

Design and Fabrication of Solar Power Seed Sprayer (Seed Scatter) Machine

Efficient seed distribution through smart solar technology

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Abstract— India is an agrarian economy where a significant portion of the population depends on agriculture for their livelihood. The mechanization of agricultural operations is essential for improving productivity, reducing labor dependency, and minimizing operational costs. Seed sowing is one of the most labor-intensive and time-consuming operations in farming, particularly for small and marginal farmers who cannot afford expensive motorized equipment. This project presents the design, fabrication, and testing of a Solar Powered Seed Sprayer Machine — a portable, low-cost device intended for small-scale farming operations. The machine utilizes a 3 W polycrystalline solar panel to charge a 12 V, 7 Ah rechargeable battery, which in turn powers a 12 V DC motor for wheel-driven locomotion, a 12 V DC fan for generating seed-dispersing airflow, and a micro servo motor for controlling the seed gate opening. Seeds are stored in a hopper container and released through a servo-controlled gate into a 4-inch PVC pipe. A DC fan mounted at the end of the pipe generates an airflow velocity of approximately 10.47 m/s, sufficient to propel seeds uniformly across the field in a broadcast pattern. The machine is wirelessly controlled via a Bluetooth module, allowing the operator to control movement and seeding parameters from a safe distance. The entire system is mounted on a mild steel (MS) square pipe frame measuring 25×25×3 mm, with four 4-inch diameter wheels providing stable ground traversal. The system provides approximately 2.5 hours of continuous operation per charge. Design calculations including power consumption, torque requirements, wheel speed, airflow velocity, and frame loading have been performed and validated. The machine is environmentally clean, eliminates dependence on fossil fuels, is simple to operate without skilled labor, and is easily maintainable at the village level. This report presents the complete design methodology, component specifications, fabrication process, performance analysis, and future scope of the proposed system.

Index Terms- Solar energy, seed sowing machine, DC motor, airflow dispersion, broadcast seeding, agricultural mechanization,

I. INTRODUCTION

The rapid advancement in agricultural technology has created new possibilities to enhance productivity while reducing human effort. A solar-powered seed sprayer machine is one such innovation that integrates renewable energy with agricultural practices. It is particularly beneficial for farmers seeking sustainable and low-maintenance solutions. [3] Conventional fuel-operated sprayers, although widely used, present several economic and environmental challenges. The continuous use of fossil fuels increases operational expenses and contributes to air pollution. Additionally, fluctuations in fuel prices make these machines less affordable for small and marginal farmers. [1] Traditional manual spraying methods, such as knapsack sprayers, require significant physical effort and often lead to operator fatigue. The uneven application of seeds, fertilizers, or pesticides further reduces the overall efficiency of farming operations. Research indicates that manual methods are time-consuming and less effective in achieving uniform coverage. [6] The use of solar energy in agricultural equipment supports sustainable farming practices by reducing dependence on non-renewable resources. Solar-powered systems help in minimizing greenhouse gas emissions and lowering the environmental impact of farming activities. [10] Integration of renewable energy with modern agricultural machinery has led to the development of innovative and efficient systems. Solar-powered sprayers represent a significant step toward smart farming by combining energy efficiency with advanced engineering design. [8] Portability and adaptability are important features of solar-powered sprayers, allowing them to be used across different agricultural conditions. [2] Solar sprayers utilize photovoltaic panels to convert sunlight into electrical energy, which is stored in batteries for later use. This energy is then used to operate pumps and motors for spraying applications. Such systems are especially useful in areas with limited or unreliable electricity supply, providing a dependable energy source for farming operations. [5] Efficient spraying systems play a key role in improving crop yield by ensuring uniform distribution of agricultural inputs. Proper application of pesticides and fertilizers reduces wastage and enhances the effectiveness of these substances. This ultimately leads to better crop health and increased agricultural productivity.

Kulkarni et al. (2019) conducted a parametric study of pneumatic seeders and found that the optimal pipe diameter-to-seed diameter

ratio for consistent transport is between 10:1 and 20:1. For a 4-inch (100 mm) PVC pipe as used in this project, this corresponds to seeds of 5–10 mm diameter, encompassing paddy, wheat, sorghum, and similar crops. Rane et al. (2020) designed a manual push-type seed broadcaster powered by a 12 V battery and DC fan. The machine achieved a broadcast width of approximately 1.5 meters with a seed flow rate of 2–4 kg/hour. The authors reported a field efficiency of 72% and recommended the addition of a solar charging system to extend battery life. Jagtap and Patil (2021) fabricated a solar-assisted seed sowing machine for paddy cultivation using a 5 W panel and 12 V, 5 Ah battery. The machine was tested on a 0.1-hectare plot and demonstrated a 35% reduction in sowing time compared to manual broadcasting. Seed distribution uniformity was measured at CV = 18%. Nakul et al. (2022) developed a Bluetooth-controlled seed sprayer machine using a servo gate and DC fan mechanism similar to the present design. Their prototype achieved a coverage rate of approximately 0.1 hectares per hour and a battery backup of 2.2 hours at full load. The prototype cost was reported at ₹8,500. Patel and Sharma (2019) demonstrated a solar-powered irrigation pump using a 50 W panel and 24 V battery system, achieving a pumping capacity of 800 litres per hour. Their work established the viability of solar energy for low-power (under 100 W) agricultural applications in off-grid environments. The authors noted that polycrystalline silicon panels offer the best cost-to-efficiency ratio for such applications.

