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AUTONOMOUS AGRICULTURAL ROBOT FOR SEEDING, SPRAYING, AND WEEDING

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Abstract: This project presents the design and development of an Autonomous Agricultural Robot for Seeding, Spraying, and Weeding operations aimed at reducing manual labour and improving farming efficiency. The system is built using a PIC Microcontroller, which acts as the main control unit to coordinate all operations of the robot. Utilizing a 1.5 mm square hollow mild steel frame with compact dimensions (24" x 16") to navigate small-scale fields, the movement is powered by PMDC worm gear motors and 8-inch nylon wheels, providing high torque for uneven terrains. The system integrates a 250g GI sheet seed box, a 500ml pesticide tank with a pump/nozzle, and a mild steel weeding mechanism. Operating in a semi-autonomous mode, this robot aims to reduce manual labor, minimize chemical wastage, and improve farming efficiency through a cost-effective, userfriendly design.

Keywords: Agricultural Robot, PIC Microcontroller, Seeding, Spraying, Mechanical Weeding, Precision Farming.

1. INTRODUCTION

Agriculture is the backbone of many global economies, yet it remains one of the most labour-intensive sectors. Traditionally, farming operations such as seeding, weeding, and pesticide spraying have relied heavily on manual human intervention or large-scale heavy machinery. While manual labour is becoming increasingly scarce and expensive, heavy machinery is often financially inaccessible and physically impractical for small-scale farmers.

This project introduces a solution in the form of a versatile, semi-autonomous agricultural robot designed specifically to address the needs of small-to-medium-scale farming. By integrating a PIC Microcontroller with robust mechanical fabrication, this system aims to automate three critical phases of the crop cycle, thereby increasing efficiency, ensuring uniformity in resource application, and significantly reducing the physical strain on the farming community.

The rapid advancement of automation and robotics has significantly influenced modern agriculture. Researchers and engineers have developed various robotic systems to improve efficiency in farming operations such as seeding, spraying, and weeding. The integration of sensors, control systems, and intelligent algorithms has enabled precision farming practices, allowing better monitoring and management of agricultural activities. Despite these advancements, many existing systems are expensive, complex, and not easily accessible to small and medium-scale farmers.

1.1 Objectives

Precision Farming: To improve accuracy in seed placement and uniform pesticide application.
Resource Optimization: To minimize wastage of seeds, water, and expensive agricultural chemicals.
Labor Reduction: To decrease the physical strain and manual effort required from farmers.
Safety: To mitigate health risks associated with direct human exposure to hazardous pesticides.
Sustainability: To promote eco-friendly practices through mechanical weeding rather than excessive herbicide use.
Accessibility: To create a low-cost, simplified interface adaptable for different crops and manageable by farmers with minimal technical skills.

2. LITERATURE REVIEW

A comprehensive review of existing technologies and research related to agricultural robots highlights the need for a cost-effective solution. The survey matrix has been condensed to focus on key relevant frameworks.

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Table -1: Literature Review Summary Matrix

Sl no	Author & Year	Journal & Topic	Key findings	Feature scope
1	Muthukaruppan Vinaitheerthan, et al. 2026	Development of a Multipurpose Agricultural Robotics System	Developed "MARS" for high-accuracy weeding.	Swarm communication.
2	Redmond Ramin Shamshiri et al. 2018	Research & Development in Agricultural Robotics	IoT and 5G reduce labor costs.	Remote teleoperation.
3	Redmond Ramin Shamshiri et al. 2006	An Autonomous weeding robot for organic farming	Established "SensingThinking-Acting" framework.	Advanced vision sensors.
4	Abhigit Khadatkar, et al. 2025	Design, development and application of a remotely controlled robotic weeder for mechanical weeding in row crops for sustainable crop production	Created "WeeRo" for mechanical uprooting.	Full RTK-GPS autonomy.
5	Arati Nimbalkar, et al. 2020	Autonomous agricultural bot	Mitigates manual labor shortages.	Real-time pest detection.

3. PROBLEM STATEMENT

The primary challenge in modern small-scale agriculture is the lack of precision and the high time consumption associated with traditional methods. Improper seed spacing leads to resource competition among plants, while uneven pesticide spraying can result in crop damage or insufficient protection. Furthermore, weeding is an exhausting task that often goes neglected, leading to reduced yields. The objective of this project is to develop a compact, cost-effective, and multi-functional robotic platform capable of performing these tasks with high precision. The system is designed to be user-friendly, allowing farmers with limited technical knowledge to operate it effectively.

The project addresses several critical challenges and inefficiencies present in traditional agricultural practices:
Inefficiency and Low Productivity: Traditional farming suffers from a lack of precision, leading to low productivity per acre, inconsistent field coverage, and delays in completing operations during peak seasons. **Poor Resource Management:** There is excessive and inefficient use of water and chemicals, alongside soil degradation caused by improper practices.
Human Health and Physical Strain: Farmers endure intense physical strain and face significant health risks due to direct exposure to pesticides and prolonged work in harsh environmental conditions.
Technological Gaps: Small-scale farmers struggle with a lack of real-time decision-making support, difficulty in handling multiple tasks, and limited awareness or financial access to bulky, high-cost smart farming technologies.

