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Drone-based field demonstrations and farmers' response towards precision spraying technology in Jammu and Kashmir

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Abstract

The Agricultural Technology Application Research Institute (ATARI), Zone I, facilitated drone demonstrations across different districts of Jammu division to promote awareness and adoption among farmers. In this project, KVK- Jammu has facilitated the drone with a target of covering the 250 hectares of land through drone demonstrations. This target was successfully achieved with 184 demonstrations, covering 256 hectares area and reaching 18,599 farmers. Among different demonstrations, the application of nano urea and herbicide spraying constituted the highest share (33%) whereas among the crops the wheat and paddy showed the highest share (35%). The maximum demonstrations and farmers gathering took place during 2025 due to large-scale awareness campaigns and training programmes. These results revealed that it helps in time savings, reduced labour requirement, and more judicious application of inputs such as glyphosate, nano urea plus, and sticker formulations. In this aspect, the majority of the farmers agreed on better performance of this technology in comparison with others and also improved their knowledge by 60-70%. This helps in effective management of *Saccharum spontaneum* (Sarkanda) weed by optimized chemical use. Although, the several constraints faced by farmers for individual ownership of drones may be due to small landholdings and financial conditions but they showed strong interest in accessing drone services through government-supported schemes. These findings indicate that drone technology can significantly enhance operational efficiency and promote precision agriculture in the region, highlighting the need for policy support and service-based delivery models to strengthen adoption.

Keywords: Awareness campaigns, drone demonstration, drone technology, nano urea and precision agriculture

Introduction

Agriculture remains the backbone of the Indian economy, supporting the livelihoods of a large rural population. However, the sector is increasingly challenged by shrinking landholdings, rising labour costs, climate variability, and the continued reliance on traditional crop management practices^[1]. These constraints are particularly evident in the Jammu division of Jammu and Kashmir, where fragmented farms and undulating terrain limit the efficiency of conventional agricultural operations. In such situations, adoption of modern technologies becomes essential to enhance productivity, reduce costs, and ensure sustainability. The drone technology has recently emerged as an innovative tool in precision agriculture. Unmanned Aerial Vehicles (UAVs) enable uniform and targeted application of crop protection

chemicals and nutrients, saving time and labour while reducing excessive input use^[2]. Compared to manual spraying, drone-based application improves coverage, minimizes human exposure to chemicals, and ensures timely operations, particularly in areas where access is difficult^[3]. Despite these advantages, awareness and adoption of drone technology among small and marginal farmers remain limited due to high initial costs, lack of technical knowledge and limited opportunities^[4]. To bridge this gap, the Agricultural Technology Application Research Institute (ATARI), Zone I, initiated and supported drone demonstrations across different districts of the Jammu division starting from 2023 to 2025. These demonstrations aimed to familiarize farmers with drone-based spraying and to assess its practical feasibility under local farming

conditions. Understanding farmers' perception, response, and willingness to adopt such advanced technologies is crucial for scaling up their use. Therefore, the present study was undertaken to evaluate the impact of drone demonstrations in farmers' fields with special reference to time efficiency, input optimization, and overall acceptance of the technology in the region.

Objectives

1. To demonstrate the effectiveness of drone based spraying in Farmers' field.
2. To compare drone spraying with knapsack and boom sprayer in term of time, cost and efficiency
3. To assess Farmers' perception, satisfaction and willingness to adopt drone technology

Methodology

The study was conducted from 2023-25 to document drone-based spraying demonstrations organized in selected districts of Jammu division of Jammu and Kashmir by Krishi Vigyan Kendra, Jammu, Jammu and Kashmir, India under the technical guidance of Agricultural Technology Application Research Institute (ATARI), Zone I. In this project, the drone was provided to KVK- Jammu for field demonstration with a target of covering the 250 hectares of land. The data recorded included date, location, number of farmers participated, area covered (hectare) and purpose of application. The entries without reported farmer participation were excluded from participation totals but included in area estimation. The data were compiled year-wise and purpose-wise. In this context, descriptive statistical tools such as totals, averages and percentages were used for analysis. The results were then interpreted in the context of extension outreach and technology dissemination.

Krishi Vigyan Kendra Drone Project: This was launched by ICAR-ATARI Zone-I in 2022 under the Ministry of Agriculture and Farmers Welfare to promote the drone technology in agriculture sector through Krishi Vigyan Kendras (KVKs) in northern states, including Jammu and Kashmir [5]. This project covers 20 KVKs with 10 drones deployed and 12 rural youth trained as drone pilots. Under this project, 424 field demonstrations were conducted covering 624.8 ha with reaching over 6000 farmers [6]. This aims to improve precision spraying of fertilizers and pesticides, enhance adoption of drone-based agricultural practices in the region.

