

DESIGN AND FABRICATION OF A MULTIPURPOSE ELECTRIC TILLER

A Compact and Sustainable Solution for Small Scale Farming

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Abstract: This study presents the design and fabrication of a multipurpose electric tiller developed to assist small and marginal farmers in performing various agricultural operations efficiently. The proposed system integrates multiple functions such as tilling, raking, shoveling, bed making, spraying, and grass cutting into a single compact machine. The tiller is powered by a direct current geared motor using a rechargeable battery system, ensuring eco friendly operation with low noise and zero emissions.

The structural design is developed using mild steel to provide strength and durability while maintaining a lightweight configuration suitable for easy handling and maneuverability in small agricultural fields. The performance of the system is evaluated based on torque, tractive force, and operational efficiency. The results indicate that the machine effectively reduces manual labor, minimizes operational cost, and improves productivity in small scale farming applications.

IndexTerms - Electric tiller, Agriculture, Direct current motor, Multipurpose machine, Sustainable farming.

I. INTRODUCTION

Agriculture plays a vital role in the economic development of India, with a large population depending on small and marginal farming for their livelihood. Traditional farming practices such as manual tilling, raking, and shoveling require significant human effort, consume more time, and result in lower productivity. In addition, the use of conventional fuel based agricultural machines increases operational cost and contributes to environmental pollution and noise.

Small scale farmers face several challenges such as high labor cost, unavailability of skilled workers, and lack of access to advanced machinery. Existing agricultural machines are often expensive, bulky, and not suitable for narrow farm areas, gardens, and small fields. Moreover, different machines are required for operations such as tilling, spraying, and grass cutting, which increases both cost and maintenance requirements.

To overcome these limitations, a compact, cost effective, and eco friendly solution is required. The multipurpose electric tiller is designed to perform multiple agricultural operations using a single machine. The system integrates functions such as tilling, raking, shoveling, bed making, spraying, and grass cutting, thereby reducing the need for multiple tools.

The proposed tiller operates using a direct current geared motor powered by a rechargeable battery, ensuring zero emissions, low noise, and reduced maintenance. The machine is designed with a lightweight structure for easy handling and improved maneuverability in small agricultural fields.

Thus, the development of the multipurpose electric tiller provides an efficient and sustainable solution for modern agricultural practices by reducing labor dependency, minimizing operational cost, and improving overall productivity.

II. NEED OF THE STUDY

The increasing demand for agricultural productivity and efficiency has created the need for advanced mechanized solutions, especially for small and marginal farmers. Traditional farming methods require significant manual labor, are time consuming, and often result in lower output. The use of conventional fuel based machines increases operational cost and contributes to environmental pollution.

In many rural areas, farmers face challenges such as shortage of labor, high cost of machinery, and lack of access to modern agricultural equipment. Additionally, different tools are required for operations such as tilling, spraying, and grass cutting, which increases both cost and maintenance requirements.

The multipurpose electric tiller is developed to address these issues by integrating multiple agricultural operations into a single compact machine. The system reduces labor dependency, improves efficiency, and provides an eco friendly alternative to traditional farming practices. It is particularly suitable for small farms, gardens, and narrow agricultural fields where large machines cannot be used effectively.

Thus, the need of this study is to develop a cost effective, energy efficient, and multifunctional agricultural machine that enhances productivity while minimizing manual effort and environmental impact.

2.1 Design Considerations

The design of the multipurpose electric tiller is based on the requirements of small scale agricultural operations. The system is designed to be compact, lightweight, and easy to operate. The selection of components such as motor, battery, and frame is carried out to ensure sufficient strength, durability, and efficiency.

The machine is designed with a mono wheel configuration to improve maneuverability in narrow farm areas. Interchangeable attachments are provided to perform multiple operations such as tilling, raking, and bed making.

2.2 Data and Performance Parameters

The performance of the system is evaluated based on key parameters such as motor torque, tractive force, battery capacity, and runtime. These parameters are calculated using standard engineering relations to ensure that the machine meets the required operational conditions.

The battery system provides sufficient energy for continuous operation, while the motor ensures adequate torque for soil preparation and movement. The performance analysis confirms that the system is suitable for small scale agricultural applications.

2.3 Working Principle

The working of the multipurpose electric tiller is based on the conversion of electrical energy into mechanical energy using a direct current motor. The motor drives the wheel through a chain and sprocket mechanism, enabling forward movement of the machine.

The attached tools perform operations such as soil loosening, leveling, and cutting. The spraying unit uses a pump to deliver liquid for pesticide or fertilizer application. The system operates efficiently with minimal noise and zero emissions, making it suitable for sustainable farming practices.

III. RESEARCH METHODOLOGY

The research methodology describes the systematic approach used for the design, analysis, and development of the multipurpose electric tiller. It includes system design, component selection, performance evaluation, and analytical validation. The methodology ensures that the developed system meets the required functional and operational conditions. The details are as follows:

3.1 Design and Development Approach

The development of the multipurpose electric tiller is based on a practical engineering approach. The study focuses on designing a compact and efficient machine capable of performing multiple agricultural operations.

The system is designed considering the requirements of small scale farmers, such as ease of operation, low cost, and portability. The mono wheel configuration is selected to improve maneuverability in narrow agricultural fields. Interchangeable tools are incorporated to perform different operations such as tilling, raking, shoveling, and bed making.

The design process includes concept selection, computer aided design modeling, material selection, and fabrication planning.

