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Battery powered self-propelled sowing machines: A review

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Abstract
Designing and fabrication of battery operated sowing machines is vital for Indian agriculture due to its potential to revolutionize traditional farming practices. These machines enhance efficiency by automating the seed planting process, saving farmers valuable time and labor. Precision in seed placement ensures optimal seed-to-seed spacing and depth, leading to improved crop establishment and higher yields. Additionally, sowing machines offer cost-effectiveness by reducing labor costs and seed wastage. They contribute to increased productivity by enabling farmers to cover larger areas in less time, thereby maximizing land utilization. Moreover, their adaptability to various crops and planting conditions makes them invaluable tools for Indian farmers operating in diverse agro-climatic regions. Overall, the design and fabrication of sowing machines represent a significant step towards modernizing Indian agriculture and ensuring sustainable food production for the growing population.

Keywords: Seed, sowing, design, efficiency

Introduction
The agriculture sector plays a pivotal role in bolstering the Indian economy, a role it will likely maintain indefinitely. Presently, many nations grapple with a shortage of skilled agricultural workers, hindering the progress of developing countries. Consequently, farmers must adopt advanced technologies for tasks like cultivation, including digging, seeding, fertilizing, and spraying. Given the challenges facing the agricultural industry today, there's a pressing need to automate processes to address these issues effectively (Pawar and Ugale, 2020) [8].

It seems like you're discussing the importance of efficient seed sowing operations in agriculture and the potential benefits of mechanization, particularly with regards to saving time, labor and energy costs. Additionally, you've touched upon the significance of optimizing energy production through solar technology.

Indeed, agriculture remains the backbone of the Indian economy, and enhancing efficiency in agricultural practices can significantly contribute to economic growth and food security. Mechanized battery operated self propelled seed sowing can play a crucial role in achieving these objectives by improving precision, reducing manual labor, and increasing productivity.

Developing multifunctional seed sowing machines that can perform simultaneous operations represents a promising direction for agricultural mechanization. By addressing the specific needs and challenges of Indian agriculture, such innovations can help overcome barriers to mechanization and drive progress towards a more efficient and sustainable agricultural sector (Chavda *et al.*, 2022) [3].

Battery Powered Self-propelled Sowing Machines
Swetha and Shreeharsha [14], developed a solar operated automatic seed sowing machine. Details the adaptation of a solar panel to charge a battery, powering a motor that operates the machine. The installed solar panel converts sunlight into electricity, stored within a 12-volt battery. This battery energy propels a motor, driving the rear wheels via chain mechanisms. A combination of bevel gears and chain drives harnesses the motor's power to facilitate device movement. Solar operated automatic seed sowing machine is to fulfill the tasks like digging, seed sowing, water pouring and fertilizing by using non-conventional energy

sources. Thus solar operated automatic seed sowing machine will help the farmers of those remote areas of country where fuel is not available easily.

Singhal *et al.* [12], demonstrates a single-cycle process of seed sowing and digging, powered by solar energy harnessed via a solar panel. Solar energy converts to electricity stored in a 12-volt battery, driving a shunt wound DC motor via chain mechanisms for rear wheel movement. An AT89S52 microcontroller regulates seed sowing frequency. Adjustment of the hopper opening controls seed dispersal, aided by an IR sensor detecting obstacles for smooth machine trajectory.

Dattatray, *et al.* [4], solar panels harvest solar energy, converted into electrical power stored in a 24V, 7.5 Amp hour batteries. This energy drives a DC motor, which, via a belt and pulley setup, powers a cutter, creating furrows in the soil for unsown seeds through shear deformation. Ground friction rotates the seed hopper, releasing seeds onto the ground. An adjuster realigns soil over seeds, followed by irrigation from a water tank-tap system. Manpower rotates the machine's tires for forward movement. Fabrication includes cutting, welding and assembly processes for various components such as the cutter, motor, and seed sower. This multipurpose machine is utilized for seed sowing, water sprinkling, and grass cutting, assisting farmers in reducing the expenses associated with hiring unskilled labor for farming. It also enhances production rates and minimizes the time required for tasks such as seed sowing, compost spraying, and grass cutting."

