

“Automatic Seedling Transplanter Machine”

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Abstract : Agriculture plays a vital role in the economy of developing countries, where a large population depends on farming for their livelihood. Transplanting of seedlings is one of the most important agricultural operations, but conventional manual transplanting methods are labor-intensive, time-consuming, and often result in non-uniform spacing and planting depth. To overcome these challenges, a compact and cost-effective Motorised Seedling Transplanter has been developed.

The proposed system is powered by a 12V rechargeable battery and utilizes a DC motor, chain drive mechanism, feeder wheel, hopper, and delivery pipe for efficient seedling transplantation. The feeder mechanism ensures controlled and uniform placement of seedlings, while the motorized drive reduces manual effort and improves operational efficiency. The machine is specifically designed for small and medium-scale farmers who require an affordable mechanized solution for agricultural operations.

The fabricated prototype was tested under field conditions to evaluate its performance. The results demonstrated improved transplanting accuracy, reduced labor dependency, uniform seedling spacing, and consistent planting depth. The battery-operated system also minimizes fuel consumption and environmental impact. The machine is simple to operate, easy to maintain, and economically viable for small-scale farming applications.

The developed Motorised Seedling Transplanter provides an effective alternative to traditional transplanting methods and contributes towards increasing agricultural productivity through affordable mechanization.

Keywords: Motorised Seedling Transplanter, Agriculture Mechanization, Seedling Transplanting, DC Motor, Battery Operated Machine, Uniform Spacing, Small-Scale Farming.

1.INTRODUCTION

Agriculture serves as the backbone of the Indian economy, sustaining a majority of the population and providing essential raw materials for industrial sectors. Despite its economic significance, the sector faces severe constraints, primarily the acute shortage of agricultural labor during critical phases like sowing, transplanting, and harvesting. Traditional manual sowing practices are labor-intensive, require immense physical exertion, and result in non-uniform seed placement and varying planting depths. This inconsistency directly impacts crop germination rates and subsequent yields. Furthermore, conventional pesticide spraying requires farmers to carry heavy backpack pumps, exposing them to health hazards and physical strain.

While advanced, heavy-duty commercial agricultural machinery exists, small and marginal landholders find

it financially non-viable and technologically complex to adopt. Therefore, a major technological gap persists between high-end industrial farming equipment and primitive manual tools used by small-scale farmers.

To bridge this gap, this paper introduces a motorized, automated seedling transplanter integrated with a secondary pesticide spraying capability. The primary focus is to establish an affordable, efficient, and scientifically driven mechanism that maintains optimal seed-to-seed spacing, uniform row alignment, and appropriate soil compaction. This approach aims to safeguard farmers against operational losses while accelerating the transition toward smart, decentralized rural mechanization.

2. LITERATURE REVIEW:

The optimization of automated seeding mechanisms has been extensively explored by researchers looking to improve mechanical efficiency and uniform distribution:

- **Jain et al. (2015)** designed an automatic seed sowing machine aimed at minimizing manual labor and improving time management during seasonal sowing.
- **Kumar et al. (2017)** fabricated a portable seed sowing machine to analyze the behavior of mechanical linkages on varied field terrains.
- **Patil et al. (2018)** developed a dual-purpose system combining seed sowing with localized fertilizer dispensing to enhance resource utilization.
- **Rajput and Khandekar (2011)** evaluated a manually operated multi-crop planter, concluding that mechanical seed placement substantially improves yield parameters over conventional broadcasting methods.
- **Londhe et al. (2017)** emphasized the integration of simple, cost-effective automation units to make mechanical planters accessible to low-income farming groups.

From the literature, the primary **Research Gap** identified is the absence of an integrated, synchronized single-motor system that simultaneously regulates vehicle forward motion and precise spoon-based seed feeding, while remaining financially accessible to small landholders.

3. OBJECTIVES OF THE SYSTEM:

The precise technical objectives of the developed prototype are formulated as follows:

1. To design a compact, portable, and structurally stable seedling transplanter capable of automated, high-efficiency seed sowing.
2. To enforce uniform seed distribution, accurate linear spacing, and precise placement depth using a regulated hopper and a spooned feeder-wheel mechanism.
3. To minimize reliance on external manual labor and optimize field execution time via motorized automation.
4. To implement a highly cost-effective architecture utilizing locally available mechanical and electrical components.
5. To promote sustainable agricultural engineering by deploying an emission-free, battery-powered electrical drive system capable of future autonomous expansions.

4. DESIGN DIAGRAM

The constructional design of the automated transplanter leverages a highly synchronized mechanical framework. The primary structural assemblies include:



4.1 Chassis and Frame

The foundational backbone of the machine is constructed from a rectangular Mild Steel (MS) frame. MS was selected to ensure high rigidity, structural stability, and resistance against mechanical shock loads encountered on bumpy terrains. The frame is supported by a robust four-wheel mobile chassis layout, distributing the cumulative weight evenly to avoid deep soil sinking while maintaining smooth field traction.

