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Design, Fabrication, and Evaluation of an Automatic Matar Peeling Machine

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ABSTRACT

Automation of matar (green pea) peeling significantly enhances productivity by reducing manual labor, ensuring uniform shelling, and minimizing product damage. This research details the design and fabrication of an electric motor-operated peeling machine optimized for continuous feed and high efficiency in small to medium-scale operations. The effects of roller clearance, speed, and feed rate on shelling efficiency are experimentally analyzed and machine performance is evaluated economically and ergonomically.

Introduction

Green peas are a staple ingredient in many cuisines, and efficient depodding is critical for cost-effective processing. Traditional manual shelling is slow and laborious, impeding scalability. Automation not only improves speed and consistency but also enhances worker safety and hygiene compliance. The motivation behind this project is to provide a user-friendly, portable, and cost-effective machine to facilitate local farmers and food processors in enhancing yield and income.[epubs.icar+2](https://www.researchgate.net/publication/35527421)

Design and Construction

- **Mechanical Design:** The peeling machine consists of a feeding tray that vibrates to evenly distribute pods to double rubber rollers, whose gap can be adjusted for different pod sizes. Rollers apply calibrated pressure to detach the peas from the pods without damaging the kernels.
- **Power System:** An electric motor powers both the rollers and feed mechanism, controlled via speed regulators to optimize shelling based on pod maturity and size.
- **Materials:** Stainless steel components ensure durability and easy cleaning, vital for hygienic food processing.
- **Safety Features:** Safety guards prevent accidental contact with moving parts while ventilation is provided to avoid overheating.

Experimental Setup and Evaluation

Tests were performed on market-available green pea pods. Parameters analyzed included roller speed, gap width, and feed rate.

- **Shelling Capacity:** Maximum achieved at ~106.8 kg/h
- **Depodding Efficiency:** Maximum 97.5%, measured by ratio of shelled peas to total input
- **Kernel Damage:** Maintained below 7%, favorable compared to manual shelling damage levels
- **Power Consumption:** 750 W motor with average consumption ~0.5 kWh for 6 hours of operation

Economic and Ergonomic Analysis

- **Cost Efficiency:** Machine operation cost reduced to ₹9/h compared to manual labor cost of ₹45–50/h, with payback in approximately 1.4 years.
- **Labor Saving:** Depodding time per kg reduced by 75%, enabling higher throughput and faster processing.

- **User Feedback:** Operators reported improved comfort and significantly reduced physical strain.

Environmental Impact

By reducing manual labor and operating on electricity efficiently, the machine supports sustainable agriculture through energy conservation and reduction of human fatigue. The design encourages local manufacturing which reduces carbon footprint compared to imported machineries.

Discussion and Improvements

Challenges such as adapting to varying pod sizes and moisture content remain. Recommendations include integrating moisture sensors to adjust peeling parameters, exploring solar-powered variants for field use, and further modularizing components for multi-crop adaptability.

Conclusions

The developed automatic matar peeling machine demonstrates substantial gains in productivity, cost-effectiveness, and user safety while ensuring high-quality output. It holds promise for widespread adoption in small-scale farming communities and commercial setups.

Future Work

- Automation with IoT-enabled sensors for real-time monitoring
- AI-based adaptive peeling force control
- Expansion to other leguminous crops (e.g., chickpeas, beans)
- Integration with sorting and packaging lines for full processing automation

Mechanical Principles and Technologies

- Machines predominantly use friction-based roller mechanisms combined with vibrating feed systems. Adjustability in roller gap, speed control, and pod feed rate are essential to accommodate pod variability.
- Emerging models incorporate pneumatic shelling for delicate pods, minimizing kernel breakage and waste.
- Sensor innovations in thickness detection and feed monitoring improve precision, reducing operator intervention.

Market Overview

- Popular globally with strong growth in South Asia due to pea-centric diets and export demand.
- Range from low-cost portable models for small farms to high-capacity continuous feeders for industrial plants.
- Investment payback ranges between 1 to 2 years due to high labor savings.

Comparative Performance Benchmarks

Feature	Manual Shelling	Basic Automatic Machine	Advanced Automatic Machine
Throughput (kg/hr)	3-4	40-70	100-150
Depodding Efficiency	85-90%	93-97%	98-99%
Kernel Damage Rate	15%+	<7%	<5%
Operating Cost (₹/hr)	40-50	9-15	15-25
Automation Level	None	Semi-automatic	Fully automated with sensors & controls

Environmental and Social Impact

- Reduction of repetitive manual labor mitigates occupational health issues.
- Local manufacturing and energy-efficient designs reduce environmental footprint.
- Democratization of mechanization promotes socioeconomic upliftment for rural communities.

Technological Innovations and Trends

- IoT and data analytics enable predictive maintenance and process optimization.
- AI-driven selective shelling responsive to pod and kernel characteristics.
- Solar power integration and battery-supported operations enable use in remote farms.
- Modular designs promote adaptability to multiple pulses and legumes beyond peas.

Challenges and Research Gaps

- Managing pod variability due to climate, variety, and harvest stage.
- Preservation of kernel integrity during high-speed continuous shelling.
- Affordable, rugged designs for economically weaker regions remain underdeveloped.

Conclusion

Automatic matar peeling machines are increasingly indispensable for modern agricultural food processing, balancing productivity, quality, and economic viability. Continued interdisciplinary innovation will drive future improvements and wider adoption, directly impacting global food value chains.

References

- Several key scholarly articles and technical reports from ICAR, ICMAS, and academia.[ijcmas+5](#)

This comprehensive documentation can guide academic submissions and encourage further research in machine design, agricultural mechanization, and food processing automation for matar peeling applications.

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