4. METHODOLOGY

The system integrates mechanical, electrical, and control components to achieve efficient farming operations using a PIC Microcontroller. The methodology is broken down into its system architecture and working flow:

System Architecture: The robot's core is a PIC Microcontroller that manages all functions. It features a 1.5 mm square hollow mild steel chassis and uses PMDC worm gear motors (Johnson geared motors) for hightorque forward movement. The system includes three functional units: a 250-gram GI sheet seed box for sowing, a 500 ml tank with a pump and nozzle for spraying, and a mild steel blade mechanism for weeding.

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Operational Flow: The system is powered by a 12V battery. Once initialized, the operator uses input switches to move the robot forward and select a specific operation mode (seeding, spraying, or weeding). The microcontroller processes these inputs and executes the selected function continuously as the robot navigates the field.

Table -2: Component Functional Roles

Category	Component Name	Functional Role
Structural & Mechanical	Mild Steel Chassis	Provides the rigid frame and structural foundation for the robot.
	Johnson Geared Motors	High-torque PMDC worm gear motors that provide movement in field conditions.
	Mild Steel Weeding Blades	Mechanical attachments used for physically removing small weeds from the soil.
	GI Sheet Seed Box	A corrosion-resistant 250-gram container for holding seeds during sowing.
	Wheels	Provide the necessary traction and mobility across agricultural terrain.
Electronic & Control	PIC Microcontroller	The "brain" of the system that processes inputs and controls all robot functions.
	12V Battery	The central power source for both the electronic circuits and the motors.
	Relay Drivers	Interface modules that allow the microcontroller to switch high-power components.
	Input Switches	User-operated controls to select specific operation modes (Sowing/Spraying/Weeding).
	Voltage Regulator	Maintains a constant voltage level to protect sensitive electronic parts.
Specialized Utility	Spray Tank (2000 ml)	A reservoir used to store liquid pesticides or fertilizers for application.
	Submersible Pump	A 12V pump used to move liquid from the tank to the spray nozzle.
	Spray Nozzle	Atomizes the liquid into a fine mist for uniform crop coverage.
	Seed Metering Mechanism	A mechanical system used to drop seeds at precise, equidistant intervals.

5. DESIGN ESTIMATION AND PROCUREMENT

The project has successfully completed the comprehensive estimation of required materials and the procurement of all necessary parts for construction. The bill of materials is outlined below.

Table -3: Bill of Materials and Cost Estimation

Sl. No.	Component	Specification	Quantity	Approx. Cost (₹)
1	PIC Microcontroller	Control unit	1	500
2	Motor Driver (L298N)	Dual H-Bridge Driver	1	300
3	PMDC Worm Gear Motors	Johnson Geared Motors	2	3000
4	Wheels (Nylon 8 inch)	Heavy duty	2	1600

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5	Battery	12V Rechargeable	1	2000
6	Chassis Material	MS Square Pipe (1.5 mm)	-	1500
7	Bearings	Standard	4	400
8	Seed Box	GI Sheet (250 g capacity)	1	300
9	Spray Pump	Mini DC Pump	1	500
10	Spray Tank	500 ml	1	300
11	Weeding Mechanism	Mild Steel Blade	1	1500
12	Switches	Control switches	3–4	200
13	Wiring & Connectors	Electrical connections	-	300
14	Fabrication Cost	Welding, cutting, fitting	-	2500
15	Miscellaneous	Nuts, bolts, clamps, etc.	-	1000
Total Estimated Cost				**₹16,900 – ₹20,000**

6. EXPECTED OUTCOMES

Based on the project's testing and objectives, the implementation of this robot yields several positive outcomes:
Operational Success: Experimental results show the robot achieves stable movement, uniform seed distribution, good pesticide spraying coverage, and effective removal of small weeds in soft soil.
Cost and Resource Efficiency: With an estimated build cost of around ₹20,000, the robot provides a highly affordable solution that minimizes the wastage of seeds, water, and expensive chemicals.
Improved Working Conditions: The semi-autonomous nature of the robot significantly reduces the need for manual labor, saves time, and lowers health risks by keeping farmers away from direct chemical exposure. **Scalability for the Future:** The project establishes a functional prototype that encourages the adoption of automation in rural areas, with the potential for future upgrades like GPS navigation, IoT monitoring, and full AI-based automation.

7. CONCLUSION

The Autonomous Agricultural Robot provides an efficient, low-cost solution tailored specifically for smallto-medium-scale farming systems. By combining seeding, spraying, and mechanical weeding into a single micro-controlled chassis, it effectively addresses local labor shortages and reduces exposure hazards associated with chemical application. Prototype validation confirms stable navigation and highly uniform payload deployment under manageable field conditions.

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