International Journal of Research and Development in Engineering Science
ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/
Regular Issue, Vol. 7, Issue.2 (March – April), 2025 , Pages: 47 - 51
Received: 18 August 2024 ; *Accepted:* 23 January 2025 ; *Published* : 25 March 2025
https://doi.org/10.63328/IJRDES-V7RI2P9
Original Paper : Laboratory Research – Experimental Research Paper

Solar-Powered Electric Vehicle-Integrated Sprayer System for Sustainable Small-Scale and Horticultural Farming

Siva Kumari Palla [1] , Padma Lalitha Mareddy [2]

[1] Jawaharlal Nehru Technological University, Anantapuramu, , Andhra Pradesh, India; *shiva07254@gmail.com*

[2] Department of Electrical and Electronics Engineering, Annamacharya University, Rajampeta , Andhra Pradesh, India; *padmalalitha.mareddy@gmail.com*

* *Corresponding Author : Siva Kumar Palla :* shiva07254@gmail.com

Abstract: This research paper examines the integration of Solar powered Electric Vehicle (EV) Technology into sprayer systems designed for small-scale and horticultural farming. As sustainable agriculture gains importance, there is an increasing need for eco-friendly and efficient farming methods. Traditional diesel-powered sprayers contribute to both air and noise pollution and face challenges with maintenance and fuel availability. To address this, the study explores the feasibility and advantages of shifting to solar -powered sprayer systems that leverage adaptable EV platforms. By proposing an innovative solution to update spraying operations for small-scale and horticultural farms, this research contributes to the field of sustainable agriculture. The findings highlight the potential of Solar powered EV-integrated sprayer systems to transform farming practices, providing a cleaner, more efficient alternative to conventional diesel-powered equipment and significantly reducing environmental impact.
Keywords: Solar, Electric Vehicle, Farming, Sprayer, Agriculture.

1. Introduction

The agricultural sector is undergoing a major shift toward sustainability, driven by the need to reduce environmental impact, improve resource efficiency, and enhance productivity. Small-scale and horticultural farms, which supply local markets with a wide range of crops, play a crucial role in this shift but face distinct challenges in efficiency, cost, and environmental stewardship[1,2,3]. To address these challenges, there is growing interest in using innovative technologies to modernize farming and support sustainable agricultural systems [4,5]. The Government of India launched the National Electric Mobility Mission Plan 2020 (NEMMP), a landmark initiative aimed at bolstering fuel security, promoting environmentally friendly and cost-effective transportation, and establishing India as a global leader in electric vehicle (EV) manufacturing. NEMMP 2020 primarily targets the reduction of environmental impacts from the transportation sector, which accounts for a significant 83% of India's fossil fuel consumption, focusing on the development of electric two-wheelers, three-wheelers, cars, and buses[6]. With 57.4% of its population reliant on agriculture, India remains a largely agrarian society[7] and accounts for a 4.79% of fossil fuel usage[8]. Conversely, Globally, nearly 20,000 farmers lose their lives each year due to pesticide exposure[9], highlighting an urgent need for safer farming practices. The proposed project seeks to address these challenges by designing a Solar powered EV integrated pesticide and fertilizer sprayer for arable and horticultural crops. This innovation emphasizes safety by incorporating remote operation, allowing farmers to control the sprayer from a safe distance and reducing direct exposure to harmful pesticides and ensures zero fossil fuel emissions. This approach represents a transformative step toward protecting farmers while fostering a productive relationship between technology and agriculture.

Integrating Solar Powered EV technology with sprayer systems offers a promising opportunity to address longstanding issues in agriculture and further attaining the sustainability goals. Diesel-powered sprayers, common in farming, contribute to air and noise pollution, operational inefficiency, and maintenance challenges. EV-integrated sprayer systems, however, offer a cleaner, more precise, and flexible alternative, reducing the environmental footprint.

Nonetheless, implementing Solar Powered EV-integrated sprayer systems in small-scale and horticultural farms presents unique challenges. Key design considerations include power needs, battery capacity, charging infrastructure, and compatibility with diverse farming

ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 7, Issue 2, 2025 , https://doi.org/10.63328/IJRDES-V7RI2P9

methods. Additionally, economic feasibility, technological practicality, and farmer acceptance are essential for the successful adoption and scalability of these systems.

