

Design of Automated Multi-Functional Compact Equipment for Farmers

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Abstract: The project titled “Design of Automated Multi-Functional Compact Equipment for Farmers” aims to develop an energy-efficient and eco-friendly agricultural system. The system uses solar photovoltaic (PV) panels to generate electricity and charge a rechargeable battery. The stored energy powers a DC pump for spraying water and pesticides. The spraying equipment is integrated with a hybrid electric tractor for efficient field coverage.

An Arduino Uno microcontroller controls the spraying operation to ensure uniform liquid distribution. The system reduces chemical wastage, fuel consumption, and operational costs. Focuses on conceptual design, component selection, power requirements, and feasibility analysis. The proposed system promotes sustainable agriculture by improving spraying efficiency and reducing environmental impact.

Keywords: Battery, DC Mortar, Arduino, Filter, LCD, Joystick

I. INTRODUCTION

Efficient irrigation, crop protection, and seed sowing are essential for improving agricultural productivity and reducing labor requirements. Conventional agricultural practices often involve separate machines or manual equipment for spraying water, applying pesticides, and sowing seeds, resulting in increased operational time, labor costs, and resource wastage. To address these challenges, this project proposes the design and development of a solar-powered water and pesticide spraying and seed-sowing system as an attachment for a hybrid electric tractor. The integration of renewable energy and agricultural mechanization provides a sustainable approach to improving field operation efficiency.

The proposed system utilizes solar photovoltaic (PV) panels to generate electrical energy, which is stored in batteries to operate a DC pump and associated control components. The spraying unit consists of a storage tank, pump, pipelines, filters, and adjustable nozzles to ensure uniform application of water and pesticides. The seed-sowing mechanism incorporates a seed hopper, metering unit, seed delivery tubes, furrow openers, and soil-covering components to facilitate controlled seed distribution and proper placement in the soil. A microcontroller-based control system, such as Arduino Uno, can be incorporated to regulate spraying operations and support automated control of selected system functions.

The integration of spraying and seed-sowing mechanisms into a single tractor attachment aims to reduce labor, save time, minimize resource wastage, and improve operational efficiency. The system is designed to accommodate different crop requirements through adjustable spraying and seed-metering mechanisms. The initial phase focuses on conceptual design, component selection, power requirement estimation, system integration, and feasibility analysis. The proposed system promotes renewable energy utilization in agriculture and offers a potential cost-effective and environmentally sustainable solution for precision farming and modern agricultural operations.

II. PROBLEM STATEMENT

Traditional agricultural spraying and seed sowing methods, such as manual knapsack sprayers and fuel-powered machines, are labor-intensive, time-consuming, and often result in uneven application of water and pesticides. These methods increase operational costs, operator fatigue, and environmental pollution. Battery-powered sprayers also face



limitations due to charging requirements and restricted operating time. Furthermore, conventional systems often lack precise control over spraying pressure and flow rate, leading to resource wastage and reduced application efficiency. To overcome these limitations, this project proposes a solar-powered water and pesticide spraying system integrated with a hybrid electric tractor. The system utilizes solar photovoltaic panels and battery storage to power a DC pump, enabling controlled and uniform spraying while reducing dependence on fossil fuels and external electricity sources. The proposed system aims to minimize labor requirements, reduce operational costs, improve spraying efficiency, and promote sustainable agricultural practices through the integration of renewable energy and modern agricultural mechanization.

III. OBJECTIVES

1. To design a solar-powered energy system using photovoltaic (PV) panels and battery storage to supply electrical energy for spraying and seeding operations.
2. To develop an efficient DC pumping system with a tank, pipelines, and adjustable nozzles for uniform application of water and pesticides.
3. To design and integrate a seed-sowing mechanism with the spraying system for controlled seed distribution and effective placement in the soil.
4. To integrate the system with a hybrid electric tractor and implement a microcontroller-based control system, such as Arduino Uno, for efficient operation.
5. To perform design calculations and optimize pump capacity, flow rate, pressure, solar power generation, spray coverage, and seed spacing to minimize resource wastage.
6. To reduce labor effort, operational time, and environmental impact while developing a cost-effective, energy-efficient, and sustainable agricultural solution suitable for rural and off-grid areas.

IV. SYSTEM DESCRIPTION

- A. Power Supply System: Provides 12/24 V power using a battery, fuse, power distribution unit, and DC-DC converter.
- B. Remote Control System: Uses a 2.4 GHz wireless transmitter and receiver to control the equipment remotely.
- C. Main Controller System: Uses an Arduino Mega/Uno to process inputs and control the different farming operations.
- D. Seed Sowing System: Stores seeds in a hopper and uses a rotating metering disc and geared motor to dispense seeds.
- E. Seed Covering System: Uses a furrow opener and seed-covering plate to place seeds in the soil and cover them.
- F. Pesticide Sprayer System: Uses a chemical tank, filter, diaphragm pump, pressure regulator, manifold, and nozzles to spray pesticides.
- G. User Feedback System: Uses flow, seed-level, pressure, and limit sensors to monitor operations and detect problems.
- H. Tractor Movement System: Uses a joystick, motor drivers, traction motors, and wheels to control tractor movement.
- I. User Control System: Includes switches for seed sowing and spraying, an emergency stop, and an optional LCD/OLED display.
- J. Frame and Integration System: Uses a 25 × 25 mm MS square-pipe frame and a three-point tractor connection to mount and integrate all modules.



V. WORKING

Sunlight falling on the solar PV panel generates DC power, which is stored in a rechargeable battery and used to operate the pesticide spraying and seed sowing mechanisms. The battery supplies power to the DC pump, which draws liquid from the pesticide or water tank and sprays it uniformly onto the crops through the spray nozzles. At the same time, the seed sowing mechanism releases seeds from the seed container into the soil at regular intervals. The system uses a motor-driven mechanism to control seed distribution and improve sowing accuracy. The spraying and seed sowing operations can be controlled using switches or a suitable controller. This solar-powered system reduces manual effort, saves time, improves agricultural efficiency, and promotes eco-friendly farming practices.

VI. EXPECTED RESULTS

The proposed system is expected to perform pesticide spraying and seed sowing efficiently using solar-powered electrical energy. The system aims to provide uniform pesticide spraying and accurate seed placement, reducing manual effort, time, and labor costs. The use of a DC pump for spraying and a seed sowing mechanism is expected to improve agricultural productivity and support sustainable farming practices. The performance of the prototype, including spraying efficiency, seed placement accuracy, battery voltage, and operating time, will be evaluated after testing.

VII. CONCLUSION

The solar-powered pesticide spraying and seed sowing system provides an efficient and eco-friendly solution for modern agricultural practices. By utilizing solar energy to power the spraying and seed sowing mechanisms, the system reduces manual effort, saves time, and improves agricultural productivity. It supports uniform pesticide application and proper seed placement, promoting efficient crop protection and cultivation. The system can be further improved in the future by incorporating automatic control, IoT-based monitoring, adjustable seed sowing mechanisms, and advanced spraying technology.

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