

Development of a Compact and Mobile Decorticator for Groundnut

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ABSTRACT

Groundnut (*Arachis hypogaea* L.) is a common oilseed crop. The way it is processed after harvesting greatly affects product quality and economic value. Decortication is the process of separating kernels from shells. Traditionally, this is done using manual or semi-mechanized methods. These methods require a lot of labour, take up considerable time, and often lead to higher losses. This study reviews the existing methods for decortivating groundnuts and points out their shortcomings in efficiency, kernel damage, and scalability. Based on these findings, we suggest a new design for a groundnut decorticator. This design includes a cylindrical shelling mechanism that aims to improve the effectiveness of shelling while keeping the kernels intact. The new design prioritizes simplicity, cost-effectiveness, and is suitable for small- and medium-scale operations. This work lays the groundwork for further development and testing of better decortication systems to improve post-harvest processing.

Keywords— Groundnut, Decortication, Groundnut Decorticator, Post-Harvest Processing, Shelling Mechanism, Conceptual Design.

INTRODUCTION

Importance of groundnut processing

Groundnut (*Arachis hypogaea* L.) processing is crucial for cutting post-harvest losses and improving the quality of the produce. Traditional shelling methods often cause kernel breakage, contamination, and inefficiencies. These issues impact both yield and market value. Proper processing, especially decortication, removes shells and impurities, leading to clean and intact kernels. This improves product quality and boosts its acceptability and demand in the market.

Moreover, groundnut processing enables additional value through oil extraction, roasting, and making various food products. Mechanized processing decreases labour needs and saves time, which makes it more suitable for small and medium-sized operations. It also enhances storage and handling by reducing bulk volume and limiting spoilage. Overall, efficient processing leads to higher productivity, better economic returns, and supports the growth of agro-based industries.



<https://www.agrocrops.com/us-en/products/raw-shelled-peanuts> 1.2 Post-Harvest Losses due to improper shelling

Improper shelling of groundnut pods causes significant post-harvest losses, affecting both the quantity and quality of the final produce. Traditional shelling methods are inefficient and often lead to many broken kernels. This decreases their market value and makes them less suitable for further processing. Incomplete shelling results in a lot of unshelled pods, which lowers overall efficiency.

Mechanical damage during shelling also makes kernels more vulnerable to microbial contamination and pest infestation. Moreover, poor shelling practices lead to material losses through spillage and improper separation of kernels and shells. These issues reduce the usable yield and increase processing time and labor needs. Therefore, using better shelling techniques is crucial to minimize losses, maintain kernel quality, and improve the overall efficiency of groundnut processing systems.

Traditional method of groundnut shelling:

Traditional methods of groundnut shelling are common in rural areas because they are simple and cheap. The most typical technique is manual shelling, where people press or break pods with their hands. Sometimes, basic tools like sticks or stones are used to crack the shells. Another common method is trampling, where groundnut pods are spread on a hard surface and crushed by foot or by letting animals walk over them.

Although these methods need little investment, they demand a lot of labour, take a long time, and are not efficient for large-scale processing. They often lead to a high number of broken kernels and incomplete shelling, which lowers product quality and increases post-harvest losses. Also, these methods lack consistency and hygiene, making them less suitable for commercial use.

Limitations of Existing Decortication Methods

Existing groundnut decortication methods, including traditional and some mechanical systems, have several limitations that affect efficiency and product quality. One major issue is high kernel breakage caused by excessive impact or poor design of the shelling mechanism. In many cases, incomplete shelling occurs, leaving some pods unshelled and reducing overall effectiveness. Additionally, the performance of these machines relies heavily on factors like moisture content and operating conditions, making it hard to achieve consistent results.

Another significant limitation is that small-scale farmers find these methods unaffordable and hard to access. Many mechanized decorticators are expensive or difficult to operate and maintain. Traditional methods are labor-intensive and time-consuming, which leads to low productivity. Furthermore, problems like poor separation of kernels and shells, high energy consumption in some machines, and maintenance challenges limit their practicality. These issues emphasize the need for a simple, efficient, and cost-effective decorticator design.

