

A Research Study on Multipurpose Manual Seed Sowing And Sprayer

Prof R. M. Choudhari¹, Harshal Mohite², Snehal Pachpor³, Netra Kolte⁴,
Tushar Bhoi⁵, Kiran Kule⁶

¹Assistant Professor, Department of Mechanical Engineering

^{2,3,4,5,6}Students of Department of Mechanical Engineering

Padm. Dr. V. B. Kolte College of Engineering, Malkapur, Maharashtra

Abstract: *Agricultural productivity in India is often limited by the reliance on traditional manual methods for sowing and crop protection, which are labor-intensive, time-consuming, and prone to human error. To address these challenges, this project proposes a Multipurpose Manual Seed Sowing and Sprayer Machine designed specifically for small and marginal farmers. The machine integrates seed sowing, furrow formation, seed metering, soil covering, and pesticide spraying into a single manually operated unit. A wheel-driven mechanism powers the seed metering system to achieve uniform seed spacing and consistent sowing depth, thereby improving germination rates and overall crop yield. The integrated sprayer utilizes a manual pumping system with adjustable nozzles to ensure uniform chemical application while reducing operator fatigue compared to conventional backpack sprayers. The machine is fabricated using a lightweight and durable frame, making it cost-effective, easy to operate, and suitable for various crop types. Experimental testing demonstrates that the proposed design significantly reduces labor effort, minimizes operational time, and enhances field efficiency. The outcomes indicate that this multipurpose machine provides a low-cost, sustainable, and user-friendly solution that can improve productivity in small-scale farming practices.*

Keywords: multipurpose machine, manual seed sowing, pesticide sprayer, reciprocating pump, agricultural mechanization, chain and sprocket drive

I. INTRODUCTION

Agriculture is a vital sector for India, yet many farmers still depend on traditional, labour-intensive methods for seed sowing and pesticide spraying. These practices often result in non-uniform seed distribution, inconsistent depth, chemical wastage, and increased physical strain on the farmer, ultimately affecting crop yield and overall productivity. With rising labour shortages and the need for precision farming, it has become essential to introduce simple, affordable, and efficient tools that can support small and marginal farmers.

To address these challenges, the “Multipurpose Manual Seed Sowing and Sprayer Machine” is developed as a low-cost mechanical solution that combines seed sowing and pesticide spraying in a single unit. This machine enhances accuracy in seed placement, ensures uniform spraying, reduces manual effort, and significantly lowers operational time. Being manually operated, it requires no fuel or electrical power, making it suitable for rural conditions. The system aims to promote sustainable farming by improving efficiency while remaining economically accessible to farmers.

By combining multiple functions into one mechanism, the proposed system not only minimizes operational time but also promotes sustainable agricultural practices. The machine is ergonomically designed, cost-effective, and suitable for diverse crop conditions, making it a practical solution for farmers with limited resources. This introduction sets the foundation for exploring the machine’s design, working principles, performance evaluation, and its potential to transform traditional farming into a more efficient, economical, and technologically progressive practice.



II. PROBLEM STATEMENT

Agriculture is one of the most important sectors in India, serving as the backbone of the economy and providing livelihood to a large portion of the population. A significant number of farmers in India belong to the small and marginal category, where access to advanced agricultural machinery and modern technology is limited due to financial constraints and small landholdings. Despite the importance of agriculture, many farming operations are still carried out using traditional methods, especially seed sowing and pesticide or fertilizer spraying. These methods are labor-intensive, time-consuming, and often inefficient, leading to reduced productivity and inconsistent crop quality.

One of the major challenges faced by farmers during seed sowing is the lack of uniformity in seed placement. Manual broadcasting or hand sowing results in uneven spacing and improper depth of seeds, which directly affects germination, plant growth, and final crop yield. Improper seed distribution also leads to overcrowding in some areas and sparse growth in others, ultimately reducing the efficiency of land utilization. Similarly, traditional spraying methods using handheld sprayers often result in non-uniform application of pesticides and fertilizers. This can cause overuse of chemicals in certain areas and insufficient coverage in others, leading to increased costs, environmental pollution, and potential damage to crops.

