

Pedal Operated Tubular Maize Sheller for Marginal and Small Farmers

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Abstract

Maize (*Zea mays* L.) is a staple cereal crop widely cultivated across developing countries, especially in India, where marginal and small farmers dominate agricultural production. Post-harvest operations such as shelling remain labor-intensive, time-consuming, and inefficient when performed manually using traditional tubular shellers. This study focuses on the design, development, and performance evaluation of a pedal-operated tubular maize sheller aimed at improving efficiency, reducing labor drudgery, and enhancing productivity for smallholder farmers. The developed machine integrates a pedal mechanism with a tubular shelling unit, enabling continuous operation without dependence on electricity or fossil fuels. Experimental results indicate that the sheller achieves a capacity of 58–62 kg/h, approximately 3–4 times higher than traditional methods, with shelling efficiency up to 98% and minimal grain damage (<2%). The study concludes that pedal-operated shellers offer a cost-effective, sustainable, and scalable solution for small and marginal farmers, contributing to rural mechanization and livelihood improvement.

1. Introduction

Maize is one of the most important cereal crops globally and serves as a major source of food, feed, and industrial raw material. In India, maize cultivation is primarily undertaken by marginal and small farmers who often lack access to mechanized equipment. Post-harvest operations, particularly shelling, play a crucial role in

determining grain quality, storage stability, and market value.

Traditional maize shelling methods include manual rubbing, beating, and the use of simple tubular shellers. These methods are characterized by low efficiency, high labor requirements, and significant physical strain. Moreover, they limit the scale of operation and reduce overall farm productivity.

Mechanized maize shellers, though efficient, are often powered by electricity, diesel engines, or tractors, making them inaccessible to resource-poor farmers due to high costs and lack of infrastructure. Therefore, there is a need for an intermediate technology that bridges the gap between manual and fully mechanized systems.

A pedal-operated tubular maize sheller offers a viable solution by combining human-powered energy with improved mechanical design. Such systems are affordable, portable, environmentally friendly, and suitable for rural conditions.

2. Literature Review

Several studies have explored the development of maize shelling technologies suitable for small-scale farming.

Research on pedal-operated maize shellers indicates that these machines significantly outperform traditional tubular shellers in terms of capacity and efficiency. A study reported that a pedal-operated sheller achieved a capacity of 58–62 kg/h with shelling efficiency of about 98% and minimal grain damage. This demonstrates the potential of such machines in improving post-harvest operations.

Earlier designs of manually operated shellers were limited by their inability to process

more than one cob at a time and were unsuitable for continuous operation. In contrast, pedal-operated systems allow continuous feeding and shelling, enhancing throughput.

Another study reported that a pedal-operated maize sheller with multiple shelling units achieved a shelling rate of up to 110 kg/h with 98% efficiency, further validating the effectiveness of pedal-powered mechanisms. The design of maize shellers typically involves components such as a feed hopper, shelling cylinder, separating unit, and power transmission system. Performance depends on factors such as moisture content, feed rate, and operating speed. Despite these advancements, there remains a need for integrating tubular shelling concepts with pedal-operated mechanisms to enhance simplicity, affordability, and adaptability.

3. Objectives

The main objectives of this study are:

1. To design and develop a pedal-operated tubular maize sheller suitable for marginal and small farmers.
2. To evaluate the performance of the developed machine in terms of capacity, efficiency, and grain damage.

3. To compare the performance with traditional tubular shelling methods.
4. To assess the economic feasibility and suitability for rural adoption.

4. Materials and Methods

4.1 Design Considerations

The design of the pedal-operated tubular maize sheller was based on the following criteria:

1. Low cost and use of locally available materials.
2. Ease of operation and maintenance.
3. Portability and compact structure.
4. High shelling efficiency with minimal grain damage.
5. Suitability for rural conditions without electricity.

4.2 Components of the Machine

The developed machine consists of the following major components:

Frame: Mild steel frame to support all components

Pedal Mechanism: Bicycle-type pedal system for power generation

Chain and Sprocket: Power transmission from pedal to shaft

Shelling Unit: Tubular cylinder with internal rasp bars

Feed Hopper: For continuous feeding of maize cobs

Outlet System: Separate outlets for grains and cobs

4.3 Working Principle

The machine operates on a pedal-driven mechanism similar to a bicycle. When the operator pedals, rotational motion is transmitted through a chain and sprocket system to the shelling cylinder. The maize cobs fed through the hopper come into contact with the rasp bars inside the tubular shelling unit, which detach the grains from the cob through impact and friction. The shelled grains fall through perforations, while the cobs are discharged separately.

