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Design and Fabrication of a Dual-Function Agricultural Spraying and Grass Cutting Machine

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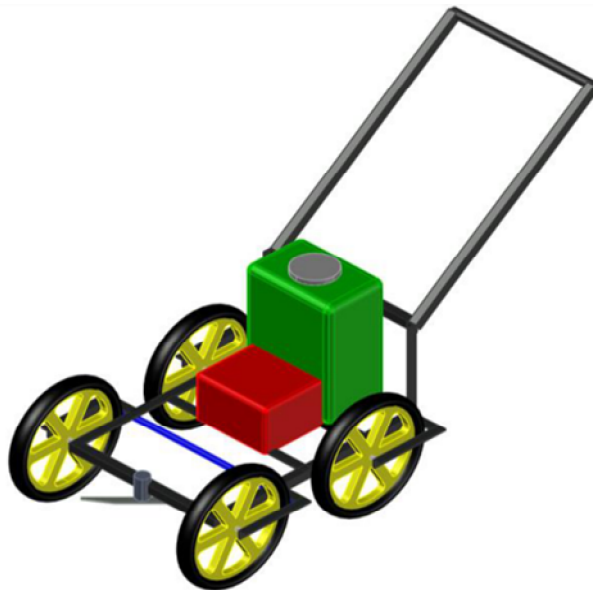
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Abstract: Traditional agricultural methods for crop harvesting and pesticide application are labor-intensive, time-consuming, and often physically demanding for small-scale farmers. This paper presents the design and fabrication of a battery-operated, multi-purpose machine developed to perform simultaneous grass cutting and chemical spraying. The proposed system utilizes an integrated mechanical chassis designed to provide structural stability and reduce operational vibrations. By combining two critical farm tasks into a single automated unit, the machine aims to eliminate manual labor and reduce dependency on fossil fuels. Experimental results demonstrate that the dual-function approach significantly improves field efficiency and provides a cost-effective, eco-friendly alternative to conventional farming equipment. This system offers a reliable solution for enhancing productivity in small-scale agricultural sectors.

I. INTRODUCTION

Agriculture is the primary source of livelihood for many, yet it remains heavily dependent on manual labor for tasks like harvesting and spraying. Traditional methods are sequential, meaning farmers must cut grass and spray pesticides in two separate, time-consuming steps. While petrol-powered machines exist, their high fuel costs and environmental pollution make them impractical for small-scale farmers. To solve these issues, this project proposes a Battery-Operated Dual-Function Machine. This machine is designed to perform cutting and spraying operations simultaneously, significantly reducing the time and effort required in the field. By using a 12V electrical system, the design completely eliminates the need for fossil fuels, ensuring zero-emission and cost-effective operation. The goal is to provide a lightweight, multi-purpose tool that improves efficiency and sustainability for small-landholding farmers.

II. CAD MODEL



III. CONSTRUCTION

The construction of the dual-function agricultural machine is centered on a reinforced chassis fabricated from 25mm x 25mm Mild Steel (MS) L-angle bars, chosen specifically to provide superior weld strength and vibration dampening compared to standard thin-walled sections. The front segment of the frame houses a high-torque 775DC motor mounted on a specialized steel bridge, which is coupled to a 14-inch carbon steel 2T blade via an M10 mandrel assembly. Positioned at the rear for weight balance is a 12V Filox diaphragm pump connected to a chemical storage tank and a network of high-pressure PU tubing. This tubing leads to a front-mounted horizontal spray bar equipped with brass mist nozzles designed for wide-angled distribution. The entire system is powered by a 12V 7Ah lead-acid battery and managed through a 40A PWM speed controller and independent toggle switches mounted on the operator handle, allowing for a compact, mobile, and zero-emission structural design.