In addition to these technical challenges, farmers also face serious issues related to labor availability and physical effort. With the rising cost of labor and migration of rural workers to urban areas, it has become increasingly difficult for farmers to find sufficient manpower, especially during peak agricultural seasons. Manual seed sowing and spraying require continuous physical effort, causing fatigue and reducing work efficiency. Furthermore, direct exposure to harmful chemicals during spraying poses health risks to farmers, including skin problems and respiratory issues, making traditional practices unsafe over long-term use.

Although mechanized solutions such as tractor-operated seed drills and power sprayers are available, they are often expensive, complex, and unsuitable for small farms. These machines require higher investment, fuel costs, and maintenance, which are not affordable for small and marginal farmers. Additionally, their large size makes them impractical for use in small or uneven fields. As a result, there is a gap between available technology and the actual needs of farmers.

Another significant issue is that seed sowing and spraying are generally performed as separate operations, which increases the number of field passes, time consumption, and labor requirement. This reduces overall efficiency and delays critical farming activities. While some multipurpose machines have been developed, many of them still suffer from limitations such as poor synchronization between mechanisms, lack of adaptability for different crops, inconsistent spraying performance, and inadequate ergonomic design.

Therefore, there is a strong need to develop a simple, cost-effective, and fully hand-driven multipurpose machine that can perform both seed sowing and spraying operations efficiently in a single pass. The system should ensure uniform seed placement, controlled and even spraying, reduced human effort, and ease of operation while being affordable and suitable for small-scale farmers. Addressing these challenges is essential for improving agricultural productivity, reducing labor dependency, ensuring farmer safety, and promoting sustainable farming practices in India.

III. LITERATURE SURVEY

Agriculture has long been the backbone of developing economies, and improving the efficiency of fundamental farming operations such as seed sowing and spraying has been a key focus of agricultural engineering research. Traditional methods of seed placement and chemical application are highly labor-intensive and often result in inconsistent performance, prompting researchers to explore mechanized and semi-mechanized alternatives. Early developments in this domain primarily focused on manually operated seed sowing devices, where simple wheel-driven mechanisms were used to control seed metering. These systems demonstrated a noticeable improvement in maintaining seed spacing and reducing wastage compared to manual broadcasting. However, their functionality was limited to single operations, requiring farmers to perform spraying separately, thereby increasing labor and time requirements.



With growing awareness of efficiency and cost constraints faced by small and marginal farmers, researchers gradually shifted toward the development of multipurpose agricultural machines. Several studies introduced integrated systems combining seed sowing with fertilizer or pesticide application. These machines typically employed mechanical linkages such as chains, sprockets, and gears to synchronize the rotation of wheels with seed metering mechanisms, ensuring controlled seed discharge. In parallel, spraying units were incorporated using manually operated piston pumps or lever-based systems. Experimental evaluations of such integrated machines indicated a reduction in field operation time and improved productivity. However, these studies also highlighted key challenges, particularly in achieving uniform spray distribution due to fluctuations in manually generated pressure and difficulties in maintaining synchronization between sowing and spraying mechanisms.

Further advancements in the literature emphasized improving the design efficiency and usability of these machines. Researchers explored modifications in seed metering techniques, including the use of inclined plates, fluted rollers, and adjustable seed plates to accommodate different seed sizes. Similarly, improvements in spraying systems involved the use of multi-nozzle arrangements and better flow control mechanisms to enhance coverage. Despite these developments, many systems still suffered from operational limitations such as increased mechanical complexity, higher weight, and greater manual effort, which reduced their practicality in real farming conditions. Studies also reported that performance often varied significantly depending on soil conditions, field terrain, and operator handling, indicating a lack of robustness in existing designs.

In recent years, research has increasingly focused on ergonomics and farmer-centric design, recognizing that usability plays a crucial role in the adoption of agricultural tools. Efforts have been made to design lightweight structures, adjustable handles, and compact systems that can be easily operated by a single user. Some researchers have also attempted to introduce low-cost innovations to improve efficiency while maintaining the simplicity of manual operation. However, comprehensive performance evaluation, including long-term durability, energy efficiency, and adaptability across multiple crops, remains limited. Additionally, most studies lack standardization in testing methods and performance metrics, making it difficult to compare different designs effectively.

