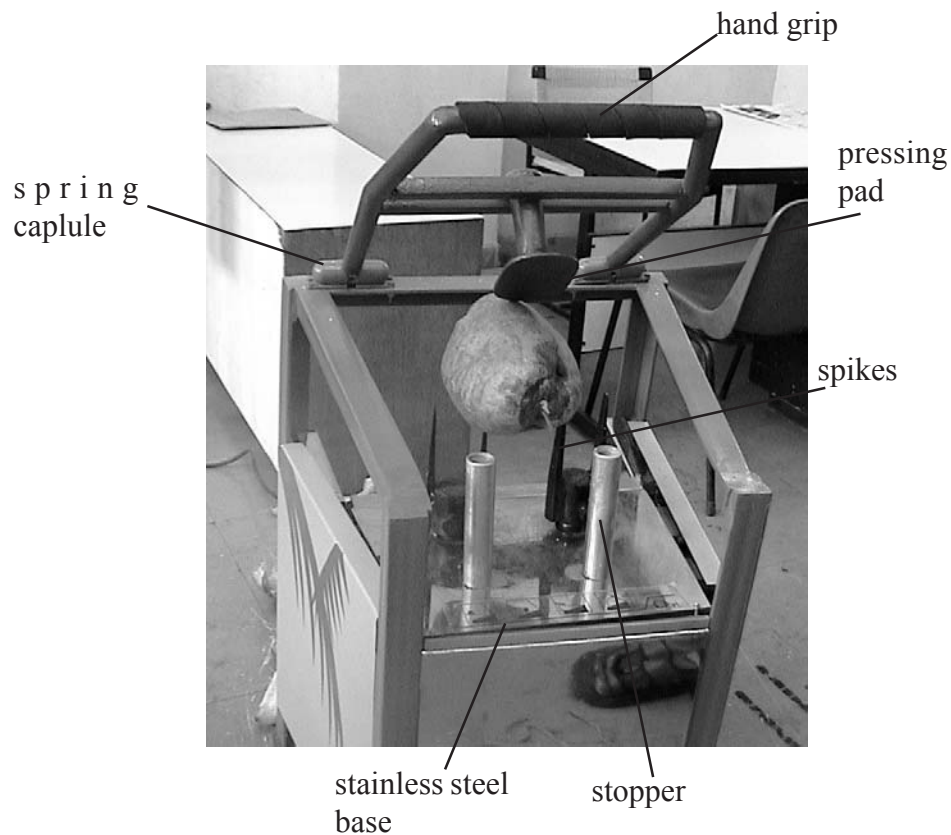
handle

structural
frame

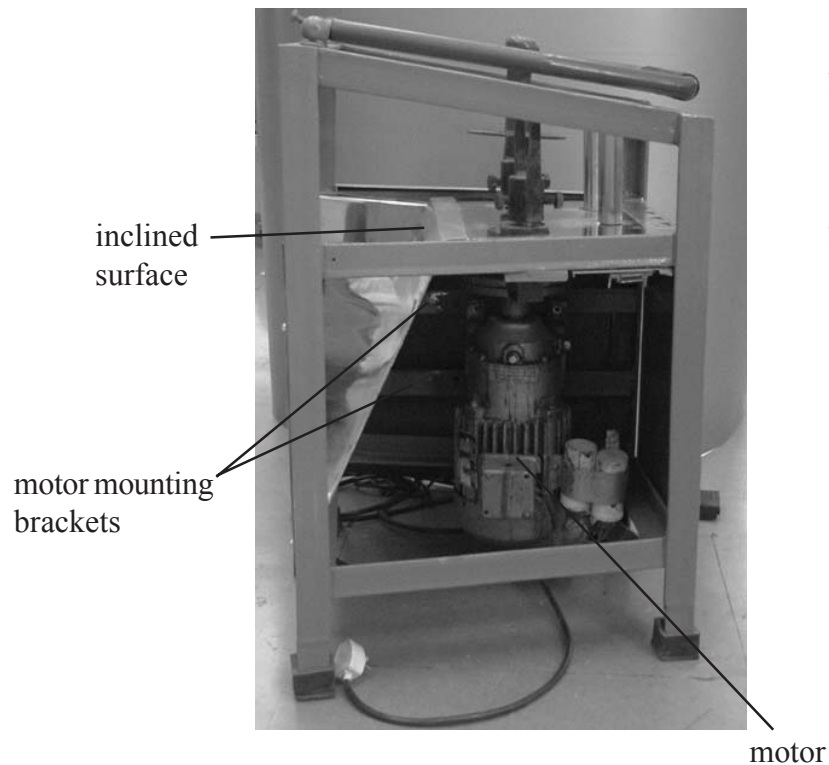
pedal switch

side panels





7. The top handle used to press the coconut on the spikes is hinged on the main frame of the machine with a **spring capsule** which eliminates the activity to push back the handle once the dehusking is complete. This capsule is spring loaded and pulls back the handle once it is released.
8. The **pressing pad** connected to the handle provides a pressing surface for the spikes to enter into the fibres of the coconut. Also the pad restricts the movement of the coconut when the dehusking activity is in progress.
9. The **spikes** are forged components and hardened to retain the sharp edge required to pierce the tough fibrous shell of the coconut. These can be easily removed for repair and replacement by only unscrewing it from the gear shaft.
10. The **stoppers** prevent the lateral movement of the coconut while being dehusked and also prevents the coconut from falling on the users side.
11. The **stainless steel base** functionally provides a rust free surface on the top as a lot of fibre fluid is released when the coconut is dehusked. The matt finished surface of stainless steel surface avoids visual strain which would otherwise happen due to the glare reflected from a glossy stainless steel surface. The stainless steel surface also lends a sense of hygiene and cleanliness to the machine.



12. The **inclined surface** on the rear side of the machine allows the dehusked fibres to freely fall into a basket or jute bag attached on the rear side. This prevents the fibres from collection on the topside.
13. The **mounting brackets** for the motor are provided on the side so as to enable easy dismounting and repair of the motor. The dismounting can be done by unscrewing the motor mounting screws from the side, after removing the side panel.
14. The motor used is a 1.5 hp, single phase 1440 rpm induction motor. The speed of the motor is reduced to 30 rpm as required for dehusing, by employing a speed reduction gear assembly with a ratio of 48. The speed of about 30 rpm is safe and convenient for dehusing.



CONCLUSION

In the developed prototype safety, ergonomic and functionality issues have been dealt with in detail. The design and development of the machine had been done with the environment of its usage in mind. The overall aesthetics of the machine has been enhanced to a marketable level.

In terms of efficiency and productivity the machine is proposed to dehusk about 600 nuts per hour.

The user interaction with the machine has been studied and analyzed to arrive at the most economical dimensions and activities to be performed while dehusking the coconut.

The concept of dehusking borrowed from the innovator has been rendered safe, user friendly and efficient to a great extent.



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