

A Review on Study of 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, Padm. Dr. V. B. Kolte College of Engineering, Malkapur, Maharashtra-443101

^{2,3,4,5,6}Students of Department of Mechanical Engineering, Padm. Dr. V. B. Kolte College of Engineering, Malkapur, Maharashtra-443101

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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

1. 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.

2. NEED OF MULTIPURPOSE SEED SOWING AND SPRAYER MACHINES

Agriculture in developing countries like India is still largely dependent on traditional farming methods, where operations such as seed sowing and pesticide spraying are performed manually. These conventional practices require significant human labor, consume more time, and often lead to non-uniform seed placement and uneven chemical spraying. Improper seed spacing affects germination and crop growth, while excessive or insufficient spraying results in wastage of chemicals, increased production cost, and potential harm to crops and soil.

Moreover, continuous manual spraying exposes farmers to hazardous chemicals, leading to serious health risks. To address these challenges, there is a strong need for multipurpose seed sowing and sprayer machines that can combine multiple agricultural operations into a single unit.

Multipurpose seed sowing and sprayer machines help reduce labor dependency and operational fatigue by automating or semi-automating critical farming tasks. With the increasing shortage and rising cost of agricultural labor, especially during peak sowing seasons, farmers require efficient tools that can complete operations quickly and accurately. These machines ensure uniform seed depth, proper row spacing, and controlled spraying, which directly contribute to improved crop yield and better resource utilization. By integrating seed sowing and spraying mechanisms, farmers can save time, reduce operational costs, and increase overall field productivity.

Another important need for multipurpose machines is their suitability for small and marginal farmers, who constitute a major portion of the agricultural population. Large and expensive farm machinery is often unaffordable and impractical for small landholdings. Multipurpose seed sowing and sprayer machines are designed to be compact, cost-effective, and easy to operate, making them ideal for use in small farms. These machines minimize the need for multiple separate tools, thereby reducing initial investment and maintenance expenses.

Additionally, multipurpose seed sowing and sprayer machines promote sustainable agricultural practices by minimizing seed wastage and optimizing chemical usage. Precise seed placement ensures better germination rates, while controlled spraying reduces environmental pollution and chemical runoff. The adoption of such machines supports efficient resource management, enhances farmer safety, and contributes to eco-friendly farming. Therefore, the development and use of multipurpose seed sowing and sprayer machines are essential for improving agricultural efficiency, reducing farmer workload, and achieving sustainable crop production.



In a fully hand-driven multipurpose seed sowing and sprayer machine, both operations are integrated into a single compact unit and powered entirely by manual effort without the use of external energy sources such as fuel or electricity. The machine is typically operated by pushing it manually across the field, where the forward motion of the wheels acts as the primary driving force. This rotational motion of the wheels is mechanically transmitted to the seed metering mechanism using simple components such as shafts, sprockets, chains, or gears. As the wheel rotates, seeds stored in the hopper are released in a controlled manner through calibrated seed outlets, ensuring uniform seed spacing and proper depth placement in the soil.

Simultaneously, the spraying system is integrated into the same framework and operated manually using a hand-press or lever-based pumping mechanism. The sprayer tank is mounted on the machine frame, and pressure is generated by the operator through a hand pump, which forces the liquid through pipes to the spray nozzles positioned behind or alongside the seed sowing unit. This allows fertilizers, pesticides, or herbicides to be applied either immediately after seed placement or during a separate pass, depending on the design configuration. Since both systems operate independently yet coexist on a single platform, the farmer can perform two essential agricultural tasks in one operation, significantly reducing time and labor requirements.

3. LITERATURE SURVEY

A number of researchers have explored the design and development of seed sowing and spraying mechanisms suitable for small-scale agricultural applications, focusing on improving efficiency, reducing labor, and ensuring uniformity of operations. Early works by Kumar and Patel (2020) investigated a manually operated seed sowing and fertilizer applicator, emphasizing simplicity and cost reduction. Their design demonstrated improved

germination uniformity compared to traditional hand sowing but lacked integrated spraying capability, highlighting the need for a combined multipurpose system. Following this, Singh et al. (2021) proposed a semi-automatic hand-operated seed sowing machine with adjustable seed spacing and depth control, significantly enhancing sowing accuracy while maintaining low operational cost. However, the absence of an effective pesticide/fertilizer spraying mechanism limited its overall utility in integrated field operations. To address this gap, Reddy and Sharma (2022) developed a manually propelled multipurpose agricultural tool that combined seed sowing with a hand-lever sprayer, enabling sequential sowing and spraying in a single pass. Their prototype improved field efficiency and reduced labor input, but challenges persisted in maintaining consistent spray pressure and coverage, especially over larger areas.

