JPPIPA 11(9) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

The Utilised Unmanned Aerial Vehicles in Forest Plantation Maintenance

Zuhdi Yahya[1], Dwi Ery Mujahiddin[1], Rendy Setiawan[1], Akas Pinaringan Sujalu[1]*

[1] Department of Forestry, Faculty of Agriculture, University of 17 Agustus 1945 Samarinda, Samarinda City, East Kalimantan, Indonesia.

Received: June 17, 2025
Revised: August 21, 2025
Accepted: September 25, 2025
Published: October 01, 2025

Corresponding Author:
Akas Pinaringan Sujalu
akaspinaringansujalu@gmail.com

DOI: 10.29303/jppipa.v11i9.12623

Abstract: The use of drones has progressed, including being used in the forestry sector, especially in Industrial Plantation Forests as an operational tool in preparation activities before planting (pre planting spraying). This research was conducted in the PT Surya Hutani Jaya Industrial Plantation Forest area, in Kutai Kartanegara Regency, using a using the purposive sampling method on work plots that have become target work locations with the aim of knowing the efficiency of labour in pre-planting spraying activities and knowing the effectiveness of spraying activities using drones. The productivity of drone spraying activities can reach 23.21 Ha / Day compared to conventional spray which only has a productivity of 0.5 Ha / Day, so that to meet the company's planting target in May 2023 covering 600 Ha requires only 1 drone spraying tool while conventional spray 48 people. This shows that the efficiency value of using spraying drone work tools has increased very rapidly reaching 4.624%. As for the spray results from observations that have been made, the target is that the weeds experience evenly distributed death so it is very good to be recommended as a supporting work tool to achieve the targets given by the company.

Keywords: Drone; Efficiency; Labour; Pre planting spraying; Productivity.

Introduction

Unmanned Aerial Vehicles (UAV) in this case refers to drones are aircraft whose use without involving a crew and whose flights are carried out over long distances have been applied to various fields, including the Forestry sector (Mohsan et al., 2022; Ronconi et al., 2014). Among them are carried out by PT Surya Hutani Jaya, one of the companies engaged in the Industrial Plantation Forest business with an area of 62,667 Ha (34.2% of the total land) used for HTI. In the development of the world, industrial forest plantations from year to year have a variety of novelties, especially in the field of technology to support the achievement of targets given by the company. For example, in terms of spraying activities, which initially used conventional knapsacks, now switches to using drone sprayers because in terms of productivity and quality it is better than conventional knapsacks (Prasad et al., 2024).

The opening of large planting areas is of course directly proportional to the need for a lot of labour, especially in pre planting spraying activities (Zheng & Xu, 2023). Therefore, it is necessary to improve the use of UAVs, especially drones, which are able to optimise the number of workers and time efficiency (Javaid et al., 2022; Tuśnio & Wróblewski, 2021). Planting Spraying (PPS) is one of the many activities that aim to prepare land ready for planting through spraying using herbicide chemicals so that weeds die shortly before the process of planting the main crop (Ye et al., 2025). Pre-planting spraying is usually carried out by labour using a manual sprayer. The use of knapsack sprayers, can cause the risk of synthetic pesticide hazards to the health of the operator (Dilaver & Dilaver, 2024). One of the technological innovations to increase the effectiveness and efficiency of synthetic pesticide sprayers and reduce the risk of harm to operator health is using a drone sprayer (Simatupang et al., 2021). In addition, the

How to Cite:
Yahya, Z., Mujahiddin, D. E., Setiawan, R., & Sujalu, A. P. (2025). The Utilised Unmanned Aerial Vehicles in Forest Plantation Maintenance. *Jurnal Penelitian Pendidikan IPA*, *11*(9), 527–532. https://doi.org/10.29303/jppipa.v11i9.12623

droplet size of Knapsack Sprayer is larger than the drone sprayer, which is 20 to 30 droplets per cm2 of the target field. this will cause lower pesticide efficacy (Syarief et al., 2024).

According to Hentschke et al. (2018) the use of Unmanned Aerial Vehicle (UAV) technology in agriculture and forestry is very important. Pre-planting spraying activities are important to be carried out properly and correctly because they affect the growth and development process of staple plant seedlings (Mekonnen & Chanie, 2024). This unmanned aircraft spraying method is one of the most widely used methods, especially in spraying fertilizers and pesticides because it has a high speed and is able to cover a large area in a short time (Chen et al., 2021; Das et al., 2015; Yang et al., 2018).

