



Automated Weed Control Systems in Modern Farming

Sukhdham Singh^{1*}, Jitendra Kumar², Saketh Pallerla³, Devraj Singh Dohre⁴, and Dr. Anil Kumar⁵

¹Ph. D. Research Scholar, Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram Meerut-250110

²M.Sc. (Ag.) Agronomy, A. S. College Lakhaoti Bulandshahar

³M.Sc. Agriculture Research Scholar, Department of Agronomy, Professor Jayashankar Telangana Agricultural University Rajendra Nagar Hyderabad Telangana- 500030

⁴M. Sc. (Ag.) Agronomy, Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram Meerut-250110

⁵Assistant Professor, Department of Agronomy, Eklavya University Damoh, Madhya Pradesh-470661

Corresponding Author

Sukhdham Singh

Email: sukhdhamsingh77@gmail.com



OPEN ACCESS

Keywords

Weed control, Artificial Intelligence, Robotic, Drones

How to cite this article:

Singh, S., Kumar, J., Pallerla, S., Dohre, D. S. and Kumar, A. 2025. Automated Weed Control Systems in Modern Farming. *Vigyan Varta* 6(4): 138-142.

ABSTRACT

Weed management is an important component of contemporary agriculture, having a direct influence on crop yield, soil quality, and farm productivity as a whole. Conventional methods of weed control, including manual weeding and chemical herbicides, are labor-intensive, environmentally demanding, and tend to cause herbicide resistance among weed populations. Automated weed control systems that combine artificial intelligence (AI), robotics, machine vision, and precision application technologies are transforming weed management by providing effective, environmentally friendly, and cost-effective solutions. These systems employ sensors, drones, autonomous robots, and intelligent sprayers to sense, identify, and selectively eliminate weeds with high precision. Deep learning and computer vision advancements allow for real-time discrimination of weeds from crops, minimizing herbicide use and environmental disturbance. The current developments in



automated weed control technologies, their benefits, limitations, and potential for the future in sustainable agriculture are the subject of this review. The implementation of these innovative systems increases the efficiency of farm operations, reduces dependence on chemical inputs, and contributes to the goal of precision agriculture to promote food security and environmental sustainability.

INTRODUCTION

Weed management is an important part of contemporary agriculture, which has a direct influence on crop yield and profitability of the farm. Conventional methods of weed control, including manual weeding and the use of broad-spectrum herbicides, are time-consuming, expensive, and frequently detrimental to the environment. Automated weed control systems provide a revolutionary solution by combining sophisticated technologies such as artificial intelligence (AI), robotics, machine vision, and precision spraying to identify and eliminate weeds effectively.

These systems make use of AI-based cameras, drones, and self-driving robots that detect and mark weeds accurately and minimize chemical usage and environmental effect. Precision spraying, laser weeding, and electric weed control also boost sustainability by providing chemical-free solutions. In spite of limitations such as high startup expense and software adjustability, the continuous study in AI, robotics, and sensors is rendering such solutions more potent and available. Automated weed control is the future of sustainable and precision farming, guaranteeing greater productivity and conservation of the environment (Bajwa *et al.*, 2015).

Evolution of Automated Weed Control Systems

The development of automated weed control systems has progressed significantly over the

past few decades. Initially, farmers relied on manual labor and basic mechanical weeding tools. With the introduction of herbicides in the mid-20th century, chemical weed control became dominant. However, concerns over herbicide resistance, environmental impact, and health risks have driven the need for non-chemical and automated alternatives.

New-generation automated weed control systems employ advanced technologies like GPS-guided robotics, AI-powered image recognition, and precision spraying technology to separate crops from weeds and remove the weeds while reducing crop damage to a minimum (Raj *et al.*, 2022).



Key Technologies of Automated Weed Control Systems

1. Machine Vision and AI-Based Detection

Machine vision technology coupled with AI and deep learning algorithms allows automated weed control systems to precisely detect weeds and crops. High-resolution cameras and sophisticated sensors record real-time images, examining plant forms, hues, and leaf patterns. AI models analyze the data, determining weed species with high accuracy.

The systems learn and adapt constantly through machine learning, refining detection accuracy. Through targeted weed removal, they decrease herbicide reliance, lower costs,



and reduce environmental footprint. This technology is transforming agriculture today, enabling more efficient, sustainable, and accurate weed control, ultimately increasing crop yields and soil health (Balas *et al.*, 2022).

2. Autonomous Weeders and Robotics

Robot weeders use AI-powered systems to drive fields autonomously, identify weeds, and perform precise removal. GPS, LiDAR, and computer vision equip these machines with the ability to map weed location and deliver pinpoint mechanical weeding or micro-applications of herbicides, cutting chemicals and labor costs. Sophisticated models, like the Naïo Oz Weeder and FarmWise Titan, utilize machine learning to improve accuracy and efficiency with time. These robots work around the clock, enhancing weed management in commercial farming while encouraging sustainable and environmentally friendly farming practices. Their adoption in contemporary farms increases productivity, minimizing the use of manual labor and conventional herbicide spraying.

