Design and Development of Battery Powered Tiller- A Review

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Abstract

This review summarizes the evolution and widespread use of power tillers in agriculture, emphasizing their versatility and importance in modern farming. It explores the development of battery-powered tillers as environmentally friendly alternatives, discussing motivations, benefits, and challenges. Common problems with engine-powered tillers are outlined, along with suggestions for improvement and future research directions. The environmental concerns associated with traditional gasoline-powered tillers are highlighted, underscoring the need for sustainable alternatives like battery-powered tillers. Research objectives, including assessing environmental impact, operational efficiency, user experience, and economic viability, are outlined. The findings support the adoption of battery-powered tillers as sustainable alternatives, with recommendations for users, policymakers, manufacturers, and continued research.

Keywords: Battery-powered Tiller, Electric Vehicle Technology, Sustainable Agriculture, Engine-powered Tillers, Solar-powered Tillers, Soil Preparation

I. INTRODUCTION

Battery-powered tillers, also known as electric tillers, are equipped with rechargeable batteries, offering a lightweight and emission-free alternative to traditional gasoline tillers. Ideal for

smaller gardening tasks such as cultivating flower beds and preparing garden plots, they represent a modern and eco-friendly innovation.

In contrast, engine-powered tillers, fueled by gasoline or diesel, can be effective but face common issues. Starting problems may arise from a clogged carburetor, faulty ignition, or old fuel. Engine stalling can result from fuel delivery issues, a dirty air filter, or mechanical problems. Poor performance may stem from factors like worn tines or an improperly tuned engine. Overheating, fuel problems, oil leaks, vibrations, and noise are additional concerns.

Moreover, engine-powered tillers emit exhaust gases contributing to air pollution and require regular maintenance, including oil changes and air filter replacements. Their fuel inefficiency and environmental impact make battery-powered tillers a more attractive option for both casual gardeners and landscaping professionals.

The development of power tillers spans various innovations and solutions tailored for different agricultural needs, addressing challenges such as rising fuel costs, environmental concerns, and the need for sustainable practices.[7] Power tillers are essential tools in agriculture, offering versatility in tasks like soil preparation, weeding, and sowing. They come in various types, including walk-behind models for small-scale farming and tractor-mounted versions for larger fields. Advancements like specialized seed drill tillers and electric tillers with fertilizer dispensers highlight the continuous innovation in this field.[6] Innovations in power tillers extend to household gardening, particularly addressing ecological challenges. In regions like Kochi, Japan, utilizing local energy resources such as solar power becomes crucial. Research explores the use of solar panels and capacitors for electric charging, offering promising solutions for sustainable agriculture.[1] The adoption of eco-friendly solutions like solar-powered tillers becomes imperative, especially in countries like India, where agriculture plays a vital role in the economy. Solar tillers not only reduce pollution but also contribute to cost-effective farming practices, ultimately benefiting farmers.[2] To tackle financial challenges and environmental pollution, portable electric power tillers emerge as viable solutions in India. These rechargeable battery-powered machines offer superior capabilities in soil mixing and weed cutting while

