

International Journal of Agriculture Extension and Social Development

Volume 9; Issue 9; September 2026; Page No. 412-415

Received: 14-06-2026
Accepted: 18-07-2026

Indexed Journal
Peer Reviewed Journal

Agricultural drone services as a source of income and employment generation in Andhra Pradesh

¹G Himasri, ¹S Rajeswari, ²Ch. Srilatha Vani and ³Y Bindiya

¹Advanced Post Graduate Centre (ANGRAU-APGC), Lam, Guntur, Andhra Pradesh, India

²Regional Agricultural Research Station (ANGRAU-RARS), Lam, Guntur, Andhra Pradesh, India

³College of Community Science (ANGRAU-CCS), Lam, Guntur, Andhra Pradesh, India

DOI: <https://www.doi.org/10.33545/26180723.2026.v9.i9f.4216>

Corresponding Author: G Himasri

Abstract

Agricultural drone services are creating new opportunities for farm mechanization, income generation and rural employment. This study examined their contribution to the livelihoods of 60 agricultural drone pilots in Andhra Pradesh. The results showed that mean annual income increased from ₹7,42,594 before drone services to ₹14,45,624 after their inclusion. Drone services contributed ₹7,03,030 per pilot annually. The paired t-test ($t = 18.94$, $p < 0.001$), Wilcoxon signed-rank test ($p < 0.001$) and Cohen's d (2.45) confirmed a significant and substantial income effect. The Gini coefficient declined from 0.44 to 0.26, indicating improved income distribution. Drone services also generated employment for 60 pilots and 42 helpers, accounting for 12,648 person-days annually. The findings highlight drones as a promising source of livelihood and rural employment.

Keywords: Farm mechanization, Gini coefficient, income distribution, income inequality

1. Introduction

Agriculture is increasingly adopting precision-based technologies to improve the efficiency and timeliness of farm operations. Among these technologies, agricultural drones have emerged as useful tools for crop spraying, crop monitoring, pest and disease management and precision application of agricultural inputs. Their ability to cover large areas within a short period and reduce dependence on manual labour has increased their relevance, particularly under conditions of labour scarcity and rising labour costs. Dutta and Goswami (2020) ^[2] highlighted the potential of drones to improve resource-use efficiency and support various agricultural operations. Similarly, Yadachi *et al.* (2023) ^[12] emphasized their contribution to reducing labour, time and input requirements. The increasing use of drones has also created opportunities for service-based agricultural enterprises. Farmers can access drone services without bearing the high cost of purchasing and maintaining the equipment themselves. This service-based model provides opportunities for trained individuals to operate drones as service providers and generate income by serving multiple farmers. Simula (2021) ^[10] identified agricultural drone services as an emerging business opportunity, while Parmaksiz and Cinar (2023) ^[8] found that farmers showed greater willingness to rent UAV services rather than purchase the technology. These findings indicate the potential for custom-hiring and service-based drone operations in agriculture.

Evidence from India further demonstrates the economic

potential of drone applications. Meera *et al.* (2023) ^[7] reported that crop spraying was the major application of agricultural drones and identified labour savings, cost reduction and improved operational efficiency as important benefits. Yazhini *et al.* (2024) ^[13] also found that drone-assisted cultivation could reduce cultivation costs and improve net returns. In Andhra Pradesh, Ravi Goud *et al.* (2024) ^[9] identified considerable potential for drone spraying, although inadequate maintenance facilities and limited availability of spare parts were reported as important constraints. Wider adoption of such services can therefore create increasing demand for trained drone operators and provide opportunities for rural service enterprises.

The livelihood and employment dimensions of drone technology have received increasing attention in recent years. Belton *et al.* (2025) ^[1] noted that the expansion of agricultural drone services can help address labour shortages while creating new forms of agricultural service provision and rural livelihood opportunities. In India, initiatives such as the Namo Drone Didi Scheme have further encouraged the use of drones as a source of income and employment by supporting Self-Help Groups in providing drone services to farmers (Government of India, 2024, 2025) ^[4, 5]. Sri Lekha *et al.* (2025) ^[11] also reported substantial income gains and the emergence of skilled employment among women involved in drone operations.

However, most existing studies have focused mainly on farmer adoption, perceptions, productivity, input savings and cost reduction. Comparatively less attention has been given

to drone pilots themselves as emerging rural entrepreneurs, particularly with regard to changes in their overall income, income distribution and employment generation. These aspects are important for assessing whether drone services can provide sustainable livelihood opportunities for operators. Against this background, the present study examines the income and employment opportunities generated through agricultural drone services among drone pilots in Andhra Pradesh. It assesses changes in annual income, the effect of drone income on income inequality, and employment generated through drone operations. The study thus provides a service-provider perspective on the livelihood potential of agricultural drone technology.