2. Literature Survey

Sprayers are essential tools in modern agriculture for applying pesticides, herbicides, and fertilizers. In recent years, their use has increased significantly due to their effectiveness in reducing crop damage and enhancing yields[10]. Farmers depend on a range of sprayers to control pests and diseases, highlighting the importance of selecting equipment carefully. This selection process considers ergonomic, economic, effectiveness, and environmental factors. Ergonomic aspects prioritize user comfort and safety, while economic factors focus on affordability and maintenance costs. Effectiveness assesses the sprayer's ability to apply pesticides accurately, and ecological considerations seek to reduce environmental impact by minimizing drift and runoff. By choosing suitable equipment and techniques, farmers can manage pests efficiently, protect the environment, and maximize crop productivity[11].

2.1. Manual Spraying

In India, traditional farming practices and equipment are still widely used, with manual sprayers being a common tool for applying pesticides and water to manage pests periodically[12] . Below are the types of sprayers typically used:

2.1.1. Hydraulic Knapsack Sprayer

This sprayer operates manually with a hand lever mechanism to maintain consistent pressure. It features a 15-liter tank and is particularly suitable for spot treatment applications in farming.

2.1.2. Pneumatic or Compressed Knapsack Sprayer

Unlike the hydraulic version, this sprayer does not require continuous pumping during use. It becomes pressurized after filling the tank about two-thirds full and is especially useful for weed control in crops like paddy and jute.

2.1.3. Motorized Pneumatic Knapsack Sprayer

Designed for low-volume spraying, this type uses a stream of air to disperse fine droplets of concentrated spray liquid, ensuring effective coverage. It can also function as a blower, although mist blowers may result in some pesticide loss due to wind drift.

2.1.4. Foot or Pedal Pump Sprayer

This sprayer is operated using a foot pedal and is commonly employed for applying crop protection products. It includes one or two long delivery hoses and can be fitted with a lance or multi-nozzle boom. Its high-volume spraying capacity makes it ideal for treating larger areas[13]. Figure 1 depicts the various types of manual sprayers in use.

Fig.1 (*a*) *Hydraulic Knapsack Sprayer*
(*b*) *Manual Pneumatic Sprayer*

Fig.1 (C) Motorized pneumatic knapsack sprayer ,
(D) Foot Sprayer.

2.2. Animal Drawn- Sprayer

Gupta et al. (2003)[14] developed a bullock-drawn fractional sprayer with a pressure of 3.5 kg/cm², achieving

ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 7, Issue 2, 2025 , https://doi.org/10.63328/IJRDES-V7RI2P9

average boom discharges of 2.47 l/min in lab and 2.53 l/min in field trials. It provided uniform spray distribution at a height of 400 mm, delivering a field capacity of 0.704 ha/h and requiring only 1.44 man-hours per hectare—nearly seven times more efficient than knapsack sprayers.

Amonye et al. (2014)[15] introduced an animal-drawn boom sprayer with CDA atomizer nozzles, a gear pump, and a chemical tank, demonstrating effective performance and energy efficiency, even on inclines, with a net pull of 820 N and Dynamic Wheel Load of 1575 N. Netam et al. (2021)[16] designed an animal-drawn solar-powered sprayer optimized at 4 kg/cm², achieving a 240 l/h discharge rate, a field capacity of 0.52 ha/h, and a high field efficiency of 83%. Covering four rows, it applied 432 l/ha of spray at an operational cost of 274.25 Rs/ha and a Payback Period of 0.26 years.

Fig.2 Animal Drawn Sprayer

2.3. Power operated Spraying

2.3.1. Self- Propelled Sprayer

Mahal et al. (2007) [17] designed a high-clearance, self-propelled power sprayer specifically for cotton farming, powered by a 20 hp two-cylinder diesel engine with a 1200 mm ground clearance, achieving speeds up to 20 km/h on roads and 5 km/h in fields. This sprayer features an 8.87 m boom with 14 nozzles spaced 67.5 cm apart, covering a 9.45 m width, and offers an adjustable boom height (315 mm to 1685 mm) to accommodate different crop heights. Its 1000-liter tank can spray up to 4 hectares per fill, with an efficient rate of 2 ha/h, requiring refills every two hours (taking 30-45 minutes each), while its high-clearance design reduces crop damage compared to traditional tractor-mounted sprayers, yielding a 10% increase in treated areas.