prioritizing environmental responsibility and sustainability.[3] Electric power tillers powered by rechargeable batteries offer significant advantages over traditional internal combustion engine-operated tillers. They enhance soil quality, reduce pollution, and optimize blade durability, making them ideal for various farm operations.[4] Similar to [3], electric power tillers powered by rechargeable batteries contribute to sustainable agriculture by reducing environmental impact and physical strain on farmers. Harnessing solar energy further enhances their eco-friendliness and efficiency.[5] The evolution of power tillers reflects a broader shift toward mechanization and automation in agriculture. Innovations like lightweight tillers and multifunctional robots demonstrate the ongoing efforts to increase efficiency and reduce labor-intensive tasks in farming practices. [7]. These tillers can be powered either by an internal combustion engine or an electric motor, with various design variations catering to different agricultural needs. From walk-behind models for small-scale farming to tractor-mounted versions for larger fields, power tillers come in diverse types [7].Innovations in power tillers extend beyond traditional models. For instance, specialized seed drill tillers streamline planting processes, while innovative electric tiller machines with fertilizer dispensers prioritize environmental friendliness and reduce physical strain on operators [7].One notable development is the introduction of solar-powered tillers, particularly in regions like Kochi, Japan, rich in natural energy resources. Solar panels are employed to charge the tiller's batteries, overcoming the limitations of traditional lead-acid batteries in weight and lifespan [6]. The research explores the feasibility of using capacitors for electric charging, showing promising results for sustainable agriculture [6].In India, where agriculture is crucial for the economy, the adoption of solar tillers is gaining traction. These tillers use an electric motor running with the help of batteries charged by solar panels. This eco-friendly approach not only reduces pollution but also contributes to cost-effective farming practices .Overall, these advancements highlight the ongoing efforts to make agriculture more sustainable, efficient, and environmentally friendly, addressing challenges such as rising fuel costs, environmental concerns, and the need for sustainable practices.

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II. RESEARCH GAP

Research and product development is conducted in the agricultural sector, on the basis of larger power tillers/tractors or small animal driven equipment. The gap between these two, where farmer lies is not being fulfilled from long time.

Devices which can work for inter-cultivation, where row to row distance is upto 8 inches (200 mm) or less are not worked upon. These inter-cultivation devices if used properly will significantly effect on the output generated by farmers.

Engine powered tillers and its subsidiaries are not cost effective in the longer runs, due to incursion of recurring costs such has fuel prices, servicing costs, etc.

III. PROBLEM STATEMENT

The engine powered tillers produce a lot of pollution, since the power sources are generally diesel engines. The efforts required to drive an engine powered tiller is more, due to vibrations occurring in the engines, smoke emission and various power distribution. The engine power tillers are comparatively larger, and cannot be assembled into a compact assembly. Due to this, tilling between crops, whose row to row plantation distance is quite less is not possible, and the farm produce output is greatly affected.

IV. MATHEMATICAL FORMULATION

Torque generated by Motor can be calculated as follows,

$$\text{Power}=\frac{Tx2\pi N}{60}$$

Where,

T – Torque generated by engine

N- Speed of shaft (in rpm)

Therefore, Torque generated by Motor

$T_{max}=\frac{PX60}{2\pi N}$

Maximum torque on shaft will be T_{max}

$T_{max} = 1.3\ X\ T_{min}$

Now, Diameter of shaft for sustaining the torque can be determined by : -

$T_{min} =\frac{\pi}{16} \times \tau \times d3$

From the above equation we can find diameter of shaft d.

V. DESCRIPTION

The drive system is designed to efficiently transfer power from the motor to the gearbox, which then adjusts the speed and increases the torque for optimal performance. Initially, a belt drive connects the output of the motor to the input of the gearbox, allowing for the transfer of high-speed rotation. From the gearbox, a chain drive is employed to further reduce the speed and increase the torque output. This chain drive ensures minimal energy loss and prevents slippage during the transmission of high torque rotation.

The use of a belt drive serves a dual purpose. It not only facilitates the transfer of power but also acts as a clutch mechanism. In the event of a breakdown or error, the belt drive allows for controlled slippage, protecting the gearbox from damage. This design feature helps prevent costly repairs by ensuring that any potential damage is limited to the belts rather than the gearbox itself.

VI. CONCLUSION

Design and development of battery-powered Tiller is to reduce farmers' input costs and enhance productivity. By leveraging electric vehicle technology, this equipment offers a promising solution to the challenges faced by conventional animal-driven and engine-driven devices. The transition to electric-powered tillers holds the potential to significantly lower running costs and increase efficiency in soil preparation and cultivation operations. This innovative approach aligns with the ongoing advancements in the electric vehicle sector and underscores the importance of sustainable practices in agriculture. Continued research and development in this field are crucial to fully harnessing the benefits of battery-powered agricultural equipment, contributing to a greener and more efficient future for farming practices.

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