2. Methodology

Study area and sampling: The empirical analysis was based on primary data collected from 60 agricultural drone pilots operating in Andhra Pradesh. The sampled pilots were engaged in providing drone-based agricultural services, particularly spraying operations. Information was collected on income from farming, non-farm activities and drone services, working days, helpers employed, number of farmers served and area covered. The analysis used the pilot as the unit of observation and compared annual income before and after inclusion of drone-service income.

Income comparison: Annual income without drone services was defined as the sum of farm and non-farm income. Annual income with drone services was calculated by adding income generated from the drone unit. The percentage increase was calculated as: $\text{Increase (\%)} = [(\text{Income with drone} - \text{Income without drone}) / \text{Income without drone}] \times 100$.

Significance testing: A paired t-test was used to test whether the mean difference between annual income before and after inclusion of drone income was statistically different from zero. Because paired income data may not satisfy normality assumptions, the Wilcoxon signed-rank test was also used as a non-parametric robustness check. Cohen's d for paired observations was used to indicate the magnitude of the income change.

Income inequality: Income inequality was measured using the Gini coefficient and Lorenz curve. The Gini coefficient ranges from 0, representing complete equality, to 1, representing complete inequality. The change in the Gini coefficient was assessed by comparing the distribution of total annual income without drone income with the distribution after adding drone income.

Income-source decomposition: To identify the role of each income source in overall inequality, the Gini decomposition framework associated with Lerman and Yitzhaki was used¹². For income source k , the contribution depends on its income share (S_k), concentration coefficient (C_k) and the resulting product $S_k C_k$. The percentage contribution to total inequality was derived from the source-specific contribution relative to the overall Gini coefficient. A source with a concentration coefficient below the overall Gini can have an inequality-reducing effect.

Employment and outreach: Employment generated was

estimated as the number of pilots and helpers engaged multiplied by the mean number of working days per person per year. Service outreach was assessed from the total number of farmers served and the total area covered by the sampled drone operators.

3. Results and Discussion

3.1 Income generated through drone services

The results demonstrate a substantial contribution of drone services to the earnings of the sampled pilots. Before income from the drone unit was considered, mean annual income was ₹7,42,594, consisting of ₹6,03,394 from farming and ₹1,39,200 from non-farm sources. Drone services generated an additional ₹7,03,030 per pilot per year, raising mean annual income to ₹14,45,624. Thus, the inclusion of drone-service income increased average earnings by approximately 95 per cent.

Table 1: Mean annual income and statistical comparison before and after inclusion of drone-service income.

Particulars	Mean annual income (₹)
Farm income	603394.00
Non-farm income	139200.00
Income from drone unit	703030.00
Mean annual income without drone unit	742594.00
Mean annual income with drone unit	1445624.00
Mean increase in income	703030.00
Increase over pre-drone income	~95%
Paired t-test	$t(59) = 18.94, p < 0.001$
Wilcoxon signed-rank test	$p < 0.001$
Cohen's d (paired)	2.45

The paired t-test produced a value of 18.94 with $p < 0.001$, indicating a statistically significant difference between income before and after inclusion of drone income. The Wilcoxon signed-rank test also yielded $p < 0.001$, providing consistent evidence without relying on the normality assumption of the paired t-test. The paired Cohen's d of 2.45 represents a very large effect. The magnitude and statistical consistency of these results suggest that drone services were not a marginal supplementary activity for the sampled pilots; rather, they represented a major component of their annual earning capacity.

3.2 Effect of drone income on income distribution

Table 2: Distribution of annual income of drone pilots before and after inclusion of drone-service income.

Statistic	Without drone income	With drone income
Mean (₹)	742594.00	1445624.00
Median (₹)	543700.00	1285936.00
Standard deviation (₹)	675012.00	731807.00
Minimum (₹)	97200.00	459366.00
Maximum (₹)	2942000.00	3728986.00
25 th percentile (₹)	317000.00	977623.00
75 th percentile (₹)	886500.00	1580986.00
Gini coefficient	0.44	0.26

The distributional results indicate that the benefits of drone services extended beyond the increase in mean income. Median income increased from ₹5,43,700 to ₹12,85,936, while the minimum income increased from ₹97,200 to

₹4,59,366. The 25th percentile rose from ₹3,17,000 to ₹9,77,623, indicating a marked improvement in the lower-income segment of the sample. The Gini coefficient declined from 0.44 before inclusion of drone income to 0.26 after its

inclusion. This represents a reduction in the Gini coefficient of about 41.3 per cent, suggesting that the additional income source was relatively more evenly distributed across the pilots than their pre-drone income sources.