Method

This research was conducted in the Industrial Plantation Forest area of PT Surya Hutani Jaya, Puan Cepak Village, Muara Kaman District, Kutai Kartanegara Regency. This study uses experiments through a quantitative approach with a sampling method carried out in industrial plantation forest work plots, namely PT Surya Hutani Jaya. This study was carried out with technical implementation through taking several samples so as to get a comparison of HOK requirements between RB-16 knapsack sprayer, TTA M6E drone spraying 10 L capacity.

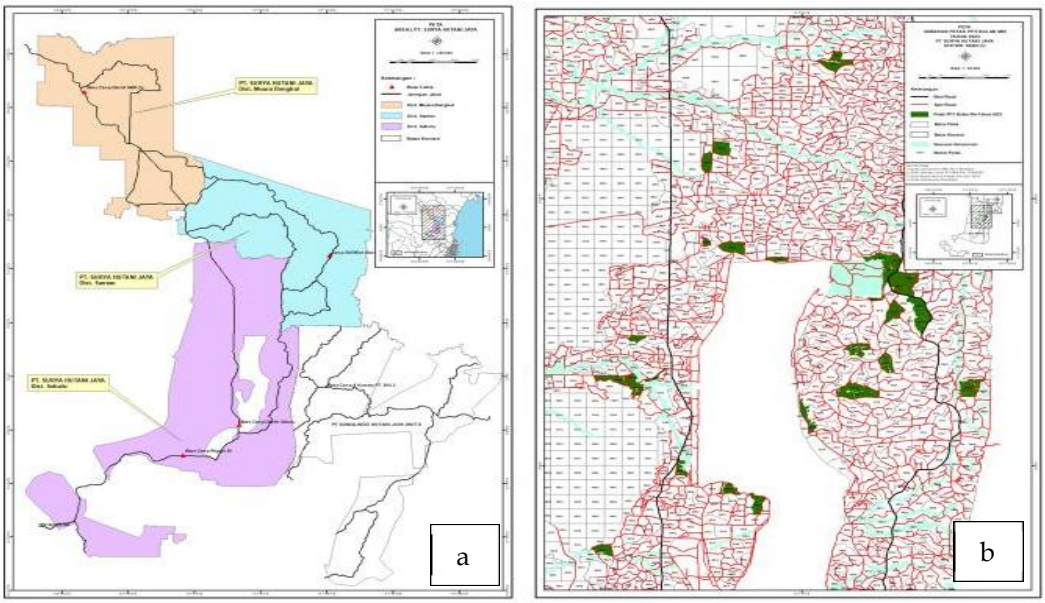

Figure 1. (a) Map of PT Surya Hutani Jaya area; and (b) Map of PPS plot distribution for the period May 2023

The determination of plots was carried out using the average reference area which ranged from 10 - 15 Ha. The research plots were located in the Sebulu district of PT Surya Hutani Jaya (Figure 1). The selection of plots refers to the purposive sampling technique in which sampling is done deliberately (non-random) for reasons known to the properties of the sample (Das et al., 2022).

With the time study method in each work tool, namely conventional knapsack and drone sprayer. The results obtained from the time study are the area and time of Daily Workers (HOK), for data collection on the quality of spraying results will be done by means of one plot will be divided into 3 parts which will be the sample plot. Based on the data that will be obtained later, to facilitate data analysis, a reference formula is used to obtain a recapitulation of the Daily Workers (HOK) in each work tool. To understand productivity, the formulation is taken from the reference book by Hasan et al. (2018) which has been modified to suit the needs of the research. Spray Tool Productivity is calculated with the Formula 1.

$$\text{Achievement tool } \left(\frac{\text{productivity of each device}}{\text{W}}\right) X \text{ WKe} \qquad (1)$$

Description:
W = Real-time working
Wke = Effective working time in 1 day (8 hours)

To find out the Daily Workers (HOK) by sampling in several plots so as to get the productivity and time needed to complete the activities in each sample plot. The data obtained will be compared to see which work tools can minimise the need for labour.