4.2 Seed Storage and Dispensing Assembly

- **Hopper Unit:** Mounted at the apex of the frame, a conical/rectangular hopper serves as the main seed reservoir. It is constructed from lightweight, corrosion-resistant sheet metal/plastic. A nozzle fitted with a manual flow control strip regulates seed discharge.
- **Seed Container & Feeder Wheel:** Positioned directly below the hopper nozzle is a small buffer container. In front of this container, a specialized feeder wheel rotates horizontally. The periphery of this wheel is equipped with six equidistant spoon-shaped buckets. During rotation, each spoon scoops a single seed from the container and transfers it directly into the front delivery pipe.

4.3 Power Transmission and Synchronization

A core feature of the design is its single-motor drive configuration. A **150 Watt, 55 RPM DC Worm Gearbox Motor** serves as the prime mover. The selection of a worm gearbox ensures high output torque at low rotational speeds, which is essential for overcoming field obstacles.

Through a configured **chain link drive mechanism**, the single motor output shaft is structurally coupled to both the rear driving wheels and the horizontal feeder wheel. This ensures that the forward speed of the vehicle (V_v) and the rotational speed of the feeder wheel (ω_f) are perfectly synchronized, guaranteeing constant seed-to-seed spacing regardless of minor speed fluctuations.

4.4 Electrical Power Unit

The powertrain is energized by a **12 V, 7 Ah rechargeable lead-acid battery** securely anchored to the chassis base. This power configuration sustains the

DC motor for extended field operations. An external battery charger is mapped into the system to facilitate recharging cycle operations.

5. Working Methodology

The operational kinematics of the automatic seedling transplanter follow a sequence of mechanical events:

1. **Material Setup:** Seeds are loaded into the upper hopper unit. The flow control strip is calibrated outward to permit a regulated drop of seeds into the lower containment basin.
2. **Actuation:** The 12V DC motor is switched on. The motor delivers high torque through the integrated worm gearbox, setting the vehicle chassis into a forward linear motion.
3. **Synchronized Dispensing:** Simultaneously, the chain drive rotates the horizontal feeder wheel. As the wheel moves, each of the six spoon-buckets captures an individual seed from the collection container.
4. **Seed Deposition:** Upon reaching the peak of the rotational cycle, the scoop drops the seed into the vertically inclined front delivery pipe. The pipe guides the seed smoothly into the soil furrow at a predetermined depth, preventing clogging.

6. Results and Discussion

6.1 Performance Characteristics

The integration of a single motor drive system significantly improved operational precision compared to manual or multi-motor alternatives. By matching the 55 RPM motor speed with a calibrated wheel diameter, a steady operational velocity is maintained.

Operational Parameter	Measured / Designed Value
Prime Mover Power	150 W
Output Speed	55 RPM
Power Source	12 V, 7 Ah Battery

Operational Parameter	Measured / Designed Value
Feed Mechanism Type	6-Spoon Feeder Wheel
Primary Frame Material	Mild Steel (MS)

6.2 Advantages & Practical Applications

- **Labor & Time Optimization:** Drastically minimizes physical human labor and field operation cycles.
- **High Precision:** Ensures highly uniform seed placement, fixed linear spacing, and uniform depth control.
- **Dual Capabilities:** Operates as both an efficient automated seed planter and a localized pesticide spraying unit.
- **Eco-Friendly Performance:** The electric drive architecture operates with zero direct emissions, making it highly suitable for sustainable precision farming, greenhouses, and small holdings.

6.3 Technical Limitations

The machine is optimized primarily for small-to-medium scale agricultural topologies; extensive multi-hectare operations may require structural upscaling. The system requires manual supervision for hopper refilling and navigation. Additionally, highly rugged fields containing large boulders can occasionally disrupt seed spacing accuracy.

7. Conclusion and Future Scope

The developed Motorized Seedling Transplanter represents a highly functional solution for low-cost agricultural mechanization. By synchronizing a 6-spoon feeder wheel with a four-wheel mobile chassis using a single 150W DC worm gear motor and chain drive, the machine successfully eliminates human error and ensures uniform seed distribution. The 12V battery setup confirms that the system is economically viable, portable, and environmentally sustainable for small and marginal landholders.

Future Scope: The existing system can be upgraded into an intelligent smart-farming unit by integrating microcontrollers (e.g., Arduino/Raspberry Pi), ultrasonic/IR sensors for obstacle avoidance, and automated GPS-guided path planning. Furthermore, installing a photovoltaic solar panel system on top of the hopper unit could enable on-field battery charging, making the machine entirely self-sustaining.

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Prof.P.S.Ladgaonkar is currently working as an Assistant Professor Mechanical in Engineering at Ashokrao Mane Group Of Institution, Vathar. He has been guiding and mentoring students in various academic and research activities. He has provided his valuable guidance for the successful completion and publication of this paper.