Similarly, Ghafoor et al. (2022) [18] developed a prototype self-propelled sprayer, powered by a 20-hp engine, with a 300-liter tank and hydraulically controlled boom equipped with eight hollow cone nozzles. Laboratory tests measured spray symmetry at various pressures (2.5 to 4 bar), and field trials refined settings for forward speed (4 to 8 km/h), spray height (40 to 70 cm), and pressure (3 to 7 bar), optimizing droplet density, coverage, and Volume Median Diameter (VMD). Optimal results were achieved with T14 (6 km/h, 55 cm, 5 bar) and T22 (8 km/h, 55 cm, 3 bar) for medium-to-low and high concentration solutions, respectively. The prototype demonstrated 61% field efficiency, significantly reducing costs compared to manual spraying and proving to be a cost-effective, eco-friendly solution for small farms.

2.3.2. Power- Tiller Operated Sprayer

Padmanathan and Kathirvel (2007) [19] evaluated a rear-mounted boom sprayer operated by a power tiller, designed for cotton and other row crops, providing a uniform spray pattern while conserving spray material. This sprayer, with sixteen hollow cone nozzles spaced 40 cm apart, covers a swath width of 3.2 m at a forward speed of 2 km/h, achieving an effective field capacity of 0.72 ha/h at an operating pressure of 3 kg/cm². Controls are conveniently placed near the operator's seat, ensuring efficient operation without health risks. Additional safety features, such as clamps and pipes, protect the operator during chemical application.

Suresh et al. (2013) [20] designed power tiller-operated intra-canopy sprayers suited for tall crops like cotton and pigeon pea, employing a five-nozzle boom to address canopy needs. Laboratory tests showed that the HCN 80250 hydraulic nozzle, paired with a 125 mm air sleeve, produced droplets within the 300-micron range, achieving 13-16% coverage on the leaf surfaces within the canopy. Field tests confirmed a field capacity of 0.146 ha/h at a speed of 1.31 km/h for pigeon pea, with even droplet coverage of 17.5-18% on both sides of the leaves and a mean droplet size of 120 to 124 microns, ensuring efficient application with over 90% of droplets smaller than 300 microns.

Fig.3 Power tiller operated back mounted boom sprayer

ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 7, Issue 2, 2025 , https://doi.org/10.63328/IJRDES-V7RI2P9

2.3.3. Tractor operated/ Mounted Sprayer

Nalavade et al. (2008) [21] developed a 15-meter tractor-mounted spray boom to improve agricultural spraying efficiency, carefully designing it to withstand structural stresses and conducting thorough lab and field tests. Compared to a locally produced 9-meter boom, the 15-meter version proved more economically advantageous, with statistical analysis confirming uniform spray distribution.

Singh et al. (2010) created a tractor-mounted air-assisted sprayer for cotton, which demonstrated higher uniformity coefficients and better droplet deposition, especially on the undersides of leaves, crucial for pest control.

Jayashree and Krishnan (2012) introduced a tractor-operated target-actuated sprayer to reduce off-target chemical application, optimizing variables like speed, plate width, chemical concentration, and sensor height, thereby enhancing chemical efficiency and reducing environmental impact. Babasaheb and Ravi (2013) evaluated a hydraulic boom sprayer for cotton, identifying an optimal discharge rate of 0.90 l/min and a pressure of 689.5 kPa for minimizing pesticide loss and achieving effective pest control.

Jassowal et al. (2016) examined a tractor-operated trailed boom sprayer, observing that increased pressures resulted in smaller droplets and variations in deposition on different leaf surfaces, allowing adaptability to crop height and density.

Sanchavat et al. (2017) assessed a tractor-mounted boom sprayer's efficiency at various pressures, noting optimal spray angle, distribution, discharge, and swath width, with a field capacity of 3.3 ha/h and 63.03% efficiency for cotton applications.

Fig. 4 *Tractor mounted boom sprayer*

2.3.4. Drone Mounted Sprayer

This sprayer proves invaluable in scenarios where human intervention for chemical spraying on crops, such as rice fields and orchards, is impractical or challenging due to terrain. Not only does this technology significantly reduce the cost of pesticide application and environmental pollution, but it also enhances the biological efficacy of the application process.

