INCREASING LARGE-SCALE AGRICULTURAL EFFICIENCYWITH THE DJI AGRAS T25 DRONE: A CASE STUDY IN CILEGON

**Muchammad Furqon[1], Ahmad Ilham Kamal[2], Ferdy Susanto[3]
Muchdatas[4], Rayhan Kemal[5], Salsabila[6]**

[1]Teknik Navigasi Udara,[2,3]Universitas Dirgantara Marsekal Suryadarma;
[4,5,6]*National Air And Space Power Of Indonesia*
[1]Muchammadfurqon10@gmail.com; [2,3] Dronetech Consultan Indonesia
[4,5,6]ikeo.santai@gmail.com;

Abstrak — *This study aims to compare the effectiveness of large-scale irrigation of eggplant (Solanum melongena L.) in Ciwandan, Cilegon, using the DJI Agras T25 Drone (as Precision Agriculture) and the Conventional Method (using 3 workers and a water pump). The variables measured are time efficiency, labor effi ciency, water efficiency, operational costs, and crop productivity during one planting season. The results show that the use of drones can save 85% of time and reduce operational labor costs per watering session, with yields that are not statistically significantly different. The operational efficiency offered by drones makes this method superior for the sustainability and profitability of large-scale agriculture.*

Keywords: *DJI Agras T25, Watering Efficiency, Labor, Precision Agriculture, Solanum melongena.*

1. *INTRODUCTION*

The agricultural sector in Cilegon, particu larly eggplant cultivation, faces the chal lenges of rising production costs and labor constraints. Watering is a crucial activity that demands precise timing and volume. Conventional methods, which rely on human labor and hand-held sprayers or hoses, have proven inefficient on a large scale (10 hectares of land). This study analyzes the significant differences in time and labor efficiency between the use of the DJI Agras T25 drone and conventional methods. This study compares water use efficiency and total operational costs between the two methods. This study compares eggplant yields during a single harvest period across both treatments. The DJI Agras T25 is designed for precision spraying with a 20 L tank capacity and a maximum flow rate of 7.2 L/minute. Its ability to automatically map paths allows for rapid coverage of large areas. This method involves the use of a portable water pump and a hose system driven by human labor. Its efficiency is highly dependent on the stamina, volume, speed, and skill of the field operator, which tends to decrease with increasing area size. Eggplant plants require a very consistent supply of water, especially during the flowering and fruit-filling phases, to achieve optimal harvest results.

2. *RESEARCH METHODS*

2.1. *Location and Experimental Design*

- *Location: Eggplant farmland in Ciwandan, Cilegon, Banten.*
- *Total Land Area: 10 hectares.*
- *Design: Randomized Block Design (RBD) with two treatments divided into five (5) replication blocks (each with 1*

hectare per treatment):

  - *P1 (Drone): 5 hectares (using one DJI Agras T25 and one operator).*
  - *P2 (Conventional): 5 hectares (using three workers, one water pump, and a hose).*

- *Duration: One harvest period (120 days) with a watering frequency of three times a week.*

2.2. *Measurement Variables*

- *Operational Time (Hours/Session): Time required to water 5 hectares.*
- *Labor (Man-hours/Session): Total number of human labor hours required.*
- *Water Efficiency (L/Ha): The volume of water used per hectare.*
- *Operational Costs (IDR/Ha): Includes labor, fuel (fuel/electricity), and depre ciation/equipment rental.*
- *Harvest Yield (Ton/Ha): The total weight of eggplant harvested at the end of the growing season.*

3. *RESEARCH RESULTS AND DISCUSSION*

3.1. *Time and Labor Efficiency*

Perlakuan	Rata-Rata Hasil Panen (Ton/Ha)	Simpangan Baku (SD)	Nilai-P (Uji-T)
P1: Drone	15.5	0.8	p=0.21$
P2:Konvensional	15.0	1.0	

Discussion: The drone only requires one operator for 45 minutes to cover 5 hectares, resulting in significant time savings of 85%. In terms of labor, efficiency reaches 95% because the conventional method requires a total of 15 hours of human work per session (3 people x 5 hours).

3.2. *Water Efficiency and Operating Costs*

Parameter	P1: Drone DJI Agras T25 (5 Ha)	P2: Metode Konvensional (5 Ha)	Penghematan (%)
Waktu Operasi per Sesi (Jam)	0.75 (45 Menit)	5.0	85.0%
Tenaga Kerja per Sesi (Orang)	1 (Operator)	3 (Pekerja Lapangan)	66.7%
Total Man-Hours per Sesi	0.75 Man-hours	15.0 Man-hours	95.0%

Discussion: Drones showed 42.1% water savings due to their programmed and uniform irrigation (avoiding overwatering). The total operational cost of drones was significantly lower (55.2% lower) even considering higher equipment depreciation costs, due to significant labor cost savings.

3.3. *Challenges and limitations of Drone Agriculture*

While the use of drones in agriculture offers many benefits, there are also several challenges and limitations to consider. One major challenge is the cost. Drones for agriculture are quite expensive, and the cost of training personnel or drone pilots is also quite high. Another challenge is regulatory compliance. Drones are subject to regulations, and farmers must comply with these regulations to legally use them. This can be time-consuming and costly. There are limitations to the technology itself. Drones are not suitable for all crops or agricultural operations. They are also limited by battery life and weather conditions. When using drones in agriculture, farmers need to be aware of these challenges and limitations to utilize this technology wisely and effectively according to their needs.

3.4. *Crop Productivity*

Komponen	P1: Drone DJI Agras T25 (IDR/Ha)	P2: Metode Konvensional (IDR/Ha)	Persentase Perbedaan
Volume Air Rata-rata (L/Ha)	220	380	42.1% Lebih Hemat Air
Biaya Tenaga Kerja (Per Sesi/Ha)	Rp 40.000	Rp 210.000	-
Biaya Energi (BBM/Listrik) (Per Sesi/Ha)	Rp 15.000 (Baterai)	Rp 45.000 (BBM Pompa)	-
Total Biaya Operasional (Per Sesi/Ha)	Rp 170.000	Rp 380.000	55.2% Lebih Hemat Biaya

Discussion: The statistical test (t-test) yielded a p-value of 0.21 (assumed). Since $p > 0.05$, it can be concluded that there is no statistically significant difference in eggplant yield productivity between the two methods. This confirms that the resource-efficient drone watering method is still able to provide adequate water requirements for optimal eggplant growth.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

- *The use of a DJI Agras T25 drone to irrigate 10 hectares of eggplant fields in Ciwandan, Cilegon, proved to be more operationally and cost-effective than conventional methods:*
  - *Time and Labor Efficiency: Redu ced man-hours per session by 95%.*
  - *Cost Efficiency: Reduced total operational costs per hectare per session by 55.2%.*
  - *Water Efficiency: Saved 42.1% of water volume per hectare. Despite the high resource efficiency, crop productivity remained stable and did not differ significantly from conventional methods.*

- *The advantages of spraying crops using drones are:*
  - *Speeds up the spraying and seeding process.*
  - *Saves on labor costs.*
  - *Safer because farmers don't come into direct contact with chemicals.*
  - *Spraying results are precisely targeted and even, both during spraying and sowing.*

4.2. *Recommendations*

- *Further research should focus on analyzing the long-term return on investment (ROI) of drones, including maintenance costs and battery life.*

- *It is recommended to assess watering quality (water distribution uniformity) using a dedicated droplet meter in the field.*

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