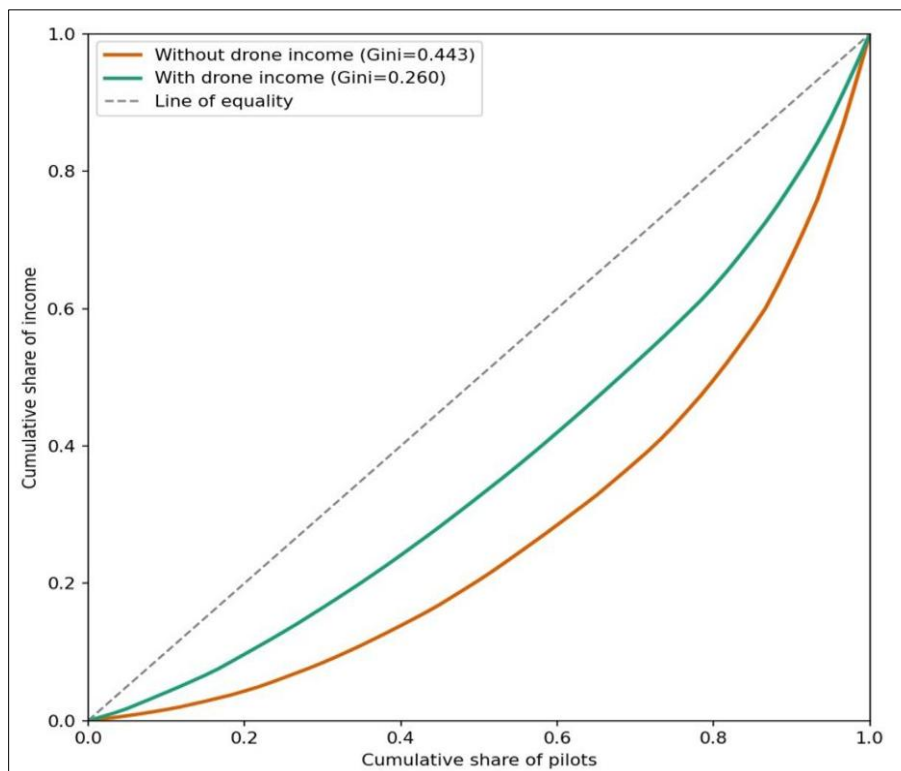


Fig 1: Lorenz Curve Showing Income Distribution Before and After Inclusion of Drone Income

The Lorenz-curve interpretation is consistent with this result. After inclusion of drone income, the curve moves closer to the line of perfect equality, reflecting a more balanced distribution of income. Thus, drone services appear to have

had a dual livelihood effect: they raised average earnings and reduced relative income inequality within the sampled group.

3.3 Decomposition of income inequality by source

Table 3: Decomposition of income inequality by income source.

Income source	Share (S_k)%	Concentration coefficient (C_k)	$S_k \times C_k$	Contribution to inequality (%)
Farm income	41.70	0.426	0.178	68.60
Non-farm income	9.60	0.158	0.015	5.90
Drone income	48.60	0.137	0.066	25.60

The decomposition analysis provides an explanation for the reduction in overall income inequality. Drone income constituted 48.60 per cent of total income but contributed only 25.60 per cent of total inequality. Its concentration coefficient of 0.137 was substantially below the overall income inequality level, indicating that drone income was comparatively more evenly distributed among the pilots. In contrast, farm income accounted for 41.70 per cent of total

income but contributed 68.60 per cent of inequality, reflecting its higher concentration coefficient of 0.426. Non-farm income made a relatively small contribution of 5.90 per cent. These results indicate that drone income partly offset the unequal distribution associated with farm income.

3.4 Employment opportunities generated through drone services

Table 4: Employment generation and service outreach of sampled drone operators.

Particulars	Value
Drone pilots self-employed (No.)	60
Helpers employed (No.)	42
Mean working days per pilot/helper per year	124
Total person-days of employment per year	12,648
Total farmers served (No.)	26,930
Mean farmers served per pilot (No.)	441
Average area sprayed per year (ha)	1,495

Agricultural drone services generated self-employment for all 60 pilots and additional employment for 42 helpers. Based on the reported average of 124 working days, the activity generated an estimated 12,648 person-days of employment per year across the sample. This demonstrates that the livelihood effect of drone technology was not limited to the owners of the equipment. The activity also created work opportunities for persons assisting with field operations, transport, battery handling and other service-related tasks. The outreach of the service was considerable. The pilots collectively served 26,930 farmers, with an average of 441 farmers served per pilot, and the average area covered was 1,495 ha per year. These figures show that drone service enterprises simultaneously functioned as income-generating businesses for the operators and as mechanization-service providers for a large number of farmers.