3. Precision Spraying Systems

Conventional herbicide use is by indiscriminate spraying, which creates excess chemical consumption, environmental pollution, and chemical resistance. Intelligent precision spraying machines incorporate AI,

sensors, and vision systems that automatically identify weeds in real-time and spray herbicides only at targeted areas. Integrated with drones or smart sprayers, the machines can achieve a 90% reduction in the use of chemicals, while reducing costs and the impact on the environment. Through high accuracy targeting of weeds, they increase efficiency, safeguard beneficial plants, and encourage sustainable agriculture. Highly advanced models such as John Deere See & Spray and Blue River Technology's Smart Sprayer are revolutionizing contemporary weed control (Monteiro and Santos, 2022).

4. Laser and Electric Weed Control

New, non-chemical weed control technologies such as laser and electric weeders provide environmentally friendly substitutes for herbicides. Laser technology utilizes high-intensity light to destroy weeds at the cellular level, inhibiting regrowth with minimal soil disturbance. Electric weeders apply high-voltage electricity to destroy weeds by deranging weed physiology, killing them without injuring plants in their vicinity. These technologies decrease chemical reliance, reduce the risk of herbicide resistance, and encourage eco-friendly farming. Sophisticated systems, like Carbon Robotics' LaserWeeder, already exhibit efficiency in precision agriculture and offer a sustainable solution for computerized, mass-scale weed control (Lameski *et al.*, 2018).

5. Drones for Aerial Detection and Control of Weeds

Multispectral and hyperspectral imaging sensor-fitted drones are transforming weed control through fast and high-definition field monitoring. They take close-up photos for detecting infestations of weeds, for examining the health of plants, and for creating accurate maps of weed distribution. Machine learning-based data processing supports farmers in

adopting precision weed control methods, minimizing the use of chemicals, labor, and operational expenses. On integration with precision sprayers, drones can selectively apply herbicides too, further optimizing efficiency. Active management of weeds through technology is made possible by this, making production more sustainable and productive with reduced environmental strain in contemporary precision agriculture (Fennimore *et al.*, 2016).

Benefits of Automated Weed Control Systems

- **Increased Efficiency:** These systems work continuously without fatigue, quickly covering large areas and reducing labor costs.
- **Environmental Sustainability:** Precision application of herbicides and non-chemical techniques reduce environmental impact and encourage sustainable farming.
- **Lower Chemical Dependency:** Automated weed management minimizes broad-spectrum herbicides, limiting the risk of herbicide resistance.
- **Cost-Effectiveness:** Although initial investment is high, labor cost savings, chemical cost reductions, and increased crop yield in the long term make these systems cost-effective.
- **Higher Crop Yields:** By efficiently eliminating weeds without harming crops, automated systems help maximize yields and farm profitability.

Challenges and Future Prospects

While their benefits are many, robotic weed control systems are also subject to high startup expenses, restricted versatility in the variety of crops and terrain types they can manage, and

frequent software upgrades required to maintain AI precision. Nonetheless, future prospects in sensor technology, AI, and robotics development are likely to offer even more advanced and economical solutions in the not-too-distant future.

Future developments may include fully integrated AI-powered farming systems where automated weed control, irrigation, and fertilization work seamlessly together for optimized crop production.

CONCLUSION

Automated weed control systems are an important innovation in contemporary agriculture that offers effective, environmentally friendly, and affordable options for weed management. With future advancements in technology, the systems will be made more affordable and versatile, finally revolutionizing the agricultural sector and opening doors for sustainable and precision-based agriculture methods.

REFERENCES

- Bajwa, A. A., Mahajan, G., & Chauhan, B. S. (2015). Nonconventional weed management strategies for modern agriculture. *Weed science*, 63(4), 723-747.
- Balas, P. R., Makavana, J. M., Mohnot, P., & Chauhan, P. M. (2022). Future Trends and Problems of Automation in Weed Control Systems: A Research. *Food Secur. Glob. Chall*, 42-47.
- Fennimore, S. A., Slaughter, D. C., Siemens, M. C., Leon, R. G., & Saber, M. N. (2016). Technology for automation of weed control in specialty crops. *Weed Technology*, 30(4), 823-837.
- Lameski, P., Zdravevski, E., & Kulakov, A. (2018). Review of automated weed



- control approaches: An environmental impact perspective. In *ICT Innovations 2018. Engineering and Life Sciences: 10th International Conference, ICT Innovations 2018, Ohrid, Macedonia, September 17–19, 2018, Proceedings 10* (pp. 132-147). Springer International Publishing.
- Monteiro, A., & Santos, S. (2022). Sustainable approach to weed management: The role of precision weed management. *Agronomy*, 12(1), 118.
- Raj, E. F. I., Appadurai, M., & Athiappan, K. (2022). Precision farming in modern agriculture. In *Smart agriculture automation using advanced technologies: Data analytics and machine learning, cloud architecture, automation and IoT* (pp. 61-87). Singapore: Springer Singapore.