Deoghare [5], introduces a solar-operated multigrain seed-sowing machine designed to assist farmers in sowing operations using solar energy with minimal effort. This versatile equipment, driven by both bullocks and solar power, serves multiple functions including equidistant seed sowing, fertilizing and plowing. Solar power captured by PV panels is stored in a battery and utilized to drive the front wheel via a motor. A chain and sprocket mechanism connects the front and rear wheels, ensuring both are driven. Seeds are dispensed from the hopper through a seed metering mechanism into a hose and onto the ground. The teeth of the machine plow the soil in a specific pattern. Furthermore, a manual seed adjustment mechanism is provided for accommodating different seed types.

Prasanth *et al*. [9], design the seed sowing machine described utilizes a 4-inch ploughing rod to create 6 cm deep holes, powered by a 12V, 1.3A DC battery charged via solar panels. Its 1000 rpm, 7 kg-cm torque motor facilitates operations, ensuring efficient seed dropping from a hopper via a cross-cut piston mechanism. This multifunctional device aims to optimize seed placement in rows, accommodating varying crop needs. Such precision aids in achieving optimal yields while reducing manual labor and enhancing efficiency. With an increasing focus on sustainable agriculture, this integration of solar-powered mechanization not only boosts productivity but also aligns with environmental goals.

Chavda *et al.* [3], the multi-crop planter comprises several components including a main frame, handle, furrow opener, seed tube, marker, metering machine, DC battery (12V), DC motor, DC speed regulator, switch, and DC charger. Its payback period was calculated at 53.42 hours on an hourly basis and 6 hectares on a per hectare basis. This indicates the time it takes for the initial investment in the planter to be recouped through savings in labor or other costs. Moreover, the benefit-cost ratio of the planter was determined to be 14.97 over a 10-year lifespan. This metric suggests that for every unit of cost invested in the planter; approximately 14.97 units of benefit are expected to be gained over its operational lifetime. Such metrics highlight the economic viability and potential returns associated with the adoption of this technology in agricultural operations.

Shinde and Awati [13], designed the seed sowing machine incorporates features such as seed storage tanks with level detection alarms to alert when seeds are low. It also includes obstacle detection capabilities to ensure smooth operation and prevent wastage. With each rotation of the rotating wheels, seeds are dispensed from the seed drum, facilitating seamless planting without seed loss. Additionally, the machine is equipped with an alarm system to indicate when the end of the field is reached. The battery-powered rotating wheels are specifically designed with fabricated rib parts to provide traction for easy maneuverability. Each wheel is powered by a 1100-watt DC motor with specifications of 12V and 7 amps, ensuring sufficient power for efficient operation. This comprehensive system simplifies seed sowing for farmers, enhancing productivity and reducing wastage.

Singh *et al.* [11], studied was to provide such a seeder that can reduce manual work done by farmers. An attempt was made to develop electric power (e-power) walk behind seeder at ICAR-IARI, New Delhi in year 2015. The major workload was shared by e-power. The unit consisted of a DC geared motor, batteries, power transmission unit, independent seeding units with vertical cell fed metering mechanism, swinging handle and frame. The seeder was tested for spinach, coriander and wheat seeds. From field studies, output with e-powered 350W seeder was 1130 m^2/h at a speed of about 2.9 km/h with field efficiency of 90.3% for tested seeds. The average draft requirement of machine was 106.1N. The developed equipment provided 2.5 times more output than manually operated seed drill with reduced drudgery by 2.6 times in terms of muscular force requirement.

