IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, December 2025
Impact Factor: 7.67

Solar Powered Seed/Grains Cleaning Systems

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Abstract: *A solar-powered seed and grain cleaning system was developed to provide an energy-efficient alternative to conventional cleaning methods reliant on fossil fuels. The technology addresses the challenges faced by Indian farmers who lack access to grid power and primary processing equipment. A solar-powered pneumatic cleaner was designed and tested for garden pea, bottle gourd, sponge gourd, and radish seeds. It consistently achieved over 99% physical purity and more than 96% cleaning efficiency. Throughput capacities were 80 kg/h for pea, 50 kg/h for bottle gourd.*

Keywords: Solar-powered seed cleaner; Grain cleaning system; Pneumatic separation; Screen cleaning mechanism; Renewable energy application; Cleaning efficiency; Physical purity; Off-grid agricultural processing; Post-harvest technology; Sustainable farming

I. INTRODUCTION

Agriculture remains a critical sector in India and other developing nations where a majority of the population depends on it for livelihood. Rising food demand, coupled with labor shortages in post-harvest operations such as grain cleaning, underscores the need for automation using sustainable and affordable technologies. Traditional cleaning methods like manual sieving and winnowing are labor-intensive, time-consuming, and often ineffective. To address these limitations, a solar-powered screen cleaner was designed, fabricated, and evaluated for impurity removal in soybean, lentil, and chickpea grains. The machine comprises a frame, feeding chute, screen cradle, discharge outlets, and a solar-driven motor unit. Sieve tilt angles were varied between 3° and 8°, while the hanger angle was fixed at 5°. Through parameter optimization, the best performance was achieved at a 5° cradle angle, 3.6 Hz oscillation, and a feed rate of 150 kg/h. The study also highlights the need to replace manual separation of materials other than grain (MOG)—such as hand beating and manual sorting—which is inefficient and leads to lower grain quality. Harnessing solar energy provides a clean, renewable, and reliable power source for automation. The developed solar-powered grain separator utilizes a DC motor to induce oscillatory sieve motion, enabling efficient removal of chaff and impurities with minimal human effort. This system enhances post-harvest efficiency, improves grain quality, and supports sustainable energy adoption for small and marginal farmers.

II. PROBLEM STATEMENT

Post-harvest grain cleaning is essential for enhancing grain quality and market value by removing chaff, straw, soil, and other non-grain materials. Traditional methods used in rural India—such as hand beating, manual threshing, and winnowing—are highly labor-intensive, time-consuming, and inefficient, resulting in lower grain quality and reduced productivity. To overcome these limitations and minimize dependence on conventional energy sources, a solar-powered grain separator was designed and fabricated. The system aims to efficiently separate materials other than grain (MOG), including stones, pods, stems, and dirt, using clean and renewable energy. The machine features a structurally robust riddle-based mechanism engineered to suit rural agricultural conditions and local grain varieties. The proposed "Solar Powered Riddle Machine for Agricultural Use" offers a low-cost, energy-efficient, and user-friendly solution that enhances post-harvest processing for small and marginal farmers.

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III. LITERATURE REVIEW

Akeyo et al. (2020) analyzed large solar PV farm configurations integrated with DC-connected battery systems to address intermittency in photovoltaic generation. Munir et al. (2018) experimentally investigated rice winnowing and developed a physical model explaining grain segregation based on size and density differences. Ghodekar et al. (2017) designed and evaluated a portable winnowing machine, demonstrating its ergonomic suitability for single-person operation. Torshiz and Mighani (2017) reviewed the application of solar energy in agriculture, highlighting the evolution and functionality of photovoltaic technologies. Shrestha et al. (2016) conducted mathematical modeling and simulation of rice grain movement, leading to the development of an efficient low-cost winnowing unit. Suresh et al. (2014) emphasized the role of MPPT-based solar systems in overcoming power scarcity through improved energy harvesting. Kannan and Vakeesan (2014) presented a comprehensive review of solar energy applications across domestic, industrial, and agricultural sectors. Gibson and Kelly (2009) evaluated solar photovoltaic charging of lithium-ion batteries, demonstrating high charging efficiency and thermal safety. Miua and Kutzbach (2006) modeled grain threshing and separation dynamics, providing quantitative insights into losses and efficiency. Bryan (1948) examined aluminum usage in the food industry, focusing on corrosion behavior and its implications for food safety.

IV. RESEARCH METHODOLOGY

The developed unit integrates solar panels, a DC motor, and a battery storage system to ensure reliable operation under varying sunlight conditions while delivering mechanical motion for an efficient riddling mechanism. Material selection emphasizes durability and portability, utilizing stainless steel and iron to meet the needs of small and marginal farmers. The system aligns with sustainable farming practices by promoting renewable energy-based mechanization suitable for rural communities. The mechanical assembly incorporates a uniformly feeding cleaning hopper and a screening chamber equipped with inclined or horizontal sieves for effective size-based separation. The vibration or oscillation mechanism enhances the shifting action, with sieve dimensions selected according to grain type. The design includes dedicated discharge outlets for clean grains, light impurities such as chaff and dust, and larger foreign materials including stones and stalks. Overall, the system offers a robust, eco-friendly solution for improving grain quality and supporting smallholder agricultural operations.