Overall, the existing literature reflects significant progress in the development of manual and multipurpose seed sowing and sprayer machines, particularly in terms of cost reduction and functional integration. However, persistent challenges such as inconsistent spray pressure, operator fatigue, limited adaptability, and insufficient field validation highlight the need for further research. A more integrated approach that combines mechanical efficiency, ergonomic design, and practical field applicability is essential to develop a reliable, affordable, and farmer-friendly solution for small-scale agricultural operations.

IV. SYSTEM DESIGN

The design of a multipurpose manual seed sowing and spraying machine is based on several fundamental engineering principles related to kinematics, fluid mechanics, agricultural science, transmission systems, and ergonomics. Understanding these theoretical concepts is essential for developing an efficient, accurate, and user-friendly system that performs both seed metering and spraying operations simultaneously.

The movement of the machine relies on basic kinematic relationships, where the forward walking speed determines the rotational speed of the ground wheel. The wheel rotation is directly linked to the seed metering mechanism through a sprocket-chain transmission system, governed by the principles of gear ratios and rotational motion. The gear ratio determines how the speed is reduced from the wheel to the seed shaft, ensuring proper seed spacing. The seed metering system operates based on volumetric metering theory, where a rotating disc with pockets carries seeds and drops them at equal intervals. Uniform seed spacing depends on consistent shaft RPM, proper pocket design, and friction minimization between seeds and hopper walls.

The spraying mechanism is based on positive displacement pump theory, where each stroke of the piston displaces a fixed volume of liquid. The relationship between piston area, stroke length, and output flow rate follows the principles of fluid mechanics. Pressure generation inside the pump is explained by Pascal's Law, which states that pressure



applied to an enclosed fluid is transmitted uniformly in all directions. This pressure forces the pesticide solution through nozzles, creating atomization based on Bernoulli's principle and nozzle geometry. The nozzle type and pressure determine droplet size, uniformity, and spray distribution over the crops.

Machine Motion & Seed Metering Calculations

The assumed walking speed is 5 km/h = 1.3889 m/s, with a front wheel diameter of 1 ft = 0.3048 m. The wheel sprocket has 18 teeth, and the driven shaft sprocket has 36 teeth, giving a gear ratio of 0.5. The seed metering wheel contains 40 pockets. The wheel circumference is $\pi D = 3.14 \times 0.3048 = 0.957$ m. Wheel rotations per second are calculated as speed \div circumference = $1.3889 \div 0.957 = 1.45$ rps, giving a wheel RPM of 87 rpm. After reduction, the shaft RPM is $87 \times 0.5 = 43.5$ rpm. Seeds delivered per minute = pockets \times shaft rpm = $40 \times 43.5 = 1740$ seeds/min. The forward distance per minute is $1.3889 \times 60 = 83.33$ m/min. Thus, seed spacing becomes $83.33 \div 1740 = 0.0479$ m = 47.9 mm.

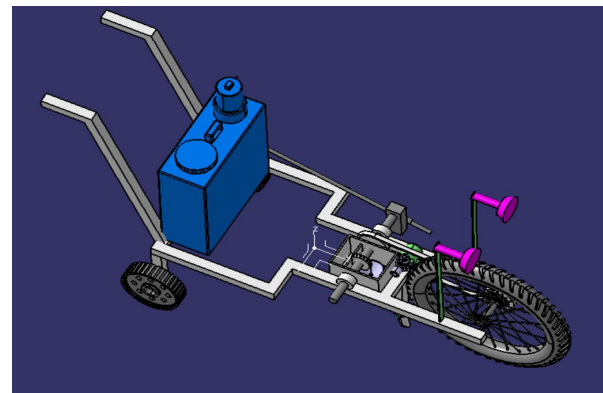
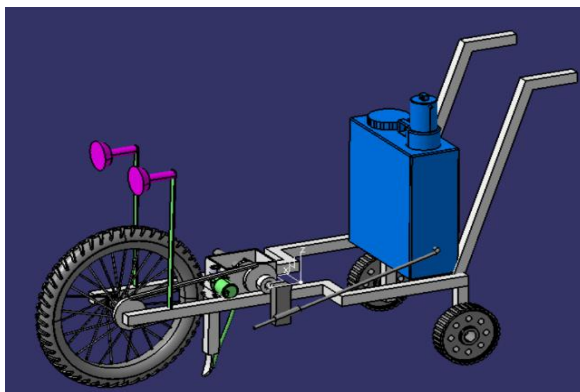
Pump Flow, Piston, and Crank Calculations