Jin *et al.* [6], designed electric seeder tailored for small-size vegetable seeds integrate power drive and optical fiber detection technology for enhanced efficiency and precision. Powered by electricity, the seeder utilizes fiber sensor technology to monitor sowing conditions, ensuring high seeding precision across various seed sizes (2-10 mm). The driving motor, located in the rear crackle, enables precise seeding while reducing pollution and dyeing. Additionally, modular design of components allows for easy disassembly and replacement of the sowing wheel, facilitating quick adjustments in row spacing and sowing depth during operation. Field tests conducted on coriander, pakchoi, and radish demonstrated a sowing precision of 95%, with the monitoring system exhibiting a relative error of less than 6% at speeds of 3 km/h and 4 km/h. This system enables real-time monitoring of seed metering, thereby enhancing the quality of sowing work.

Adedeji *et al*. [1], developed the fabrication process of the seed sowing machine involved assembling various parts. The chassis was constructed using mild steel square pipes, while the hopper was made from 16-gauge steel sheets and 12 mm steel rods. A soil digger with specific dimensions and rake angle was incorporated into the design. Following assembly, the machine underwent testing and performance evaluation. The Arduino program and circuit design proved successful, with both controlled and mechanical components operating synchronously. During operation, the machine dispenses 3 to 4 seeds at 1-foot intervals within 5 seconds. With an operational efficiency of 76%, the machine demonstrates effective seed sowing capabilities.

Ylagan 2017 [15], study explores the feasibility of replacing a gasoline engine with a lead-acid battery-DC motor setup, augmented by STP010-12 is a 10 watt, 12 volt solar panel and will provide enough power to trickle charge a 12V deep cycle battery. Solar panels and a piezoelectric array for regenerative inputs. By analyzing power input and output, it was found that the addition of solar panels could extend battery life to approximately 8 minutes compared to using the battery alone, with an additional minute extension provided by the piezoelectric array. This setup offers potential benefits for small-scale rice farmers due to its compact structure and reduced reliance on gasoline.

Manjesh and Manjunatha [7], designed the machine integrates solar energy through a solar panel, converting it into electrical power to charge a 12V battery. This battery energizes a shunt wound DC motor, driving the rear wheel via chain drives. The project aims for efficient synergy between the electric and mechanical systems. Sowing operations prioritize precise seed placement, considering factors like spacing, rate, and depth, tailored to various crops and agro-climatic conditions. A typical crop range includes cereals, groundnuts, pulses, and oilseeds. The solar panel, functioning as a power source, enhances sustainability and reduces reliance on conventional energy. An AT89S52 microcontroller automates machine control, while IR sensors aid in obstacle detection and automated turning. Such integrated systems optimize efficiency and support sustainable agriculture.

Sawalakhe *et al.* [10], developed the seed sowing machine begins by drilling a hole using a 4-inch land drill bit with a shaft diameter of 7 mm and edge diameter of 25 mm, achieving a depth of cut of 76.2 mm. This drilling operation is powered by a motor with specifications of 300 rpm and 12 kg-cm torque, running on a 12V, 7A DC battery charged via a solar panel. Control over the motor is managed by an 8-bit microcontroller, allowing for start/stop functionality as well as control over the motor's direction of rotation. Seed dropping is facilitated by a hopper mounted behind the motor, with a lever mechanism on the handle triggering the automatic release of seeds into a pipe attached to the hopper, depositing them into the drilled hole. An adjustable iron plate at the rear of the machine collects soil to cover the drilled land. This process enables efficient and automated seed sowing, streamlining agricultural operations.

Babatunde [2], results reveal that, on average, the planter deposits 2 seeds per hole. The actual number of seeds dropped by the metering device was recorded and their spacing was measured practically using a tape measure. The average seed spacing was found to be 15.63 cm, close to the calibrated spacing of 15 cm on the metering device. However, slight deviations may be attributed to inaccuracies in cell location spacing on the metering device. To mitigate interference from reflected infrared light, a dark black rubber hose was utilized around the sensor light detection set, absorbing 97% of interfering light. The sensor device demonstrated an efficiency of 95%, considering overlapping of seeds and planter speed. Seed damage percentage was calculated at 18%, possibly due to uneven seed grade or abrasion between the metering device and its housing. Overall, the planter's sowing efficiency was determined to be 78%.

