

Design & Fabrication of Mini Electric Tiller Machine for Farmers

Raghavendra Prasad S.A*, Mahesh Kumar, Kripa Sambhava, Mahammad Shafeek, Bharat**

*Assistant Professor, Mechanical Engineering, Vivekananda College of Engineering & Technology, Puttur, Karnataka

**Final Year students, Mechanical Engineering, Vivekananda College of Engineering & Technology, Karnataka

Email: 107raghu@gmail.com

Abstract:

Agriculture has always been an important aspect of the human ecology. It is important part in human life as it feed us and thereby it runs the ecosystem though. It is extreme important section for living beings. But modern farming techniques are heavy-coughed and very intensive. In Indian Agriculture, generally tractors or cultivator machines are commonly used for ploughing. Farm tilling is one of the most labor-intensive agricultural procedures. Low-cost portable battery powered electric mini tiller machine is manufactured as a one-stop contemporary solution to improve traditional farming practices by reducing labor at a very cheap cost through the use of a motorized tilling mechanism. Electric tiller is capable of digging the soil using high speed rotating motor which has spikes. Motor is rotating with the help of arechargeable battery which is mounted on the machine frame. A handle with controllerswitches helps thefarmer to startand stop the motor asrequired.Rear supporting wheelhelp the machine to counter balance the weight. Cutter wheel rotate at high speed andpenetrateintothesoil.Arechargeable batteryandmotor system make this machinecheaper as compared to ICenginedrivenmachines.

Keywords -- Electric tiller, Farmer, Tiller machine, Battery & Engine

I. INTRODUCTION

India being farming major, the need for modern technologies in agriculture routines is undisputed. Traditionally, manual labor or bulk machinery was employed to till the soil, preparing it for planting. Conventional tool like a Pick, Shovel, Hoe or Trowel need to be used one after another for land digging, soil lifting and moving operations respectively. Wheel-barrow also required transporting small amount of soil. However, with advancements in technology, the introduction of electrical portable mini tillers has transformed the agricultural landscape. These compact and efficient machines offer numerous advantages, making them a game-changer in the world of farming.

Electrical portable mini tillers are small-sized, lightweight machines powered by electricity. They are designed to assist farmers in soil cultivation, seedbed preparation, and weed removal. Unlike their gas-powered counterparts, electrical tillers operate quietly, emit no harmful fumes, and require minimal maintenance. Their compact size and maneuverability make them ideal for small spaces, raised beds, and urban farming. One of the standout features of electrical portable mini tillers is their convenience and portability. Traditional tillers are often heavy and challenging to transport, limiting their usability. In contrast, electrical tillers are compact and lightweight, making them easy to carry and maneuver. Their portability allows farmers to effortlessly

move them around the farm, reaching tight corners and confined spaces with ease. Furthermore, their small size facilitates effortless storage, requiring minimal space in sheds or garages. Electrical portable mini tillers are designed with user-friendliness in mind. They typically feature intuitive controls, allowing farmers of all experience levels to operate them without difficulty. Starting an electrical tiller is as simple as plugging it in and pressing a button. The absence of a pull cord or complex starting procedures eliminates the frustration and physical strain associated with traditional tillers. Farmers can now focus more on their farming tasks rather than struggling with machinery. In an era where environmental consciousness is paramount, electrical portable mini tillers provide a sustainable alternative to their gas-powered counterparts.

They produce zero emissions during operation, contributing to cleaner air quality in the farm environment. Additionally, electrical tillers operate quietly, minimizing noise pollution and creating a peaceful farming experience. Their eco-friendly nature aligns with the growing trend of organic farming and sustainable practices, making them an attractive choice for environmentally conscious farmers. Despite their smaller size, electrical portable mini tillers deliver impressive performance. Equipped with powerful electric motors, they can effectively break up compacted soil, churn through weeds, and create the ideal seedbed for planting. Some models also offer adjustable tilling widths and depths, allowing farmers to customize the tiller's performance according to their specific needs. The versatility of electrical tillers extends beyond soil cultivation; they can also be equipped with optional attachments, such as aerators or edges, further expanding their functionality. Compared to gas-powered tillers, electrical portable mini tillers require minimal maintenance. They eliminate the need for oil changes, fuel mixing, and spark plug replacements. Routine maintenance typically involves cleaning and inspecting the machine, ensuring it remains in optimal working condition.