The Agricultural drone or UAV (Agribot by IoTech World) used for field demonstration was provided under Krishi Vigyan Kendra Drone Project which mainly consists of a hexacopter with 4 ha/hr efficiency, maximum take off weight of 25 Kg along with tank volume of 10 L, move upto a maximum height of 0-30 m, work efficiently at 0-50 °C, fly at maximum speed of 0-10 m/s, maximum flight time without payload is 15-20 minutes, move within a range of 2 Km, spray width is 3 m, maximum discharge rate is 0.85 L/minutes per nozzle, battery capacity is 16000 mH, battery voltage 22.2 or 44.4V and life is 300 cycles [7]. The various drone demonstrations were shown to the institutional and farmers field as shown in the given images:



Fig 1: Agricultural drone demonstrations were shown at the institutional and Farmers' field

Results and Discussion

The results revealed a steady expansion of drone-based agricultural demonstrations in Jammu division over the study period. A total of 184 demonstrations were conducted across three years covering 256 hectares. Direct farmer participation was recorded with a reach of 18,599 farmers, indicating substantial participation.

Year-wise Trend: The number of demonstrations increased from 3 in 2023 to 74 in 2024 and peaked at 107 in 2025, showing rapid expansion of drone-based extension activities. Interestingly, farmer participation was highest in 2025 (10,496 farmers), largely due to mega awareness events such as institutional and training programmes (Figure 2). This indicates that large-scale campaigns significantly enhance outreach impact compared to routine farm demonstrations. The increasing trend reflects growing institutional emphasis on precision agriculture and positive farmer response toward emerging technologies.

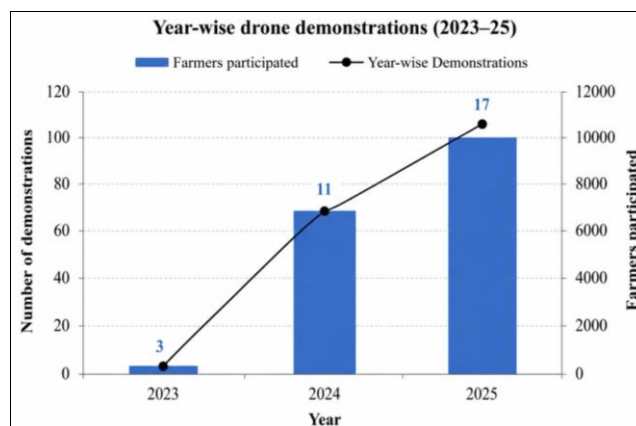


Fig 2: Year-wise distribution of drone demonstrations (2023-25)

Farmers' perception towards drone technology: The results showed that the majority of the farmers show a positive response towards the spraying application through drones. In this aspect, the 88% of the farmers agreed that drone application saves time, while 84% of farmers reported that it also provides the uniform spray coverage. Similarly, the 81% of the farmers believed that drone spraying reduces exposure to chemicals and 91% considered it a useful technology (Table 1). This positive response may be due to time saving, reduced labour cost, uniform spray distribution and improved safety measures.

Table 1: Farmers' perception towards drone spraying technology (2023-25)

Statement	Agree (%)	Neutral (%)	Disagree (%)
Drone spraying saves time	88	8	4
Drone spraying provides uniform spray coverage	84	11	5
Drone spraying reduces farmers exposure to chemicals	81	13	6
Drone technology is useful in agriculture	91	6	3

Increase in Farmers' knowledge by drone demonstrations: The results showed an increase in Farmers' knowledge regarding drone technology after the field demonstrations. The awareness about agricultural drones increased from 29% to 85% after the demonstration while the knowledge about the nano-urea spraying through

drones has increased from 24% to 88%. The similar results were obtained regarding the fungicides and pesticides as well (Table 2). This improvement may be attributed to practical field demonstrations, direct interaction with the farmers, better understanding of the technology and directly seeing the results.

Table 2: Effect of drone demonstrations on Farmers' knowledge level (2023-25)

Knowledge aspect	Before demonstrations (%)	After demonstrations (%)	Knowledge gain (%)
Awareness about agricultural drones	29	85	65.88
Knowledge about nano-urea application through drones	24	88	72.72
Knowledge about fungicide and pesticide application through drones	27	83	67.46
Knowledge about advantages of drone spraying	25	92	72.83

Comparison of different spraying methods: The results clearly indicate that the drone sprayer had outperformed the other spraying methods with highest field capacity (3.03 ha/hr), lowest water requirement (25 L/ha) and minimum time taken (20 min/ha). In comparison, the knapsack sprayer showed the lowest efficiency (0.40 ha/hr, 500 L/ha, 150 min/ha), while the boom sprayer performed moderately

(0.60 ha/hr, 600 L/ha, 100 min/ha). The drone sprayer is more efficient because it sprays chemicals from the air with GPS-controlled precision, ensuring uniform coverage, reducing water and chemical use, reducing labour requirement and also saves time as compared to other spraying methods (Table 3).

