www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 8 AUGUST, 2024

APPLICATION OF DRONE TECHNOLOGY IN HORTICULTURAL CROPS

Susmita Dey*, Sagnik Ghosh, Sagnik Saha
Faculty of Agriculture, JIS University, Agarpara, Kolkata-700109, West Bengal, India
*Corresponding author email: susmita.dey@jisuniversity.ac.in

ABSTRACT

Drone technology is revolutionizing horticulture through precision farming, agricultural surveillance, and yield estimation. Equipped with multispectral and hyperspectral sensors, drones enhance crop health monitoring, while GPS and GIS technologies support the precise application of pesticides and fertilizers. They also improve disaster response speed and minimize environmental impacts. Despite these advancements, challenges such as high initial costs, legal constraints, and a lack of technological expertise persist. Future research and regulatory adjustments will be crucial for the broader adoption of drones in Indian horticulture.

KEYWORDS: Drone technology, GPS, GIS, UAVs.

INTRODUCTION

The possibilities for using drone technology in horticultural crops have recently attracted a lot of attention because of its ability to drastically change agricultural practices. Drones, technically otherwise known as UAVs, can conduct enhanced crop monitoring, precise irrigation, and efficient pesticide applications singularly or as a part of Unmanned Aircraft Systems (UAS), conferring numerous advantages. By deploying multispectral and thermal imaging sensors, data on plant health, soil moisture, and pest infestations can be meticulously collected (Dutta and Goswami, 2020). These capabilities enable timely and informed decisions to be made by farmers, thereby optimizing crop yield and reducing resource wastage. The integration of drones into horticulture is further supported by advancements in the domains of autonomous flights and Machine Learning (ML) algorithms, which facilitate the precise targeting of interventions. Moreover, environmental sustainability is promoted through the reduced application of chemicals and water resources, thus mitigating the ecological footprint of agricultural activities.

PRIMARY AVENUES OF IMPLEMENTATION

In the contemporary landscape of Indian horticulture, the incorporation of drone technology has surfaced as a transformative innovation, particularly within the sector. The multifaceted applications of drones have substantially enhanced productivity, efficiency, and sustainability. Drones in Indian horticulture have exhibited significant potential across various critical domains, including crop monitoring, Precision Agriculture (PA), pesticide and fertilizer application, disaster management, yield estimation, research, and development.

CROP HEALTH MONITORING AND ASSESSMENT

Crop health monitoring and assessment have been revolutionized by the deployment of drones equipped with multispectral and hyperspectral sensors. These sensors capture processable data to generate detailed images depicting various plant health parameters, enabling the early detection of diseases, nutrient deficiencies, and water stress. Such proactive measures facilitate timely interventions, mitigating potential crop losses and optimizing input usage. In India, where extensive landscapes prevail, drones provide a practical solution for comprehensive crop surveillance, reducing dependence on labour-intensive manual monitoring practices. The integration of advanced imaging techniques with artificial intelligence (AI) algorithms has further enhanced the efficacy of crop health monitoring. This technological advancement ensures that precise and timely actions can be taken to address emerging issues, thereby safeguarding crop yields and quality (Al Dawasari et al., 2023; Dutta and Goswami, 2020).

PRECISION AGRICULTURE (PA)

Another area where drones have been shown to have a significant impact is precision agriculture. Drones can provide accurate field maps using Geographic Information System (GIS) and Global Positioning System (GPS) technologies, allowing for site-specific agricultural management (Quamar et al., 2023). This includes the variable rate application of inputs such as water, fertilizers, and pesticides. The precision afforded by drones ensures that these inputs are applied only where needed, thereby conserving resources and minimizing environmental impact (Zhang and Kovacs, 2012).

PLANT HEIGHT MEASUREMENT

Recent advancements have identified multispectral drone imaging as a useful tool for assessing tree crop canopy structure. Finding the best values for the flight planning variables is an important part of this programme since it affects the quality of the imagery and the maps that are produced that biophysically characterize crops and trees. To get the best drone imagery, variables including flying height, image overlap, flying direction, speed, and solar elevation need to be carefully considered. Results showed that data quality was improved when flying low picture pitch angles, high solar elevation, and along the hedgerow (Tu et al., 2020).

SPRAYING PROTECTIVE AND NUTRIENT AGROCHEMICALS

Traditional methods of agrochemical applications often result in uneven distribution and excessive use of chemicals, posing risks to both crops and the environment (Bisht and Chauhan, 2020). Drones, however, facilitate uniform and controlled application, reducing the number of chemicals required and minimizing human exposure to hazardous substances. This method not only enhances the efficacy of pest and disease control measures but also supports the production of healthier, chemical-residue-free horticultural products. Advanced drone technologies enable the precise targeting of specific areas within a field that requires treatment. This targeted approach minimizes the impact on non-target organisms and reduces the overall chemical load on the environment (Nawaz et al., 2019).