Moreover, electrical tillers have a longer lifespan due to their simpler construction and fewer moving parts, translating into cost savings for farmers in the long run.

II. DESIGN OF MINI TILLER

Solid Edge V20 is computer-aided design (CAD) software developed by Siemens Digital Industries Software. It is a version of the Solid Edge software suite, which is designed to assist engineers and designers in creating 3D models and 2D drawings for various industries. Solid Edge V20 provides advanced capabilities for creating and manipulating 3D models. With Solid Edge V20, you can efficiently design and manage large assemblies. The software allows for the creation of assembly structures, component relationships, and constraints. It offers tools for collision detection, interference checking, and motion simulation. Solid Edge V20 enables the generation of detailed 2D drawings and documentation from 3D models. Users can create orthographic views, section views, and detail views. The software supports the creation of dimensions, annotations, and tables to accurately communicate design intent.

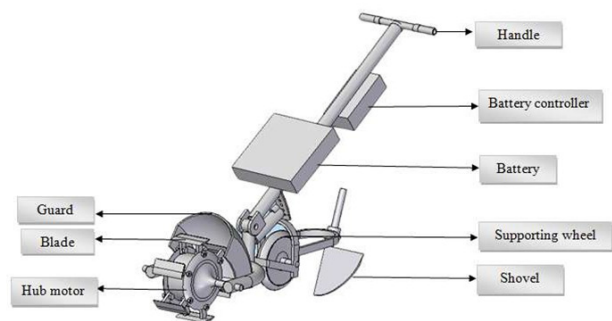


Fig 1: 3D Model of Mini Tiller

III. MAJOR PARTS OF MINI TILLER

The hub motor (also called wheel motor, wheel hub drive, hub motor or in-wheel motor) is an electric motor that is incorporated into the hub of a wheel and drives it directly. The cutting blades are welded to the hub motor. When it rotates, the blades also rotate at high speed. It is a 48V 1000W hub motor which weighs 8kg and has a diameter of 254mm. It is made

of alloy steels.

A lithium-ion or Li-ion battery is a type of rechargeable battery which uses the reversible reduction of lithium ion to store energy. The negative electrode of a conventional lithium-ion cell is typically graphite, a form of carbon. This negative electrode is sometimes called the anode as it acts as an anode during discharge. The positive electrode is typically a metal oxide; the positive electrode is sometimes called the cathode as it acts as a cathode during discharge. Battery is used which weighs 8kg and has 260x240mm cross section.

To control a hub motor with a power rating of 48W, typically it needs an electronic speed controller (ESC) specifically designed for electric motors. An ESC is a device that regulates the speed and direction of an electric motor based on the inputs signals it receives.

Electric tillers have a separate switch specifically for starting and stopping the motor. This switch is typically a momentary switch that is pressed and held to start the tiller and released to stop it. Switches are located in handlebar and bicycle's handle is used.

IV. FABRICATION OF TILLER MACHINE

The fabrication process involves the construction and shaping of the individual components of the mini tiller. Various tools and techniques, such as cutting, welding and machining may be employed to shape the metal or other materials used in the construction. The fabrication phase requires precision and attention to detail to ensure that all components are accurately manufactured according to the design specifications. After the fabrication of the components, the assembly stage takes place. Here, the individual parts of the mini tiller are carefully joined together to create the functioning machine. Assembly involves fitting the components, securing them in place with bolts, screws, or other fasteners, and ensuring proper alignment and functionality. This step also involves incorporating the necessary controls and other systems into the mini tiller. Throughout the fabrication

and assembly process, quality control measures should be implemented to ensure that the mini tiller meets the desired standards. This involves inspecting the components for defects, conducting tests to verify the machine's performance, and making any necessary adjustments or improvements.

