

Design and Development of a Safety-Enhanced Manual Horizontal Coconut Dehusking Machine

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ABSTRACT

Coconut dehusking is an essential process in coconut-producing regions and is commonly performed using traditional vertical spike tools or simple mechanical devices. Although effective, these methods pose serious safety risks to operators because the process requires pressing the coconut onto a sharp spike with considerable force. Slippage during operation may lead to severe injuries. This study presents the design and development of a safety-enhanced manual horizontal coconut dehusking machine that improves operator safety and ergonomics. The proposed machine incorporates a circular positioning ring to securely position the coconut while a cutting blade mechanism approaches from the top using a manually operated lever system. The horizontal arrangement eliminates the need for direct downward force on a sharp spike and significantly reduces the risk of accidental injury. A 3D model of the machine was developed using SolidWorks to validate the design configuration and analyze component arrangement. The proposed machine aims to provide a low-cost, safe, and efficient alternative for rural coconut processing applications.

Keyword: - Coconut Dehusking, Manual Agricultural Machine, Safety Design, Rural Mechanization, Ergonomic Mechanism

1. INTRODUCTION

Coconut is one of the most important agricultural products in tropical regions, including India. It is widely used in food processing, oil production, and various household applications. Before the coconut can be used, the fibrous outer husk must be removed, a process known as dehusking. Traditionally, coconut dehusking is carried out using a vertical spike fixed to the ground or mounted on a frame. The operator manually forces the coconut onto the spike and pulls the husk away from the shell. Although this method is simple and widely used, it requires considerable skill and physical effort. One major drawback of this method is the high risk of injury. During the dehusking process, the operator must apply significant force to push the coconut against the sharp spike. If the coconut slips or the operator loses balance, the sharp spike can cause serious injuries. Such accidents are not uncommon in rural areas where coconut processing is performed manually. Several mechanical and motorized coconut dehusking machines have been developed to improve productivity. However, many of these machines are expensive, require electrical power, or still involve potentially dangerous cutting mechanisms. Therefore, there is a need for a safer, low-cost, and easy-to-operate coconut dehusking machine suitable for rural applications. This paper presents the design and development of a manual horizontal coconut dehusking machine that improves safety and reduces operator skill requirements.

2. LITERATURE REVIEW

Various attempts have been made to improve coconut dehusking techniques through mechanical designs. Traditional dehusking methods involve a stationary vertical spike mounted on a wooden or metal frame. While this method is widely used, it presents several safety hazards and requires significant physical effort. Researchers have proposed mechanical coconut dehusking machines that use lever mechanisms, rotating blades, or powered systems. Motorized dehusking machines improve productivity but increase cost and maintenance requirements. These machines are often unsuitable for small-scale farmers and rural households. Manual mechanical machines have also been developed using lever-based systems that reduce the effort required for dehusking. However, many of these designs still expose the operator to sharp cutting elements and require precise handling. Recent studies in agricultural machinery design emphasize the importance of ergonomic and safety-oriented designs. The goal is to minimize operator risk while maintaining efficiency and affordability.

The proposed horizontal coconut dehuscing machine focuses primarily on improving safety by eliminating the traditional vertical spike and introducing a controlled cutting mechanism.

3. PROBLEM STATEMENT

Traditional coconut dehusking methods using vertical spikes require the operator to exert significant downward force on a sharp cutting point. If the coconut slips during operation, the operator may lose balance and come into direct contact with the spike, leading to severe injuries. Additionally, the traditional method requires considerable skill and experience to perform efficiently. Beginners often find it difficult to handle the tool safely. Therefore, there is a need for a safer coconut dehusking mechanism that:

- Reduces the risk of injury
- Requires less skill to operate
- Maintains simplicity and low cost
- Improves operator ergonomics

The present work proposes a horizontal coconut dehusking machine designed to address these issues.

4. PROPOSED MACHINE DESIGN

The proposed design is a manually operated horizontal coconut dehusking machine consisting of the following major components:

1. Frame Structure
2. Coconut Positioning Ring
3. Dehusking Blade
4. Lever Handle System
5. Base Support

The frame structure supports all machine components and provides stability during operation. The lever mechanism is connected to a wedge-shaped cutting blade which penetrates the coconut husk during the dehuscing process. A circular positioning ring is provided on the machine frame to guide the correct placement of the coconut before the dehusking operation. The ring does not clamp or rigidly hold the coconut; instead, it acts as a positioning reference that ensures the coconut is aligned with the cutting blade. This simplifies operation for the user and ensures consistent blade engagement with the husk. The horizontal orientation of the coconut and the controlled cutting motion significantly reduce the risk of accidental injury. The complete machine was modelled using SolidWorks to visualize the assembly and verify component arrangement.

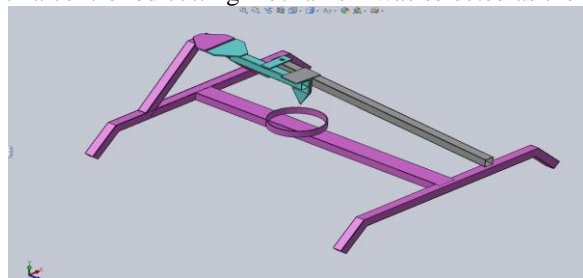
5. DESIGN METHODOLOGY

The design of the horizontal coconut dehusking machine followed a systematic engineering approach.

5.1 Concept Development

Initially, several conceptual ideas were discussed to improve the safety of coconut dehusking operations. The main objective was to eliminate the dangerous vertical spike used in traditional methods.

