# Design and Development of Automatic Pesticide Spraying Machine

Pratik Nagpure [1], Jaydeep Pawar[2], and Vinayak Kulkarni[3], Aditya Patil[4], Dr. Mahesh Gaikwad[5]
*JSPM's JSCOE Pune, India*

***Abstract - This paper presents the design and development of an Automatic Pesticide Sprayer Machine aimed at improving the efficiency, safety, and effectiveness of pesticide application in agricultural fields. Manual spraying methods often lead to uneven coverage, excessive chemical usage, and direct exposure of farmers to hazardous substances. To address these challenges, the proposed system integrates a mobile spraying unit with an automated mechanism that ensures uniform distribution of pesticides while minimizing human intervention. The design incorporates a compact chassis, a 5-liter chemical tank, a pump-driven spray system, and a control unit that governs the spraying operation. Emphasis is placed on optimizing the flow rate, spray pattern, and coverage area through mechanical design and system calibration. The prototype has been tested under varied field conditions to evaluate its performance, with results showing significant improvements in pesticide usage efficiency and operator safety. This project offers a practical solution for small and medium-scale farmers, promoting sustainable and precision-based agricultural practices***

***Keywords- Automatic Pesticide Sprayer, Agricultural Automation, Arduino UNO, Precision Farming, Bluetooth Control, Spray System, Embedded Systems, DC Geared Motor, Cone Nozzle, Remote Pesticide Application, IoT in Agriculture.***

## I. INTRODUCTION

Agriculture remains a cornerstone of the global economy, especially in developing countries like India, where a significant portion of the population is dependent on farming for livelihood. One of the critical challenges faced by farmers is the effective and safe application of pesticides to protect crops from pests and diseases. Traditional methods of pesticide spraying are often labor-intensive, inefficient, and hazardous, exposing farmers to harmful chemicals and resulting in inconsistent pesticide coverage.

The need for automation in pesticide application has become more prominent with the increasing focus on precision farming, environmental safety, and labor shortages in rural areas. Automated pesticide sprayers offer a promising solution by ensuring uniform pesticide distribution, reducing chemical wastage, and enhancing operator safety. These machines are particularly beneficial for small and medium-scale farmers who cannot afford large, sophisticated agricultural equipment.

This paper presents the development of a compact and cost-effective Automatic Pesticide Sprayer Machine designed to address these issues. The machine includes a mobile chassis, a 5-liter chemical tank, a pump and nozzle-based spraying system, and a basic control unit for regulating the spray. The design focuses on ease of use, low maintenance, and
adaptability to various crop types and field conditions. The aim is to contribute to the ongoing efforts in mechanizing Indian agriculture while promoting sustainability and safety in farming operations.

## II. OBJECTIVES

A. To minimize human exposure to harmful pesticides by allowing operators to control the machine remotely, keeping them at a safe distance from the chemicals being applied.
B. To ensure accurate and uniform distribution of pesticides across the entire crop area
C. To automate the pesticide application process to reduce the need for manual labor, saving time and reducing labour costs for farmers.
D. To display the collected data on the User Interface

## III. LITERATURE SURVEY

Early studies on agricultural automation identified pesticide spraying as a high-risk, labor-intensive task prone to inefficiencies. Patil et al. [1] demonstrated that Arduino-based spraying vehicles significantly reduce human exposure to harmful chemicals; however, their system depended on manual activation and lacked dynamic adaptability to changing field conditions. Sharma and Kumar [2] built an RF-controlled sprayer with moderate success in remote navigation, yet their prototype showed limited range and control precision.

To enhance automation, Joshi et al. [3] proposed a Bluetooth-operated sprayer using an L298N motor driver and HC-05 module. Their model improved operator flexibility but suffered from signal instability in large or obstructed farms. Ghosh et al. [4] integrated IoT sensors and cloud monitoring for precision agriculture, enabling real-time adjustments based on environmental data—though their system was cost-prohibitive for small-scale farmers. Shinde and Pawar [5] introduced a solar-powered variant with ultrasonic obstacle avoidance, advancing autonomy and sustainability, but they reported performance drops under cloudy weather and uneven terrains.