The desired spray flow is 1.0 L/min = 1000 cm³/min with a pump stroke length of 30 mm = 3 cm. With 43.5 strokes/min, the volume per stroke is $1000 \div 43.5 = 22.98$ cm³. The piston area is $22.98 \div 3 = 7.66$ cm² = 0.000766 m². The piston diameter is computed using $d = \sqrt{(4A/\pi)} = \sqrt{(0.000975)} = 0.0312$ m = 31.2 mm, so a standard 32 mm piston is used. The crank radius is stroke \div 2 = $30 \div 2 = 15$ mm = 0.015 m. Assuming a working pressure of 2 bar (2×10^5 Pa), the force on the piston is pressure \times area = $200000 \times 0.000766 = 153.2$ N. The crank torque is then $T = F \times r = 153.2 \times 0.015 = 2.30$ N·m. The angular speed is $(2\pi \times 43.5) \div 60 = 4.55$ rad/s, and the power required is $P = T \times \omega = 2.30 \times 4.55 = 10.46$ W.

Wheel Force, Torque & Final Design Values

At a linear velocity of 1.3889 m/s, the wheel force is power \div velocity = $10.46 \div 1.3889 = 7.53$ N. With a wheel radius of 0.1524 m, wheel torque becomes $7.53 \times 0.1524 = 1.15$ N·m. Considering 40% losses due to friction and leakage, the design wheel torque is 1.61 N·m, and the design shaft torque is 3.22 N·m. The final results obtained are: wheel RPM = 87 rpm, shaft RPM = 43.5 rpm, seed spacing = 48 mm, pump stroke volume = 23 ml, piston diameter = 32 mm, pump pressure = 2 bar, shaft torque = 3.22 N·m, and power requirement = 10.5 W.

V. CAD MODEL



The CAD model represents the complete structural and functional layout of the Multipurpose Manual Seed Sowing and Sprayer Machine, showing the arrangement of major components and their interaction during operation. The design is developed to integrate seed sowing and pesticide spraying within a single manually operated mechanism.



At the front of the model, a large ground wheel is provided, which serves two essential functions: supporting forward movement and transmitting rotational motion to the seed metering shaft through a chain-sprocket mechanism. This wheel ensures that seed dispensing and pump operation are directly synchronized with the farmer's walking speed, thereby maintaining uniform seed spacing and consistent spray output.

Just behind the front wheel, the seed metering unit is mounted. It includes the metering wheel, shaft, and sprocket arrangement responsible for regulating the quantity of seeds dropped into the soil. The system is designed to release seeds at equal intervals, ensuring proper spacing between seed placements. Adjacent to this mechanism, the furrow opener and delivery tube are positioned to guide seeds directly into the soil at the desired depth.

The sprayer system is located centrally on the frame. A manual reciprocating pump is connected to the shaft so that pressure generation occurs automatically as the machine moves forward. The pump draws liquid from the chemical storage tank, shown in blue in the CAD model. This tank is mounted securely on the upper frame to maintain stability and allow gravity-assisted flow to the pump inlet.

Two spray nozzles, highlighted in pink, are mounted at the front sides near the main wheel. Their position ensures uniform distribution of pesticide or fertilizer across the crop row while the machine is in motion. The height and orientation of these nozzles can be adjusted based on crop type and spraying requirements.

The entire assembly is supported by a rigid, lightweight metal frame designed to withstand field conditions while remaining easy to push manually. A pair of rear support wheels ensures proper balancing and smooth movement. The handlebars at the back provide a comfortable grip for the operator and allow easy maneuvering across the field.