Objective of the present study:

This study examines current groundnut decortication methods to identify their limitations regarding efficiency, kernel damage, and operational constraints. It looks at both old and new mechanical methods to show how hard it is to shell groundnuts.

The work also shows a conceptual design for a better groundnut decorticator that aims to get around these problems. The suggested design focuses on good shelling, less damage to the kernel, and ease of building and using, which makes it good for small and medium-sized projects. This study further establishes a basis for subsequent development and experimental validation of the proposed system.

LITERATURE REVIEW

Conventional Groundnut Shelling Practices

Decortication of groundnuts has been performed for centuries using various traditional techniques, such as manual methods, such as; hand-shelling, beating with sticks or trampling. These methods are commonly practised because they require very little investment and are easy to implement, but they are also time-consuming and labour-

intensive, making them impractical for large-scale use (Adeeko and Ajibola, 2015; Jain and Rai, 2015). Studies have shown that manually shelling groundnuts produces inconsistent results, with a very high proportion of both broken kernels and unshelled pods, leading to lower overall efficiency (Yadav and Jindal, 2016; Umoetok, 2016).

In addition, additional research indicates that traditional shelling methods result in large amounts of post-harvest losses due to poor handling and operational practices (Olaniyan, 2017; Tiwari et al., 2017). Moreover, due to the lack of control over the operating conditions, the quality and price of the kernels can vary greatly (Oluwole et al., 2018; Singh and Goswami, 2018). All of these issues show the need for better techniques for decorticating groundnuts to improve productivity and quality.

Design Improvements and Mechanization Approaches

To solve the problems that are associated with the old, traditional methods of shelling, many new types of machines were developed to perform the shelling process mechanically. The first studies on these mechanical machines were aimed at increasing the efficiency of shelling while decreasing damage on the groundnut kernels (Pradhan et al., 2019; Owolarafe et al., 2019). The development of the drum-style decorticators has increased productivity through the use of both impact and friction forces during the process of shelling the nuts (Ojolo et al., 2020; Nasir, 2020).

The next step in the process was to develop ways to maximize the efficiency of the machines through regulating the parameters of the machine, such as drum speed, feed rate, and concave clearance (Kachru, 2020; Chakraverty, 2021). Researchers also recognize that the physical properties of the groundnut itself, such as size, shape, and moisture content, should also be considered when designing an efficient mechanical decorticator (Sahay and Singh, 2021; Mohsenin, 2021).

Current research in the design and manufacture of mechanical decorticators has focused on developing smaller, more portable, and cost-effective machines that can be used by small-scale farmers (FAO, 2022; ICAR, 2022). Improvements in choice of materials and structure have also been investigated in order to create machines that will be more durable and operate more efficiently (CIAE, 2023; Zaalouk, 2023). While all of these equipments have seen tremendous advancements, the same issues, such as the possibility of incomplete shelling, breakage of kernels, and sensitivity to moisture content, still remain (Bhole and Jadhav, 2023; Gbabo et al., 2024).

Emerging Trends and Design Gaps

Recently, image processing and Artificial Intelligence (AI) have been utilized for the automation of monitoring, grading and quality checking of agricultural products. This has increased the efficiency and consistency of post-harvest operations (Yadav et al., 2024; Singh et al., 2024).

Image-processing technology has been used widely for the detection of defects and grading of kernels as well as improving the accuracy of sorting of agricultural products (Ra et al. 2025; Kumar et al. 2025). The use of AI-based systems is helping to create real-time analysis of processing conditions and allow optimisation of parameters, leading to improved decision-making and decreased losses (Patel et al., 2025; Sharma et al., 2025).

In addition, recent studies have focused on the importance of advanced technology such as smart sensors and machine learning algorithms in improving the performance and automation of agricultural machinery (Gupta et al., 2026; Verma et al., 2026). These technological developments open the door to integrating intelligent systems into the decortication process to improve both the efficiency and quality of products.

