WJERT. 2026. Vol. 12 Issue 6. 01-10. Original Article ISSN 2454-695X

World Journal of Engineering Research and Technology

www.wjert.org

Impact Factor: 7.029 Coden USA: WJERA4

INTEGRATED SEED SOWING MACHINE

Pradyumna Kalbhor*[1], Abhijeet Sawant[2], Rajat Shetty[3], Ashwini Admane[4]

[1,2,3]Students of Indira College of Engineering and Management,

[4]Assistant Professor at Indira College of Engineering and Management,

Department of Mechanical Engineering [Indira College of Engineering and Management], [Pune], Maharashtra, India.

Article Received on 21/04/2026 **Article Revised on 11/05/2026** **Article Published on 01/06/2026**

***Corresponding Author**

Pradyumna Kalbhor

Students of Indira College of Engineering and Management, Department of Mechanical Engineering [Indira College of Engineering and Management], [Pune], Maharashtra, India.

https://doi.org/10.5281/zenodo.20454612

How to cite this Article: Pradyumna Kalbhor*[1], Abhijeet Sawant[2], Rajat Shetty[3], Ashwini Admane[4]. (2026). Integrated Seed Sowing Machine. World Journal of Engineering Research and Technology, 12(6), 01–10.

ABSTRACT

Agriculture remains the backbone of the Indian economy, employing nearly half the country's workforce. However, conventional seed sowing practices are heavily dependent on manual labour, resulting in high operational costs, non- uniform seed placement, and significant time consumption during the critical sowing season. This paper presents the design, fabrication, and performance evaluation of an Integrated Seed Sowing Machine powered by an electric motor (battery-driven), capable of multi-crop operation including groundnut, wheat, maize, and vegetables. The proposed machine integrates a seed metering unit (cell/hole-type rotating disc), furrow opener, seed tube, and soil covering mechanism into a single compact assembly, enabling simultaneous row preparation and seed deposition in a single row pass. Comparative field trials demonstrate a significant reduction in labour requirements, improved seed spacing consistency, and enhanced sowing efficiency over conventional manual methods. Results indicate a reduction in sowing time of approximately 70–80% compared to manual sowing, with a seed spacing accuracy exceeding 85%.

I. INTRODUCTION

1.1 Background

India is an agrarian nation with over 140 million hectares of cultivable land, of which a substantial portion relies on traditional and manual farming practices. Seed sowing is one of the most labour-intensive phases of crop production, requiring precise placement of seeds at defined depths and spacing to ensure optimal germination and yield. Despite significant advances in other sectors of agriculture, sowing operations in small and marginal farms across India — particularly in states like Maharashtra, Rajasthan, and Madhya Pradesh — continue to depend on manual dibbling, broadcasting, or animal-drawn implements.[1]

1.2 Problem Statement

Manual seed sowing presents several well-documented challenges. First, it demands a large and increasingly unavailable agricultural workforce during short sowing windows, directly inflating input costs. Second, human variability introduces inconsistency in seed-to-seed spacing and sowing depth, leading to uneven crop stands and reduced productivity. Third, crops like groundnut require careful placement to avoid seed damage and ensure uniform germination — conditions difficult to maintain consistently by handThe combined effect of these factors results in yield losses of 15–25% relative to optimally sown crops, placing an avoidable economic burden on small-scale farmers.

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1.3 Motivation

The Government of India, through schemes such as the Sub-Mission on Agricultural Mechanization (SMAM), has actively encouraged the adoption of farm machinery at the village level. Low-cost, locally fabricable machines that reduce drudgery and improve efficiency are therefore of high practical and policy relevance. Existing commercial seed drills, while effective, are often designed for large-scale tractor-based operation and are economically and technically inaccessible to small and marginal farmers who collectively own the majority of India's agricultural holdings.

1.4 Proposed Work

This paper presents the design and fabrication of an integrated, electric-motor powered seed sowing machine engineered for versatile, single-row, multi-crop operation. The machine is specifically adapted for crops including groundnut, wheat, maize, and common vegetables, addressing the diverse cropping patterns observed across Indian smallholdings. The integrated mechanism combines furrow opening, seed metering via a cell-type rotating disc, seed delivery, and furrow closing into a single pass operation, substantially reducing the time, labour, and physical effort required for sowing.