Yallappa et al. (2017) developed and field-tested a drone-mounted sprayer equipped with BLDC motors, LiPo batteries, a pesticide tank, a pump, and a supporting frame. This hexacopter design used six BLDC motors and could lift a payload of up to 5 kg, powered by two 6-cell 8000 mAh LiPo batteries. The drone carried a 5-liter conical-square tank for pesticide, pressurized and atomized by a 12 V DC motor with a pump and four nozzles, all supported by an aluminum frame for stability and safety. Controlled via a transmitter and monitored through an HD FPV camera, the drone achieved field capacities of 1.15 ha/h for groundnut and 1.08 ha/h for paddy crops at a 1-meter spray height and 3.6 km/h speed, with operational costs of 345 and 367 Rs/ha, respectively. Increased spray height and operating pressure enhanced spray uniformity, with average droplet sizes of 345 µm (VMD) and 270 µm (NMD) in lab conditions.

Mogili et al. (2018) emphasized the role of UAVs in precision agriculture, which is vital for increasing productivity among India's predominantly agrarian rural population. UAVs offer an effective, safe alternative to manual pesticide spraying, reducing health risks for workers and providing a practical solution in difficult terrain or where labor and equipment resources are limited, addressing significant health and operational challenges in pesticide application.

Fig.5 Drone Mounted Sprayer.

Basavaraj et al. (2020) [30] developed a solar-operated sprayer that is both economical and eco-friendly, using solar energy to eliminate the need for external power sources, making it practical for farmers. Evaluated in sugarcane and paddy fields, the sprayer achieved a theoretical field capacity of 0.6 ha/h, an effective field

ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 7, Issue 2, 2025 , https://doi.org/10.63328/IJRDES-V7RI2P9

capacity of 0.5 ha/h, and a field efficiency of 83.33%. It features adjustable nozzles with varying flow rates to suit different crop requirements. Similarly, Issa et al. (2020) created a versatile solar sprayer that operates in direct mode (using a 50W solar panel) and indirect mode (with a 12V battery), ensuring uninterrupted operation via a 20-liter tank and capable of spraying up to 1 acre in 2.13 hours. Tested on multiple crops, this sprayer includes extra features for rural usability, such as a charging kit for inconsistent power supply areas.

Sinha et al. (2018) addressed the limitations of knapsack sprayers by developing a solar-powered alternative, offering higher efficiency (0.3 ha/h) and consistent droplet quality with minimal energy consumption and operator discomfort, presenting a valuable tool for small and marginal farmers.

Fig.7 Solar Powered Sprayer.

2.4. METHODOLOGY

2.4.1. Design Considerations

To Calculate the power required for the Electric vehicle based pesticide sprayer machine, the following factors are to be considered

- Weight of Payload and Curb weight including solar panel weight.
- Distance to be covered during spraying operation
- Speed of the vehicle during spraying

Payload points to the weight of the spraying equipment and the pesticide tank filled full. Here, the tank capacity is assumed to be 30 litres and the density of the pesticide is taken to be 1.2kg/L and the weight of the tank and other spraying equipment accessories are taken to be 5 Kgs. Hence, the payload mass can be expressed as shown in equation. 1

$$M_{pay\ load} = (\text{Tank Capacity in litres} * \text{Density of fluid filled in the Tank}) + M_{spray} \quad \text{……Eq.1}$$

Where $M_{payload}$ is the mass of the payload,

M_{spray} is the mass of the spraying equipment and its accessories

The Curb mass indicates the weight of the vehicle in which the mass of the Electric propulsion system, wheels, batteries, chassis transportation system, weight of Solar panel the controlling system and remaining accessories are included and is indicated by M_{curb}.

The total mass can be expressed as shown in Equation.2

$$M_T = M_{payload} + M_{curb} \quad \text{………………..Eq.(2)}$$

The total tractive force(F_T) of a vehicle can be expressed as the sum of several forces acting on a vehicle. These forces include:

a. Rolling Resistance ($F_{rolling}$) is the force required to resistance between the tires and road surface and it can be expressed in Equation.3

$$F_{rolling} = C_{rr} * M_T * g \quad \text{………………..Eq.(3)}$$

Where Crr is the coefficient of rolling resistance , in general for agricultural fields the Crr ranges between 0.04 to 0.09.

$M_T$is the total mass and g is the acceleration due to gravity(9.81m/s2) Aerodynamic Drag(F_{drag}) is the force opposing the vehicles motion due to air resistance and is expressed in Equation. 4

$$F_{drag} = 0.5 * C_d * A * \rho * v^2 \quad \text{…………………Eq.(4)}$$

Where $C_d$is the co-efficient of Drag,

A is the frontal area of the vehicle,

ρ is the air density and V is the velocity of vehicle relative to air.