V. WORKING

The solar-powered seed/grain cleaning system utilizes photovoltaic panels to generate electricity, which charges a battery for continuous operation under varying sunlight conditions. A DC motor powered by the battery drives the mechanical components of the system. Grains are fed into a cleaning hopper that ensures uniform flow into the screening chamber. The chamber is equipped with inclined or horizontal sieves that separate grains based on size and weight. A vibration or oscillation mechanism enhances the sieving action, allowing fine separation of chaff, dust, and other light impurities. Larger foreign materials such as stones, stalks, and pods are diverted to a separate outlet. Cleaned grains pass through a dedicated outlet for collection. The system operates with minimal human intervention, reducing labor requirements. Its design emphasizes portability, durability, and suitability for small and marginal farmers. Overall, the system provides an energy-efficient, eco-friendly, and reliable method for improving post-harvest grain and seed quality.

WORKING PRINCIPLE

Step 1:-Solar Energy Collection: Photovoltaic panels capture sunlight and convert it into electrical energy.

Step 2:-Energy Storage: Electricity is stored in a battery to ensure uninterrupted operation.

Step 3:-Power Transmission: A DC motor, powered by the battery, drives the cleaning mechanism.

Step 4:-Grain Feeding: Harvested grains are fed uniformly into a cleaning hopper for controlled flow.

Step 5:-Sieving and Separation:Grains pass through inclined or horizontal sieves, while vibration or oscillation removes dust, chaff, and lightweight impurities.

Step 6:-Foreign Material Removal: Larger materials such as stones, stalks, and pods are separated through dedicated outlets.

Step 7:-Clean Grain Collection: Clean grains are collected at the output, ready for storage or further processing.

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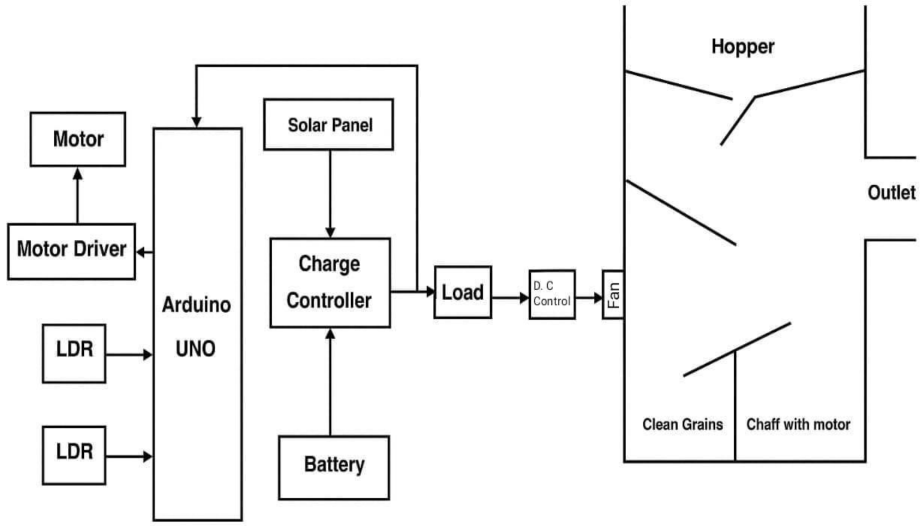
VI. BLOCK DIAGRAM



COMPENTS USED

- Motor
- Motor driver
- LDR(light dependent resistor)
- Arduino UNO
- Solar Panel
- Charge Controller
- Battery
- Load
- DC Controller
- Fan
- Hopper
- Exhaust

VII. COMPONENTS DESCRIPTION

- **Motor:** A motor is an electromechanical device that converts electrical energy into mechanical energy, enabling rotation or movement of system components.
- **Motor Driver:** This electronic circuit controls and supplies appropriate power to the motor, acting as an interface between a microcontroller (e.g., Arduino UNO) and the motor, ensuring correct speed and direction.
- **LDR (Light Dependent Resistor):** An LDR is a photosensitive resistor whose resistance varies with light intensity; resistance decreases with increasing light. It is commonly used in automatic light-sensing applications.
- **Arduino UNO:** Arduino UNO is a programmable microcontroller board that controls sensors and devices, acting as the central processing unit of automated systems.
- **Solar Panel:** Comprised of multiple photovoltaic cells (typically silicon-based), solar panels convert sunlight into electrical energy. In this system, 3 W, 5 V panels provide sustainable power for the components.
- **Charge Controller:** The charge controller regulates voltage and current from the solar panel to the battery, preventing overcharging, over-discharging, and protecting battery health.