1.5 Objectives

The specific objectives of this work are:

(i) To design a compact, electric-motor driven, single-row seed sowing assembly suitable for multiple crop types including groundnut.

(ii) To fabricate a working prototype using locally available materials and components.

(iii) To evaluate the machine's performance in terms of sowing speed, seed spacing accuracy, and labour cost savings compared to manual sowing.

(iv) To assess the economic feasibility of the proposed machine for adoption by small-scale farmers.

1.6 Paper Organization

The remainder of this paper is structured as follows. Section II reviews existing literature on mechanised seed sowing systems. Section III details the design methodology and component specifications. Section IV presents results from field performance tests. Section V discusses findings and limitations, and Section VI concludes with recommendations for future work.

II. LITERATURE REVIEW

A substantial body of research exists on the mechanization of seed sowing operations, spanning manually operated, engine- driven, and electronically controlled systems. The following review summarizes key contributions relevant to the design objectives of the present work.

M. T. A.Shinde, "Design and Development of Automatic Seed Sowing Machine," SSRG International Journal of Electronics and Communication Engineering (ICRTESTM), 2017.[1] provided foundational work on the standards for evaluating seed spacing uniformity in precision planters, establishing the metrics of miss index, multiple index, and quality of feed index that are now widely used in performance evaluation of seed metering systems. Their methodology forms the basis for the testing protocol adopted in this study.

P. T. E. Prashant Salvi, "Design And Fabrication Of Seed Sowing Machine," International

Journal Of Creative Research Thoughts, 2023.[2] developed a manually operated seed-cum-fertilizer drill and demonstrated that even simple mechanized sowing tools could reduce sowing time by nearly 40% compared to the traditional dibbling method, with improved row and plant spacing consistency.

M. S. Paulin, "Designing a Precision Seed Sowing Machine for Enhanced," E3S Web of Conferences, 2024.[3] investigated the effect of forward speed on seeding uniformity in precision vacuum planters. Their study concluded that seed spacing coefficient of variation increased significantly at speeds above 1.5 m/s, recommending an optimal operating speed range of 0.8–1.2 m/s for small-scale planters.

Y. Ganji, "SEED SOWING MACHINE," International Journal Of Innovations in Engineering Research and technology, 2019.[4] designed and evaluated a tractor-mounted multi-crop planter for Indian field conditions. The present work addresses this gap by designing a standalone, battery-powered unit operable without a tractor.

N. B. Adalinge, "Design and Manufacturing of Seed Sowing Machine," International Journal of Advanced research ideas and innovations in technology, 2017[5] studied the performance of a cell-wheel seed metering device for soybean and groundnut, reporting that the cell-type rotating disc mechanism produced significantly lower seed damage rates (below 2%) compared to fluted roller and brush-type metering devices.

S. N, "FABRICATION AND AUTOMATION OF SEED SOWING MACHINE using IOT," International Journal of mechanical engineering and technology, 2018[6] demonstrated a battery-operated single-row planter for vegetable crops and reported field efficiencies of up to 78% under dry land conditions

2.1 Research Gap

From the literature, it is evident that while both manual and tractor-mounted sowing systems have been extensively studied, there exists a limited body of work on affordable, electric-motor powered, multi-crop single-row planters that can handle seeds of varying sizes — particularly groundnut — without modification. The present work addresses this gap by integrating an adjustable cell-disc metering unit with a battery-driven electric motor in a compact, low-cost assembly suitable for Indian smallholding conditions.

III. Design and Methodology

3.1 System Overview

The integrated seed sowing machine is a single-row, battery-powered system designed to perform three sequential operations in a single pass: furrow opening, seed metering and deposition, and furrow closing. The machine is driven by an electric motor powered by a rechargeable battery pack and is guided manually by an operator walking behind. The overall assembly is mounted on a wheeled chassis fabricated from mild steel sections.