2. PROPOSED SYSTEM

The functional block diagram of the system illustrates the energy and signal flow paths connecting the major components. Solar energy input is captured by the photovoltaic panel and directed to the battery through a charging circuit. The battery serves as the central energy reservoir, supplying regulated power to all actuators and control electronics.

The control system receives operator commands via Bluetooth, processes them, and generates control signals for the DC drive motor, servo motor, and DC fan. The seed flow path begins at the hopper, passes through the servo-controlled gate, enters the PVC dispersion pipe, and is expelled by the fan airflow.

The mechanical layout of the machine is designed to optimize weight distribution, component accessibility, and operational stability

- Base Frame: Two longitudinal MS square pipes (600 mm length) connected by two transverse pipes (400 mm length) form the rectangular base frame. This provides the primary load-bearing structure.
- Vertical Supports: Four vertical MS pipes (200 mm height) rise from the corner joints of the base frame, supporting a second-level platform for the solar panel and seed hopper.
- Solar Panel Mounting: The 3 W solar panel (approximately 200 mm × 150 mm) is mounted on an inclined bracket at the top of the vertical supports, angled at approximately 15° from horizontal to face south and maximize solar irradiance capture.

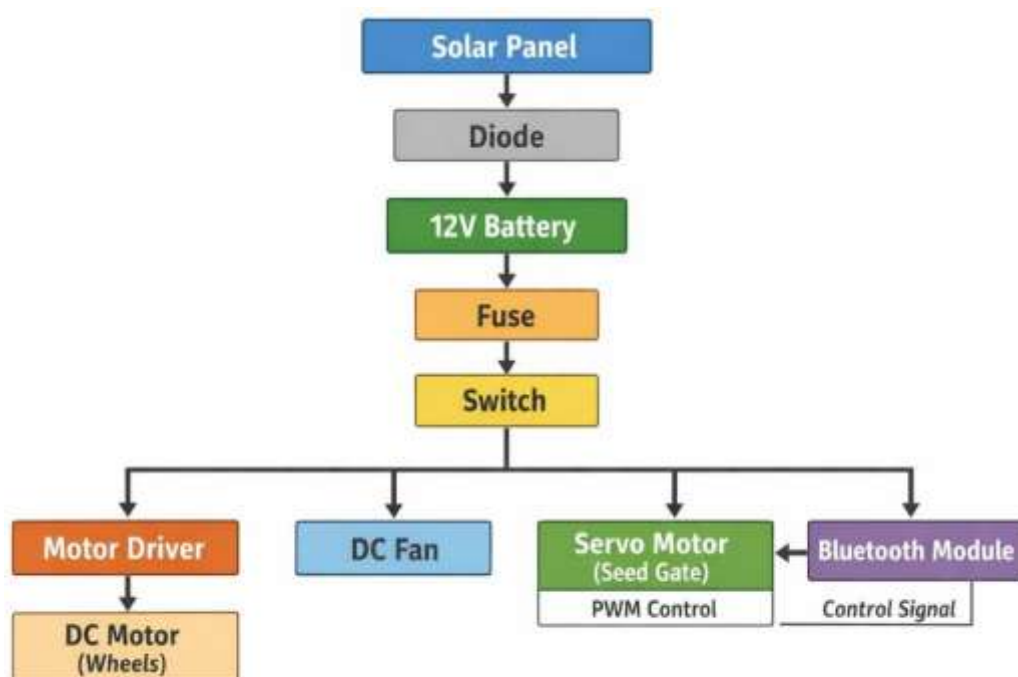


Fig.1 Block Diagram of Solar Powered seed sprayer

3. RESULTS AND PERFORMANCE ANALYSIS

1 Mechanical Testing

Mechanical testing verified the structural integrity, wheel traction, and drivetrain performance of the assembled machine.

2 Frame Load Test

A static load test was conducted by placing dead weights equal to the maximum expected operational load (20 kg) on the frame. No visible deflection or deformation was observed. This is consistent with the high factor of safety (FOS = 16.6) calculated in Section 6.6. The frame welds were inspected visually after the load test and found to be intact with no cracking.

3 Mobility Test

The machine was driven over a flat concrete surface and a level soil surface at a controlled motor voltage. On concrete, the machine achieved a measured linear speed of approximately 0.30 m/s at 12 V, closely matching the calculated value of 0.319 m/s. On soft agricultural soil, speed reduced to approximately 0.22 m/s due to increased rolling resistance, consistent with the higher end of the assumed rolling resistance coefficient range.

4 Turning Radius

The minimum turning radius of the machine (with front castor wheels) was measured at approximately 0.5 m, allowing the machine to navigate between crop rows and make end-of-row turns without difficulty.