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- **Battery:** A rechargeable storage device that converts chemical energy into electrical energy to supply power to the system when sunlight is insufficient.
- **Load:** Any component that consumes electrical power, such as the motor, fan, or sensors, is considered the load in the system.
- **DC Controller:** This device manages and regulates DC power flow, maintaining correct voltage and current for connected components, and can control motor speed.
- **Fan:** An electrically powered device that creates airflow to facilitate ventilation, drying, or separation of lighter impurities during grain cleaning.
- **Hopper:** A funnel-shaped container used to store and feed grains uniformly into the cleaning mechanism.
- **Exhaust:** Refers to the removal of unwanted air, dust, or lighter impurities from the cleaning chamber to maintain efficiency and clean operation.

VIII. ADVANTAGES

Energy Efficiency and Renewable Power Utilization

Solar energy eliminates dependence on grid electricity or conventional fuels, significantly reducing operational energy costs while ensuring sustainability.

Reduced Operational Costs

The use of photovoltaic (PV) modules minimizes recurring expenses associated with diesel or electricity, making the system highly economical for small- and medium-scale farmers.

Environmental Sustainability

Solar-powered systems produce zero emissions during operation, contributing to reduced carbon footprint and alignment with global clean-energy initiatives.

Improved Accessibility in Remote Areas

Solar-powered units can be deployed in off-grid agricultural regions, providing reliable operation where electricity supply is unavailable or unstable.

Enhanced Seed Quality and Purity

Consistent power delivery from solar energy supports uniform fan and separator performance, leading to improved removal of impurities and higher seed/grain grading accuracy.

Low Maintenance Requirements

Solar PV systems generally require minimal maintenance, resulting in reduced downtime and prolonged equipment life compared to combustion-engine alternatives.

Operational Safety and User-Friendliness

The elimination of fuel storage and combustion reduces fire hazards, while simplified controls make the system suitable for rural user operation.

Support for Sustainable Agricultural Practices

Adoption of renewable-powered cleaning units promotes eco-friendly farming and aligns with climate-smart agriculture principles.

Economic Benefits for Rural Communities

Reduced input costs and improved product quality can increase profit margins for farmers, encouraging widespread adoption and supporting rural economic growth.

IX. LIMITATIONS

1. Dependence on Solar Irradiance

System performance is directly influenced by weather conditions and seasonal variation in solar intensity, which may lead to inconsistent operation during cloudy, rainy, or low-sunlight periods.

2. High Initial Capital Investment

The installation of photovoltaic panels, batteries, charge controllers, and inverters increases upfront cost, posing financial constraints for small-scale farmers with limited resources.

3. Energy Storage and Power Management Challenges

Efficient operation during non-sunlight hours requires battery storage, which adds complexity, increases maintenance needs, and reduces system efficiency due to storage losses.

4. Capacity Limitations for Large-Scale Operations

Solar-based systems may not generate sufficient power to handle high-throughput grain cleaning tasks, restricting their application primarily to small- and medium-scale processing units.

X. CONCLUSION

The solar-powered seed/grain cleaning system provides an energy-efficient and environmentally sustainable solution for post-harvest processing. By integrating photovoltaic power with a mechanical cleaning mechanism, the system enables continuous operation in remote agricultural regions with limited or unreliable electricity access. Its cleaning unit effectively removes dust, chaff, stones, and immature grains, thereby enhancing grain purity, storage stability, and market value. The adoption of solar energy reduces operational costs, minimizes carbon emissions, and aligns with clean-energy agricultural practices. Furthermore, the system's simple construction, portability, and low maintenance requirements make it particularly suitable for small and marginal farmers. Overall, this technology offers a practical and scalable approach that strengthens post-harvest management, promotes energy self-reliance, and supports sustainable agricultural development.

XI. FUTURE SCOPE

The future development of solar-powered seed/grain cleaning systems may focus on integrating advanced sensors and automation to improve grading accuracy and operational efficiency. Enhanced energy storage technologies, such as high-capacity batteries or hybrid renewable systems, can further ensure continuous operation during low-sunlight conditions. Incorporating IoT-based monitoring and data analytics may enable real-time performance tracking and predictive maintenance. Scaling the system for higher throughput could expand its applicability to commercial grain-processing units. Additionally, the use of lightweight materials and modular designs may improve portability and adaptability for diverse field conditions. Continued research in photovoltaic efficiency and cost reduction will further strengthen the system's feasibility for widespread adoption in sustainable agriculture.

REFERENCES

[1] Sharma, R., Patel, V., & Singh, D. (2018). Development and performance evaluation of a solar-powered grain cleaner for small-scale farms. *International Journal of Agricultural Engineering*, **11**(2), 145–152.

[2] Kumar, S., & Rao, P. (2020). Solar photovoltaic integration in post-harvest machinery: A case study on seed cleaning efficiency. *Renewable Energy in Agriculture*, **7**(1), 33–41.

[3] Banerjee, A., & Thomas, J. (2019). Design optimization of solar-assisted seed processing equipment for rural applications. *Journal of Sustainable Agricultural Systems*, **14**(3), 201–210.

[4] Mehta, R. & Goswami, A. (2021). Performance assessment of hybrid solar-powered cleaning and grading systems for cereal grains. *Journal of Agricultural Science and Technology*, **23**(4), 87–95.

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