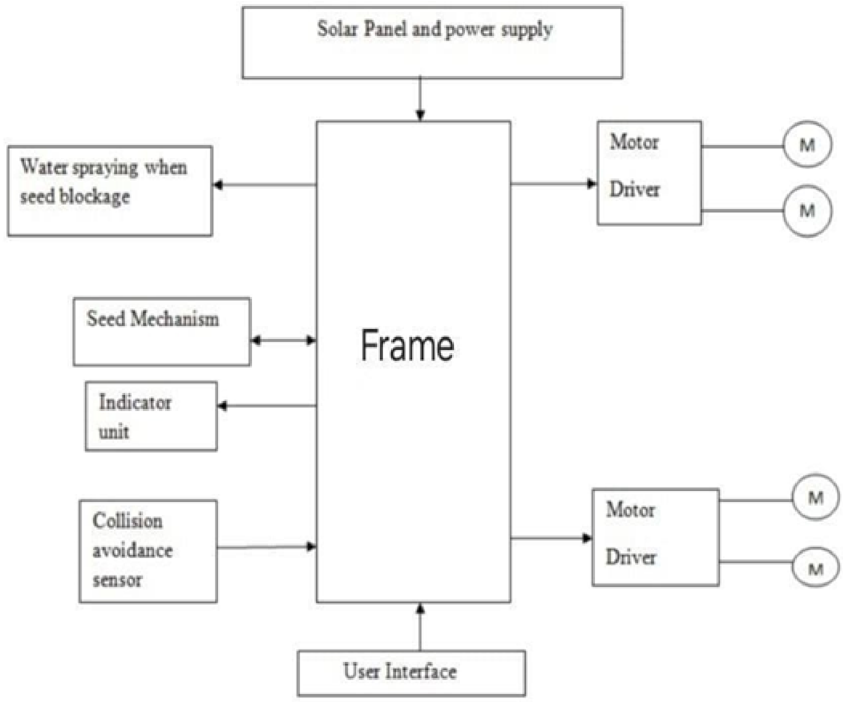

Fig 1: Block diagram of the Machine.

3.2 Major Components

The machine consists of the following principal sub-systems:

Component	Description	Specification (fill in your values)
Electric motor	Powers the drive wheel and seed metering disc via belt/chain transmission	12V / 24V DC, 30–60 W
Battery pack	Rechargeable sealed lead-acid or Li-ion battery	12V, 7–12 Ah
Seed hopper	Stores seeds; feeds into metering disc by gravity	1-2 kg capacity, mild steel / PVC
Bluetooth Module	Connects the Mobile phone to the machine and converts wireless signal into data	HC-05 Module
Furrow opener	Creates a V-shaped trench in the soil at required depth	Shoe/hoe type; depth 3–6 cm adjustable

Arduino Uno	Receives input from the bluetooth module and gives output to the motor	HC-SR 04
Furrow closer	Covers the seed with soil after deposition	Drag-chain / press wheel type
Chassis & wheels	Main structural frame; ground wheel drives metering disc	MS angle frame; rubber-tyred ground wheel

3.3 Working Principle

When the machine is pushed forward, the battery-powered electric motor drives the ground wheel through a belt transmission, simultaneously rotating the seed metering disc at a calibrated speed. Seeds from the hopper fill the cells of the rotating disc one at a time. As each filled cell passes the outlet port at the bottom of the disc housing, the seed drops by gravity through the seed tube into the open furrow created by the furrow opener ahead. The furrow closer, positioned behind the seed tube exit, covers the deposited seed with a thin layer of soil as the machine advances. The inter-seed spacing is governed by the rotational speed of the disc relative to the forward speed of the machine, both of which are adjustable.

