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Design and Development of a Portable Paddy Thresher and Winnowing Machine

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Abstract
Paddy is one of the most important staple crops in India. However, traditional methods of threshing and winnowing paddy are labour - intensive, time-consuming, and often inefficient. This project presents the Design and Development of a Portable paddy thresher and winnowing machine aimed at addressing these challenges. The proposed machine integrates both threshing and winnowing processes into a single compact and portable unit, making it suitable for small and medium scale farmers for the rural communities. The portable paddy thresher reduces the physical effort and time required for threshing. The winnowing system uses airflow generated by a fan to separate lighter chaff and husk from heavier paddy grains, ensuring a cleaner and more efficient process compared to manual methods. The machine is designed by a small electric motor and make it a compact efficient machine. The idea into improves the productivity (i) reduce post-harvest losses. (ii) make paddy processing more accessible. The design is mobile, and cost effective, enabling easy usage in rural areas. The machine's efficiency, easy to operate, and low maintenance requirements are expected to enhance the overall agricultural community. Increase farmer income, and promote sustainable agricultural practices.

Keywords: *Threshing is the process of separating grains from the harvested crop (stalk).*

1. Introduction
Agriculture plays a vital role in the economy, and advancements in farm machinery have improved post-harvest processing efficiency. Paddy threshers and winnowing machines are important tools that help reduce labour, save time, and improve grain quality[1-2] However, traditional threshing and winnowing methods are labour-intensive, time-consuming, and often result in higher grain loss. In addition, small and marginal farmers face difficulties in accessing large mechanized equipment due to high cost and maintenance requirements. To address these challenges, this project focuses on the design and development of a compact and portable paddy thresher cum winnowing machine. The machine integrates threshing and winnowing operations into a single unit and can operate using electric power or manual pedaling [3-5] The proposed system aims to reduce labour dependency, minimize grain loss, improve processing speed, and provide a cost-effective post-harvest solution suitable for rural farming conditions.

1.1. Objectives
- Design and fabricate a portable paddy thresher and winnowing machine suitable for small-scale farmers.
- To integrate threshing and winnowing mechanisms in a single compact machine to reduce human effort and time.
- To improve threshing efficiency and grain recovery while minimizing post-harvest losses.

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- To promote low-cost mechanization for rural and semi-urban agricultural practices.

2. Methodology

The methodology adopted for the development of the portable paddy thresher and winnowing machine involves the design, fabrication, and working analysis of an integrated system capable of performing threshing and winnowing operations in a single unit. The machine is designed to reduce manual labour, minimize grain loss, and improve post-harvest efficiency for small and marginal farmers.

2.1. Feeding of Paddy

Harvested paddy bundles are manually fed into the hopper provided at the top of the machine. The feeding tray guides the crop uniformly towards the threshing drum and ensures continuous feeding without overloading the system. Proper feeding improves operational efficiency and prevents blockage inside the threshing chamber.

2.2. Threshing Process

The threshing unit consists of a rotating drum fitted with beaters or peg teeth. The drum rotates at high speed using an electric motor or manual pedaling mechanism. As the paddy enters the threshing chamber, impact and rubbing action separate the grains from the straw. The detached straw moves forward and exits through the straw outlet.

2.3. Grain–Chaff Mixture Collection

After threshing, the separated grains pass through the concave sieve located below the drum. The sieve allows grains, husk, and small straw particles to fall into the collection tray. This stage ensures preliminary separation of larger straw particles from the grain mixture.

2.4. Grain Collection

Cleaned grains are discharged through the output chute and collected in bags or trays for drying, storage, or further processing. The collection mechanism minimizes grain loss and ensures easy handling of processed grains.

2.5. Portability and Power Transmission

The entire machine is mounted on a portable frame with wheels, making it easy to transport from one field to another. The system is powered by a small electric motor and can also operate using manual pedaling in areas with limited electricity supply. Power transmission is achieved using belt and pulley arrangements connected to the threshing drum and blower shown in Figure 1.