Result and Discussion

The boxplot data in Figure 1 shows a comparison of the range of productivity values of each drone (part a) showing the range of productivity values per day for both drone A and drone B. Based on the boxplot data, the productivity of drone A has a range of values between 20.50 - 25.12 Ha / Day with an average productivity value reaching 22.51 Ha / Day.

The pre-planting spraying activities in this study were carried out by the vendor PT Skytech Indonesia, which was divided into two drones, namely drone A and drone B with the Tiannong M6E-1 Agriculture UAV type with a capacity of 10 litres. Based on Figure 1, the pre-planting spraying activities were carried out on five different work plots. The work plots taken are work plots with an area ranging from 10-15 Ha which have the same type of slope, namely 8-15%.

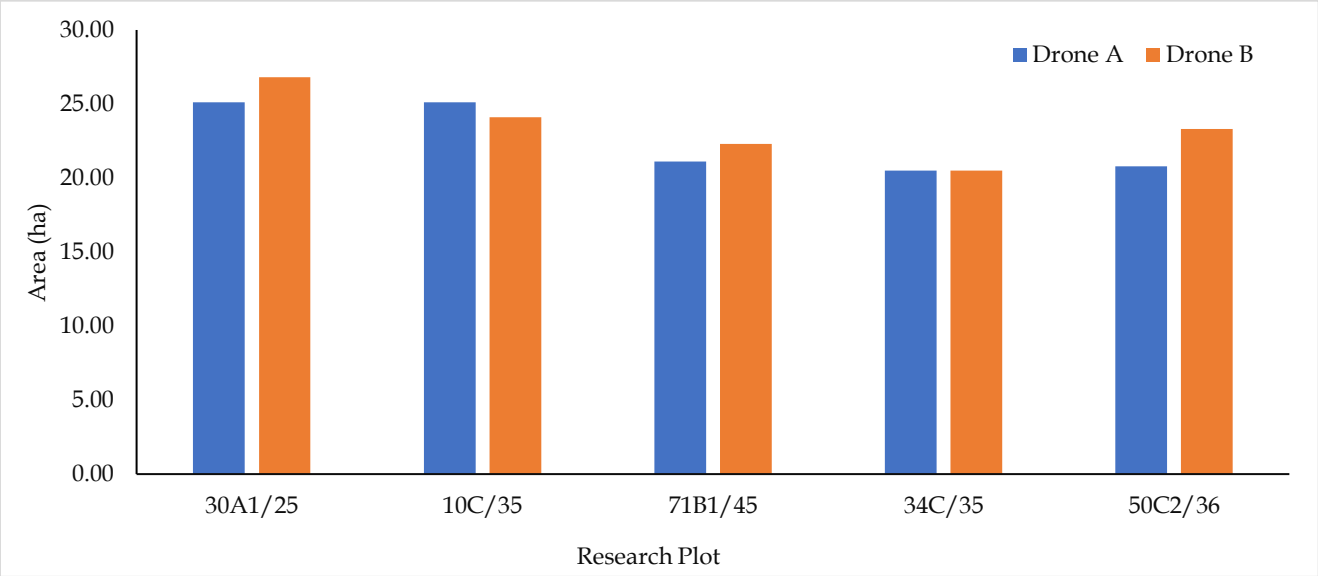

Figure 2. Comparison of the range of productivity values of each drone and in each work plot area

The productivity of drone B has a range of values between 22.30 - 26.78 Ha/Day with an average productivity slightly higher than drone A, which is 23.98 Ha/Day. Comparison of productivity achievements by each work tool in spraying activities is presented in Figure 2.

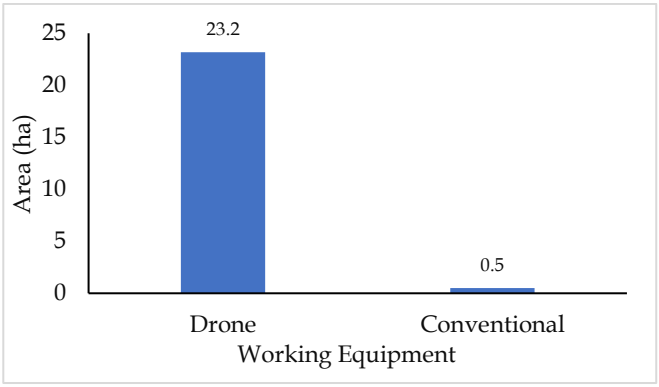

Figure 3. Comparison of productivity of each working tool (drone and conventional).