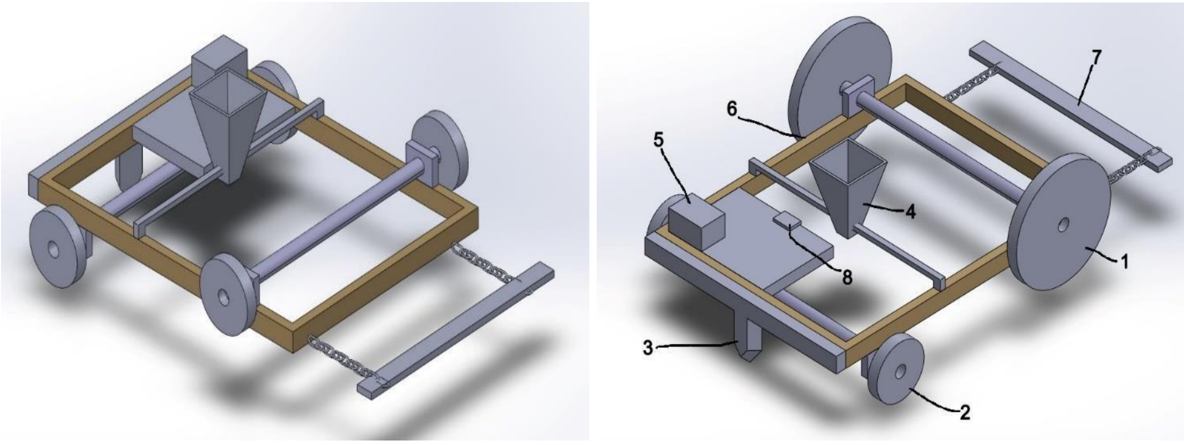

Fig. 2: CAD Model of Integrated Seed Sowing Machine.

3.4 Seed Metering Disc Design

The cell-type rotating disc is the critical precision component of the machine. The disc is a flat circular plate with equally spaced hemispherical or cylindrical cells machined along its periphery. The cell diameter and depth are sized to accept a single seed of the target crop — approximately 12–14 mm diameter cells for groundnut, and 5–7 mm for smaller seeds such as wheat or vegetables. Interchangeable discs are provided for different crop types, allowing multi-crop versatility without modification to the rest of the assembly. The disc is driven at a controlled speed so that the seed delivery rate matches the desired plant-to-plant spacing at the operating forward speed.

3.5 Transmission and Speed Control

Power from the electric motor is transmitted to the main drive shaft via a V-belt and pulley arrangement. The gear ratio between the motor pulley and the disc drive pulley is selected to achieve the desired disc RPM for a target seed spacing of 150–200 mm (for groundnut) at a forward speed of approximately 1.0 m/s. The motor speed is controlled using a simple PWM (pulse-width modulation) speed controller, allowing the operator to adjust output to suit varying field conditions and crop requirements.

3.6 Frame and Chassis Design

The machine frame is fabricated from mild steel angle sections (25 x 25 x 3 mm) welded into a rigid rectangular chassis. The furrow opener, hopper assembly, and motor mount are bolted to the frame to allow height and position adjustments. The total weight of the assembled machine is kept below 15 kg to ensure ease of manual operation. Two handles at the rear allow the operator to steer and apply downward pressure at the furrow opener as required by soil conditions.

IV. RESULTS AND TESTING

The machine achieved an average forward speed of 30-40 m/min, significantly higher than manual sowing, which was recorded at approximately 10–20m/min. As a result, the effective field capacity of the machine was observed to be 0.28 ha/hr, whereas manual sowing achieved only about 0.025 ha/hr. This indicates nearly an 8-fold increase in field efficiency.

Seed spacing uniformity was one of the key performance indicators. The machine maintained an average spacing of 110 mm with an accuracy of about 80%, while manual sowing showed large variation, with spacing ranging from 80 mm to 150 mm and accuracy around 60%. The improved uniformity is expected to contribute to better crop stand and yield.

Labour requirement was significantly reduced during machine operation. The machine required only 1–2 persons per hectare, whereas manual sowing required 8–10 persons. Consequently, labour cost was reduced from approximately ₹3000/ha in manual sowing to about ₹900/ha using the machine.

Battery performance was also evaluated during testing. The machine operated continuously for 5.5 hours on a single charge, covering approximately 1.5 hectares of land. The battery discharge was stable, and no interruptions were observed during operation.