Material used for frame is GI square pipe and GI flat plate. Because hub motor is connected to the frame as it requires high strength to withstand the stresses produced during tilling. One shaft is provided between frame at the bottom to locate supporting wheel which has diameter of 200mm. Supporting wheel is connected to shaft using bearings. A sheet metal is bent and welded at frame as guard to avoid muds produced during tilling. Hub motor shaft is connected using nut and bolts to GI flat plate which is drilled and welded to frame.

Tilling involves cutting through soil, rocks, and other debris, which can cause significant wear on the blade. Fabrication of blade is made up of mild steel plate. Blade has thickness 3mm and 6in number. Blades are connected around hub motor through a nut and bolt



Fig 2: Body of Mini Tiller

Handlebar is aligned with the designated mounting points on the tiller's body. Secure them tightly by welding. Position the motor in its designated location, by ensuring that it is aligned properly and securely. Attach the wheels to the axles on the tiller. This is fitted with bolts or clips by making sure that they were firmly in place. Attach control panel to the handlebar of the machine. This panel typically includes an on/off switch, speed control, and other relevant buttons or levers. Depending on the tiller's power source (battery or mains electricity), connect the appropriate power

ercable to the motor and control panel. Makesure the connections are secure and properly insulated.



Fig 3: Mini Tiller Machine

V. PERFORMANCE OF TILLER MACHINE

The machine was tested on field for covering 1 acre area and it was done on medium hard soil so has to avoid blade damages.

Toplough a 1-acre area (4044.96m²), with each ploughing depth of 30 mm and a ploughing width of 1m, it would take 3.7 hours. This calculation is based on the ploughing time for each 1 m distance is 3.3 seconds, and there are 63 rows to cover the entire area. The power consumption for this operation, considering the battery power of 1000W, would be 3700W/hr. or 3.7 units of electricity. If the cost per unit of electricity is Rs. 7, the total cost for ploughing the 1-acre area would be Rs. 26. Considering the time and cost factors, the cost per hour of operation would be Rs. 7.02. The ploughing process would cover an area of 1093.23m² per hour.

TABLE I
PERFORMANCE OF MACHINE

Speed(N)	Time(t) for 1 meter	Time(t) for 1 acre	Cost per acre
730rpm	3.3sec	3.7hrs.	Rs. 26

Overall, these results provide an estimate of the time, power consumption, and cost associated with ploughing a 1-acre area using the given parameters. It's important to note that these calculations may vary in practice due

to various factors such as soil conditions, plow efficiency, operator skills, and equipment performance.

VI. ADVANTAGES & LIMITATIONS

The machine advantages are as follows,

A. Portable and easy to operate: Electric tillers are typically lightweight and compact, making them easy to transport around garden. They are designed for ease of use, with simple controls and ergonomic handles, making them accessible for users of varying physical strength and abilities.

B. Cost-effective as compared to IC engine: Electric tillers are generally more cost-effective compared to their IC engine counterparts. They have lower maintenance requirements since they don't require oil changes, fuel refills, or spark plug replacements. Additionally, electric tillers are more energy-efficient, resulting in lower operating costs in the long run.

C. Reduction of human effort: Electric tillers eliminate the need for manual labour and excessive physical effort. They are equipped with powerful electric motors that do the work of breaking up and aerating the soil, reducing the strain on the user. This feature is particularly beneficial for individuals with limited strength or mobility.

D. Speed is restricted to 730rpm: The maximum speed at which the electric tiller can operate is limited to 730 revolutions per minute (rpm). This restriction can impact the tiller's efficiency in breaking up and turning the soil. Higher speeds can often result in faster and more effective tilling, especially in tougher soil conditions. Therefore, this limitation may affect the tiller's performance and make it less suitable for heavy-duty or challenging tilling tasks.