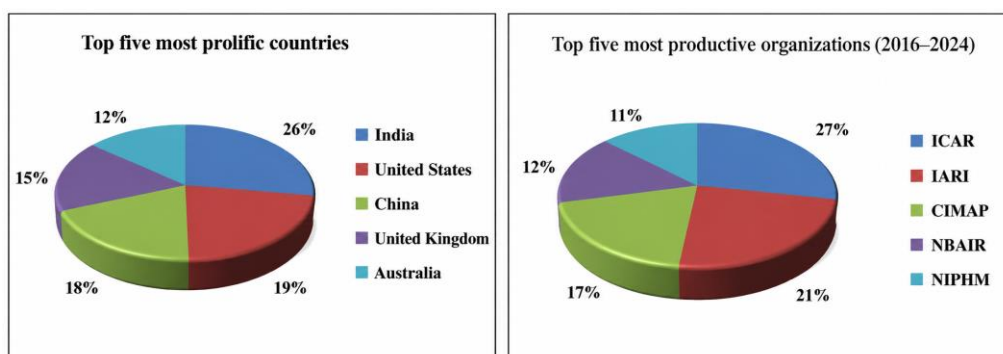
Table 3: Comparative performance of different spraying methods

Parameters	Drone sprayer	Knapsack sprayer	Boom sprayer
Field capacity (ha/hr)	3.03	0.40	0.60
Labour requirement	1	2	2
Water requirement (L/ha)	25	500	600
Time required (min/ha)	20	150	100
Uniformity of spray	Very high	Medium	High
Cost of operation (Rs/ha)	1000	1250	1500
Mode of operation	By remote and GPS	Manually	Tractor mounted
Water saving (%)	95-96%	16-17%	-

Purpose-wise Analysis: As shown in fig. 3a, the spraying of nano-urea and weedicide constituted the highest proportion (33%) of total demonstrations. This suggests that precision nutrient management and weedicide applications are a primary focus area in drone deployment. The fungicide (8%) and pesticide (10%) applications further demonstrate the versatility of drone technology in crop protection. Awareness-only campaigns (17%) played a crucial role in sensitizing farmers and building initial confidence toward the technology.

Crop-wise Focus

The crop demonstrations consist of wheat and paddy (35%) each, which were the major crops covered, reflecting their dominance in the region. Limited demonstrations on maize indicate potential scope for expansion in diversified cropping systems (fig. 3b). The concentration of activities on major cereals suggests that drone services are currently aligned with high-area crops where scale advantages are significant.

**Fig 3:** The purpose wise (a) and crop wise (b) demonstrations of drone application (2023-25)

Extension Perspective: The data indicate that institutional-led demonstrations are effective tools for technology diffusion. High farmer participation in organized events shows increasing acceptance, though small landholdings may restrict individual ownership. Therefore, custom hiring models and government-supported service systems may be more feasible for widespread adoption. Some of the government schemes which make the feasibility of small scale farmers to use drones:

1. **Sub-Mission on Agricultural Mechanization (SMAM):** This scheme was launched in 2014-15 by the Ministry of Agriculture and Farmers Welfare to increase the reach of farm mechanization for small scale and marginal farmers. This program provides 50% subsidy for small scale farmers and 40% subsidy for women farmers. In this scheme, the funds amount of Rs. 141.39 crores released towards drone promotion. In this 263 agri-drones have been procured by 193 institutions of ICAR across the country and 263 personnel from these institutions have undergone drone pilot training^[8].
2. **Custom Hiring Centers (CHC) Scheme:** In this scheme, the different centers were opened by Government of India to provide the farm machinery and equipment for small and marginal farmers on a rental basis. These are mainly formed to help the modern agriculture practices are affordable and accessible. In this scheme, 44607 CHCs with 139319 agricultural machineries for renting out are registered on mobile app in which total of 114461 farmers are registered on this mobile app named CHC App^[9].
3. **Namo Drone Didi (NDD) Scheme:** It is launched in 2023 by the Government of India for empowering women-led Self-help Groups by provide the drone technology for agricultural services. The scheme provides 80% subsidy on drone costs up to 8 lakhs and 20% can be financed through loans under Agriculture Infrastructure Fund. This scheme has an outlay of Rs.1261 crore from the period 2023–26 by targeting the distribution of 15000 drones to selected SHGs in which only 500 drones have been distributed^[10].

Overall, the study confirms that drone demonstrations have moved beyond experimental exposure and are gradually integrating into mainstream extension strategies.

Conclusion

The study documented that the target of covering of 250 hectares of land through drone demonstrations was successfully achieved by conducting 184 drone demonstrations between 2023 and 2025 in Jammu division, covering 256 hectares and reaching 18,599 farmers. Demonstrations increased substantially during 2024 and 2025, indicating growing institutional support and farmer interest. The nano urea and weedicide applications were the dominant operational purposes, particularly in wheat and paddy crops. The large-scale awareness programmes significantly enhanced outreach impact. Henceforth, the findings suggest strong potential for scaling drone-based custom hiring services in the region. Continued extension support and policy backing will be critical for sustained adoption of drone technology in smallholder farming

systems.

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