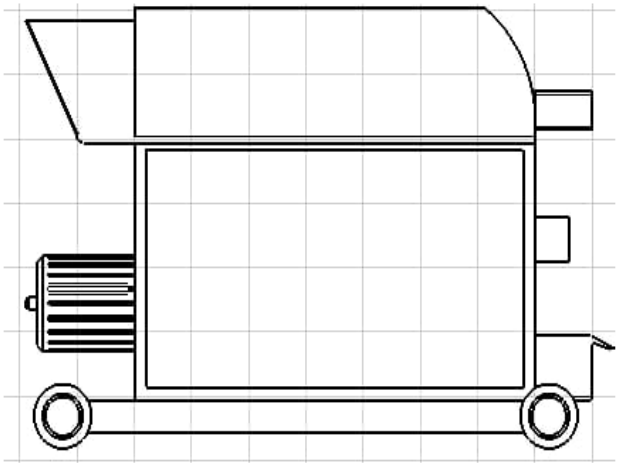

Figure 1 2-D sketch of model

3. Design Calculations

3.1. Motor Design

The power required for the portable paddy threshing and winnowing machine was supplied using an electric motor of 1 HP capacity. The motor was selected based on the load requirement of the threshing drum, conveyor mechanism, and blower unit. The operating speed of the motor was maintained at 350 RPM to ensure effective threshing and smooth operation of the machine. The torque developed by the motor was calculated using the relation:

$$T = \frac{P \times 60}{2\pi N}$$

Where:

- T= Torque (Nm)
- P = Power (W)
- N = Speed (RPM)

Given:

- Power, P=1 HP =746 W
- Speed, N=350 RPM

$$T = \frac{746 \times 60}{2 \times 3.14 \times 350}$$

$$T = 20.37 \text{ Nm}$$

Thus, the motor provides sufficient torque for efficient threshing and winnowing operations.

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3.2. Shaft Design

The shaft was designed to transmit power from the motor to the threshing drum. Mild steel material was selected due to its good strength, machinability, and availability. The shaft diameter was chosen based on torsional load conditions. Selected shaft specifications are as follows:

- Material: Mild Steel
- Shaft Diameter: 12 mm
- Length: As per machine frame dimensions

The selected shaft diameter was found adequate for safe transmission of torque without excessive deformation or failure.

3.3. Conveyor Design

A belt conveyor mechanism was incorporated to feed paddy uniformly into the threshing drum. The conveyor dimensions were selected to ensure smooth material handling and compact machine size.

Design parameters of the conveyor are:

- Belt Length = 0.8 m
- Belt Speed = 0.3 m/s

The conveyor speed was maintained at a moderate level to avoid overfeeding and ensure proper threshing efficiency.

3.4. Sieve Design

The sieve unit was designed to separate grains from straw and other unwanted particles after threshing. Proper sieve dimensions and perforation size were selected for effective cleaning performance.
Sieve specifications are:

- Hole Size = 4 mm
- Sieve Dimensions = 300 x 200 mm
- Open Area = 30 - 35%

The selected hole size allows clean paddy grains to pass through while retaining larger straw particles, thereby improving the overall cleaning efficiency of the machine.

4. Results and Discussion

4.1. Results

- The portable paddy thresher and winnowing machine was successfully developed and tested.
- The machine achieved an efficiency of approximately 82-87%.
- Output capacity obtained was around 15-20 kg/hr.
- The blower effectively separated husk and dust from paddy grains.
- The machine reduced labour requirement and processing time compared to traditional methods.
- The compact and portable design makes it suitable for small-scale farmers and rural applications.

4.2. Discussion

The developed machine performed threshing and separation operations effectively under different working conditions. The threshing drum and concave sieve successfully separated grains from stalks and impurities. The belt conveyor ensured smooth feeding of paddy into the machine. Compared to traditional manual methods, the machine reduced human effort, time consumption, and post-harvest losses. The machine is economical, portable, and suitable for rural agricultural applications. Machine performance depends on feed rate and moisture content of paddy. Further improvements can be made to increase output capacity and automation.

Figure 2 Final Model

Conclusion

The developed portable paddy thresher and winnowing machine successfully performs threshing

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and cleaning operations with good efficiency. The machine is portable, economical, and suitable for small-scale farmers. It reduces labour, saves time, and minimizes post-harvest losses shown in Figure 2.

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