ENERGY EFFICIENT AND ENVIRONMENTAL FRIENDLY ELECTRIC POWER TILLING MACHINE FOR SMALL SCALE FARMERS

Project Reference No.: *48S_BE_3329*

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Keywords:

Electric power tilling machine, Energy efficient, BLDC motor, Controller, Gel battery, Gear box, GPS tracker

Introduction:

Agriculture is a vital sector with small-scale farmers playing a significant role. Traditional farming practices rely on fuel-operated machinery, which is costly and polluting. This project designs an electric power tilling machine using electric vehicle technology to reduce costs and environmental impact. The machine is designed for planting vegetables like radishes, beans, and tomatoes. It uses a BLDC motor, gearbox, and controller for efficient operation. A gel battery powers the motor, and a throttle ensures smooth control. Additional features include a pesticide sprayer and GPS tracker. A smart key enables safe and convenient operation. The machine's lightweight design makes it accessible to aged people and women workers. This electric tiller improves agricultural productivity and sustainability, contributing to a cleaner environment. It promotes sustainable farming practices and has a positive impact on the environment. The machine's design prioritizes user-friendliness and efficiency. Overall, it enhances the livelihoods of small-scale farmers and supports modern agriculture. The electric power tilling machine is a valuable tool with far-reaching benefits. Its adoption leads to increased productivity and reduced

environmental impact. It's an exciting development in agricultural technology, promoting eco-friendly agriculture.

Objectives:

- To design and develop an electric power tilling machine for small-scale farmers.
- To reduce operating costs, environmental pollution, and noise pollution.
- To create a user-friendly machine accessible to a wide range of users.
- To promote eco-friendly farming practices and reduce reliance on fuel-operated machinery.
- Equip the machine with a GPS tracker for location tracking and a pesticide sprayer for efficient pest management.
- To enhance the livelihoods of small-scale farmers through innovative technology.

Methodology:

A) Proposed block diagram

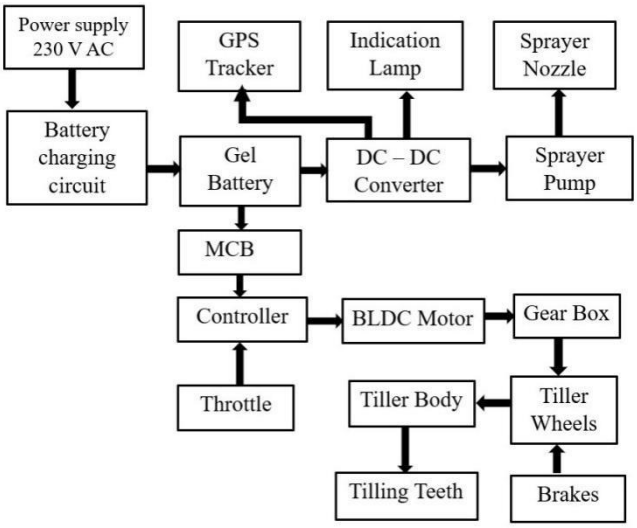


Fig 1 : Block diagram of electric power tilling machine

The electric power tilling machine operates as follows:

- 230V AC supply is converted to DC voltage by the battery charging circuit to charge the gel battery.
- The gel battery provides DC output to the DC MCB for over-current protection.
- The MCB output is fed to the BLDC motor controller, regulating motor speed and torque based on throttle input.
- The controller sends output to the BLDC motor, coupled with a 10:1 ratio helical gearbox.
- The gearbox transmits mechanical power to the tilling machine's wheels.
- A brake is attached to the wheels for stopping the machine.
- The throttle, installed on the handle, controls the machine's pace and direction.
- A 48/12V DC-DC converter provides 12V DC power for additional functions like GPS tracker, indication lamp, and pesticide sprayer.
- A pesticide pump reduces physical strain on farmers when spraying pesticide solution.
- A GPS tracker monitors the machine's location in real-time and prevents theft.

B) Components used

Component	Specification
BLDC Motor	1000W, 48V DC, 4000 RPM
Gel battery	48V DC , 28 Ah
Controller	1000W , 48 V , 50 A

DC-DC Converter	48V/12 V
Component	**Specification**
Gear box	10:1 ratio
MS angle	1/4 inch
Tilling teeth	1 feet - Length 1 feet - Width 1 feet - Height
Throttle	-
GPS tracker	DB2-4G
Pesticide sprayer set	12 V pump, 3 leter pesticide solution filling can
DC MCB	12V-220V DC , 60 A DC
Solid rubber wheels	14 inch

Result and Conclusion:

Result: The figures below illustrate the electric tilling machine in action—digging the land, measuring output, and spraying pesticide.