These studies reveal three persistent gaps:

A. Static control logic – most systems use hard-coded motor speeds and spraying intervals that don't adapt to different crop heights or densities.
B. Manual dependency – despite wireless control, most systems still require manual direction or initiation, limiting full automation.
C. Lack of real-time feedback – few models use onboard sensors or feedback mechanisms to adjust operations based on terrain or obstacle detection.

The prototype proposed in this paper addresses these challenges by integrating Bluetooth control with adaptive motor actuation, a modular spraying mechanism, and a lightweight embedded system tested under realistic field-like conditions using Arduino-based control and wireless user interface.

## IV. TECHNOLOGY AND HARDWARES IN PROJECT

A. Arduino UNO - The Arduino UNO is an open-source microcontroller based on the ATmega328P chip, offering a simple and cost-effective solution for automation in the pesticide sprayer machine. With 14 digital I/O pins, six analog inputs, and a 16 MHz clock, the Arduino UNO controls the pump and spray mechanism based on pre-programmed logic. It interfaces with sensors, such as ultrasonic or infrared, to detect crops and obstacles, adjusting the spray accordingly. Additionally, the Arduino enables manual or remote control through buttons, joysticks, or Bluetooth modules. Its flexibility and ease of use make it ideal for agricultural automation, and it allows for future upgrades like GPS or AI integration..

B. Bluetooth HC05 Module - HC-05 is a class-2 bluetooth module with Serial Port Profile, which can configure as either Master or slave. a Drop-in replacement for wired serial connections, transparent usage. You can use it simply for a serial port replacement to establish connection between MCU, PC to your embedded project and etc.

C. Relay Module - A relay module is an electromechanical switch used to control high-power devices with low-power signals from microcontrollers like the Arduino UNO. In the Automatic Pesticide Sprayer Machine, the relay acts as an interface between the Arduino and the DC pump or motor. Since the Arduino cannot directly supply the current required to operate these components, the relay is used to switch them ON or OFF based on control signals. Typically, a 5V single-channel relay is used, capable of handling up to 10A of current. It ensures safe and reliable operation of the spraying mechanism by electrically isolating the low-voltage control side from the high-power load side. The inclusion of a relay module enhances automation and protects the microcontroller from potential overload or damage.

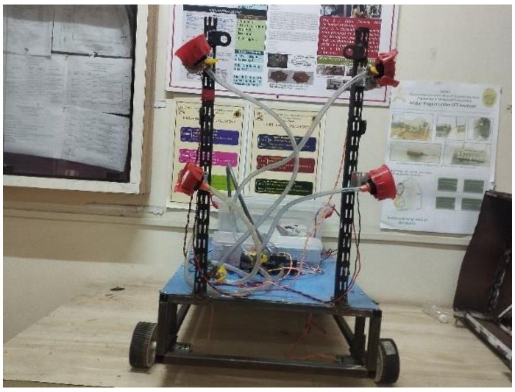

D. 12V 300 rpm Geared motor - A 12V 300 RPM geared DC motor is used to drive the wheels of the Automatic Pesticide Sprayer Machine, providing the necessary torque and speed for smooth movement across agricultural fields. This motor consists of a standard DC motor coupled with a gearbox that reduces the motor's speed while significantly increasing its torque output. Operating at 12 volts, it delivers a rotational speed of approximately 300 revolutions per minute, making it ideal for applications requiring controlled motion and moderate load-handling capacity. The geared configuration ensures sufficient traction and stability, allowing the machine to navigate uneven terrain with ease. These motors are compact, energy-efficient, and easy to interface with motor drivers or relay modules for directional and speed control via the Arduino. Their use enhances the mobility and automation capabilities of the sprayer system.