FORECASTING AND ESTIMATION OF YIELD

Yield estimation and forecasting are essential in horticulture. Drones are increasingly being employed for these purposes, capturing high-resolution images and utilizing advanced algorithms to estimate crop yield with high accuracy (Narasimha Reddy and Brahma Reddy, 2023). Farmers and policymakers can make informed decisions regarding the marketing, storage, and distribution of horticultural produce based on the procured information. The predictive capabilities of drones contribute to enhancing the economic stability of farmers and ensuring food security. The integration of machine learning techniques with drone imagery has further improved the accuracy of yield estimation models. Machine Learning algorithms can analyse vast amounts of data for pattern recognition and correlations that are indicative of crop yield potential. This advanced analytical capability enables more precise yield predictions, which are critical for effective agricultural planning and management (Dutta and Goswami, 2020).

RESEARCH AND DEVELOPMENT

Drones can have noteworthy roles in the Research and Development Sector of Horticultural Sciences and its allied disciplines. They facilitate the collection of extensive and precise data required for scientific research. This includes monitoring plant growth, studying the effects of different agricultural practices, and conducting experiments on crop varieties. Integrating drones in research activities accelerates the pace of innovation and the development of new techniques and technologies in horticulture. Moreover, implementing Drone Technology in research enhances the accuracy and reliability of experimental results, as it minimizes the odds of human error and ensures consistent data collection protocols (van der Mewre et al., 2020).

CHALLENGES

This newly evolved technology has some major challenges like data analysis, regulations, and cost scalability.

- Data Interpretation and Analysis: Managing and processing the massive amounts of data that agricultural drones collect can be difficult and time-consuming. To extract practical insights from drone data, farmers must develop intuitive software and analytical tools. (Emimi et al., 2023).
- Rules and Safety: While using agricultural drones, operators need to follow aviation rules and safety precautions. Among the most important issues to handle are ensuring adherence to airspace laws, protecting privacy, and reducing the risks involved in flying close to populated areas. (Emimi et al., 2023)
- Cost and scalability: For small-scale farmers, the expense of purchasing and maintaining agricultural drones may be a deterrent. For drone technology to be more widely used and accessible, it must become more affordable and scalable, especially in terms of training, equipment, and support services. (Emimi et al., 2023)

PROSPECTS

During the Green Revolution of the 1960s, India achieved self-sufficiency in food grain production by utilizing modern cultivation techniques, including high-quality seeds, efficient irrigation, chemical fertilizers, and pesticides. Drones collect data related to crop yields, soil quality, nutrient levels, and weather patterns. This data can then be used to accurately map existing issues and develop data-driven solutions. Drone analysis includes soil pH, salinity, texture, slope, water availability, and hazard assessment based on mapping results (Khadse, 2021). UAVs are used by farmers and producers to assess crop development, track biodiversity, and observe ecological landscape aspects. Furthermore, they can also be utilized efficiently for water spraying and other pesticides due to the harsh topography of farmland, especially when farmers must cultivate crops there. Robotics has improved crop output and productivity in the agriculture industry in addition to drones. Robotic weed eaters and sprayers are reducing the use of pesticides (Sylvester, 2018).

CONCLUSION

Despite countless benefits, the widespread adoption of drone technology in Indian horticulture faces several challenges. High initial investment costs, lack of technical expertise, and regulatory constraints are significant barriers. However, initiatives by the government and private sector to promote drone usage, coupled with advancements in technology, are expected to overcome these hurdles. The prospects of drone technology in Indian horticulture are promising, with potential applications extending to precision irrigation, soil health monitoring, and beyond. Policy reforms aimed at creating a favourable regulatory environment for drone operations in agriculture are critical for facilitating their widespread adoption. Additionally, capacity-building initiatives focused on training farmers and agricultural professionals in the use of UAVs and UAS will be essential for ensuring its effective deployment. With the advent of novel technologies over time, the cost of drones is expected to decrease, making them more accessible to small and marginal farmers. Farming techniques and resources will be enhanced by farmers implementing these cutting-edge technologies. Such cutting-edge technological progress can open the door to sustainable agriculture.

REFERENCES

Al Dawasari, H. J., Bilal, M., Moinuddin, M., Arshad, K., & Assaleh, K. (2023). DeepVision: Enhanced Drone Detection and Recognition in Visible Imagery through Deep Learning Networks. *Sensors*, 23(21), 8711. https://doi.org/10.3390/s23218711.