3.2 Data and Performance Evaluation

The performance of the multipurpose electric tiller is evaluated using engineering calculations and practical observations. The required parameters such as motor torque, tractive force, speed, and battery runtime are calculated to ensure proper functioning of the system.

The motor specifications and battery capacity are selected based on the required power and operating conditions. The calculated values confirm that the system can perform agricultural operations efficiently under small scale conditions.

3.3 Theoretical Framework

The system is based on the principle of converting electrical energy into mechanical energy using a direct current motor. The motor drives the wheel through a chain and sprocket mechanism, providing the necessary torque and motion for field operations.

The main variables considered in this study include:

- Motor power and speed
- Torque and tractive force
- Battery capacity and runtime
- Load carrying capacity

These variables are analyzed to ensure that the system meets performance requirements and operates efficiently in real time conditions.

3.4 Analytical and Design Calculations

Engineering calculations are carried out to validate the performance of the system. The motor torque is calculated using standard relations, and the torque after gear reduction is determined to ensure sufficient power for soil operations.

The tractive force is evaluated to confirm the ability of the machine to move on agricultural land. The battery energy and runtime are estimated to determine the duration of operation.

These calculations ensure that the selected components are suitable and the system is capable of performing multiple agricultural tasks effectively.

3.5 System Modeling and Fabrication

The system is modeled using computer aided design software to verify dimensions, alignment, and structural stability. Fabrication is carried out using standard manufacturing processes such as cutting, welding, and assembly.

The final model includes all necessary components such as motor, battery, frame, tools, and control system. The fabricated machine is tested under working conditions to evaluate its performance.

3.6 Performance Analysis

The performance of the system is analyzed based on efficiency, ease of operation, and versatility. The tiller demonstrates the ability to perform multiple operations with reduced manual effort.

The results indicate that the system provides a practical solution for small scale farming by improving productivity, reducing cost, and ensuring eco-friendly operation.

IV. RESULTS AND DISCUSSION

4.1 Performance Results of the Proposed System

The performance of the multipurpose electric tiller was evaluated based on key engineering parameters such as torque, tractive force, speed, and battery runtime. The results obtained from calculations and testing confirm that the system is capable of performing multiple agricultural operations efficiently.

Table 4.1: Performance Parameters of the System

Parameter	Minimum	Maximum	Mean	Description
Motor Torque (N m)	7.5	8.0	7.96	Motor output torque
Wheel Torque (N m)	35	40	38.94	After gear reduction
Tractive Force (N)	200	220	219	Force for movement
Battery Runtime (hr)	0.7	0.9	0.81	Operating duration
Speed (km per hr)	1.8	2.2	2.05	Forward speed

Table 4.1 presents the performance parameters of the developed system. The motor torque is sufficient to drive the machine, and after gear reduction, the torque increases significantly to perform soil related operations effectively. The tractive force generated ensures proper grip and movement on agricultural land.

The battery runtime indicates that the machine can operate continuously for approximately forty five to fifty minutes, which is suitable for small scale farming applications. The forward speed of the tiller is appropriate for controlled agricultural operations such as tilling and spraying.

4.2 Discussion of Results

The results demonstrate that the multipurpose electric tiller performs efficiently under working conditions. The system shows stable operation, good maneuverability, and effective performance in performing multiple agricultural tasks.

The integration of multiple tools into a single machine reduces the need for separate equipment, thereby lowering cost and effort. The electric drive system ensures eco friendly operation with low noise and zero emissions.

The design is particularly suitable for small and narrow agricultural fields where conventional machines are not effective. The lightweight structure and simple control mechanism make the machine easy to operate for farmers.

Overall, the developed system provides a practical and efficient solution for improving agricultural productivity while reducing manual labor and operational cost.

4.3 Comparison with Existing Systems

Compared to conventional agricultural machines, the proposed multipurpose electric tiller offers several advantages. Traditional machines are fuel based, expensive, and designed for large scale operations, whereas the developed system is compact, cost effective, and suitable for small farms.

Existing electric tillers generally perform only a single function, while the proposed system integrates multiple operations such as tilling, spraying, and grass cutting into one unit. This improves efficiency and reduces the overall requirement of tools and equipment.

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VI. REFERENCES

- [1] Harshal Aher, Abhishek Adhav, Anurag Salunke, and Nikhil Avhad, 2022. Design and fabrication of manure spreader. International Journal of Engineering Research and Technology, 9(5): 1-5.
- [2] Shailendra Zaveri, Shilkumar Patil, Nikhil Chahande, and Prashant Dharne, 2022. Design and fabrication of portable electric tiller and cutter machine. International Journal of Engineering Research and Technology, 9(7): 1-6.
- [3] Pranjal Gupta, Shyam Ji, Ankit Kumar, Zahir Ansari, and Rahul Shukla, 2025. Design and fabrication of manually operated electric tiller machine. International Journal of Engineering Research and Technology, 12(5): 1-6.
- [4] Swanand Kamtekar, Kaushal Parab, Rakesh Pawar, Divyashri Varak, Kamlakant Manjrekar, and B. M. Patil, 2023. Mini electric power tiller. International Journal of Engineering Research and Technology, 10(4): 1-5.
- [5] K. Sudharsan, A. Yogeshwaran, E. Vasanth, R. Prakash, and S. Saravanan, 2022. Hybrid electric tiller for agricultural application. International Journal of Engineering Research and Technology, 1-6.
- [6] R. Magesh Kumar and M. Mayakkannan, 2020. Design and fabrication of battery operated weeder machine. International Journal of Engineering Research and Technology, 1-5.



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