Fig 2: Land digging images output measurements

Fig 3:Land digging

Fig 4 : Pesticide spraying on plants

Output measurements :

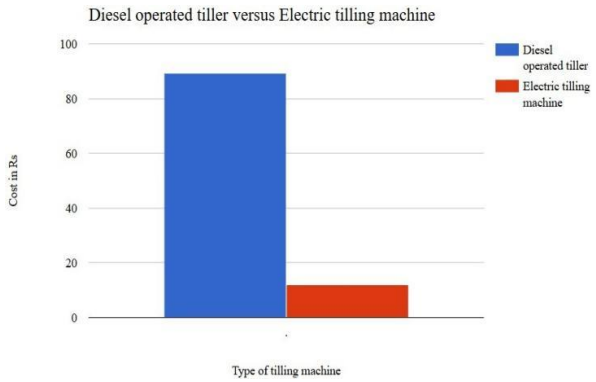
1) Dry land :

- Depth : 8cm = 3.15 inch
- Width : 17cm= 6.69 inch

2) Wet land :

- Depth : 11cm= 4.33 inch
- Width : 26 cm = 10.24 inch

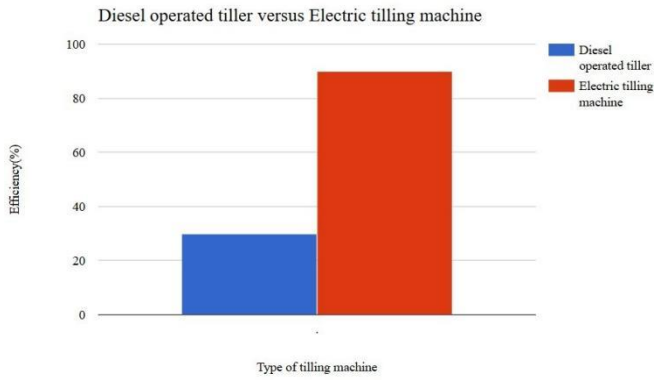
Cost comparison (operating cost) with fuel operated tiller



Graph 1 : Operating cost comparison of tilling machine with fuel operated tilling

The graph compares the operating costs of this electric tilling machine with a diesel-operated tiller, showing that the electric option is significantly cheaper. With a charging cost of only ₹14 per use versus ₹89–₹90 for diesel, the electric tiller is ideal for small-scale farmers.

Energy Efficiency comparison with diesel operated tiller



Graph 2 : Energy Efficiency comparison of electric tilling machine with fuel tiller

Energy efficiency refers to how effectively a vehicle converts fuel or electricity into motion; internal combustion engines typically achieve only 20–30% efficiency due to heat loss. In contrast, the electric tilling machine uses a BLDC motor with up to 90% efficiency, offering high reliability and lower energy consumption.

Final hardware outcome :

Fig 5: Final hardware outcome of electric power tilling machine

Conclusion :

The energy-efficient and environmentally friendly electric power tilling machine project has been successfully designed and developed. This tilling machine is designed by using electrical components such as a BLDC motor, controller, and battery; therefore, there is no noise pollution and emission (carbon dioxide).This tilling machine reduces

the operating cost for farmers compared to diesel-operated tillers, and also this machine is suitable for small-scale farmers in order to plant the vegetables such as radishes, beans, and tomatoes. The integration of pesticide sprayers will reduce the chemical waste and also physical stress of the farmers during chemical spraying for vegetable plants, and the integration of GPS trackers will provide real- time location tracking information, and also it will help us from theft. Through the ergonomic design, we make this machine suitable for both aged farmers and women workers.

Project Outcome & Industry Relevance:

Project outcomes:

- Reduced environmental pollution
- Real time tracking and monitoring
- Cost reduction for small scale farmers
- Easy of maintenance
- Reduced noise pollution
- Improved efficiency
- Enhanced soil health and reduces physical stress for farmers

Industry Relevance:

This project is highly relevant to the agricultural and renewable energy industries. It addresses two key challenges: the high operational costs associated with diesel-powered farming equipment and the need for sustainable agricultural practices. By integrating electric power into tilling machinery, the project promotes the adoption of cleaner energy sources in agriculture. The electric tiller could be widely used in developing countries, where small-scale farming is prevalent, helping farmers save on fuel expenses and reduce their environmental impact. Additionally, it opens up opportunities for industries involved in agricultural machinery, renewable energy solutions, and sustainable farming technologies to expand their offerings and meet the growing demand for eco-friendly farming solutions.

Future Scope:

The successful design and development of the energy-efficient and environmentally friendly electric power tilling machine opens up opportunities for future growth and innovation. Building on the project's achievements, we envision scaling up production, conducting extensive field testing, and gathering feedback from farmers and agricultural experts to refine the design. We also plan to explore new markets, adapt the machine for use with other crops, and develop complementary technologies, such as mobile apps or data analytics platforms, to support small-scale farmers and promote sustainable agriculture practices. Additionally, we aim to optimize the motor's efficiency, develop more advanced pesticide spraying systems, and integrate the machine with other agricultural equipment to further enhance its benefits and reduce environmental impact. By pursuing these goals, we can improve the livelihoods of small-scale farmers, reduce operating costs, and promote environmentally friendly farming practices.