4.4 Experimental Procedure

The performance of the machine was evaluated under different operating conditions:

Moisture content of maize: 10–14%

Pedaling speed: Variable (controlled manually)

Feed rate: Continuous

Performance parameters measured:

Shelling capacity (kg/h)

Shelling efficiency (%)

Grain damage (%)

Labor requirement

5. Results and Discussion

5.1 Shelling Capacity

The developed pedal-operated tubular maize sheller achieved a capacity of 58–62 kg/h

under optimal conditions. This is approximately 3–4 times higher than traditional tubular shelling methods. The increase in capacity can be attributed to continuous operation and improved mechanical design.

5.2 Shelling Efficiency

The shelling efficiency of the machine was found to be around 98%, indicating effective removal of grains from cobs. Higher efficiency was observed at lower moisture content (around 10–12%).

5.3 Grain Damage

Mechanical damage to grains was less than 2%, which is acceptable for both consumption and storage. Excessive speed and high moisture content were found to increase grain damage.

5.4 Comparison with Traditional Methods

Parameter	Traditional Tubular Sheller	Pedal Operated Sheller
Capacity	15–20 kg/h	58–62 kg/h
Efficiency	85–90%	~98%
Labor Requirement	High	Moderate
Drudgery	High	Reduced

The pedal-operated sheller significantly reduces labor drudgery while increasing productivity.

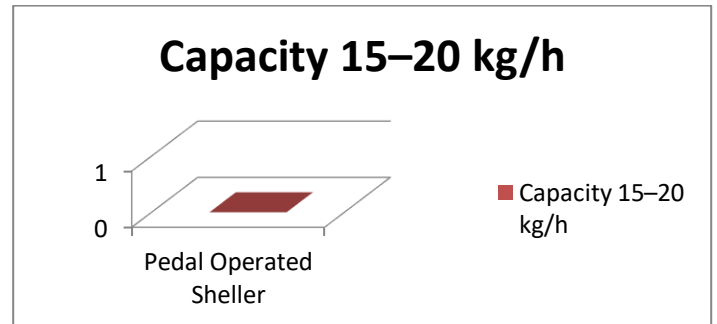


Fig-1: capacity of sheller

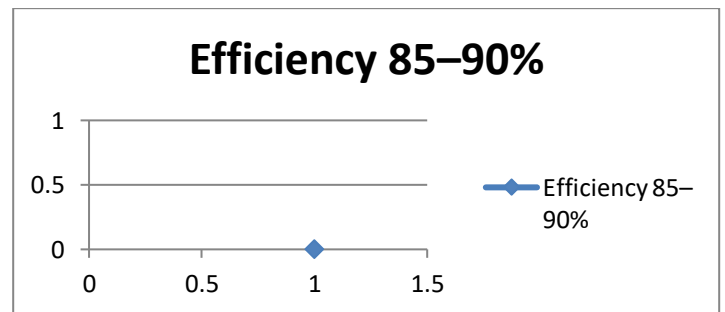


Fig-1: Efficiency of sheller

5.5 Ergonomic Advantages

The pedal mechanism allows the operator to use leg power instead of hand force, reducing fatigue and increasing working duration. This is particularly beneficial for small farmers and women laborers.

5.6 Economic Analysis

The machine can be fabricated using locally available materials at a relatively low cost. The increased efficiency and reduced labor requirement lead to:

- a. Lower operational cost
- b. Higher income for farmers
- c. Quick return on investment

6. Advantages of Pedal Operated Tubular Maize Sheller

No dependency on electricity or fuel: Environmentally friendly, Affordable for small farmers, Portable and easy to operate, Reduces labor drudgery, High efficiency and low grain damage.

7. Limitations

- ❖ Requires physical effort for operation
- ❖ Performance depends on operator endurance
- ❖ Not suitable for very large-scale operations
- ❖ Efficiency may vary with moisture content

8. Future Scope

Future research can focus on: Integration with flywheel systems to reduce pedaling effort Development of hybrid systems (pedal + motor) use of lightweight materials to improve portability, automation of feeding mechanism. Field testing across different agro-climatic conditions

9. Conclusion

The pedal-operated tubular maize sheller represents an appropriate technology for marginal and small farmers. It effectively bridges the gap between traditional manual methods and expensive mechanized systems.

The developed machine demonstrates high efficiency ($\approx 98\%$), low grain damage ($< 2\%$), and significantly higher capacity compared to conventional tubular shellers.

By reducing labor drudgery and increasing productivity, the machine contributes to improved livelihoods and sustainable agricultural practices. Its low cost, simplicity, and adaptability make it a promising solution for rural mechanization in developing countries.

References

- Prajwal, R., et al. (2021).** Design and Development of Pedal Operated Maize Sheller for Small and Marginal Farmers. *Int. J. Curr. Microbiol. App. Sci.*
- Chitoda, K. R., et al.** Review on Design of Pedal Operated Maize Sheller.
- Sandeep, N., et al.** Development & Performance Evaluation of Maize Sheller.
- Patil, S. B., et al. (2014).** Development and Performance Evaluation of Pedal Operated Maize Sheller.
- Abishek, A., et al. (2025).** Design and Development of Maize Sheller Machine.