4. Conclusion

The study established that agricultural drone services made a substantial contribution to the income and employment opportunities of the sampled drone pilots in Andhra Pradesh. Importantly, the income effect was accompanied by an improvement in income distribution, with the Gini coefficient declining from 0.44 to 0.26. Drone services also generated self-employment for all 60 pilots and additional employment for 42 helpers, resulting in an estimated 12,648 person-days of employment annually. The pilots collectively served 26,930 farmers and covered substantial agricultural area, demonstrating the wider service-delivery role of drone enterprises. Overall, the findings suggest that agricultural drone services can function as a viable rural enterprise while strengthening individual incomes, creating employment and expanding access to mechanized farm services. Policies that support appropriate training, affordable finance, technical assistance and reliable service ecosystems could help sustain these livelihood and employment benefits.

References

1. Belton B, Baldiga L, Justice S, Minten B, Narayanan S, Reardon T. Can the global drone revolution make agriculture more sustainable? *Science*. 2025;389(6764):972-976. <https://doi.org/10.1126/science.ady1791>.
2. Dutta G, Goswami P. Application of drone in agriculture: a review. *International Journal of Chemical Studies*. 2020;8(5):181-187. <https://doi.org/10.22271/chemi.2020.v8.i5d.10529>.
3. Government of India. Department of Agriculture and Farmers' Welfare has released the operational guidelines of Central Sector Scheme "Namo Drone Didi". Press Information Bureau. 2024 Nov 1.
4. Government of India. Implementation of Drone Didi Scheme. Press Information Bureau, Ministry of Agriculture & Farmers Welfare. 2025 Jul 29.
5. Lerman RI, Yitzhaki S. Income inequality effects by income source: a new approach and applications to the United States. *The Review of Economics and Statistics*. 1985;67(1):151-156. <https://doi.org/10.2307/1928447>.
6. McCarthy C, Nyoni Y, Kachamba DJ, Banda LB, Moyo B, Chisambi C, *et al*. Can drones help smallholder farmers improve agriculture efficiencies and reduce food insecurity in Sub-Saharan Africa? *Local perceptions from Malawi. Agriculture*. 2023;13(5):1075. <https://doi.org/10.3390/agriculture13051075>.
7. Meera SN, Shaik N. Meera: Director, ICAR-Agricultural Technology Application Research Institute (ATARI), Hyderabad. LinkedIn profile [accessed 2026 Aug 26]. <https://www.linkedin.com/in/shaik-n-meera-176603ba/>.
8. Parmaksiz O, Cinar G. Technology acceptance among farmers: examples of agricultural unmanned aerial vehicles. *Agronomy*. 2023;13(8):2077. <https://doi.org/10.3390/agronomy13082077>.
9. Ravi Goud E, Dhanalakshmi G, Sudhakar M, Raghavendra Chowdary K, Adinarayana M, Sohail M. SWOT analysis on drone technology in agriculture—a case study approach. *International Journal of Economic Plants*. 2024;11(4):525-530. <https://doi.org/10.23910/2/2024.5662a>.
10. Simula A. Establishing drone technology to agriculture as a service provider. Bachelor's thesis. Jyväskylä: JAMK University of Applied Sciences, School of Business, Degree Programme in International Business; 2021. p. 59. <https://www.theseus.fi/handle/10024/504391>.
11. Sri Lekha S, Ariputhiran A, Manimuthu S, Loganathan R, Thulasiram R, Selvarani M. Empowering women through technology: an economic impact of the Namo Drone Didi scheme on women's economic and social development. *International Journal of Environmental Sciences*. 2025;11(16s):899-905. <https://doi.org/10.64252/p44cs007>.
12. Yadachi S, Nagajjanavar K, Thippanna KS, Girijal S, Thejasvi PT. Role of drones in sustainable development of agriculture: Indian perspective. *The Pharma Innovation Journal*. 2023;12(5):1866-1873.
13. Yazhini A, Malaisamy A, Raswanthkrishna M. Economic analysis of drone technology in agriculture: insights from Farmer Producer Organisation in Tamil Nadu. *Journal of Experimental Agriculture International*. 2024;46(12):611-617. <https://doi.org/10.9734/jeai/2024/v46i123168>.