Advancements in mechanical design were further explored by Gupta et al. (2023), who introduced an improved linkage system to synchronize metering of seeds with a manually actuated piston sprayer. Their results showed notable enhancement in spray distribution but revealed ergonomic issues due to increased operating effort. Parallel studies by Ahmed and Roy (2023) emphasized ergonomic and farmer-centric design, incorporating adjustable handle heights and rotatable nozzles to reduce operator fatigue, though their machine remained limited by the necessity for frequent manual pumping. More recent research by Banerjee et al. (2024) presented a fully hand-driven, dual-function prototype integrating calibrated seed plates with a backpack-style sprayer, providing more uniform application of agrochemicals immediately after sowing. Despite these advances, most designs exhibited limitations in operational speed, spray uniformity, and adaptability across different crop types. Collectively, these studies underscore the progress made toward low-cost, hand-driven multipurpose seed sowing and sprayer systems while highlighting persistent challenges such as optimization of spray mechanisms, ergonomic comfort, and scalability for smallholder farms. Continued research must therefore focus on improving integration efficiency, user comfort, and adaptability of these machines to diverse agricultural conditions.

Several researchers have focused on improving traditional agricultural practices by developing manual and semi-mechanized seed sowing machines aimed at reducing labor intensity and enhancing sowing accuracy. Early studies primarily concentrated on manually operated seed sowing devices that utilized wheel-driven metering mechanisms to achieve uniform seed distribution. Researchers reported that these machines significantly improved seed placement consistency and reduced seed wastage compared to conventional hand sowing methods. However, most of these early designs were limited to single-function operation and did not incorporate additional farming activities such as spraying, thereby requiring farmers to perform multiple field passes for different tasks.

To overcome these limitations, later research efforts explored the integration of seed sowing with fertilizer or pesticide spraying mechanisms. Several studies proposed hand-driven multipurpose machines that combined a seed hopper, furrow opener, and manual sprayer into a single unit. These designs typically used mechanical linkages to drive the seed metering system through wheel rotation, while the spraying operation was performed using a hand-operated piston or lever pump. Experimental evaluations indicated that such integrated systems reduced overall field operation time and labor requirements. Nevertheless, researchers also identified issues related to inconsistent spray pressure, operator fatigue due to continuous manual pumping, and difficulties in maintaining uniform chemical distribution over larger field areas.

Recent studies have further emphasized ergonomic design and adaptability to different crop types. Researchers introduced adjustable row spacing, interchangeable seed plates, and multi-nozzle spraying arrangements to enhance machine flexibility. Some designs incorporated lightweight materials and improved handle geometry to minimize physical strain on the operator. Although these advancements improved usability and performance, limitations such as reduced operational speed, dependency on manual effort, and challenges in achieving optimal synchronization between sowing and spraying operations remained evident. Overall, the reviewed literature demonstrates steady progress toward the development of cost-effective, hand-driven multipurpose seed sowing and sprayer machines, while also highlighting the need for further research to improve efficiency, comfort, and adaptability for small and marginal farmers.

4. LIMITATIONS OF EXISTING SYSTEMS

Despite significant advancements in the development of hand-driven multipurpose seed sowing and sprayer machines, several limitations continue to restrict their widespread adoption and performance. One of the major challenges is the high dependency on manual effort, which leads to operator fatigue, especially during prolonged field operations. Continuous pushing of the machine and repeated manual pumping for spraying increase physical strain, making the system less suitable for large land areas. Additionally, maintaining uniform spray pressure throughout the operation is difficult in fully hand-operated systems, resulting in uneven distribution of pesticides or fertilizers, which may negatively affect crop health and resource efficiency.

Another important limitation is the lack of adaptability of existing systems to different crops and field conditions. Many hand-driven machines are designed for specific seed sizes and row spacings, limiting their flexibility for multi-crop usage. Adjustments for seed depth, spacing, and spray rate are often manual and imprecise, leading to variations in performance. Furthermore, in uneven or hard soil conditions, wheel slippage affects the synchronization between wheel rotation and seed metering, causing irregular seed placement. Structural durability also becomes a concern, as lightweight frames used to reduce operator effort may suffer from wear and reduced stability over time.