V is the velocity of the vehicle relative to air

a. Grade Resistance(F_{Grade}) is the force required to overcome the effects of gravity when uphill or downhill and is expressed in Equation. 5

$$F_{Grade} = M_T * g * \sin\theta \quad \text{……………….. Eq. 5}$$

Where θ is the angle of inclination

b. Acceleration Force (F_{accl}) is the force required to accelerate or decelerate the vehicle. And is expressed in Equation 6

$$F_{accl} = M_T * g \quad \text{………………… Eq.(6)}$$

The Total Tractive Force (F_{TT}) represents the combined effort required from the vehicles propulsion system to maintain or change its velocity under various operating conditions and is represented in equation.7

$$F_{TT} = F_{rolling} + F_{drag} + F_{Grade} + F_{accl} \quad \text{…………… Eq.(7)}$$

ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 7, Issue 2, 2025 , https://doi.org/10.63328/IJRDES-V7RI2P9

These expressions provide a quantitative understanding of the various forces acting on a vehicle, which are crucial for analyzing its performance and optimizing its design and operation[32].

The power required (P_{req}) for the entire system can be expressed in equation. 8

$$P_{req} = (F_{TT} * V)/ \eta \quad \text{………………… Eq.(8)}$$

Where V is the velocity of the vehicle (for spraying the preferred speed is 1.2 to 1.5 m/s) and η is the efficiency of propulsion system (assumed to be 0.9 for electric motor and transmission system combined)

2.4.2. Modelling

For designing the Solar Powered Electric Vehicle Integrated sprayer system which can be operated from approximately 220m away, two NRFL transceivers, one on the EV vehicle and one on the remote are used. Four wheel drive system is used for designing the Electric vehicle and it is integrated with a spraying system with pumping motor pressure level of 650 KPa with a discharge rate of 4 litres per minute.

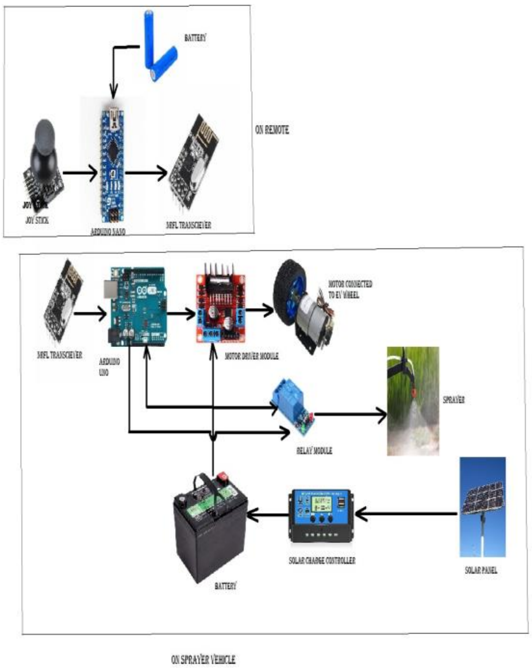

Fig.8 Block diagram of Solar Powered Remote operated Electric Vehicle Integrated Sprayer system.

For the purpose of communication from Vehicle to Remote NRFL Technology is used and for designing the system controlling Arduino Nano (Micro controller) is used. A 12V, 12Ah Lead acid battery along with PWM battery charge controller along with a Solar Panel is made use to powerup the entire system. The transmitter gathers joystick and button inputs and transmits them wirelessly to the receiver via the NRF24L01 module. The receiver decodes the transmitted data to control the motors' speed and direction and toggles the LED, enabling precise and responsive remote vehicle control. Figure 8 represents the block diagram of Solar Powered Remote operated, Electric Vehicle integrated Sprayer. Figure 9 represents the developed model of solar powered electric vehicle mounted pesticide sprayer

Fig.9 Developed model of Solar Powered Electric Vehicle mounted Pesticide Sprayer

3. Results and Analysis

The designed system has a provision of 1-2 delivery hoses where if required 2-6 nozzle booms can be fitted and it is tested in the field of one hectare of different vegetable crops for 15 days and the average time taken is observed to be approximately 48 minutes for spraying the pesticide. The used communication system is able to reliably communicate from a distance of 200m.