Scope of the Study

This research examines the available methods for dehulling peanuts, including traditional methods and mechanical machines, to evaluate the limitations of each based on their performance in terms of efficiency, damage to kernels and any obstacles encountered in the process of shelling peanuts. In addition to discussing each of these methods, this research also explores factors affecting peanut shelling such as moisture content, design of

the decorticating machine and mechanism of operation which will be used to identify potential gaps within the industry regarding available technology.

In addition, this document will present a conceptual design of a peanut decorticator that will address these noted limitations by providing an effective and simple means of peanut shelling. Emphasis is placed on developing a low-cost and user-friendly solution that will be appropriate for small to medium scale applications. The scope of this project is limited to the analysis of the designs and conceptual development with hopes of providing the basis to facilitate future actual fabrication and/or experimental verification.

MATERIALS AND METHODS

Design Considerations and System Overview

The design of the groundnut decorticator is primarily based on the need to improve shelling efficiency while minimizing kernel damage and operational complexity. Several key factors were considered during the conceptual development of the system. The physical properties of groundnut pods, such as size, shape, and moisture content, play a crucial role in determining the effectiveness of the shelling process. Proper consideration of these properties ensures efficient separation of kernels without excessive breakage. Additionally, operational parameters such as drum speed, clearance between the drum and concave, and feed rate were taken into account to achieve consistent and controlled shelling action.

Simplicity, cost-effectiveness, and ease of fabrication were also important design considerations, particularly for suitability in small- and medium-scale applications. The system is designed to require minimal maintenance and to be easily operable by users with limited technical expertise. Material selection and structural stability were considered to ensure durability under continuous operation while keeping the overall cost low.

The proposed groundnut decorticator consists of a feeding hopper, a cylindrical shelling drum, a concave or perforated screen, a supporting frame, and a power transmission system. Groundnut pods are fed into the hopper and directed into the rotating drum, where shelling occurs due to the combined action of impact and friction between the drum and concave surface. The broken shells and kernels are discharged through the outlet for further handling. The overall system is compact and designed to provide efficient shelling with reduced losses, forming a suitable base for future development and integration with additional processing units.

Description of the Developed Machine

The developed groundnut decorticator is designed as a compact and mobile unit, making it suitable for small- and medium-scale applications, especially in rural and farm-level operations. The machine is constructed with a simple layout to ensure ease of transportation, operation, and maintenance. It integrates all essential components within a lightweight frame, allowing it to be easily moved and operated in different locations. The design focuses on achieving efficient shelling while maintaining structural simplicity and cost-effectiveness.

Feeding Hopper

The feeding hopper is provided at the top of the machine and serves as the entry point for groundnut pods. It is designed to allow uniform and controlled feeding of material into the shelling unit. The shape and inclination of the hopper ensure a smooth flow of pods into the drum without clogging.

Shelling Drum

The drum is the core component of the decorticator. It rotates at a controlled speed and is responsible for the shelling action. The drum surface is designed to create impact and friction forces, which help in breaking the groundnut shells while minimizing damage to the kernels.

Rotating Blade Mechanism

A key feature of the developed machine is the blade mounted on the rotating shaft inside the drum. This blade is responsible for the shelling action. As the shaft rotates, the three blades strike and agitate the groundnut pods, generating impact and shear forces required to break the shells.

The configuration ensures uniform distribution of force, leading to better shelling efficiency and reduced chances of clogging. It also helps in continuous mixing and movement of pods inside the drum, improving overall effectiveness while minimizing kernel damage.

Concave

The concave is positioned below or around the drum and consists of a perforated surface. It works in combination with the rotating drum to facilitate shelling. The clearance between the drum and concave is maintained carefully to ensure effective shelling while preventing excessive kernel breakage. The perforations allow smaller particles, such as kernels and broken shells, to pass through.

Blower Unit

A blower is incorporated to improve the cleaning and separation process. It generates airflow that helps in separating lighter shell particles from heavier kernels. As the mixture passes through the outlet, the blower removes husk and dust, resulting in cleaner kernel output and reducing the need for additional manual separation.