Comparison of the productivity of each work tool (drone and conventional) shows a significant difference in drone work tools with conventional work tools, where the drone work tool productivity value reaches 23.24 Ha / Day, while conventional work tools through the use of knapsack productivity value is only 0.50 Ha / Day. Based on the productivity data of the two tools, when referring to labour requirements to meet the company's planting target in May 2023 of 600 hectares, only 1 drone spraying tool is needed, while using conventional work tools requires 48 workers. This shows that the efficiency value of using spraying drones has increased very rapidly, reaching 4,540%.

The value of labour productivity in this study is clearly influenced by three aspects, namely technological developments, the use of work tools, and the skills possessed by workers (Sairmaly, 2023). The use of drones, which is one of the results of technological developments, has a positive impact on the value of productivity in spraying activities (Hafeez et al., 2023; Zhichkin et al., 2023) before planting in the PT Surya Hutani Jaya HTI area, on the other hand it also supports the fulfilment of labour which is quite difficult to work in the industrial forest plantation sector, especially spraying activities.

Another study conducted by Simatupang et al. (2021), stated that the application of drone technology tested and applied to pesticide and liquid fertiliser spraying activities in Pinrang Regency, South Sulawesi

has a productivity value of 2.03 Ha / hour or if converted in one working day (8 hours) is equivalent to 16.24 Ha / Day. The productivity value obtained is lower than the drone productivity value in this study. This difference is due to many factors, one of which is the different types of drones operated. In addition, according to Syarief et al. (2024), drone sprayer working time (0.17) hours/ha; more efficient than knapsack sprayer (11.57 hours/ha). This can be due to the Drone sprayer has a tank capacity of 22 litres. Flow rate of 8 litres/minute, wicket working width of 8 m, speed of 3.2 m/sec, turning time of 20 seconds. Knapsack sprayer has a tank capacity of 16 litres, flow rate of 0.885 litres/minute, wicket width of 2.47 m., speed of 0.12 m/sec, turning time of 2400 seconds.

Based on the results of research using drones in the field of Industrial Forest Plantations has advantages as well as disadvantages (Mohan et al., 2021). Among the advantages of using drones in pre-planting spraying activities are as follows: Work becomes faster, the achievement of drone spraying work area is significantly different from the use of human labour, therefore the completion of work becomes faster; Reduces the number of labourers, one drone spraying is equivalent to 48 workers, reducing the need for labour in pre-planting spraying activities; Reducing production costs, the production cost in question is the wages of cheaper labour activities; Reducing the danger of herbicide liquid, contact of herbicide liquid with labour is minimised because it is carried out by drone personnel; Work can be done remotely. The remote control can navigate the drone spraying tool from a distance and there is even drone technology that has an auto-pilot feature; and spraying pesticide liquid can be more evenly distributed. This spraying drone has a flight path and speed that has been set before the activity (Chen et al., 2022; Ismail et al., 2021).

In addition to the advantages, the use of drones also has several disadvantages including: need special expertise to repair in case of damage (Vazquez-Carmona et al., 2022). Technology and parts that are quite numerous and complicated make this spraying drone if damaged need to be handled by experts; relatively high initial investment costs. Purchasing drones and other components can reach hundreds of millions because they have renewable technology. There is a need for training to fly this tool both certification and internal training; dependence on weather. Pre-planting spraying activities cannot necessarily be carried out in various weather conditions, such as during strong winds, clouds, and rain; and spraying pesticide liquid can be more evenly distributed. This spraying drone has a flight path and speed that has been set before the activity. (Borikar et al., 2022)

Conclusion

Based on the results of the research conducted, it can be concluded that the use of UAVs (drones) in pre-planting spraying activities is more efficient and productive, safer from contamination and faster, productivity of drone spraying activities is 23.21 Ha / Day while manual spray is 0.5 Ha / Day. To meet the company's planting target of 600 Ha, labour for spraying drones requires 1 drone tool, while manual spraying requires 48 people.

Acknowledgments
All members of the author would like to express their thanks to the parties involved in this research.

Author Contributions
This article was written by four authors, namely J., R., N. A., and T. J. R. All authors contributed to each stage of the implementation of the activities until this article was completed.

Funding
This study was not funded by any organization or agency.

Conflicts of Interest
The authors declare no conflict of interest.

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