Table.1 Performance comparison of EV mounted sprayer and Drone Sprayer.

	Cost	Distribution	Labor Cost	Power Requirement	Application Efficiency
EV Mounted Sprayer	5000 INR	More Evenly distributed because of no Drift	300 INR	70W	80%
Drone Sprayer	30000INR	Uneven distribution because of drift	800INR	1500W	72%

To test the application efficiency of the designed sprayer DepositScan software is used and found that the drift is reduced by 50% based on the obtained results(as more than 50% of the droplets size is less than 100µm in dia) which is the indication of effective application of pesticide and also the percentage of targeted area covered by the designed system is more when compared to that of the Drone sprayer. The power requirement of Designed sprayer is 70W (for 15 ltrs of weight of payload) whereas

ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 7, Issue 2, 2025 , https://doi.org/10.63328/IJRDES-V7RI2P9

for Drone sprayer it is 1500W(for 6 ltrs of weight of payload)[33]. Table.1 represents the Performance comparison of EV mounted sprayer and Drone prayer

The analysis of remote-operated Solar Powered Electric vehicle-integrated sprayer systems for small-scale and horticultural farming unveils several key insights one among them is remote operation allows for precise control over spraying parameters such as flow rate, nozzle orientation, and coverage area. This results in more efficient pesticide application, reduced wastage, and improved crop protection, particularly in complex or irregularly shaped fields common in small-scale and horticultural farming.

Remote operation eliminates the need for direct human presence in potentially hazardous or challenging environments, such as steep slopes or areas with dense vegetation. This enhances operator safety and accessibility, enabling spraying operations in conditions that may be difficult or unsafe for manual operation. Remote-operated systems can be easily integrated with electric vehicles of various sizes and configurations, making them adaptable to different farming practices, crop types, and terrain conditions. This versatility enhances the scalability and applicability of electric vehicle-integrated sprayer technology across diverse agricultural settings.

Despite the advantages, remote-operated systems present technological challenges related to communication reliability, signal latency, and system robustness. Ensuring seamless connectivity and responsiveness between the operator and the vehicle-sprayer system is crucial for maximizing performance and user satisfaction. In addition to evaluating the environmental and economic implications of employing different sprayer technologies, recommendations tailored to specific agricultural applications would be offered. This holistic approach aims to provide valuable insights into the selection and utilization of agricultural sprayers, thereby aiding in the optimization of farming practices while minimizing adverse environmental effects.

4. Conclusion and future Scope

In conclusion, this study highlights the promising role of electric vehicle (EV) technology in modernizing sprayer systems for small-scale and horticultural farms, aligning with the shift toward sustainable agriculture. Solar Powered EV integrated sprayer systems offer a viable, eco-friendly alternative to traditional diesel-powered equipment, reducing both air and noise pollution while lowering operational and maintenance demands. By demonstrating the adaptability and efficiency of EV-based platforms in farming applications, this research underscores their potential to significantly decrease environmental impact and improve sustainability in agricultural practices. The findings support a growing trend in adopting clean energy solutions for efficient and responsible farm management, paving the way for broader applications of Solar power and EV technology in agriculture. The research opens up several avenues for future exploration and development in the field of remote-operated electric vehicle-integrated sprayer systems:

Autonomous Operation: Future research can focus on enhancing the autonomy of electric vehicle-integrated sprayer systems, enabling fully autonomous operation without the need for direct human intervention. This could involve advancements in artificial intelligence, machine learning, and sensor technology to enable real-time decision-making and adaptive spraying strategies.

1.
2. ***Sensor Integration:*** Integrating advanced sensors such as LiDAR, cameras, and multispectral imaging devices can further enhance the precision and effectiveness of remote-operated sprayer systems. These sensors can provide real-time feedback on crop health, pest infestations, and environmental conditions, enabling targeted and optimized spraying practices.

3.
4. *Data Analytics and Decision Support:* Leveraging data analytics and decision support tools can help farmers optimize spraying operations based on historical data, weather forecasts, and agronomic insights. By integrating remote operation with intelligent decision-making algorithms, farmers can maximize crop protection while minimizing input costs and environmental impact.