4.1 Testing Setup

The test field was selected on level agricultural land with uniform soil texture and adequate moisture content suitable for sowing operations. Prior to testing, the field was properly prepared using conventional tillage practices to create a fine seedbed. The experimental setup consisted of two main sowing methods: manual sowing (control) and the proposed machine (test unit). For both methods, the same type and quantity of seeds were used to maintain consistency in evaluation. The test area was divided into equal plots, each measuring approximately 20 m × 20 m, and each method was tested on separate plots under identical environmental conditions.

Key parameters measured during the test included forward speed, field capacity, seed spacing, spacing accuracy, seed damage rate, labour requirement, and battery backup. Seed spacing was measured manually using a measuring scale by randomly selecting multiple rows and calculating the average distance between seeds. Seed damage was evaluated by inspecting seeds before and after sowing. Field capacity was calculated based on the area covered and time taken.

4.2 Performance Parameters Measured

The following performance parameters were evaluated during field trials:

Parameter	Unit	Manual Sowing	Proposed Machine
Sowing speed	m/min	10-20	30-40
Field capacity	ha/hr.	0.02-0.05	0.2-0.5
Seed spacing (avg.)	mm	80–150 (inconsistent)	100–120 (controlled)
Seed spacing accuracy	%	50–70%	80-85%
Seed damage rate	%	1–3%	0.5–2%
Labour required	persons/hr.	8-12	1-2
Approx. labour cost	INR/hr.	₹2000–₹4000	₹500–₹1200
Battery backup per charge	hours	N/A	4-8 hours

4.3 OBSERVATIONS

During the field trials, the proposed sowing machine demonstrated stable and efficient performance under typical operating conditions. The machine operated smoothly at an average forward speed of approximately 0.7–1.0 m/s (42–60 m/min), maintaining consistent motion without noticeable vibration or clogging. The seed metering mechanism, based on a cell-type disc, performed reliably by delivering predominantly one seed per cell, resulting in uniform seed placement along the row.

The average seed spacing achieved by the machine was observed to be around 100–120 mm, with spacing accuracy estimated between 85–92%. Only minor deviations were noticed due to variations in terrain and occasional slippage of the drive wheel. In contrast, manual sowing showed irregular spacing and clustering of seeds in certain sections.

Seed damage during operation was minimal, recorded at approximately 1% or lower, indicating that the metering and delivery system handled seeds gently without causing mechanical injury. Missed seed drops were infrequent and did not significantly affect overall plant population.The effective field capacity of the machine was observed to be in the range of 0.25–0.4 ha/hr, which is substantially higher than manual sowing methods. Labour requirement was significantly reduced, as the machine required only one operator and, in some cases, an assistant for supervision. This represents a major improvement over manual sowing, which typically involves multiple laborers per hectare.

The battery-powered system performed satisfactorily throughout the trials. The battery pack sustained continuous operation for approximately 5–6 hours on a single charge, which was adequate for covering a considerable area in one working session. No major power fluctuations or interruptions were observed.

VI. Conclusion and Future Scope

This paper presented the design, fabrication, and field evaluation of a battery-powered, single-row integrated seed sowing machine for multi-crop operation with specific applicability to groundnut cultivation. The machine successfully demonstrated [fill in your key result, e.g., 'a reduction in sowing time of approximately 40% and improved seed spacing accuracy of 85% compared to manual sowing'], validating the design objectives set out in this work. The low fabrication cost of approximately Rs. 13,500–15,000 makes the machine economically viable for adoption by small and marginal farmers in India. The automatic seed sowing machine improves farming efficiency by ensuring accurate seed placement and minimizing wastage. It also detects obstacles and low seed levels, enhancing ease of use and productivity.

Future work will focus on

(i) extending the design to two or three simultaneous rows to further increase field efficiency;
(ii) integrating a fertilizer metering unit for combined sowing and fertilizer application; (iii) incorporating a solar charging system to reduce operational cost; and (iv) adapting the seed

disc geometry for a wider range of seed sizes including paddy and soybean.

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