Frame Structure

The entire machine is supported by a rigid frame that provides stability during operation. The frame is designed to be strong yet lightweight, contributing to the overall compactness and mobility of the unit. In some designs, wheels can be attached to enhance portability.

Power Transmission System

The machine is powered through a motor or manual drive system, depending on the design. The power is transmitted to the shelling drum using components such as belts and pulleys. This system ensures smooth and consistent rotation of the drum, which is essential for uniform shelling.

Outlet Section

The outlet is provided at the bottom or side of the machine, through which the mixture of kernels, shells, and unshelled pods is discharged. It allows easy collection of output for further processing or separation.

Working Principle

The design of the decorticator entails the use of impact and shear forces produced by the interaction of groundnut pods against the inner surface of a drum that rotates. The machine works by feeding groundnut pods into the hopper and then shelling them inside the shelling chamber.

Within the drum is the rotating blade attached to the central shaft. The function of the three-way rotating blade is crucial in shelling groundnuts. During rotation of the shaft, the three blades interact with the groundnut pods by striking, lifting, and agitating them repeatedly inside the drum. Due to the above interactions, the shells of groundnuts are cracked open, causing minimal damage to the kernels.

As a result of the agitation and impact force caused by the rotating blades, all the groundnut pods inside the drum get shelled efficiently. The use of a concave within or below the drum helps separate the kernels from the shells.

Once shelling of the pods has taken place, small kernel particles and shell fragments pass through the perforations and leave behind large groundnut pods which require more shelling.

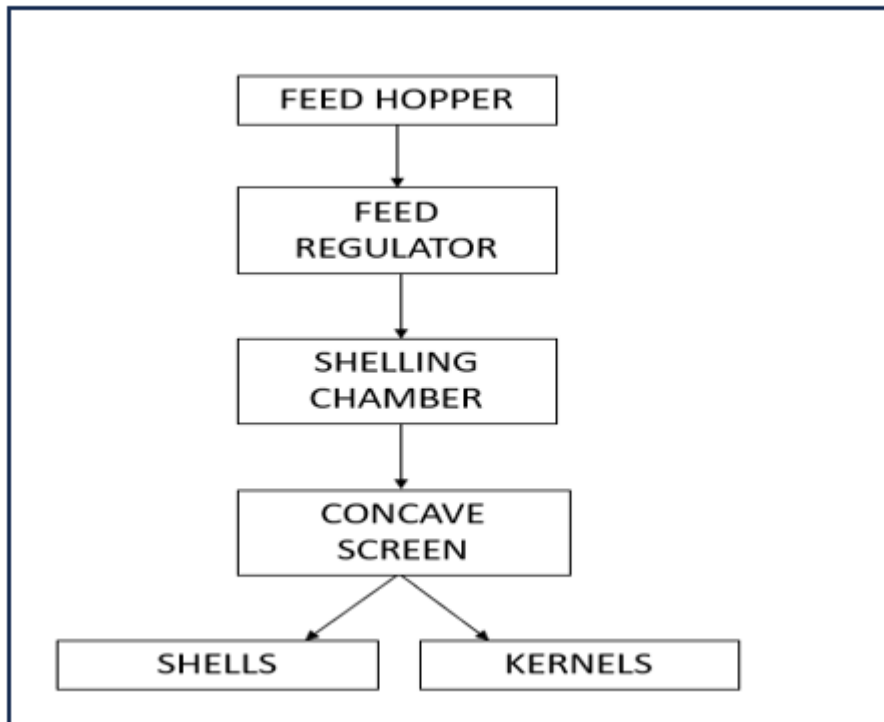


Fig. 3.4 Work flow

Materials Used and Fabrication Details:

The choice of materials for the construction of the groundnut decorticator took into consideration the strength, durability, availability, and costs of production. Mild steel was chosen because of its suitability in terms of mechanical properties and ease of fabrication. For the structure, angles and/or square pipes made out of mild steel were used in order to achieve durability while keeping the device compact and mobile.