5.
6. *Sustainability and Environmental Impact:* Future research should also focus on assessing the sustainability and environmental impact of remote-operated electric vehicle-integrated sprayer systems. Life cycle assessments and environmental modelling can provide valuable insights into factors such as energy consumption, carbon emissions, and pesticide runoff, guiding the development of more sustainable agricultural practices. By pursuing these avenues of research, stakeholders can continue to advance the development and adoption of remote-operated electric vehicle-integrated sprayer systems, paving the way for a more efficient, sustainable, and resilient agricultural future.

References

[1]. Opada, Fany Marice Mince, et al., " Talent Acquisition Strategies: A Comprehensive Examination of Recruitment Policies for Organizational Success." Advances in Human Resource Management Research 2.2 (2024): 63-77.

ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 7, Issue 2, 2025 , https://doi.org/10.63328/IJRDES-V7RI2P9
[2]. Okolo, Omachi. "Comparison of Machine Learning Prediction Models on Domain-specific Recruitment Data." Journal of Institutional Research, Big Data Analytics and Innovation 1.1 (2024).
[3]. Aoudia, Haithem Habib. "Enhancing Recruitment Through Advanced NLP." (2024).
[4]. Yanik, Erim, et al. "Video-based formative and summative assessment of surgical tasks using deep learning." Scientific Reports 13.1 (2023): 1038.
[5]. Kabir, Moumita. IntelCV: An Intelligent Skilled Resume Selection Method for Job Purposes. Diss. United International University, 2024.
[6]. Tejaswini, K., et al. "Design and development of machine learning based resume ranking system." Global Transitions Proceedings 3.2 (2022): 371-375.
[7]. Zhang, Yufei, and Chang Yu. "Exploration of the Construction and Path Selection of the Deep Integration Model of Industry-Education in Universities." Journal of Contemporary Educational Research 8.3 (2024): 187-192.
[8]. Singh, Jayesh, et al. "A Comprehensive Campus Recruitment and Placement System for Optimizing the Hiring Process."
[9]. Golej, Robert, and Agata Pietroń-Pyszczek. "Applying AI in the recruitment and selection process and building the organizational climate (part II)." Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie 201 (2024).
[10]. Chen, Lankun. "Research on Improving Recruitment Using Natural Language Processing and AI Technology." (2024).
[11]. Yanamala, Kiran Kumar Reddy. "Integration of AI with traditional recruitment methods." Journal of Advanced Computing Systems 1.1 (2021): 1-7.
[12]. Opada, Fany Marice Mince, et al. "Talent Acquisition Strategies: A Comprehensive Examination of Recruitment Policies for Organizational Success." Advances in Human Resource Management Research 2.2 (2024): 63-77
[13]. S. T, P. B. P, R. K. O, V. R. K, and U. V. A, "Gestured Control Virtual Mouse with AI Chatbot," *International Journal of Computational Science and Engineering Research*, vol. 1, no. 4, p. 15, Oct. 2025, doi: 10.63328/ijcser-v1ri4p4.
[14]. Roy, Pradeep Kumar, Sarabjeet Singh Chowdhary, and Rocky Bhatia. "A Machine Learning approach for automation of Resume Recommendation system." Procedia Computer Science 167 (2020): 2318-2327.
[15]. Anupama, P. R., and Nithin Sebastian. "Campus Recruitment Prediction." Indian
[16]. Vikas, Sona, et al. "Recruitment and the Role of Hr in Talent Acquisition: Optimal Methods for Hiring Top Talent." Journal of Informatics *Education and Research* 4.1 (2024).
[17]. Zhang, Ye, and Xinrong Chen. "Empirical analysis of university–industry collaboration in postgraduate education: A case study of Chinese universities of applied sciences." *Sustainability* 15.7 (2023): 6252.
[18]. Surbakti, Ronny Trian. "The effect of artificial intelligence on the effectiveness of the recruitment process in startup companies." *International Journal of Science and Research Archive* 13.1 (2024): 250-256.
[19]. S. V and B. M. N, "Advancing Cloud Data Protection with Secure Cryptographic Algorithms," *International Journal of Computational Science and Engineering Research*, vol. 2, no. 2, p. 8, May 2025, doi: 10.63328/ijcser-v2i2p2.
[20]. Koman, G.; Boršoš, P.; Kubina, M. The Possibilities of Using Artificial Intelligence as a Key Technology in the Current Employee Recruitment Process. *Adm. Sci.* 2024, *14*, 157. https://doi.org/10.3390/admsci14070157