Advantages of Battery Powered Sowing Macine

The automatic seed-sowing machine offers numerous advantages for farmers throughout the farming process. Some of the benefits of this machine include:

1. Portability: Since they are battery-powered, they don't require a constant connection to a power source, providing greater flexibility in terms of where they can be used. This portability allows for sowing in remote areas or places where access to electricity is limited.

2. Ease of use: Self-propelled machines reduce the physical effort required by the operator, as they move autonomously across the field. This makes them easier to handle and reduces operator fatigue, leading to increased efficiency and productivity.

3. Environmentally friendly: Battery-powered machines produce zero emissions during operation, making them environmentally friendly compared to traditional fuel-powered alternatives. This is particularly important as there is growing concern about carbon emissions and air pollution.

4. Quiet operation: Battery-powered machines typically produce less noise compared to their fuel-powered counterparts. This can be beneficial for operators working in noise-sensitive areas or during times when noise restrictions are in place.

5. Cost savings: While the initial investment in a battery-powered sowing machine may be higher than a conventional one, they often result in cost savings over time. They eliminate the need for fuel, reducing operating costs, and require less maintenance since they have fewer moving parts.

6. Precision and consistency: Self-propelled sowing machines are often equipped with advanced technologies such as GPS and sensors, allowing for precise and consistent seeding patterns. This results in more uniform crop emergence and better overall crop yield.

7. Flexibility: Battery-powered machines can often be programmed or controlled remotely, allowing for greater flexibility in terms of scheduling and operation. Operators can adjust seeding rates and patterns on the fly, optimizing planting strategies based on field conditions and crop requirements.

8. Safety: With fewer mechanical parts and no fuel combustion, battery-powered machines generally pose fewer safety risks to operators and the environment. This can lead to a safer working environment and reduce the likelihood of accidents or injuries.

Limitations of the battery operated seed sowing machine

While battery-powered self-propelled sowing machines offer several advantages, they also have some limitations:

1. Limited battery life: Battery-powered machines rely on rechargeable batteries, which have a limited lifespan and require recharging. Depending on the capacity of the battery and the size of the field, the machine may need to be recharged multiple times during a single day of operation, leading to downtime.

2. Charging infrastructure: Adequate charging infrastructure is required to support battery-powered machines. This may involve investing in charging stations or ensuring that sufficient charging capacity is available in the field or at the farm. Without proper infrastructure, the efficiency of the machine may be compromised.

3. Initial cost: Battery-powered self-propelled sowing machines often have a higher upfront cost compared to conventional fuel-powered models. While they may offer long-term cost savings in terms of fuel and maintenance, the initial investment can be a barrier for some farmers, particularly those with limited financial resources.

4. Environmental impact of battery production: While battery-powered machines produce zero emissions during operation, there are environmental concerns associated with the production and disposal of batteries. This includes the extraction of raw materials, energy-intensive manufacturing processes, and proper disposal or recycling at the end of the battery's life cycle.

5. Weather dependence: Battery performance can be affected by environmental factors such as temperature and humidity. Extreme temperatures, especially cold conditions, can reduce battery efficiency and overall machine performance, requiring additional precautions or adaptations.

6. Technology integration challenges: Advanced technologies such as GPS and sensors require proper integration and calibration to ensure accurate and reliable operation. Maintenance and troubleshooting of these technologies may require specialized skills or training, which could be a challenge for some users.

Conclusion
The innovative seed sowing equipment holds significant promise for agriculture offering time and cost savings, particularly beneficial for small-scale farmers. Through battery-powered machines, precise control over row spacing, seed rate and depth is achieved, minimizing seed wastage. Additionally, its ability to perform multiple operations simultaneously reduces labor requirements, resulting in substantial savings in both time and cost. Overall, battery-powered self-propelled sowing machines offer numerous advantages in terms of efficiency, environmental impact and ease of use, making them an attractive option for modern agricultural operations. This makes the equipment accessible and affordable for farmers, contributing positively to their livelihoods.

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