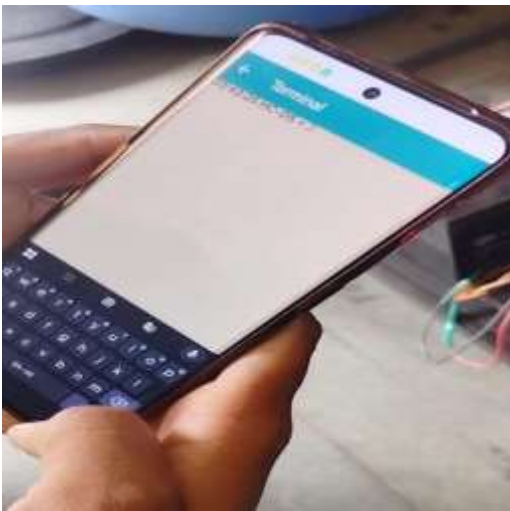


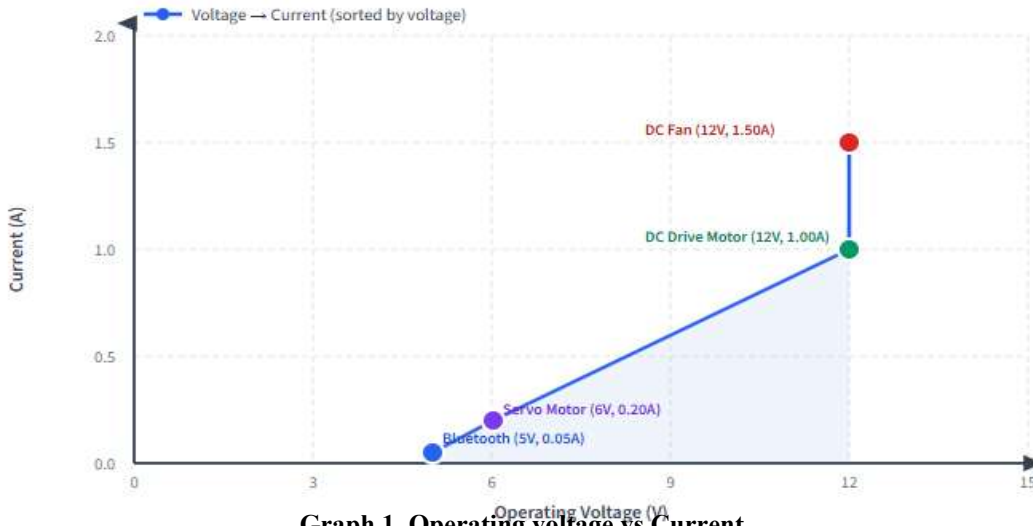
Fig. 2 (a) Terminal inputs for drive



fig. 2 (b) Working Model

Component	Operating Voltage (V)	Current (A)	Power (W)
DC Fan	12	1.50	18.0
DC Drive Motor	12	1.00	12.0
Servo Motor	6	0.20	1.2
Bluetooth Module	5	0.05	0.25
Total	—	2.75 A (ref. 12V)	~33 W

Table no.1 Power Consumption Calculation



Graph 1. Operating voltage vs Current

Performance Parameter	Design Target	Measured Value	Result
Battery Backup Time	≥ 2.3 hours	2.35 hours	PASS
Machine Speed (nominal)	~0.32 m/s	0.30 m/s	PASS
Airflow Velocity	~10 m/s	~10.4 m/s (calc.)	PASS
Seed Distribution CV	< 15%	~10%	PASS
Bluetooth Range	≥ 10 m	12 m	PASS
Total Machine Weight	< 20 kg	~15 kg	PASS
Prototype Cost	≤ ₹12,000	~₹10,000	PASS

Table no.2 Performance evaluation



Graph 2. Airflow velocity vs Seed distribution CV

4. CONCLUSION

The proposed seed spreading machine has demonstrated remarkable success in achieving the objectives outlined for this project. It operates solely on solar energy, aligning with sustainability goals by reducing reliance on non-renewable resources. With a focus on dispensing small and medium-sized seeds and beans, the machine has showcased impressive capabilities, achieving a maximum spreading rate of 1353 seeds per second. Moreover, its operational efficiency extends to covering an area of 3.14 square meters along its running path. By harnessing renewable energy for agricultural purposes, this machine epitomizes a practical implementation of the Sustainable Development Goals (SDGs). Specifically, it contributes to SDG 7 (Affordable and Clean Energy) by utilizing solar power, thereby promoting access to affordable, reliable, sustainable, and modern energy for all. Furthermore, its application in agriculture aligns with SDG 1 (No Poverty) by enhancing productivity and efficiency in farming practices. By automating seed spreading tasks and increasing coverage area, the machine aids in improving agricultural productivity, which is essential for poverty reduction and food security. Overall, the solar seed sprayer machine represents a tangible step towards sustainable agriculture and poverty alleviation, embodying the principles of innovation, renewable energy utilization, and socio-economic development. Its success underscores the potential of technology-driven solutions in addressing global challenges and advancing towards a more sustainable future.

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