Bisht, N., & Chauhan, P. S. (2020). Excessive and disproportionate use of chemicals causes soil contamination and nutritional stress. *Soil contamination-threats and sustainable solutions*, 2020, 1-10. http://dx.doi.org/10.5772/intechopen.94593.

Borikar, G. P., Gharat, C., & Deshmukh, S. R. (2022, October). Application of drone systems for spraying pesticides in advanced agriculture: A review. *In*: IOP Conference Series: Materials Science and Engineering, 1259(1): 012015. IOP Publishing. http://dx.doi.org/10.1088/1757-899X/1259/1/012015.

Daud, S. M. S. M., Yusof, M. Y. P. M., Heo, C. C., Khoo, L. S., Singh, M. K. C., Mahmood, M. S., & Nawawi, H. (2022). Applications of drone in disaster management: A scoping review. *Science & Justice* 62(1): 30-42. https://doi.org/10.1016/j.scijus.2021.11.002.

Dutta, G., & Goswami, P. (2020). Application of drone in agriculture: A review. International Journal of Chemical Studies, 8(5), 181-187. https://doi.org/10.22271/chemi.2020.v8.i5d.10529.

Emimi, M., Khaleel, M., & Alkrash, A. (2023). The current opportunities and challenges in drone technology. *International Journal of Electrical Engineering and Sustainability* 74-89. ISSN: 2959-9229.

Khadse, K. (2021). To study applications of agricultural drones in irrigation and agriculture. July 2021 *Bioscience Biotechnology Research Communications* 14(9), 81-86. http://dx.doi.org/10.21786/bbrc/14.9.18.

Narasimha Reddy, K.V., Brahma Reddy, E. (2023). Crop Yield Prediction Based on Weather and Soil Parameters Using Regression Tree Model. In: Sarkar, D.K., Sadhu, P.K., Bhunia, S., Samanta, J., Paul, S. (Eds.). Proceedings of the 4th International Conference on Communication, Devices and Computing. ICCDC 2023. *Lecture Notes in Electrical Engineering* 1046:1-10. Springer, Singapore. https://doi.org/10.1007/978-981-99-2710-4_1.

Natu, A. S., & Kulkarni, S. C. (2016). Adoption and utilization of drones for advanced precision farming: A review. *International journal on recent and innovation trends in computing and communication*, 4(5): 563-565. https://doi.org/10.17762/ijritcc.v4i5.2237.

Nawaz, A., Sufyan, M., Gogi, M.D., Javed, M.W. (2019). Sustainable Management of Insect-Pests. In: Farooq, M., Pisante, M. (Eds.). *Innovations in Sustainable Agriculture* (pp. 287-335). Springer, Cham. https://doi.org/10.1007/978-3-030-23169-9_10.

Quamar, M. M., Al-Ramadan, B., Khan, K., Shafiullah, M., & El Ferik, S. (2023). Advancements and applications of drone-integrated geographic information system technology—A review. *Remote Sensing*, 15(20), 5039. http://dx.doi.org/10.3390/rs15205039.

Sylvester, G. (2018). E-Agriculture in Action: Drones for Agriculture; Food and Agriculture Organization of the United Nations and International: Rome, Italy, p. 126. Available online: http://www.fao.org/3/a-i5564e.pdf (accessed on 2 March 2021).

Tu, Y. H., Phinn, S., Johansen, K., Robson, A., & Wu, D. (2020). Optimising drone flight planning for measuring horticultural tree crop structure. *ISPRS Journal of Photogrammetry and Remote Sensing*, 160, 83-96. https://doi.org/10.1016/j.isprsjprs.2019.12.006.

van der Mewre, D., Burchfield, D. R., Witt, T. D., Price, K. P., Sharda, A. (2020). Chapter One - Drones in agriculture. In: Sparks, D. L. (Ed.). *Advances in Agronomy*, (Vol. 162, pp. 1-30). Academic Press. https://doi.org/10.1016/bs.agron.2020.03.001.

Zhang, C., & Kovacs, J. M. (2012). The application of small unmanned aerial systems for precision agriculture: a review. *Precision agriculture*, 13, 693-712. https://doi.org/10.1007/s11119-012-9274-5.

Zude-Sasse, M., Fountas, S., Gemtos, T. A., & Abu-Khalaf, N. (2016). Applications of precision agriculture in horticultural crops. *European Journal of Horticultural Sciences*, 81(2), 78-90. http://dx.doi.org/10.17660/eJHS.2016/81.2.2.

How to Cite:

Dey, S., Ghosh, S., and Saha, S. (2024). Application of drone technology in horticultural crops. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(8):9-15.

*********XXXXX**********