For the drum and concave, mild steel sheets were used, whereby holes were drilled in the concave for separation purposes. Also, the shaft and blade were made from steel due to their exposure to constant impact during operations.

For the fabrication process, basic procedures such as cutting, welding, drilling, and machining were used. Construction of the frame came first, after which the drum was fabricated and the shaft with the blade attached. The concave was then fixed and aligned, as well as the motor and pulley system to ensure that all these operate efficiently.

RESULT AND DISCUSSION

The designed groundnut decorticator was analyzed on the basis of its structural and mechanical setup. The inclusion of a rotating three-bladed assembly within a cylindrical drum is believed to help in effective shelling as it will keep on giving impact and agitation to the pods of groundnuts. Thus, due to increased contact, better shelling is anticipated.

The inclusion of a concave with proper clearance is important because it facilitates easy shelling by separating the kernels from shells without breaking them. Moreover, the rotation of pods in the cylindrical drum will ensure that the pods get even impact from the machine, resulting in fewer unshelled nuts.

As opposed to conventional shelling methods, the designed concept has the following benefits, including lower labour intensity, enhanced uniformity, and effective handling. In contrast to other mechanized decorticating devices, the suggested machine emphasizes simplicity, size reduction, and portability. This characteristic makes it more convenient for individuals operating on a smaller scale.

On the other hand, the efficiency of the machine will be dependent on the moisture level, speed of the drum, and blade clearance. Optimizing these variables will be essential to maximize the performance while minimizing the damage to the kernel. This study has provided a conceptual basis for the development of the design, and experimental analysis must be conducted to determine the performance parameters of the machine.

DESIGN ADAPTABILITY AND PERFORMANCE CONSIDERATIONS

The groundnut decorticator has great potential for efficient shelling thanks to its simple and compact design. We can improve the system's performance by optimizing key operational factors like moisture content, drum speed, and blade clearance. Adjusting these factors carefully can lead to better shelling efficiency while reducing kernel damage.

The design also allows for flexibility to suit different groundnut varieties and pod characteristics. With proper calibration, the machine can respond better to changes in size, shape, and physical properties of the pods, which improves operational consistency.

While this work focuses on initial development, the proposed system provides a solid base for further improvements. Adding features like better cleaning mechanisms and optimized airflow can boost separation efficiency and overall output quality. These points show the potential for performance improvement and practical optimization in real operating settings.

FUTURE SCOPE AND DESIGN ENHANCEMENT OPPORTUNITIES

The proposed decorticator offers a strong foundation for further development and practical use. Future work can focus on detailed experiments to measure key performance factors, such as shelling efficiency, kernel integrity, and separation effectiveness under various operating conditions. These studies will help fine-tune machine settings for the best performance.

To increase versatility, the design can be improved with adjustable features for drum speed and blade clearance. This will allow the machine to process different groundnut varieties more efficiently. Adding alternative power sources, like pedal-driven or solar-assisted systems, can make it more accessible and user-friendly in rural and resource-limited areas.

Additional improvements could involve enhancing operator comfort with ergonomic design, lowering operational noise, and using stronger materials to extend the machine's lifespan. Incorporating simple monitoring systems or sensors could also help maintain better control over operating conditions and improve consistency in output.

In summary, these improvements can greatly enhance the efficiency, adaptability, and user-friendliness of the decorticator, allowing it to become a dependable solution for small- and medium-scale groundnut processing.

CONCLUSION

The research was conducted on currently available groundnut decorticating techniques with emphasis placed on their shortcomings in relation to the amount of labour required, efficiency levels and the tendency to damage the kernels. In light of the above challenges, a small and portable groundnut decorticating unit was conceptualized with an effective design.

The decorticating unit will be utilized as a drum with a rotation system. It aims to increase the efficiency of shelling by use of impact and shear force. The main features of this model will be its ease of handling, affordability and adaptability to small and medium-scale production units.

In conclusion, this study can be considered a stepping stone towards developing an effective decortication technique. More research should be focused on designing and testing the unit.

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