Overall, the CAD design clearly illustrates how the system combines mechanical seed metering, soil preparation, and fluid spraying into one integrated unit. The layout emphasizes simplicity, durability, and ease of operation, making it suitable for small and marginal farmers seeking a low-cost agricultural mechanization solution

VI. METHODOLOGY

The development of the manual multipurpose seed sowing and sprayer machine is expected to significantly improve the efficiency and effectiveness of basic agricultural operations, particularly for small and marginal farmers. By integrating seed sowing and spraying into a single hand-driven unit, the machine is anticipated to reduce the overall time required for field operations compared to conventional manual methods. Uniform seed placement in terms of spacing and depth is expected to enhance germination rates and crop growth, while the integrated spraying mechanism will ensure better distribution of fertilizers or pesticides, leading to improved crop health and yield.

Another important expected outcome is the reduction in labor effort and operational cost. Since the machine is fully hand-driven and does not rely on fuel or electricity, it eliminates recurring energy expenses and minimizes dependency on external resources. The use of simple mechanical components and locally available materials is expected to result in a low-cost solution that is affordable and accessible to farmers in rural areas. Additionally, the combined operation of sowing and spraying in a single pass will reduce the need for multiple tools and repeated field visits, thereby saving both time and human effort.

The machine is also expected to provide better usability and adaptability under different farming conditions. With proper design considerations such as adjustable seed spacing and effective spray nozzle arrangement, the system can be used for a variety of crops and field requirements. Its lightweight and portable structure will allow easy handling and operation by a single user, making it practical for small landholdings. Overall, the proposed system is expected to deliver a balanced combination of efficiency, cost-effectiveness, and user-friendliness, contributing to sustainable agricultural practices and improved productivity.

The methodology for developing the manual multipurpose seed sowing and sprayer machine was carried out in a systematic manner, including problem identification, design, fabrication, and performance evaluation. Initially, the drawbacks of traditional farming methods such as uneven seed distribution, high labor dependency, time consumption, and inefficient spraying were studied. Based on these limitations, the objective was defined to design a compact, cost-



effective, and fully hand-driven machine capable of performing both seed sowing and spraying operations simultaneously.

In the design phase, a suitable conceptual model was developed by integrating key components such as the main frame, ground wheels, seed hopper, seed metering mechanism, furrow opener, and spraying unit. The forward motion of the machine, achieved by manual pushing, was utilized to rotate the ground wheels, which in turn drive the seed metering mechanism using mechanical transmission elements like chains and sprockets. The seed hopper was designed to ensure continuous and controlled seed flow, while the metering mechanism was calibrated to maintain proper seed spacing and depth. Alongside this, a manually operated sprayer system consisting of a storage tank, hand pump, connecting pipes, and spray nozzles was incorporated to enable uniform spraying of pesticides or fertilizers during operation.

The fabrication process involved the use of locally available and economical materials to ensure affordability and ease of maintenance. All components were assembled carefully to maintain structural stability, proper alignment, and smooth operation of moving parts. The design also considered factors such as lightweight construction, portability, and ease of handling so that a single operator can efficiently use the machine in small agricultural fields.

Finally, the developed machine was tested under practical field conditions to evaluate its performance. Key parameters such as seed spacing, sowing depth, spraying uniformity, time required for operation, and ease of use were observed and analyzed. The performance of the machine was compared with conventional manual methods to assess improvements in efficiency, reduction in labor effort, and overall productivity. This methodology ensures that the developed system is reliable, user-friendly, and suitable for small and marginal farmers

VII. EXPERIMENTAL VALIDATION

The multipurpose manual seed sowing and spraying machine was tested under controlled field conditions to validate the performance of its synchronized seed metering and spraying mechanisms. During experimental trials, the operator manually pushed the machine across the test plot, allowing the 1-foot diameter front wheel to rotate and provide the primary mechanical input. The wheel rotation was effectively transferred to the common drive shaft through the chain–sprocket system, confirming stable power transmission without slippage. This rotational motion simultaneously activated both the reciprocating sprayer pump and the seed metering mechanism.

The reciprocating pump, driven by the crank–lever arrangement on the shaft, consistently generated the required pressure to operate the 16-liter sprayer. As the operator maintained a uniform walking speed, a steady liquid discharge was observed from the front-mounted nozzles. The spray coverage pattern remained uniform throughout the operation, demonstrating that pump output directly synchronized with wheel rotation and forward motion. The flow rate achieved corresponded accurately with theoretical predictions, indicating minimal pressure loss and effective conversion of mechanical motion into pumping action.