A horizontal arrangement with a controlled cutting mechanism was selected as the most suitable design.



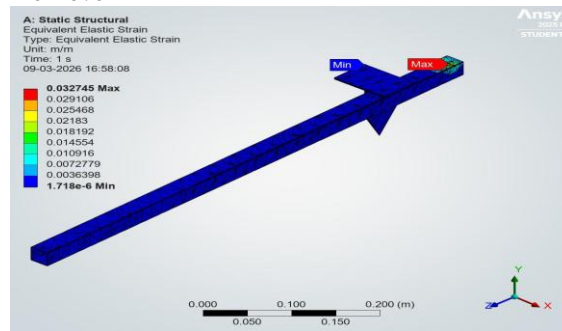
5.2 Cad Modelling

A detailed 3D model of the machine was created using SolidWorks. The CAD model helped visualize the machine components and evaluate the overall structure.

The modeling process included:

- Frame design
- Cutter assembly
- Holding ring design
- Lever mechanism

5.6: Strain Distribution Of The Lever Arm



6. SAFETY AND ERGONOMIC ANALYSIS

Safety improvement is the primary advantage of the proposed design. In traditional vertical spike systems, the operator must apply downward force directly toward a sharp spike. This creates a dangerous working condition. In contrast, the proposed horizontal machine provides several safety advantages:

- The coconut is securely held in a circular ring, reducing slipping.
- The cutting blade moves in a controlled direction.
- The operator's body is positioned away from the cutting point.
- Force is applied through a lever rather than direct body pressure.

From an ergonomic perspective, the machine allows the operator to work in a more comfortable posture. The lever mechanism reduces the effort required to penetrate the husk, making the process easier for inexperienced users.

7. ECONOMIC ANALYSIS OF THE COCONUT DEHUSKING MACHINE

7.1 Estimated Cost Of The Machine

The estimated manufacturing cost of the manual horizontal coconut dehusking machine is calculated based on the materials used and fabrication requirements. The major components and their approximate costs are listed in Table 7.1.

TABLE 7.1: MAIN COMPONENTS AND ESTIMATED COST

No	Component	Material	Estimated Cost (INR)
1	Frame Structure	Mild Steel	₹1200 – ₹1800
2	Coconut Positioning Ring	Mild Steel Ring	₹200 – ₹400
3	Dehusking Blade	Hardened Steel	₹400 – ₹700
4	Lever Handle System	Steel Rod / Pipe	₹300 – ₹500
5	Base Support Plate	Mild Steel	₹300 – ₹600
6	Fasteners (Nuts, Bolts, Welding)	Steel	₹150 – ₹300
7	Fabrication and Welding Labour	—	₹600 – ₹1000

7.2 Total Estimated Machine Cost

Based on the component costs and fabrication expenses, the total estimated manufacturing cost of the machine is summarized in Table 7.2.

Type	Cost
Minimum Cost	₹3,150
Maximum Cost	₹5,300

AVERAGE MANUFACTURING COST: ₹4000 – ₹4500

7.3 Cost Per Coconut

Since the machine is manually operated, the operational cost mainly consists of **machine depreciation and labour cost.**

ASSUMPTIONS

- Machine life: **10,000 coconuts**
- Machine cost: **₹4000**

MACHINE COST PER COCONUT

Machine Cost per Coconut = $4000 \div 10,000$

Machine Cost per Coconut = **₹0.40**

LABOR COST (APPROXIMATE)

If a worker dehusks **120 coconuts per hour** and earns **₹300 per day (8 hours)**:

Labor cost = $300 \div (120 \times 8)$

labour cost \approx **₹0.31 per coconut**

7.4 Total Processing Cost Per Coconut

Cost Type	Cost
Machine Cost per Coconut	₹0.40
Labor Cost	₹0.31
Total Cost per Coconut	\approx ₹0.70

7.5 Summary of Economic Performance

Item	Value
Machine Manufacturing Cost	₹4000 – ₹4500
Cost per Coconut (Operation)	₹0.70 approx.
Machine Capacity	100 – 150 coconuts per hour

8. EXPECTED PERFORMANCE

The proposed machine is expected to offer several operational advantages:

- Improved operator safety
- Reduced physical effort
- Lower skill requirement
- Simple and low-cost construction

The horizontal design ensures better stability during operation. The lever mechanism provides mechanical advantage, allowing the operator to apply sufficient force with minimal effort. The machine is particularly suitable for small-scale coconut processing in rural areas where power-driven machines may not be feasible.

9. CONCLUSION

This paper presented the design and development of a safety-enhanced manual horizontal coconut dehusking machine. The proposed design replaces the traditional vertical spike method with a controlled cutting mechanism that significantly reduces the risk of operator injury. The machine incorporates a circular holding ring, lever-based cutter mechanism, and stable frame structure to improve safety and ease of operation. The design was modeled using CAD tools to verify component arrangement and functionality. The proposed machine offers a low-cost and practical solution for safer coconut dehusking, particularly in rural and small-scale agricultural environments.

10. FUTURE SCOPE

Further improvements can be made to enhance the performance of the machine.

Possible future developments include:

- Development of a motorized version of the machine
- Incorporation of multiple cutting blades for faster operation
- Use of stainless-steel components for improved durability
- Experimental testing and performance evaluation
- Design optimization using engineering analysis tools

These improvements may increase productivity and broaden the application of the machine in commercial coconut processing.

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