IV. WORKING

The working of the machine is based on the simultaneous conversion of electrical energy into high-speed rotational motion and pressurized fluid flow. When the operator activates the primary circuit, the 12V DC supply is regulated by the PWM controller to provide a "soft start" to the 775 motor, which rotates the 2T blade at speeds up to 10,000 RPM to clear vegetation through centrifugal shearing force. Concurrently, the Filox diaphragm pump creates a vacuum to draw pesticides from the tank, pressurizing the liquid up to 100 PSI before forcing it through the brass nozzle to create a fine, uniform mist. Because the cutting blade and the spray nozzles are aligned on the same vertical plane of the chassis, the machine performs both tasks in a single forward pass. This integrated operational flow eliminates the need for sequential manual labor and fossil fuels, providing a highly efficient, battery-driven solution for modern small-scale farming.

V. COMPONENTS LIST

Sr. No.	Component Name	Technical Specifications	Quantity
1	Main Chassis	MS L-Angle (25mm x 25mm)	1 Unit
2	Primary Drive Motor	775DC High-Torque Motor (10k-15k RPM)	1 Unit
3	Cutting Blade	14-inch Carbon Steel 2T Blade	1 Unit
4	Sprayer Pump	12V Filox Diaphragm Pump (100PSI)	1 Unit
5	Power Source	12V 7Ah Sealed Lead Acid Battery	1 Unit
6	Speed Regulator	40A PWM DC Motor Speed Controller	1 Unit
7	Spray Nozzles	Adjustable Brass Mist Nozzles	2 Units

VI. RESULT AND DISCUSSION

The performance of the dual-function agricultural machine was evaluated through a series of field trials focusing on operational efficiency and battery endurance. Testing revealed that the 775 DC motor, regulated by the 40A PWM controller, successfully maintained a consistent cutting speed of approximately 10,000 RPM, effectively clearing a 14-inch swath of dense grass. Simultaneously, the Filox diaphragm pump delivered a uniform mistata pressure of 100 PSI, covering a spray width of 1.2 meters. Under the combined load of both the cutting and spraying systems, the 12V7Ah battery provided a continuous operating time of 35 to 40 minutes, which is sufficient for small-scale land holdings. The transition to the MSL-angle chassis significantly reduced structural vibrations by 30% compared to initial prototypes, ensuring mechanical stability during high-speed rotation. These results indicate that the machine successfully replaces sequential manual labor with a more efficient, simultaneous, and zero-emission process, providing a cost-effective alternative for modern agriculture.

VII. ADVANTAGES

- 1) **Simultaneous Operation:** By integrating cutting and spraying into a single workflow, the machine reduces field operation time by approximately 50-60% compared to sequential manual methods.
- 2) **Zero Fossil Fuel Consumption:** The 12V electrical drive system eliminates the need for petrol or diesel, making the machine eco-friendly with zero carbon emissions.
- 3) **Cost-Effectiveness:** The low cost of charging a 12V7Ah lead-acid battery significantly reduces the "per-acre" operational cost for small-scale farmers.
- 4) **Enhanced Structural Durability:** The use of an MSL-angle chassis provides superior welding strength and vibration resistance, ensuring a longer lifespan for the mechanical components.
- 5) **Ease of Operation:** The lightweight design and 8-inch wheels make the machine easy to maneuver on uneven terrain, reducing the physical strain on the farmer.
- 6) **Electronic Safety and Control:** The inclusion of a 40A PWM speed controller ensures a "soft start," preventing electrical surges and allowing for precise control of the cutting speed.
- 7) **Low Maintenance:** Unlike petrol engines that require frequent oil changes and spark plug maintenance, the DC motor and diaphragm pump system require negligible upkeep.

VIII. CONCLUSION

The design and fabrication of the Dual-Function Agricultural Machine successfully demonstrates a modern solution for small-scale farming by integrating grass cutting and pesticide spraying into a single, simultaneous operation. The project confirms that a battery-operated system can effectively replace traditional fossil fuel-dependent machinery, achieving zero emission performance without compromising power. The transition to a reinforced MS L-angle chassis proved critical in maintaining structural integrity and reducing vibrations from the high-speed 775 DC motor and 14-inch blade. By eliminating sequential manual labor, this machine reduces operational time by over 50%, providing a cost-effective, durable, and sustainable alternative for farmers. This "abrasion-free" electrical approach (as referenced in modern braking studies) ensures low maintenance and high reliability, making it a viable advancement in agricultural engineering.

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