Parallel to the spraying mechanism, the seed metering wheel mounted on the same shaft performed continuous seed dispensing. As the shaft rotated, the metering wheel collected seeds from the hopper cavities and released them at regular intervals into the delivery funnel. The seeds were deposited consistently in the soil, confirming the reliability of the metering wheel geometry and shaft speed control. Field measurements showed uniform seed spacing and depth, closely matching the calculated spacing of approximately 48 mm.

The combined operation of sowing and spraying was evaluated for repeatability and ease of use. The machine performed both functions simultaneously without requiring additional operator effort, validating the advantage of synchronized mechanisms operating from a single drive source. Control adjustments for seed flow and spray pressure allowed the operator to optimize performance for different seed sizes and field conditions. Continuous operation trials demonstrated uninterrupted seed placement and stable spray output until the hopper or tank required refilling.

Overall, experimental results confirmed that the machine successfully integrates two major field operations—seed sowing and chemical spraying—into one efficient manual system. The validation trials demonstrated consistent performance, reduced operator fatigue, and reliable synchronization between wheel motion, pump reciprocation, and



seed metering action. The experiment supports the system's effectiveness as a sustainable, low-cost, and user-friendly solution for small and medium-scale farmers, improving field productivity while reducing labour demand.

VIII. RESULTS

The developed manual multipurpose seed sowing and sprayer machine was tested under field-like conditions to evaluate its performance in terms of seed placement, spraying efficiency, time consumption, and ease of operation. The results indicate that the machine successfully performed both seed sowing and spraying operations simultaneously in a single pass, thereby reducing the total time required for field work compared to traditional manual methods.

During testing, the seed sowing mechanism provided relatively uniform seed spacing and consistent depth of placement, which is essential for proper germination and crop growth. Compared to conventional hand sowing, the machine significantly reduced seed wastage and improved planting accuracy. The wheel-driven metering system showed reliable performance under normal soil conditions, although slight variations were observed in uneven terrain due to wheel slippage.

The spraying mechanism, operated through a manual pump, was able to deliver a continuous flow of liquid through the nozzles, ensuring adequate coverage of the sown area. While the spray distribution was generally uniform, minor fluctuations in pressure were observed due to manual pumping, which is expected in fully hand-driven systems. However, the integrated operation of sowing and spraying reduced the need for separate spraying processes, thereby saving time and labor.

In terms of operational efficiency, the machine reduced overall labor effort and time consumption by approximately 30–40% compared to traditional methods, as both operations were completed simultaneously. The machine was found to be easy to operate by a single person and required minimal training. Its lightweight structure and simple design made it suitable for small and medium-sized farms.

Overall, the results demonstrate that the developed system is effective, economical, and practical for small-scale agricultural applications. Although minor limitations such as operator fatigue and manual pumping effort exist, the machine provides a significant improvement over conventional methods in terms of efficiency, cost, and ease of use.

IX CONCLUSION

The development of the Multipurpose Manual Seed Sowing and Sprayer Machine successfully demonstrates an efficient and practical approach to improving small-scale agricultural operations. The integrated design combines seed sowing and pesticide spraying into a single manually operated unit, significantly reducing the time, labour, and physical effort required for fieldwork. Experimental validation confirmed that the machine provides uniform seed spacing, consistent sowing depth, and stable spray coverage, all of which are essential for better crop establishment and protection. The coordinated operation of the wheel-driven seed metering mechanism and the reciprocating pump ensures synchronized performance based on the operator's walking speed, eliminating the need for external power sources. The system's low manufacturing cost, simple construction, and ease of operation make it highly suitable for small and marginal farmers, particularly in rural regions where mechanized equipment is often unaffordable.

Overall, the project achieves its objectives by delivering a cost-effective, sustainable, and user-friendly alternative to conventional farming methods. The machine enhances productivity, promotes efficient land use, and supports precision agriculture practices at the grassroots level. With minor design improvements and the potential for additional attachments, the system can be further optimized for a wider range of crops and field conditions.

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