E. 100 mm all terrain wheels - The 100 mm all-terrain wheels are employed in the Automatic Pesticide Sprayer Machine to ensure reliable mobility over varied agricultural surfaces. These wheels are designed with a durable rubber or polymer outer surface that provides strong grip and shock absorption on uneven, muddy, or grassy terrain. The 100 mm diameter offers a balanced combination of ground clearance and stability, allowing the machine to move smoothly without getting stuck in soft soil or small obstacles commonly found in farms. The rugged tread pattern enhances traction, while the reinforced hub design ensures compatibility with geared DC motors through standard couplings or shaft mounts. These wheels play a crucial role in improving the field performance, durability, and overall efficiency of the spraying machine.

F. Nozzles - The cone-type nozzle is used in the Automatic Pesticide Sprayer Machine to ensure effective and uniform distribution of pesticide over crops. This type of nozzle produces a finely atomized, hollow cone spray pattern, which is ideal for covering a wide area with minimal pesticide wastage. It operates efficiently at low to moderate pressures and is compatible with the 12V DC diaphragm pump used in the system. The cone nozzle ensures even droplet dispersion, which enhances the pesticide’s ability to stick to the surface of leaves and stems, improving pest control effectiveness. Typically made from chemical-resistant plastic or brass, the nozzle offers durability and resistance to corrosion. Its easy mounting and maintenance make it suitable for repeated field use in varying agricultural conditions.

## IV. IMPLEMENTATION

The implementation of the Automatic Pesticide Sprayer Machine involved a systematic approach, starting from component selection and design to assembly and functional testing. The machine was built on a mild steel chassis, designed to support the pesticide tank, wheels, pump, electronics, and spraying system. A 5-liter chemical-resistant tank was mounted at the center of gravity to maintain balance. Mobility was achieved using two 12V 300 RPM geared motors attached to 100 mm all-terrain wheels, ensuring smooth movement over agricultural terrain.



The spraying mechanism consisted of a cone-type nozzle connected to a 12V DC diaphragm pump, which was responsible for drawing the pesticide from the tank and dispersing it uniformly. The pump was activated through a relay module controlled by an

Arduino UNO microcontroller. The Arduino was programmed to regulate the spraying process, either manually or based on sensor input, depending on the mode selected. Power was supplied through a 12V rechargeable battery, capable of running the system for a reasonable time under field conditions.

The entire setup was mounted in a compact, portable frame, designed to be user-friendly and field-serviceable. After assembly, the machine was tested in open field conditions to evaluate spray range, droplet uniformity, motor performance, and system reliability. The results showed efficient pesticide delivery with reduced manual effort and improved coverage, proving the viability of the system for small and medium-sized farms.

## IV. CONCLUSION

The Automatic Pesticide Sprayer Machine developed in this project effectively addresses the need for safer, more efficient, and cost-effective pesticide application in agricultural fields. By integrating components such as the Arduino UNO, DC geared motors, a diaphragm pump, and a cone-type nozzle, the system ensures uniform spraying, reduced human effort, and minimized exposure to harmful chemicals. The machine is capable of operating in varied field conditions due to its all-terrain wheels and robust construction. Test results have shown improved spray accuracy and mobility, making it a promising solution for small and medium-scale farmers. Additionally, the modular design allows for future enhancements such as automation based on crop detection, GPS tracking, and IoT integration, further increasing its potential for smart farming applications. Overall, this project contributes toward sustainable and modern agricultural practices.

## REFERENCES

[1] S. Patil, A. Raut, and V. Deshmukh, “Automated pesticide spraying vehicle,” in Proc. Int. Conf. on Engineering Research and Technology (ICERT), 2017.

[2] R. Sharma and A. Kumar, “Design and development of RF controlled pesticide sprayer,” in Proc. Int. Res. J. Eng. Technol. (IRJET), vol. 5, no. 6, pp. 1789–1793, 2018.