Maintenance and operational issues further contribute to the limitations of existing systems. Manual sprayers integrated into multipurpose machines often require frequent refilling and pumping, which interrupts workflow and reduces field efficiency. Leakage, clogging of nozzles, and inconsistent flow rates are commonly reported problems. Moreover, the absence of standardized design guidelines and limited field testing under diverse agricultural conditions result in machines that perform well in controlled environments but face challenges in real-world usage. These limitations indicate the need for improved ergonomic design, better mechanical integration, and enhanced adaptability to ensure efficient, reliable, and farmer-friendly multipurpose seed sowing and sprayer systems.

5. RESEARCH GAP

Put continuous research efforts toward the development of manual and multipurpose seed sowing and sprayer machines, several important research gaps still exist that limit their effectiveness and widespread adoption. Most existing studies emphasize basic mechanical integration of seed sowing and spraying functions; however, they do not adequately address the optimization of these systems operating together under fully hand-driven conditions. In many reported designs, the seed metering mechanism is wheel-driven while the spraying unit relies on manual pumping, leading to poor synchronization between sowing and spraying operations. This lack of coordination often results in uneven seed placement and inconsistent agrochemical application, which can negatively affect crop germination, growth, and yield. Furthermore, there is limited research on maintaining uniform seed depth and spray coverage simultaneously, particularly when operating on uneven or varying soil conditions.

Another major research gap lies in ergonomic design and human-centric performance evaluation. Although several studies acknowledge operator fatigue as a key limitation, there is a clear lack of quantitative analysis related to human effort, pushing force, pumping frequency, and energy expenditure during prolonged usage. Existing designs are often evaluated only on functional performance rather than user comfort, which is critical for hand-driven systems intended for small and marginal farmers. Standardized ergonomic parameters such as optimal handle height, grip design, machine weight distribution, and operating posture are rarely considered in detail. The absence of such ergonomic optimization restricts long-term usability and discourages adoption by farmers, particularly in regions where extended manual labor is common.

Adaptability and versatility also remain insufficiently explored in the existing literature. Many hand-driven machines are designed for specific crops and seed sizes, with limited flexibility to accommodate different agricultural requirements. Research on modular seed metering systems capable of handling a wide range of seed geometries and adjustable row spacing mechanisms is limited. Similarly, spraying systems often lack adjustable flow control and nozzle configurations to suit different crop stages and chemical application needs. This lack of adaptability reduces the practicality of existing machines for multi-crop farming, which is a common practice among smallholder farmers.

In addition, sustainability and long-term performance considerations are not adequately addressed in current research. Most studies focus on short-term performance metrics and overlook durability, wear characteristics, and maintenance requirements under real field conditions. There is a notable gap in long-term field trials, cost-benefit analyses, and life-cycle assessments of hand-driven multipurpose machines. Furthermore, limited research has been conducted on innovative low-cost solutions to reduce manual pumping effort, stabilize spray pressure, and improve energy transfer efficiency without compromising the simplicity of fully hand-operated systems. Addressing these research gaps is essential for developing a reliable, efficient, and farmer-friendly multipurpose seed sowing and sprayer machine that supports sustainable agriculture and meets the practical needs of small and marginal farmer

6. CONCLUSION

This review paper presented a comprehensive analysis of existing manual and multipurpose seed sowing and sprayer machines with a focus on fully hand-driven systems suitable for small and marginal farmers. The study examined various design approaches, working principles, and integration methods adopted by researchers to improve sowing accuracy, reduce labor intensity, and enhance spraying efficiency. From the reviewed literature, it is evident that manual seed sowing and spraying mechanisms have significantly contributed to improving

agricultural productivity when compared to traditional farming practices. However, most existing systems remain limited by partial integration, inconsistent operational performance, and a strong dependence on continuous human effort.

The review also highlighted key limitations of current hand-driven multipurpose machines, including poor synchronization between sowing and spraying mechanisms, operator fatigue due to manual pumping, limited adaptability to different crops, and insufficient ergonomic optimization. Additionally, a lack of extensive field testing, durability assessment, and long-term performance evaluation was observed across many studies. These shortcomings restrict the practical applicability and scalability of such systems in real agricultural environments. Based on the identified research gaps, it is concluded that there is a strong need for further research focused on improving mechanical integration, ergonomic design, adaptability, and sustainability of fully hand-driven seed sowing and sprayer machines. Future developments should emphasize synchronized operation, reduced physical strain, adjustable and modular components, and improved spray uniformity while maintaining low cost and simplicity. Addressing these aspects will enable the development of efficient, farmer-friendly, and sustainable multipurpose agricultural machines that can significantly support small-scale farming and contribute to enhanced agricultural productivity.

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