The machine limitations are as follows,

E. Balancing is a problem and needs to be adjusted: Electric tillers may face challenges with balancing, particularly when navigating uneven or rough terrain. Achieving proper stability and balance is crucial to ensure safe and efficient tilling. If the tiller's design or construction lacks sufficient balance or if the

operator fails to adjust and maintain it correctly, it can lead to issues such as difficulty in controlling the machine, poor tilling performance, or even potential accidents.

F. Blade lengths need to be changed: The blades of an electric tiller play a significant role in breaking up and aerating the soil. The lack of flexibility in blade length can limit the tiller's adaptability to different soil types or depths. If the blade length cannot be modified or replaced easily, it may hinder the tiller's ability to achieve optimal tilling results in various gardening or landscape scenarios.

VII. APPLICATIONS OF MACHINE

A. Preparation of soil for seed sowing: Electric tillers are commonly used to prepare the soil before sowing seeds. They are designed to break up compacted soil, remove weeds, and create a loose and well-aerated seedbed. By tilling the soil, the electric tiller helps to improve its structure, which promotes better seed germination, root development, and overall plant growth.

B. Weed control: Mini electric tillers can be utilized for weed control in agricultural fields. Weeds compete with crops for nutrients, water, and sunlight, which can significantly reduce crop yield. Electric tillers with appropriate attachments or tines can effectively uproot and bury weeds, preventing their growth and minimizing competition with crops. This helps in maintaining weed-free fields and ensuring healthier crop growth.

C. Incorporating fertilizers into the soil: Fertilizers are essential for providing plants with the necessary nutrients for optimal growth. Electric tillers can assist in incorporating fertilizers into the soil, ensuring that the nutrients are evenly distributed and readily available to the plant roots. By tilling the soil and mixing the fertilizers thoroughly, electric tillers help to enhance nutrient absorption by the plants, resulting in improved crop productivity.

VIII. SCOPE OF THE PROJECT

Portable mini electric tillers are designed to

break up and cultivate soil in small areas such as flower beds, vegetable gardens, and container gardens.

Electric tillers are useful for preparing soil beds before planting. They can help in tilling and leveling the soil, creating a suitable environment for planting seeds or seedlings.

Electric tillers produce less noise compared to their gas-powered counterparts, making them suitable for residential areas. They also eliminate the need for fuel and produce zero emissions, contributing to an eco-friendly gardening experience.

In terms of cost, mini-portable electric tillers tend to be more affordable.

VIII. COST DETAILS

TABLE 2
 COST DETAILS

S/No	Description	Cost
1.	Hub-Motor	10,500
2.	Battery	20,000
3.	Frame Materials	2,000
4.	Transportation	500
5.	Miscellaneous (Electrode, Nut and Bolts, Grinding and Cutting Wheel, Electronic Components)	5,000
Total		37,000/-

IX. CONCLUSIONS

The mini-portable electric tiller is designed to be lightweight and easy to carry, making it ideal for small gardens or areas with limited space. Its compact size allows for effortless manoeuvrability and storage.

Unlike gas-powered tillers, the mini-portable electric tiller runs on electricity, eliminating the need for fuel and reducing both noise and air pollution. This makes it an environmentally friendly choice for gardening.

The electric tiller is designed to be user-friendly, with simple controls and

intuitive operation. It requires minimal effort to start and operate, making it suitable for gardeners of all skill levels, including beginners.

Despite its small size, the mini portable electric tiller is capable of effectively tilling the soil. It features sharp tines that penetrate the ground, breaking up compacted soil and preparing it for planting or seeding.

The electric motor provides sufficient power to handle most ploughing tasks. The electric tiller is versatile and can be used for various gardening purposes. It can be employed for tilling small flower beds, vegetable gardens, or even maintaining potted plants.

Its compact size allows it to access tight spaces where larger tillers cannot reach. Electric tillers generally require less maintenance compared to gas-powered counterparts. They do not require oil changes or fuel refills, and there are no spark plugs to replace. Regular cleaning and blade sharpening are usually the main maintenance tasks.

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