[3] A. Joshi, R. Mehta, and S. Gupta, “Bluetooth controlled pesticide sprayer robot using Arduino,” in Proc. Int. J. Innov. Res. Electr.,

Electron., Instrum. Control Eng. (IJIREEICE), vol. 9, no. 3, pp. 55–59, 2021.

[4] M. Ghosh, S. Roy, and T. Dutta, "IoT-based smart spraying system for precision agriculture," Int. J. Comput. Appl., vol. 182, no. 47, pp. 1–5, 2019.

[5] K. Shinde and B. Pawar, "Solar operated automatic pesticide sprayer with obstacle detection," Int. J. Sci. Res. Eng. Manag. (IJSREM), vol. 4, no. 8, pp. 40–44, 2020.

[6] A. K. Sharma and P. Verma, "Smart pesticide spraying robot," in Proc. Int. Res. J. Eng. Technol. (IRJET), vol. 9, no. 7, pp. 135–138, 2022.

[7] D. K. G. Parmar, D. S. Patil, S. S. Shinde, and S. K. Zende, "Design & development of automatic pesticide spraying machine," in Proc. Int. J. Eng. Technol. Res., vol. 9, no. 3, pp. 45–50, 2024.

[8] R. B. Pawar, A. H. Shaikh, M. D. Shaikh, and S. S. Shaikh, "Developments in solar powered agricultural sprayers: A review," Int. J. Curr. Microbiol. Appl. Sci., vol. 9, no. 12, pp. 1234–1240, 2020.

[9] S. Kumar and M. Singh, "Design and development of an intelligent vehicle for spraying pesticides," in Proc. AIP Conf., vol. 2358, no. 1, p. 080013, 2021.

[10] V. N. Patil and C. Pokale, "Smart pesticide spraying robot," in Proc. Int. J. Creative Res. Thoughts (IJCRT), vol. 9, no. 4, pp. 677–680, 2021.

[11] M. Shete, M. Bhilare, and R. Pawar, "Automatic pesticide sprayer bot," in Proc. Int. J. Comput. Eng. Res. Trends, vol. 9, no. 1, pp. 101–105, 2021.

[12] A. K. Sharma and P. Verma, "Design and development of an IoT based smart pesticide spraying robot," in Proc. Int. J. Res. Appl. Sci. Eng. Technol. (IJRASET), vol. 9, no. 3, pp. 699–703, 2021.

[13] A. K. Sharma and P. Verma, "Solar operated automatic pesticide sprayer," in Proc. Int. J. Res. Eng. Sci. Manag. (IJRESM), vol. 2, no. 6, pp. 851–854, 2020.

[14] S. G. Vichare, S. Wani, and V. Pawar, "Bluetooth controlled solar multiple agricultural robot," in Proc. Int. J. Innov. Res. Technol. (IJIRT), vol. 7, no. 10, pp. 894–897, 2021.

[15] R. Sharma and A. Verma, "RF controlled pesticide spraying," in Proc. Int. Res. J. Eng. Technol. (IRJET), vol. 8, no. 8, pp. 206–209, 2021.

[16] A. K. Sharma and P. Verma, "Automatic agriculture spraying using Arduino," in Proc. Int. J. Mod. Res. Sci. Technol., vol. 7, no. 5, pp. 16–20, 2021.

[17] M. Khan, R. Kale, and S. Wani, "Solar powered mobile operated multifunction agriculture robot," in Proc. Int. J. Sci. Eng. Res. (IJSER), vol. 7, no. 9, pp. 404–408, 2020.

[18] A. K. Sharma and P. Verma, "Solar powered sprayer with automatic single axis tracking system," SSRN Electron. J., 2020.

[19] A. Deshmukh, R. Pawar, and V. Kadam, "Automatic smart pesticide spraying pump," in Proc. J. Emerging Technol. Innov. Res. (JETIR), vol. 7, no. 4, pp. 579–583, 2021.

[20] A. K. Sharma and P. Verma, "Controlled automatic sprayer machines," in Proc. Propuls. Power Res., vol. 9, no. 1, pp. 5359–5363, 2021.